RUTGERS

New Jersey Agricultural Experiment Station

2021/2022 New Jersey Commercial Tree Fruit Production Guide

Rutgers Cooperative Extension E002

PREFACE

NOT TO BE USED BY HOME GARDENERS

This is your personal copy of the **2021/2022 New Jersey Commercial Tree Fruit Production Guide. Do not use previous editions for pesticide recommendations. Keep previous copies on file for pesticide records.** This guide is based on Rutgers and U.S. Department of Agriculture research results, combined with industry and grower knowledge and experience.

The authors welcome constructive criticism and suggestions from growers and industry personnel who may wish to help improve future editions of this publication.

The New Jersey State Agricultural Development Committee adopted the Tree Fruit Production Guide as the commercial tree fruit production agricultural management practice (AMP) N.J.A.C. 2:76-2A.6 to protect commercial farm operations from private and public nuisance lawsuits. Updates to this guide are not automatically included in the AMP.

This fruit production guide is intended for the **commercial grower**. The proper choice of the herbicide, pesticide, and plant growth regulators is the individual fruit grower's responsibility. This guide is intended to facilitate decision-making. This guide is not a substitute for pesticide labeling. **Read the label before applying any pesticide.**

This guide will be updated as changes in labels and restrictions warrant. All necessary and important changes in recommendations will be announced at twilight fruit meetings and posted in the Plant Pest Advisory Newsletter. Record these changes in this publication to keep it up to date. The Plant and Pest Advisory Newsletter subscription forms are available from your local agricultural agent, and from the website:
https://plant-pest-advisory.rutgers.edu/

Trade or Brand Names
The trade or brand names given herein are supplied with the understanding that no discrimination is intended and no endorsement by Rutgers Cooperative Extension is implied.

Discipline Editors

Dr. Thierry Besançon	Weed Science
Dr. George Hamilton, Ms. Patricia Hastings	Pesticide Safety
Dr. Norman Lalancette	Tree Fruit Pathology
Dr. Megan Muehlbauer	Plant Growth Regulators, Soil Fertility, Horticulture
Dr. Joseph Heckman	Soil Fertility
Dr. Hemant Gohil, Dr. Daniel Ward	Peach Varieties, Horticulture
Dr. Anne Nielsen, Mr. Dean Polk,	Tree Fruit Entomology
Mr. David Schmitt	Additional Resources

Coordinated and Edited by
Dean Polk, Statewide Fruit IPM Agent
Dr. Margret van Vuuren

Cooperating Agencies: Rutgers, The State University of New Jersey, U.S. Department of Agriculture, and New Jersey Board of County Commissioners. Rutgers Cooperative Extension, a unit of the Rutgers New Jersey Agricultural Experiment Station, is an equal opportunity program provider and employer.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLES

FIGURES

1 Pesticide Safety

1.1 General Information

Pesticides are hazardous substances that can cause serious harm if used improperly. Federal and state pesticide laws and regulations control product sale and distribution, storage, transportation, use, and disposal of pesticides. For food and feed crops, EPA establishes legal amounts of pesticide residue allowed on a crop at harvest (or in processed foods). State pesticide laws and regulations may be more restrictive, and would take legal precedence over federal.

Pesticide Registration

All pesticides sold or distributed in the United States are required to be registered by the United States Environmental Protection Agency (EPA) under the requirements of the Federal Insecticide Fungicide Rodenticide Act As Amended (FIFRA), unless they qualify for an exemption. State product registration is also required, and can be more restrictive. For example, some states require state registration of "minimum risk pesticides" which are exempt from federal registration. But, in no case can a State allow registration of a pesticide, or a use of it, without prior registration or exemption by the federal EPA.

Pesticides have an inherent toxicity, or capacity to cause harm to living organisms. Under FIFRA, EPA may only register those pesticide uses that do not pose unreasonable risk of harm to human health and the environment. EPA's determination of whether and how a pesticide is registered for sale is based on evaluation of scientific data and assessment of risks and benefits of a product's use.

The process of registering a pesticide is a scientific, legal, and administrative procedure through which EPA examines: the ingredients of the pesticide, the particular site or crop where it is to be used, the amount, frequency, and timing of its use, and storage and disposal practices.

EPA requires extensive scientific data on the potential health and environmental effects of a pesticide before granting a registration. The process EPA uses for evaluating the potential for health and ecological effects of a pesticide is called **risk assessment**. This includes evaluating the potential for harm to humans, wildlife, fish, and plants, including non-target organisms and endangered species. It also includes evaluating contamination of surface water or ground water from runoff, leaching, or spray drift.

As a condition of registration, EPA must review and approve the label. EPA then assigns an **EPA Registration Number** which is a unique product number for regular registrations, distributor registrations, Special Local Needs registrations, and Experimental Use Permits.

In order to mitigate the risk of harm to human health and the environment, EPA will impose a set of conditions, directions, and precautions that define who may use a pesticide, as well as where, how, how much, and how often it may be used. These mandatory requirements for registration are incorporated into pesticide product label statements. Pesticide product labels are legal documents. In other words, the label is the law.

> This statement is found on all registered pesticide product labels in the United States:
> **"It is a violation of Federal law to use this product in a manner inconsistent with its labeling"**

EPA Registration Review is required a minimum of every 15 years. EPA is legally authorized to initiate this process or other actions earlier, at any time in the product life cycle. EPA has the authority to suspend or cancel the registration of a pesticide if subsequent information shows that continued use would pose unreasonable risks. Pesticides (or particular pesticides uses) that no longer meet the safety standard of not posing unreasonable risk of harm to human health and the environment may be cancelled, or reregistered only with strict limitations and changes in labeled uses.

Pesticides and Food Safety

For food and feed crops, EPA is required to establish maximum pesticide residue limits allowed on a crop at harvest called "tolerances" by commodity. Tolerances, or exemptions from the requirement of a tolerance, are published in the Code of Federal Regulations at 40 CFR 180.

The Food Quality Protection Act (FQPA) of 1996 required that all existing tolerances be re-evaluated by EPA so that pesticides used on food and feed would meet a legal safety standard of "a reasonable certainty of no harm" when used according to the pesticide label. Once registered, a Registration Review of a pesticide's registration and tolerances are conducted by EPA a minimum of every 15 years to ensure that a pesticide's FQPA safety standard is still being met.

Tolerances are legally enforceable by the United States Department of Agriculture and Food and Drug Administration. **Meeting established food safety standards requires strict adherence to the pesticide label**. ***It is illegal and unsafe when a grower exceeds the rate of application on the label; uses a product on a crop that is not on the label; or harvests a crop before the pre-harvest interval on the label.*** If the residue exceeds the set tolerance, the crop may not be marketed or sold. It is subject to condemnation and seizure by federal or state regulatory agencies.

1.2 Certification and Licensing of NJ Pesticide Applicators

EPA considers certain pesticides to have the potential to cause unreasonable adverse effects to the environment and injury to applicators or bystanders unless users are specially trained in handling and application. As a condition of registration, EPA may restrict use of a pesticide, (or certain of its' uses) solely to certified applicators, or someone under that applicator's direct supervision. A "**restricted use pesticide**" (RUP) is a pesticide that EPA requires may only be applied by or under the direct supervision of **trained and certified** users.

In 1972 under FIFRA, EPA required states to set up a program to train and certify applicators of RUP to use them safely without endangering human health or the environment. Pesticide applicators become certified by demonstrating that they are competent to apply or supervise the use of RUPs, generally by examination. Many states approve recertification courses that certified applicators can take to maintain their certification. The examinations and training courses pertain to a category or type of pesticide application (*e.g.*, agricultural plant pest control, seed treatment, structural pest control, etc.).

Certified users of pesticides are further classified as either private applicators or commercial applicators. Certification requirements and processes are somewhat different for each group, and may differ by State when state requirements are more stringent than federal. **New Jersey requires that each applicator also becomes licensed after passing a certification exam**. The definitions of private and commercial applicators are as follows:

Private Applicator. Any person who uses, or supervises the use of, pesticides for the purpose of raising some type of agricultural commodity. The application can be done on land owned or rented by the applicator or the applicator's employer. However, any applications done on a "for-hire" basis for the purpose of raising an agricultural commodity are considered commercial applications. Examples of private applicators are dairy farmers, vegetable or fruit growers, greenhouse growers, and ranchers that apply pesticides only within their own confines.

Commercial Applicator. Any person who uses, or supervises the use of, pesticides on a "for-hire" basis; any person who applies pesticides for non-agricultural purposes; or any person who applies pesticides as a part of their job. This includes employees using pesticides in the course of their job working with any governmental agency such as a County mosquito control commission.

Examples of commercial applicators in agriculture are those individuals who work for a commercial pesticide handling establishment that provide handler services to growers or nurseries during the growing season. When hiring application services, verify that the handlers have certification as a *commercial* applicator, as well as the *corresponding category of use* required by your State for the application being made (for example, Agricultural Pest Control, Plant Agriculture Pest Control, or Aerial Application). Individuals providing soil fumigation services for hire must be licensed as commercial applicators by the State where they **perform** fumigation.

IMPORTANT:
New Jersey regulations for pesticide certification and licensing are more stringent than Federal EPA. New Jersey private and commercial applicators, including organic growers, **must be certified, AND possess a valid applicator license,** to make applications or supervise the use of **ANY EPA-registered pesticide** as required by State pesticide regulations at NJAC 7:30.

To become a licensed pesticide applicator in New Jersey, one must first pass a State certification exam. Private applicator certification is accomplished by passing the New Jersey Department of Environmental Protection (NJDEP) Private pesticide applicator certification exam. This exam is based on the training manual entitled **"Pesticide Applicator Training Manual - Private."** This training manual can be ordered online and directly shipped to you. Or you may continue to obtain manuals from your County Cooperative Extension Office. See Rutgers PSEP Applicator Manual website at: *https://pestmanagement.rutgers.edu/pat/manuals/* for details.

In 2020, New Jersey pesticide regulations were revised to specifically allow DEP to designate a third party to administer pesticide examination registration. NJDEP's approved third party exam registration system **P**esticide **A**pplicator **C**ertification **E**xam **R**egistration (**PACER**) is managed by the Rutgers NJAES Office of Continuing Professional Education (OCPE). See Section 1.7 for specifics on exam registration using PACER.

Due to the COVID pandemic, in-person examinations were discontinued for 2020. In January 2021, NJDEP and Rutgers OCPE announced the availability of online pesticide examinations. Once registered, you may take your pesticide exams online 24/7. In-person exams will resume after COVID precautions are no longer necessary.

Once having successfully become certified, a private pesticide applicator must then complete and file a license application with the NJDEP. This must be completed within 12 months after a person has become fully certified and eligible to become licensed as a private pesticide applicator. Any certified pesticide applicator who fails to file for a license within the 12 month period will lose certification status and shall again have to become certified in accordance with the exam process.

If there are any questions on the certification program for Private Pesticide Applicators, please call the NJDEP at (609) 984-6507. Once you have passed your certification exam, your certification is good for a minimum of 5 years. There is no fee charged for Private Certified Pesticide Applicator licenses. In order to maintain a valid Pesticide Applicator Certification in the state of New Jersey, pesticide applicators must earn a minimum of 24 recertification credits within the subsequent 5 year period by attending continuing education courses.

Private applicators must accumulate 8 units of credit (one unit equals 30 minutes of instruction time) in Core subject matter and 16 units of credit in Private Part 2 (PP2) subject matter over the 5 years. Examples of Core subject matter are topics such as pesticide regulations, the hazards of pesticide use, and the use of personal safety equipment. Examples of PP2 subject matter are topics such as pest ID, methods of pest control, including integrated pest management, and the proper use of specific pesticides.

Check the NJDEP Recertification Course page at *https://www.nj.gov/dep/enforcement/pcp/bpo-recert.htm* for courses currently being offered by Rutgers Cooperative Extension, professional associations, and private companies. As the land-grant university for the state of New Jersey, Rutgers University's New Jersey Agricultural Experiment Station Cooperative Extension (RCE) provides cutting-edge programs and conferences, with sessions eligible for recertification credit. Rutgers is tapped for the expertise of its Cooperative Extension Specialists, County Agents/Program Coordinators, and Pesticide Safety Education Program (PSEP).

You will receive an update of your recertification status from the NJDEP at least once a year. The "Recertification Update Form" will tell you when your 5 year certification period is up; how many recertification units you have accumulated; and how many more you need. If you have not accumulated the required 24 recertification credits within the 5 year period, your Recertification Update Form will notify you that your license is about to expire due to lack of recertification credit; you have until October 31st of that year to get your credits. You always have the option of taking the Private Applicator Exam to become certifiable to become a licensed Private Pesticide Applicator in NJ. **New licenses are NOT sent automatically** *(see box on next page)*

IMPORTANT:

New licenses are NOT sent automatically, even if you have accrued the required credits.
Hardcopy licenses are generated for both private and commercial applicators within the NJDEP computer system through the generation an "invoice" sent to the applicator. In the case of private applicators, you will receive an invoice for $0.00 because there are no licensing fees for private applicators.

If you have accumulated the requisite number of credits within the 5-year recertification period, the Recertification Update Form provides instructions for you to process your zero invoice by mail or online in order to receive your new hardcopy license*. NJDEP's online Invoicing System (versus mail) is recommended for use by private applicators to greatly expedite the processing of your license.*

1.3 The Pesticide Label

Your best guide to the correct and safe use of any pesticide is the product label. Pesticide labels contain such important and pertinent information as the brand or trade name, the amount of active ingredient, directions for use, environmental hazards, what to do in the case of an accident, and storage and disposal directions. Each product is required to have its EPA registration number and EPA establishment number as part of the container label. These numbers are valuable to pesticide applicators as unique identifiers in case of: accidental poisoning; claims of misuse; faulty product (poor control or phytotoxicity, for example); or liability claims.

1.3.1 Labels and Labeling

A pesticide applicator is legally bound by the labeling found on and with the pesticide container in their possession. Labels are the written, printed, or graphic matter on, or attached to, the pesticide or device or any of its containers or wrappers. "Labeling" means the label and any technical bulletins, circulars, leaflets, or other printed or graphic material to which the label refers to, or which accompanies the product when distributed or sold. Advertising material not accompanying the product is not considered labeling.

Literature such as Safety Data Sheets legally become a part of the pesticide labeling, **but only <u>when accompanying</u> a pesticide (*i.e.*, during distribution and sale).** The SDS (formerly called a MSDS) is written or printed material concerning a hazardous chemical that is prepared by the manufacturer or the company importing the product describing the physical and chemical properties of the product according to specific guidelines.

Webpages cited in/on the label are legally considered labeling. This includes when a label has a Quick Response Code (QR Code) barcode that leads to consumer information. Another example is when a label requires the completion of EPA-approved training and provides its web link. A condition of legal use by the applicator of the pesticide product would be completion of the online training (*see example in section 1.3.3 Soil Fumigants*).

"Web-distributed labeling" is a legally-valid, enforceable labeling for a pesticide product that is accessible online. The product label provides a link that directs users to the website with the web-distributed labeling. The complete online label must be printed and in the possession of the applicator when using the product. Web-distributed labeling is **currently voluntary for pesticide manufacturers to adopt**, and not supported by the vast majority of pesticide manufacturers.

With the exception of "web-distributed labels" or specific links found directly on the product label, **pesticide labels downloaded from the web are NOT legal documents**. Sources of online labels include: State regulatory agencies; EPA; and labeling services such as Kelly Solutions, CDMS, National Pesticide Information Retrieval System (NPIRS), Agrian, and others. Almost all provide disclaimers that they are only "specimens" of a label. Online labels may be helpful, but they should not be substituted for the label distributed with and on the container itself. Product formulations and directions periodically change. Although a product container may appear the same, never assume that a replacement container has exactly the same contents and labeling as what you last purchased.

Labeling can include **Supplemental Labels** that are distributed with the product. These partial labels are EPA-approved new, not previously registered uses of the product. These new uses will typically be included in subsequent product labels. Supplemental labels must bear the product's EPA registration number, and direct users to the product label for complete directions and precautions. Another example of a Supplemental Label is a "Section 24C Local Needs" label (Section 24C) where a State issues a Supplemental Label with an additional use of a federally registered pesticide product, or a new end use product to meet special local needs. Compliance with both the product label and supplemental labeling is required to safely and effectively use these products. **Important: Both the product label AND supplemental labeling must be in the possession of the user when using the product.**

1.3.2 Label Statements

FIFRA requires that each product label bear both hazard and precautionary statements for humans and domestic animals. Hazard statements describe the type of hazard that may occur, while precautionary statements will either direct or inform the user of actions to take to avoid the hazard or mitigate its effects. EPA's decision to register a product is based, in part, on the assumption that mandatory use directions, restrictions, and precautions of the pesticide label will be followed by the applicator. This section contains information on selected statements that will be found on a pesticide label.

Restricted Use Classification Statement

The "**Restricted Use Pesticide**" (RUP) classification, and the reason for RUP classification must appear at the very top of the label's front panel directly under the phrase "Directions for Use". EPA may assign a restricted use classification when it has determined that the pesticide product, or its use, has a high acute toxicity; has a history of accidents; may cause oncogenic effects (tumors), teratogenic effects (birth defects), fetotoxic effects (harm to a developing fetus), or reproductive effects (such as a lowered sperm count); can leach into ground water; or can harm wildlife.

As a condition of product registration, a pesticide (or certain uses of it), that are classified as restricted use, must bear the statement: "For retail sale to and use only by Certified Applicators or persons under their direct supervision and only for those uses covered by the Certified Applicator's certification".

The RUP statement must also include the reason for restricting use. The RUP statement for a particular pesticide product containing the active ingredient atrazine is depicted below. The label signal word for this product is "Caution", and would not warrant RUP classification by acute toxicity. However, in this instance, EPA restricted use to certified applicators and those under their direct supervision due to ground and surface water concerns.

On a case-by-case basis, some product-specific RUP statements may be more restrictive based on risk management decisions by EPA. Paraquat is a recent example; see section 1.3.3 for details on its more restrictive RUP statement: "Restricted Use Pesticide Due to Acute Toxicity For Retail Sale To and Use By Certified Applicators Only – Not to Be Used by Uncertified Persons Working Under the Supervision of a Certified Applicator".

Also, some states may impose further restrictions on a RUP, such as limiting sale to certified applicators only. For example, only certified applicators, possessing a valid New Jersey applicator license, may purchase restricted use pesticides. At no time can either licensed pesticide operators or unlicensed handlers purchase RUPs in NJ. **Please contact the New Jersey Department of Environmental Protection or your Rutgers Extension Pesticide Safety Education Program for further assistance.**

RESTRICTED USE PESTICIDE

(GROUND AND SURFACE WATER CONCERNS)

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

THIS PRODUCT IS A RESTRICTED-USE HERBICIDE DUE TO GROUND AND SURFACE WATER CONCERNS. USERS MUST READ AND FOLLOW ALL PRECAUTIONARY STATEMENTS AND INSTRUCTIONS FOR USE IN ORDER TO MINIMIZE POTENTIAL FOR ATRAZINE TO REACH GROUND AND SURFACE WATER.

Signal Words

An important feature of pesticide labels is that they are required by law to carry certain "signal words" on the front panel of the label that indicate their **relative acute toxicity to humans**. The signal word on EPA pesticide products can be **DANGER**, **WARNING**, or **CAUTION**. Signal words help alert users to the **acute (short-term)** toxicity of the formulated pesticide product.

The signal words are typically determined by the results of the six acute toxicity studies performed with the product formulation: acute oral, acute dermal, acute inhalation, primary eye irritation, primary skin irritation, and sensitization. The acute toxicity studies measure systemic toxicity by route of exposure; while the primary eye and skin studies measure irritation or corrosion; and the dermal sensitization study evaluates the potential for allergic contact dermatitis.

EPA signal words designated on a product label are based on the LD_{50} acute toxicity data of the pesticide product as formulated. Data is collected from small mammal population studies where a common measure of acute toxicity is the lethal dose (LD_{50}) or lethal concentration (LC_{50}) that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals.

EPA categorizes acute toxicity of pesticides into four toxicity categories (I - IV) using LD_{50} data according to regulations at 40 CFR §156.62 and its draft revision in 1984. Chemicals are considered highly toxic when the LD_{50}/LC_{50} is small (Toxicity Category 1) and practically non-toxic (Toxicity Category IV) when the value is large.

Table 1.1 EPA Signal Words According to Toxicity Categories (I, II, III, IV) of Pesticide Products[1]

Study	Category I		Category II	Category III	Category IV
	 **Danger** **Poison** *(red)*	**Danger**	**Warning**	**Caution**	**None or Caution**
Acute Oral	$LD_{50} \leq 50$ mg/kg	_	$LD_{50} > 50$ - 500 mg/kg	$LD_{50} >500$ - 5,000 mg/kg	$LD_{50} >5,000$ mg/kg
Acute Dermal	$LD_{50} \leq 200$ mg/kg	_	$LD_{50}>200$ - 2,000 mg/kg	$LD_{50} >2,000$ - 5,000 mg/kg	$LD_{50} >5,000$ mg/kg
Acute Inhalation	$LC_{50} < 0.05$ mg/liter	_	$LC_{50} >0.05$ - 0.5 mg/liter	$LC_{50} >0.5$ thru 2 mg/liter	$LC_{50} >2$ mg/liter
Primary Eye Irritation	_	Corrosive; irreversible destruction of ocular tissue; corneal involvement or irritation persisting more than 21 days	Corneal involvement or irritation clearing in 8-21 days.	Corneal involvement or irritation clearing in 7 days or less	Minimal effects clearing in less than 24 hours
Primary Skin Irritation	_	Corrosive (tissue destruction into the dermis and/or scarring)	Severe irritation at 72 hours (severe erythema or edema)	Moderate irritation at 72 hours (moderate erythema)	Mild or slight irritation (no irritation or slight erythema)
Dermal Sensitization	Positive			Negative	
	Product is a sensitizer or is positive for sensitization			Product is not a sensitizer or is negative for sensitization	

[1] Adapted from EPA Label Review Manual Chapter 7, rev March 2018.

Assignment of Signal Words: The signal word is determined by the most severe toxicity category assigned to the five acute toxicity studies (see Table 1.1). Dermal sensitization is simply positive or negative and is not assigned a Toxicity Category. So, for example, if a pesticide product was assessed a Toxicity Category III for inhalation but a Toxicity Category II for oral, the Signal Word placed on the label would be WARNING corresponding to the the more highly toxic Category II. A signal word is required for all registered pesticide products, unless the pesticide product is classified as Toxicity Category IV for all routes of exposure, and is negative for dermal sensitization.

- **EPA Toxicity Category I: DANGER POISON** (*red*). Highly toxic, causing acute systemic illness if eaten, absorbed through the skin, or inhaled. The approximate lethal dose to kill the average person by ingestion is a taste to a teaspoon. The product labels of any products with "Danger-Poison" must have: 1) the skull and crossbones; 2) the word "POISON" prominently printed in red on a background of distinctly contrasting color; and 3) A statement of an antidote or a practical treatment in case of poisoning by the pesticide.

- **EPA Toxicity Category I: DANGER**. Highly toxic, through corrosivity causing irreversible damage to the skin or eyes. Poison should not be used for products Category I Toxicity when the determining effect is not systemic illness (by oral, respiratory, or skin absorption routes of exposure).
- **EPA Toxicity Category II: WARNING**. Moderately toxic if eaten, absorbed through the skin, inhaled; or it causes moderate eye or skin irritation. The approximate lethal dose to kill an average person through ingestion is a teaspoon to an ounce.
- **EPA Toxicity Category III: CAUTION**. Slightly toxic if eaten, absorbed through the skin, inhaled; or it causes slight eye or skin irritation. Ingestion of an ounce to more than a pint is the approximate amount needed to kill the average person.
- **EPA Toxicity Category IV: None Required (or CAUTION as optional)**. Lowest EPA toxicity category (IV) by all routes of exposure (oral, dermal, inhalation); and does produce the other effects of eye or skin irritation. They do not require a signal word. However, a manufacturer may voluntarily use the signal word "Caution" for Toxicity Category IV.

Signal Words alert the applicator to the relative acute toxicity for short term exposure, during the application itself. It is important for applicators to understand that LD_{50}/LC_{50} data has limited use for comparing pesticides (other than acute toxicity). They do not reflect what dose may lead to other less serious, acute systemic effects, or to other, possibly equally serious contact effects or delayed systemic effects.

- LD_{50}/LC_{50} data does not reflect any effects from long-term exposure (*i.e.*, cancer, birth defects or reproductive toxicity) that may occur at levels below those that cause death.
- Also, they do not translate directly to humans because our body systems are slightly different from those of test animals (*e.g.*, rats, mice, etc.).
- Lastly, the LD_{50} and LC_{50} are measures of a single exposure, not the potential buildup of effects resulting from multiple exposures.

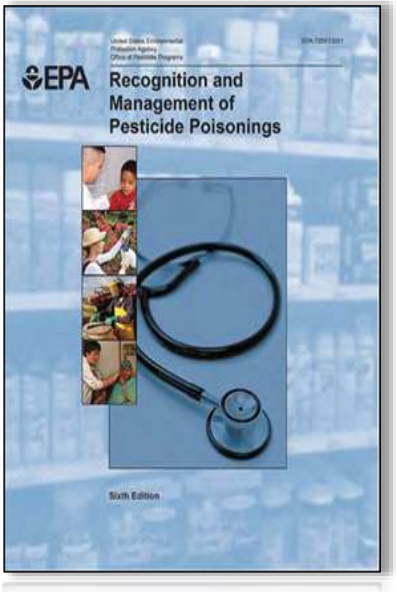
Most importantly, the results of the six acute toxicity studies determine the appropriate precautionary statements for the hazards to humans and domestic animals, personal protective equipment, and first aid statements. Hazards to Humans and Domestic Animals statements are required for products classified as toxicity categories I, II, or III, or positive for skin sensitization. Hazards to Humans and Domestic Animals statements may specify both mandatory actions and advisory information.

IMPORTANT:
The danger in handling pesticides does not depend *exclusively* on toxicity values. A compound may be highly toxic but present little hazard to the applicator if the precautions are followed carefully.
Hazard is a function of both toxicity and the amount and type of exposure…

First Aid Statements

First aid statements generally provide initial first steps to take when accidental exposure occurs, and may inform physicians and emergency responders of appropriate medical procedures for victims of poisoning. Pesticide labels are required to have First Aid statements if the product has systemic effects in EPA Toxicity Category I, II, or III, or skin or eye irritation effects in Category I or II. Some labels will have First Aid statements for use dilutions specified by the label.

Get medical advice immediately if you or any of your fellow workers have unusual or unexplained symptoms that develop within 24 hours of a pesticide exposure. Be alert for the early symptoms of pesticide poisoning and contact effects in yourself and others. Recognizing symptoms early and providing an immediate first-aid response may save a life or prevent permanent injury. Do not wait until you or someone else gets dangerously ill before calling a physician or going to a hospital. It is better to be too cautious than to act too late.



Take the pesticide label with you, either a duplicate copy or the one attached to the container (or at a minimum, the EPA registration number of the product). To avoid contamination and exposure, do not carry pesticides in the passenger space of the vehicle. The ***Recognition and Management of Pesticide Poisonings: 6th Edition*** manual gives healthcare providers a quick reference resource for the best toxicology and treatment information for patients with pesticide exposures. Downloadable in its entirety or by chapter at: *https://www.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings*. The fifth edition is available in Spanish. Free copies of the manual (EPA publication # 735K13001) are available from the National Service Center for Environmental Publications at: *https://www.epa.gov/nscep*.

Other Label Statements

If risks of concern are identified in the risk assessment, EPA evaluates potential risk management measures. Precautionary statements that reduce risk will be included on the label, such as:

- reductions in application rates and changes to directions for use;
- extending the restricted-entry interval;
- requiring engineering controls, such as use of closed systems for mixing and loading to reduce potential exposure to those who mix and load pesticides;
- safe handling procedures to avoid spills;
- not spraying the pesticide when a crop blooms to protect pollinators; or
- create buffers of unsprayed zones along water bodies to reduce exposure to surface water, etc.

In some cases, the use of a pesticide may only be acceptable if one or more risk mitigation measures are implemented. In other cases, pesticides will not be reregistered for certain use sites or for all uses because of unacceptable worker risk. When EPA determines that labeling cannot sufficiently mitigate the risk of pesticide harm, it may include special risk mitigation measures. See section 1.3.3 Soil Fumigants and Paraquat Dichloride (Paraquat) for recent label changes to allow continued registration for these highly toxic pesticides.

If you are having a medical emergency after using pesticides, call 911 immediately.

If you have any of the following symptoms during or shortly after using pesticides: headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest, call a physician and the National Poison Control Center hotline (1-800-222-1222).
Your call will be routed to your State Poison Control Center.
Anyone with a pesticide exposure poisoning emergency can call the toll-free telephone number for help. Personnel at the Center will give you first-aid information and direct you to local treatment centers if necessary.

For immediate medical attention call 911. Prompt action and treatment may save a life.

POISON Help®
1-800-222-1222

In Case of an Accident

- **Remove the person from exposure**
- **Get away from the treated or contaminated area immediately**
- **Remove contaminated clothing**
- **Wash with soap and clean water**
- **Call a physician and the Poison Control Center (1-800-222-1222) or agency in your state.**
- **Have the pesticide label with you!**
- **Be prepared to give the EPA registration number to the responding center/agency**

1.3.3 Significant Labeling Changes

Soil Fumigants

EPA required specific safety measures to increase protections for handlers, re-entry workers, and bystanders from risk of exposure for use of the soil fumigants **chloropicrin, dazomet, metam sodium/potassium, 1,3-dichloropropene (Telone), iodomethane, dimethyl disulfide (DMDS), and methyl bromide**. As gases, fumigants move from the soil to the air at the application site and may move off site at concentrations that produce adverse health effects in people from hours to days after application. These health effects range from mild and reversible eye irritation to more severe and irreversible effects, depending on the fumigant and the level of exposure.

Revised safety measures were incorporated in the product labels to increase protection for agricultural workers and bystanders - people who live, work, or otherwise spend time near fields that are fumigated. **Each of these fumigants have been reclassified as restricted use pesticides due to acute toxicity, and can only be used by a certified applicator or persons under their direct supervision.** Additionally, the labels of these pesticides were amended to require that only trained handlers can assist with application and apply these soil fumigants.

In 2012, each manufacturer was required to develop and implement **training programs for applicators in charge of soil fumigation** so these applicators are better prepared to effectively manage fumigant operations. Training must be completed every 3 years. Currently **EPA-approved soil fumigant training** for certified applicators may be found at: *https://www.epa.gov/soil-fumigants/soil-fumigant-training-certified-applicators*.

Soil fumigant labels require users to prepare a site-specific **fumigation management plan** (FMP) before the application begins. EPA has developed fumigant management plan templates that fulfill the elements required by the labels; see *https://www.epa.gov/soil-fumigants/fumigant-management-plan-templates-phase-2-files-listed-chemical*. Alternately, users may develop their own fumigant management plan or use one developed through an outside vendor to meet the label requirements rather than using these templates.

Some states currently require pesticide applicator certification categories for soil fumigation. These states may develop separate manuals, or they may use a national manual/certification study guide, the "Soil Fumigation Manual" produced by the National Association of State Departments of Agriculture Research Foundation can be downloaded: *http://s3.amazonaws.com/nasda2/media/Pages/Fumigation_lo.pdf?mtime=20171025135626.*

Additionally, some states will be requiring applicators to notify their state's licensing agency prior to use of these fumigants. If you use commercial fumigators, be sure to verify their category license for your State.
Currently, New Jersey does not have a separate license requirement for use of soil fumigants. Private applicators do not have to have an additional license to apply soil fumigants in New Jersey. And commercial soil fumigation may be performed by those commercial applicators possessing a category license in Agricultural Plants. However, private or Agricultural Plant category applicators are still required to read and follow all elements of the soil fumigant label, just like any other pesticide. In New Jersey there is no requirement for notification of soil fumigant use to the NJDEP. Rutgers has a limited stock of the national Soil Fumigation Manual (cited above) available to NJ applicators to use as a reference.

Based on revision of federal applicator certification regulations, some method of separate **method-specific soil fumigation certification** will be required by all state pesticide regulatory agencies, if not already in place. These changes will require revision of state regulations in most cases.
Earliest anticipated implementation is 2022.

Paraquat Dichloride (Paraquat)

Paraquat dichloride (also referred to as paraquat) is highly toxic to humans. One small accidental sip can be fatal, and there is no antidote. Dermal or eye contact can also have serious lasting effects. A combination of public concern and EPA's evaluation of incident data prompted an in-depth statistical analysis of paraquat incidents ahead of the typical mitigation phase of Registration Review.

PESTICIDE SAFETY

EPA's "Paraquat Dichloride Human Health Mitigation Decision" required changes in allowed uses of paraquat to mitigate risk to human health incidents involving paraquat. Risk mitigation measures that must be implemented to address accidental ingestion and worker exposure incidents were based on the high number and severity of human health incidents associated with the pesticide.

Sample revised RUP statement on paraquat product label with "acute toxicity" reason for RUP status.

In order for pesticide products containing paraquat to meet the FIFRA standard for registration, EPA determined the following risk mitigation measures were necessary for continued registration:

1. Use of paraquat is restricted to certified pesticide applicators only (*see RUP statement graphic above*).
2. Noncertified persons working under the supervision of a certified applicator are prohibited from using paraquat (including mixing, loading, applying the pesticide, and other pesticide-related activities);
3. Applicators are required to take an EPA-approved paraquat training program every 3 years in order to mix, load, apply, or handle paraquat;
4. Changes to the pesticide label and warning materials (*see cap seal to right*) to highlight the toxicity and risks associated with paraquat; and
5. New closed-system packaging designed to make it impossible to transfer or remove the pesticide except directly into the proper application equipment.

Paraquat Cap Sticker

All persons handling paraquat are expected to take the training every 3 years and retain documentation of successful completion. The pesticide label provides the link *www.usparaquattraining.com* to access the training; this redirects to the Extension Campus site where the EPA-approved paraquat training is hosted at *https://campus.extension.org/enrol/index.php?id=1660*. The one hour training is available in both English "How To Safely Use and Handle Paraquat-Containing Products" and Spanish "Cómo Utilizar y Manejar con Seguridad los Productos que Contienen Paraquat." After completion, a training certificate is generated for applicators to keep in their records for three years.

1.4 Handling Pesticides

1.4.1 Prior to Pesticide Application

Use pesticides for only those crops specified on the label, and use only those that have both state and federal registration. Using a pesticide for any other uses or in any other manner than specified on the label is against the law.

Verify, prior to application, that a commodity-specific tolerance or tolerance exemption exists for a particular pesticide prior to use on food or feed crops. For a list of pesticides that have tolerances or exemption from the requirements of an tolerance, see *https://www.epa.gov/pesticide-tolerances/how-search-tolerances-pesticide-ingredients-code-federal-regulations*). Contact your Rutgers Cooperative Extension Specialists, Agents, and IPM Program for assistance when in doubt.

In advance of the application itself, applicators should **read and review the label carefully**, and make preparations to be able to follow all directions and precautions specified by the label. Determine in advance proper safety equipment, protective clothing, and measuring equipment you will need for the pesticide task that you will be performing. The protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label. Consult the Precautionary

Statements of the pesticide label for the minimum Personal Protection Equipment (PPE) required by law. See sections 1.5.2 Personal Protection Equipment for Pesticides, and 1.5.3 Respiratory Protection for Pesticide Handlers for further direction on selection and use of the protective equipment according to the pesticide label.

Make sure that all application equipment that will be used has been **properly maintained and calibrated, and is in good working order** prior to application.

Prior to application, be sure to **check the First Aid statements of the label**. Have any label-specified antidotes on hand in advance.

Your physician should be advised of the types of pesticides you use, in your work. They may determine the need for medical monitoring for continued use; this includes certain uses of cholinesterase-inhibiting organophosphate and N-methyl carbamate pesticides (*see box below*). When a pesticide is a cholinesterase inhibitor, this is identified in the First Aid statements of the label.

When you will be using a pesticide that requires the use of a respirator, you will need to be medically evaluated and receive a medical clearance for your use of that respirator under its conditions of use. See section 1.5.3 Respiratory Protection for Pesticide Handlers for details.

Prior to applying or otherwise handling pesticides, be sure to have a supply of clean water and liquid detergent available for drenching and washing in case of an accident. When the label requires eye protection, handler employers must provide at least one pint of water per handler in portable containers that are immediately available to each handler. Whenever a handler is mixing or loading a pesticide product whose labeling requires protective eyewear during handling (or is mixing or loading any pesticide using a closed system operating under pressure), the handler employer must provide at each mixing/loading site, at least one system that is capable of delivering gently running water at a rate of least 0.4 gallons per minute for at least 15 minutes; or at least six gallons of water in containers suitable for providing a gentle eye-flush for about 15 minutes.

Medical Monitoring Cholinesterase-inhibiting Pesticides*:
It is recommended that you advise your physician if: you will be using Class 1 and Class 2 organophosphates (OPs) and N-methyl carbamates; or simply OPs. Monitoring of blood cholinesterase level is recommended for those who will be using these pesticides for greater than a total of 30 hours in 30 consecutive days. **Before the start of the spray season**, each applicator should have a baseline blood cholinesterase level determination. The level of blood cholinesterase should be re-evaluated using the same lab during the spray season when 30 hours use within 30 days is reached or exceeded.
**The Migrant Clinicians Network website "Cholinesterase Testing Protocols for Healthcare Providers" outlines protocols, when medical removal from the job is necessary, and return to duty can be allowed. See:*
https://www.migrantclinician.org/toolsource/resource/cholinesterase-che-testing-protocols-and-algorithm-healthcare-providers.html

1.4.2 Pesticide Application

Always have the label readily available when applying a pesticide.

- Do **not** handle or apply pesticides if you have a headache or are not feeling well.
- **Never** smoke, eat or drink (or use cell phones) while handling pesticides.
- **Avoid** inhaling pesticide sprays, dusts, and vapors. If the pesticide is dangerous to your respiratory system, the label will tell you to wear a respirator and specify which type (see section 1.5.3 Respiratory Protection for Pesticide Handlers).
- Thoroughly wash exposed areas of yourself before eating, drinking, using tobacco products, using the bathroom, or using your cell phone. Wash your gloves with soap and water before you take them off. Then wash your hands and face.
- If hands, skin, or other body parts become contaminated or exposed, wash the area immediately with clean water and a liquid detergent. If clothing becomes contaminated, remove it immediately. If you splash a concentrate of a pesticide labeled with a "Danger "or "Warning" signal word, take your contaminated clothing off immediately. Dispose of garments drenched with concentrates of any pesticides labeled with Danger or Warning signal words; do not wash these items.

PESTICIDE SAFETY

- After each spraying or dusting, bathe and change your clothing; always begin the day with clean clothing. Wash contaminated clothing separately from other garments, and run an extra rinse cycle afterwards.
  Always have someone with you or close by if you are using highly toxic pesticides (those with the signal word **DANGER** plus skull and crossbones)

Application Rate

Always follow the pesticide label 'Directions for Use' regarding who may use, where, how, how much, and how often the pesticide may be used. In addition to those mandatory statements, pesticide manufacturers also provide additional advisory information on the label on how to use a pesticide most effectively.

Application Records

Records document proper application. Records are one of the first things that regulators review when they have received a complaint. Consider treating each record as documentation of a lawsuit going forth in court. Always keep a record of all pesticides used (dates, locations, quantities, etc.) as required by the NJDEP.

For New Jersey, there are legal requirements for what information must be included and how long application records must be maintained by licensed applicators. For application record templates, see Rutgers Pesticide Safety Education Program's website at: *https://pestmanagement.rutgers.edu/pat/record-forms/.*

For additional information on pesticide application recordkeeping, contact the New Jersey Department of Environmental Protection, or Rutgers Cooperative Extension Pesticide Safety Education Program.

1.4.3 Pesticide Transport

When pesticides are transported, containers must be well secured to prevent breakage or spillage. If pesticide containers are glass, pad and secure them to prevent breakage. When containers are larger than 5 gallons, tightly brace them to a structural part of the vehicle to prevent accidental spills. Carry a supply of absorbent material to soak up or contain any liquid spills. Keep a shovel and/or broom and pan in the transport vehicle to help quickly contain any spills. Carry a working fire extinguisher (10 - B: C dry chemical, or carbon dioxide) immediately accessible on board as well.

While under transport, pesticides must be stored in a separate compartment from the driver such as the bed of a pick-up truck or a van equipped with a partition. All pesticide containers and equipment must be secured to the vehicle so as to prevent removal by unauthorized person(s) when the vehicle is unattended. The door or hatch of any service vehicle tank containing a pesticide must be equipped with a cover that will prevent spillage when the vehicle is moving. The above requirements would not apply if the vehicle is being used to hold and/or transport pesticides within the boundaries of a private applicator's property.

For additional information on pesticide transport, contact the New Jersey Department of Environmental Protection, or Rutgers Cooperative Extension Pesticide Safety Education Program.

1.4.4 Pesticide Storage

Improper storage of pesticides can lead to accidental poisonings, contamination of the environment, and deterioration of the chemicals themselves. Pesticides should always be stored in their original containers and kept tightly closed. **NEVER** transfer pesticides to food or beverage containers. Store pesticides in a cool, dry, well-ventilated area that is not accessible to children and others who do not know and understand their safe and proper use. For the protection of others, and especially in case of fire, the storage area should be posted as *Pesticide Storage* regardless of the use classification, and kept securely locked.

Minimize the amount of product you need to store. Plan pesticide purchases so that supplies are used by the end of the growing season, and will not have to be overwintered. Write the purchase or delivery date of the product on the label with indelible ink on the product container. Check and record expiration dates listed on the product label. EPA regulations require that pesticide manufacturers must place the statement "**Not for sale or use**

after [date].” on product labels where the formulation changes in chemical composition significantly in a prominent position on the label. The product must meet all label claims up to the expiration time indicated on the label.

Always read the label. Most, if not all, pesticide labels will contain a general statement such as “do not contaminate water, food, or feed by storage, disposal, or cleaning of equipment.” Special storage recommendations or restrictions will often be included. Moisture is a critical concern with dry pesticides, including granular materials and wettable powders, which have a strong affinity for water. When this is the case, the label may have the statement, “store in a dry place.”

In New Jersey, any restricted use pesticide (or empty containers still contaminated with their residues) must be stored in a secure, locked enclosure while unattended. That enclosure must bear a warning that pesticides are stored there. If any pesticide must be stored in other than its original container (for example if the original container is leaking), that container must be labeled with the brand or trade name; EPA registration number; name and percentage of the active ingredient(s); the signal word; and precautionary statements for the pesticide. If the pesticide in the new container has been diluted, also write the dilution of the mixture. Keep an inventory of all pesticides held in storage and locate the inventory list in an accessible place away from the storage site, so it may be referred to in case of an emergency at the storage site.

Keep your local fire department informed of the location of all pesticide storage locations. Fighting a fire that includes smoke from burning pesticides can be extremely hazardous. A fire with smoke from burning pesticides may also endanger the people of the immediate area or community. The people of an area or community may have to be evacuated if the smoke from a pesticide fire drifts in their direction.

In **New Jersey**, applicators are required maintain a list of pesticides in storage or likely to be stored during the license year. Applicators must send this inventory to their local fire department by May 1st each year. It must also include a written description or depiction of the exact location of the pesticide storage area. For inventory and cover letter templates, see Rutgers Pesticide Safety Education Program’s website at:
https://pestmanagement.rutgers.edu/pat/record-forms/.

Inspect Product and Container Conditions

Inspect the condition of products stored and containers you have in storage routinely. Maintain pesticides within the temperature range specified on the product label. Poor storage practices impact product efficacy, and accelerates product deterioration.

General signs of deterioration per formulation type are:

- EC - Evidence of separation of components, such as sludge or sediment.
  Milky appearance does not occur when water is added.
- Oils - Milky appearance does not occur when water is added.
- WP, SP, WDG - Excessive lumping; powder does not suspend in water.
- D, G, WDG - Excessive lumping or caking

Consult the “**Storage and Disposal**” statements listed on the label to determine whether a pesticide can freeze with no adverse effects. Some pesticide labels may indicate that if freezing occurs and crystals form, then the product may be reused if it is warmed up. After freezing, the pesticide container should be checked to make sure it is not ruptured or cracked from the expansion of the frozen liquid BEFORE attempting to thaw the pesticide. To thaw a pesticide, place the container in warm storage, 50-80°F (10-27°C), and shake or roll the container every few hours to mix product or eliminate layering. If layering persists or if all crystals do not completely dissolve, do not use product. If in doubt, call the manufacturer for guidance. Additional information can be obtained from manufacturers' websites, or consult “Cold Weather Storage & Handling of Pesticides, January 2018” by the Montana State University Extension, available at:
https://store.msuextension.org/publications/AgandNaturalResources/MT201801AG.pdf.
See section 1.4.5 below regarding disposal of deteriorated product.

1.4.5 Disposal of Pesticides

Pesticides (and their empty containers still containing residues) should not be disposed of in sanitary landfills or by incineration, unless disposal sites and equipment are especially designed and licensed for this purpose by your state.

Always refer to the current pesticide label "Storage and Disposal" requirements because there may be product–specific requirements on the disposal of pesticides themselves or unrinsed containers or rinsate. Pesticide labels now have specific directions on disposal for non-refillable and refillable containers.

Pesticide wastes may be hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

For non-refillable bags of granulars and powders, completely empty bag into application equipment by shaking and tapping sides and bottom to loosen clinging particles. If not emptied in this manner, the bag may be considered an acute hazardous waste and must be disposed of in accordance with local, state, and federal regulations.

After emptying a product container, triple rinse container (or equivalent) promptly. The **triple rinse-and-drain** procedure or the **pressure-rinse** procedure are recommended methods to prepare pesticide containers for recycling or (see section 1.4.6 below).

Although the **New Jersey** Department of Agriculture does not sponsor pesticide waste disposal, it does promote recycling of "empty" pesticide containers (see section 1.4.6 below).

1.4.6 Disposal of Pesticide Containers

Recycling or drum reconditioning are preferred disposal options for container disposal. Options for empty pesticide containers depend upon state or local regulations and ordinances (and recycling program availability). Crushed/punctured containers may be accepted by sanitary landfills or landfills that accept industrial waste. Check with landfill operators prior to taking empty containers for disposal.

For dilutable pesticides in rigid non-refillable containers, the label must include triple rinse instructions unless EPA waives the requirement. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal.

Acceptable methods to prepare non-refillable containers that contained dilutable pesticides for recycling and/or disposal are **triple rinsing-and-draining** or **pressure-rinsing, as follows:**

Triple Rinse-and-Drain Method (for refillable containers larger than 5 gallons): To empty a pesticide container for disposal, drain the container into application equipment or mix tank by holding container in a vertical position for 30 seconds. Add a solvent, capable of removing the pesticide, to the pesticide container, so that it is approximately one-fourth full. Agitate the container thoroughly, and then drain the liquid (rinsate) into the application equipment or mix tank by holding in a vertical position for 30 seconds. Repeat two more times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal.

Pressure Rinse Method: An optional method to rinse small pesticide containers is to use a special rinsing device on the end of a standard water hose. The rinsing device has a sharp probe to puncture the container and several orifices to provide multiple spray jets of water. After the container has been drained into the sprayer tank (container is upside down), jab the pointed pressure rinser through the bottom of the inverted container. Rinse for at least 30 seconds. The spray jets of water rinse the inside of the container and the pesticide residue is washed down into the sprayer tank for proper use. Thirty seconds of rinse time is equivalent to triple rinsing. An added benefit is the container is rendered unusable.

The **New Jersey Agricultural Recycling Programs** are promoted by the New Jersey Department of Agriculture (NJDA). Pesticide container disposal is offered to agricultural, professional and commercial pesticide applicators who hold a NJDEP pesticide license as well as state, county and municipal government agencies. One core credit

will be given to pesticide license holders who follow required processing steps and bring their license with them at time of collection. The program accepts non-refillable, high-density polyethylene #2 (HDPE) containers that are no larger than 55 gallons and that have been triple rinsed. Contact Tim Fekete of the NJDA Division of Agricultural and Natural Resources for more details on recycling requirements, scheduling, and locations at (609) 292-5540, or consult the NJDA website at: *https://www.nj.gov/agriculture/divisions/anr/nrc/recycling.html*. Two of the locations for the 2021 season will be Helena Chemical in Woodstown and Hammonton.

Always refer to the current pesticide label "Storage and Disposal" requirements. For additional information on the disposal of pesticides themselves or unrinsed containers or rinsate, call your State agency responsible for hazardous waste.

1.5 Reducing Risks to Handlers and Workers

1.5.1 Agricultural Worker Protection

"Agricultural Workers" are those persons who are employed by the agricultural establishment to perform tasks such as harvesting, weeding, or watering, relating to the production of agricultural plants on a farm, forest, nursery, or greenhouse.

"**Handlers**" are those persons who are employed by an agricultural establishment or commercial pesticide application company who mix, load, or apply pesticides; who handle opened pesticide containers; who act as flaggers; who clean, maintain, or repair application equipment; who assist with the application of a pesticide; who enter a treated greenhouse to operate ventilation equipment; who adjust or remove coverings or check air levels; who enter an outdoor area that has been fumigated to adjust or remove soil coverings; who perform tasks as a crop advisor; or who dispose of pesticides or their containers.

In 1994 EPA first implemented the Federal Worker Protection Standard – CFR Title 40, Part 170 (WPS) regulations to provide specific safety requirements for both general agricultural workers and pesticide handlers. The 1992 WPS regulations were revised on November 2, 2015.

The WPS regulations are applicable to any agricultural establishment that employs either pesticide handlers or agricultural workers where <u>any EPA-registered pesticides</u> are used in the production of agricultural commodity(ies). The WPS also applies to custom pesticide applicators and labor contractors supplying employees or independent crop consultants who are hired by these establishments. State regulations may differ, and when more stringent take precedence over federal regulations. The WPS reduces risks of occupational illness and injury from exposure to pesticides in three ways:

- **INFORM** workers and handlers about potential exposures to pesticides;
- **PROTECT** worker, handlers, and others from exposure to pesticide(s); and
- **MITIGATE** any pesticide exposures that workers or handlers receive.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. Refer to supplemental labeling under "Agricultural Use Requirements" in the Directions for Use section for information about this standard.

Only "WPS-labeled" pesticides may be used in the production of an agricultural commodity. These pesticides are identified by a box on the product label with the title "**AGRICULTURAL USE REQUIREMENTS**". The first paragraph within the box **invokes by reference a requirement for compliance with the <u>all of the</u> WPS regulations**.

Specifically, the paragraph reads: "Use this product **only in accordance with labeling and with the Worker Protection Standard 40 CFR part 170**. The Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to statement on the label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered under the Worker Protection Standard…"

The NJDEP Agricultural Worker Protection regulations [N.J.A.C. 7:30 Subchapter 12] provide New Jersey's regulations for Worker Protection. New Jersey's pesticide regulations were just revised on April 6, 2020, and incorporate or exceed the revisions of the federal WPS.Agricultural employers of workers or handlers, or commercial applicator businesses providing handler application services in New Jersey will be in full compliance with both federal and State laws for agricultural worker protection when they adhere to New Jersey's revised N.J.A.C. 7:30 regulations; see *https://www.nj.gov/dep/enforcement/pcp/pcp-regs.htm*. For specific questions or concerns about NJDEP's implementation of the revised WPS, please contact Supervisor of the Worker Protection Unit Nancy Santiago at 609-984-6568, or contact her by email at: *pcp@dep.nj.gov*.

This section provides a brief overview of some of these regulations, with special notation where New Jersey worker protection regulations differ. Compliance resources for regulation specifics and other information are provided at the end of this section.

INFORM

To ensure that employees are informed about exposure to pesticides, employers must provide certain information to their farmworkers. This includes providing **annual pesticide safety training** to both pesticide handlers and agricultural workers. Grace period for worker training is eliminated. Workers must be trained before they work in an area where a pesticide has been used or a restricted-entry interval has been in effect in the past 30 days.

Training content under the 2015 Revised WPS has expanded, and is freely available (*see "Compliance Assistance" at the end of this section for free training resources, including videos*). Worker training topics have been expanded to 23 items, and handler training has been expanded to 36 items. Resources developed for the training of workers and handlers per the requirements of the 1992 Worker Protection Standard (as amended) can no longer be used, effective December 2018. Training of employees using the old materials does NOT have the new content required under the 2015 Revised WPS, and would be invalid. Do not use training materials unless they are approved for use with the 2015 Revised Worker Protection Standard. Download approved training videos at the Rutgers NJAES Worker Protection webpages (*https://pestmanagement.rutgers.edu/worker-protection/worker-handler-training/*). IMPORTANT: Make sure to replace your old 1992 WPS training videos or booklets with 2015 Revised WPS training materials!

Trainers must be either: certified applicators; designated as a qualified trainer by EPA or their state pesticide regulatory agency; or have completed an EPA-approved "Train the Trainer" course. Approved trainers must use EPA-approved training materials. Employers are required by federal regulations to retain records of WPS training for 2 years. The 2020 revised **New Jersey** regulations on worker and handler training recordkeeping are more stringent, requiring that **training rosters be maintained by both the trainer and the agricultural employer for three years.**

The NJDEP Worker Protection website has downloadable forms for trainer recognition, worker training rosters, and handler training rosters; *see https://www.nj.gov/dep/enforcement/pcp/pcp-wps.htm* for forms and retention times and responsible parties. Training records of handlers must be sent to the NJDEP by the trainer or agricultural employer within 30 after each training session. Worker training records are no longer required to be sent to the NJDEP. All rosters must be maintained on file by WPS trainers and agricultural employers in New Jersey for 3 years.

Other requirements for providing information include **displaying WPS-required pesticide safety information** at a central location (and certain decontamination sites). Safety information may be displayed in any format, including a poster that meets the requirements. The Pesticide Education Resource Collaborative (PERC) has developed for EPA a WPS safety information poster.

Agricultural employers must also provide workers and handlers access to both **Safety Data Sheet (SDS)** and **pesticide application information** for applications at the establishment. An SDS is required to have specific information set forth by the OSHA Hazard Communication Standard, but they are not reviewed or approved by government officials like pesticide labels. EPA requires that employers maintain SDS and pesticide application information on file for two years and provide access/copies of records to workers, handlers, treating medical personnel, or a "designated representative". State regulations may differ; where more stringent, they take legal precedence over federal requirements. **New Jersey's** revised regulations are more stringent, and require that the **agricultural employers maintain copies of SDS for three years.**

EPA Revised WPS also requires that the following **pesticide application information** be displayed be in a centrally located area: 1. Pesticide product name, EPA registration #, and active ingredients(s); 2. Crop or site treated, & location and description of treated area; 3. Date(s), times application started and ended; and 4. Duration of REI. **In New Jersey**, pesticide application information must be displayed **either before workers enter treated fields or prior to workers entering fields at the beginning of the next workday**, whichever occurs first. This is more stringent than the Federal rule. Once posted, this information must remain posted for 30 days following the date for safe reentry. New Jersey pesticide application information display requirements are more specific including posting a **map of the farm** for designation of treated areas. **NJDEP requires column headings for posted pesticide application information** that include: 1. Crop; 2. Pesticide name; 3. Safe Reentry Time; 4. Application Date; 5. Application start and finish times; and 6. Application Location.

PROTECT

Employers are required to ensure that employees will be protected from exposures to pesticides. Employers must take measures that applications do not expose unprotected workers during applications. The Revised WPS has requirements for restricting access around application equipment in a defined area called the "**Application Exclusion Zone**" surrounding applications in progress. Employers must also provide personal protective equipment (PPE) to handlers, and early entry workers per the pesticide label (see sections 1.5.2 and 1.5.3 for information on PPE).

Employers must notify early-entry workers of application specifics, tasks to be performed, conditions of the early-entry exception, and hazard information from the pesticide label.

All WPS-labeled pesticide products are required to have a prescribed REI. These range from 4 to 48 hours or longer. Check your pesticide's label for the reentry time in effect. Some pesticides have one REI, such as 12 hours, for all crops and uses. Other products have different REIs depending on the crop or method of application. When two (or more) pesticides are applied at the same time, and have different REIs, you must follow the longer interval. To protect farmworkers, employers are required to **post warning signs** (see right) around treated areas when the **product applied outdoors has an REI greater than 48 hours**; and when the **product applied indoors has an REI greater than 4 hours**. When a product applied outdoors has an REI of 48 hours or less; or a product applied indoors has an REI of 4 hours or less, the employer may choose either to post the treated area or give oral notification, unless the labeling requires both types of notification.

However, there are situations where the WPS allows workers to enter treated areas before the end of an REI to do non-hand labor tasks, but is limited to a maximum of one hour per day. Early entry cannot be made until four full hours have passed since the completion of the application. The Revised WPS requires that "early-entry workers", with the exception of immediate family, be at least 18 years old. **Note: New Jersey regulations require that both handlers and early entry workers be at least 18 years old.** Early-entry workers must be given label-prescribed PPE for early entry prior to entry if they will contact treated surfaces.

MITIGATE

To mitigate or lessen the impact of pesticide exposures that employees do receive, employers must provide decontamination sites and emergency assistance. Employers must provide supplies for emergency eye flush at all pesticide mixing and loading sites when handlers use products that require eye protection. Decontamination sites must contain a supply of water, soap, and towels for both routine washing and emergency decontamination. Employers must provide emergency assistance which includes transportation to medical care facilities in the event of a pesticide-related injury, and providing information about the pesticide(s) involved to the medical staff.

Immediate Family Exemptions:

The Revised WPS has expanded the definition of immediate family to include: spouse, parents, stepparents, foster parents, father-in-law, mother-in-law, children, stepchildren, foster children, sons-in-law, daughters-in-law, grandparents, grandchildren, brothers, sisters, brothers-in-law, sisters-in-law, aunts, uncles, nieces, nephews, and first cousins.

Owners of agricultural establishments and their immediate family members are exempt from most WPS requirements. If only immediate family members are employed by the agricultural establishment, owners are exempt from providing themselves and their family members:

- pesticide safety training and information;
- providing, cleaning, and maintaining PPE;
- information at a central location;
- decontamination facilities;
- emergency assistance requirements;
- notifications of pesticide applications; and
- handler monitoring.

EPA's WPS does not exempt owners of agricultural establishments from providing themselves or their family members from the respiratory protection requirements when using pesticides requiring respirators to be worn. The Revised WPS requires that when a WPS-covered pesticide label requires a handler to wear a respirator, the handler's employer must provide them with a medical evaluation, fit test, and respirator training. these requirements (see section 1.5.3 for details).

Federal Compliance Assistance Resources

EPA is providing resources to agricultural employers and handler employers to assist with compliance with the Revised WPS in conjunction with the Pesticide Educational Resources Collaborative (PERC).

Key resources developed and posted at the PERC website (*http://pesticideresources.org/*) are:

- "Quick Reference Guide to the Worker Protection Standard (WPS) as Revised in 2015"; see *http://pesticideresources.org/wps/hosted/quickrefguide.pdf*. This one-page double-sided chart outlines requirements with direct hyperlinks to the text of the regulation for each item being cited in the chart.
- "How to Comply With the 2015 Revised Worker Protection Standard For Agricultural Pesticides"; see *http://pesticideresources.org/wps/htc/index.html*. The purpose of this online guide is to help users of agricultural pesticides comply with the requirements of the revised federal Worker Protection Standard.
- The Revised WPS requires that specific pesticide safety information with newly expanded content be accessible to workers at any time during normal work hours. EPA does not require a specific format. PERC has produced an updated "WPS Safety Poster" meeting EPA's new requirements for "Central Posting" areas and certain decontamination sites.
- WPS Safety Posters in English, Spanish, Chinese, Haitian-Creole, Ilocano, Karen, Russian, Tagalog, and Vietnamese may be downloaded from *http://pesticideresources.org/wps/cp.html*, or may be purchased from the National Pesticide Safety Education Center's online store at *https://npsecstore.com/pages/perc-page*.

PERC will use email distribution lists to keep interested parties informed about new publications. PERC has developed lists for several target groups, including "Agricultural Employers and Handler Employers" to distribute

notices relevant to agricultural employers and commercial pesticide handler employers, as defined by the WPS. See *http://pesticideresources.org//lists.html* to enroll in the email list(s) of your choice.

PERC is collaborating with the National Pesticide Safety Education Center (NPSEC) as its distributer for printed resources and posters. You can purchase printed copies of PERC's resources, including laminated WPS Safety Posters, at the NPSEC Store at: *https://npsecstore.com/*.

Contact your local Extension offices and state Extension Pesticide Safety Education Program (PSEP) for further assistance. Rutgers New Jersey PSEP provides WPS outreach to agricultural producers at conferences, meetings, its Worker Protection webpages at: *https://pestmanagement.rutgers.edu/worker-protection/* and the Rutgers NJAES Plant and Pest Advisory Commercial Agriculture blog.

1.5.2 Personal Protective Equipment (PPE) for Pesticides

Wearing PPE can greatly reduce the potential for dermal, eye, oral, and inhalation exposure; and thereby significantly reduce the chances of pesticide poisoning or injury. PPE includes such items as coveralls or protective suits, aprons, gloves, footwear, headgear, eyewear, and respirators. When selected correctly, these all reduce the risk of dermal exposure; but they do not eliminate it. All PPE should either be disposable, or easy to clean and sturdy enough for repeated use.

Coveralls

If the pesticide label only lists 'coveralls', it is allowable to wear a coverall made of any fabric, including wovens (like cotton or twill); as well as disposable non-wovens. These do not have to be chemical resistant.

Chemical Resistant PPE

Generally speaking, labels will specify PPE that is "chemical resistant" for protecting the body from moderately toxic (signal word 'Warning') or highly toxic (label signal word 'Danger') pesticides. However, that may not always be the case for specific products; always follow the label. It is important that all pesticide handlers understand the limitations of PPE. Different types of PPE are not equally resistant to all pesticides and under all conditions. Chemical resistance of a given protective suit, for instance, can vary between different pesticides. Some materials restrict pesticide entry for a long time, while others allow the pesticide to pass through quickly.

There are several criteria for chemical resistance: **penetration**, **degradation**, and **permeation**. Penetration occurs when the chemical leaks through seams, pinholes, and other imperfections in the material. Degradation is a reduction in one or more physical properties of PPE due to contact with a chemical; it essentially starts to break down. Permeation is the process by which a chemical moves through protective material on a molecular level; measured as a volume per area over time. Breakthrough is what occurs when there is complete passage of a pesticide to the inside of PPE, measured in elapsed time. Once this occurs, your skin is directly exposed to the pesticide. In some instances, degradation of protective fabric is easy for applicators to recognize. PPE may swell, discolor, shrink, soften, become brittle, or change texture. Be alert for these signs and replace compromised clothing immediately to minimize your exposure to pesticides.

Permeation of a pesticide into a material may begin as soon as it gets on its surface. Once a pesticide is absorbed onto the surface of a garment, it is difficult to detect or decontaminate. In these cases, the pesticide continues to move into and through the PPE. How fast a given pesticide moves through different PPE materials (its permeation rate) can vary widely. Things that can affect the extent of permeation are contact time, concentration, temperature and physical state of the contaminant.

Pesticide breakthrough of PPE can occur without any noticeable signs. If a material is not chemical resistant to a pesticide, complete passage through it can occur very quickly, in just minutes.

Pesticide residues that remain on PPE are likely to continue to permeate through the material once contaminated. If using "reusable" PPE, pay close attention and be ready to change them whenever the inside surface is contaminated or there are signs of pesticide permeation. Even if you do not see any signs of wear, replace reusable chemical-resistant items regularly - the ability of a chemical-resistant material to resist the pesticide decreases each time an item is worn.

Be sure to clean all reusable PPE items between uses, even if worn for only a brief period of exposure. If you wear that PPE again, pesticide may already be on the inside of the material next to your skin. In addition, PPE worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic. Disposable PPE is a preferred option to reusable PPE. They are low-cost, and their use minimizes clean-up and spread of contamination.

Selecting Chemical Resistant PPE

Always follow the pesticide label directions for what is required for you to use under the law. For pesticide handlers, the precautionary statement on the pesticide label indicates if chemical-resistant PPE is required. For workers performing "early entry" tasks, the Agricultural Use Requirements box on the label indicates PPE requirements.

For gloves, labels will often specify materials that are chemical resistant for that product. Older pesticide labels may add another statement that you can consult an EPA chemical resistance category chart for more options. In these cases, the glove type that provides highest protection is listed. Use only those listed.

In some cases, a pesticide label may say "wear chemical-resistant PPE" without specifying the material that protects you. This is more typically the case for suits, aprons, boots, and headgear. In these circumstances, you should consult the PPE manufacturer or their literature (often available online). They can recommend the best garments/gloves to wear with the pesticide that you will be using. Consult the pesticide manufacturer to find out what PPE they recommend to be chemical resistant. You can also contact your state Cooperative Extension pesticide safety office for assistance.

Gloves

The area of the body receiving most exposure from pesticides is hands and forearms. Research has shown that workers mixing pesticides received 85 percent of the total exposure to the hands and 13 percent to their forearms. The same study showed that wearing chemical-resistant gloves reduced exposure by 99 percent *(Source: The Farm Family Exposure Study, John Acquavella)*.

Wear the type of chemical-resistant glove specified by the product labeling. Select glove materials according to the label, or by chemical resistance charts, or manufacturer directions. Make sure not to use gloves made of any kind of absorbent material, leather, cloth, cloth-lined, or flocked, unless specified by the label. All of these materials can absorb pesticides, and hold them against your skin. Cotton gloves may be prescribed on the label in very specific uses such as protection for certain fumigants including aluminum phosphide. Always use label-prescribed gloves.

Gloves, non-woven (including coated non-woven) coveralls and hoods, such as Tyvek®, usually are designed to be disposed of after use. Most are intended to be worn for only one work day. For example, you might use disposable gloves, shoe covers, and an apron while pouring pesticide into a hopper or tank, cleaning or adjusting a nozzle, or making minor equipment adjustments. Place disposable PPE in a separate plastic bag or container prior to disposal.

Footwear

Pesticide handlers often get pesticides on their feet. Sturdy shoes and socks may be sufficient to protect your feet during many handling activities. However, some product labels require that you wear waterproof or chemical-resistant footwear.

If the product labeling specifies "chemical-resistant footwear", you can wear any chemical-resistant shoes; boots; or shoe coverings worn over shoes or boots. Leather or canvas footwear is not chemical resistant; they absorb pesticides and cannot be decontaminated. Do not wear leather boots in these cases.

Eye Protection

Eyes readily absorb pesticides. When a label simply says to "wear protective eyewear", you may use any of the following: goggles; face shield; safety glasses with shields at front, brow and temple; or a full-face respirator. Select goggles made of impact-resistant material such as polycarbonate. Goggles that have covered air baffles reduce lens fogging while keeping liquids out. Under the agricultural Worker Protection Standard, if the label requires eye protection, then the handler must have immediate access to eyewash of 1 pint of water at all times.

1.5.3 Respiratory Protection for Pesticide Handlers

Occupational users of pesticides can be exposed to toxic gases and vapors, particulates, or both. Various pesticide formulations, environments, and application methods require different types of respiratory protection devices (respirators).

EPA requires that pesticide manufacturers determine and specify respiratory protection according to the anticipated hazards and risk of inhalation. Manufacturers provide requirements for respiratory protection on the pesticide label that are product- and task-specific. **It is extremely important** to read and follow the product label for respirator requirements since pesticides may have different formulations and use directions.

The pesticide label states whether you must use a respirator and, if so, which type. Atmosphere-supplying respirators provide clean, breathable air from an uncontaminated source, while air-purifying respirators remove contaminants from the air that you breathe. Both may be configured with either tight- or loose-fitting face pieces. When a tight-fitting respirator is used, **fit testing** is required to select the correct size, model, and manufacturer. **Occupational users of pesticides must understand the capabilities and limitations of each respirator they will use.**

The pesticide label specifies use of **"NIOSH-approved" respirators**. The NIOSH-approval certificate that accompanies the respirator indicates the approved configuration, protection, and cautions and limitations of the respirator. For example, air purifying respirators do not supply oxygen, and must not be used in an environment containing less than 19.5% oxygen.

When air-purifying respirators are required, the label will specify the type of particulate filter and/or chemical cartridge or canister. For example, non-powered particulate filters differ according to their oil resistance. When a pesticide contains oil or an oil-like substance, an N-series (not oil proof) cannot be used; and the pesticide label will specify R-series (oil-resistant) or P-series (oil-proof) filters. Powered air purifying respirators only have a single type of particulate filter, HE. EPA regulations [40 CFR 170.507(d)] require replacement of particulate filters when damaged, torn, soiled, or it becomes uncomfortable for the wearer to breathe. Additionally, particulate filters should be replaced according to respirator manufacturer recommendations or pesticide labeling (whichever is more frequent).

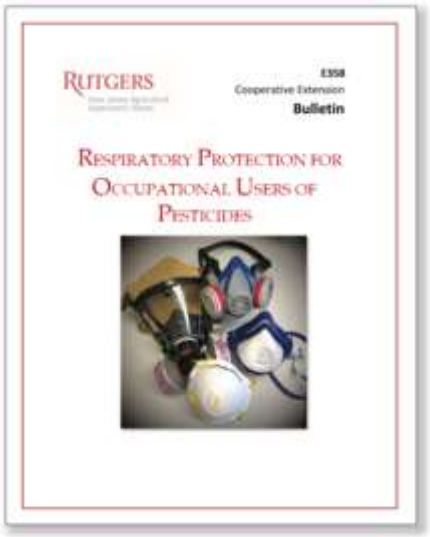
Always use the type of purifying element required by the pesticide label. The most typical chemical cartridge or canister specified by the label for pesticide use is an organic vapor (OV) cartridge or canister. They contain activated carbon that adsorbs organic vapor gas or vapor molecules from the air being drawn in through the container. A chemical cartridge/canister is effective until the sorbent bed is filled and the gas or vapor "breaks through." Breakthrough is the penetration of a gas or vapor through a chemical air-purifying element to inside the wearer's mask. Any taste, smell, or irritation is a warning that breakthrough of the pesticide through the sorbent may have occurred, and that you should exit the area. Respirator manufacturers recommend that OV cartridges/canisters should not be used beyond one day. Change cartridges/canisters earlier if contaminant odor, taste, or irritation is detected inside the face piece.

The Revised WPS requires that when a WPS-covered pesticide label requires a handler to wear a respirator, the handler's employer must provide them with a medical evaluation, fit test, and respirator training.

Prior to use of respirators, users must be **medically evaluated** to determine that they can safely use the respirator under the conditions of use. When use of a respirator is required by the pesticide label, both commercial applicator and agricultural employers must provide pesticide handlers a medical evaluation per OSHA 29 CFR 1910.134(e) to determine their ability to safely use the respirator specified.

Annual respirator training is required. Employers of occupational users of pesticides must provide effective respirator training per OSHA 29 CFR 1910.134(k) to those employees required to wear respiratory protection by the product label. Respirator users must know how to properly inspect, recognize danger signals during use and what to do; don and doff (put on and remove). After use, proper care, maintenance, and storage of their respirator can prolong the life of the respirator.

Call your Pesticide Safety Education Program if you have any questions about pesticide safety equipment. Your Rutgers Extension Pesticide Safety Education Program will be able to assist you in selecting and using the correct respirator and any component parts from the pesticide label.



Consult **Rutgers Bulletin E0358**
"Respiratory Protection for Occupational Users of Pesticides"
for detailed guidance on the different types of respirators; their limitations, use, care, maintenance, and storage; as well as requirements for the medical evaluation, fit testing, and training of respirator users. It outlines regulatory requirements of EPA and OSHA that apply to commercial users and also agricultural operations that use pesticides.

The publication may be downloaded at : *https://njaes.rutgers.edu/pubs/publication.php?pid=E358*.
Hardcopies are available at the NPSEC online store at:
https://npsecstore.com/collections/respiratory-guides

1.6 Protect the Environment

Generally speaking, to protect the environment from pesticide exposure:

- Always read the pesticide label prior to selection of a pesticide, and check for environmental concerns and restrictions.
- Do not burn pesticides. The smoke from burning pesticides is toxic and can pollute air.
- Do not dump pesticides in storm sewers or sewage disposal because this will contaminate water.
- Avoid using excess quantities of pesticides. Calibrate your sprayer to make sure of the output.
- Adjust equipment to keep spray on target. Chemicals that drift or move off-target can pollute and do harm to fish, wildlife, honeybees, and other desirable organisms.
- Keep pesticides out of ponds, streams, and water supplies, except those intended for such use. A small amount of drift can be hazardous to food crops and to wildlife.
- When cleaning or filling application equipment, do not contaminate streams, ponds, or other water supplies. Empty and clean sprayers away from water areas.
- Protect bees and other beneficial insects by choosing the proper chemical and time of day for application.
- See additional precautions in section 1 6.2 "Protection of Groundwater."

Minimize Spray Drift

Avoid drift to non-target areas. When pesticide drift occurs, some part of the pesticide is not reaching its intended target, and the potential benefit from the application is reduced. Dusts drift more than liquid sprays; air blast sprays drift more than boom sprays. Generally speaking, to minimize off-target drift:

- Use lowest spray pressure and largest droplets that provide sufficient coverage and control.
- Choose days with better weather. Avoid spraying when windy, high temperature without low humidity, or inversion conditions. Spray when soil is coolest and relative humidity is highest.
- Do not use nozzles or nozzle configurations that produce small droplets; consider use of "low drift" nozzles.
- Adjust boom height as low as is practical.
- Use lower travel speeds.
- Use non-volatile pesticides
- Use drift control additives when permitted by the pesticide label.

ALWAYS READ AND FOLLOW THE PESTICIDE LABEL. Pesticide labels will have mandatory drift requirements, as well as manufacturer's advisory statements for best management practices to control drift. This may include application methods, droplet size, nozzle types, and tank mix partners.

1.6.1 Protection of Pollinators

ALWAYS READ AND FOLLOW THE PESTICIDE LABEL.

Based upon the results of required ecological risk assessment or incident reports, the Environmental Hazards statements for foliar application to agricultural crops must include use precautions and/or restrictions for all identified non-target birds, mammals, fish, aquatic invertebrates, and bees.

Neonicotinoid Pesticide Labels: EPA Pollinator Protection "Bee Icon"

In some cases, EPA may require product-specific labeling to protect non-targets, such as pollinators. This would include foliar applications to alfalfa, peas, or beans if the crop or weeds in treatment area are in bloom; or to corn during pollen shed. In 2014, EPA required that all manufacturers of pesticide products containing active ingredients from the neonicotinoid group of insecticides relabel these products with an **advisory "pollinator protection box"** advising users to look for restrictions on the product's use indicated with a "bee icon" (*see above*). **Mandatory product-specific pollinator protection** "**Directions for Use'** were required on the label.

Generally speaking, pesticide applicators must take measures that will minimize the risk of pollinators contacting a "bee-toxic" pesticide. "Bee-toxic" pesticides are those pesticides that have information on the label indicating that the pesticide is toxic to bees, and precautionary statements for the protection of pollinators on the product labeling.

Do not apply or allow drift of bee-toxic pesticides until all flowering of crop, cover crops, or weeds is complete/petal fall, unless you take necessary precautions to minimize exposure to foraging bees or and their hives. **Do not** apply bee-toxic pesticides when bees are foraging in cover crops or weeds. Precautions may include: making applications after sunset, when the temperature has dropped below 55˚F, and notifying beekeepers in advance. Notification of beekeepers allows them to move, cover, or otherwise protected prior to spraying. This protects a valuable agricultural resource, and avoids conflicts and possible lawsuits. **Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at:** *https://pesticidestewardship.org/pollinator-protection/*

New Jersey Beekeeper Notification Regulations (N.J.A.C. 7:30-9.11)

Beekeepers that have hives overwintering in New Jersey are allowed to voluntarily register their bee yards with the NJDEP. A list of registered beekeepers is provided on the NJDEP's Beekeeper Notification webpage at *https://www.nj.gov/dep/enforcement/pcp/bpo-bee.htm*. Pesticide applicators are required to notify those beekeepers within a 3-mile radius at least 24 hours prior to the application of any pesticide labeled as toxic to bees. Once notified, it is the responsibility of the beekeeper to take action to protect their hives. Agricultural applications are exempt from the notification requirements, unless specifically listed under 7:30-9.11 (i); see: *https://www.nj.gov/dep/enforcement/pcp/regulations/Subchapter%209%20Changes%20in%20Red%202020.pdf*

Beekeeper notification is mandatory for growers using "bee-toxic" pesticides within three miles of the target site at least 24 hours prior to the date of application on the following crops within the dates stated below or when in the flowering stage (***i.e., both***). "Flowering stage" specifically means when plants bear any portion of a blossom as part of the blooming process associated with pollen and nectar production:

- **Apples, pears, strawberries, peaches, and blueberries:** April 15th to May 15th
- **Holly:** June 1st to June 30th
- **Cranberries:** June 15th to August 15th
- **Vine Crops (Cucurbits):** June 1st to August 31st
- **Sweet corn** (during flowering stage)
- **Fields where flowering weeds are present**

Notification must include: intended date and approximate time of application; location of the application, brand name and active ingredients of the pesticide to be applied; and the name and license number of the pesticide

applicator. Notification to the apiarist can be made in person, by phone, by fax, by email, or regular or certified mail (as long as it is received 24 hours before the application).

Pesticide Incident Reporting

Immediately report pesticide incidents (*e.g.*, bee kills) to your State pesticide regulatory agency. Pesticide incidents should also be reported to the National Pesticide Information Center at: *www.npic.orst.edu* or directly to EPA at: *beekill@epa.gov.*

1.6.2 Protection of Groundwater

Groundwater is the water contained below our soils. This water is used by 90% of the rural population in the United States as their sole source of drinking water. Contamination of our water supply by pesticides and other pollutants is becoming a serious problem. One source of contamination is agricultural practices. Protection of our groundwater by the agricultural community is essential.

Groundwater collects under our soils in aquifers that are comprised of layers of sand, gravel or fractured bedrock which, by their nature, hold water. This water comes from rainfall, snowfall, etc., that moves down through the soil layers to the aquifer. The depth of the aquifer below the surface depends on many factors. Where it is shallow, we see lakes, ponds and wetlands.

Factors That Affect Movement of Water and Contaminants

The depth of aquifers, in conjunction with soil types, influences how much surface water reaches the aquifer. Their depth also affects how quickly water and contaminants reach an aquifer. Thus, shallow water tables tend to be more vulnerable to contamination than deeper ones.

This tendency, however, depends on the soil type. Soils with high clay or organic matter content may hold water longer and retard its movement to the aquifer. Conversely, sandy soils allow water to move downward at a fast rate. High levels of clay and/or organic content in soils also provide a large surface area for binding contaminants that can slow their movement into groundwater. Soil texture also influences downward water movement. Finer textured soils have fewer spaces between particles than coarser ones, thus decreasing movement of water and contaminants.

Chemistry Plays a Role

The characteristics of an individual pesticide affect its ability to reach groundwater. The most important characteristics are solubility in water, adsorption to soils, and persistence in the environment.

Pesticides that are highly soluble in water have a higher potential for contaminating groundwater than those which are less soluble. The water solubility of a chemical indicates how much chemical will dissolve in water and is measured in parts per million (ppm). Those chemicals with a water solubility greater than 30 ppm may create problems. A chemical's ability to adhere to soil particles plays an important role. Chemicals with a high affinity for soil adsorption are less likely to reach the aquifer. Adsorption is also affected by the amount of organic matter in the soil. Soils with high organic matter content are less vulnerable than those with low organic matter content.

Finally, how persistent a chemical is in the environment may affect its ability to reach groundwater. Those which persist for a long time may be more likely to cause contamination than materials which breakdown quickly. Persistence is measured by the time it takes half of a given pesticide to degrade (half-life). Chemicals with an overall estimated half-life longer than 3 weeks pose a threat to groundwater.

How to Prevent Contamination of Your Ground Water

1. Examine the chemical properties of the pesticides that you use. If you are using materials which persist for long periods of time, are very water soluble, or are not tightly held by the soil, then you may be contaminating your groundwater. You may wish to select another material that has a shorter persistence, lower water solubility or higher potential for soil adsorption. The following table will assist you with these decisions.

2. Determine your local soil and geologic circumstances. If you are in an area with a shallow water table or your soil is low in organic matter or sandy in nature, you have a greater risk of contaminating your groundwater. In these cases, choose a pesticide that has a low water solubility and is not persistent (has a short half-life).
3. Evaluate your management practices. They may be the most important factor in determining your risk of contaminating your groundwater. If you use the same materials year after year, or many times a season, you can increase the potential for contamination due to the amount of pesticide in your soil. The timing of pesticide applications has an effect on groundwater contamination. If you make applications during periods of high rainfall or heavy irrigation, it is more likely that contamination may occur. Also, the water table in the spring may be higher than at other times. Early season applications, therefore, may pose a greater chance for groundwater contamination. Finally, the method of application may have an effect on ground water contamination. Direct injection, incorporation, and chemigation all increase the chance of contamination. If you use these techniques, be sure to follow the procedures listed on the material's label.
4. The location of your wells can be important. If your sprayer loading area or pesticide storage building is too close to your well, the risk of contamination may be greater. Wells used for drinking water or other purposes should be at least 50 feet away from pesticide storage buildings and loading areas. In the event of an accident, this distance should prevent contamination. This minimum distance should also be followed for field irrigation wells. If they are too close to application areas, contamination might occur.
5. Check the condition of any wells in the vicinity of sprayer loading areas, pesticide storage areas or field applications. If they have cracked casings you are inviting trouble. Cracks in a well casing provide a direct point of entry for pesticide-contaminated water in the soil around the well.
6. Incorporate an anti-backflow device in any system used for chemigation or to fill your sprayer with water. In the event of a pump shutoff or other failure, if any back-flow into the water system occurs, these devices will prevent pesticides from entering your well. In many states these devices are now required for sprayers by laws.
7. Care and maintenance of your equipment is also an important consideration. If your equipment does not function properly, you may be applying more than is needed and increasing the chance of groundwater contamination. Prior to the season, inspect all of the working parts of your sprayer or chemigation system. Check the pump to see if it is working properly. For both sprayers and chemigation systems, check the water lines for clogs and leaks. For sprayers, check the nozzles for wear and clogs. Clogged, leaking or worn lines and nozzles can cause pesticides to be delivered excessively or in unwanted areas. Be sure to calibrate your equipment. Uncalibrated equipment can cause over delivery as well. You should calibrate your equipment at the beginning of the season, periodically during the remainder of the season and any time you make changes or adjustment to the equipment.
8. Apply materials only when needed. The use of extraneous pesticides can increase the threat of contamination. Check your irrigation practices as well. **Do not** irrigate immediately after a pesticide application, unless required by a pesticide's label. The increased water content in the soil might speed up the movement of a pesticide into ground water. **Remember, you must protect your groundwater.**

1.6.3 Pesticide Spills

Keep a supply of an absorbent agent on hand to contain liquid spills in the area that you store pesticides, as well as transport pesticide product. Industrial sorbents rated by sorption capacity and type of liquid are commercially available for absorbing the liquids in a cleanup. Use label-prescribed PPE including chemical resistant gloves to clean up spills. Barrier laminate gloves have a broad range of chemical resistance are a good choice to keep in a spill kit. Rubber gloves might break down depending on the pesticide. Let it soak a couple of hours to absorb the spilled pesticide from the floor. This procedure is also recommended for cleaning truck beds that are contaminated.

Specific information concerning pesticide cleanup can be obtained by calling the manufacturer directly or consulting the product Safety Data Sheet (SDS). **The phone numbers for emergencies are listed on every product**

label. Information can also be obtained by calling CHEMTREC at 1-800-424-9300, or visiting *http://www.chemtrec.com/*.

In New Jersey, the licensed dealer, dealer business, commercial pesticide operator, applicator or applicator business, shall *immediately* notify the NJDEP at 1-877-927-6337 of **any reportable pesticide spill** occurring under such person's direct supervision and/or direct observation. The following eight elements are required to be included during the reporting of a reportable pesticide spill:

1. Date and time
2. Name/address/phone of the pesticide applicator
3. Name /address/phone of the applicator or dealer business, if any
4. Name/phone of the property owner or operator
5. Location of the incident
6. Name and EPA registration number of the pesticide(s)
7. Estimated amount & dilution rate of pesticide(s) involved
8. Corrective action(s) taken

New Jersey "reportable spills" of pesticides include:

1. Outside a structure – only if more than 1 pound active ingredient;
2. Inside a structure – only if more than 1 pound active of dry pesticides; or 1 gallon of liquid (pesticide &/or diluent); and
3. Indoor spill of termiticide – only if more than 50 in² organochlorine termiticide contamination at one injection point; or greater than 1 yd² aggregate contaminated by organochlorine termiticide on/at interior wall base; and/or when heating duct/system is contaminated.

Within ten days of the spill, a written report must be submitted to the NJDEP at Pesticide Control Program, P.O. Box 411, Trenton, NJ 08625-0411 outlining the eight elements listed above. You may download a template "Spill Report Card" from the Rutgers NJAES PSEP website at *https://pestmanagement.rutgers.edu/pat/record-forms-2/*.

Table 1.2 K_d, K_{oc}, Water Solubility and Persistence Values for Selected Pesticides

Pesticide	Adsorption to Soil K_d[1]	Adsorption to Organic Matter K_{oc}[1]	Water Solubility (ppm)[2]	Half Life (days)[3]
atrazine	127	160	33	60
bensulide	--	1,433-4,326	5.6	--
clethodim	0.05-0.23	--	--	3
Dacthal	--	1,500	~7	30
fomesafen	--	60	50	100
glyphosate	324-600	24,000	15,700	47
mesotrione	--	14-390	15,000	~15
methomyl	0.03	28	57,900	8
metribuzin	0.11	60	1,100	30
oxamyl	0.16	1	280,000	7
pendimethalin	--	17,200	0.3	44
S-metolachlor	--	200	488	20
terbacil	0.78	55	710	90

[1]A lower K_d or K_{oc} number indicates a greater chance for groundwater contamination. [2]A higher water solubility indicates a greater chance for groundwater contamination. [3]A longer half-life indicates a greater chance for groundwater contamination.

1.7 State Contacts for NJ Pesticide Applicator Programs

Rutgers

Rutgers NJAES Pesticide Safety Education Program (PSEP)

Contact: 848-932-9802
George C. Hamilton, Extension Specialist in Pest Management, 848-932-9801. *hamilton@njaes.rutgers.edu*
Patricia D. Hastings, Extension PSEP Coordinator/WPS Lead for New Jersey. 848-932-0176. *hastings@njaes.rutgers.edu*

Rutgers Pesticide Applicator Training Resources

Certification & Training Home Page: *https://pestmanagement.rutgers.edu/pat/*
Rutgers Pesticide Records and Forms: *https://pestmanagement.rutgers.edu/pat/record-forms-2/*
Rutgers Pesticide Applicator Training Manuals: *https://pestmanagement.rutgers.edu/pat/manuals/*
Pesticide Safety & Regulatory Updates Blog Archive: *https://pestmanagement.rutgers.edu/news/*
Rutgers PSEP posts concurrently to the NJAES Plant & Pest Advisory on topics in applicator certification and training, and worker protection.

Rutgers Worker Protection Standard Resources

Home Page: *https://pestmanagement.rutgers.edu/worker-protection/*
Rutgers "Quick-Connect" – WPS Training Videos:
https://pestmanagement.rutgers.edu/worker-protection/worker-handler-training/
Respiratory Protection for Occupational Users of Pesticides. Rutgers Bulletin EO358. March 2018.
https://njaes.rutgers.edu/pubs/publication.php?pid=E358

Rutgers NJAES Office of Continuing Professional Education (OCPE)

NJDEP **P**esticide **A**pplicator **C**ertification **E**xam **R**egistration **(PACER) :** *https://pacer.rutgers.edu*
Responsive, courteous help desk support Monday through Friday, 8:00am-4:30pm. Phone: 848-932-9271, Option 7; Fax: 732-932-1187; E-mail: *pacer@njaes.rutgers.edu.*

New Jersey Department of Environmental Protection

Contact: 609-984-6507

N.J.A.C. 7:30 Pesticide Regulations:

https://www.state.nj.us/dep/enforcement/pcp/pcp-regs.htm

NJDEP Bureau of Licensing & Registration

Home Page: *https://www.nj.gov/dep/enforcement/pcp/bpo-licensing.htm*
Private Applicator Certification**:** *https://www.nj.gov/dep/enforcement/pcp/bpo-appprivate.htm*
Recertification Course Webpage: *https://www.nj.gov/dep/enforcement/pcp/bpo-recert.htm*

NJDEP Bureau of Pesticide Compliance

Home Page: *https://www.nj.gov/dep/enforcement/pcp/pcp-bpc.htm*
Worker Protection Unit: *https://www.state.nj.us/dep/enforcement/pcp/pcp-wps.htm*
For specific questions or concerns about NJDEP's implementation of the revised WPS, please contact Supervisor of the Worker Protection Unit Nancy Santiago at 609-984-6568, or contact her by email at *pcp@dep.nj.gov*.

2 Orchard Nutrition

2.1 Tree Crop Soil Fertility and Plant Nutrition Principles

The main objective of soil fertility management for tree crops is to synchronize plant demand for nutrients with supplies from soils and fertilizers to produce quality fruit. Thus, an understanding of the physiology and tree demand for nutrients is important to optimizing soil fertility and fertilizer applications. Both plant and soil testing are useful tools to monitor nutrient status and guide fertilizer practice. Interpretation of the test results must consider the unique physiology of trees and how they regulate nutrient demand during different growth stages.

Tree crops are perennials that require the same essential nutrients as annuals like field crops and vegetables. However, perennial trees differ from annuals in plant nutrient uptake dynamics, especially for N. In general, the seasonal pattern of nutrient uptake by a particular crop is closely tied to the patterns of vegetative and reproductive growth. Usually, the period of most rapid N uptake by a crop corresponds with the period of most rapid vegetative growth. In the case of tree crops, however, the size of the internal pool of nutrients stored from one season to the next within the woody tissues influences the regulation and demand for nutrient uptake from soil.

Because woody perennial crops have a capacity to cycle some nutrients internally from season to season, plant tissue analysis is used extensively for diagnostic purposes. Leaf tissue samples collected from fruit trees in late July or early August are used to gage nutrient status. The findings from the previous season leaf tissue analysis test report may be used, along with a current soil test report to adjust and plan fertilizer practice.

Coordinating fertilizer applications with periods of high nutrient demand and uptake by trees improves fertilizer use efficiency. Nitrogen uptake by deciduous trees can occur throughout the year, but demand for N fluctuates over the growing season depending on the strength of the various vegetative and reproductive sinks for N. The amount of N uptake during a single year is generally small in relation to the total amount of N already present in the biomass of a mature tree.

In the spring before bud break there is little uptake of N from the soil into the woody parts of the tree. There is also modest N uptake from the soil during the first spring growth flush. The developing new leaf, shoot, and flower tissue is furnished with N primarily from nutrient reserves accumulated in bark and wood of roots, trunk, and stems during the previous year. The peak demand for N occurs during the early summer period when there is a high demand for N in developing leaf tissue and fruit. During the second flush of shoot growth, the tree has an increasing demand for external N, which is accompanied by increasing N uptake from the soil.

Trees generally respond well to application of N fertilizer towards the end of the first spring growth flush. In fruit trees, this timing of initial N application may correspond with approximately 4 to 6 weeks after bud break. The peak demand for external N (uptake from soil) is generally expected to occur in late spring or early summer. Most of the season's total N fertilizer should be applied in advance of this peak demand. The amount of N fertilizer to apply depends on tree age and size but application rate should be adjusted based on other growth and cultural factors (see below: "How to Determine Nutritional Needs of Trees").

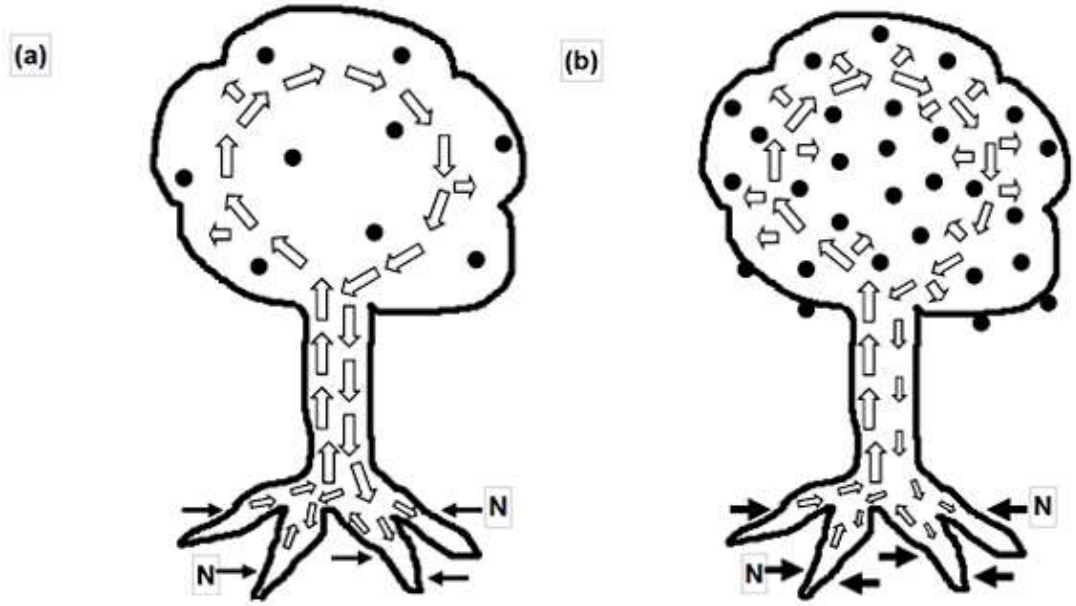
A significant portion of the N absorbed during summer becomes stored in woody perennial tissues. Also, in late summer, soon after maximum leaf area expansion, the N concentration in leaf tissue begins to decrease as N is exported from leaves to perennial tree parts. This process marks the onset of senescence when protein is exported from leaf tissue to storage in woody perennial tissues. As much as half of the N in leaves may be remobilized to storage tissues. This reabsorption of leaf N by deciduous trees conserves N that would otherwise be lost by leaf abscission.

Proteins are the major chemical form in which trees store N, but amino acids are the primary chemical forms of N that move within the tree from senescing leaves in the fall to woody storage tissues and from storage back to developing tissues in the spring. The pool of amino-N that cycles within the vascular system of the tree has a regulatory influence on N uptake. When this cycling pool of amino-N is large, such as during the spring growth flush, N uptake from soil is inhibited. As the pool of amino-N becomes depleted, there is less inhibition on N uptake by the roots and more N is taken up from the soil.

A heavy fruit load also draws from the pool of cycling amino N and reduces the inhibition on N uptake from the soil. In the fall with the onset of senescence, the pool of cycling amino-N increases as leaf N is mobilized to storage tissues and N uptake by roots from the soil is again inhibited. (Figure 2.1)

Figure 2.1 Tree Fruit Load and N Uptake from Soil

A tree with a small fruit load (a) has a larger pool of cycling amino N that inhibits N uptake from soil. A tree with a large fruit load (b) has a depleted pool of cycling amino N and less inhibition of N uptake from soil. Arrow size and direction illustrates the amino N concentration in the tree and demand for N uptake from soil (adapted from Youssefi, F., P.H. Brown and S.A. Weinbaum. 1999. Regulation of nitrogen uptake at the whole-plant level: a study in almond trees. HortTechnology 9(4)598-600).



In summary, N fertilizer applications should be coordinated with the cycles of plant demand for N. Tree crops should receive the major portion of their seasonal N application around the time of the initial flush of spring growth. This should coincide with the peak demand for N and improve recovery and efficiency of fertilizer N. If the fruit load is light or heavy the N application rate may be adjusted accordingly. An advantage of delaying a portion of a fruit crop's total N application until after fruit set is that it allows for adjustment of the N fertilizer rate in the event of a late spring frost. Late season and excess applications of N should be avoided because this may increase the susceptibility of buds and perennial tissues to cold injury. The N application rate should be adjusted based on a leaf tissue analysis performed the previous season and coordinated with cultural practices to minimize plant disease and enhance crop quality. Fruit tree N management should consider the potential influence of N supply on the fruit quality, vigor of shoot and spur growth, and flower development and fruit set in the following growing season.

Understanding Annual verses Perennial Crops

A common principal of N nutrition in all plants is that N promotes growth and leaf expansion. Export of N from senescing leaf tissue occurs in both annual crops and perennial crops. In annual crops this remobilized N is stored in seeds, while in perennial crops it is stored primarily in woody tissues. In either case, the function of this stored N is to support the initial growth in the following season. It should be noted here that there is a close connection between carbohydrate and N metabolism/storage in both annual and perennial crop tissues. The pool of N and carbohydrates stored in seeds is probably more limited than the pool of N and carbohydrates stored in woody perennial tissues. This factor, along with the shorter growth and smaller root system of the annual crop, accounts for why the N supply must be more concentrated and immediately available to annual crops. **This also explains why managing the nutrition of annuals emphasizes soil testing while for perennials the emphasis is on plant tissue analysis**.

2.2 How to Determine the Nutritional Needs of Trees

Fruit tree growers must make an annual judgment regarding the nutritional status of their trees. They must decide whether to continue with the past year's program or modify it in some manner to try to improve the productivity of their trees and fruit quality.

Soil testing can be used to evaluate soil acidity and soil fertility conditions before the growing season. Plant analysis can be used to evaluate the nutritional status of the trees during the growing seasons. Wise growers will use both diagnostic tools, along with a critical evaluation of their own notes made during the previous growing season, in arriving at a decision concerning the need to adjust soil fertility inputs and/or apply foliar sprays.

Foliar Tissue Analysis Overview

Leaf tissue analysis is a widely used method to monitor tree fruit responses to various cultural practices and to identify apparent nutritional disorders. In New Jersey, the nutritional status of fruit trees can best be diagnosed from analysis of leaf samples collected during the period between July 15 to August 15. Leaf mineral concentrations change throughout the growing season, so for consistency of interpretation, leaf collection must be performed during the appropriate period.

Foliar tissue analysis measures the levels of macro and micronutrients in plant tissue. It provides an assessment of the balance of nutrients being taken up by a tree with regards to deficiency, sufficiency, or toxicity. Optimal fruit tree foliar nutrient ranges for macro- and micronutrients are listed in Tables 2.1 and 2.2.

Keeping records of leaf tissue analyses over a period of years can help growers identify trends and inform growers of approaching nutrient deficiency or toxicity. This information may be used as a guide in making changes in limestone and fertilizer programs to better meet nutritional requirements. Interpretation of leaf tissue analysis data involves two separate and distinct functions: (1) decisions regarding which nutrient(s) have been causing an unwanted response, and (2) decisions regarding treatments necessary to improve the response. These functions require that the person evaluating the analytical results has a thorough knowledge of the ranges in leaf concentration values of fruit trees and is able to interpret and formulate fertilizer treatment options.

A leaf analysis program is offered to fruit growers through the NJ Tree Fruit IPM program. Growers who want to use this service should contact their county fruit extension agent or statewide fruit IPM agent in June of each year to review what blocks are to be sampled.

Table 2.1 Optimal Foliar Nutrient Ranges of Macronutrients for Different Fruit Trees

Nutrient (% Dry Matter)	Apple	Pear	Peach/Nectarine	Cherry
Nitrogen	1.0 - 2.0	1.60 - 2.40	2.50 - 3.40	2.30 - 3.30
Phosphorous	0.15 - 0.30	0.18 - 0.26	0.15 - 0.30	0.23 - 0.38
Potassium	1.2 - 2.0	0.20 - 2.0	2.10 - 3.0	1.0 - 1.90
Calcium	1.3 - 3.0	1.3 - 3.0	1.9 - 3.50	1.60 - 2.60
Magnesium	0.2 - 0.40	0.30 - 0.60	0.20 - 0.40	0.49 - 0.65
Sulfur	0.16 - 0.41	0.17 - 0.26	0.20 - 0.41	0.15 - 0.49

Table 2.2 Optimal Foliar Nutrient Ranges for Micronutrients for Different Fruit Trees

Nutrient (ppm, parts per million)	Apple	Pear	Peach/Nectarine	Cherry
Boron	35 - 50	35 - 80	25 - 50	39 - 80
Iron	40 - 100	50 - 400	51 - 200	50 - 250
Manganese	22 - 140	20 - 200	19 - 150	18 - 150
Copper	6 - 25	6 - 25	6 - 25	6 - 25
Zinc	20 - 200	20 - 200	20 - 200	20 - 200

Procedures for Foliar Tissue Sampling

As with soil fertility, nutrient status of leaves should be monitored by sampling leaf tissue every 1-3 years or more often if necessary. Samples of 50-60 leaves should be taken 60-70 days after petal fall (July 15th through August 15th). Leaf analyses should be performed at least every 3 years to monitor nutrient status or more often if necessary. Leaves should be collected from trees of the same cultivar and age. Avoid mixing cultivars, rootstocks, or trees under different management. Also, avoid sampling after pesticide cover sprays which can leave residues that may skew results. The leaves should be normal looking leaves taken from the midpoint of the current season's shoot growth. The leaves should come from branches midway up the tree (about shoulder height) in the outer canopy. The person collecting the leaf samples must have clean hands. Be careful to prevent leaf samples from becoming contaminated with any kind of dust or soil.

Soil Analysis Overview

A soil test provides an index of soil nutrient availability that is correlated with plant response. It is not a direct measurement of the total plant-available nutrient content of a soil even though it may be reported in units of pounds per acre. Soil test results and interpretations are specific for the soils of a region and for the soil test method employed.

Reading and understanding the soil report from any laboratory depends on knowing what soil test method was used and what units are used to express the soil nutrient levels, *i.e.*, pounds per acre, or parts per million (ppm). Most labs will specify on the soil test report units and extraction method, as well as interpretive information. If not, contacting the lab is advised. Many different types of soil test extraction methods are in use, but only a few are appropriate for our local soils. The Mehlich-3 soil test is used by the Rutgers Soil Testing Laboratory and is the most widely used method in the Eastern United States.

Procedures for Soil Sampling

Soil samples should be taken in the fall months following the harvest season, and sent to the laboratory for analysis, so that the information provided by the test is available for decision making before the spring rush. Growers that wait until the spring months to take soil samples may not get the results of the tests back from the laboratory in time to make effective use of them.

Take separate soil samples from under the tree dripline and from the grass sod rows. Collect about 15 cores from each area by sampling the 0–6-inch depth. Label each soil sample by location and date.

Soil Fertility Test Interpretation

A soil fertility test evaluates the nutrient-supplying power of a soil. Test results are used to predict if, or how much, fertilizer is required for optimum plant growth. Even though soil tests do not directly measure soil nitrogen availability, test results for organic matter content can provide an indication of the nitrogen suppling capacity of a soil. An estimated 15 to 20 lb/A of nitrogen is released and available for uptake by trees annually from each percent soil organic matter content. An orchard site with 2% soil organic matter content can potentially supply 30 to 40 lb of available N whereas a soil with 4% organic matter may supply 60 to 80 lb of available N per acre. Thus, depending on organic matter content, a soil may supply a significant part of the tree nitrogen requirement.

Nitrogen fertilizer recommendations shown in Tables 2.3 and 2.4 may be adjusted if soil test organic matter content levels are outside of the norm for a given soil texture. For **sandy loam** soils 2% organic matter content is typical, a 1% organic matter content is low, and 3% organic matter content is very good. On the other hand, a **silt loam** soil with 3% organic matter content is typical, a 2% organic matter content is very poor, and 4% organic matter content is very good. When soil organic matter contents are well above the norm for a given soil texture, the N fertilizer rates listed in Tables 2.3 and 2.4 may be reduced by 10 to 20%. Leaf tissue analysis results for N from the previous growing season should also be taken into consideration (see Table 2.1 for the range for optimal foliar N concentration).

The conceptualized relationship between soil test nutrient levels and plant response is shown in Figure 2.2. Relative soil fertility levels for the major nutrients (phosphorus, potassium, magnesium, and calcium) are classified into three main categories: **Below Optimum**, **Optimum** and **Above Optimum**. Below Optimum is divided into

subcategories: **Very Low**, **Low**, and **Medium**. These soil fertility categories gauge the probability of a plant having a beneficial response to the addition of a given nutrient, assuming that other crop production factors (*e.g.*, bad weather) are not limiting. The soil test categories are the basis for phosphorus (P) and potassium (K) fertilizer applications. In the case of liming recommendations, soil test categories for calcium and magnesium are used to select the most appropriate type of limestone, calcite, or dolomite.

Table 2.3
Nutrient Recommendations for Preparing Soils for New Tree Plantings and Maintaining Orchard Middles for Apple, Peach and Other Tree Fruit Production[1]

Crop	Recommended Plant Nutrients Based on Soil Tests								
	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level				Soil Potassium Level			
		Low	Medium	High	Very High	Low	Medium	High	Very High
		Pounds P_2O_5 per Acre				Pounds K_2O per Acre			
Cover crops at seeding time									
Legume-grass mixtures	20-30	100	50	25	0	100	50	25	0
Grasses only	25-50	100	50	25	0	100	50	25	0
Topdressing sod crops									
Legume-grass mixtures	0	100	50	25	0	100	50	25	0
Grasses only	20-30	75	50	25	0	75	50	25	0

[1] Sod crops growing in orchard middles should be fertilized biannually in October or November, where an individual tree fertilization program is being followed as suggested in Table 2.4. Sod crops in orchard middles usually will not need fertilizing if a broadcast fertilization program is being followed that covers the entire orchard area.

Table 2.4 Nutrient Recommendations for Tree Fruit Production[1,2,3,4,5,6]

Crop	Recommended Plant Nutrients Based on Soil Tests						
	Nitrogen (N) Pounds per Year	Soil Phosphorus Level			Soil Potassium Level		
		Low	Medium	High	Low	Medium	High
		Pounds P_2O_5 per Year of Tree Age			Pounds K_2O per Year of Tree Age		
Apples							
Nonbearing trees	0.1 - 0.2	0.2	0.1	0	0.2	0.1	0
Bearing trees	0.05 - 0.1	0.1	0.05	0	0.1	0.05	0
Pears							
Nonbearing trees	0.05 - 0.1	0.2	0.1	0	0.2	0.1	0
Bearing trees	0.025 - 0.05	0.1	0.05	0	0.1	0.05	0
Peaches, nectarines, cherries and plums							
Nonbearing trees	0.1 - 0.2	0.2	0.1	0	0.2	0.1	0
Bearing trees	0.05 - 0.1	0.1	0.05	0	0.1	0.05	0

[1] Recommendations in this table were developed for spreading the total fertilizer requirement in the drip area under trees. When fertilizer is broadcast over more area than is occupied by the drip area of trees, increase fertilizer rate so that the approximate rates recommended in this table will be applied under the drip area of trees. For example, if the drip area of trees occupies 50 percent of the land area, then multiply rates recommended in the table by the number of trees per acre and then double this rate to determine the rate per acre for broadcast application.

[2] Mature, standard-size apple trees require 0.5 to 1.5 pounds of nitrogen (N) per year per tree. Dwarf apple trees require 0.25 to 0.75 pound of nitrogen (N) per year per tree. Pear trees should receive less nitrogen than apple trees because of fire blight problems. Mature peach, nectarine, cherry, and plum trees require 0.5 to 1 pound of nitrogen (N) per year per tree. Nitrogen needs of tree fruits depend on variety, rootstock, tree vigor, soil type and fertility level, and pruning and weed control practices. Apply nitrogen or mixed fertilizers on sandy loam or loamy sand soils 1 month before bloom. Nitrogen or mixed fertilizers may be applied earlier on loam and silt loam soils. Heavily pruned trees need considerably less nitrogen than moderately pruned trees.

[3] Apply limestone as needed to maintain soil pH near 6.5.

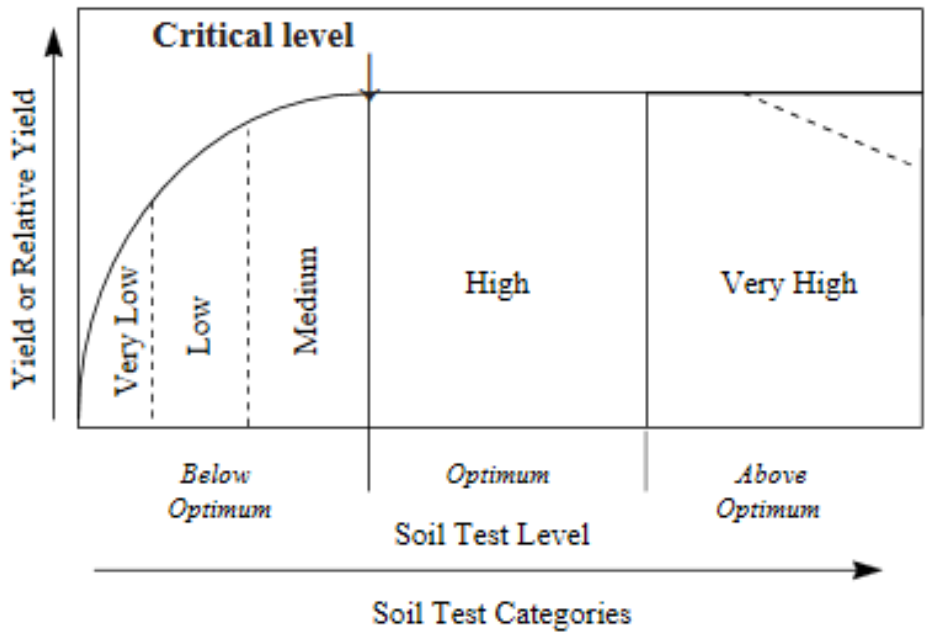
[4] Broadcast 1 to 2 pounds of actual boron (B) per acre of mature apple trees that have been diagnosed to be boron deficient. This is in addition to boron sprays recommended for apples. If using fertilizer borate (14.9% B) apply 6.7 lb/A of this product to supply 1 lb of boron. Or if using Solubor fertilizer (20.5% B) apply 4.9 lb/A of this product to supply 1 lb of boron.

[5] For dwarf trees, reduce application rates in the table by half for nitrogen, phosphorus, and potassium.

[6] The fall and winter months are often the best and most convenient times to apply needed lime applications in fruit orchards. Fertilizer applications are generally more effective if they are split. About half of the season's total fertilizer N application should be applied in late March before bloom. Apply the remainder of the recommended N application in May, after bloom. If fruit load has been reduced due to late freezes, adjust, or reduce this N fertilizer application accordingly.

Figure 2.2 Soil Test Response Curve

This conceptual soil test response curve is divided into categories that correspond with **Below Optimum**, **Optimum**, and **Above Optimum** soil test values. The critical level is the soil test level below which a crop response to a nutrient application may be expected, and above which no crop response is expected. At very high soil test levels, crop yield may even decrease due to nutrient excess or imbalance.



Definition of Soil Fertility Test Categories for Macronutrients:

Below Optimum (Very Low, Low, Medium)

The nutrient is considered deficient and will probably limit crop yield. There is a high-to-moderate probability that crops will benefit from additions of the nutrient.

Optimum (High)

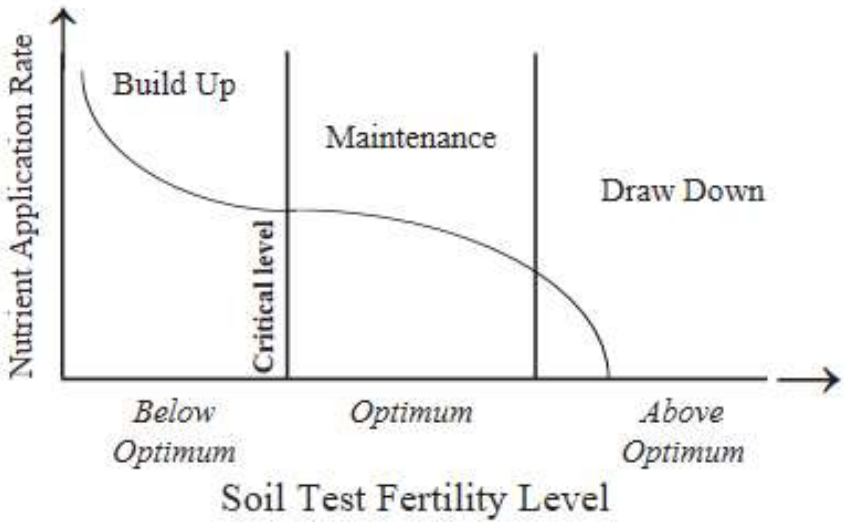
The nutrient is considered adequate and addition of more of the nutrient will probably not benefit crop production. A maintenance application may be recommended to account for nutrient removal.

Above Optimum (Very High)

The nutrient is considered more than adequate and will not limit crop yield. There is a very low probability of a benefit from additions of the nutrient to crop production. At very high levels there is even a possibility of a negative impact on crops if nutrients are added. Thus, no application of the nutrient is recommended.

When the soil fertility category is Below Optimum, the nutrient recommendation for a particular crop is designed to achieve its full crop yield potential and to build the soil fertility level into the optimum range over time. If the soil fertility level is already in the optimum range, the nutrient recommendation is designed to replace the amount of nutrient removed by the crop to maintain optimum soil fertility. No nutrient application is recommended when the soil test category is above optimum. This allows "draw-down" of the nutrient level to the optimum range. These concepts are illustrated in Figure 2.3.

Figure 2.3 Nutrient Application Rates in Relation to Soil Test Category



Soil Test Interpretation for Micronutrients

The Rutgers Soil Testing Laboratory also tests for the micronutrients Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), and Zinc (Zn). Soil test interpretations for micronutrients are described as either "Low", "Adequate", or "High". Because micronutrient availability is strongly influenced by soil acidity, soil pH must also be considered for interpretation. Except for molybdenum, most micronutrients become less plant available as soil pH increases. A soil test level of "Low" indicates the micronutrient is very likely deficient. A soil test level of "Adequate" is probably not deficient but leaf tissue analysis and soil pH should be considered as part of the interpretation.

Sustainable Nutrient Management

A major objective of nutrient management is to bring the soil fertility level into the optimum range and to sustain that fertility level for the long term. Once the soil fertility has been built up to the optimum level, the nutrient application rate should be only large enough to maintain the optimum level. This can be accomplished by applying nutrients at a rate that closely matches the rate of nutrient removal in the harvested crop.

On average, a 500-bushel per acre yield of apples would remove 10 lb P_2O_5 and 45 lb K_2O and a 600-bushel per acre yield of peaches would remove 35 lb P_2O_5 and 20 lb K_2O.

Keeping records of soil test results enables growers to track changes over time and to adjust recommendations as needed, to maintain soil fertility in the optimum range. Meaningful records require a consistent approach to soil testing in terms of sample collection, sampling depth, and laboratory submission. Soil test levels can vary somewhat from sample to sample, and having records helps to spot unusual soil test values that should be rechecked.

If soil fertility levels are observed to fall below optimum, under-fertilization is indicated. The nutrient recommendation should be adjusted so that the nutrient application rate is large enough to meet the needs of the current crop and gradually rebuilds the nutrient supply to the optimum level. If soil fertility levels are observed to climb well above optimum, over-fertilization occurs by the application of additional nutrients. Good crop yields can be obtained without adding the nutrient. Over time, nutrient removal by crops should allow the soil fertility level to fall back into the optimum range.

2.3 Liming Soils for Fruit Trees

The optimum soil pH for tree fruit production is slightly acid with a target of pH 6.5. Most soils in the Mid-Atlantic region are naturally acidic and tend to become more so because of crop removal of calcium and magnesium and from the use of ammonium-based fertilizers. When soil pH in the orchard approaches pH 6.0, liming is necessary to adjust it towards a soil pH of 6.5 and to supply crops with calcium and magnesium. For an effective program, results of both the soil pH and the soil fertility test are needed to determine the amount and type of liming material to apply.

The application rate of limestone needed to raise soil pH is much greater on fine texture soils than it is on coarse texture sandy soils. For example, a sandy loam soil with a starting soil pH level of 6.0 may need an application of 1800 pounds of limestone per acre to reach pH 6.5. Whereas a silt loam soil may need 4500 pounds of limestone to raise soil pH by the same amount. See Table 2.5 for information on the relationship between soil pH and soil texture as a guide to limestone application rates. However, when a soil test includes a "buffer pH" (aka Lime Requirement Index), the soil test report will provide a better estimate of the limestone application rate based on the soil's pH buffering capacity.

Because liming materials are not pure substances, actual application rates should be based on the Calcium Carbonate Equivalent or CCE. Thus, soil test recommendations for liming soils should be given in pounds of calcium carbonate equivalent per acre (lb CCE/A). Pure calcium carbonate ($CaCO_3$) has a CCE of 100% and is the standard against which all liming materials are measured. The CCE of liming materials available in New Jersey may vary from 40 to 179%. However, the more commonly available calcium carbonate-based limestone materials typically have CCE values in the 80 to 100% range. The CCE of a liming material must be given on the product label by law.

The amount of liming material needed to supply a given quantity of CCE can vary considerably and needs to be calculated. The following is an example of how to calculate the corresponding application rate of a given liming material:

1) Soil test recommendation is to apply 2000 lb CCE/A. The liming material as purchased has 80% CCE.
2) Actual amount of liming material required: (2000 ÷ 80) x 100 = 2500 lb liming material/A.

An alternative approach to determining the application rate of limestone is to base the estimated limestone application rate on soil pH and soil texture. The soil texture classification (*i.e.*, loamy sand, sandy loam, loam, or silt loam) may be considered a fixed property of a soil because it is not readily changed. Once soil texture is known and soil pH is measured, a soil's lime requirement can be estimated. The Rutgers Cooperative Extension fact sheet FS902 "Liming New Jersey Soils for Fruit Crops" (*https://njaes.rutgers.edu/pubs/publication.php?pid=FS902*) has tables showing how much limestone is needed. Be careful to avoid over-application of lime because an excessively high soil pH may induce nutrient deficiencies.

Table 2.5
Recommended Pounds of Calcium Carbonate Equivalent per Acre (lb CCE/A) for a Target Soil pH of 6.5

	Soil Texture			
Initial Soil pH	**Loamy Sand**	**Sandy Loam**	**Loam**	**Silt Loam**
4.1-4.4	4500	5400	9800	11600
4.5-4.8	3600	4500	8100	9800
4.9-5.2	2700	3600	6300	8100
5.3-5.7	1800	2700	4500	6300
5.8-6.0	900	1800	2700	4500
6.1-6.4	500	900	1800	3600
Above 6.5	0	0	0	0

Selection of Liming Material

Selection of an appropriate liming material depends on the degree of soil pH correction required and the need to replenish soil Ca and Mg. Fine sized liming materials are recommended when rapid neutralization of soil acidity is desired. Medium and coarse sized liming materials are best suited for maintenance of soil pH once the desired soil pH range has been attained using fine sized liming material.

For apples, it is very important that soil Ca levels be given consideration, because bitter pit and cork are associated with inadequate Ca levels in the fruit. Soil and leaf tissue samples should be analyzed, and corrective lime or gypsum treatments made, where necessary, to make sure that soils are kept adequately supplied with Ca. In general, the need for a liming material containing Mg occurs more frequently on sandy soils. Fine textured (loam and silt loam) soils frequently need liming materials with a high Ca and low Mg concentration.

Application of Liming Materials

Careful attention to liming prior to planting orchards is very important. Once the trees are established, it is difficult to correct a soil acidity problem using surface applications. Liming materials can be applied at any time of the year, provided weather and soil conditions permit. Limestone is slow to react in soil. The desired soil pH increase may require several months, and may be reduced by using fine sized liming materials. Thus, it is important to apply limestone well in advance of planting.

Soils naturally become acidic over time. The frequency of lime application varies with soil characteristics, cropping system and fertilizer practice. Use of ammonium and urea nitrogen fertilizers causes soil acidification. Soil testing for pH measurement should be performed every two to three years. Reapply limestone as recommended by soil testing to avoid development of excess acidity in the root zone.

Lime Placement

Lime applications are most effective at neutralizing acidity when they are spread uniformly and thoroughly mixed with the soil by plowing, disking, and harrowing. When fields are to be plowed and the limestone recommendation exceeds 3,000 pounds per acre, it is best to use split applications. Plow under half the needed amount and apply the other half after plowing and then disk in as deeply as possible. Liming rate recommendations are generally based on an assumed plow depth of 8 inches. In the case of 10-inch plow depth, multiply the usual application rate by 1.2 to adjust to the deeper treatment layer.

After broadcasting limestone, orchard soils should be sub-soiled to a depth of 2-3 feet in two directions prior to sod establishment and planting. Sub-soiling serves to break up hardpans and it helps to move limestone particles and nutrients down into the root zone. This practice is best done after a dry period when the soil hardpan is more susceptible to fracture.

In already established orchards where tillage is not possible, limestone should be surface applied, but the rate of pH adjustment will be much slower. Monitor soil pH change and the need for liming to avoid the need for high limestone rates. Surface limestone application rates should not exceed 3,000 pounds CCE per acre.

Limestone and fertilizer work together as a team to produce crop yield and quality. The proper use of the two together makes for profitable fruit crop production.

2.4 Soil Management for New and Established Plantings

Selection of Soils for New Plantings

The best soils for growing fruit trees are medium textured, friable, well-drained soils that are deep with no hard pan. They have good structure and have been adequately limed and fertilized at least two years prior to new orchard establishment. Apples can be grown successfully on sandy loam, loam, and silt loam soils. Most clonal dwarfing apple rootstocks do not perform well on course textured sandy soils. Loamy sand soils should be avoided, especially where adequate irrigation is not feasible. Winter injury problems in peach trees appear to be more severe on soils having very sandy subsoils. Soil organic matter levels should be near 2% for sandy loam soils and around 3 to 4% for loam and silt loam soils.

Good subsoil aeration and drainage are essential for good growth and longevity of fruit trees. Soils that have high water tables or poor internal drainage, resulting from compacted soil layers, should not be used for planting sites. Avoid planting trees in areas where surface or subsoil water accumulates and remains for several days following heavy rains or irrigation. It is difficult or impossible to establish and maintain a good orchard on poorly drained soil sites.

It is highly recommended that a soil excavation pit be completed two years prior to the establishment of an orchard on a potential site. Several holes should be dug down through the topsoil and subsoil to look for shale, clay layers, or hardpans caused by excessive soil compaction.

On rolling landscapes, side slopes provide desirable orchard sites. Bottom of slopes or lowlands are more susceptible to frost injury and should be avoided.

Soil Preparation for New Plantings

No fertilizer should ever be put into the soil at the time of tree planting. Tree nurseries may void tree warranties if any fertilizer is added to the planting hole.

New orchards should be planned out 1-2 years in advance of planting. Soils to be used for new plantings of fruit trees should be adequately limed and fertilized based on soil test recommendations from the previous year. The recommended target soil pH for orchard sites is pH 6.5. If soil test recommendations call for liming, the limestone should be broadcast and incorporated with tillage in the year before planting.

Commercial calcite limestones (also referred to as high calcium limestones) mined from the Earth are never pure calcium carbonate. A typical product label will show that it is approximately 40% calcium along with about 1% magnesium. Dolomite limestones are chemical blends of calcium and magnesium carbonates; a typical product label may show that it contains about 20% calcium and 10% magnesium. By New Jersey state law, the exact elemental composition must be shown on the limestone product label.

Soil testing must be used to determine the right type of limestone and how much to apply. Soil test reports based on the Mehlich-3 method should report percent saturation of the CEC (Cation Exchange Capacity) with the three major cation nutrients: calcium, magnesium, and potassium. Properly limed fertile soils with a pH near 6.5 will typically have CEC exchange sites occupied with about 68% calcium, 12% magnesium, and 3 to 5% potassium. These soil test CEC saturation percentage levels are not requirements but rather they each serve as a useful target. When a soil test report shows that exchangeable calcium levels are below the 68% saturation level, calcite limestone (high calcium limestone) should be the type applied.

The reason for emphasizing the use of calcite limestone for most orchards is because it is a source of calcium that is very important to fruit quality. Inadequate calcium levels in apple fruit are associated with bitter pit and corking. Except for soils that test very low for available magnesium, calcite limestone is the preferred liming material. Although dolomite limestone (which supplies calcium and magnesium) may be used in those cases, excessive application of magnesium to orchard soils may result in reduced uptake of calcium, a nutrient critical to fruit quality. Never use high magnesium limestone on soils that test medium or high in magnesium.

Occasionally soil test results show that soil pH is sufficiently high (pH 6.5) and liming is not recommended. However, if soil test levels for calcium are still low and magnesium levels are high, an application of supplemental calcium is recommended. Where extra calcium is needed, calcium sulfate (or gypsum 23% Ca) is an excellent source. Gypsum supplies plant available calcium and sulfur yet it does not appreciably change soil pH. Typical application rates for gypsum range from 1 ton/A on sandy loam soils to 2 ton/A on silt loam soils. Whether adding calcium as limestone or from gypsum, appropriate application rates may be calculated based on data for targeted cation saturation levels as shown in Table 2.6.

A simple but less accurate guide to liming practice is to select the type of liming material based on soil test levels for calcium and magnesium. Soil test levels for major nutrients on the Rutgers Soil Test Report are expressed as Below Optimum, Optimum, or Above Optimum. Calcite limestone should be used except when magnesium soil test levels are rated as well Below Optimum. A more advanced and accurate guide to liming practice factors in the initial soil pH, the target soil pH, and the soil texture as listed in Table 2.5.

Table 2.6 Target Cation Exchange Values for Calcium, Magnesium, and Potassium

CEC (meq.L)	Calcium 68%	Magnesium 12%	Potassium 5%
2	544	58	78
4	1088	115	156
6	1632	173	234
8	2176	230	312
10	2720	288	390
12	3264	346	468
14	3808	403	546
16	4352	461	624
18	4876	518	702
20	5440	576	780

Permanent Sod Establishment

Permanent sod covers in new orchard middles help prevent soil compaction, decrease surface water runoff, increase soil-water infiltration rates, minimize wind and water erosion, maintain or increase soil organic matter content, conserve plant nutrients, and make it easier to move sprayer and other equipment in the orchard during wet periods. It is very important to treat sod middles to eliminate broadleaf weeds, which not only compete with trees for the attention of bees during bloom, but may also harbor harmful insects and act as virus vectors in orchard settings.

Seed areas to a permanent sod cover at least 6 months in advance of planting trees. Application of phosphate fertilizer at 25 lb/A P_2O_5 helps bring about more rapid sod establishment (Table 2.3). Hard and tall fescue cultivars are the preferred species. Fall is the best time to establish new sod, with August 15 through September 15 as your target seeding dates. This permanent sod should be left in the row middles when planting new trees.

In the tree row, either plant through killed sod, or use tillage to make rows for planting trees. Killed sod remaining in the tree row has several benefits such as suppressing summer annual weed growth, maintaining organic matter, and assisting in water retention and infiltration during the first season of establishment. For specific sod cover recommendations, see the Orchard Floor Management section in the Weed Control in Orchards chapter.

Soil Management for Established Plantings

Soil management in established plantings of apples and peaches can be divided into two distinctly different programs:

1) Soil Management for Tree-Row Middles.

Maintain a permanent sod cover, of tall or hard fescue and their combinations, in tree-row middles of apples and peaches. Tree-row middles in both apples and peaches should be kept adequately limed based on soil tests to maintain a soil pH near 6.5. The grass sod should be fertilized with about 25 to 50 lb N/A annually in the fall to maintain a dense permanent sod cover (Table 2.3).

2) Soil Management under Drip Area of Fruit Trees.

Keep soil areas under trees as free of vegetation as possible to eliminate weed competition with the trees for moisture and nutrients. This is the area from which the trees derive most of their water and nutrients for growth and production. Adequate lime and fertilizer should be provided in this area based on the results of soil and plant analyses (Table 2.4). Mulch or compost may be applied under trees to build organic matter content and soil water holding capacity.

2.5 Guidelines on Nutrients, Soil Tests, and Leaf Analyses

Macronutrients

Nitrogen (N)

Available N from soil is usually not enough to meet the needs of fruit trees. Slow growth and yellowing of leaves (especially older leaves) are signs of N deficiency. Supplemental N fertilizer can be applied to balance a shortfall from the soil. Excessive use of N fertilizer is also a concern. It can cause excessive growth, degrade fruit quality, and increase susceptibility to plant diseases such as fire blight. If leaf analysis finds a high N level and tree vigor is high, reduce the N application rate next season. If leaf analysis finds a low N level and tree vigor is low, increase the N application rate next season. Also consider observations on leaf color and environmental stress factors.

Phosphorus (P)

Many NJ soils are well supplied with P. Soil testing is an effective way to identify the occasional orchard site where P is a limiting nutrient. Symptoms of P deficiency are exhibited as darker than normal leaf color. Fertilizer P is most beneficial before new orchard establishment and for seeding of grass alleys. On established orchards where soil tests and leaf analyses indicate P levels are high, eliminate P fertilizer application.

Potassium (K)

Loams and silt loam soils can provide more K than sandy soils, and deficiency of K occurs most often on sandy soils. Symptoms of K deficiency appear first on older leaves as yellowing or necrosis around the leaf edge. Potassium draws water into plant cells and for this reason K fertility is very important to fruit size. Soil testing is an effective way to access soil K availability. Fertile soils should have between 3 to 5% exchangeable K. If leaf analysis finds a high K level and soil test K is high, decrease K application rate next season. If leaf analysis finds a low K level and soil test K is optimum or below, increase K application rate next season. It is important to balance the needs of this nutrient against the needs for calcium and magnesium, which all compete for plant uptake. Excess K application tends to suppress uptake of calcium and magnesium.

Calcium (Ca)

Soils properly limed to pH 6.5 are generally well supplied with this nutrient. Calcium uptake into the growing fruit is very important to quality. A deficiency of Ca is associated with fruit disorders such as bitter pit in apple and cork spot in pear. Fertile soils at pH 6.5 should have an exchangeable Ca saturation close to 68%. Calcium sprays are commonly applied during the growing season to improve fruit quality and reduce the incidence of bitter pit and cork spot in pome fruits.

Magnesium (Mg)

Soils properly limed to pH 6.5 are generally well supplied with this nutrient. Magnesium deficiency is not common on fruit trees in NJ. A deficiency of Mg is exhibited as yellowing between the veins on older leaves. Fertile soils at pH 6.5 should have an exchangeable Mg saturation close to 12%. Growers should strive for a balance between K, Ca, and Mg. Selection of the appropriate liming material, calcite limestone versus dolomite limestone, as guided by soil testing is key to achieving that balance. If leaf analysis and soil tests find low levels of Mg, fertilizer magnesium may be applied.

Sulfur (S)

Soil testing for sulfur is not common practice, but leaf tissue analysis reports from samples collected across NJ suggests that S deficiency is becoming more common. Sulfur is needed by crops in about the same amount as P. Until recently there was an abundance of S freely available from the atmosphere from combustion of sulfur-containing fuels. However, advances in air quality standards have now increased the potential for S deficiency in crops. Typical symptoms of S deficiency are yellow or pale green leaves and slow growth. These symptoms are sometimes mistaken for N deficiency. But unlike N deficiency, S deficiency is exhibited most clearly on younger leaves. Reduced flowering and increased susceptibility to plant diseases are also associated with S deficiency. If leaf analysis detects low levels of S, apply S fertilizer. Use of commercial fertilizers such as ammonium sulfate, potassium sulfate, or gypsum will prevent S deficiency. Compost is also a good source of S.

Micronutrients

Boron (B)

Fertilizer B application is common practice for orchards, but it should be guided by soil testing and leaf tissue analysis to evaluate B status. Boron is lost from soil by leaching. Sandy soils with low levels of organic matter are most vulnerable to B deficiency. Where B fertilizer is needed but neglected, deficiency symptoms will likely follow. Boron deficiency symptoms are exhibited as death of growing points, failed flower development, and poor fruit set. Other symptoms may include misshapen fruit, internal cork, cracking, fruit drop, discolored fruit, and reduced yield. Soil test levels less than 1 ppm B indicate B deficiency. If leaf analysis and soil testing find low levels of B, apply 1 to 3 lb/A B fertilizer as a broadcast over soil. Boron fertilizers can also be applied as foliar spray but each spray solution should not exceed 0.3 lb B per 100 gal water. Multiple applications of B sprays at low rates are preferred. Best times for B sprays are after harvest or in spring just before flowering. When B is sprayed before flowering it can enhance fertilization of flowers and fruit set. Boron application rates must be carefully calculated to avoid over-application since excessive application of B by mistake can be toxic. If soil test B levels are high, suspend B fertilization.

Chlorine (Cl)

This nutrient is typically present in soils and plants as the negative ion known as chloride. Often chloride is accompanied by sodium (Na) in which case it is known as salt. Although chlorine is classified as a micronutrient, it can be taken up in amounts comparable to levels of macronutrients. Excessive uptake of Cl along with Na is an indication of salt toxicity. In moderate amounts, Cl helps with plant water relations and disease resistance. It also plays a role in photosynthesis. Chloride is a constituent of many commercial fertilizers and manures and so supply is seldom a limiting factor in crop production.

Copper (Cu)

Soil testing and leaf tissue analysis are effective ways to evaluate Cu status. Copper deficiency is not common in NJ orchards. Copper containing pesticide sprays can leave behind residues on leaf samples which can distort interpretation of plant tissue analysis. If Cu leaf analysis levels are high, consider possible contamination from sprayed products. If Cu leaf analysis and soil test levels are low, broadcast 10 lb/A of Cu using cooper sulfate. Usually, a single application of Cu fertilizer will correct a Cu deficiency for many years.

Iron (Fe)

Soil testing and leaf tissue analysis are not definitive ways to evaluate Fe status. Iron deficiency in orchards is not common in NJ. Deficiency symptoms are exhibited on leaves as loss of chlorophyll or yellowing between green veins. When deficiency occurs, it is probably a result of applying too much limestone and an excessively high soil pH. Measuring soil pH is a useful diagnostic test to explain why Fe may be deficient.

Manganese (Mn)

Soil testing along with soil pH measurement is an effective way to evaluate Mn availability. Manganese deficiencies are common on many types of crops grown on the sandy coastal plain soils of NJ. Deficiency symptoms for Mn are much like those described for Fe: loss of chlorophyll or yellowing between green veins. Applying too much limestone and an excessively high soil pH can lead to Mn deficiency, especially on sandy soils. On loamy soils and in the northern region of NJ, Mn deficiency is not common. If leaf analysis finds low levels of Mn, correct the deficiency by applying 1 lb/A of Mn as a spray. Manganese fertilizer sprays are a more effective treatment than soil applications of Mn fertilizer. Manganese sulfate or chelate Mn products are effective Mn fertilizers. Manzate is a widely used pesticide in orchards and it contain Mn. Spraying Manzate probably provides more than enough of Mn to prevent deficiencies. Spray residues from the use of Manzate may confound any interpretation of plant tissue analysis for Mn.

Molybdenum (Mo)

Deficiency of Mo is not common in orchards. Availability of Mo increases as soil pH increases. Molybdenum is needed for biological N fixation and for metabolism of nitrate in plants.

Nickel (Ni)

Although Ni is classified as an essential nutrient, research is needed to understand its role in tree fruit production (some research suggests it may be important for disease resistance). Ni deficiency has been observed to occur in pecan orchards where symptoms are described as "little leaf" or "mouse ear". Nickel is a component of the enzyme urease and is involved in urea metabolism. Leaf analysis and soil testing are not common practice for Ni.

Zinc (Zn)

Zinc deficiency is widespread in tree fruit crops; it is a common nutritional malady in peach, apple, and pecan. Zinc is essential to several plant enzyme systems and is involved in the synthesis of the growth hormone indoleacetic acid, which regulates stem elongation. Zn deficiency symptoms include stunted growth, shortened internodes (rosetting), leaves that are smaller and narrower than normal (little leaf), and light green areas between the veins of new leaves (chlorosis). In peach, Zn deficiency typically appears as rosetting and little leaf. Because Zn is relatively immobile in trees, a continuous supply of this nutrient is needed throughout the growing season. A critical period for Zn nutrition is between budbreak and fruit set. Zinc deficiencies at this stage may stunt leaf and shoot growth and result in abnormal development of pollen tubes and poor fruit set. Later in the season, Zn deficiency may be exhibited as small fruit and/or poor color development.

Many factors influence soil Zn availability. On average, NJ coastal plain soils have lower levels of plant available Zn than the finer textured soils of Northern NJ. Soil pH has a marked influence on Zn availability. As soil pH increases, Zn availability decreases. Excessive application of limestone may induce Zn deficiencies. Very high soil test levels of P are antagonistic to Zn nutrition and may increase the incidence of Zn deficiency. Repeated application of more P fertilizer to soils already above the optimum for P can aggravate Zn deficiency problems. Phosphorus-induced Zn deficiency is common in over-limed soils. Mycorrhizae, a beneficial symbiotic relationship between soil fungi and plant roots, can assist Zn uptake by trees. Phosphorus fertilization, however, often suppresses mycorrhizal colonization of plant roots. Zinc availability is generally greater from organic matter rich, surface soil than from subsoils. Thus, severely eroded soils are more prone to Zn deficiency. Weather conditions can also influence Zn availability. Zinc deficiencies are more common during cool, wet, spring weather, because low soil temperatures decrease Zn availability and cloudy weather reduces the ability of plants to take up Zn.

Soil test zinc levels only provide a rough guide to zinc nutrition of trees but can be useful for diagnostic purposes when used along with leaf tissue analysis. Zinc soil fertility levels (Mehlich-3 soil test) are generally considered adequate in the range of 1 to 50 ppm. However, this soil test is not always a good predictor of the responsiveness of trees to zinc fertilization because of the influences of other soil factors.

Leaf tissue analysis is a useful way to evaluate Zn nutritional status of trees, but one must be aware of several factors that may impact interpretation. The presence of Zn residues on leaves from previous Zn foliar fertilizations or from Zn containing fungicides (such as Ziram or Mancozeb) can make leaf tissue analysis difficult or impossible to interpret. In addition, leaf tissue Zn concentrations from Zn treated trees may sometimes be confounded by a dilution effect resulting from increased growth. The desired level of Zn in leaf tissue for tree fruits is 35 to 50 ppm. Zinc levels between 20 to 35 ppm are considered low, and when they are below 20 ppm, they are deficient. Phosphorus concentrations in leaf tissue should be examined at the same time as Zn because P tends to reduce the physiological activity of Zn within the tree because of the formation of Zn precipitates. Leaf tissue P concentrations should be 0.13 to 0.33%. The ratio of P to Zn in leaf tissue has been suggested as a way to evaluate the relative Zn status. To make this calculation, it is necessary to convert P from percent to ppm by multiplying by 10,000. A P to Zn ratio greater than 150 indicates Zn deficiency, a ratio in the range of 100 to 150 indicates that Zn is low, and a ratio less than 100 indicates that the Zn nutrition level is adequate. Note, however, that these diagnostic criteria cannot be used if the trees were sprayed with Zn or a Zn containing fungicide.

There are many Zn fertilizers, but only zinc sulfate, which contains 35.5% to 36% Zn, and zinc chelates are recommended for use on tree crops. Zinc oxide is not recommended because it has a poor availability for plant uptake. Some zinc materials that are being sold as fertilizer zinc sulfate are of low solubility and/or have high levels of contamination with heavy metals such as lead (Pb) or cadmium (Cd). To avoid these inferior products, only purchase zinc sulfate fertilizers that contain at least 35.5% Zn and appear white. In Washington state, all commercial fertilizer products must be tested for nine different heavy metals and the results are posted at: *https://agr.wa.gov/departments/pesticides-and-fertilizers/fertilizers/product-database*

Because many of the fertilizers listed at that website are national brands, farmers in NJ can use this information for selecting products with the lowest levels of heavy metals. There are several forms of chelated Zn fertilizers. Some of them have not been evaluated on fruit crops. One product, NTA-zinc, has caused severe injury when applied to tree foliage. There are several different EDTA-zinc chelate products. In general, EDTA-zinc chelates are relatively safe for foliar application but one product, Zinche-10, has caused injury to fruit when sprayed on apples. To minimize risk of crop injury, use chelated products at rates recommended by the manufacturer. Because zinc sulfate is a highly corrosive salt, be sure to thoroughly rinse spray tank, pump, lines, and nozzles after each application.

Before establishment of orchards on Zn deficient soils (soil test level less than 1 ppm Zn), the application of 50 to 100 lb/A of Zn, applied broadcast as zinc sulfate, is recommended. The broadcast zinc should be thoroughly worked into the soil before planting trees. In already established orchards, zinc sulfate applications to soil are usually ineffective and generally not recommended.

Zinc deficiency symptoms on established trees can be alleviated with foliar sprays, but they must be applied at frequent intervals because of the low mobility of Zn within trees. Foliar applications of zinc sulfate should only be made during dormancy or postharvest. Zinc sprays should not be used during the growing season unless deficiency symptoms are severe. There is always a risk of injury to fruit from in season applications. EDTA-zinc chelate fertilizers applied during the growing season have a lower risk of injury. Foliar applications of Zn must be thorough and timely for optimal effect. A critical spray time for stone fruits is the late dormant period, and for apples and pears, the dormant to silver tip stage. At this stage, zinc sulfate can be applied at 3.5 to 5 lb Zn in 100 gal for 1 acre as a dilute spray alone or with fresh hydrated lime as a safener. It is important that these sprays be dilute (do not exceed a 2X tank mix concentration) to ensure thorough tree coverage. The application of oil sprays following an application of zinc sulfate can increase the risk of crop injury. Freezing temperatures within 2 to 4 days of application also increases the risk of injury. Additional foliar applications of Zn, as ETDA-zinc chelate, are recommended during the growing season as a Zn maintenance program. Apply the first EDTA-zinc spray beginning 7 to 14 days after petal fall. Apply one or more additional sprays of EDTA-zinc at 14-day intervals. Sprays of EDTA-zinc generally have a higher level of safety than zinc sulfate. Postharvest sprays of Zn on apple trees are sometimes effective. Apply 3 to 5 lb of Zn as zinc sulfate in combination with 5 lb of urea per 100 gallons as a dilute spray.

2.6 Adapting Soil Fertility Recommendations to Organic Farming

Synthetic N fertilizers are prohibited materials in the organic system. Organic farmers may use compost or manures to build and maintain soil fertility. When using raw manure, the organic standards require a minimum of 120 days between time of application and crop harvest. These natural fertilizers will also supply, besides N, useful amounts of all essential nutrients but they should be analyzed at a lab to determine nutrient content. If more P is needed than can be supplied by compost or manures, organic farmers can apply rock phosphate. Certain types of K fertilizers are approved for use in organic farming. If potassium is needed there are several commercial K fertilizers, such as langbeinite or potassium sulfate, which may sometimes be used with certain restrictions in organic farming. Naturally derived Chilian nitrate may be used in limited amounts as a supplemental N fertilizer. Legumes might be planted in the sod alley ways as a supplemental N source; however, such practice might complicate orchard pest management.

Since naturally occurring limestones are approved for use in organic farming, the practice of liming and soil pH management is much the same as in conventional farming. Industrial processed liming materials, such as burnt lime and hydrated lime, are not approved for use in organic farming.

When micronutrient deficiencies occur, they can be corrected as necessary for organic crop production using many of the same fertilizer materials and application practices as used in conventional agriculture. In organic farming, however, micronutrient fertilizer products cannot be routinely applied without prior soil or plant diagnostics to confirm a specific nutrient deficiency.

Always check with the organic certifier to be sure a certain product or material is approved for use in organic farming. Also, be prepared to provide documentation and farm records about any applied materials to one's organic certification program.

3 Orchard Frost Protection

3.1 Monitoring for Active Frost Protection

The economic sustainability of an orchard requires maintaining the annual production of fruit at an optimal level. Frost events, specifically during the early spring flower bud development, can cause crop loss which could vary from minor loss of quality and quantity to a total crop loss. In recent years, frost events that result in damaged blossoms have been occurring more frequently. These events have been driven by warmer spring temperatures that are pushing bud growth to earlier in the spring, increasing the chance that blossoms are already present during a spring frost (NOAA Technical Report, 2012). While sufficient information on frost protection (FP) methods is available, new challenges such as insufficient labor, increased labor costs, environmental regulations, high-density orchards, and newer technologies strongly support revisiting this topic.

There are two types of FP methods: (1) ***Active***, which are employed at the time of frost events and work to either prevent or reduce the loss of thermal energy from plant tissues, and (2) ***Passive***, which are generally cultural practices such as site and cultivar selection, orchard floor management, and manipulation of orchard nutrition, which are performed substantially before frost events. This guide focuses on *Active* FP methods. The success of any FP method will depend on an understanding of its working principles and the combination of environmental factors necessitating its use.

Active FP methods are costly, and only highly effective when used properly. Frost damage occurs when plant tissues are exposed to subfreezing temperatures (Figure 3.1). However, it is the co-occurrence of other factors that determines the extent of the damage. The following plant and environmental conditions should be monitored. Thorough knowledge of the prevailing conditions in the orchard will help determine which FP method to employ and for how long.

Figure 3.1 Frost Damage in Apple and Peach Bloom

Frost damage in apple following the freeze event in 2010 in PA (Left panel photo by R. Crassweller), and frost damage in peach bloom following the freeze in 2016 in NJ (Right panel photo by H. Gohil).

Bud Stage

Regular monitoring of the bud development stage**,** starting from bud swell**,** will help in determining the actual threat of frost damage. Critical temperatures have been researched and calculated for each bud development stage. For example, in an apple orchard, at 24°F, one can expect up to 90% crop loss at the ”first pink” stage, but only marginal to zero percent loss at the “green tip” stage. Critical spring temperatures for tree fruit bud stages for some of the most important pome and stone fruit crops are listed in Table 3.1. It is important to note that the critical temperature for damage at a particular bud stage may vary by 4 or 5°F depending on temperatures during the previous few days before the cold event. Therefore, growers should use caution when attempting to use these published critical temperatures for active frost protection methods.

Table 3.1 Critical Spring Temperatures (°F) for Tree Fruit Bud Stages

(compiled by Mark Longstroth, MSU Extension)

Pome Fruit									
Apples	**Silver Tip**	**Green Tip**	**½ Inch Green**	**Tight Cluster**	**First Pink**	**Full Pink**	**First Bloom**	**Full Bloom**	**Post Bloom**
Old temp	16	16	22	27	27	28	28	29	29
10% kill	15	18	23	27	28	28	28	28	28
90% kill	2	10	15	21	24	25	25	25	25
Pears	**Bud Swell**	**Bud Burst**		**Tight Cluster**	**First White**	**Full White**	**First Bloom**	**Full Bloom**	**Post Bloom**
Old temp	18	23		24	28	29	29	29	30
10% kill	15	20		24	25	26	27	28	28
90% kill	0	6		15	19	22	23	24	24

Stone Fruit								
Apricots	**Bud Swell**	**Bud Burst**	**Red Tip**	**First White**	**First Bloom**	**Full Bloom**	**In the Shuck**	**Green Fruit**
Old temp	--	23	--	25	--	28	--	31
10% kill	15	20	22	24	25	27	27	28
90% kill	--	0	9	14	19	22	24	25
Peaches	**Bud Swell**	**Calyx Green**	**Calyx Red**		**First Pink**	**First Bloom**	**Full Bloom**	**Post Bloom**
Old temp	23	--	--		25	--	27	30
10% kill	18	21	23		25	26	27	28
90% kill	1	5	9		15	21	24	25
European Plums	**Bud Swell**	**Side White**	**Tip Green**	**Tight Cluster**	**First White**	**First Bloom**	**Full Bloom**	**Post Bloom**
Old temp	--	--	--	--	23	27	27	30
10% kill	14	17	20	24	26	27	28	28
90% kill	0	3	7	16	22	23	23	23

Sweet Cherries	**Bud Swell**	**Side Green**	**Green Tip**	**Tight Cluster**	**Open Cluster**	**First White**	**First Bloom**	**Full Bloom**	**Post Bloom**
Old temp	23	23	25	28	28	29	29	29	30
10% kill	17	22	25	26	27	27	28	28	28
90% kill	5	9	14	17	21	24	25	25	25
Tart Cherries	**Bud Swell**	**Side Green**	**Green Tip**	**Tight Cluster**	**Open Cluster**	**First White**	**First Bloom**	**Full Bloom**	
10% kill	15	24	26	26	28	28	28	28	
90% kill	0	10	22	24	24	24	24	24	

Old standard temperature (Old temp) is the lowest temperature that can be endured for 30 minutes without damage, or critical temperatures as previously published. This chart also shows the average temperature that will kill 10% and 90% of normal fruit buds. These numbers were taken from Washington State University (WSU), and Michigan State University (MSU) Extension Bulletins: Apple - WSU EB0913, Pears - WSU EB0978, Cherries - WSU EB1128, Peaches - WSU EB0914, Apricots - WSU EB1240, Concord Grapes - WSU EB1615, Tart Cherries - MSU Research. Rpt. 220.

Type of Frost Event

There are two types of frost: advective and radiative frost. Advective frost occurs when a large mass of cold air moves in from another region and replaces warmer air such as during a polar vortex. During such events, there is a rapid movement of cold air to replace warmer air, coupled with high winds, low humidity, and generally the absence of an inversion layer, often creating the potential for a prolonged event. Active FP methods will generally be ineffective during an advective frost. Conversely, radiative or radiational frost occurs when there is a rapid loss of heat from the ground, usually with a cloudless open sky, dry air, and little wind, which leads to the likely formation of an inversion layer. This frost is more manageable with FP methods.

Inversion Layer

An inversion occurs when a layer of the atmosphere higher in altitude is warmer than the atmosphere lower or close to the ground (Figure 3.2). This is a reversal of normal temperature behavior. A strong inversion layer can be a source of relatively warm air that is above the colder air, and trapping the colder air close to the ground in the tree canopy. For this reason, inversions need to be closely monitored.

Figure 3.2 Strong Inversion Layer over a Field in Pennsylvania
(Photo by R. Crassweller)

Air Temperature

Frost can occur when the ambient temperature dips below freezing (32°F). The weather forecast will indicate the lowest possible temperature, but the hourly rate of falling temperatures should also be taken into account. The temperature experienced by trees, however, will not necessarily be the same as the ambient temperature. To measure the temperature of the flower buds, farmers must take into account the cooling effect of evaporation of the moisture on the trees which is referred to as the wet-bulb temperature. The wet-bulb temperature is the lowest temperature experienced that can be reached and still be cooled by evaporation of water into the air. Generally, the wet-bulb temperature will be a few degrees lower than the dry-bulb temperature except at 100% RH. Table 3.2 provides an example of determining the wet bulb temperature, without a wet-bulb thermometer, using the ambient temperature and the dew point temperature.

Hand-held and digital psychrometers can be used in the field to determine the wet-bulb temperature. Knox *et al.* (2017) at the University of Georgia showed that wet bulb temperature can be simply derived by "subtracting one third the difference between ambient temperature and dew point, from the ambient temperature." Modern frost alarms measure wet bulb temperature, and can directly transmit real-time data to the user's mobile phone or computer.

Relative Humidity (RH)

The RH is often overlooked in orchard frost management. However, it plays a significant role in determining the extent of frost damage. As RH increases, moisture condenses near sensitive flower parts which at subfreezing temperatures, begin to form ice crystals. According to Levitt (1980), it is likely that freeze injury results from ice forming outside the cell wall but inside the plant tissue (Figure 3.3). Higher RH can cause greater frost damage compared to low RH, for the same freezing temperature.

Figure 3.3
Damaged and Undamaged Pistils after a Frost Event
Damaged pistil in closed flower (left) and open flower (middle), and undamaged pistil in open flower (right) following a frost event in a peach orchard in New Jersey (Photo by H. Gohil).

Table 3.2 Determination of Wet Bulb Temperature (°F) Using Ambient and Dew Point Temperatures (Courtesy, Don Smith, Penn State University). Wet Bulb Temperature (°F) as determined by Ambient Temperature (first row) and Dew Point Temperature (first column)

		Ambient Temperature (°F)						
		23.0	**24.0**	**25.0**	**26.0**	**27.0**	**28.0**	**29.0**
Dew Point Temperature (°F)	**29.0**							29.0
	28.0						28.0	29.7
	27.0					27.0	28.7	30.4
	26.0				26.0	27.6	29.3	31.0
	25.0			25.0	26.5	28.3	29.9	31.6
	24.0		24.0	25.5	27.1	28.8	30.5	32.2
	23.0	23.0	24.5	26.0	27.7	29.4	31.1	32.8
	22.0	23.5	25.0	26.6	28.3	30.0	31.6	33.3
	21.0	24.0	25.6	27.2	28.8	30.5	32.1	33.8
	20.0	24.5	26.2	27.7	29.3	31.0	32.6	34.3
	19.0	25.1	26.7	28.2	29.8	31.4	33.1	34.8
	18.0	25.6	27.1	28.6	30.2	31.9	33.5	35.2
	17.0	26.0	27.4	29.0	30.7	32.3	34.0	35.7
	16.0	26.4	27.9	29.4	31.1	32.7	34.4	36.2
	15.0	26.8	28.3	29.9	31.5	33.1	34.8	36.5
	14.0	27.2	28.7	30.2	31.9	33.5	35.2	36.9
	13.0	27.5	29.0	30.6	32.2	33.9	35.5	37.2
	12.0	27.8	29.3	30.9	32.6	34.2	35.9	37.6
	11.0	28.2	29.7	31.2	32.9	34.5	36.2	37.9
	10.0	28.7	30.0	31.6	33.2	34.8	36.5	38.2
	9.0	29.0	30.3	31.9	33.5	35.1	36.8	38.5

Dew Point

Dew point is commonly reported as the atmospheric temperature below which water droplets begin to condense, forming dew or fog. At low temperatures, the moisture in the air transitions from a gas to a liquid, as air temperature reaches the dew point. A higher dew point is associated with relatively slow drops in temperature and vice versa. A lower dew point also generally means surface moisture will evaporate quicker.

Cloud Coverage

Clear skies normally result in lower temperatures than when there is cloud cover trapping radiant energy from the ground.

Wind Speed

Wind is a major determinant of the rate of loss of thermal energy. Almost all FP methods will have reduced efficiency at wind speeds above 10 mph, and are therefore not recommended when winds are above 10 mph.

Effective FP requires weather stations and sensors for each of the fields you are seeking to monitor and protect. Data from nearby weather stations may not always be reliable. On-farm weather stations are the most accurate source of weather data and should be linked with a frost alarm. This alarm will sound based on the wet temperature and should be precise down to 0.1°F. To ensure the sensor is putting out an accurate reading, never install a temperature sensor or weather station next to a building or body of water. Ensure the sensor is no higher off the ground than the lowest flower bud. Sensors should be placed in contact with or close to buds or leaves of the tree.

If there are significant slopes in your orchard, consider investing in two temperature monitoring devices, monitoring both the lowest and highest points in the orchard. Examples of these instruments and their sources are provided in Table 3.3. The extension bulletin by Bayer *et al*. 2017 (*https://ag.umass.edu/print/16269*) provides information on the establishment and use of weather stations to monitor all of the above indicators of a frost.

Table 3.3 Frost Protection Instruments

Instrument	Trade name	Manufacturer/Contact Information
Frost Alarm	Frost Alarm	Agro Frost, 1 800-634-5557 *https://www.oescoinc.com/*
	Watch Dog Color	Spectrum Technologies, 1 800-248-8873 *https://www.specmeters.com/*
	HOBO Rx 3000	Onset, 1-800-564-4377 *https://www.onsetcomp.com/*
Heater	Ag Heat Propane Heater	Ag Heat Inc., 1 541-490-1928 or 1 541-400-4875 *http://www.agheat.com/*
	Frost Dragons	Dynamic Dezigns, 1 800-567-8264 *http://www.dynamicdezigns.com/frostcontrol.html*
	Frost Busters	Agro Frost, 1 800-634-5557 *https://www.oescoinc.com/*
Wind Machine	Wind Machine	Orchard Rite, 1 616-971-8177 *https://orchard-rite.com/*
	Tow and Blow	Vailmont Vineyards, 1 905-563-2880 *https://www.vailmontvineyards.com/* *https://www.towandblowusa.com/*
Weather Station	AcuRite	AcuRite *https://www.acurite.com/* Online chat support: *https://support.acurite.com/hc/en-us*
	Ambient Weather WS Series	Ambient Weather, 1 480-346-3380 or *support@AmbientWeather.com* *https://ambientweather.com/*
	Vantage Pro	Davis Instruments, 1 510-732-7814 *https://www.davisinstruments.com/*
	Zentra Systems	Meter Environment, 1 509-332-5601 *https://www.metergroup.com/*
	AgroMET-MB MK-III	RainWise Inc., 1 800- 762-5723 *https://www.rainwise.com/*

3.2 Active Frost Protection Methods

Active frost protection (FP) methods are mainly of three types: irrigation, heat application, and mixing of the air. In recent years, some FP methods using chemicals have been developed.

3.2.1 Irrigation

Overhead Irrigation

Overhead irrigation is one of the most effective of all FP methods, specifically for orchard crops. Water is applied over plant tissues, and at sub-freezing temperatures turns into a layer of ice (Figure 3.4). This layer prevents the rapid cooling of plant tissue; at the same time, heat is given off as the water freezes during the phase change from liquid to ice, maintaining the temperature at the freezing point. However, to compensate for the loss of thermal energy due to radiation, evaporation, and convection, water has to be continuously applied to continually refreeze which generates additional heat (Figure 3.5). At wind speeds between 5-10 mph, the effectiveness of overhead irrigation will be reduced, resulting in a need to increase the rate of application. Once all of the ice has melted off of the trees and wires, which is the indication that the temperature is above freezing, the irrigation system can be shut off.

Figure 3.4 Frost Protection Using an Overhead Irrigation System in the High Density Apple Orchard in PA (Photo by R. Crassweller).

Pros: Overhead irrigation doesn't produce noise or air pollution as compared to other methods, and it can also be used for summer irrigation. This method will provide FP down to 22°F with no wind or 24-25°F with a slight wind (Longstroth, 2012). Very few methods can achieve a level of FP to this temperature. This system has low energy consumption when compared to other methods, however, one needs to consider the energy used to pump the water from its source. Operational costs per acre for overhead irrigation are low compared to other methods.

Cons: This system requires a substantial amount of water. For example, in an apple orchard setting, about 5,400 gallons of water per acre per hour is required during a frost event (Hannan, 2019). However, research has shown that water applications can be cycled on and off resulting in a reduction of water use by 1/3 (Heinemann *et al*., 1992; Heisey *et al*., 1994). The development of ice on sprinkler heads must be monitored when temperatures go below 23°F. It may be necessary to use a metal or wooden rod to strike individual nozzles to shatter any ice buildup on younger trees, as the weight of the ice can break scaffolding branches. High installation costs may be incurred specifically if the water source is not adjacent to the block being treated.

Once operating, the system cannot be turned off and must be continuously fed with water. Turning off the system during a frost can cause significantly more damage. It requires a certain degree of skill to maintain the layer of ice, preventing air mixing with water seen as clouded ice, and to avoid applying excessive water by cycling the water on and off to reduce the amount of water applied (Heinemann *et al*., 1992).

Caution: The discharge capacity of the water pump and capacity of the well or pond source should be considered for irrigation and FP well before planting a new orchard. Valves must be installed on all lines to ensure lines can be emptied. Irrigation will cause evaporative cooling; hence wet bulb temperature should be considered before turning on the system. Overhead sprinklers should not be turned on when the wind speed is more than 10 mph. At temperatures below 23°F, ice can develop over impact heads, and the head can get stuck in one direction, wasting much of the water and minimizing its protective coverage. Regular monitoring is needed to make sure the system is running continuously and effectively. Experience suggests that metal impact heads can freeze just as easily as plastic heads. The main advantage of metalheads is they are less likely to break. However, metalheads are more expensive than plastic heads.

One way to address the challenge of needing a substantial amount of water is to use **overhead micro-sprinklers**. This method targets mostly the canopy, and as a result, one has better control over the coverage. This system uses about 35-40% less water per acre, and the savings in energy costs are roughly half of overhead irrigation (Rieger, et. al, 1990). However, the installation cost could be higher than the overhead impact sprinklers. This system requires a trellis to support half-inch polyethylene laterals. However, since new high-density orchard plantings already use trellising for training young trees, these can also be used to support the installed micro-sprinklers.

Figure 3.5 Example of Continuous Ice Formation over Apple Tree Using Overhead Irrigation Clear ice and non-cloudy layer indicate successful FP (Photo by R. Crassweller).

Under-Tree Sprinkler Systems

Under-tree sprinkler systems work on the same principle as overhead systems, but with a reduced scope of coverage since they only cover the lower canopy and soil underneath the tree (Figure 3.6). In addition, under-tree sprinkler irrigation may also be used to increase heat transfer from the ground to the air if used according to the same principles as outlined for drip irrigation (see below). If used also for irrigation, it becomes cost-effective. Most systems use small (5/64" – 3/32") low trajectory sprinkler heads operating at 40-50 psi. There are main hoses on each side of the tree, and each micro-sprinkler has a little tube inserted into that hose. Applications range from 0.08-0.12 inch/hr. An application of water at 69.8°F has been used in Mexico and WA using a large boiler located at the side of the field. This additional cost to heat the water has to be added to the cost-effectiveness equation of this system. This under-tree system may be preferred over another irrigation delivery system when well or pond capacity is limited. It uses much less water compared to the overhead system but with lower effectiveness, particularly for mature trees.

Figure 3.6 Frost Protection Using Under-Tree Sprinkler Irrigation in Peach Orchard in Delaware (Photo by B. Fifer, Fifer Orchard).

Drip Irrigation

If soil is irrigated to field capacity (maximum water holding capacity of that soil), it can store as much heat in the orchard soil as possible during the day and increase the loss of radiative heat during the night. In some soils, it may take more time to "top up" the soil profile. Drip irrigation, in combination with a weed-free strip under a tree, raised the temperature of the orchard floor by 3-5°F (Snyder and de Melo-Abreu, 2005). It may require more than 8-10 hours of irrigation for heavier soils to reach field capacity. Again, this approach should be avoided if the wind speed is forecasted to be more than 10 mph.

3.2.2 Heat Application

During sub-freezing temperature events, additional heat can be supplied to the orchard through burning propane or natural gas. The introduced heat replaces that lost by radiation and wind. However, this can be highly inefficient as the heat created can be lost to the sky, especially if the orchard area is large. Oil burning orchard heaters also called Smudge pots are cheaper than permanently installed systems. A permanent heating system requires laying underground pipes which must handle a specific maximum pressure in case there is a failure at the tank. The heat from the burned fuel keeps the surrounding air warmer by up to 3-5°F depending on the wind speed. At wind speeds greater than 10 mph, the rate of heat dissipation is greater than heat addition. Considering installation and fuel costs, it is a very expensive system unless you are a retail orchard grower located in a high-value market area.

Mobile heaters

Mobile heaters have propane tanks, a heater, and vents that are pulled through the orchard by a tractor. The moving tractor applies warmer air through the vents to the tree canopy area (Figure 3.7). After the tractor passes, the warm air may mix with the cooler air, moving away from the tree. Fortunately, there is no need for immediate reheating, as the deposition of ice crystals does not kill the plant tissue if warm air is applied before the ice crystals begin to freeze plant tissues. The machines trade named 'Frost Buster' and 'Frost Dragons' (Table 3.3) use propane burners and can effectively protect 5-6 acres at temperatures down to 23°F, or a larger area at higher temperatures.

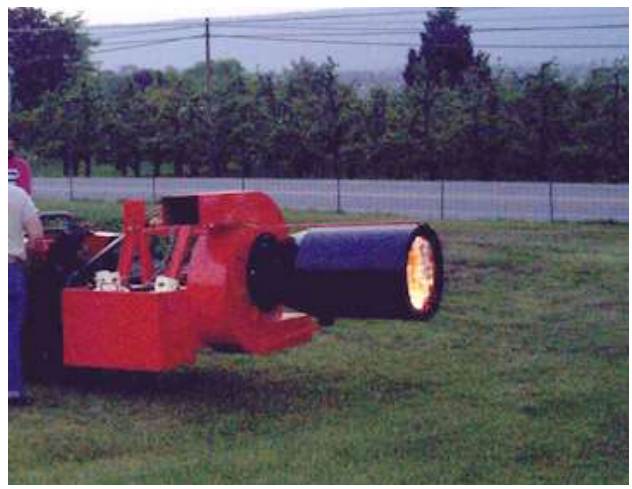


Figure 3.7 Frost Protection Using a Mobile Propane Heater (Photo by R. Crassweller).

Using a mobile heater in a traditionally-spaced peach orchard, you can drive down every other row, while in a high-density apple orchard it can cover multiple rows. Hot air is dispersed 150-200 feet evenly in both directions. Growers must make a carefully timed loop to prevent overheating or cooling the orchard. If returning to the same trees too soon or if the heater vents are too close to the flower buds, the system may scorch the buds. These machines could cost upwards of $25,000 per unit. Examples of these instruments and their sources are provided in Table 3.3.

Pros: In a situation where water is scarce, heat application may be the only option for FP. If done correctly, it can be effective down to 23°F. These mobile units may be less expensive than an in-ground permanent heating system, affording the flexibility of moving heat application units within and to different orchard blocks.

Cons: Cost-effectiveness of all heater-based methods depends on the current market price of fuel. Having large propane tanks on the back of the tractor could be dangerous. However, newer designs are much safer, easier to operate, and can be operated for a longer period of time. In hilly terrain that requires slower tractor speeds, using this method would decrease the potential size of the protected area.

Caution: If using this method, one must place thermometers throughout the orchard and carefully note the affected temperature changes. There may be pockets within the orchard that require more FP than others. Growers have commented that the most common cause of a mobile heating machine not being effective is because it was started earlier than needed and ran out of propane before dawn, or due to the loss of pressure when all tanks aboard the tractor have less than 50% fuel left (M. Boyer, personal communication). The machine can be unwieldy, and safe operation depends on good driving conditions in the orchard. In any case, depending on the length of the row and the shape of the orchard, the grower should return to the starting spot within 10 minutes, before the applied heat is lost due to dissipation.

3.2.3 Mixing Air

A large mass of relatively warmer air may be available when an inversion layer forms above the orchard. That air can be mixed to prevent cold air stratification and to bring the temperature in the tree canopy area above the critical temperature.

Wind machines

Wind machines are designed to do just that and are becoming more popular (Figure 3.8). Wind machines can also be used if there is no inversion layer, though they may not be as effective. The machines can be equipped with a controller which can automatically turn them on or off at a designated temperature. Also, connecting the frost alarm to these wind machines can help in reducing excess hours of electricity and noise. Temperature probes should be placed strategically throughout the orchard to reflect the overall ambient temperature in the flower zone area. A single machine can be effective for up to 10 acres, but total coverage will depend on the orchard site and the size of the machine (Ballard and Proebsting, 1972).

Overlapping coverage areas also assures much better coverage - in a 70-acre orchard, one may need 10 machines instead of 7. Natural or predominant wind direction should be considered when designing and placing wind machines in your orchard. Examples of these instruments and their suppliers are provided in Table 3.3.

Pros: Though the installation cost is very high, the operating cost can be quite low. This method requires much less labor and uses significantly less fuel than other methods, and the investment has a relatively long lifespan.

Cons: These machines are very large (27-30 feet tall) and can be quite loud. They are less effective in the absence of a strong inversion layer and work best when trying to maintain a determined temperature rather than heating the orchard. Wind machines can cost up to $40,000 depending on the accessories.

Figure 3.8 Wind Machine in Apple Block of Gardenhour Orchards in Maryland (Photo by R. Crassweller).

Portable Wind Machines

Portable wind machines have some applications in small specific locations. In a rolling terrain within orchards, the strategic placement of a portable wind machine can alleviate cold air accumulation in low spots. The fan operates from the PTO (Power Take-off) shaft of a tractor, preventing cold air from accumulating (Table 3.3).

Pros: These portable wind machines are highly effective as a site-specific method for dips or lower elevations within an orchard and are less expensive than a large wind machine. **Cons**: They are only useful in a limited site and require a running tractor with an engaged PTO throughout the frost event.

Helicopters

Helicopters can also be used for the same air mixing purpose and work on the same principle as a wind machine (Figure 3.9). It is advised to use helicopters only if there is an inversion layer. One helicopter can be used to protect up to 30 acres when the temperature is about 28°F, which can raise the orchard temperature by 4°F a minute after its pass (B. Fifer, personal communication). It should pass over the entire area to be protected every 6-7 min to prevent cold air stratification (Snyder, 2002). Strategically placed lights surrounding the orchard at night can help the pilot determine the boundaries of the orchard. Operating costs for this method are very high, as renting a helicopter can cost around $1500/hr. However, considering the area covered (30 acres) and the duration of operation (4 hours), it can cost around $200/acre, which can be very cost-effective when compared to other methods. For the best effectiveness, the ground crew should communicate to the pilot the current observed temperature, both before and after they pass.

Pros: Helicopters can cover a substantially large area in a relatively short period. While there is no installation expense, rental rates are high and availability may be limited. This method may be a good option in areas where FP is only occasionally required.

Cons: Service may not be readily available, and pilots may experience dangerous operating conditions due to poor visibility and orchard terrain. Varying degrees of success have been reported with air mixing via helicopters. If there is no inversion layer, this method is ineffective. The service provider may also ask for holding fees which sometimes are nonrefundable.

Figure 3.9 Frost Protection Using a Helicopter in Fifer Orchard, Delaware (Photo by F. Fifer)

3.2.4 Chemical Methods

In recent years, some spray formulations have become available for FP in an orchard setting, but more research is needed. For example, plant growth regulators Promalin® and Perlan®, mixtures of Gibberellins A_4A_7 plus 6-BA, have been labeled for use on apple, which if applied immediately following a frost event, can help fruit set. Ice-nucleating bacteria, (*e.g.*, trade name BlightBan®) can be applied in a spray to trees prior to a frost, allowing ice crystals to form around them rather than plant parts. Anti-freeze formulations such as FreezePruf are also available (Francko *et al*., 2011). Note that caution should be used with any of these materials, since some of them are unproven technologies.

3.3 Frost Protection References

Ballard, J. K. and Proebsting, E. L. 1972. Frost and Frost Control in Washington Orchards. Cooperative Extension Service. W.S.U. Bulletin 634.

Bayer, A., van Iersel, M. and Chappell, M. 2017. What is a Weather Station and Can it Benefit Ornamental Growers? The University of Massachusetts, Center for Agriculture, Food and the Environment. *https://ag.umass.edu/print/16269*

Francko, D., Wilson, K., Li, Q. and Equiza, M. 2011. A Topical Spray to Enhance Plant Resistance to Cold Injury and Mortality. HortTechnology 21(1):109-118.

Hannan, J. 2019. Frost Protection for High Density Orchards. 2019. Iowa State University Extension and Outreach. *https://www.extension.iastate.edu/smallfarms/frost-protection-high-density-orchards*

Knox, J.A., Nevius, D.S. and Knox, P.N. 2017. Two Simple and Accurate Approximations for Wet-bulb Temperature in Moist Conditions with Forecasting Applications. Bulletin of American Meteorological Society. 98, 1897-1906.

NOAA Technical Report. 2012. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. National Oceanic and Atmospheric Administration

Levitt, J. 1980. Responses of Plants to Environmental Stresses, Vol. 1 (2nd ed). New York NY: Academic Press. 497p.

Longstroth, M. 2012. Using Sprinklers to Protect Plants from Spring Freezes. *https://www.canr.msu.edu/news/using_sprinklers_to_protect_plants_from_spring_freezes*

Heinemann, P., Morrow, C., Stombaugh, T., Goulart, B. and Schlegel, J 1992. Evaluation of an Automated Irrigation System for Frost Protection. Applied Engineering in Agriculture. 8(6): 779-785.

Heisey, L., Heinemann, P., Morrow C. and Crassweller, R. 1994. Automation of an Intermittent Overhead Irrigation Frost Protection System for an Apple Orchard. Applied Engineering in Agriculture 10:669-675.

Rieger, M. and Stephen, C. M. 1990. Over-tree Micromprinklers Irrigation for Spring Freeze Protection of Peaches. HortScience 25(6): 632-635.

Snyder, R.L. 2002. Principles of Frost Protection. The University of California. FP005.

Snyder, R. and de Melo-Abreu, J. 2005. Frost Protection: Fundamentals, Practice, and Economics. FAO. Vol.1, Ch. 7.

4 Orchard Weed Control

4.1 Weed Control Measures and Orchard Floor Management

Introduction

The control of unwanted vegetation in orchards provides several advantages.
Weeds harm the crop in the following ways:

1. Competing for light, water, nutrients, and space.
2. As alternate hosts for harmful insects, diseases, and nematodes, and by providing cover for undesirable animals.
3. Adversely affecting crop quality and/or reducing yield.
4. Impeding or preventing harvest.

Weed Control Measures

Weed identification is the first step in a successful weed control program. Knowledge of the weed species in an orchard is needed for control measures to be successful and economical. Plan control measures when the weed is most susceptible. **Good cultural practices** can reduce many weed problems. Control difficult perennial weeds before planting a new orchard. Sow areas in the orchard where bare ground is not desired to a cool season grass that will not compete vigorously with the trees, but will suppress weeds. **Prevent weed seed production.** Many weeds can produce 10,000 to over 100,000 seeds/plant. Most will be "hard" seed that will not germinate for several years. One good year of weed seed production can result in a supply that will last many years. Preventing seed production of new "hard-to-control weeds" is particularly important.

Mechanical weed control methods include plowing, disking, and harrowing before planting an orchard and disking, mowing, and hand-weeding after trees are planted. Many weeds, including established perennials, can be controlled mechanically by starving the roots. The weed begins to send food to the roots 10 to 14 days after a shoot emerges from the soil. Repeated close mowing or shallow cultivation within 7 to 10 days after any new shoots appear can eventually kill the weed. Many repeated cultivations are usually needed. One late or missed cultivation can "save" the weed. Mechanical weed control has disadvantages. Close cultivation can injure tree trunks, and cultivating too deep can prune tree roots. Repeated cultivation can destroy soil structure and reduce the organic matter content.

Chemical weed control has many advantages over mechanical weed control in an established orchard. Chemical weed control is effective, economical, and safe, when used correctly. It also eliminates trunk injury from cultivating too close, eliminates root pruning from cultivating too deep, and reduces mouse injury by completely eliminating cover near the tree.

Orchard Floor Management

Recommended management of the orchard floor includes **maintaining a vegetation free zone in the tree row and establishment of a perennial grass sod between the rows**. Integration of vegetation management with insect and disease control programs is essential. Maintain the vegetation free zone in the tree row to prevent competition with the fruit tree. The width of the vegetation free zone should be about forty percent of the distance between the tree rows in most orchards. The width may vary, however, depending on soil fertility, water holding capacity, and exposure to erosion. Do NOT reduce the width of the vegetation free zone in young, nonbearing orchards. Maintain the full width of the vegetation free zone in newly planted orchards to achieve maximum tree growth.

Sod between the tree rows prevents soil erosion, provides traction for equipment, increases soil organic matter, improves soil structure and water permeability, and furnishes shelter for beneficial insects. Sod should not include plants that are an alternate host for insect pests, or diseases and nematodes that attack fruit trees. In addition, the sod should be easily maintained, tolerant to drought, require little or no fertilization, and compete minimally with the fruit trees.

ORCHARD WEED CONTROL

Tall fescue perennial grass sod is recommended for orchard row middles. Fescue is tolerant to disease, drought, low pH, and low fertility. Fescue sod competes effectively with weeds, does not spread or creep into the tree row by rhizome or stolen growth, and is semi-dormant during the hot, dry, summer months. Tall fescue is vigorous and is easily established, but requires frequent mowing. Newly developed "turf type" tall fescue varieties are vigorous, and have a lower mowing requirement than the traditional "Kentucky 31" tall fescue. Hard fescue grows close to the ground and has a minimal mowing requirement, but grows more slowly than the tall fescues and is difficult to establish.

The addition of clover or other legumes is not recommended for orchard sods. Although legumes do fix nitrogen, release for plant use is unpredictable and often at the wrong time of year, which can reduce winter hardiness. Legumes are also alternate hosts for pests such as catfacing insects, nematodes, and tomato ring-spot virus, which causes stem pitting in stone fruits and union necrosis in pome fruits. Legume bloom frequently coincides with apple bloom, and is preferred by bees and other pollinators.

Preparation for sod establishment should begin before the orchard is planted. Control perennial weeds and nematodes, and correct soil pH and nutrient deficiencies first. Complete primary tillage operations the summer **before** the orchard will be planted. Build gently sloping raised ridges to improve drainage in the future tree rows before sowing grass or planting trees. Orchards planted flat have developed depressions in the row between the strips of sod due to the improving soil structure in the sod compared with the vegetation free strip.

The success of a sod planting will depend on accurate seeding and timing. Sow fescues in late-summer into a well-prepared seedbed. Use 40.0 to 75.0 lb of seed/broadcast A. The higher rates will provide for a faster establishment and thicker cover. Use a seeder manufactured to sow grass and other similar sized seed that will ensure proper seed placement, a firm seedbed, and good seed and soil contact. Failure to use adequate equipment for seeding frequently results in poor establishment. Seeding should be completed by September 1st in the northern counties of New Jersey, and by September 20th in the southern counties. Apply nitrogen at 50.0 lb N/A at seeding and repeat in late-fall or early-spring to encourage rapid establishment.

Planting in killed sod has been shown to be an effective method to help newly planted trees get off to a fast start. Use perennial ryegrass in the row rather than fescue, and seed the fescue between the future tree rows. Rapid establishment and growth and susceptibility to herbicides make perennial ryegrass a better choice for the in-row use. Kill the sod in the row just prior to when the trees are planted and "no-till" the trees into the dead sod. Use recommended herbicides to control weeds. The sod's roots increase soil organic matter, and improve soil structure and water permeability before it is killed, and act as a mulch to conserve water and prevent erosion during the establishment year of the orchard. By fall, the dead sod will have deteriorated and will not be attractive to rodents.

Establishment of a dense sod that is competitive with weeds will require fifteen to twenty months. Some additional effort during this period will ensure success. Apply Prowl H2O to the sod in early spring to control large crabgrass and other summer annual grasses. Use 1.0 to 2.0 lb of active ingredient/A, about half the rate recommended for use in the tree row on newly planted trees. Use 2,4-D choline 0.5 to 1.0 pt of active ingredient/A early the first spring after sowing the grass to control broadleaf weeds. Continue to use 2,4-D choline in the fall or early spring in subsequent seasons, at normal recommended orchard rates, when needed to control dandelions and other broadleaf weeds in the sod.

4.2 Herbicides Categories

Residual

Residual herbicides remain in the soil and kill weeds through their roots for up to several months. Application should be made before weeds germinate. Weeds begin to compete with most crops within 2 to 4 weeks after they appear, and some products are effective only on germinating seeds. Rainfall or overhead irrigation is usually needed to move the herbicide into the soil and make it available to emerging weeds. If weeds are present, a postemergence herbicide should be combined with the residual herbicide. Residual herbicides are applied incorporated or preemergence.

Incorporated

Incorporated herbicides are mechanically mixed with the soil. This application method is NOT well suited to orchards. It is difficult or impossible to incorporate herbicides near the tree trunk, and tree roots may be pruned by the equipment.

Postemergence

These herbicides are applied when weeds are present. Postemergence herbicides kill weeds through their leaves rather than through the roots. They can be safely used in orchards by carefully applying the herbicide to the weeds without allowing it to contact the fruit tree. The herbicide should be applied when weeds are growing rapidly. Do not treat weeds that are dormant or under stress from drought, extreme heat, cold, or other adverse growing conditions. The optimum weed stage of growth for herbicide application depends on the herbicide used and the weed species. Most herbicides that enter the plant through the leaves need a minimum rain free period of at least 8 hours after application for maximum effectiveness. Postemergence herbicides may be selective or nonselective, and work only where they contact the plant or translocate throughout the plant.

Selective postemergence herbicides kill only certain weeds. Plants that are not susceptible will not be harmed. Poast, Fusilade DX and 2,4-D are examples of selective postemergence herbicides. Poast and Fusilade DX kill grasses. 2,4-D affects only broadleaf plants (including fruit trees).

Nonselective postemergence herbicides kill or injure any treated plant. They may be *contact* or *translocated*. *Contact* herbicides work only where they are placed. Thorough spray coverage is essential for good results. Roots of established perennial weeds may survive. *Translocated* herbicides move in the weed after treatment. Application at the proper growth stage will often result in good control of the roots as well as tops of established and perennial weeds. Translocated herbicides work slowly, because movement throughout the plant takes time. Results may not be evident for several weeks.

4.3 Herbicide Application Notes

CAUTION: Strict Rate Control Is Necessary.

Improperly applied herbicides or herbicides applied above recommended rates may cause crop damage. Residual herbicide rates must be matched with soil type and percentage of organic matter to obtain good weed control and crop safety (see Table 4.4). Adjust by changing tractor speed and maintaining pressure when spraying an orchard with soil that requires different herbicide rates. Determine type and percentage of organic matter for each soil on the farm with a separate soil test for each soil. **Herbicide application** should be accomplished with a "conventional" fixed-boom sprayer calibrated to accurately deliver 40.0 to 60.0 gal of water/A using flat fan nozzles and 30 to 40 psi, unless otherwise stated. **Herbicide rate recommendations are made on a broadcast basis (amount of herbicide applied/sprayed A).**

Good agitation is needed for uniform distribution of the chemical in the spray solution. It is most important when wettable powders are sprayed. Good agitation can be achieved mechanically with paddles or hydraulically with spray material from the bypass line. If hydraulic agitation is used, be sure the pump has the capacity to spray and agitate at the same time. Tank shape also affects agitation. Corners and edges in tanks increase the agitation requirement. The boom should be modified to reach under the tree canopy. The outside nozzle should be of the offset type to reach into the row.

Nozzle tips may be made from many materials, including plastic, brass, stainless steel, and tungsten carbide. Plastic and brass tips wear more rapidly and should be replaced annually. Use ONLY stainless steel or tungsten carbide nozzles if wettable powders are used regularly. These products are abrasive and wear other tips too quickly.

Flat fan nozzle tips are designed for herbicide application. Most herbicides should be applied with an 8002 to 8004 nozzle. Larger nozzles deliver too much water. Smaller nozzles clog easily and produce more "fine" spray particles which drift easily. Flat fan nozzles have a wide spray angle so the boom can be kept close to the ground to reduce drift. They produce spray droplets that are large enough not to drift easily and small enough to provide

good coverage of weeds with postemergence herbicides with little or no run-off. Most herbicides can be applied effectively with flat fan nozzles using between 10.0 and 50.0 gal of water/A.

Flood jet nozzle tips are economical to use but do not provide the uniform coverage obtained with flat fan nozzles. They are suitable for applying preplant incorporated and preemergence herbicides, but are less suited for postemergence herbicide application. The droplets produced by flood jet nozzles are too large to wet existing weed foliage uniformly without dripping or runoff. Postemergence herbicide results, using flood jet nozzle tips, can be improved and may be acceptable by using the following procedures to improve spray coverage:

1. Reduce the distance between nozzles on the boom by one-half. For example, space the flood jet nozzles 20 inches apart, instead of the standard 40-inch spacing. This will result in an overlapping spray pattern, wetting both sides of a weed.
2. Spray at the maximum recommended pressure for the flood jet nozzles being used.
3. Increase the amount of water sprayed/A. Use 40.0 to 60.0 gal/A.

4.4 Influence of Soil Properties and Water (Rainfall and Irrigation) on Herbicides

Weed control programs rely on residual preemergence herbicides and non-residual postemergence (knockdown) herbicides to control weeds. Applications are typically sprayed in orchards once a year in the spring, or twice a year, in late-fall and late-spring. Residual herbicides applied at these times are relied on to control weeds through the summer months and harvest. After application to the soil surface, most residual herbicides must be moved into the soil by rainfall or overhead irrigation to be effective. The amount of rain or overhead irrigation needed depends on weeds targeted, soil properties, and the chemical properties of the herbicide.

Weeds Targeted

Many weeds (*e.g.,* pigweed species) produce huge numbers of tiny seeds. Small seeds must germinate at or very near the surface of the soil. Other weeds (*e.g.,* morningglory or yellow nutsedge) can germinate or sprout from several inches deep. Early in the season, herbicides must be moved further into the soil to control weeds that germinate or sprout from deeper in the soil. Later in the season, shallow germinating weeds may become established and escape control if the herbicide has moved too deep into the soil to be available during weed emergence and establishment.

Soil Properties: Texture, pH, Cation Exchange Capacity

Soil properties have a strong influence on weed growth and residual herbicide effectiveness, especially texture, percent organic matter, and pH. Soil maps list soil texture and standard soil tests use the “feel” method to gauge soil properties. However, these approaches may give you inaccurate information about your soil. Instead, arrange a more accurate one-time mechanical soil analysis, which will determine the amounts of sand, silt, and clay in the mineral portion of the soil. The texture will not change unless soil is lost by erosion or other means.

Sand particles are the largest, **silt** is medium in size, and **clay** particles are the smallest soil particles. Soils with a large percentage of large sand particles are considered to be coarse in texture and are called sand, loamy sand, or sandy loam. Soils with a moderate amount of each size soil particle are considered to be medium in texture, and are called loam, or silt loam. Soils with a large percentage of small clay particles are considered to be fine in texture and are called silty clay loam, clay loam, or clay.

Soil particles are negatively (-) charged and attract positively (+) charged molecules from fertilizers, such as $H_2PO_4^+$, K^+, Ca^{++}, Mg^{++}, and many herbicides. This attraction slows leaching. Other fertilizer molecules (*e.g.*, NO^-) and a few herbicides have a negative charge. Negatively (-) charged molecules are not bound to the soil and are more subject to leaching, especially if they are highly soluble in water. Since substances that are positively (+) charged are called cations, the measure of a soil‘s ability to hold onto cations is called the **Cation Exchange Capacity** or **CEC**. Sand has the lowest CEC value, of less than 1. Silt has an intermediate CEC value, near 5. Clays have the highest CEC value of the mineral component of soil, near 35, depending on the type of clay.

Organic matter makes up only a small part of most soils, usually between 0.5 and 5.0 percent in soils across the northeastern United States, but it has the highest CEC value, near 200. Even small changes in the percent organic matter in soils, especially sandy soils, can have a strong influence on herbicide performance. That is the reason why small changes in percent organic matter may require herbicide rate changes. Rate tables may have several columns with different herbicide rates for different levels of organic matter in each soil type (Table 4.4).

Soil pH also affects the performance of some herbicides by influencing the degree of attraction to soil particles. Recommended soil pH levels for many crops range between 6.0 and 7.0. Low pH (below 6.0) or high pH (above 7.0) may affect the availability of certain herbicides by changing the positive (+) charge of the molecule. Weed control may be reduced and/or herbicide carryover may be increased if the herbicide is more tightly bound to the soil than at "recommended" pH levels. The risk of crop injury may increase if an herbicide is less tightly bound to the soil, and more available, than at "recommended" pH levels. Herbicides that are affected by pH may have **DO NOT USE** warnings on the label if the soil pH is above or below a value that increases the risk of crop injury, herbicide carryover, or poor weed control.

Chemical Properties of the Herbicide: Water Solubility and Adsorption to Soil Particles

The solubility, or the ease with which an herbicide dissolves in water, affects the rate of movement through the soil (Table 4.1). An herbicide that is more soluble in water may be "activated" by less rainfall or irrigation, but may not provide the duration of control that could be obtained with a less soluble herbicide, especially in a coarse-textured soil low in organic matter.

In addition, most **residual herbicides** can become bound to soil particles. When attached or bound to the soil, these individual herbicide molecules are not available for uptake by the weeds or the crop. Herbicides can be held onto by the soil to varying degrees (Table 4.1). The degree of binding is influenced by the chemistry of the herbicide, the soil pH, and the **Cation Exchange Capacity (CEC)** of the soil. Lower herbicide rates are needed to prevent crop damage in soils with a low CEC. Plant nutrients, such as NO_3^-, and herbicides with a negative (-) charge are not held by the soil, leach more rapidly, and are less affected by soil texture than those with a positive (+) charge.

Table 4.1 Herbicide Water Solubility and Soil Adsorption Characteristics

Category	Herbicide	Solubility	Soil Adsorption
Residual Herbicides	Alion (indaziflam)	Low	Moderate to Strong
	Broadworks (mesotrione)[1]	High	Strong
	Chateau (flumioxazin)	Very Low	Not Available
	Goal 2XL/Galigan 2E (oxyfluorfen)	Very Low	Strong
	Karmex (diuron)	Low	Strong
	Kerb (pronamide)[1]	Low to Moderate	Strong
	Matrix FNV (rimsulfuron)	Low	Not Available
	Norosac/Casoron (dichlobenil)	Low	Moderate
	Princep (simazine)	Very Low	Moderate
	Prowl (pendimethalin)	Very Low	Strong
	Sinbar (terbacil) [1]	Moderate	Weak
	Solicam (norflurazon)	Low to Moderate	Strong
	Surflan (oryzalin)	Very Low	Strong
Postemergence Herbicides	2,4-D choline	Very High	Very Weak
	Fusilade 2000 (fluazifop butyl)	Very Low	Very Strong
	Glyphosate products	Very High	Very Strong
	Gramoxone SL2.0 (paraquat)	Very High	Very Strong
	Poast (sethoxydim)	Moderate to Very High (pH dependent)	Moderate
	Sandea (halosulfuron) [2]	Low to Moderate	Moderate
	Select (clethodim)	NA	Weak
	Starane (fluroxypyr)	Moderate to High	Weak
	Stinger (clopyralid) [2]	Very High	Very Weak

[1] Broadworks, Kerb, and Sinbar are residual herbicides that will also control young seedlings of sensitive weed species
[2] Sandea and Stinger are herbicides that will control emerged weeds AND have residual activity

Non-residual postemergence herbicides may have no activity after application for one of two reasons. First, some herbicides are too tightly bound to the soil to be available to plants after application. However, in soil-less growing environments care must be exercised, where surprising residual activity can be observed from these herbicides. Secondly, some herbicides are highly soluble in water and are not bound to soil particles. Residual activity from these herbicides can be observed in the soil, but it often lasts only a few days. They are rapidly degraded and/or leached out of the zone of weed seed germination.

Examples of non-residual herbicides which are too tightly bound to the soil to have residual activity are glyphosate and paraquat,. These herbicides are completely unavailable to plants after application and remain tightly bound to the soil until broken down. Glyphosate can be degraded or digested by soil microorganisms. Paraquat is degraded by sunlight, and is less likely to cause problems when used on plastic mulch, in greenhouses, or in soil-less growing systems.

In another example, 2,4-D choline is highly soluble in water and has a negative (-) charge, which is repelled by the soil particles. This herbicide is not bound tightly to the soil and is readily available for chemical or biological degradation and leaching. Disappearance of 2,4-D in the soil environment is rapid. Residual activity in the soil can be observed, but it often lasts only a few days to a week. Stinger and Starane are also soluble in water, but have longer residual activity in the soil.

Trickle Irrigation and Herbicide Effectiveness

Efficiency, water conservation, and disease control are reasons to consider trickle irrigation in orchards. The crop can be irrigated using less water provided by a smaller pump delivered at lower pressure than with traditional overhead sprinkler systems. In addition, evaporation losses are lower. Since trickle lines and micro-sprinklers operate under the tree, the fruit and foliage remain dry, reducing the incidence of many diseases. **Unfortunately, improved weed control is NOT a benefit of trickle irrigation. Expect higher herbicide and application costs, and less effective and less consistent weed control in trickle irrigated orchards.** No herbicide, not even the least soluble in water and most tightly bound to the soil, can withstand leaching from the volume of water that flows from an emitter hole in trickle irrigation tubing. Herbicide failure can be first observed in fields under trickle irrigation by small tufts of weeds growing at each emitter. As the season progresses, the weeds grow more readily, and the spot enlarges as a wider area is leached free of herbicide. Although trickle irrigation prevents the crop from water stress, weeds can be fierce competitors for nutrients and sunlight, can act as hosts for insects, and can interfere with harvesting.

Modifications to the trickle irrigation system can moderate the weed control problem. Any change in the system that reduces the volume of water applied at a point source will reduce herbicide leaching. Unfortunately, reducing the distance between the holes in traditional trickle tubing or suspending the tubing from a trellis wire to increase distribution by splashing is not likely to eliminate the weed problem. Burying the tubing more than 4 inches deep will effectively reduce the adverse effects on residual herbicides, since their effectiveness is usually confined to the upper 2 to 4 inches of soil. Switching from trickle tubing that drips, to micro-sprinklers, in crops where they can be used, also effectively reduces the adverse effects of the irrigation on weed control.

When trickle irrigation will be used, choose herbicides for the residual herbicide weed control program during the irrigation season that are least soluble in water and most tightly adsorbed by the soil (Table 4.1). On coarse-textured sandy soils low in organic matter, Prowl H2O (pendimethalin) or Surflan (oryzalin) (for annual grass control) and Princep (simazine) (for annual broadleaf weed control) are the best choices, based on the very low water solubility of these herbicides. On fine-textured soils and soils higher in organic matter, Prowl H2O (pendimethalin) or Surflan (oryzalin) (for annual grass control) and Karmex (diuron) (for annual broadleaf weed control) are the best choices based on their very low or low water solubility and strong adsorption to the soil. Unfortunately, certain weeds (*e.g.*, yellow nutsedge) escape this herbicide combination. Adjust the application timing in the spring so the herbicides can be “activated” by 1 to 2 inches of rainfall or overhead irrigation before the trickle irrigation is used. This will allow the herbicides to move into and be attached to the soil before being subjected to the intense leaching of the trickle irrigation.

Remember that choosing the herbicide(s) that are least soluble in water and most strongly adsorbed to the soil will delay, but not prevent, herbicide failure and weed breakthroughs in trickle irrigated crops. Coarse-

textured sandy soils and soils low in organic matter that require frequent irrigation, increase the likelihood of weed control failure, especially during prolonged periods of heat and drought stress. Plan to use repeated applications of non-residual postemergence herbicides on a regular schedule, every 2 to 4 weeks during the growing season, to control weeds in trickle irrigated crops. Time the application of residual herbicides to derive the maximum benefit from their use when harvest approaches and preharvest interval (PHI) restrictions will not permit the continued use of the non-residual postemergence herbicides.

4.5 Reducing the Risk of Herbicide Resistance

Reducing the risk for developing herbicide-resistant weed populations requires incorporating a number of guidelines in managing your orchards:

- Spray only when necessary.
- Use alternative methods of weed control whenever possible such as mowing , cover-cropping, or mechanical cultivation.
- Rotate herbicides' site of action (HRAC Group Number – see note below).
- Limit the number of applications of herbicide(s) with the same site of action in a given growing season.
- Use mixtures or sequential herbicide treatments with different site of action that will control the weeds of concern.
- Scout orchards after herbicide application to detect weed escapes or shifts.
- Clean equipment before leaving orchards infested with or suspected to have resistant weeds.

HRAC Group Number

A classification of herbicides based on site of action, was developed to better understand and plan for resistance management. **Rotating herbicides with different sites of action is important for minimizing the risk of developing herbicide-resistant weeds**. The system was developed by the Weed Science Society of America (WSSA) and the Herbicide Resistance Action Committee (HRAC). More information on herbicide-resistant weeds and herbicide's sites of action can be found at *https://hracglobal.com/herbicide-resistance/overview*. See Table 4.2 for the HRAC Group Number of herbicides registered for use on tree fruits.

4.6 Tree Fruit Herbicide Recommendations

A good orchard floor management program eliminates and prevents the reestablishment of undesirable vegetation. Weeds compete with fruit trees for water, nutrients, and light; serve as alternate hosts for diseases and harmful insects; harbor rodents; and impede harvest. Herbicides used to control weeds must have a good margin of crop safety to minimize the risk to the tree.

Choose herbicides for use in the tree row that are labeled, have adequate crop safety (Table 4.2), and control the weed species in your orchard (Table 4.3). Use the correct amount of residual herbicides for each soil type (Table 4.4) or emerged weed species (Table 4.5). Make sure to respect Re-Entry Interval (**REI**) AND Pre-Harvest Interval (**PHI**) following herbicide application (Table 4.6).

The use of herbicide combinations, herbicide rotations, and sequential or spot treatments in a well-managed weed control program will eliminate or minimize problems. The recommended herbicides have been evaluated for crop safety and effectiveness. Information on dwarf trees and trees growing on their own roots is incomplete. Use herbicides with care on these trees.

Labels can be found on the CDMS website at: *http://www.cdms.net/LabelsMsds/LMDefault.aspx*.

Table 4.2 Crop Safety of Herbicides for Use in New and Established Orchards

Herbicides are listed by group number based on chemical structure and mechanism of action, as classified by the Herbicide Resistance Action Committee (HRAC). **Bolded group numbers are herbicides at higher risk for selecting resistant weed populations.** (Abbreviations: G = Good, F = Fair, P = Poor (not recommended), L=Labeled (data insufficient or not recommended), – = NOT LABELED (DO NOT USE), Est = Established)

Commercial Product	Active Ingredient	HRAC Group	Apple		Pear		Peach		Plum		Cherry	
			New	Est	New	Est	New	Est	New	Est	New	Est
INCORPORATED (RESIDUAL)												
Treflan HFP 4EC	trifluralin	3	–	–	–	–	L	L	L	L	–	–
PREEMERGENCE (RESIDUAL) THE AREA TO BE TREATED MUST BE FREE OF SURFACE LITTER												
(Matrix SG, Solida) 25WG	rimsulfuron	**2**	–	G	–	G	–	G	–	G	–	G
(Kerb) 50WP, (Kerb) 3.3SC[1]	pronamide	3	–	G	–	G	–	G	–	G	–	G
(Prowl H2O) 4AS	pendimethalin	3	G	G	G	G	G	G	G	G	G	G
(Surflan, Oryzalin) 4S (Surflan XL) 2G[5]	oryzalin + benefin[8]	3	G	G	G	G	G	G	G	G	G	G
(Princep, Simazine) 4L (Princep Caliber) 90WDG	simazine	**5**	–	F/G	–	F/G	–	F/G	–	L	–	L
(Sinbar) 80WDG	terbacil	**5**	L	F/G	L	–	L	F	L	–	L	–
(Karmex) 80DF, (Direx) 4L	diuron	**5**	–	L	–	L	–	L	–	–	–	–
(Solicam) 80DF	norflurazon	12	F/G	G	–	L	F/G	G	–	L	–	L
(Zeus Prime XC) 3.5 XC	sulfentrazone+ carfentrazone	**14**	–	G	–	–	–	–	–	–	–	–
(Goal 2XL, Galigan) 2EC	oxyfluorfen	**14**	G	G	G	G	G	G	G	G	G	G
(Chateau) 51SW (Tuscany) 4SC	flumioxazin	**14**	G	G	G	G	G	G	G	G	G	G
(Casoron) 4G	dichlobenil	29	L	G	L	G	–	–	–	–	L	L
(Casoron CS) 1.4L	dichlobenil	29	–	G	–	G	–	–	–	–	–	L
(Gallery, Trellis) 4.16SC	isoxaben	29	G	L[6]	G	–	G	–	G	–	G	–
(Motif) 4L	mesotrione	27	–	F/G	–	F/G	–	F/G	–	F/G	–	F/G
(Alion) 1.67SC	indaziflam	29	–	G	–	G	–	G	–	G	–	G
POSTEMERGENCE (SELECTIVE) DIRECTED UNDERNEATH TREE												
(Fusilade DX) 2EC	fluazifop	**1**	G	–	G	–	G	G	G	G	G	G
(Poast) 1.5EC	sethoxydim	**1**	G	G	G	G	–	G	G	–	G	G
(Select Max) 1EC (Select, Intensity) 2EC	clethodim	**1**	G	–	G	–	G	L[7]	G	–	G	–
(Sandea) 75WG[2]	halosulfuron	**2**	–	G	–	G	–	–	–	–	–	–
(Embed) 3.8SL[2, 4]	2,4-D choline	4	-	G	-	G	-	G	-	G	-	G
(various manufacturers and brands)3.8SL[2, 4]	2,4-D amine	4	F	G	F	G	F	G	F	G	F	G
(Stinger, Spur) 3EC	clopyralid	4	–	G	–	–	G	G	G	G	G	G
(Aim) 2EC[2]	carfentrazone	**14**	G	G	G	G	G	G	G	G	G	G
(Treevix) 70WG[2]	saflufenacil	**14**	–	L	–	L	–	–	–	–	–	–
(Venue) 0.17L[2]	pyraflufen-ethyl	**14**	G	G	G	G	G	G	G	G	G	G
(Motif) 4L[2]	mesotrione	27	–	F/G	–	F/G	–	F/G	–	F/G	–	F/G
POSTEMERGENCE (NON-SELECTIVE) DIRECTED UNDERNEATH TREE												
(Starane Ultra) 2.8SL[3]	fluroxypyr	4	–	L	–	L	–	–	–	–	–	–
(various brands and formulations)[3]	glyphosate	**9**	G	G	G	G	G	G	G	G	G	G
(Rely, Interline) 2.34L[3]	glufosinate	10	G	G	G	G	G	G	G	G	G	G
(Gramoxone SL) 2SL (or generic paraquat)[1,2]	paraquat	22	G	G	G	G	G	G	G	G	G	G

[1] **Restricted use pesticide**. [2] Do NOT allow spray to contact young, green bark. [3] Do NOT allow spray to contact any part of the tree, including mature bark. [4] Use only 2,4-D formulation(s) labeled for use in orchards! [5] Surflan XL 2G is only labeled on non-bearing fruit trees. [6] ONLY Trellis SC is labeled for use on bearing apples. [7] ONLY Select Max is labeled for use on bearing peach. [8] Benefin only present in Surflan XL.

Table 4.3 Herbicide Effectiveness on Common Weeds in Orchards

Herbicide performance is affected by weather, soil type, herbicide rate, weed pressure, and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by Rutgers, The State University of New Jersey, on coarse- to medium-textured soils. Actual performance may be better or worse than indicated in this chart. (Abbreviations: G = Good, F = Fair, P = Poor, N = None, – = insufficient data)

	Barnyardgrass	Crabgrass, large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (seedlings)	Yellow nutsedge	Carpetweed	Cocklebur, common	Galinsoga, hairy	Jimsonweed	Lambsquarters, common	Marestail/Horseweed	Morningglory sp.	Nightshade, Eastern black	Pigweed sp.	Purslane, common	Ragweed, common	Shepherd's-purse	Smartweed, Pennsylvania	Velvetleaf	Bindweed, Hedge	Dandelion	Horsenettle	Thistle, Canada
Preemergence (residual)																									
(Alion) 1.67SC	G	F/G	–	G	G	–	N	G	–	G	G	G	G	F	G	G	G	F	G	–	G	N	–	–	N
(Casoron) 4G (Casoron CS) 1.4L	F	G	F/G	G	F	F	–	–	–	–	–	G	F	–	–	G	G	–	G	–	–	–	–	–	–
(Chateau) 51SW (Tuscany) 4SC	F	F	F	F	F	F	P	G	–	G	G	G	G	G	G	G	G	G	G	G	G	–	P	–	N
(Gallery, Trellis) 4.16SC	N	N	N	N	N	N	F	–	G	G	G	G	G	G	G	G	G	G	G	G	G	N	N	N	N
(Goal 2XL, Galigan)2EC	F	F	F	F	–	–	P	G	–	G	G	G	G	–	G	G	G	G	G	G	G	N	N	N	N
(Karmex) 80DF (Direx) 4L	G	F/G	G	G	F/G	N	N	G	–	G	G	G	G	G	G	G	G	G	G	F	G	N	N	N	N
(Kerb) 50WP (Kerb) 3.3SC	G	G	G	G	G	–	N	G	N	P	N	G	P	–	–	G	G	P	–	–	P	N	N	N	N
(Matrix, Solida) 25WG	G	F	F	G	P	–	F	–	F/G	–	F	F	–	F	N	G	G	F	P	P	F	–	F	–	–
(Motif) 4L	N	P	N	N	N	N	F	G	F	G	G	G	F/G	F/G	G	G	–	F/G	G	G	G	–	F	F	F
(Princep, Simazine) 4L (Princep Caliber) 90WDG	F/G	F	F/G	F	F	P	N	–	F/G	G	G	F	G	G	G	F	G	G	G	G	F/G	N	N	N	N
(Prowl H2O) 4AS	G	G	G	G	G	F	N	G	N	N	N	F/G	N	N	N	F	F/G	N	–	–	F/G	N	N	N	N
(Sandea) 75WG	N	N	N	N	N	N	G	P	G	G	P	N	–	P	P	G	G	G	G	F/G	G	–	–	–	–
(Sinbar) 80WDG	P	F	F	F	F	–	P	G	–	G	G	G	F	G	G	G	G	G	G	G	G	N	N	N	N
(Solicam) 80DF	G	G	G	G	G	F	F	P	P	–	F	F	P	P	–	F	G	F/G	–	P	F	N	N	N	N
(Surflan, Oryzalin) 4S (Surflan XL) 2G	G	G	G	G	G	G	N	F/G	N	N	N	F/G	N	N	P	F/G	F/G	N	N	P	P	N	N	N	N
(Zeus Prime XC) 3.5 XC	G	G	G	G	F	–	–	G	–	–	G	G	–	–	–	–	–	G	–	F	–	–	–	–	–

*Table 4.3 Herbicide Effectiveness on Common Weeds in Orchards - **Postemergence (selective) and (non-selective) on next page***

ORCHARD WEED CONTROL

*Table 4.3 Herbicide Effectiveness on Common Weeds in Orchards - **Postemergence (selective) and (non-selective)***

	Barnyardgrass	Crabgrass, large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (seedlings)	Yellow nutsedge	Carpetweed	Cocklebur, common	Galinsoga, hairy	Jimsonweed	Lambsquarters, common	Marestail/Horseweed	Morningglory sp.	Nightshade, Eastern black	Pigweed sp.	Purslane, common	Ragweed, common	Shepherd's-purse	Smartweed, Pennsylvania	Velvetleaf	Bindweed, Hedge	Dandelion	Horsenettle	Thistle, Canada
Postemergence (selective)																									
2,4-D amine	N	N	N	N	N	N	N	G	G	F	F/G	G	F	F/G	F	G	G	G	G	F	G	F	F	P	F
(Aim) 2EC	N	N	N	N	N	N	N	P	N	–	N	F	N	F	F	G	–	N	F	N	F	N	N	N	N
(Embed) 3.8SL	N	N	N	N	N	N	N	G	G	F	F/G	G	F	F/G	F	G	G	G	G	F	G	F	F	P	F
(Fusilade DX) 2EC	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
(Motif) 4L	N	P	N	N	N	N	F	G	F	G	G	G	F/G	F/G	G	G	–	F/G	G	G	G	–	F	F	F
(Poast) 1.5EC	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
(Sandea) 75WG	N	N	N	N	N	N	G	P	G	G	P	N	–	P	P	G	G	G	G	F/G	G	–	–	–	–
(Select Max) 1EC (Select, Intensity)2EC	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
(Stinger, Spur) 3EC	N	N	N	N	N	N	N	N	G	G	F/G	P	F	N	F	P	N	G	N	P	P	N	F	P	G
(Treevix) 70WG	N	N	N	N	N	N	N	G	–	–		G	G	F	–	F/G	–	G	–	G	G	–	–	–	–
(Venue) 0.17L	N	N	N	N	N	N	N	N	–	–	N	F/G	N	F	F	F	–	N	–	N	G	N	N	N	N
Postemergence (non-selective)																									
(Gramoxone SL) 2SL (or generic paraquat)	F/G	F/G	F/G	G	F/G	–	N	F	G	G	G	F/G	F	F/G	G	G	F/G	F/G	G	F	G	P	P	P	N
glyphosate	G	G	G	G	G	G	P/F	G	G	G	G	G	N	F	F	G	G	G	G	G	G	F	F	F	G
(Rely, Interline) 2.34L	F/G	F/G	F	G	N	F	P/F	G	G	G	G	G	G	F/G	F	G	–	G	–	G	F/G	–	–	–	–
(Starane Ultra) 2.8SL	N	N	N	N	N	N	N	–	F/G	–	–	–	F/G	–	–	–	–	F/G	–	–	F/G	F	F	F	–

Table 4.4 Recommended Residual Herbicide Rates on Soil Types with Different Textures and Organic Matter Percentages (Active Ingredients, lb/A, – = NOT LABELED, DO NOT USE)

Soil Type	Sand		Loamy Sand		Sandy Loam			Loam		Silt Loam		Clay Loam	
% Organic Matter	**0-1**	**1-2**	**0-1**	**1-2**	**0-1**	**1-2**	**2-4**	**1-2**	**2-4**	**1-2**	**2-4**	**1-2**	**2-4**
(Alion) 1.67SC	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.085	0.085	0.085	0.085	0.085	0.085
(Casoron) 4G (Casoron CS) 1.4L	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6	4-6
(Chateau) 51SW (Tuscany) 4SC	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38	0.19-0.38
(Gallery, Trellis) 4.16SC	0.75	0.75	0.75	0.75	0.75	0.75	1	0.75	1	1	1	1	1
(Goal 2XL, Galigan) 2EC	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2	1.5-2
(Karmex) 80DF[2] (Direx) 4L[2]	–	–	–	–	–	1.5	2	2	2.5	2.5	3	3	3
(Kerb) 50WP (Kerb) 3.3SC	2	2	2	2	2	2	2	2.5	3	3	3.5	3.5	4
(Matrix, Solida) 25WG	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
(Motif) 4L	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
(Princep, Simazine) 4L[1] (Princep Caliber) 90WDG[1]	–	–	–	–	–	2	2	2	3	2	3	3	4
(Prowl H2O) 4AS	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4
(Sandea) 75WG	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047	0.023-0.047
(Sinbar) 80WDG[1] - **New planting**	–	–	–	–	–	0.4-0.8	0.4-0.8	0.4-0.8	0.4-0.8	0.4-0.8	0.4-0.8	0.4-0.8	0.4-0.8
(Sinbar) 80WDG[1] - **Established**	–	–	–	–	–	1.6	2.4	2	2.8	2	2.8	2.4	3.2
(Solicam) 80DF	–	–	–	2	–	2	2.5	2.5	2.5	2.5	3	3	4
(Surflan, Oryzalin) 4S[2] (Surflan XL) 2G[2]	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4
(Treflan HFP) 4EC[3]	0.5	0.5	0.5	0.5	0.5	0.63	0.75-1	0.63	0.75-1	0.63	0.75-1	0.63	0.75-1
(Zeus Prime XC) 3.5 XC	–	0.21-0.41	–	0.21-0.41	–	0.21-0.41	0.21-0.41	0.21-0.41	0.21-0.41	0.21-0.41	0.21-0.41	0.21-0.41	0.21-0.41

[1] Use 50% of the recommended rate when tank-mixing with another preemergence herbicide. [2] Use the lower recommended rate when tank-mixing with another preemergence herbicide, unless annual grass pressure is severe. [3] Recommended rates for new planting. For established planting, apply 1 to 2 lb a.i/A regardless of texture or %OM.

Table 4.5 Recommended Postemergence Herbicide Rates in New and Established Orchards (Active Ingredients, lb/A, – = NOT LABELED, DO NOT USE)

Commercial Product	Active Ingredient	Apple		Pear		Peach		Plum		Cherry	
		New	Est	New	Est	New	Est	New	Est	New	Est
(various manufacturers and brands) 3.8SL	2,4-D amine	0.95 to 1.4		0.95 to 1.4		0.95 to 1.4		0.95 to 1.4		0.95 to 1.4	
(various brands and formulations)	glyphosate	1 to 2		1 to 2		1 to 2		1 to 2		1 to 2	
(Aim) 2EC	carfentrazone	0.008 to 0.025		0.008 to 0.025		0.008 to 0.025		0.008 to 0.025		0.008 to 0.025	
(Embed) 3.8SL	2,4-D choline	-	0.48 to 1.9	-	0.48 to 1.9	-	0.48 to 1.9	-	0.48 to 1.9	-	0.48 to 1.9
(Fusilade DX) 2EC	fluazifop	-	0.125 to 0.38	-	0.125 to 0.38	0.125 to 0.38		0.125 to 0.38		0.125 to 0.38	
(Gramoxone SL) 2SL (or generic paraquat)	paraquat	0.6 to 1		0.6 to 1		0.6 to 1		0.6 to 1		0.6 to 1	
(Motif) 4L	mesotrione	-	0.094 to 0.188	-	0.094 to 0.188	-	0.094 to 0.188	-	0.094 to 0.188	-	0.094 to 0.188
(Poast) 1.5EC	sethoxydim	0.19 to 0.47		0.19 to 0.47		-	0.19 to 0.47	0.19 to 0.47	-	0.19 to 0.47	
(Rely, Interline, Lifeline) 2.34L	glufosinate	0.88 to 1.5		0.88 to 1.5		0.88 to 1.5		0.88 to 1.5		0.88 to 1.5	
(Sandea) 75WG	halosulfuron	-	0.023 to 0.047	-	0.023 to 0.047	-	-	-	-	-	-
(Select Max) 1EC (Select, Intensity) 2EC	clethodim	0.094 to 0.125	-	0.094 to 0.125	-	0.094 to 0.125	-	0.094 to 0.125	-	0.094 to 0.125	-
(Starane Ultra) 2.8SL	fluroxypyr	-	0.35 to 0.70	-	0.35 to 0.70	-	-	-	-	-	-
(Stinger, Spur) 3EC	clopyralid	-	0.094 to 0.25	-	-	0.125 to 0.25		0.125 to 0.25		0.125 to 0.25	
(Treevix) 70WG	saflufenacil	-	0.044	-	0.044	-	-	-	-	-	-
(Venue) 0.17L	pyraflufen-ethyl	0.0040 to 0.0053		0.0040 to 0.0053		0.0040 to 0.0053		0.0040 to 0.0053		0.0040 to 0.0053	

Table 4.6 Herbicide Reentry Interval (REI) and Preharvest Interval (PHI) Restrictions (– = NOT LABELED, DO NOT USE, nl = not listed, h = hours, d = days)

Commercial	Apple		Pear		Peach		Plum		Cherry	
Product	REI	PHI	REI	PHI	REI	PHI	REI	PHI	REI	PHI
Incorporated (residual)										
(Treflan HFP) 4EC	–	–	–	–	12 h	nl	12 h	nl	–	–
Preemergence (residual)										
(Alion) 1.67SC	12 h	14 d	12 h	14 d	12 h	14 d	12 h	14 d	12 h	14 d
(Casoron) 4G, (Casoron CS) 1.4L	12 h	nl	12 h	nl	–	–	–	–	12 h	nl
(Chateau) 51SW, (Tuscany) 4SC	12 h	60 d	12 h	60 d	12 h	60 d	12 h	60 d	12 h	60 d
(Gallery, Trellis) 4.16SC	12 h	30/ 365 d[1]	12 h	365 d	12 h	365 d	12 h	365 d	12 h	365 d
(Goal 2XL, Galigan) 2EC	24 h	nl	24 h	nl	24 h	nl	24 h	nl	24 h	nl
(Karmex) 80DF, (Direx) 4L	12 h	nl	12 h	nl	12 h	nl	–	–	–	–
(Kerb) 50WP, (Kerb) 3.3SC	24 h	nl	24 h	nl	24 h	nl	24 h	nl	24 h	nl
(Matrix, Solida) 25WG	4 h	7 d	4 h	7 d	4 h	14 d	4 h	14 d	4 h	14 d
(Motif) 4L	12 h	30 d	12 h	30 d	12 h	30 d	12 h	30 d	12 h	30 d
(Princep, Simazine) 4L (Princep Caliber) 90WDG	12 h	150 d	12 h	nl	12 h	nl	12 h	nl	12 h	nl
(Prowl H2O) 4AS	24 h	60 d	24 h	60 d	24 h	60 d	24 h	60 d	24 h	60 d
(Sandea) 75WG	12 h	14 d	12 h	14 d	–	–	–	–	–	–
(Sinbar) 80WDG	12 h	60 d	12 h	nl	12 h	60 d	12 h	nl	12 h	nl
(Solicam) 80DF	12 h	60 d	12 h	60 d	12 h	60 d	12 h	60 d	12 h	60 d
(Surflan, Oryzalin)4S, (Surflan X)L 2G	24 h	nl	24 h	nl	24 h	nl	24 h	nl	24 h	nl
(Zeus Prime XC) 3.5XC	12 h	nl	–	–	–	–	–	–	–	–
Postemergence (selective)										
2,4-D amine	48 h	14 d	48 h	14 d	48 h	40 d	48 h	40 d	48 h	40 d
(Aim) 2EC	12 h	3 d	12 h	3 d	12 h	3 d	12 h	3 d	12 h	3 d
(Embed) 3.8SL	48 h	14 d	48 h	14 d	48 h	40 d	48 h	40 d	48 h	40 d
(Fusilade DX) 2EC	12 h	365 d	12 h	365 d	12 h	14 d	12 h	14 d	12 h	14 d
(Motif) 4L	12 h	30 d	12 h	30 d	12 h	30 d	12 h	30 d	12 h	30 d
(Poast) 1.5EC	12 h	14 d	12 h	14 d	12 h	25 d	12 h	365 d	12 h	25 d
(Sandea) 75WG	12 h	14 d	12 h	14 d	–	–	–	–	–	–
(Select Max, Intensity One) 1EC (Select, Intensity) 2EC	24 h	365 d	24 h	365 d	24 h	14/ 365 d[2]	24 h	365 d	24 h	365 d
(Stinger, Spur) 3EC	12 h	30 d	–	–	12 h	30 d	12 h	30 d	12 h	30 d
(Treevix) 70WG	12 h	0 d	12 h	0 d	–	–	–	–	–	–
(Venue) 0.17L	12 h	0 d	12 h	0 d	12 h	0 d	12 h	0 d	12 h	0 d
Postemergence (non-selective)										
glyphosate	4 h	1 d	4 h	1 d	4 h	17 d	4 h	17 d	4 h	17 d
(Gramoxone SL) 2SL (or generic paraquat)	24 h	nl	24 h	nl	24 h	14 d	24 h	28 d	24 h	28 d
(Rely, Interline) 2.34L	12 h	14 d	12 h	14 d	12 h	14 d	12 h	14 d	12 h	14 d
(Starane Ultra) 2.8SL	24 h	14 d	24 h	14 d	–	–	–	–	–	–

[1] 30 d only applicable for Trellis SC, all other isoxaben products are 365 d.

[2] 14 d only applicable to Select Max, all other clethodim products are 365 d.

4.7 Weed Control in Tree Rows

New Plantings

Weed control in a newly planted orchard should be planned to provide a maximum margin of crop safety. Tillage and/or herbicides prior to planting should control established biennial and perennial weeds. Apply a combination of herbicides to control annual grasses and broadleaf weeds. Apply in early spring after 1 to 2 inches of rainfall or irrigation has settled the soil around the roots of the trees, but before weeds emerge or tree buds break.

Established Orchards

Apply herbicides to the tree row in established orchards twice annually, in late-fall and in late-spring. Herbicides applied in late- fall control winter annuals, certain perennials, and early season summer annuals. Spring herbicide applications extend summer annual weed control through harvest. Advantages of two herbicide applications/year include:

1. Control of winter annual weeds, including camphorweed, wild lettuce and horseweed (marestail) and summer annual weed control for the same cost as most single application weed control programs.
2. Improved spring labor and equipment distribution requirements by controlling early summer annual weeds with residual herbicides applied the previous fall, thus delaying the need to spray in the spring until May or early June.
3. Increased consistency of weed control treatments, especially control of summer annual weeds when dry weather follows the spring herbicide application.
4. Decreased risk of crop injury, since each herbicide application must last less than a full year. Herbicides can be alternated and rates can be reduced or split to improve crop safety.
5. Decreased competition from established winter annual weeds and summer annual weed seedlings in March, April, and May for fertilizer and water when the trees begin to grow.

Late-Fall Herbicide Applications should be applied after soil temperatures at the 4 inch depth drop below 50°F, but before the soil freezes. Include a translocated postemergence herbicide and a residual broadleaf herbicide. Apply 2,4-D choline or Gramoxone to control emerged winter annual broadleaf weeds tank-mixed with Princep for residual control. Consider a labeled glyphosate product if perennial weeds are present and treatment is recommended in the fall. Add Princep for residual control of broadleaf weeds.

The use of a grass herbicide in the fall depends on the product chosen. Kerb is the only grass herbicide that must be applied in the fall, if it is used to control cool season perennial grasses. An additional residual annual grass herbicide is needed in the spring to provide full season summer annual grass control following a fall application of Kerb.

Solicam 80DF, Surflan 4AS, and Prowl H2O are annual grass herbicides that should be applied in late-fall or as a split application, the first half in the fall and the second half in the spring. Use the split application when grass pressure is heavy for best results. The use of these herbicides in spring only has resulted in inconsistent weed control when dry weather followed the application.

Sinbar 80WDG applications for annual grass control should be applied only in late-spring. The relatively high solubility of Sinbar 80WDG results in leaching when applied in the fall. Increased risk of crop injury and poor weed control can result.

Follow-up Late-Spring Applications should include a different residual broadleaf weed herbicide and a residual grass herbicide. Add a postemergence herbicide only if needed. Use Karmex 80DF for residual broadleaf weed control. Apply Sinbar 80WDG or the second half of a split herbicide treatment of Solicam 80DF, Surflan 4AS, or Prowl H2O for annual grass control. Include 2,4-D choline if seedling annual broadleaf weeds are observed, or a labeled glyphosate product to control established annual or perennial grasses and broadleaf weeds. Sinbar 80WDG is also effective for seedling weed control postemergence. No other postemergence herbicide may be needed if no established weeds are present and seedling weeds are sprayed before they exceed 1 inch in height. See Table 4.2 for recommended herbicides for each crop.

4.8 Weed Control in Sod Between Tree Rows

Broadleaf weeds are undesirable in an orchard sod growing between the tree rows. Competition with the crop and mowing requirements may be increased. Many weeds are alternate hosts for diseases, insects, and nematode pests. The flowers of dandelion, clover, mustard species, and other weeds coincide with apple bloom and are preferred by pollinating insects. The same weeds, and others, may also bloom before or after the trees bloom and attract bees into the orchard when insecticides must be sprayed. The seedheads of dandelion clog tractor radiators and delay other orchard maintenance operations. Many broadleaf weeds can be controlled or suppressed in the fall with 2,4-D choline applied before the weeds become dormant for the winter. Use 2.0 pt/A of Embed Extra (1.0 lb a.e./A 2,4-D choline). Spray to uniformly wet the foliage of the target weeds. Flat fan nozzles provide more uniform coverage than flood tips and should be used to apply postemergence herbicides. Choose a day to spray when no rain will occur for a minimum of eight hours after application.

Clover is difficult to control, but can be suppressed or controlled in an orchard sod with good management practices and herbicides. Manage fertilizer applications to favor grass rather than the clover. Nitrogen fertilizer stimulates grass growth, and phosphorus and potassium stimulate clover growth in a mixed grass and legume sod. Do not apply fertilizer containing phosphorous or potassium to sod if clover control is a problem. Rather, apply fertilizer for tree growth in the vegetation free strip. Mowing height also influences the composition of a mixed grass and clover sod. Close mowing favors the clover. Taller sod will favor the grass. Mow no closer than four inches if clover control is a problem in the sod. Clover is difficult to control with 2,4-D, but excellent control can be obtained by tank-mixing Stinger with 2,4-D. Certain other weeds, including wild onion and garlic, and clover can be suppressed or controlled with 2,4-D, but good results require additional effort. The leaves of clover are densely covered by fine hairs and wild onion leaves are waxy and vertical. Both weeds retain spray poorly. Add nonionic surfactant to increase wetting and spray retention to improve control. Add the surfactant in units of 1.0 qt/100 gal of spray solution. Check for improved wetting after adding each quart of surfactant. The amount of surfactant needed will depend on the characteristics of the water used. Use the amount needed to improve wetting. Too much or too little surfactant will reduce control. Splitting the application by applying half the 2,4-D rate twice, about 7 to 14 days apart, will further improve the suppression or control of clover and wild onion. Use 2,4-D in conjunction with good fertilization and mowing practices to suppress clover on sites where the weed is well adapted.

4.8.1 Residual Herbicides

Alion (indaziflam) – 0.065 to 0.085 lb a.i./A. Use 5.0 to 6.5 fl oz/A Alion 19F. Apply in late-fall or spring to weed free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Primarily for the control of most annual broadleaf weeds, and many annual grasses. Use the lower rate on coarse-textured sandy soils low in organic matter, and the higher rate on fine-textured soils. Tank-mix with Prowl, Surflan, or Solicam to improve annual grass control. Tank-mix with flumioxazin, oxyfluorfen, diuron or simazine to improve annual broadleaf weed control. Apply sequentially with rimsulfuron or rimsulfuron plus terbacil for yellow nutsedge control. Apply to trees established a minimum of 3 years.
For established (bearing) stone fruits and pome fruits including apples, cherries, peaches, and pears.

Casoron (dichlobenil) – 4.0 to 6.0 lb a.i./A. Use 100 to 150 lb/A Casoron 4G. Apply between November 15 and February 15 to control labeled perennial/biennial weeds or in early spring, before weed growth begins and daily high temperatures exceed 50°F, to control labeled annual weeds. Casoron is volatile in warm temperatures and must be irrigated or incorporated after application if applied in warm weather.
For newly planted (nonbearing) and established (bearing) apples, pears, and cherries.

Chateau (flumioxazin) – 0.19 to 0.38 lb a.i./A. Use 6.0 to 12.0 dry oz/A of Chateau 51SW. Apply in the late-fall or in early- spring, before bud break and before weeds emerge, or add an appropriate postemergence herbicide to kill existing weeds. Chateau controls many annual broadleaf weeds, and controls or suppresses annual grasses.

ORCHARD WEED CONTROL

Tank-mix with pendimethalin, oryzalin, or norflurazon to improve control of annual grasses. Do not apply to trees in the field less than one year old unless the tree is protected by a tree guard, a waxed container, or another non-porous wrap or guard. Do not use more than 6.0 dry oz/A in orchards where the soil contains more than 80% sand (sands and loamy sands) until the trees have been in the field for three years. Do not apply to pears during the period from after bloom through final harvest. Chateau can be difficult to clean out of a sprayer. Follow tank and sprayer "Clean Out Instructions" on the label if the tank or any part of the sprayer will be used to spray other crops.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries. For established (bearing) apples, peaches, pears, plums, and cherries.

Goal 2XL/Galigan 2E (oxyfluorfen) – 2.0 lb a.i./A. Use 4.0 qt/A Goal 2XL or Galigan 2E. Apply in early spring before bloom. Add an appropriate postemergence herbicide to kill existing vegetation. Goal 2XL/Galigan 2E controls annual broadleaf weeds and suppresses annual grasses. Tank-mix with pendimethalin, oryzalin or norflurazon to improve length of annual grass control. Do NOT incorporate Goal 2XL/Galigan 2E into the soil with a disk or other implement, or reduced weed control may result.
For newly planted (nonbearing) apples, peaches, pears and cherries. For established (bearing) apples, peaches, pears and cherries.

Karmex (diuron) – 1.0 to 3.0 lb a.i./A. Use 1.25 to 3.75 lb/A Karmex 80DF or 1 .0 to 3.0 qt/A of Direx 4L. Apply in late-fall OR spring to weed-free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Primarily for annual broadleaf weed control. Tank-mix with pendimethalin, oryzalin or norflurazon to improve length of annual grass control. Use one-half the labeled Karmex rate when used alone for the soil type, to improve crop safety, and the range of weeds controlled when tank-mixing with an annual grass herbicide. Apply to apples and pears established a minimum of 1 year, and to peaches established a minimum of 3 years.
For established (bearing) apples, peaches, and pears.

Kerb (pronamide) –2.0 to 4.0 lb a.i./A. Restricted use pesticide. Use 4.0 to 8.0 lb/A Kerb 50WP. Apply in November when soil temperatures are between 35 and 55°F (1.67° and 12.8°C). Primarily controls perennial grasses, including quackgrass, bluegrass, ryegrass sp., fescue sp., and also provides early control of annual grasses the following spring. Apply Surflan, Prowl, Solicam, OR Sinbar the following May or June for full season annual grass control. Tank-mix Kerb with 2,4-D and Princep for postemergence and residual broadleaf weed control.
For established (bearing) apples, peaches, pears, plums, and cherries.

Matrix SG (rimsulfuron) – 0.031 to 0.062 lb a.i./A. Use 4.0 dry oz/A. of Matrix SG in a single application or split the application and apply 2.0 dry oz two times. Apply in the spring, or split the application and apply Matrix SG in late-fall or spring and repeat in early summer. Matrix SG controls many annual grasses and broadleaf weeds, and will suppress or control yellow nutsedge. Always add nonionic surfactant to be 0.25% of the spray solution, and always maintain the spray solution at a pH between 4.0 and 8.0. Matrix SG is a group 2 herbicide and will not be effective on group 2 resistant horseweed. Tank-mix or use Matrix SG in combination with other herbicides with a different mode of action in your annual weed control program.
For established (bearing) apples, peaches, pears, plums, and cherries.

Motif (mesotrione) – 0.19 lb a.i./A. Use 6.0 fl oz/A Motif 4L. Provides both residual and post-emergence control of susceptible broadleaf weeds. Apply in late fall and/or spring. Add oil concentrate to be one percent of the spray solution to improve control of susceptible emerged weeds. Motif controls many annual broadleaf weeds, and is especially effective for the control of horseweed and common lambsquarters. Tank-mix with pendimethaline, oryzalin, or norflurazon to provide control of annual grass. Add an appropriate postemergence herbicide to control emerged broadleaf weeds and grasses. A second application of Motif at the same rate may be applied 5 months after the previous application. Do not apply more than 12.0 fl oz/A in one year. Do not use on soils containing greater than 20 percent gravel.
For established (1 year) apples, pears, peaches, nectarines, plums and cherries.

Princep (simazine) – 2.0 to 4.0 lb a.i./A. Use 2.2 to 4.4 lb/A Princep 90DF or 2.0 to 4.0 qt/A Princep 4L. Apply in late-fall or spring to weed-free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Primarily for annual broadleaf weed control. Tank-mix with pendimethalin, oryzalin or norflurazon to improve length of annual grass control. Use one-half the labeled Princep rate when used alone for the soil type, to improve crop safety and the range of weeds controlled, when tank-mixing with an annual grass herbicide. Apply to trees established a minimum of 1 year.
For established (bearing) apples, cherries, peaches, and pears.
Prowl H2O (pendimethalin) – 1.9 to 3.8 lb a.i./A. Use 2.0 to 4.0 qt/A Prowl H2O 3.8SC. Apply in late-fall and/or early-spring to weed-free soil or add an appropriate postemergence herbicide to kill existing vegetation. Use the high rate for long-term control (4 to 8 months) and the low rate for short-term control (2 to 4 months). Prowl primarily controls annual grasses. Tank-mix with simazine plus 2,4-D in late-fall or with oxyfluorfen, diuron, OR terbacil in the spring, when labeled for this crop, to control annual broadleaf weeds. **Do NOT exceed 6.3 qt of Prowl H2O/A/year.**
For newly planted (nonbearing) apples, peaches, plums, and cherries.
For established (bearing) apples and peaches.

Sandea (halosulfuron) – 0.023 to 0.047 lb a.i./A. Use 0.5 to 1.0 dry oz/A Sandea 75DF in late-spring and/or early-summer to control yellow nutsedge. Always add nonionic surfactant to be 0.25% of the spray solution. **Provides both residual and post-emergence control of susceptible weeds**. Use in combination or tank-mixed with other residual herbicides for annual grass and improved annual broadleaf weed control. When yellow nutsedge pressure is heavy, apply in the spring after the weed has emerged and developed several leaves, and repeat the application 45 to 60 days later if additional yellow nutsedge emerges. Sandea is a group 2 herbicide and will not be effective on group 2 resistant horseweed. Do NOT apply more than 2 dry oz of Sandea/A/year. Sandea will not injure established orchard sod. Apply to trees established a minimum of 1 year.
For established (bearing) apples.

Sinbar (terbacil) – 1.0 to 3.0 lb a.i./A. Use 1.25 to 3.75 lb/A Sinbar 80WDG. Apply in the spring to weed-free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Use at one-half the labeled Karmex rate when used alone for the soil type, to improve crop safety and the range of weeds controlled, when tank-mixing with an annual grass herbicide. Apply to trees established a minimum of 3 years.
For established (bearing) apples and peaches.

Solicam (norflurazon) – 2.0 to 4.0 lb a.i./A. Use 2.5 to 5.0 lb/A Solicam 80DF. Apply in late-fall and/or spring to weed-free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Primarily for annual grass control, Solicam may provide partial control of many broadleaf weeds. Tank-mix with simazine plus 2,4-D in late-fall or with oxyfluorfen, diuron, OR terbacil in the spring, when labeled for the crop, to improve the control of broadleaf weeds. *For newly planted (nonbearing) apples and peaches.*
For established (bearing) apples, cherries, peaches, plums, and pears.

Surflan (oryzalin) – 2.0 to 6.0 lb a.i./A. Use 2.0 to 6.0 qt/A Surflan 4AS (or other labeled formulations). Apply in late-fall and/ or early-spring to weed-free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Use the high rate for long-term control (4 to 8 months) and the low rate for short-term control (2 to 4 months). Surflan primarily controls annual grasses. Tank-mix with simazine plus 2,4-D in late-fall or with oxyfluorfen, diuron, OR terbacil in the spring, when labeled for the crop, to control annual broadleaf weeds.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Trellis SC, Gallery SC (isoxaben) – 0.50 to 1.0 lb a.i./A. Use 16.0 to 31.0 fl oz/A Trevis SC. Apply in late-fall or early-spring to weed-free soil to control many broadleaf weeds. In newly planted trees, allow the soil to settle and fill any depressions around the tree before application. Add a postemergence herbicide to improve the control of

emerged weeds. Trellis SC primarily controls annual broadleaf weeds. Tank-mix with pendimethalin, oryzalin, or norflurazon to control annual grasses.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples.

Zeus Prime XC (sulfentrazone + carfentrazone) – 0.21 to 0.41 lb a.i./A. Use 7.7 to 15.1 fl oz/A Zeus Prime XC. Apply in early-spring to weed-free soil, or add an appropriate postemergence herbicide to kill existing vegetation. Surflan primarily controls annual broadleaf weeds and yellow nutsedge. Tank-mix with oryzalin, pendimethalin, or norflurazon to control annual grasses. Sequential applications of Zeus Prime can be applied when directed as a banded application (50% band or less of orchard floor) so long as total use rate does not exceed 15.1 fl oz/A on a broadcast basis within a year and the second application is not applied within 60 days of the initial application. Apply to trees established a minimum of 3 years.
For established (bearing) apples.

4.8.2 Postemergence Herbicides: Selective

Note: Add a labeled insecticide for catfacing insects to the weed spray in peach, nectarine, and plum orchards when a crop, the pest(s), and heavy weed vegetation are present.

Aim (carfentrazone) – 0.008 to 0.032 lb a.i./A. Use 0.5 to 2.0 fl oz/A of Aim to control emerged broadleaf weeds in the 2- to 3-leaf stage including morningglory species, pigweed, lambsquarters, ragweed, and horseweed. The addition of nonionic surfactant at 0.25%v/v or crop oil concentrate at 1% v/v at a minimum of 20 GPA is required for optimum herbicide performance. Aim may be tank mixed with other preemergence or postemergence herbicides. Sequential applications may be used so long as there is 14 days between applications and total use rate for year does not exceed 7.9 ounces/acre..
For newly planted (nonbearing) and established (bearing) apples, pears, peaches, nectarines, plums, and cherries.

Embed (2,4-D choline) – 0.5 to 1.9 lb a.e. (acid equivalent)/A. Use 1.0 to 4.0 pt/A Embed. Controls a wide variety of broadleaf weeds. Effectiveness depends on herbicide rate, weed species, and growth stage. Apply to weed foliage in the fall after harvest (including drops), or in early spring before trees or dandelions flower. Fall applications are more effective and reduce the risk of herbicide drift injury to adjacent crops. Weeds are most susceptible to 2,4-D when they are growing vigorously, not under stress, and before flower buds appear. Apply before the leaves of perennial weeds lose normal, summer green color. No more than 8 pts of Embed can be applied within a 12-month period. DO NOT apply on loamy sand or coarser soils.
WARNING: **Use only 2,4-D formulation(s) labeled for use in orchards!** BEWARE of herbicide drift! Grapes, many flowers, and vegetables are extremely sensitive to 2,4-D. Injury may occur in adjacent fields if sprayed when unfavorable conditions prevail.
For established (bearing) apples, peaches, pears, plums, and cherries.

Fusilade DX 2EC (fluazifop butyl) – 0.18 to 0.38 lb a.i./A. Use 12.0 to 24.0 fl oz/A Fusilade DX 2EC. Add 2.0 pt crop oil concentrate OR nonionic surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution). Use the lower rate on most annual grasses less than 6 inches tall and to Johnsongrass. Use the higher rate to control other perennial grasses, crabgrass, and annual grasses more than 6 inches tall.
WARNINGS:
1. Do NOT tank-mix Fusilade DX 2EC with any other pesticide.
2. Do NOT apply within 1 hour of rainfall.
3. Do NOT apply to grasses suffering from drought, heat, cold, or any other stress condition.

For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) peaches, nectarines, cherries, and plums.

Poast (sethoxydim) – 0.2 to 0.5 lb a.i./A. Apply 1.0 to 2.5 pt/A Poast 1.53EC. Add 2.0 pt crop oil concentrate/A. Use the lower rate to control annual grasses less than 6 inches tall. Use the higher rate to control annual grass 6 to 12 inches tall and to control perennial grasses.

WARNINGS:

1. Do NOT tank-mix Poast with any other pesticide.
2. Do NOT apply within 1 hour of rainfall.
3. Do NOT apply to grasses suffering from drought, heat, cold, or any other stress condition.

For newly planted (nonbearing) apples, pears, plums, and cherries.
For established (bearing) apples, pears, peaches, and cherries.

Select 2EC/Select Max 1EC (clethodim) – 0.094 to 0.125 lb a.i./A. Apply 6.0 to 8.0 fl oz/A of Select 2EC or 12.0 to 16.0 fl oz/A of Select Max 1EC to control most grass weed species, including certain hard to control grass weeds, such as small grain volunteers and cover crops, and perennials such as hard fescue, tall fescue, Bermudagrass, orchardgrass, quackgrass, Johnsongrass, and wirestem muhly. Use the lower rate to control annual grasses and the perennial grasses listed above. Repeat the application if regrowth occurs. Always add crop oil concentrate to be 1% of the spray solution to Select 2EC or nonionic surfactant to be 0.25% of the spray solution to Select Max 1EC.

WARNINGS:

1. Do NOT tank-mix with any other pesticide unless labeled.
2. Do NOT apply within 1 hour of rainfall.
3. Do NOT apply to grasses suffering from drought, heat, cold, or any other stress condition.
4. Do NOT apply within 12 months of harvest.
5. Unless otherwise stated on label, all clethodim products are for non-bearing orchards ONLY!

For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.

Stinger, Spur 3EC (clopyralid) – 0.07 to 0.25 lb a.i./A. Use 3.0 to 10.5 fl oz/A of Stinger 3EC (or other labeled formulations) to control certain annual and perennial broadleaf weeds in the legume and composite plant families. Troublesome legume weeds include vetch and clover species. Common weeds in the composite family include ragweed species, common cocklebur, thistle species, goldenrod, aster species, and mugwort (wild chrysanthemum). Use 3.0 to 4.0 fl oz/A to control annual weeds and all clover species. Use 8.0 to 10.5 fl oz/A of Stinger 3A, tank-mixed with 2,4-D, to control perennial weeds in the composite plant family, such as Canada thistle, goldenrod, aster species, and mugwort (wild chrysanthemum). Treat susceptible perennial weeds as they emerge in the spring, or, for the most consistent control, split the treatments. Apply 5.25 fl oz/A of Stinger, tank-mixed with 2,4-D, when the weeds emerge in early spring. Apply another 5.25 fl oz/A of Stinger sixty to ninety days later. Treat the sod middles as well as the tree rows. **Stinger is a postemergence foliage absorbed herbicide AND a residual herbicide, therefore, Stinger must be applied with a calibrated sprayer that can deliver a predetermined number of gallons of spray solution/A. Maintain a 30 day PHI.**

For newly planted (nonbearing) peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, plums, and cherries.

Treevix (saflufenacil) – 0.044 lb a.i./A. Use 1.0 dry . oz/A of Treevix to control horseweed, purslane, morningglory species, pigweed, ragweed, and smartweed. The addition of MSO at 1% v/v plus ammonium sulfate at 8.5 to 17 lb/100 gal of spray solution is required for optimum herbicide performance. Treevix may be tank mixed with glyphosate, glufosinate, sethoxydim, and oxyfluorfen. Do not apply more than 3 ounces/acre per year. Allow at least 21 days between applications. ***For established (bearing) apples and pears.***

4.8.3 Postemergence Herbicides: Nonselective

Gramoxone SL (or generic paraquat) – 0.6 to 1.0 lb a.i./A. Restricted use pesticide. Use 2.5 to 4.0 pt/A Gramoxone SL2.0. Contact killer only; no translocation or residual activity. Best results occur when weeds are 6 inches tall or less. Regrowth may occur from the root systems of established weeds. Use a surfactant to be 0.25% of the spray solution (1.0 qt/100 gal of spray solution). Combine with recommended preemergence herbicide(s) for residual weed control. Do not allow spray or drift to contact green bark, leaves, or fruit. Crop damage may result. **DANGER:** Do not breathe spray mist. Read safety precautions on the label.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Glyphosate (many labeled formulations) will control many serious annual and perennial weeds. It is a translocated, slow-acting herbicide with no soil or residual activity. Results will become evident 1 to 3 weeks after application. Optimum rate and time of application depend on weed species and growth stage. Weeds should be growing vigorously when treated. Do not treat weeds that are under stress from drought, extreme heat, cold, or other adverse conditions. Trees are more susceptible to glyphosate injury from mid-summer until dormant.
Broadcast: 0.56 to 3.0 lb a.e./A. See your product's label for the rate/A. Apply lower rates to control seedlings and annual weeds and to suppress established perennial weeds. Use shields and do not allow glyphosate to contact the foliage or green shoots. See warnings below.
Spot Treatment: See your product's label for rate. Apply to wet the foliage to the drip point. See warnings below.
WARNINGS:
1. Do NOT allow glyphosate to contact the leaves, young green bark, fresh trunk wounds, or root suckers, or severe crop injury may occur.
2. Do NOT allow glyphosate to contact ANY IMMATURE PART or SUCKERS of the tree.
3. Do NOT use GALVANIZED containers. Glyphosate may react with the container to produce explosive hydrogen gas.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Rely (glufosinate) – 0.88 to 1.50 lb a.i./A. Use 48 to 82 fl oz/A of Rely to control most annual broadleaf and grass weeds plus some perennials. Apply as a directed spray at a minimum of 20 GPA. Repeated applications may be necessary for control of perennial weeds. The addition of ammonium sulfate will enhance glufosinate activity on difficult to control species; however, the addition of surfactants and crop oil will increase risk of crop injury. For optimal performance, spray under cloudless conditions and when sun is high in the sky.
WARNINGS:
1. Do NOT allow Rely to contact the leaves, young green bark, fresh trunk wounds, or root suckers, or severe crop injury may occur.
2. Do NOT allow Rely to contact ANY IMMATURE PART or SUCKERS of the tree.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Starane Ultra (fluroxypyr) – 0.35 to 0.70 lb a.i./A. Use 0.7 to 1.4 pt/A of Starane Ultra to control many annual and certain perennial broadleaf weeds, including hemp dogbane, milkweed sp., curly dock, blackberry, and horsenettle, and to suppress bindweed sp. Apply to the foliage of actively growing weeds. Starane Ultra will not control certain common annual broadleaf weeds, including common lambsquarter and pigweed sp. Tank-mix with 2,4-D to improve the spectrum of annual broadleaf weeds controlled, or with a glyphosate product to control emerged annual grasses and broadleaf weeds, and with residual herbicides for season long annual weed control. Do not apply more than 1.4 pt of Starane Ultra/year. Do not apply Starane Ultra more than one time/year, during bloom, within 14 days of harvest. Do not treat trees less than 4 years old. This use is not listed on the Starane Ultra label because it is on a supplemental label. ***For established (bearing) apples and pears ONLY.***

4.9 Troublesome Weeds

Annual: A Weed that lives less than 1 full year.
Biennial: A Weed that lives longer than 1 year, but less than 2 full years. The plant often grows vegetatively during the first year, then flowers and dies during the second year.
Perennial: A Weed that lives longer than 2 full years, often reproducing vegetatively by horizontal shoots, roots, or rhizomes, as well as by seed.
Most problem weeds are either perennial or biennial plants. Complete weed control (eradication) of any weed is difficult or impossible. Established perennial weeds are among the most difficult to kill. One application of an herbicide recommended below may not provide complete control, but regrowth should be limited and competitive ability reduced. Follow-up spot treatments will improve the long-term result of the initial herbicide application.

Bindweed Species (Field & Hedge)

This perennial weed has deep vertical roots for food storage, and horizontal roots that spread the weed vegetatively. Shoots emerge from this extensive root system in the spring and wind themselves around any available support. Flowers first appear in June, and flowering continues throughout the summer.

Glyphosate. Apply when the weed is growing actively and has flowers in late-spring or early summer and/or in late-summer or early-fall after harvest, but before the first frost. Late-spring or fall applications may be more effective than applications made in mid-summer. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.
Broadcast: 3.0 to 3.75 lb a.e./A. Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Starane Ultra (fluroxypyr) – 0.25 to 0.5 lb a.i./A. Use 0.7 to 1.4 pt of Starane Ultra/A control or suppress bindweed species. Apply to the foliage of actively growing bindweed in late-spring. Treat the tree rows and sod middles in the area where bindweed is established. Do not apply more than 1.4 pt of Starane/year. Do not apply Starane Ultra more than one time/year, during bloom, within 14 days of harvest. Do not treat trees less than 4 years old. If bindweed regrowth occurs in late-summer or early-fall, treat sod middles with 2,4-D, and tree rows with 2,4-D or a glyphosate product after harvest, but before frost.
For established apples and pears ONLY.

Canada Thistle

This perennial weed has deep vertical roots for food storage, and horizontal roots that spread the weed vegetatively. Shoots emerge from this extensive root system in the spring. Flowers appear in late-June, and seed is dispersed in July. The shoots die after the seed is dispersed. New shoots appear in late-summer and grow vegetatively until frost. These fall shoots make food for the roots and do not flower.

Glyphosate (Roundup products, Touchdown products, Glyphomax Plus and other labeled formulations). Apply in late- June when Canada thistle has flower buds or flowers, or in the fall after the shoots are 6 to 8 inches tall, but before frost. Roundup translocates into the vertical roots of the plant well, but in less quantity into the horizontal roots. Follow-up spot treatments may be needed to control regrowth from pieces of horizontal roots that were not killed by the initial application. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.
Broadcast: 2.25 lb a.i./A. Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point. Wet a minimum of 50 percent of the weed foliage for effective control. ***For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.***
For established (bearing) apples, peaches, pears, plums, and cherries. *Canada Thistle - continued on next page*

Canada Thistle - continued

Stinger 3EC (clopyralid) – 0.25 lb a.i./A. Use 10.5 fl oz/A of Stinger 3EC (or other labeled formulations) to control Canada thistle. Treat the weed when it emerges in the spring, or, for the most consistent control, split the treatments. Apply 5.25 fl oz/A of Stinger when the weed emerges in early spring. Apply another 5.25 fl oz/A of Stinger sixty to ninety days later. Treat the sod middles as well as the tree rows. **Stinger is a postemergence foliage absorbed herbicide AND a residual herbicide, therefore, Stinger must be applied with a calibrated sprayer that can deliver a predetermined number of gallons of spray solution/A. Maintain a 30 day PHI.**

Camphorweed

This is a biennial in the southern states. Seeds germinate in the late-summer or fall, and the plant overwinters as a rosette. Flowers are produced the following summer, and the plant dies. Whether camphorweed seedlings overwinter in NJ, or originate from seed that germinates in the spring, is unknown.

Glyphosate (Roundup products, Touchdown products, Glyphomax Plus and other labeled formulations). Apply when the weed is growing rapidly. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.

Broadcast: 0.75 to 1.5 lb a.e./A.

Spot Treatment: Use the lower percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.

For newly planted (nonbearing) apples, peaches, pear, plums, and cherries.

For established (bearing) apples, peaches, pears, plums, and cherries.

Dandelion

This perennial plant grows actively during the spring and fall. Flowering in the spring coincides with many fruit trees and may interfere with pollination by attracting bees away from the trees. This weed is known to be an alternate host for the stem-pitting virus of peaches and other stone fruits.

Glyphosate (Roundup products, Touchdown products, Glyphomax Plus and other labeled formulations). Apply when the weed is growing actively and has flower buds. Spring or fall applications may be more effective than applications made in mid-summer. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.

Broadcast: 3.0 to 3.75 lb a.e./A.

Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.

For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.

For established (bearing) apples, peaches, pears, plums, and cherries.

Goldenrod Species

These closely related weeds are perennials that begin growth in April from rosettes or rootstocks. Typically, yellow blooms appear in late-summer and the stems die in the fall. Some regrowth, as short stems or rosettes, often occurs before winter. Strong root systems overwinter and resume growth in the spring. The weeds spread using underground horizontal roots. Once established, control of this weed is difficult, since it is tolerant to most herbicides and the roots can be spread by cultivation or other tillage practices.

Glyphosate. Apply in May or June after spring growth is 8 to 10 inches tall, but before the shoots become too tall for good coverage with the spray solution. Generally, broadcast sprays must be applied in May, while spot treatments and ropewick applications can be delayed until June. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.

Broadcast: 1.5 to 3.0 lb a.e./A. Use 2.0 to 4.0 qt/A Roundup Ultra Max.

Goldenrod Species - Glyphosate - continued on next page

Goldenrod Species - Glyphosate - continued

Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point. Ropewick Applicator: Wipe twice; travel in opposite direction for each wipe.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Stinger 3EC (clopyralid) – 0.25 lb a.i./A. Use 10.5 fl oz/A of Stinger 3EC (or other labeled formulations) to control goldenrod. Treat the weed when it emerges in the spring, or, for the most consistent control, split the treatments. Apply 5.25 fl oz/A of Stinger, tank-mixed with 2,4-D, when the weed emerges in early spring. Apply another 5.25 fl oz/A of Stinger sixty to ninety days later. Treat the sod middles as well as the tree rows. **Stinger is a postemergence foliage absorbed herbicide AND a residual herbicide, therefore, Stinger must be applied with a calibrated sprayer that can deliver a predetermined number of gallons of spray solution/A. Maintain a 30 day PHI.**

Hemp Dogbane

Glyphosate. Apply when the weed is growing actively and has flowers in early summer and/or treat fall regrowth in late-summer or early-fall after harvest, but before the first frost. Late-spring or fall applications may be more effective than applications made in mid-summer. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.
Broadcast: 3.0 to 3.75 lb a.e./A. Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Starane Ultra (fluroxypyr) – 0.25 to 0.5 lb a.i./A. Use 0.7 to 1.4 pt of Starane Ultra/A to control or suppress hemp dogbane. Apply to the foliage of actively growing dogbane in late-spring. Treat the tree rows and sod middles in the area where dogbane is established. Do not apply more than 1.4 pt of Starane/year. Do not apply Starane Ultra more than one time/year, during bloom, within 14 days of harvest. Do not treat trees less than 4 years old. If dogbane regrowth occurs in late-summer or early-fall, treat sod middles with 2,4-D, and tree rows with 2,4-D or a glyphosate product after harvest, but before frost.
For established apples and pears ONLY.

Horseweed (Marestail)

Horseweed is a biennial plant with seed that germinates in late-summer or early-fall. The seedling grows as a rosette during the fall and early spring. The plant bolts during the summer, flowers, sets seed, and dies during its second late-summer and fall season. The common name “marestail” is a misnomer. Herbicide labels that claim “marestail control” may be referring to another weed.

Stinger 3EC (clopyralid) – 0.094 to 0.125 lb a.i./A. Use 4.0 to 5.25 fl oz/A of Stinger 3EC, tank-mixed with 2,4-D, to control horseweed. Treat in the spring, while the weed is still in the rosette stage of growth, for best results. Thorough wetting of the foliage is needed for optimum control. Ensure good wetting of the foliage if treatment is delayed until after the weed has begun to grow tall in the late-spring to flower. Expect poor control after flower buds have formed. **Stinger is a postemergence foliage absorbed herbicide AND a residual herbicide, therefore, Stinger must be applied with a calibrated sprayer that can deliver a predetermined number of gallons of spray solution/A. Maintain a 30 day PHI.**

Note: GLYPHOSATE RESISTANT horseweed, also called marestail or stickweed locally, has been identified in the Mid-Atlantic Region, including NJ. Horseweed can behave like a biennial or summer annual weed, but usually behaves like a winter annual. The weed produces a large number of wind distributed seed in late-summer and early-fall. Due to the wind borne distribution of the seed, it is likely that glyphosate resistant
Note: GLYPHOSATE RESISTANT horseweed - continued on next page

Note: GLYPHOSATE RESISTANT horseweed - continued

biotypes will spread to your farm despite good integrated weed management by individual growers. Therefore, all horseweed populations should be considered potentially glyphosate resistant. Glyphosate, formulated as Roundup products, Touchdown, Glyphomax Plus, and other generic formulations were recommended for horseweed control prior to 2003, but have been removed from the recommendations for horseweed control due to the resistance development.

Milkweed, Common

Glyphosate. Apply when the weed is growing actively and has flowers in early summer and/or treat fall regrowth in late-summer or early-fall after harvest, but before the first frost. Late-spring or fall applications may be more effective than applications made in mid-summer. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.

Broadcast: 3.0 to 3.75 lb a.e./A.

Spot Treatment:

Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.

For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.

For established (bearing) apples, peaches, pears, plums, and cherries.

Starane Ultra (fluroxypyr) – 0.25 to 0.5 lb a.i./A. Use 0.7 to 1.4 pt of Starane Ultra/A to control or suppress common milkweed. Apply to the foliage of actively growing milkweed in late-spring. Treat the tree rows and sod middles in the area where milkweed is established. Do not apply more than 1.4 pt of Starane/year. Do not apply Starane Ultra more than one time/year, during bloom, within 14 days of harvest. Do not treat trees less than 4 years old.

For established apples and pears ONLY.

Mugwort (wild chrysanthemum)

Stinger 3EC (clopyralid) – 0.25 lb a.i./A. Use 10.5 fl oz/A of Stinger 3EC (or other labeled formulations) to control mugwort. Treat the weed when it emerges in the spring, or, for the most consistent control, split the treatments. Apply 5.25 fl oz/A of Stinger, tank-mixed with 2,4-D, when the weed emerges in early spring. Apply another 5.25 fl oz/A of Stinger sixty to ninety days later. Treat the sod middles as well as the tree rows.

Stinger is a postemergence foliage absorbed herbicide AND a residual herbicide, therefore, Stinger must be applied with a calibrated sprayer that can deliver a predetermined number of gallons of spray solution/A. Maintain a 30 day PHI.

Poison Ivy

This woody perennial vine or shrub is capable of climbing a fruit tree. Contact with any part of the plant may result in an itching, blistering skin rash. Nonselective postemergence herbicides must be used to control this weed. Take control measures before vines grow up the tree trunk.

Glyphosate. Apply in mid- to late-summer, after the weed flowers in late-June or early-July, or in early-fall before fall colors appear. Results of the fall application may not become evident until the following spring. Best results have been obtained in late-summer after the fruit has formed. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.

Broadcast: 3.0 to 3.75 lb a.e./A.

Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.

For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.

For established (bearing) apples, peaches, pears, plums, and cherries.

Quackgrass

This perennial plant grows actively in the late-spring and early-fall when daily high temperatures range between 65° and 80°F (18.3° and 26.7°C). High mid-summer temperatures, above 85°F (29.4°C), and/or low soil moisture cause the weed to become dormant or semi-dormant until moisture and cooler weather return. The weed reproduces by seed and vegetatively by rhizomes, horizontal underground stems that eventually curve upward and make new shoots. The seedhead, which appears in June, resembles ryegrass, except each floret is rotated one quarter turn compared to ryegrass. The rhizomes are about 0.125 inch in diameter and may grow horizontally for up to several feet in length before curving upward and making a new shoot. Ryegrass does not have rhizomes.

Glyphosate. Apply in late- spring, May or June, or in the fall, October or November, when the weed has vigorous healthy foliage, a minimum of 4 to 6 leaves, and has begun to tiller. Do NOT till the field or otherwise disrupt the root and rhizome system of the weeds in the soil for a minimum of 8 months before treatment.
Broadcast: 1.5 lb a.e./A.
Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Kerb (pronamide) – 2.0 to 4.0 lb a.i./A. Restricted use pesticide. Use 4.0 to 8.0 lb/A Kerb 50WP. Apply in November when soil temperatures are between 35° and 55°F (1.67° and 12.8°C). Primarily controls perennial grasses, including quackgrass, bluegrass, ryegrass sp., fescue sp., and also provides early control of annual grasses the following spring. Apply Surflan, Prowl, Solicam, or Sinbar the following May or June for full season annual grass control. Tank-mix Kerb with 2,4-D and Princep for postemergence and residual broadleaf weed control.
For established (bearing) apples, peaches, pears, plums, and cherries.

Virginia Creeper

Virginia Creeper is a woody perennial vine, capable of climbing and smothering a fruit tree. Nonselective postemergence herbicides must be used to suppress or control this weed. Remove the vine from the tree during winter pruning and lay it on the ground. Do NOT "prune out" the vine. Maximum leaf area is needed for herbicide application during the summer.

Glyphosate. Apply in mid- to late-summer after vine flowers in early July, but before fall colors appear. Applications in spring or early summer, before flowering, have been less effective. Repeat applications may be needed. One application may merely suppress Virginia Creeper. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.
Broadcast: 3.0 to 3.75 lb a.e./A. Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established apples, peaches, pears, plums, and cherries.

White Heath Aster

This is a perennial that begins growth in April from rosettes or rootstocks. Typically, blooms are about 0.5 inch in diameter. The flowers have white or slightly tinted purple petals with yellow centers. They appear in late-summer, set seed, and the stems die in the fall. Some regrowth, as short stems or rosettes, often occurs before winter. The weed spreads using underground horizontal roots. Once established, control of this weed is difficult since it is tolerant to most herbicides and the roots can be spread by cultivation or other tillage practices.

Glyphosate. Apply in May or June after spring growth is 8 to 10 inches tall, but before the shoots become too tall for good coverage with the spray solution. Generally, broadcast sprays must be applied in May, while spot

White Heath Aster - Glyphosate - continued on next page

White Heath Aster - Glyphosate - continued

treatments and ropewick applications can be delayed until June. See WARNINGS for glyphosate in the listing of Postemergence Herbicides - Nonselective above.
Broadcast: 1.5 to 3.0 lb a.e./A. Spot Treatment: Use the higher percent solution on the label of the glyphosate product being used. Apply to wet the foliage to the drip point.
For newly planted (nonbearing) apples, peaches, pears, plums, and cherries.
For established (bearing) apples, peaches, pears, plums, and cherries.

Stinger 3EC (clopyralid) – 0.25 lb a.i./A. Use 10.5 fl oz/A of Stinger 3EC (or other labeled formulations) to control white heath aster. Treat the weed when it emerges in the spring, or, for the most consistent control, split the treatments. Apply 5.25 fl oz/A of Stinger, tank-mixed with 2,4-D, when the weed emerges in early spring. Apply another 5.25 fl oz/A of Stinger sixty to ninety days later. Treat the sod middles as well as the tree rows. **Stinger is a postemergence foliage absorbed herbicide AND a residual herbicide, therefore, Stinger must be applied with a calibrated sprayer that can deliver a predetermined number of gallons of spray solution/A. Maintain a 30 day PHI.**

Yellow Nutsedge

This perennial sprouts from over wintering nutlets from mid- to late-spring through early summer. In late-spring and early- summer the weed grows vegetatively and spreads by underground rhizomes that curve up and establish new plants. In late-summer, after about August 1st, rhizomes stop curving up to make new plants. A new flush of rhizomes grow down, the tips swell, and form new nutlets. In early- to mid-fall the plant dies, separating the nutlets from each other. The nutlets survive the winter and may sprout the following spring, or may remain dormant for several years before sprouting.

Casoron (dichlobenil) – 4.0 to 6.0 lb a.i./A. Use 100 to 150 lb/A Casoron 4G. Apply between November 15 and February 15 to control labeled perennial/biennial weeds or in early spring, before weed growth begins and daily high temperatures exceed 50°F, to control labeled annual weeds. Casoron is volatile in warm temperatures and must be irrigated or incorporated after application if applied in warm weather.
For newly planted (nonbearing) and established (bearing) apples, pears, and cherries.

Matrix SG (rimsulfuron) – 0.031 to 0.062 lb a.i./A. Use 4.0 dry oz /A of Matrix SG in a single application or split the application and apply 2 dry oz two times. Apply in the spring, or split the application and apply Matrix SG in late-fall or spring and repeat in early summer. Matrix SG controls many annual grasses and broadleaf weeds, and will suppress or control yellow nutsedge. Always add nonionic surfactant to be 0.25% of the spray solution, and always maintain the spray solution at a pH between 4.0 and 8.0. Matrix SG is a group 2 herbicide with a single site of action in susceptible weeds, which makes it a high risk for weed resistance development. Tank-mix or use Matrix SG in combination with other herbicides with a different mode of action in your annual weed control program. ***For established (bearing) apples, peaches, pears, plums, and cherries.***

Sandea (halosulfuron) – 0.023 to 0.047 lb a.i./A. Use 0.5 to 1.0 dry oz/A Sandea 75DF in late-spring and/or early-summer to control yellow nutsedge. Always add nonionic surfactant to be 0.25% of the spray solution. Use in combination or tank-mixed with other residual herbicides for annual grass and improved annual broadleaf weed control. When yellow nutsedge pressure is heavy, apply in the spring after the weed has emerged and developed several leaves, and repeat the application 45 to 60 days later if additional yellow nutsedge emerges. Do NOT apply more than 2 dry oz of Sandea/A/year. Sandea will not injure established orchard sod. Apply to trees established a minimum of 1 year.
For established (bearing) apples.

Sinbar (terbacil) – 1.0 to 3.0 lb a.i./A. Use 1.25 to 3.75 lb/A Sinbar 80 WDG in late spring to suppress or control emerged yellow nutsedge for 6 to 10 weeks. Rainfall is required for herbicide activation, but, above average rainfall after application will reduce length of control. Below average rainfall will increase length of control. Tank-mix with Matrix plus nonionic surfactant to improve control. Use lower rate on coarse textured soils low in organic matter, and a higher rate on fine textured soils and on soils high in organic matter. Observe a 60 day PHI. ***For established (bearing) apples and peaches.***

5 Tree Fruit Pests and Controls

5.1 Diseases of Stone Fruit

5.1.1 Diseases of Stone Fruit (in Alphabetical Order)

Anthracnose

Anthracnose disease on peach, plum and cherry, also sometimes referred to as ripe rot, only occurs sporadically in New Jersey. The last two significant infections in commercial peach orchards were in 1998 and 2003. In the latter year, orchards consisting of the cultivars 'White Lady', 'Klondike', 'Bounty', 'PF Lucky 13', and 'Harrow Beauty' had very high levels of fruit infection resulting in considerable yield reduction. Since no information is available on resistance of peach cultivars to anthracnose, all cultivars must be presumed susceptible at this time.

The disease is caused by the plant pathogenic fungi *Colletrotrichum gloeosporioides* and *Colletrotichum acutatum*. These same two pathogens are known to cause bitter rot on apple and anthracnose fruit rot on blueberry. *C. gloeosporioides* also causes ripe rot on grape and anthracnose on pepper. The pathogens are also found on a wide variety of herbaceous plants, including many legumes. On peach fruit, symptoms initially appear as small brown spots, often resembling brown rot. However, unlike brown rot, the circular lesions enlarge more slowly and become characteristically sunken. Older lesions often have concentric rings covered with orange or salmon-colored masses of spores.

Adequate control of anthracnose on peach usually results when Captan 80 WDG at 2.5 lb/A is applied during the cover sprays. The final cover sprays leading up to the first preharvest brown rot spray are particularly critical. Frequent summer rains probably reduce the available residue of this fungicide, thereby decreasing the level of protection; in this case, closer application intervals are required. Also, the practice of switching from captan to sulfur cover sprays most likely increases the risk of infection. Little information is available on the efficacy of sulfur on peach anthracnose. Nevertheless, since sulfur provides poor control of bitter rot on apple, good control of peach anthracnose is not likely.

Fruit susceptibility increases as the fruit ripens and infection is particularly favored by moist, warm (80-90°F) weather. Orchards are at risk if one or more of the following factors are true: (1) the orchard has a past history of anthracnose; (2) the orchard is adjacent to an inoculum source (*e.g.*, apple orchard, woods, previously harvested peach block with anthracnose); (3) weed control has been inadequate, particularly for legumes such as clover; (4) sulfur was used instead of captan for cover sprays; or (5) captan was applied during the cover sprays, but too infrequently relative to frequency of rainfalls (*e.g.*, 14-day or longer interval).

Bacterial Canker

Bacterial canker can be a serious bacterial disease of some stone fruit grown in New Jersey. Apricot is extremely susceptible; cherry and plum are highly susceptible; peaches are only moderately susceptible; and almond and tart cherry are least susceptible. Given this susceptibility scale, control is normally only necessary for apricot, sweet cherry, and plum.

Bacterial canker, or bacterial gummosis, is caused by a *Pseudomonas* bacterium. This pathogen overwinters in canker margins, systemically in the vascular system, and in healthy buds. During cool and wet spring weather, the pathogen multiplies epiphytically and infects buds, blossoms, young leaves, and rarely fruit. Buds or flowers injured by frost are commonly attacked, resulting in a blossom blight appearance. Eventually, however, the pathogen will grow into the woody tissue to form a canker.

Cankers are the most important identifying symptom on sweet cherry trees. The canker is somewhat sunken and darker in color than other areas of the bark. The inner wood of the canker is orange to brown, and gummy amber ooze may be observed. Cankers continue to enlarge in lateral branches and the central leader, sometimes even advancing into two-year wood. The canker may eventually girdle the branch or trunk, causing significant limb loss or tree death, respectively.

Pruning practices and other cultural practices should be modified to prevent canker. During the warmer, drier summer months, the epiphytic pathogen populations tend to be low. Thus, only summer pruning should be performed, preferably after harvest. Prune during dry weather to prevent infection of pruning cuts.

During fall, the return of cool, wet weather allows the epiphytic bacterial pathogen population to once again peak. Autumn rains splash-disperse the bacteria to newly exposed leaf scars, where they infect and begin to form cankers. For susceptible cultivars, successive applications of copper in the fall may help to reduce disease incidence. Bordeaux sprays can begin September 1st if safened with vegetable oil. The sprays are repeated at 14-day intervals for a total of 4-5 sprays. An additional spray should be applied just before bud swell to aid in reducing spring infections. See "Bordeaux Mixture" in this chapter (section "Fungicides and Bactericides") for information on how to make Bordeaux mixture.

Although copper applications may help to provide some level of control, results of Michigan studies have shown inconsistent reductions in spring bacterial populations from fall applications. While the fall applications may help to reduce leaf scar infections, the non-systemic copper will not affect bacteria residing in cankers. Thus, fall applications are at best only partially effective in the overall management plan. In some fruit growing areas, particularly the Pacific Northwest, copper is not recommended at all as a control measure. Copper-sprayed trees in these regions have actually been observed to have more bacterial canker than on non- sprayed trees. Furthermore, pathogen resistance to copper is also problematic.

Given that no spray material or timing is highly effective, an integrated approach is currently the best and recommended form of bacterial canker management. Such a program utilizes a variety of cultural control measures, including use of resistant cultivar/ rootstock combinations, proper tree planting and pruning practices, avoidance of tree injury, modifying irrigation practices, weed and nematode control, etc. An excellent bulletin by the Oregon State University Extension Service describes 12 steps to manage bacterial canker on sweet cherry; it can be found at: *https://catalog.extension.oregonstate.edu/em9007* (Bulletin EM 9007, May 2010).

Bacterial Spot

Bacterial spot is caused by the plant pathogenic bacterium *Xanthomonas arboricola pv. pruni*. This bacterium can attack leaves, twigs, and fruit. Foliar infection results in angular, grayish lesions about 0.125 inch in diameter. As lesions age, they become purple and necrotic, and sometimes abscise, leaving a shot-hole appearance. Multiple lesions result in leaf chlorosis (yellowing) and defoliation. Lesions often concentrate along the leaf midribs and tips, the latter resulting in a tip burn appearance.

Cankers are visible in early spring as slightly raised, blister-like areas along the twig. If the terminal bud region becomes infected, the shoot tip becomes a blackened canker that may extend downward along the shoot for about an inch. In this case, the terminal bud is killed. Fruit symptoms are first observable three to five weeks after petal fall. Look for small, depressed, brownish lesions, sometimes accompanied by pits, cracks, or exuding gum. These lesions may eventually coalesce to cover large areas of the fruit surface.

Bacterial spot infections occur anytime from petal fall until after harvest. The two-four week period immediately after petal fall is critical for both early foliage and fruit infection. Thus, to properly control fruit infection, sprays should be applied from petal fall until 15 days before harvest. Mycoshield, FireLine, and fixed-coppers have provided satisfactory disease control.

In addition to the protective sprays mentioned above, there is some evidence that early applications just before bud-swell and prior to bloom can help to reduce the overwintering epiphytic inoculum on tree surfaces. These sprays lower the bacterial population, thereby decreasing the likelihood of infection of newly emerging leaves and fruit. Also, autumn applications during leaf drop may be beneficial in preventing canker formation. Fixed-copper materials can be used at both these times; see section "Fungicides and Bactericides" in this chapter.

Table 5.1 classifies peach and nectarine cultivars according to their relative susceptibility to infection. Many of the newer cultivars listed are the result of evaluations performed in NJ orchards.

The amount of disease that occurs in any given season is dependent on the weather, spray efficacy and timing, inoculum availability, and cultivar resistance. All cultivars have some susceptibility to the disease, but those less susceptible will have lower levels of fruit infection in years favorable for infection. Thus, the best control measure is to plant only cultivars with the least amount of susceptibility.

Table 5.1 Relative Susceptibility of Peach and Nectarine Cultivars to Bacterial Spot

Determination of bacterial spot susceptibility: Trees of new and standard varieties were grown in mixed cultivar blocks located at commercial orchards in southern NJ. Cultivar plots, which typically consisted of four trees of a single variety, were planted at one location in a block (without replication). Qualitative observations on foliage and fruit were made at harvest over a minimum of four years. Disease levels on foliage, fruit, or both determined susceptibility rating. Bactericides were applied, but usually at rates or frequencies below commercial level.

Low Susceptibility			
Allstar	FlaminFury PF#Lucky12	Harkin	Redstar
Biscoe	FlaminFury PF#Lucky13	Harrow Beauty	Ruby Prince
Blazeprince	FlaminFury PF#14Jersey	Harrow Dawn	Saturn
Blazing Star	FlAminFury PF#15A	Harrow Diamond	Scarlet Pearl
Candor	FlaminFury PF#19-007	Harrow Fair	Scarlet Prince
Coralstar	FlaminFury PF#Lucky24B	Madison	Sentinel
Derby	FlaminFury PF#28-007	Manon	Sentry
Desiree	Glenglo	Messina	Spring Prince
Dixired	Gloria	NJF14	Starfire
Earliglo	Glowingstar	NJF16	Sunbrite
Early-Red-Fre	Harbelle	NJF17	Vinegold
FlaminFury PF#1	Harbinger	NJN100	Vulcan
FlaminFury PF#5B	Harbrite	Redhaven	
FlaminFury PF#7	Harcrest	Redkist	
Medium Susceptibility			
Arcticglo	Easternglo	GaLa	Loring
Autumn Star	Elberta	Galaxy	NJF15
Bellaire	Emeraude	Garnet Beauty	Parade
Blake	Empress	Glohaven	Queencrest
Blushing Star	Encore	Harblaze	Raritan Rose
Bounty	Fantasia	Harflame	Ruston Red
Carogem	Flameprince	Harvester	Salem
Carolina Belle	FlaminFury PF#11	Jade	Spring Snow
Contender	Flamin Fury PF#17	Jefferson	Stark Ovation
Cresthaven	FlaminFury PF#20-007	Jerseydawn	Sugar May
Crimson Snow	Flamin Fury PF#23	Jerseyglo	Summer Beaut
Earlired	Flamin Fury PF#24-007	Jim Dandee	Summer Serenade
Early Loring	Flamin Fury PF#25	John Boy	Triogem
Early Sunhaven	Flamin Fury PF#27A	Late Sunhaven	White Lady
High Susceptibility			
Arctic Belle	Flavor Top	Lady Nancy	Spring Flame
Arctic Blaze	Flavorcrest	Laurol	Sugar Giant
Arctic Gold	Glacier	Maygrand	Sugar Lady
Arctic Jay	Heavenly White	Redgold	Suncrest
Arctic Pride	Honey	Rio Oso Gem	Sunglo
Arctic Star	Honeykist	Snow Beauty	Sunhigh
Arctic Sweet	Honeyroyale	Snow Bride	Sweet Dream
Autumnglo	Jerseyland	Snowfire	Sweet Sue
Autumn Lady	Jerseyqueen	Snow Giant	Topaz
Babygold 5	Johanna Sweet	Snow King	Yukon King
Benedicte	Jolly Red Giant	Snow Prince	Zephyr
Big Red	Karlarose	Snow Queen	
Fayette	Klondike	Springold	

Black Knot

Black knot is a serious disease of commercial plum and is also frequently found on wild cherry and wild plum. The causal agent of black knot, the plant-pathogenic fungus *Apiosporina morbosa*, can infect peach, sweet cherry, and apricot, but its occurrence on these crops is uncommon and not of commercial importance. Although not as common as on plum, losses from black knot have been reported on sour cherry. Characteristic symptoms included elongated black, corky swellings on shoots, branches, and sometimes, even trunks. These outgrowths, which grow lengthwise annually, can be as short as one-half inch to as much as one foot in length. Infected shoots and limbs are stunted and can be eventually killed by a girdling action.

Infection can occur on new shoot growth at any time from bud-break until shoot elongation ceases. However, the period from prebloom through first cover is the most critical time for disease development. During this period, the fungus produces and discharges the greatest number of ascospores on two-year-old knots. These spores are only disseminated when rain periods last at least 6 hours, during which they are splash dispersed to new, healthy tissue. If temperatures during these wetting periods are optimum, at 54 to 75°F, then spores germinate rapidly and infection is most likely. Once infection occurs, some knots may be visible as soon as autumn, while others will become evident the following spring and summer.

Black knot management on plum consists of integrating cultivar resistance, inoculum reduction, and the application of fungicide sprays. Unfortunately, some of the most important plums are highly susceptible: ‘Stanley‘, ‘Damson‘, ‘Bluefree‘, and ‘Shropshire‘. Moderately susceptible cultivars are ‘Brodshaw‘, ‘Early Italian‘, ‘Fellenburg‘, ‘Methley‘, and ‘Milton‘. The cultivars ‘Formosa‘, ‘Shiro‘, and ‘Santa Rosa‘ are considered slightly susceptible, while ‘President‘ is the only one reported as highly resistant. Removal of inoculum sources, namely the knots in the orchard as well as on neighboring wild trees, is of great importance for disease control. Knots should be pruned out during the summer when actual canker size is more indicative of the advancing fungal infection; make cuts at least 3-4 inches below the bottom edge of the swelling. Remove or burn prunings before the subsequent spring so that they don‘t act as a potential inoculum source.

Bravo is the best fungicide for control of black knot on plum, and should be applied in a series of three sprays at approximately 7-10 day intervals: pink, bloom, and petal fall. At shuck-split and first cover, apply either captan alone or a mixture of captan + Topsin M. Note that although Bravo is labeled for use at shuck-split, fruit injury has been observed, so avoid use at this time. Higher rates of these materials should be used in severe situations when weather is favorable and inoculum is readily available; also, an additional spray at second cover might be beneficial in these situations if shoots are still actively growing. Lower rates would suffice for well-maintained orchards in which black knot has not been a problem. See the Plum Chapter, section “Plum Pest Management” for details on rates.

Brown Rot

The plant-pathogenic fungus *Monilinia fructicola* causes brown rot. Infection can occur at bloom or during the preharvest period. Bloom infection results in blossom blight, a necrosis of flowers. Once a flower is infected, the fungus can also proceed into the stem and cause a canker. A spore produced on these flowers and cankers then becomes the inoculum for subsequent infection during the preharvest fruit rot phase.

Normally, two sprays are applied during the bloom period, the first at 5-10% bloom and the second at full bloom. If the weather is very dry, then only one spray may be needed. Conversely, if much rainy weather is encountered, then a third spray at petal fall may be desirable.

During bloom, the most susceptible part of the flower is the pistil. With cultivars that possess short petals, the pistils may be exposed for a considerable period before the flower opens; whereas in cultivars with large petals, the pistil is protected until the flower is open. Consequently, the first bloom spray should be timed to coincide with that period when most of the anthers have just become exposed.

As the fruit softens during ripening, it becomes more susceptible to brown rot. Maintain protection by applying fungicides at regular intervals. Apply the first spray at 14-21 days preharvest, or at first color. Usually, only two sprays at 7-14 days apart are needed, but a third spray may be necessary in the event of very wet weather and/or a high inoculum level. A final application of a systemic material just before harvest is also a good practice to protect fruit during shipping and packing operations. Fungicides differ in spray and preharvest intervals, so follow labels carefully.

Insect feeding injury increases brown rot infection; therefore, maintain adequate insecticide protection. Also, experiments indicate that brown rot is most difficult to control where peach trees make excessive growth. In such orchards, use nitrogen-containing fertilizers sparingly.

Special attention to brown rot control is required where trees are planted closely or where the orchard is surrounded by woods. Such conditions reduce air drainage, and dew or rain evaporates more slowly from blossoms and fruit than where air drainage is better.

A large variety of fungicides are available for control during both the blossom blight and fruit rot stages of disease development. Refer to the "Fungicides and Bactericides" section in this chapter, and the stone fruit pest management sections, for details on materials and resistance management.

Constriction canker

Constriction canker, previously called Fusicoccom canker, results in the death or necrosis of both vegetative and fruiting shoots. During fall leaf drop, the normal abscission of leaves exposes leaf scars to the environment. Since temperatures are becoming cooler during this period, plant growth is slowing down, and more time is required for leaf scar healing. Consequently, the scars remain susceptible to invasion by pathogens for a longer period of time than under warmer summer conditions.

During rainy periods, the fungal causal agent, *Phomopsis amygdali*, produces spores in fruiting bodies embedded in the cankers. These spores are disseminated by rain-splash and wind-blown rain to fresh leaf scars. After entering the twigs, the pathogen begins to colonize the surrounding tissue. Sometimes, by late fall or early winter, very small slightly sunken reddish-brown cankers can be seen surrounding infected leaf scars. These cankers continue to develop and enlarge during any warm periods in the winter and into the next spring and summer. Eventually, the mature tan to silver colored cankers girdle the twigs, causing classic shoot blight symptoms and direct fruit loss.

In addition to fall infection through leaf scars, the pathogen can also infect shoots through bud scale scars in early spring. As buds break dormancy, the bud scales detach, producing an exposed scar not unlike those produced during fall leaf drop. Infection through these scars results in cankers identical to those produced by fall infections.

Fungicides should be applied at 14-day intervals during the entire fall leaf drop period to protect scars from infection. In the Mid-Atlantic region, begin sprays in mid-September and continue until all leaves have dropped, generally by late November. Similarly, two to three sprays are applied during the spring bud-break period. The idea is to maintain fungicide protection on susceptible scars throughout each period. This program is recommended only for moderate to severely infected orchards, not as a general purpose spray program for all orchards.

A variety of systemic and protectant fungicides were examined for management of constriction canker. The most effective were the protectants Bravo and Captan. Unfortunately, current labels only allow a single fall or post-harvest spray of these materials. However, a 24(c) special local need label was obtained for application of Bravo on peach in New Jersey. Applications are recommended at 3-4 pt/A, preferably at high enough volume to get good coverage of leaf scars.

Although the fungicide programs significantly reduce disease development, they are at best only 50 to 70% effective. To achieve higher levels of control, growers must also reduce inoculum by removing cankers, and the timing of this pruning operation is critical. If pruning is done too early then many of the younger, non-girdling cankers are missed. So, late summer is the best time to prune out cankers since the majority of them have killed the shoots, making them much easier to find. The pruned cankers do not need to be removed from the orchard and can remain on the orchard floor. Inoculum produced by the cankers during rains does not readily move upward.

Peach and nectarine cultivars differ in susceptibility to this disease. In a NJ survey, the cultivars 'Autumnglo', 'Jerseyglo', 'Encore', 'Cresthaven', 'Biscoe', 'Sunqueen', 'Harbrite', 'Jerseyland', 'Redhaven', and 'Harcrest' were all observed with moderate to high levels of canker. In addition, earlier observations have shown 'Blake', 'Golden Jubilee', 'Raritan Rose', 'Derby', 'Rio-Oso-Gem', 'Early- Red-Free', 'Slaybaugh', 'Jerseyqueen', 'Triogem', and 'Redgold' to also be quite susceptible. 'Sunhigh', 'Dixired', 'Harken', 'J.H. Hale', and 'Coronet' are less susceptible. There are no completely resistant cultivars.

Cytospora Canker

Cytospora canker is one of the principal causes of limb loss and tree death. Control of the disease can be achieved using the guidelines listed below. In all cases where a wound occurs or pruning is performed, paint larger cuts with a water-based asphalt emulsion. An interior white latex paint can be substituted for the asphalt paint during periods when the sap is not "running" profusely.

● Delay pruning until growth begins in spring, preferably after bloom and before shuck-split. Remove cankers from critical areas as soon as possible after they begin to gum. ● Control brown rot, scab, borers, and Oriental fruit moth to reduce the number of infection sites. In blocks with a high level of disease, lesser peach tree borer control is often difficult. ● Do not cultivate so close that bark is injured. Where "hilling" is employed, it is extremely important to cut out any infected area of the lower trunk that will be covered with soil. ● Paint the trunks with white latex paint before January (see section "Peach Winter Injury" in the Peaches and Nectarines chapter). Do not use acrylic latex paint, for many of these are phytotoxic. ● Burn all prunings from cankered trees, and burn all trees that are removed from orchards infected with canker. A permit is required for burning.

Leaf Curl.

Peach and nectarine leaf curl, caused by the plant pathogenic fungus *Taphrina deformans*, is typically not a difficult disease to control in the eastern United States. However, if inoculum levels are high, environmental conditions favor infection, and/or control methods are sub-par, severe defoliation and stunting can occur. Fruit infection, which results in the formation of irregular raised wrinkled areas on the fruit surface, is generally rare.

Taphrina deformans principally overwinters as spores on the bark surface; the pathogen may also be found in old infected leaves. Initial infection occurs during bud swell in late winter when spores are disseminated by water to buds with loose scales. Additional infection can occur between bud-break and petal fall. Once the pathogen enters leaf tissue, it stimulates rapid cell division and enlargement, resulting in thickened, curled, and puckered leaves. These "tumor-like" areas on the leaves often have a red discoloration. Eventually, the leaves drop or sometimes remain attached, turning brown.

Italian research in 2006 (*https://apsjournals.apsnet.org/doi/pdf/10.1094/PHYTO-96-0155*) described the effects of temperature and moisture on foliar infection. At near optimum temperatures, infection begins after a minimum 12 hours wetness and increases steadily until 48 hours of wetness. Longer durations of wetness do not increase disease levels. In these studies, duration of surface wetness was the primary moisture determinant for infection. If the wetness period was caused by rainfall, the amount of precipitation did not influence the severity of infection. Wetness periods from dew or fog were often too short for infection.

Air temperature during the wetness period needs to be less than 61°F for foliar infection to occur. The amount of infection increases as temperatures decrease to 41°F. In the study, the maximum amount of shoot infection was observed at 41°F. Lower temperatures were not examined, so the minimum temperature at which infection no longer occurs is not known.

A single fungicide spray in fall, after leaf drop, or in late winter just prior to bud-swell, will in most cases provide sufficient control. The recommended fungicides are ziram or chlorothalonil (Bravo, Echo, etc.). Both of these fungicides have provided near 100% control in studies on 'Redgold' nectarine at the Rutgers Agricultural Research and Extension Center (RAREC); non-treated trees had 39% bud infection.

In general, fixed-copper products provide a fair level of control. For example, in the same study at RAREC, Champ Formula 2 at its highest rate (10 pt) provided 68% control. However, it is possible that newer copper formulations, such as Kocide 3000, Nordox, or Badge X2 may be more effective.

Assuming leaf curl has not been problematic in a particular orchard, coppers are the recommended material for bacterial spot susceptible cultivars. In this case, the copper efficacy should be adequate for the lower leaf curl risk while also helping to reduce epiphytic inoculum for bacterial spot.

Peach Decline

Peach trees can die from many causes. The most prevalent loss occurs from winter injury to weakened trees. The problem is most severe where peaches follow peaches, and preplant fumigation for nematode control is not practiced. However, the effect of the preplant treatment lasts only for about 1 year, and a postplant application is needed in the fall following the second growing season. Additional postplant treatments are needed yearly,

through the sixth growing season, for maximum control. Other cultural practices required to maintain strong trees are also highly beneficial. One practice, which should be avoided, is pruning 1 to 6 year-old trees prior to February. Also, see the Nematode Control Section in this chapter.

Phytophthora Root and Collar Rot

Phytophthora root and collar rot, caused by various species of the fungal pathogen *Phytophthora*, is a serious problem on peach as well as on apple. It is most troublesome in orchards where the internal soil drainage is poor or where water lays. No cultivar resistance is known for peach rootstocks, and the problem frequently develops from the use of infected nursery stock. However, the pathogen survives well in the soil and newly planted trees could just as easily become infected from resident inoculum.

The most effective control consists of ridging the planting row to ensure that water does not lie in the area of the tree roots and crown. Since the disease can be introduced with infected nursery stock, a careful examination of trees received from the nursery is required.

Ridomil Gold, at 2.0 qt/ treated A, can be used on both nonbearing and bearing trees. Apply in a band corresponding to the weed control strip or apply as an under-the-canopy spray using a handgun to drench the soil. Use enough volume (*e.g.*, 1.0 gal of spray for 1-4 year old trees) to provide good penetration into the root zone or irrigate 0.5” to 1.0” after application. Alternatively, perform the application just prior to a rainfall. Two applications in spring (April and May) and one in September are recommended for sites known to have poor drainage or past problems.

Aliette 80WP can be used on nursery and nonbearing trees within the orchard. It is applied as a series of foliar sprays. Consult label for specific rates and timing schedule.

Fixed-copper-containing fungicides and maneb may also be helpful in preventing infection. They must be applied prior to infection to be of value. Use 4.0 lb/100 gal of either fungicide and add to the borer spray in the fall to reduce costs. When applied with the borer spray, make sure the entire root zone is covered (area under the canopy) and not just the tree trunk. Another application is needed in the spring to increase the effectiveness of these materials.

Powdery Mildew

The fungus *Sphaerotheca pannosa* causes powdery mildew of peach and nectarine. This pathogen overwinters as mycelium in dormant buds, infecting shoots as they emerge during spring. Infection of leaves, shoots, and fruit results in tissues becoming covered by powdery white mycelium and spores; leaves and young fruit can become stunted or malformed. Since the fruit becomes resistant to infection shortly before pit hardening, infections generally occur between pink-bud and third cover sprays. However, once lesions are established, they will continue to expand in size. Sulfur (4 lb) provides reasonably good control, while Rally is extremely effective.

Prunus Necrotic Ring Spot Virus

Prunus necrotic ring spot virus has been present for many years in this region. The disease is pollen transmitted and transmitted through the seed and by grafting with buds from infected trees.

For many years the virus was considered to be a latent virus, one which was present but producing no symptoms. The strain of the virus present in this region did produce raised blisters on scaffold limbs, a fine net cracking of the bark on older wood, a canker similar to Cytospora Canker, and a slight reduction in size.

We now apparently have a more aggressive strain of the virus present. Symptoms consist of the development of black, sunken cankers on the present year’s growth in mid-summer. The canker development weakens the terminals and they break-off during periods with heavy winds. The disease generally occurs throughout the tree, with all of the terminals dying. The tree appears to be dying but new shoots eventually develop. The initial symptom is the “Shock Symptom” which develops when the plant first becomes infected. Symptoms rarely appear on the same tree the following year, but other trees in the block may exhibit these symptoms.

Rhizopus Rot.

Rhizopus rot, caused by the fungus *Rhizopus stolonifer*, is very rarely seen in the orchard because healthy, uninjured fruit in the tree are not susceptible to infection. However, the fungus often colonizes any injured, fallen fruit. Airborne spores from these diseased fruit contaminate fruit on the tree. Then, once fruit fully ripen, usually

after harvest, the inoculum is already present on the fruit, ready to infect and cause disease.

Rotted fruit is identified by a mass of white, threadlike mycelium covered with an abundance of black spore-producing structures, called sporangia. The fungus produces an enzyme that dissolves the tissue which holds the skin to the flesh. Thus, the skin "slips" easily from the flesh when pressure is applied to the skin in the area of the rot. Although preharvest control is usually not necessary, the application of fungicide, such as Botran 75WP, may be necessary in very wet years. For postharvest control, the fungicide Scholar can be used in conjunction with the wax spray. Also, care should be taken to prevent mechanical damage during harvest and packing.

Rusty Spot.

Rusty spot of peach is caused by the fungal plant pathogen *Podosphaera leucotricha*. Since this is the same pathogen that causes apple powdery mildew, rusty spot is often observed in peach orchards adjacent to susceptible apple cultivars. Therefore, locating peach orchards upwind of apple orchards makes sense. However, high levels of rusty spot have also been observed in peach blocks not adjacent to apples or anywhere near apple orchards. Thus, additional powdery mildew pathogens may also be acting as causal agents. See Table 5.2 for the relative susceptibility of selected peach cultivars.

Rusty spot causes direct crop loss through infection of the fruit epidermis. Early symptoms on young peach fruit, which appear 1 to 2 weeks after 100% shuck split, consist of small, circular white lesions that soon turn orange to tan in color. Since the fungal pathogen does not grow well on peach, it rarely sporulates and so lesions do not appear "powdery". As the lesions age, the trichomes or peach hairs detach and the epidermis becomes smooth and russetted. Unlike true powdery mildew of peach, rusty spot does not occur on leaves or shoots.

Rusty spot epidemics are pretty short. They begin at shuck-off and end at 50 days after full bloom. Thus, typical epidemics last only 17 to 30 days. Only very young fruit are susceptible, as fruit become resistant at pit hardening. Given this pattern of disease development, the optimum timing for fungicidal control consists of three to five applications beginning at 90 to 100% petal fall. In most years, four fungicide sprays - applied at petal fall, shuck-split, first cover, and second cover - have provided excellent control.

The DMI fungicide Rally is the standard material for control, although good control has been achieved with Gem, Inspire Super, and Quadris Top. Sulfur typically provides about 50% control. Higher fungicide rates should be used for very susceptible cultivars, while low to mid-range rates are acceptable for moderately susceptible cultivars. Peach cultivars that have low to very low susceptibility rarely need to be sprayed. Studies have shown that the SDHI fungicides are not that effective.

Finally, for those interested in reducing usage of conventional fungicide, an integrated biorational program has been developed as an alternative. The integrated program consists of alternating a conventional fungicide, such as Rally, with one of three possible biorational fungicides, namely Armicarb, Kaligreen, or Serenade Optimum. The conventional product is applied at petal fall and first cover, while the biorational is applied at shuck-split and second cover. This integrated program has been shown to provide rusty spot control equivalent to application of Rally alone. Note that although these biorationals significantly reduce rusty spot incidence, their efficacy is not high enough at the labeled rates for them to be used alone in a program. Details on fungicide rates are provided in the Peaches and Nectarines Chapter, section "Peach and Nectarine Pest Management."

Table 5.2 Relative susceptibility of peach cultivars to rusty spot

Very Low	Low	Moderate		High	Very High
Blake	Redhaven	Desiree	Melik Early Topaz	Biscoe	Autumnglo
Gloria	Snow Giant	Encore	Messina	Bounty	Jerseyqueen
Harrow Beauty	White Lady	John Boy	Raritan Rose	Jefferson	Rio-Oso-Gem
Sugar Lady		Jerseyglo	Suncrest	Redskin	
Sugar May		Laurol	Victoria		
Saturn		Loring			

Scab

The fungus *Fusicladosporium carpophilum* causes peach scab. The pathogen overwinters in lesions produced on current season's fruiting shoots. In New Jersey, spore production on these lesions begins during bloom and ends early- to mid-July. The spores are not readily released into the air until they become wetted. The period between infection and visual symptoms of the disease on the fruit is very long, from 40 to 70 days. Because of this long period, early maturing cultivars may be harvested before the fruit spots are visible to the naked eye. Infections can occur on the fruit, green twigs, and leaves. Infections occur most readily at temperatures between 65 and 75°F, when rainfall is abundant. Infections can occur at temperatures as low as 40 -45°F and as high as 90-95°F.

Lesions formed on current season twigs are light brown, diffuse, and small initially (0.0625 to 0.125 inches in diameter). As they increase in size, they become circular with a darker brown color. A slightly raised bark callus surrounds the margin of the lesion. In the spring, velvety-textured, olive-colored spots appear within the lesion.

On fruit, tiny spots appear around third cover (early July in southern counties) when the fruit are about one-half their final size. The spots develop quickly into very dark, olive-colored, circular spots. Later the spots appear almost black in color. The spots do not "break" the skin as do the fruit spots caused by bacterial spot. However, the skin frequently cracks open in the areas where numerous infected spots occur, and the Brown Rot or Rhizopus Rot fungus then attacks the flesh of the fruit. The spots are usually more numerous on the stem end of the fruit.

Topsin M (0.5 lb/100 gal), when applied at petal fall, has resulted in "burn out" of many of the overwintering lesions on the twigs. Thus, disease pressure can be measurably reduced as a result of a lower inoculum level. Fruit infections are most common from shuck-split through third cover. Foliar sprays are effective in protecting the fruit from infection, and a single fungicide spray applied around first cover will provide reasonably good control of twig infections in nonbearing blocks.

The disease is troublesome in commercial blocks when the trees did not receive a regular spray program in the preceding year. This occurs when the block was "frozen-out" the previous year and when a new block is first coming into production. The disease can be troublesome during periods of drought, since only 3 hours of 100% RH is necessary for sporulation to occur. Where disease is troublesome, apply Gem, Topsin M + Captan, Bravo, Abound, or Quadris Top; use higher rates and shorter spray intervals if frequent rains occur. In addition to protectant activity, Gem and Abound also act as antisporulants, thereby reducing inoculum production on twig lesions. Sprays should be applied until 40 days before harvest.

Sour Rot

The yeast *Geotrichum candidum* causes sour rot. The disease may occur in the orchard during years when temperatures are abnormally high, but is far more damaging in the postharvest period. Affected fruit exhibit a moderately firm rot on green fruit and the skin does not slip readily. The rot on ripe fruit is very soft and is quite watery in the later stages. A cheese- like scum can be observed within the watery fruit and when the juice dries on the surface. Sulfur provides poor control in the orchard, while captan and maneb provide fair control. The use of chlorine in the hydrocooler water and in dump tanks is the only effective control of the postharvest phase.

Stem Pitting

This virus disease becomes established in a block as a result of planting infected nursery stock or by planting healthy nursery stock in infested soils. Since the virus is transmitted by nematodes, preplant nematicide treatments are mandatory for control. Additional postplant nematicide treatments will probably be needed every 2 years to reduce possible spread. See the Nematode Control section in this chapter for recommendations.

The probability of introducing the virus into new blocks with planting stock has been greatly reduced in the last couple of years since nursery trees from areas known to have the virus are grown in fumigated soil. Growers should select trees that were grown in fumigated soil or from areas not known to have this problem.

Dandelion, dock, and other broadleaf weeds serve as hosts for the stem pitting virus (TomRSV). Thus, to prevent spread within the orchard, a concerted effort to control broadleaf weeds and nematodes is needed.

Trees that are infected prior to planting will begin to decline during the third growing season. Trees that decline during the fourth growing season may have been infected prior to or after planting in the orchard. Those declining in later years were infected after the trees were planted.

5.1.2 Special Nectarine Pest Control Issues

Nectarines are identical to peaches except that they lack pubescence (fuzz). Most management practices are similar for peaches and nectarines, but pest control for nectarines is frequently more difficult than for peaches. Pests, which attack the fruit, are generally the ones causing most concern, but those attacking the foliage may also be more difficult to control. The two diseases that are more troublesome on nectarines than on peaches are brown rot and bacterial spot. For insects, thrips, aphids, and Japanese beetles are frequently more troublesome on nectarines than on peaches.

Russet of the fruit skin is also much more of a problem on nectarines. The smooth skin of the nectarine subjects the fruit to considerable russet in most years. The causes of russet are similar to those that cause russet on 'Golden Delicious', *i.e.*, cold weather from pink into the early cover sprays when the fruit have a coating of moisture. Russet is related to both weather conditions and the pesticides used during this sensitive period. Most of the russet is superficial and the fruit may still be graded as U.S. Fancy.

A partial explanation of the increased susceptibility of many nectarine cultivars is genetic. Many of the higher quality nectarines were developed in California where brown rot is not a serious problem. Thus, these cultivars were probably not rigorously screened for brown rot tolerance. The smooth nectarine fruit has a much smaller total surface area than hairy peaches. Thus, the nectarine surface cannot retain rates of pesticides, to provide the protection against pest attack, that the peach surface does. This problem can often be corrected through the use of an effective spreader-sticker and improved spray practices to ensure better coverage and retention.

Nectarine fruit, like all smooth-skinned members of the genus Prunus, are subjected to "latent infections," whereas peach fruit have never been shown to be similarly affected. Latent infections generally occur during the bloom period and remain confined to a tiny number of cells beneath the skin surface for extended periods. As the fruit increases in size, its chemical composition changes, resulting in increased susceptibility to the brown rot fungus. At this time, the fungus starts to grow and soon becomes visible as a brown rot infected fruit. This is generally the time that growers become more concerned about brown rot and initiate a more vigorous spray schedule. Unfortunately, sprays are much less effective, since the infection occurred in the bloom period. A more effective approach would include better timing of highly effective fungicides applications (*i.e.*, from pink through petal fall), together with better spray coverage.

Russet of the fruit also contributes to increased brown rot, since nutrients are exuded through the cracks in the skin. The spores of the brown rot fungus will not germinate without an external supply of nutrients, and the cracks in the skin provide all that is needed for spore germination and infection.

Blossom blight and early fruit infections with the brown rot fungus generally result in extreme difficulty in control of the disease just before and after harvest. In a casual evaluation of the peach and nectarine cultivar block at Cream Ridge NJ during the spring of 1987, several cultivars of nectarines had more than 80 percent of the blossoms infected with blossom blight, while none of the peach cultivars had more than 25 percent blighted blossoms. Further, when examined during the summer, the cankers produced from infected blossoms on nectarine cultivars appeared to be actively sporulating all summer long, whereas those on peaches appeared to become inactivated by mid-summer. These observations suggest that some nectarine cultivars may prove to be a better host for overwintering of the fungus.

Similar principles and altered control practices for nectarines could be provided for other pests, but to conserve space they will not be listed. To prevent pest problems from developing on nectarines, consider the following suggestions:

- Where possible, select cultivars with high levels of resistance to pests (see Tables 5.1 and 5.2).
- Use the most effective pesticides at the proper rate and proper time from pink through petal fall.
- Employ practices which will improve spray coverage and retention, including the use of spreader stickers. Evaluate and delete pesticides which increase fruit russet.

Many growers are successfully producing high quality nectarines and they are encouraged to continue utilizing those practices that have proven successful.

5.1.3 Postharvest Peach and Nectarine Treatment

FDA regulations specify any food crop to which a nonexempt chemical is added after harvest must be so labeled. The container that goes to the retailer must contain words such as, "These peaches treated with (name of chemical) to prevent rotting." Postharvest fungicide treatment is important in preventing fruit rot development during storage and in the marketing channel. Good postharvest treatments will ensure the consumer of a highly desirable product.

Hydrocooler Treatment

Fruit in bulk bins should be hydrocooled as quickly as possible before placing in cold storage. The hydrocooler water should contain one of the chlorine-generating products at a minimum of 100-150 ppm at a water pH of 6.5 to 7.0 to kill spores and fungal mycelium on the fruit surface (see Table 5.3 and recommendations below). This treatment will sterilize the fruit surface but provides no residual fungicide protection. A Supplement Label must be in hand to use these materials.

Table 5.3 Materials for Hydrocooler

Material*	Rates for 1000 gal
Agclor 310 (12.5%)	0.75 gal
Household bleach (5.25%)	1.8 gal
HTH Chlorine (65%)	1.33 lb

*Do not mix Allisan with these materials.

The maintenance of proper chlorine levels will provide postharvest sanitation/disease control, and will reduce the discoloration from 'inking' at 120+ ppm when the proper pH is maintained. There are many chlorinating systems available from various packinghouse equipment manufacturers. These include:

a) Gaseous chloride systems that monitor chlorine levels and automatically dispense chlorine gas into the water.
b) Liquid sodium hypochloride systems that also monitor chlorine levels and automatically dispense liquid chlorine into the system.
c) Powdered sodium hypochlorite (Ag Clor 311) for use as a chlorinating agent.
d) There is a supplemental label available from your County Agricultural Agent for the use of HTH swimming pool chlorine as an additional source of chlorine. It is important to remember that the supplemental label must be in the grower's possession before use.

To keep iron insoluble, maintain the pH of the water between 6.5 and 7.0. If the water is acid, less than pH 6.0, then a buffer should be added to raise the pH to 6.5 to 7.0. Your County Agricultural Agent or Rutgers Extension Specialist can provide specific recommendations based on the pH of your water.

Drain and refill the water in the hydrocooler and dumptank on a regular basis daily, if possible. Be sure to remove all dirt, leaves, and other debris after draining.

Packing Line Treatment for Disease Control

Good postharvest disease control for stone fruit begins with a strong preharvest fungicide program. As indicated in the spray guide, preharvest fungicide applications during the fruit ripening period are absolutely critical for the prevention of brown rot. If late infection by *Monilinia fructicola* occurs, the fruit may appear healthy upon harvest, and perhaps even store well when maintained at cold temperatures. However, once the fruit are warmed, the fungus will continue its rapid growth, causing extensive rot within one or two days. After several years of testing, the reduced-risk fungicide fludioxonil (Scholar 50WP) has been labeled for postharvest disease control on stone fruit crops, including apricots, peaches, nectarines, plums, cherries, plumcots, and prune (fresh). When applied properly to fruit on the packing line, through T-Jets or control droplet-type applicators, fludioxonil has been shown to provide excellent control of brown rot, Rhizopus rot, gray mold, and Gilbertella rot. Since fludioxonil has a different chemistry (phenylpyrrole) than all other fungicides currently being used in the field, development of cross-resistant pathogens is not a concern at this time.

Fludioxonil can be applied on the packing line at a concentration of 8.0-16.0 oz/100 gal or enough to do an aqueous flooding of 200,000 of fruit. The fungicide can be mixed with either water alone or with a wax/oil emulsion. A dip application for peach is also registered for use. See label for further details.

Allisan is the only other fungicide currently labeled for postharvest use on stone fruit. However, since this material does not control brown rot (it is only effective against Rhizopus rot), its usefulness is limited.

Postharvest Peach Skin Discoloration and Its Control

Skin discoloration (also known as inking, ink spot, black spot, streak, or purple spot) is a disorder of peach which has been observed in New Jersey for more than 20 years. No disease-causing organism can be isolated from affected fruit. The initial symptoms are development of burgundy-colored areas within the red flesh of the peach. These areas eventually turn purplish- black or ink color.

Research conducted at Clemson University, University of California, and Rutgers University has shown that any operation which causes a peach to rub, roll, or physically abrade against another peach can result in discoloration. Inking has also been triggered by iron (in excess of 10 ppm) in the hydrocooler and dumptank water, leachate from latex-rubber drying rollers, excessive brushing or vibration, ammonia, and fungicide sprays. Research to date has resulted in these suggestions for control:

- Avoid any operation that causes excessive vibration, rubbing, or rolling; reduce operations that cause bouncing from the orchard to the packinghouse.
- Keep field bins, held outside the packinghouse prior to hydrocooling, in a shaded area out of sunlight.
- Remove “field heat” as soon as possible. Fruit temperatures, out of the field, can range from 75 to 95° F. Remove field heat with a hydrocooler rather than attempting to remove it with a ventilated cold room.
- Keep hydrocoolers and dumptanks as clean as possible. Excessive iron in treatment water can cause discoloration. Failure to clean hydrocoolers and dumptanks properly can result in high levels of rust in the water, thus increasing discoloration. Drain and refill with fresh water on a regular basis.
- Maintain the pH of water in hydrocoolers and dumptanks between 6.5 and 7.0. Water at a pH of 4.0 and 6.0 has caused problems with discoloration. Proper pH also reduces iron levels.
- Check equipment for a loss of ammonia. Leaks in the refrigeration system can also stimulate inking. Peaches can be affected by ammonia at levels under 1 ppm - below levels that emit an odor.

5.2 Diseases and Disorders of Apples

5.2.1 Early Season Diseases

Apple Scab

This disease, caused by the fungal plant pathogen *Venturia inaequalis*, is the most important apple disease in our area. The fungus overwinters in fallen leaves on the ground. Ascospores (sexual spores) are released from these fallen leaves when they become wet during spring rains. The critical period for spore release is from the time green tissue is first visible through third cover. Any infections which occur during this period result in primary scab, since the ascospores are the initial inoculum for the growing season.

Primary scab infection periods can be predicted by gathering data on wetness period duration and average air temperature during the wetness period. Table 5.4 shows the minimum hours of wetness needed at various temperatures in order for infection to take place. For example, if the average wetness period temperature was 55.4°F and the period duration was 11 hours, then an infection period occurred since only 8 hours of wetness are needed at this temperature.

Research has shown that most ascospores are released only during daylight hours (dawn to dusk). Thus, if a rainfall begins at night, the infection period (duration of wetness) does not begin until sunrise. However, if a rainy period begins late in the day and continues into the night, then the night-time hours of wetting need to be included in the wetness duration, since initial wetting (and spore release) would have occurred during daylight.

Wetness durations and average air temperatures can be determined by visual observations and use of a min/max thermometer. However, a variety of mechanical and electronic devices can be purchased to help automate data gathering. The use of local leaf wetness and weather stations tied to a computer based modeling system can be more efficient. Rutgers University is part of the Network for Environmental and Weather Applications (NEWA), housed at Cornell University. This system models both disease and insect biology and control timing, and can be found here: *http://newa.cornell.edu/*

A variety of fungicides are available for control of scab during the primary period. However, whether or not a fungicide is prone to the development of resistant scab influences how it is used (see Apple Chapter, section Apple Pest Management). If a fungicide is selected that is not at-risk to resistance, then it can be used alone (*e.g.*, captan or ziram). If a material is selected that is at-risk, then it should be mixed with a fungicide that is not at risk. For example, Rally or Indar should be used in combination with another non-risk fungicide, such as captan. When used in combination, the non-risk fungicide is applied at half the standard rate.

Resistance development is not the only factor which determines use patterns of fungicides. The EBDC fungicides can be applied up to bloom at full rate when used alone. However, they can be used in an extended program, through second cover, when they are applied at half-rate in combination with another non-EBDC fungicide (see Disease Tables in the section Apple Pest Management).

In general, if scab is properly controlled with fungicides during the primary scab period, then no further scab disease control is needed for the remainder of the season. However, if field observations at the end of the primary period indicate the presence of primary scab lesions, then additional sprays will be necessary. These lesions produce asexual spores, called conidia, which can continue to cause infection throughout the summer. However, unlike the primary ascospores, conidia can be released during any period of the day when rain or heavy dew occurs.

Strains of the apple scab fungus that are resistant to Topsin M and Syllit are present in all areas of New Jersey. Therefore, these fungicides should not be used unless scab isolates from your orchard have been tested for fungicide resistance.

With the heavy dew and cooler nighttime temperatures from mid-August through harvest, scab can become reactivated. Late fruit infections may not be visible to the naked eye, but these infections can develop into tiny fruit infections which develop in storage.

Table 5.4 Minimum Requirements for Apple Scab Leaf Infection[1]

Average Temperature (°F) during wetness	34	36	37	39	41	43	45	46	48	50	52	54	55	57	59	61-75	77	79
Hours of leaf wetness during daylight	41	35	30	28	21	18	15	13	12	11	9	8	8	7	7	6	8	11

[1]Revised Mills

Bitter Rot

The fungus causing this disease, *Colletrotrichum gloeosporioides*, overwinters in cankers on the twigs, branches, and spurs, or in mummified fruit on the tree, or on the ground. The spores are splashed from the infected tissue during periods of rain. Infections occur to uninjured fruit beginning in mid-June. Infections can continue to occur into October. Fruit infections are firm and they appear flattened or sunken.

Control consists of using fungicides with longer residual activity and spraying orchards on a regular schedule. Proper pruning to remove dead wood also assists in control. This pathogen also causes anthracnose on peach.

Black Rot

The fungus *Botryosphaeria obtusa* overwinters in cankers and mummified fruit on the tree. It is responsible for frog-eye leaf spot and black rot on apples. The spores wash and splash from twigs and mummies to foliage and fruit below. Therefore, dead twigs, especially fire blight twigs, should be removed during the pruning operation. Ferbam and captan have shown promise as protectants against black rot infection.

Blister Spot

This disease is caused by the bacterial pathogen *Pseudomona syringae* pv. *Papulans*. It is troublesome on 'Mutsu' and 'Magnolia' cultivars during years when excessive rainfall occurs during the early part of the growing season. It may also occur on other cultivars in lesser quantities. Symptoms consist of purplish-black lesions, 4-5 mm in diameter, that appear at fruit lenticels. Disease is first noticeable at 2-3 months after petal fall, at which time only small, green, raised blisters are visible. These blisters eventually expand and darken with age.

Control consists of using copper containing fungicides (1 lb ai/100 gal) beginning at FIRST COVER. Repeat sprays at SECOND and THIRD COVER. Streptomycin is as effective as copper-containing fungicides but Terramycin is ineffective in control.

Cedar Apple Rust

Rust infections occur between pink and third cover spray. Infections which occur early can occur on the fruit and leaves. Infections which occur after first cover infect only the leaves. Materials which are effective against rust include the protectants mancozeb, maneb, polyram, ferbam, thiram, and ziram, as well as the DMI fungicides Indar, Proline, Rally, Vintage, and Inspire Super.

Collar Rot

Collar rot, caused by various species of the *Phytophthora* fungus, can be a serious problem with MM106 and MM104 rootstocks. It also causes some loss of trees on other rootstocks. The disease is most troublesome in orchards with poor internal drainage or in areas where water lays. Control consists of using more tolerant rootstocks and improving drainage. The disease can be brought into the orchard with infected trees, so care should be used when purchasing trees.

Ridomil 2E, Ridomil Gold, and Aliette are labeled for control in bearing and nonbearing blocks, and are effective when used according to label directions (see the Fungicides and Bactericides section in this chapter for details on using these products). Copper-containing fungicides have provided some measure of control when applied as a drenching spray to the trunk. Use 2.0 lb of actual copper in 100 gal of spray, and apply 1.0 gal of spray/tree in late-March to mid-April and again in late-September to mid-October.

Fire Blight

The following practices should be employed to reduce loss from this disease:

- Pruning. The most recent theory on control suggests that infected shoots should not be cut out until the terminals harden-off. After terminals harden-off and before leaf fall, prune twigs 4-6 inches below any visible evidence of the disease. If the disease progresses into the main trunk, the trunk should be cut back 4-6 inches below any visible symptoms. Pruning tools should be disinfected by wiping them with a cloth saturated with 70 percent isopropyl (rubbing) alcohol or sodium hypochlorite (household bleach) 1:10 dilution with water. Tools may also be dipped in these solutions. Tools dipped in bleach should be washed in clean water at the end of the day to prevent corrosion of the metal parts.
- Prebloom Sprays. In blocks where fire blight is anticipated, growers may wish to apply a copper spray at HALF-INCH GREEN. This spray will kill the bacteria present on the plant surface and may reduce later infections. It will also help for scab control. For details on early season sprays, see bordeaux mixture and copper (fixed) in the Fungicide and Bactericide section in this chapter.
- Blossom Sprays. Make application any time after the first flower opens, the temperature is 65°F or above, and the relative humidity is 60 percent or above. Make subsequent applications on a 3- to 5- to 7-day schedule, depending upon weather conditions.
- Post-bloom Sprays**.** Apply streptomycin sulfate at 10- to 14-day intervals from petal fall until conditions become unfavorable for spread. When hail occurs, apply a spray immediately following the storm, regardless of when last application was applied. Do not use within 50 days before harvest.

Use streptomycin sulfate 17% at the rate of 50 ppm (0.25 lb) when used alone and when drying conditions are poor. The addition of Regulaid (1 pt) to streptomycin has increased the level of control. If streptomycin is added to any of the other fungicides, increase the rate of streptomycin to 75 to 100 ppm (0.38 to 0.5 lb). As a resistance management strategy, alternate sprays of streptomycin with oxytetracycline. On pome fruit, this latter antibiotic

is available as Mycoshield and FireLine. Applications during poor drying conditions are much more effective. Late evening or night spraying is the preferred method. Do not apply during a rain or when rain is forecast, as the material must be taken up systemically to be effective.

Moldy Core

This disease can become troublesome in some years when the petal fall spray is delayed too long. For control, use Captan 50WP (2 lb) before the calyx closes.

Nectria Canker

This disease, also called European canker, can be a problem on cultivars with enlarged terminal fruiting spurs, such as 'Rome Beauty' and 'Jerseyred'. Infections occur in the fall as leaves are dropping. The symptoms of infection occur in June when the terminals begin to die. The disease can be confused with fire blight except all infections arise from the swollen terminal fruiting spur with European canker.

Powdery Mildew

The powdery mildew fungus, *Podosphaera leucotricha*, overwinters as mycelia in the terminal buds. Although the disease is present every year, it is more prevalent during years when weather is dry and morning dews are heavy. The cultivars Ginger Gold, Suncrisp, Crimson Crisp, Delblush, and Sundance are considered very susceptible to mildew. The mycelium becomes active early in the season. Therefore, control should begin at the prepink stage. Additional sprays are required through the third cover spray.

Rally, Procure, and Vintage are the most effective against mildew. Sulfur provides good control, but produces russeting with some cultivars. Cultivars not sensitive to sulfur russet are 'Rome Beauty', 'McIntosh', 'Cortland', and 'Golden Delicious'. Cultivars sensitive to sulfur russet include 'Starr', 'Twenty Ounce', 'Rhode Island Greening', 'Stayman', and 'Delicious'.

As soon as first noticed (about pink stage), branches or twigs showing systemic or over-wintering mildew should be pruned out to reduce secondary mildew. This is particularly beneficial in young blocks.

White Rot

White rot is caused by the fungal plant pathogen *Botryosphaeria dothidea*. It survives from season to season as mycelium and fruiting structures in cankers, dead bark, and mummified fruit. Current season fire blight strikes are often colonized by the fungus and are also an important source of inoculum.

Effective white rot control requires a combination of good sanitation and preventative sprays. All dead limbs, cankers, and mummies should be removed from the trees. Also, prunings should not be left in the orchard as they can become colonized and serve as an inoculum source during the same growing season. The 'Rome Beauty', 'Jerseyred', and 'Julyred' cultivars are most susceptible to this disease.

On apple, application of Captan plus Topsin, from first cover through harvest, provides good control. Sovran and Pristine also provide good control and, unlike captan, are also labeled for use on pear.

5.2.2 Summer Diseases

The summer diseases consist of X-Disease, Black Pox, Brook's Spot, Sooty Blotch, and Flyspeck. Infections can occur any time from FIRST COVER through harvest, but infections are most common and numerous from early August through September.

Brooks Spot

This disease, caused by *Mycosphaerella pomi*, is most troublesome on 'Rome' and 'Stayman', but it can also be troublesome on other apple cultivars. Fruit symptoms appear 8 to 12 weeks after the infection occurred as slightly sunken, greenish lesions associated with the lenticels of the fruit. At harvest, the spots are dark purple in color. Foliar lesions appear in August as small, purplish flecks around the leaf stomata. Benlate was highly effective in control, but is no longer available; Topsin M may be an acceptable substitute. Other fungicides with long residual activity may provide good control.

Sooty Blotch and Flyspeck

These diseases almost always occur together and the control measures are the same for both diseases. The fruit infections are superficial on the skin and can be brushed off with vigorous rubbing.

The fungi causing these diseases over-winter on dead twigs and brush within and around the orchard site. Rainfall is needed for spore release, dispersal, and infection. Infections occur most readily when the relative humidity (RH) is 95% or higher and temperatures are between 60-70°F. Temperatures between 50-60°F and 70-80°F are quite favorable for fruit infections. Conditions which increase disease incidence include:

- Frequent showers and high RH with moderate temperature.
- Inadequate pruning, which restricts drying.
- High inoculum levels in dead twigs within the tree, in adjacent hedgerows, or on the ground within the orchard.
- Use of ineffective fungicides or fungicides with short residual activity. Once infection occurs, at least 30-45 days incubation are required before fruit infections become visible to the naked eye. Heavy levels of fruit infections may occur when the last fungicide application is made more than 30 days before harvest.

Captan alone, or combined with Topsin M are effective in control. Sovran, Flint, and Pristine also provide excellent control (for rates, see the Apple and Pear Pest Management sections, Covers Disease Tables). Alternation of these materials with captan or ziram during cover sprays has provided excellent control in field tests under high disease pressure.

5.2.3 Physiological Disorders

The incidence of these disorders may be reduced by the nutrient sprays described in the **Orchard Nutrition** chapter. A description of these problems is presented below.

Bitter Pit

Fruit spots vary in size from 0.125 to 0.25 inch in diameter and normally develop after the fruit is harvested. They never approach the size of large cork spots. The spots are initially dark brown and quickly become blackish brown. The affected skin tissue is less firm than adjacent healthy tissue.

The affected tissue beneath the spot on the skin is shallow and spongy in texture. Individual fruits frequently contain 30 or more spots, with most of the spots located around the calyx end of the fruit. The spots are not associated with the fruit lenticels.

Cork

Fruit spots vary in size from 0.25 to 0.5 inch in diameter, with the larger size more common. Spots become visible between the time the fruit is half-grown and harvested. The spots are greenish at first; later they turn blackish-brown. The affected skin tissue is firmer than adjacent healthy tissue at harvest. The spongy, brown tissue that underlies the spots on the skin extends deeply into the flesh. Individual fruits rarely contain more than three to five cork spots. The spots are not associated with the fruit lenticels.

Jonathan Spot

This is often a serious problem in the ‘Jonathan‘ cultivar, and it more closely resembles bitter pit than cork spot. The fruit spots are almost always associated with the lenticels. The flesh adjacent to the lenticels is soft and dark in color, but the fruit spots do not extend deeply into the flesh. Affected tissue frequently becomes infected with one or more fungi, which cause an increase in size of the spots during storage. Several other cultivars show similar spots that are generally classed as Jonathan Spot. A few include ‘Rome Beauty‘, ‘Wealthy‘, ‘Grimes Golden‘, and ‘Twenty Ounce‘.

5.2.4 Postharvest Diseases and Disorders

Many factors determine the successful control of postharvest diseases and disorders. Some of the factors are a good spray program during the growing season; proper maturity at harvest; proper handling of fruit; and proper storage, sanitation, and chemical treatment.

Blue Mold and Storage Scab

Use one of the following water dips prior to placing fruit in storage. All of these materials are compatible with DPA and Stop Scald.

- Captan 50WP (2.5 lb)/100 gal
- Mertect 340-F (1.0 pt) plus Captan 50WP (1.0 lb)/100 gal

Since all of these materials will settle-out on standing, the solution must be constantly agitated. Further, all of the above can be removed from the solution with the settling of dirt particles. Thus, the solution should be recharged with fresh fungicide on a regular basis. Recharging should be accomplished after every 30 bins/100 gal of capacity, *i.e.*, after 300 bins in a 1000 gal tank. Add about 1/5 the initial fungicide rate when recharging the tank.

Storage facilities, packing houses, and orchard boxes should be treated with a 1:34 bleach solution (1.0 gal of 5.25% bleach in 34 gal water). Permit complete drying of the exposed surfaces before exposing fruit.

Scald

Either Stop Scald (ethoxyquin) or DPA will provide control of scald if properly used. Each can be used as a dip or spray treatment. The rates that provide adequate control, except on ‘Rome Beauty‘ are:

- Stop Scald 3 pt/100 gal water (2,700 ppm) OR;
- DPA (liquid or dry) 2 qt of 31% (2,000 ppm)

With the ‘Rome Beauty‘ cultivar, adequate control is obtained with the following rates:

- Stop Scald 2 pt/100 gal water (1,800 ppm), OR;
- DPA (liquid or dry) 1 qt of 31% (1,000 ppm)

Both of these materials are more effective on warm than on cold fruit. DPA is more apt to injure fruit than Stop Scald. Injury is minimized if the treated apples are dried before storage. DPA is the preferred choice on ‘Delicious‘, ‘Stayman‘, ‘Winesap‘, and ‘Cortland‘. The risk of injury with DPA is greater if used on ‘Rome Beauty‘, ‘Baldwin‘, or ‘Golden Delicious‘. Stop Scald is preferred on these three cultivars, and it can be used successfully on ‘Delicious‘ and ‘Stayman‘.

<u>Additional factors to consider:</u>

- Liquid formulations are preferred. Keep solution well agitated if DPA is used.
- The 100 gal Stop Scald mixture or the 120 gal DPA mixture should be sufficient to dip or rollerspray 1,000 bushels. If the solution gets dirty, change it. Replace solution at least every other day.
- If dipping, submerge for no more than 30 seconds; remove, and tilt box to drain solution that has collected in the stem or blossom end of the fruit.
- These materials are most effective if applied within 1 day after harvest. Apples stored 1 to 2 weeks can still be treated, but fruit temperature must rise to 60°F or above to obtain proper coverage and control. This is especially true for ‘Delicious‘, which is difficult to cover at lower temperatures.
- Solution temperatures must be 50 to 80°F to obtain the most effective results.
- To prevent possible reduced control and fruit injury, do not allow fruit to set in the sun after treatment.
- Do not apply Stop Scald to fruit that has been sitting in the sun. Fruit staining and reduced control can result.
- Scald inhibitors can be irritating to the skin of some individuals. Plastic or rubber gloves should be worn by these persons.
- Postharvest treatments must be labeled on the shipping container. For Stop Scald, the stamp should read: “Treated with Ethoxyquin to Retard Spoilage.” For DPA, it should read: “Treated with Diphenylamine to Retard Spoilage.”The lettering must be as large as other information on the container. For polyethylene bags, stamp the master carton only.

5.3 Fungicides and Bactericides

The following alphabetical listing of fungicides and bactericides is meant to provide additional information on the capabilities and limitations of registered tree fruit fungicides and bactericides. These descriptions are not intended to be complete compilations of all the properties of the materials listed, but rather provide additional insight on chemical usage. **For specific information on rates, consult individual product labels.**

Abound 2.08F (azoxystrobin) is a derivative of naturally occurring fungicides, which can be found in edible, wood-decay mushrooms. Because of its low toxicity, Abound has been classified by the EPA as a reduced risk fungicide. It belongs to the QoI class of fungicides. Abound is registered for control of blossom blight, scab, brown rot, and powdery mildew on peach, nectarine, cherry (sweet and tart), plum and apricot. Abound provides good to excellent control of brown rot and scab. Because of its different chemistry, Abound makes a good partner for alternation with the DMI fungicides Indar, Orbit, or Elite. However, Abound should not be alternated with Flint or Pristine since these materials are also QoIs. Abound has also been labeled for several diseases on grapes.

Azoxystrobin has been found to be highly phytotoxic to certain apple cultivars. Thus, users should be careful to avoid spray drift and not use the same sprayer for apples. Also, growers spraying Quadris on vegetables should avoid drift on apples, as this product also contains azoxystrobin as its active ingredient. Furthermore, spray tanks cannot be adequately rinsed with water to allow safe usage on apple.

In tests conducted during 1999-2000, 41% of approximately 100 apple cultivars were sensitive; insensitive varieties showed no adverse effect. If you have mostly stone fruit and only a few apple cultivars, a simple test can be conducted to determine their sensitivity. Contact your agricultural agent for details on performing this test.

Agri-mycin 17WP (streptomycin) is an antibiotic with activity against a broad range of bacterial plant pathogens causing spots, blights, wilts, rots, etc. On tree fruit, it is registered for use in controlling fire blight on apples and pears. Firewall 17WP and Streptrol 17WP are other available formulations of streptomycin.

Sprays should be applied two-three times during bloom, or timed according to a disease forecasting system. Routine sprays during the summer are not cost-effective, but applications should be performed immediately after hailstorms if the orchard has a history of blight. Dilute volumes are best, as getting complete spray coverage is critical.

The fire blight pathogen can become resistant to streptomycin. Consequently, other bactericides, such as copper materials and oxytetracycline (pear only) should be incorporated into the spray program.

Aliette 80WDG (fosetyl-Al) is registered on both pome and stone fruit for control of crown and root rot caused by Phytophthora species. On apple, it is labeled for both bearing and nonbearing trees, while on stone fruit, it can only be used for nonbearing trees.

On pome fruit, Aliette can be applied as a root dip prior to planting a new orchard. Mix 3.0 lb/100 gal and soak roots for 30 to 60 minutes. Aliete is not registered for use as a dip for stone fruit.

On bearing pome and stone fruit orchards, Aliette is applied as a series of foliar sprays during the spring and early summer when conditions favor high soil moisture. Make three or four applications on a 60-day spray interval at 5 lb/100 gal; or alternatively, apply six to eight applications at 2.5 lb/100 gal.

Aprovia fungicide is registered for use on many pome fruit crops, including apple, pear, Asian pear, crabapple, and quince. It is not registered for use on stone fruit crops. Aprovia has a 12 hour REI, a 30-day PHI, a rate range of 5.5-7.0 fl oz/A, and a maximum rate of 27.6 fl oz/A per year. **Note**: the application at the lower rate would technically allow five applications per year, but the label limits the number of applications to four per year.

The active ingredient in Aprovia, benzovindiflupyr, is a succinate-dehydrogenase inhibitor (SDHI) belonging to FRAC group 7. The fungicide's formulation is a 0.83EC, or 0.83 lb of benzovindiflupyr per gallon of emulsifiable concentrate. For resistance management, do not apply more than two consecutive applications of Aprovia before switching to a non-group 7 fungicide.

The Aprovia label lists control of nine pome fruit diseases: apple scab, pear scab, Alternaria blotch, Alternaria rot, cedar apple rust, quince rust, powdery mildew, sooty blotch and flyspeck. The major fruit rot diseases

(bitter rot, black rot, white rot, and brooks fruit spot) are only listed as suppressed on the product's label. Field studies have shown excellent control of scab, sooty blotch, and flyspeck.

The addition of spreading / penetrating type adjuvant is recommended. See the label for details.

Armicarb 100 85SP (potassium bicarbonate), is a broad-spectrum contact biorational fungicide registered for control of diseases on a wide variety of crops, including most major stone and pome fruit species. In particular, potassium bicarbonate has been shown to be effective against many powdery mildew pathogens. In peach studies in NJ, potassium bicarbonate (Armicarb, Kaligreen) has been shown to significantly reduce incidence of peach rusty spot. However, since control is only partial, the recommended program integrates potassium bicarbonate with the conventional fungicide myclobutanil (Rally). For further details on this program, see the "Rusty Spot" section in this chapter. Armicarb has a REI of 4 hours and a PHI of 0 days.

Bordeaux Mixture (copper sulfate + calcium hydroxide), which was discovered in 1882 in a grape vineyard in Bordeaux, France, controls many fungus and bacterial leaf spots, blights, downy mildews, and cankers. However, it is also phytotoxic to plants and often has compatibility problems with other materials. For these reasons, Bordeaux has largely been replaced by fixed or insoluble copper fungicides (see Copper, fixed).

Although Bordeaux displays foliar phytotoxicity, it can still be useful as a dormant spray for control of peach leaf curl and fire blight on apple and pear. For leaf curl, a common formula is 4-6-100, while for blight, a good mix is 8-8-100 plus 1 percent of 60- or 70-second emulsifiable spray oil. In both cases, the first number is pounds of copper sulfate, the second number is pounds of hydrated spray lime, and the third is gallons of water.

For bacterial canker on sweet cherry and plum, a 4-6-100 formula can be applied during the fall leaf drop period and as a dormant spray in spring. During the first few fall sprays, add canola or cottonseed oil, at 2.8 qt/100 gal, as a safener to lessen the mixture's phytotoxicity.

Botran 75WP (dicloran) is extremely effective against Rhizopus rot on stone fruit. At higher rates it will also control brown rot, but efficacy is still less than many other preharvest materials. It is registered for applications during the blossom blight and preharvest fruit rot periods on peach, nectarine, plum, prune, and sweet cherry.

Bravo WeatherStik 6F, Bravo Ultrex 82.5WDG, (chlorothalonil) will provide good control of brown rot, blossom blight, and scab on stone fruit. Blossom blight applications should be made from popcorn through petal fall. Bravo can be applied as late as shuck-split for peach scab control. Bravo is also effective against leaf curl, coryneum blight, and cherry leaf spot.

Bumper 41.8EC (propiconazole) – see Orbit.

Cabrio 20EG (pyraclostrobin) is a QoI fungicide labeled for use in controlling blossom blight and powdery mildew on sweet and tart cherry. Cabrio is applied at 9.5 oz/A, and should be alternated with other non-QoI fungicides. Cabrio is <u>not</u> labeled for use on peach (see Pristine).

Captan 50WP, 80WDG (captan) is an excellent protective fungicide for control of scab, frog-eye leaf spot, black rot, white rot, Brook's spot, bitter rot, sooty blotch, flyspeck, and calyx-end rot on pome fruit. Captan can be used for post-infection control of apple scab, but must be applied within 18 hours from the beginning of an infection period. This fungicide will not control cedar apple rust and powdery mildew.

On stone fruit, captan provides very good control of brown rot and scab. It is ineffective for powdery mildew and peach rusty spot. Mite problems in captan-treated blocks are generally more severe than where other fungicides are used. Captan is not compatible with oil or lime.

Cevya fungicide is registered for use on many pome fruit crops, including apple, pear, Asian pear, crabapple, and quince. The fungicide can also be used on a wide variety of stone fruit crops, including peach, nectarine, plum, cherry, and apricot. For both crop groups, Cevya has a 12-hour restricted-entry interval (REI); a 0 day pre-harvest interval (PHI); a rate range of 3.0 – 5.0 fl oz/A; and a maximum rate of 15 fl oz/A per year. Thus, only three to five applications can be made per year at the maximum to minimum rates, respectively.

The active ingredient in Cevya, mefentrifluconazole, is a demethylation inhibitor (DMI) which disrupts cell membrane synthesis in susceptible plant pathogenic fungi. Thus, Cevya is classified as a Group 3 fungicide by the

Fungicide Resistance Action Committee, or FRAC. Cevya contains 3.34 lb of this active ingredient per gallon of the suspension concentrate; hence, the formulation is a 3.34 SC. For resistance management, alternate or mix Cevya with other non-group 3 fungicides.

Cevya is labeled for control of eight diseases on each crop group. On pome fruit, Cevya has efficacy against alternaria blotch, scab, black rot / frogeye leaf spot, cedar apple rust, flyspeck, sooty blotch, white rot, and pear scab. Powdery mildew and quince rust are suppressed. On stone fruit, Cevya is listed as controlling alternaria leaf spot, brown rot blossom blight, brown rot fruit rot, leaf spot, Rhizopus rot, rust, scab, and shothole. Powdery mildew on peach is suppressed.

In four field studies conducted on apple at universities in the Mid-Atlantic and Northeast regions, Cevya provided excellent control of apple scab on fruit, providing 92 to 100% control. Management of foliar scab was very good to excellent, with an average 90% control and a range of 78 to 98% control. Results from a single study indicated excellent control of cedar-apple rust, sooty blotch, flyspeck, and white rot; however, more data are needed to confirm these findings. Also, white rot disease pressure was low in this study. Powdery mildew control from a single study was rated as fair, which agrees with the label statement of “suppression only”. Finally, poor control of bitter rot was observed in two studies, which explains the absence of this disease on the label.

On peach, when Cevya was applied during the preharvest fruit ripening period, results from four assessments conducted in the Mid-Atlantic region demonstrated very good to excellent control of brown rot at harvest. Percent brown rot control was 74, 94, 96, and 94% for these four assessments, with an average 90% control. In a single study, Cevya provided good control of brown rot blossom blight and rusty spot, yielding 78 and 80% control, respectively; additional data are needed to confirm.

Champ Formula 2.79F (copper hydroxide) - see copper (fixed).

Chlorothalonil 720 (chlorothalonil) – see Bravo.

Copper (fixed) is a form of copper compound in which the copper ion is fixed securely to the molecule, thereby making it relatively insoluble in water. Thus, when a fixed copper compound is applied in a spray, a coating of copper compound crystals is deposited on the plant surfaces. During wet conditions, these crystals slowly solubilize and release copper ions, which are the active ingredient that kill the pathogenic bacteria or fungi. Unfortunately, the copper ions are not discriminatory and can also injure sensitive plant cells, such as peach leaves or apple fruit surfaces. Cool, humid conditions tend to slow drying after an application, resulting in greater uptake by the plant and more injury, while warm dry conditions (*e.g.*, spraying during mid-day) tend to reduce phytotoxicity.

Although all fixed copper compounds provide the same active ingredient, copper ions, they do differ in the type of molecule used to deliver the copper. These molecules can release the ions at different rates, and can be formulated in different ways, particularly with respect to particle size. These differences, along with the rate of application, ultimately determine the efficacy and phytotoxicity of any given copper compound.

Six types of fixed copper compounds are available based upon the type of molecule used to deliver the copper: (1) copper hydroxide (Kocide, Champ, Nu-Cop); (2) copper sulfate (Cuprofix, Bordeaux mixture); (3) copper oxychloride (C-O-C); (4) cuprous oxide (Nordox); (5) copper ammonium carbonate (Copper-Count-N); and (6) organometallic copper (Cueva). Some copper products are mixtures of these types, such as Badge X2 (copper oxychloride + copper hydroxide) or C-O-C-S (copper oxychloride + copper sulfate). Copper products using other copper compounds are available, but less commonly used. Cueva, Nordox, and Badge X2 are OMRI listed for use on organically grown crops.

On apple, an early spray of copper can be applied, from green-tip to 0.25 inch green, for control of fire blight. Spray 2.0-4.0 lb of copper hydroxide (Champ, Kocide, Nu-Cop)/100 gal, plus 1% 60- or 70-second emulsifiable spray oil. Use high volumes so that runoff occurs, thus ensuring complete coverage. Do not apply later than 0.25 green, as copper is severely phytotoxic.

Repeated use of coppers for bacterial leaf spot and bacterial canker control can result in the development of copper-tolerant strains of the bacterium.

Double Nickel. This biofungicide, which has the bacterium *Bacillus amyloliquefaciens* strain D747 as its active ingredient, is available as a water dispersible granular formulation (25WDG) and as an aqueous suspension (LC) formulation. Each product can be applied up to and including the day of harvest and has an REI of 4 hours. They are OMRI listed for use in organic production.

Both formulations are registered for use on a wide variety of stone fruits, including peach, nectarine, cherry, plum, and apricot, and a wide variety of pome fruits, including apple, pear, crabapple, and quince. Most research has examined Double Nickel in combination with and/or in alternation with other active ingredients and conventional standards. Thus, efficacy of the product alone against most pathogens needs to be determined.

Decco No Scald DPA. (diphenylamine) is registered as a post harvest anti-scald material for apples. It is delivered either in an aerosol or fogger operation in an enclosed operation.

Elevate 50WDG (fenhexamid) is registered for use on stone fruit, grapes, and strawberries. On peach and nectarine, Elevate is labeled for control of blossom blight and brown rot. A zero PHI (postharvest interval) allows the fungicide to be applied up to and including the day of harvest.

Fenhexamid has a different chemistry than all other fungicides labeled on stone fruit, thus making it a good candidate for fungicide resistance management. However, Elevate has never been tested under NJ conditions and results from other sites indicate sporadic efficacy against brown rot, achieving only moderate levels of control.

Ferbam 76WDG (carbamate) is a protectant-type fungicide with good efficacy against cedar-apple rust and as a fall or spring dormant spray for peach leaf curl. It is also effective for black knot on cherries and plums, and for leaf and fruit spot on pears. Ferbam will russet sensitive apple cultivars such as ‘Golden Delicious‘, but is safe on ‘Delicious‘ and ‘Rome Beauty‘. This fungicide has only moderate activity for control of apple scab, sooty blotch, cherry leaf spot, and brown rot of stone fruit.

FireLine 17WP (oxytetracycline) – See Mycoshield.

FireWall 17WP (streptomycin) – See Agri-mycin.

Flint 50WG (trifloxystrobin) is a QoI fungicide registered for use on apple, pear, crabapple, loquat, mayhaw, and quince. Like other QoI fungicides, Flint exhibits broad-spectrum activity against a variety of fungal diseases.

On apple, Flint provides excellent control of scab; good control of powdery mildew, sooty blotch, and flyspeck; and fair control or suppression of white rot and bitter rot when used at higher rates. The level of black rot control has yet to be determined; a limited number of studies indicate poor control of rust. Flint is also registered for use on grapes, although it should not be applied to Concord grapes or crop injury may occur.

Preventative applications of Flint should be applied at 7-14 day intervals, depending on target pathogen and level of disease pressure. Excellent control of scab, sooty blotch, and flyspeck can be achieved at 2.0 oz/A, while a 2.5 oz/A rate will be needed for cultivars that are very susceptible to powdery mildew. A higher 3.0 oz/A rate is needed for bitter and white rot suppression. Up to 100 hours curative capability is possible when applying Flint for post-infection scab control. In this case, use the higher 2.5 oz/A rate, followed by a second application at 7-10 days later.

For best apple scab resistance, alternate sprays with another fungicide having a different chemistry, such as Rally, Procure, or Vangard. Or apply sprays in a block program, where no more than two consecutive sprays of Flint are used. For summer apple disease control, Flint alternating with Captan or Ziram provides good control.

Fontelis 1.67SC (penthiopyrad) is labeled for use on most stone fruits (apricot, sweet and tart cherry, nectarine, peach, plum, plumcot, and prune) as well as apple and pear. On these crops, Fontelis has a rate range of 14.0-20.0 fl oz/A and a REI of 12 hours. The PHI for stone fruit crops is 0 days while the PHI for apple and pear is 28 days.

Fontelis has a single active ingredient, penthiopyrad, which belongs to the SDHI (FRAC code 7) chemical group. Consequently, for resistance management reasons, a maximum of two sequential Fontelis applications are allowed before switching to a fungicide with a different chemistry. A total of 61.0 fl oz/A/season can be applied to an orchard, which results in 3-4 applications/year.

Fontelis has been extensively field tested for peach disease control at the Rutgers Agricultural Research and Extension Center, Bridgeton. Over a six-year period, Fontelis provided excellent blossom blight control and good to excellent brown rot control. In contrast, Fontelis' control of rusty spot and peach scab were only rated as fair and poor, respectively. However, it should be noted that scab pressure in the test blocks was extremely high; better scab control was achieved in other states under more typical disease levels.

Given the above peach disease control profile, the recommended use for Fontelis is for management of brown rot during the preharvest period. At this timing, Fontelis can be rotated with other fungicides of different chemistries, such as the DMIs (Indar, Meteor, Bumper, and Quash), the QoIs (Gem and Abound), or DMI-QoI premixes (Quadris Top). Although Fontelis performed very well for blossom blight control, use of other chemistries such as the anilinopyrimidines (Vangard), dicarboximides (Rovral), and protectants is preferred during bloom for resistance management.

On apple, Fontelis is rated as good for scab control, but only fair for powdery mildew and rust control. Consequently, Fontelis is best deployed during the early season for primary scab control; a powdery mildew fungicide may be added if this disease is problematic. When Fontelis is applied as a mixture with a protectant, such as mancozeb (*e.g.*, Manzate 75DF at 3.0 lb/A), the combination provides excellent control of scab and good control of rust. A lower 10.0-12.0 fl oz rate of Fontelis is labeled for use in these mixtures; however, 14.0 fl oz is the recommended minimum, even for mixtures.

Gem 500SC, Gem 25WG (trifloxystrobin). Gem has the same active ingredient as Flint. Gem should be used for stone fruit, while Flint is now only registered for pome fruit. On stone fruit, Gem is labeled for control of cherry leaf spot, powdery mildew, and scab. Good to excellent control of peach rusty spot has been achieved at 2.85 fl oz/A (Gem 500SC) or 6 oz/A (Gem 25WG) on highly-susceptible cultivars (25WG formulation). Gem also has good to excellent activity against peach scab. Research is currently in progress to determine the best approach for controlling scab with trifloxystrobin.

In New Jersey, a FIFRA 2(ee) Recommendation is available for application of Gem 500SC or Gem 25WG during the preharvest period for management of brown rot. Both product labels allow applications up to 1 day before harvest. Studies in NJ have shown that when applied at high rates, Gem provides good control of the fruit rot phase. Since Gem is a QoI fungicide, it is a good choice for alternation with DMI fungicides such as Indar, Elite, and Orbit during the preharvest period.

Indar 2F (fenbuconazole) is a highly effective fungicide for control of brown rot, blossom blight and fruit rot on peach, nectarine, cherry, and apricot. It also provides control of peach scab and cherry leaf spot, and there is some evidence of rust and shot-hole suppression. As with any DMI fungicide, Indar should be mixed or rotated with other non-DMI fungicides to avoid the development of resistant pathogens.

In New Jersey, an EPA 24C Special Local Need registration allows use of Indar 2F at a maximum 12.0 fl oz/A rate on peach and nectarine, or twice the standard rate. This higher rate is normally not required, but may be necessary if DMI resistance becomes widespread in NJ orchards.

Although Indar has been used as a stone fruit fungicide for years, the newer **Indar 2F** formulation was first registered for use on apple in 2007. The active ingredient fenbuconazole is a group 3 DMI fungicide, and so a maximum of two consecutive Indar or group 3 fungicides sprays is recommended before alternating to a non-DMI fungicide. Like Inspire Super MP, Indar 2F has better scab activity than the older DMIs Rally (Nova) and Procure. However, Indar's mildew activity is somewhat less than these three products. On apple, Indar is labeled for use at 6.0-8.0 fl oz/A with a PHI of 14 days and a REI of 12 hours. Indar 2F is recommended for primary scab control and rust control through second cover. As with Inspire Super MP, summer cover spray applications of Indar 2F are not recommended.

Inspire Super 2.82EW (difenoconazole + cyprodinil) fungicide is labeled for use on most stone fruits, including apricot, tart cherry, nectarine, peach, plum, plumcot, and prune and on many pome fruits, including apple, crabapple, loquat, mayhaw, pear, Asian pear, and quince. Inspire Super should not be applied to sweet cherries. Application rates are 16.0-20.0 fl oz/A on stone fruit and 12.0 fl oz/A on pome fruit.

The two active ingredients in Inspire Super consist of the DMI fungicide difenoconazole, found in Inspire 250EC, and the AP fungicide cyprodinil, found in Vangard 75WG. Since these two active ingredients belong to

different FRAC groups, 3 and 9 respectively, use of the mixture is a resistance management strategy. However, both active compounds are rated as having a "medium risk" for resistance development. Thus, a maximum of two consecutive applications is recommended before rotating to another chemistry not belonging to groups 3 or 9.

In peach field studies at the Rutgers Agricultural Research and Extension Center, Inspire Super has provided excellent control of blossom blight canker development and good control of brown rot fruit rot, scab, and rusty spot. The recommended use for Inspire Super is for brown rot fruit rot control when disease pressure is low to moderate. Given a PHI of 2 days, preharvest applications of Inspire Super could be rotated with QoI (group 11) or SDHI (group 7) fungicides. As a resistance management strategy, application during bloom should be avoided since the goal is to limit use of "at-risk" fungicides during this time, especially DMIs.

On pome fruit, efficacy of Inspire Super is excellent against scab and rust and good against powdery mildew, sooty blotch, and fly speck. Recommended usage is for primary scab control and for powdery mildew and rust control from petal fall through second cover. Although the 14-day PHI would allow some summer applications for sooty blotch and fly speck control, use beyond second cover is not recommended because of potential continued selection pressure for scab resistance, particularly on any secondary scab that resulted from less than perfect primary scab control.

Iprodione 4L – see Rovral.

Kaligreen 82SP (potassium bicarbonate) – see Armicarb.

Kocide 3000 30DF (copper hydroxide) – see copper (fixed).

Kumulus 80DF (wettable sulfur) – see Sulfur.

Luna Sensation 4.2SC (fluopyram + trifloxystrobin) is labeled for apple, sweet cherry, and tart cherry. On apple, the recommended rates range from 4.0 to 5.8 fl oz/A, depending on the target disease, with a PHI of 14 days. On sweet and tart cherry, Luna Sensation is applied at 5.0 to 5.6 fl oz/A with a PHI of one day.

The two active ingredients in Luna Sensation, fluopyram and trifloxystrobin, belong to the SDHI (group 7) and QoI (group 11) chemical classes, respectively. These compounds are rated as having medium to high risk of resistance development. Thus, a maximum of two consecutive applications are allowed before rotating to a different fungicide class. Furthermore, the label limits the total number of applications/season to four for apple and only two for cherry.

On apple, Luna Sensation provides excellent control of scab and powdery mildew, and good control of rusts. This profile makes the fungicide a good choice for use during the primary scab season, but as indicated above the fungicide should be rotated and/ or mixed with other fungicide chemistries.

On cherry, Luna Sensation delivers excellent control of brown rot blossom blight and leaf spot and good control of brown rot fruit rot. Since only two applications are available, the recommended use is for fruit rot management in conjunction with other chemistries, such as the DMIs (group 3). As a resistance management strategy, other chemistries (AP or dicarboximide) or protectant fungicides should be considered for blossom blight control.

Luna Tranquility 4.16SC (fluopyram + pyrimethanil). The current label only allows use on apple. The fungicide is applied at a rate range of 11.2 to 16.0 fl oz/A and has a PHI of 72 days. The two active ingredients, fluopyram and pyrimethanil, are classified as SDHI (group 7) and AP (group 9) fungicides, respectively. SDHI fungicides have a medium-to-high risk of resistance development, while AP fungicides are rated as medium risk compounds.

On a poor to excellent rating scale, Luna Tranquility provides good control of both apple scab and apple powdery mildew, but poor control of rusts. Given this efficacy and its high PHI, the fungicide is recommended for early season primary scab and powdery mildew control in orchards having low to moderate disease pressure. If rust diseases are problematic, an additional fungicide, such as an EBDC protectant (*e.g.*, Manzate), can be added to provide rust control as well as scab resistance management.

Since both active ingredients in Luna Tranquility are at risk for resistance development, the label requires users to make no more than two consecutive applications before rotating to a fungicide of a different group. Furthermore, a maximum of 54.7 fl oz can be applied/A/season, which results in only three to four applications,

depending on the rate chosen. DMI (group 3), QoI (group 11), and protectant fungicides, as well as combinations of these materials, are acceptable partners for rotation in a program with Luna Tranquility.

Mancozeb (coordination product of zinc ion + manganese EBDC) is a broad-spectrum fungicide registered for use in controlling scab, rusts, sooty blotch, flyspeck, and Fabraea leaf spot on pome fruit. Available Mancozeb products are Dithane, Manzate, and Penncozeb. No mancozeb materials are labeled for use on stone fruit.

Mancozeb can be applied in one of two ways. When used at full rate, the fungicide is applied from half-inch green-tip through bloom. When used at half rate in combination with another fungicide, sprays can be applied through second cover. This latter approach is called "extended application".

The mancozeb materials have maximum application limits in terms of amount of fungicide that can be applied/A each year; see labels for product-specific amounts. Also, EBDC fungicides cannot be applied within 77 days of harvest.

Manzate 75DG – see **mancozeb.**

MeloCon WG – see **Nonfumigant Nematicides** in the Nematode Control section in this chapter

Merivon 4.18SC (fluxapyroxad + pyraclostrobin) is currently registered for use on stone fruits (apricot, sweet and tart cherry, nectarine, peach, all plum types, and prune) and pome fruits (apple, crabapple, Asian pear, and pear).

The two active ingredients in Merivon, fluxapyroxad and pyraclostrobin, belong to the SDHI (group 7) and QoI (group 11) chemical classes, respectively. Since these compounds have medium to high risk of resistance development, a maximum of two consecutive applications are allowed before rotating to a fungicide that does not belong to either group 7 or 11. In addition, the maximum number of applications that are permitted/season is three for stone fruits and four for pome fruits. As with all high-risk fungicides, proper integration with other chemistries and protectant fungicides is an important strategy for preventing resistance development.

On stone fruit crops, Merivon is labeled at rates of 4.0 to 6.7 fl oz/A and has a PHI of 0 days. Results of several years of research on peach at the RAREC demonstrated that Merivon at 5.0 to 6.5 fl oz/A provides excellent control of brown rot blossom blight and fruit rot, good control of Rhizopus fruit rot, and fair control of peach scab and rusty spot. Given this profile, the recommended usage for Merivon is for preharvest brown rot control, where it could be used in rotation with DMI (group 3) and protectant fungicides. Although Merivon provided excellent control of blossom blight, the fungicide is not recommended for use at this time. As a resistance management strategy, other chemistries (such as AP, dicarboximide, and protectants) are best used during bloom.

On apple, Merivon provides excellent control of scab and powdery mildew and good control of rusts. Although this efficacy profile indicates that Merivon could be deployed alone during the primary scab season, rotation with other chemistries and/or mixing with protectants, such as mancozeb (*e.g.*, Manzate 75DF at 3.0 lb/A), is the recommended approach for resistance management. Even so, the labeled rate range of 4.0 to 5.5 fl oz/A only allows four applications/season.

On all crops, Merivon should not be applied with EC or solvent based formulations or with crop oil concentrate (COC) or methylated seed oil (MSO) adjuvants. On pears, to avoid damage to foliage and/or fruit, do not apply Merivon with horticultural mineral oil.

Meteor 4F – see **Rovral.**

Micro Sulf 80DF (wettable sulfur) – see **Sulfur.**

Microthiol Disperss 80DF (wettable sulfur) – see **Sulfur.**

Miravis fungicide is registered for use on many pome fruit crops, including apple, pear, and quince, and many stone fruit crops, including apricot, cherry, nectarine, peach, and plum. The active ingredient in Miravis is pydiflumetofen, a succinate-dehydrogenase inhibitor (SDHI) belonging to FRAC group 7. The fungicide's formulation is a 1.67SC, or 1.67 lb of pydiflumetofen per gallon of suspension concentrate.

On pome fruit, Miravis is registered for application at only one rate, 3.4 fl oz/A, while on stone fruit Miravis can be applied within the rate range of 3.4 to 5.1 fl oz/A. For both crop groups, do not make more than two consecutive applications and no more than four applications at maximum rate per year. The maximum annual

rate on pome and stone fruit is 13.6 fl oz/A/year and 20.4 fl oz/A/year, respectively; see label for further use restrictions, including guidelines for resistance management. Although the restricted-entry interval (REI) for both crop groups is the same (4 hours), the pre-harvest interval (PHI) for pome fruits is 30 days while the PHI for stone fruits is 0 days.

The Miravis label lists control of nine pome fruit diseases and eight stone fruit diseases. On pome fruits, Miravis has activity against alternaria blotch, alternaria rot, apple scab, cedar apple rust, quince rust, flyspeck, sooty blotch, powdery mildew, and pear scab. The fungicide only provides suppression of bitter rot, white rot, black rot, and brooks fruit spot. On stone fruits, Miravis has activity against Alternaria spot and fruit rot, anthracnose, brown rot blossom blight, brown rot fruit rot, leaf rust, powdery mildew, scab, and shot hole.

In two separate studies on apple, Miravis provided excellent control of both fruit and foliar scab. The fungicide yielded 96 to 97% control of fruit scab, and 91 to 98% control of scab on leaves. However, powdery mildew control was only fair; in two separate studies, only 50 and 63% control was obtained. In a single study, under heavy bitter rot disease pressure, Miravis yielded only 22% control, which is too low for even a “suppression” rating. However, additional data are needed to confirm this finding.

When applied on peach during the pre-harvest fruit ripening period, Miravis provided very good to excellent control of brown rot at harvest and post-harvest. In results from two separate studies, brown rot control averaged 88%, with a range of 74 to 98%. In contrast, Miravis only provided 67% control of brown rot blossom blight in results from a single study. Under light disease pressure, the fungicide yielded 100% control of peach scab. However, for both these latter two diseases, additional data are needed to confirm the findings.

Mycoshield 17WP (oxytetracycline) is an antibiotic extremely effective against bacterial spot of stone fruit. It is a brand of agricultural terramycin. The desired concentration for control is 150 ppm, or 12.0 oz of material/100 gal water applied. FireLine 17WP is another available formulation of oxytetracycline.

Since it has a short residual of only five to seven days, terramycin must be applied on a weekly schedule beginning at shuck-split. Furthermore, this bactericide is most effective when it gets inside the plant tissue. Thus, applications are best made when conditions allow slow drying, such as during the evening when relative humidity tends to be higher. This approach greatly improves tissue penetration and subsequent control.

For effective control of bacterial spot using this antibiotic, complete spray coverage is also critical. It is important to use a spray volume that thoroughly wets the foliage and fruit to the point of runoff. Typical volumes are 3.0 gal/tree for planting densities of 80 trees/A, which translates into 240 gal of spray/A. For trees of different sizes and/or densities, adjust the volume to maintain good wetting, but maintain the concentration at 150 ppm.

Since bacterial plant pathogens can become resistant to antibiotics, alternation of Mycoshield with other materials, such as fixed- coppers, should be considered. This strategy is particularly important for highly susceptible cultivars, which have a higher rate of development of disease.

Mycoshield is also registered for use in controlling fire blight on pear. Some pear cultivars, especially the Asian pears, are sensitive to this antibiotic and may show injury.

Mycoshield and FireLine are now also registered for use on apple against fire blight. Their labels for apple are very similar, except that Mycoshield can only be applied five times/season, while the FireLine label allows up to six applications. The oxytetracycline active ingredient is a tetracycline (group 41) antibiotic, while the bactericide most commonly used for fire blight on apple, streptomycin, is a glucopyranosyl antibiotic (group 25). Thus, alternating use of these oxytetracycline products with streptomycin products (Agri-mycin, FireWall) allows for an “all-antibiotic” resistance management strategy. Note that although Mycoshield, FlameOut, and FireLine are applied at 150 ppm (12.0 oz/100 gal) for bacterial spot control on stone fruit, the proper concentration for fire blight control on apple and pear is 200 ppm, equivalent to 16.0 oz in 100 gal water. Since coverage is critical for bacterial disease control, use of higher volumes of spray/A is recommended. Both products have a PHI of 60 days and REI of 12 hours.

Nordox 75WG - see copper (fixed).

Nu-Cop 50DF (copper hydroxide) – see copper (fixed).

Orbit 3.6EC (propiconazole), previously called Tilt, provides excellent control of brown rot on most stone fruit crops, including apricot, cherry (sweet and sour), nectarine, peach, plum, plumcot, prune, and other hybrids of these crops. It also provides control of blossom blight, powdery mildew, and cherry leaf spot. PropiMax 3.6EC and Bumper 41.8EC are other available formulations of propiconazole for use on stone fruits.

In recent years, resistant strains of *Monilinia fructicola*, causal agent of brown rot, have been detected in a number of peach growing regions in the eastern United States, including New Jersey. Since Orbit (Tilt) and related DMI fungicides Indar and Elite are important tools for brown rot management, alternation of these materials with other fungicide chemistries is highly recommended. This action is necessary to prevent or delay the widespread occurrence of pathogen resistance to the DMI's.

Orius 45DF, Orius 20AQ (tebuconazole) is a DMI fungicide registered for control of brown rot, blossom blight and fruit rot on peach, nectarine, and cherry. It is also effective for use on leaf spot and powdery mildew of cherry. Since Orius also has good activity against Rhizopus rot, it would be an excellent choice for preharvest application when wet weather results in "in-field" development of this disease. As with other DMIs, the potential for resistance development exists. Thus, Orius should be applied as a mix or in alternation with fungicides of a different chemistry.

Oso 5%SC. This fungicide is registered for use a wide variety of stone fruit crops, including apricot, cherry, nectarine, peach, plum, plumcot, and prune. On pome fruits, Oso is labeled for apple, crabapple, loquat, mayhaw, pear, and quince. The active ingredient is a zinc salt of polyoxin D, which belongs to FRAC code 19 (cell wall biosynthesis inhibitors). Polyoxin D has a medium risk of resistance development. Although a type of antibiotic, polyoxin D does not control bacteria. The product has an REI of 4 hours and a PHI of 0 days.

Oso is labeled for control of botrytis blossom blight and powdery mildew on peach, and for alternaria leaf spot, leaf blotch, powdery mildew, and scab on pome fruit. Control of rusty spot on peach in field studies at Rutgers has been variable. Very good control (88%) was observed in 2014, while an insignificant level of control (42%) was obtained in 2015; in both years disease pressure was low. Management of brown rot at harvest was somewhat more consistent, yielding 72% control under heavy disease pressure and 95% control under light disease pressure. Blossom blight control under very heavy disease pressure in 2015 was very good to excellent, yielding 87% control in incidence with a 92% reduction in canker formation; however, a second year of data are needed to confirm these efficacy results. Addition of a sticker/spreader is suggested.

Oxidate (hydrogen dioxide) is an OMRI approved broad-spectrum bactericide / fungicide registered for use on many crops, including both stone and pome fruit. When applied, it acts as a surface sterilant. Effective control of diseases in the field needs to be demonstrated. Given the active ingredient, also known as hydrogen peroxide, residual activity against pathogens is considered unlikely. Oxidate is also labeled, and perhaps more useful, for sterilization of equipment and cutting tool surfaces. Rendition is a similar material.

Penncozeb 75DF – see mancozeb.

Polyram 80DF (metiram) is an EBDC fungicide mixture, the main component being ammoniates of zinc EBDC. On apple, it is effective as protectant sprays for control of scab, cedar-apple rust, sooty blotch, and flyspeck. This fungicide has no activity against powdery mildew. As with the mancozeb fungicides, Polyram can be used at full rate prior to bloom or at half this rate for an extended application program through second cover.

Pristine 38WG (pyraclostrobin + boscalid) consists of a mixture of QoI and SDHI fungicides labeled for use on apricot, cherry (sweet and sour), nectarine, peach, plum, plumcot, prune, apple, pear, and Oriental pear. The resulting product provides broad- spectrum disease control. Stone fruit diseases listed on the label are alternaria leaf spot, anthracnose, blossom blight, brown rot, leaf spot, powdery mildew, rusty spot, scab, and shothole. Pome fruit diseases listed on the label are alternaria blotch, apple scab, pear scab, bitter rot, black rot, white rot, powdery mildew, brooks spot, flyspeck, and sooty blotch. Cedar-apple rust and quince rust are only suppressed by Pristine.

Field studies in New Jersey showed excellent control of brown rot on peach when applied in preharvest sprays at 10.5 oz/A. On peach cultivars highly susceptible to rusty spot, Pristine provided adequate control only when

applied at its highest rate of 14.5 oz/A. Under heavy disease pressure, Pristine was not effective in controlling peach scab when applied via airblast at 100 gpa; however, good control was obtained when applied dilute via handgun, indicating the importance of complete coverage when disease pressure is high. Although data are limited, Pristine also showed excellent control of blossom blight and anthracnose.

Field tests on apple examined application of Pristine (14.5 oz/A) in alternation with Ziram 76DF during cover sprays. Four applications of Ziram and three applications of Pristine provided excellent control of sooty blotch, flyspeck, and bitter rot; good control was obtained for white and black rots. Pristine should be rotated with fungicides of different chemistry to lessen the risk of resistance development. The DMI fungicides are good candidates for this purpose when managing brown rot or blossom blight.

Procure 50WS (triflumizole) is a DMI fungicide with activity against powdery mildew, scab, and rust on apple and powdery mildew and scab on pear. This fungicide is readily absorbed, locally systemic, and can act as an anti-sporulant when applied to lesions already present. In addition to being a protectant, Procure can be applied up to 72 hours post-infection when used at its higher 4.0 oz/100 gal rate.

PropiMax 3.6EC (propiconazole) – see Orbit.

Quadris Top 2.72SC is labeled for apricots, sweet and tart cherries, peach, nectarines, plums, plumcots, and prunes. It is also labeled for use on grapes and strawberries. The fungicide is a premix of two active ingredients, the second generation DMI difenoconazole and the QoI azoxystrobin. Difenoconazole is the active ingredient in the fungicide Inspire, while azoxystrobin is the active ingredient found in Abound.

In several years of field testing on peaches at Rutgers, Quadris Top applied at the labeled 12.0 to 14.0 oz/A rate provided excellent control of brown rot blossom blight, scab, and brown rot fruit rot. Management of peach rusty spot was considered good, while control of Rhizopus rot was only fair in postharvest evaluations. Quadris Top was the first and currently the only fungicide rated as excellent for management of peach scab. This high level of control, even under very heavy disease pressure was most likely due to the fact that both active ingredients in the product are active against *Fusicladium carpophilum*, the scab pathogen. Several other stone fruit diseases are also listed on the label, including anthracnose and shot hole; however, no data are currently available to indicate the efficacy of this fungicide against these diseases.

In peach disease management programs, Quadris Top fits best as a preharvest brown rot fungicide given its 0-day PHI; a maximum of two consecutive sprays are allowed at this time. The fungicide can also play an important role, along with Gem and Bravo, in controlling peach scab when inoculum levels are high and environmental conditions are very favorable (many wetting periods following shuck-split). Although Quadris Top provided excellent blossom blight control, management of the brown rot pathogen at this time is best performed with other fungicide chemistries (not DMI or QoI) as a resistance management strategy. Possible alternatives for blossom blight control include protectant fungicides (*e.g.*, Bravo or Captan), Topsin M, Rovral, Vangard, or Elevate.

Quash 50WDG (metconazole) is a DMI fungicide labeled for use on stone fruits. It is labeled for and provides good control of brown rot blossom blight on apricot, nectarine, peach, cherry (sweet and sour), and plum. It also labeled for brown rot and scab on peach, nectarine and apricot, as well as for powdery mildew control on cherry and plum.

In two years of testing on peach in New Jersey, Quash has shown outstanding control of brown rot during the preharvest fruit ripening period. However, the current (2009) label only allows Quash to be used up to 14 days before harvest. Thus, for brown rot management on peach and nectarine, Quash can only be used for the first preharvest application, typically applied between 21- and 14-days preharvest. Scab control has only been fair under heavy disease pressure in NJ tests; better scab control has been observed under less pressure in other states. Several use restrictions apply, including a maximum of 3 applications/season.

Quintec 2.08F (quinoxyfen) is a protectant fungicide for control of powdery mildew on sweet and tart cherry. Generally, powdery mildew is not problematic on cherry in New Jersey. However, if this disease has occurred in the prior year, apply Quintec beginning at shuck-fall following label directions. Quinoxyfen is also labeled for grape powdery mildew control. Currently, a supplemental label allows use on peach, but control of rusty spot was only rated as fair.

Rally 40WSP (myclobutanil), formally called Nova, is a DMI fungicide that is effective against blossom blight and brown rot, has some activity against powdery mildew, but is weak against peach scab. It is labeled for use during bloom, cover sprays, and preharvest period. At 4.0-5.0 oz/A, Rally is the best material for control of peach rusty spot.

On apples, Rally is registered for control of scab, powdery mildew, and cedar apple rust. When used in a protectant schedule, the postbloom sprays should include a non-related protectant fungicide to guard against resistance development. For post-infection scab control, Rally should be applied within 96 hours from the start of the infection period. As a curative spray, Rally can suppress sporulation of lesions, but this approach requires several applications.

Rendition (peroxyacetic acid and hydrogen peroxide) is a broad spectrum surface sterilant with 5.2% peracetic acid as its active ingredient. It is active on fungi, bacteria, viruses, and algae. Rendition can be applied to foliage, soil, surfaces, post-harvest in line sprays and water treatment. It can be applied to all fruit crops. Rendition has a 1 hour REI and 0 day PHI. Oxidate is a similar material.

Ridomil Gold EC (mefenoxam) provides excellent control of root and collar rot caused by *Phytophthora* species on both pome and stone fruit. Up to three applications, each at 2.0 qt/treated A, are allowed/season. A treated acre is defined as the actual surface area contacted with an application, *i.e.*, the tree row. Typically, two sprays are applied in spring, the first being in early April, followed by one in fall, usually October. Optimum timing is during periods of wet weather when soil moisture is high.

Ridomil can be applied in a band application using an herbicide sprayer. In this case, the material should then be irrigated with one-half to one-inch of water to move it into the root zone. Band applications make sense for mature orchards since most of the tree row soil contains tree roots. However, for younger orchards, the fungicide can be more economically applied as a soil drench only to the area beneath the canopy. Instructions for a soil drench application for apples are given in the product label. These same instructions can be followed for stone fruit, as long as the labeled 2.0 qt/treated acre rate is not exceeded.

Rovral 4F (iprodione) is a dicarboximide fungicide registered for control of blossom blight on stone fruit. A maximum of two applications/season at 1.0-2.0 pt/A is allowed. Rovral and similar products (Meteor, Iprodione) are not labeled for use after petal fall.

Scala 5SC (pyrimethanil) is an anilinopyrimidine fungicide registered for management of scab on pome fruits, including apple, pear and Oriental pear. Scala's unique chemistry, similar to that of Vangard, makes it useful for resistance management by alternating with DMI or QoI fungicides.

Scala is also registered on stone fruit (peach, nectarine, plum) for control of brown rot, blossom blight, shot hole, and gray mold. In a 2015 study under heavy blossom blight disease pressure, Scala 5SC at 14 fl oz/A provided very good control of blossom blight canker and was equivalent to the iprodione (Rovral, Meteor) standard. Scala reduced cankers per shoot by 89% while Rovral provided a 91% reduction. However, before Scala can be recommended, at least one additional year of data are needed to show that it can consistently control blossom blight. Based on much earlier studies, Scala is not recommended for preharvest brown rot control. Scala is not effective for rusty spot control.

Scholar 50WP (fludioxonil) – see the section on Postharvest Peach and Nectarine Treatment in this chapter.

Sercadis fungicide is registered for application on just one tree fruit crop, apple. Currently, there are no plans for addition of other pome or stone fruit crops to the label. The formulation is a suspension concentrate that contains 2.47 lb of the active ingredient fluxapyroxad per gallon, or a 2.47SC. This active ingredient is a succinate-dehydrogenase inhibitor (SDHI) or FRAC group 7. Fluxapyroxad is one of the two active ingredients in Merivon fungicide.

On apple, Sercadis can be applied within the rate range of 3.5 to 4.5 fl oz/A, with a maximum of four applications or 18 fl oz/A per year. For resistance management, mix or alternate with other non-SDHI fungicides, and do not apply more than two sequential applications. It has a restricted-entry level interval (REI) of 12 hours and a pre-harvest interval (PHI) of 0 days. The Sercadis label lists control of apple scab, powdery mildew, alternaria

blotch, black rot / frogeye leaf spot, and flyspeck; rust diseases, namely cedar apple rust and quince rust, are only suppressed.

In two apple studies conducted in the Mid-Atlantic region, Sercadis provided only fair to good control of foliar scab (63 and 71% control), but very good control of fruit scab (83 and 86% control). Powdery mildew control was fair under heavy disease pressure in two studies, ranging from 54 to 60% control, while very good management (80% control) was observed under light disease pressure in a third study. In a single study, Sercadis provided excellent management of cedar-apple rust (94% control) under moderate disease pressure. Given that the label only lists suppression for cedar-apple rust, additional data are needed to confirm this finding.

A variety of studies examined Sercadis for summer disease control. In three separate studies conducted in the Mid-Atlantic and Northeast apple growing regions, Sercadis consistently had better control of flyspeck than sooty blotch. In these studies, flyspeck control was 97, 85, and 95%, while control levels for sooty blotch were 81, 71, and 46%, respectively. Results from a single study showed poor management of bitter rot; only 28% control was achieved. This finding explains why bitter rot is not listed on the label.

Performance of Sercadis can be improved with use of adjuvants or additives. However, mixture with some oils and emulsifiable concentrates (EC) can cause phytotoxicity. See label for details.

Serenade Optimum 26.2WP (QST 713 strain of *Bacillus subtilis*) is a broad-spectrum biological/biorational fungicide registered for use on a wide variety of crops, including both stone and pome fruits. On both types of crops, Serenade Optimum has an REI of 4 hours and a 0 day PHI. The product is also listed for use in organic production.

In New Jersey, Serenade has been examined extensively for use in managing peach rusty spot, where it has been shown to significantly reduce disease incidence. However, since control is only partial, the recommended program integrates Serenade with the conventional fungicide myclobutanil (Rally). For further details on this integrated program, see the “Rusty Spot” section in this chapter.

On pome fruit, Serenade Optimum is listed as providing suppression of fire blight and scab; rotation with conventional fungicides/ bactericides is recommended.

Sovran 50WG (kresoxim-methyl) is a QoI fungicide registered for use on apple, pear, quince, crabapple, loquat, mayhaw, and Oriental pear. This broad-spectrum fungicide provides excellent control of scab, sooty blotch, and flyspeck; good control of powdery mildew, white rot, and black rot/frogeye leaf spot; fair control of cedar apple rust; and no efficacy against bitter rot. In addition, limited tests have shown good control of brooks spot. No results are yet available on activity against fabraea leaf spot on pear. Sovran is also registered for use on grapes. Labeled rates for Sovran are 4.0 to 6.4 oz/A at 10-14 day intervals. Results of efficacy studies in NJ indicated excellent control of sooty blotch and flyspeck at the lower 4.0 oz/A rate and 100 gpa volume. For scab control, Sovran also exhibits up to 96 hours of curative capability. However, when used for post-infection control, the higher rate should be applied, followed by a second application, 10 days later. Antisporulant activity also occurs against scab and powdery mildews.

For resistance management, limit the number of consecutive sprays of Sovran to three before switching to a fungicide of different chemistry; or use an alternate spray strategy. Thus, Sovran makes an excellent partner in spray programs that have relied heavily on the DMI fungicides Rally or Procure. Furthermore, Sovran provides an additional management tool for summer diseases.

Streptrol 17WP (streptomycin) is registered for bacterial disease control on apples and pears. See Agri-mycin 17WP for details on usage.

Sulfur is available as dry wettable powders, dry flowables, and as liquid lime sulfur. The lime sulfur form is best used for dormant applications, as it can be injurious to both foliage and fruit. The wettable sulfurs are much less injurious, but can still cause some leaf burning and fruit russeting on apple if used during hot weather (above 85°F). Newer sulfur formulations, such as Kumulus, Micro Sulf, Microthiol Disperss, or That Flowable Sulfur, cause less injury. The labeled rate range for these materials on stone and pome fruit is 8.0-24.0 lb of actual sulfur/A. Typically, application at 10-12 lb actual sulfur/A provides a good compromise between getting adequate disease control and minimizing injury.

As a fungicide, sulfur is quite effective against powdery mildews on pome and stone fruit. It also has good efficacy against scab on peaches and nectarines. However, it has little activity for control of cedar-apple rust, the fruit rots, summer diseases, and only partial control of peach rusty spot. Do not use sulfur within seven days after an oil application.

Sulfur is not recommended for control of apple scab, as it is only moderately effective. Many other superior fungicides are available for this use. Similarly, on stone fruit, sulfur should not be used for brown rot control during the critical bloom or preharvest period, particularly if the weather is favorable for disease development. However, sulfur can be used during the cover sprays when fruit are less susceptible to brown rot infection. During this period, sulfur provides good control of scab on peach and nectarine.

Syllit 3.4FL (dodine) is available for use on both pome and stone fruit. On apple, this fungicide gives excellent control of scab, but does not control powdery mildew, rust, rots, or most summer diseases. Dodine can be used for post-infection scab control, but must be applied at the highest rate and within 36 hours from the start of the infection period.

Although registered for application on peach and nectarine, label restrictions limit usage, particularly for orchards east of the Mississippi River. On cherry, Syllit is excellent against leaf spot.

That Flowable Sulfur 6F (sulfur) – see **sulfur.**

Thiram Granuflo 75WDG (thiram) provides fair protection against brown rot and peach scab. On apple, it is effective for controlling rust. This fungicide is not recommended when conditions are extremely favorable for disease. Thiram is also used as a deer repellent.

Top Cop with sulfur (basic copper sulfate, sulfur) – see **copper (fixed), sulfur.**

Topguard 1SC (flutriafol) is a DMI fungicide registered on stone fruit for control of brown rot blossom blight and fruit rot, powdery mildew, and cherry leaf spot. Stone fruit crops listed on the label include apricot, peach, nectarine, sweet cherry, tart cherry, plum, Japanese plum, Damson plum, chicksaw plum, plumcot, and prune. On pome fruit Topguard is registered for for control of scab, powdery mildew, quince rust, and cedar-apple rust. Labeled pome fruit crops are apple, crabapple, loquat, mayhaw, and quince. Topguard is not registered for use on pear.

Topguard has not been tested in New Jersey. Results of two years of testing on peach in Georgia and South Carolina indicated only fair control of brown rot fruit rot. No data are currently available for efficacy against brown rot blossom blight or peach rusty spot. On cherry in Michigan trials, Topguard has similarly provided only fair control of brown rot. Results from Michigan on control of cherry leaf spot were inconclusive because leaf-spot resistant strains were believed to be present in the test orchard. However, a single year of cherry leaf spot data from Oregon, albeit under light disease pressure, indicated good control.

As with other DMI and at-risk fungicides, Topguard should be rotated with fungicides of a different chemistry as a resistance management strategy. The REI on stone and pome fruit is 12 hours, while the PHI is 7 and 14 days, respectively.

Topsin M 70WDG, Topsin M 70WP, Topsin M 70WSB (thiophanate-methyl) is registered for control of brown rot, peach scab, powdery mildew, black knot, and cherry leaf spot on a variety of stone fruit crops. On apple, Topsin M is effective for scab, powdery mildew, black rot, sooty blotch, and flyspeck control. The 70WDG formulation has an REI of 12 hours, while the other formulations have an REI of 2 days.

Thiophanate-methyl is an MBC fungicide, which has a high risk of resistance development. Consequently, extended use of Topsin M without other non-MBC fungicides can result in the development of resistant plant-pathogenic fungi.

Vangard 75WG (cyprodinil) is an anilinopyrimidine fungicide registered for use on both stone and pome fruits. It is currently registered for apricot, tart cherry, nectarine, peach, plum, prune, apple, and pear. Cyprodinil has low toxicity and has been classified by the EPA as a reduced risk compound. It has a medium risk of resistance development.

On apple and pear, Vangard provides 48 hours postinfection capability for scab control, with six days residue for forward, preventative activity. It also exhibits good suppression of apple powdery mildew. On stone fruit, Vangard is registered only for use in controlling brown rot blossom blight. In NJ field studies conducted during 2009 and 2010, Vangard applied at 5.0 oz/A during bloom provided 83 to 100% control of blossom blight canker formation.

Vintage 1SC (fenarimol) is highly effective against scab, powdery mildew, and rust on pome fruit. It will provide up to 96 hours of post-infection control against scab. However, since it has a residual activity of only 3 days, it must be combined with a protectant- type fungicide if spray intervals are longer than 7 days. Vintage replaces the older EC formulation of fenarimol.

Ziram 76DF (ziram) is a zinc salt derivative of dithiocarbamic acid, the precursor to a wide variety of organic sulfur fungicides, such as the EBDC's. On apple, it can be applied from pre-bloom through cover sprays for use in controlling scab, both cedar-apple and quince rusts, sooty blotch, flyspeck, bitter rot, and necrotic leaf blotch. On pear, it also has activity against Fabraea leaf spot. On both of these pome fruits, ziram can be used as a mixing partner along with a MBC or DMI fungicide.

On peach and nectarine, ziram can be used for both peach scab and brown rot control. On cherry, ziram is also effective against leaf spot as well as brown rot. However, for all these stone fruits, it cannot be applied within 14-days of harvest and so has limited use for late season fruit rot control.

Ziram is one of the best fungicides for leaf curl control on stone fruit. Dormant applications, either in fall after leaf drop or in spring prior to bud-swell, can be applied for controlling this disease. In a 2008-2009 NJ study, a fall application of Ziram 76DF at 6.0 lb/A reduced leaf curl incidence by 99% (non-treated trees had 62% bud infection).

5.4 Insect and Mite Pests of Fruit Trees

Apple Maggot

Adult flies usually begin to emerge in mid-June and continue to emerge for about 3 months. Female flies lay eggs in fruit. Upon hatching, the maggot feeds and tunnels within the fruit. Abandoned, unsprayed apple and pear trees plus hawthorn and pyracantha are all major sources of infestation. Control should be applied within 1 week of when the first adult flies are trapped. Consider removing wild/abandoned host trees surrounding your orchard.

Black Peach Aphid

The black peach aphid establishes colonies and feeds belowground on peach roots and large populations can severely debilitate young trees. In spring, many of these overwintering root feeders emerge to establish colonies on the buds. Their color is dark brown to black and when full grown, are nearly 0.1 inch long. Populations can increase rapidly as the winged forms spread the infestation throughout the orchard. In mid-summer, aphids migrate downward through soil cracks to peach roots where they spend the winter. Once aphids become established on the roots, control is difficult. The most effective control of the black peach aphid is to prevent its introduction into the orchard on the roots of nursery stock. This is easily accomplished by dipping the roots of young trees in a solution as described under Peach Tree Borer.

Brown Marmorated Stink Bug (BMSB)

Brown marmorated stink bug is an invasive species whose populations have become damaging in New Jersey since its introduction. For identification and to distinguish from native stink bug species, visit:
http://www.stopbmsb.org/stink-bug-basics/life-stages/ or http://njaes.rutgers.edu/stinkbug/similar.asp.

BMSB is a highly mobile pest that feeds on many agricultural crops including tree fruit as well as landscape plants found in the wood borders on your farm. Unlike some orchard pests, BMSB can cause damage throughout its life cycle and is present for much of the growing season. There are a large number of effective compounds against BMSB, however, many have short residual activity against this pest and require multiple applications.

Alternate row middle sprays on a 7-day interval have shown effective in apples and border sprays show promise in peaches, however, both need additional testing. Be cautious about over use of pyrethroid insecticides, which have been shown to cause secondary pest outbreaks (scale, mites, and aphids).

Monitoring: Unlike native stink bug species, BMSB is not found in the ground cover. Monitoring to detect populations is best made through either pheromone or light traps to indicate activity, supplemented with visual observations on plants. BMSB moves into an orchard from either the wood edge or other crops and initial monitoring on host plants can be done on the orchard perimeter. Additional inspections of fruit will help to determine damage, as this pest can be difficult to detect. We currently do not have economic or treatment thresholds but can use 1-2% catfacing injury on fruit as guidelines. Based on phenology, management at this time is not necessary until 1st cover.

Phenology: Rutgers has developed and is testing a phenological model to predict populations in the field. BMSB requires 538 DD (base 14˚C) to complete development. Females require an additional period of 40-200 DD (dependent on host resources and photoperiod) for reproductive development. Adults disperse to the orchard, especially peach, at ~80-100 DD (accumulations starting 1 Jan), generally the second to third week of May. Termination of overwintering state requires a lengthening of photoperiod and thus, early warming periods will not speed up activity. The adults dispersing into the orchard are reproductively mature and egg masses can be found in about 1 week. The first adults appearing in the orchard are generally found in peach, which is a highly suitable host plant. Adults will move in and out of peach orchards and eventually into apple throughout the season. Nymphs can complete their development in peach and possibly apple. In New Jersey we have two generations of BMSB although at this time, the second generation appears to be a small subset of the population.

Catfacing Insects

The tarnished plant bug and the dusky, green, and brown stink bugs collectively form the group called catfacing insects. Their feeding on peaches during the pink and petal fall through shuck-split periods generally results in dimpled, fuzz-free areas, and aborted fruit. Feeding during the shuck-fall to second and third covers results in unsightly, slightly sunken, callused, black blemishes on the skin surface generally 0.0625 to 0.25 inch in diameter. Damage closer to harvest appears as water soaked lesions. These insects overwinter as adults and move into peach orchards about the time buds begin to swell. Because these bugs are strong fliers, their presence may be widespread, and depending upon availability of other host plants, injury can vary considerably from block to block. Other hosts include vetch, alfalfa, clover, goldenrod, fleabane, dog fennel, pigweed, ragweed, lambsquarter, and dozens of different kinds of flowers and commercial vegetables. Where catfacing has been a problem, insecticide applications are essential at petal fall and shuck-split. Additional bug controls are needed during the shuck-split to shuck-fall period through third covers, depending upon the extent of the bug populations. Early season orchard cultivation is risky because it forces the bugs up into the trees. Eliminating alternate weed hosts in the orchard should reduce damage caused by this pest complex.

Codling Moth

Codling moth attacks fruit of apples and pears and is not tolerated in commercial fruit. The earliest fruit entries by codling moth larvae usually occur about the time the second cover is applied. Second brood larval activity takes place during August. Control should be timed with trap catches and a degree-day model.

Dogwood Borer/Apple Bark Borer

These insects are attracted to apple burr knots or partially developed root initials that form a mass of soft tissue on the trunk of size-controlling rootstocks. Eggs are laid on the burr, and upon hatching, larvae then burrow into it. Feeding disrupts sap flow and girdling can occur and kill the tree. The borer problem can be aggravated by mesh, screen rabbit guards that collect and hold leaves about the trunk, thus providing a more favorable environment for development. Chemical control options are limited to Lorsban 4E or Lorsban Advanced (1.5 qt/100 gal) trunk sprays in mid- to late June. These products have 28-day PHI and a 4-day REI. Mating disruption options are also available (see section “Mating Disruption Technology for Key Insect Pests in Apples” in the Apple chapter).

European Apple Sawfly

European apple sawfly adults are small, dark brown, clear-winged, fly-like wasps. Larvae overwinter in the soil, and pupate in the early spring. Adults emerge and lay eggs between pink and petal fall. Eggs are laid near the calyx end of the fruit. As the larvae feed, they form a winding borrow just under the skin, leaving a russetted scar at harvest. Uncontrolled larvae can enter a second fruit and borrow into the core. A petal fall spray usually provides adequate control, but in problem blocks both pink and petal fall sprays may be needed.

European Red Mite

The European red mite overwinters in the egg stage on twigs and in bark cracks and crevices. On apples, eggs normally hatch during the prepink to early bloom bud stages, whereupon the mite larvae crawl to the unfolding leaves and commence feeding. European red mites can build up to the point where leaf bronzing is visible by mid- to late July. If leaf damage is both heavy and early enough (second to fourth covers), next year's crop can even be affected. Superior Oil applications on apple, from delayed dormant through tight cluster, provide good control as do prebloom Apollo and Savey applications. In recent years, a number of orchards were found to have strains of mites with various degrees of resistance to Kelthane, Carzol, and Vendex. Early control measures often increase the likelihood of good predator-to-prey ratios by allowing mite predators to keep mites below treatment levels.

Green Peach Aphid

Large numbers of green peach aphids suck the plant juice from the leaves causing them to become stunted, curled, and discolored (yellow) by June. Aphids normally disperse to other host plants by mid-June. For best results, make applications before leaves become curled and discolored.

Leafrollers

There are several species of leafrollers in NJ orchards. Tufted apple bud moth and variegated leafroller (see TABM and VL below) are two that are somewhat resistant to Imidan. The red-banded leafroller with three generations/year and the fruit tree leafroller with one generation/year are still susceptible to most insecticides. The most important times to control these latter two pests are in the petal fall and first cover sprays.

Lesser Peach Tree Borer

Lesser peach tree borer attacks weak and injured trees, winter-damaged orchards, and diseased trees. Adult borers (moths) are attracted to injured trees and deposit eggs in wounds from May through early July and again in September. Insecticide protection is recommended primarily for the control of the second brood in early September, and slightly later in northern counties. Applications should be made with a hand gun to the point of run off, making sure to cover all cankers. Lorsban 4E, Asana, or Pounce should be applied postharvest with a handgun. See labels for dosage rates.

Oriental Fruit Moth

Oriental fruit moth attacks both stone and pome fruit. There are normally four generations of this insect each year, but a fifth generation may occur in the southern two-thirds of the state during a warm year. First generation larvae bore into succulent twigs usually about the time when shucks split. Later generations attack developing fruit, often boring into the fruit as tiny larvae, close to the stem. First brood larval control is timed to degree day accumulations and usually commences about the time shucks split.

Peach Silver Mite

This is a very tiny mite that feeds on leaf surfaces causing them to become silvery. In orchards where sulfur is used, they are not a problem. This mite is unlikely to cause injury.

Peach Tree Borer

Peach tree borers usually fly from mid-June on, but most of the larvae are present in the trees by early September. Control can be achieved by drenching the tree trunk and scaffold limbs at the 1.5 lb/100 gal rate, Lorsban 4E at the 1.5 qt/100 gal rate, or Asana XL at 5.8 oz/100 gal rate. Trees should be treated for peach tree borers the same time that the scaffold limbs are treated for lesser peach tree borers. The fumigating action of the insecticide, along

with its residual action, should give good kill for those larvae already in the tree, if applied by early to mid-September. The residual action should also provide control for those young larvae still hatching from eggs. For best results, apply 0.5 to 1.0 gal of spray to each trunk, preferably with a handgun. Airblast sprayers are not suited for borer control because not enough spray reaches the target area. Protect young trees before planting with a root dip. To prepare dip, mix 1.0 lb with every 10 gal of water. This solution must be agitated to prevent settling out of the wettable powder. Lorsban 4E may be used as a preplanting root dip at the equivalent rate of 3.0 qt/100 gal water. Dip trees to a point several inches above the bud scar and allow them to dry. Dip trees several days before planting. **Note**: Wear rubber gloves while making the treatment and dispose of excess dip in area where people, pets, fish, and wildlife will not be harmed.

Pear Leaf Blister Mite

Pear leaf blister mite causes brownish blisters beneath the leaves. By late summer, blisters may nearly cover the entire under leaf. In spring as buds develop, tiny (0.008 inch long) mites commence feeding on leaves, forming blisters.

Pear Psylla

This tiny insect has developed resistance to practically all insecticides used for its control since the 1960's. Psylla adults become active and start laying eggs in spring as outdoor temperatures reach 45°F. Yellowish-white eggs are laid on bud scales, bark cracks, and crevices of fruiting spurs. Nymphs soon hatch and commence sucking sap from tender young leaves. For best results, commence control early in the growing season. Thorough spray coverage is absolutely essential for control. A dilute spray application invariably results in better, more lasting control than a concentrate application. Pre-bloom Superior Oil, plus a pyrethroid insecticide (Asana, Ambush, or Pounce) applied dilute during the dormant period when eggs are first laid, is still one of the most effective means of delaying psylla buildup. In problem blocks, a second oil application plus a pyrethroid is advised during the green cluster bud stage. Be sure to read the labels for restrictions when using pyrethroids before bloom.

Post-bloom use of any pyrethroid insecticide is discouraged. Pyrethroids are toxic to various predator insects. See the Pear Chapter, section "Pear Pest Management" for materials effective after bloom.

Pear Rust Mite

Pear rust mite feeding results in a russeting on the fruit. If rust mites were troublesome the previous season, start controls at green cluster bud and repeat at petal fall. Thorough spray coverage is essential for satisfactory control of mites. Concentrate or alternate row sprays generally result in inadequate control due to minimal spray deposit.

Plum Curculio

Generally, overwintering Plum Curculio adults (weevils) make their first appearance in orchards during bloom. Cool weather slows down their emergence from overwintering sites while warm spells (70°F and above) can produce large numbers of weevils suddenly in trees. There is one generation/year in North Jersey, two in South Jersey. The petal fall, shuck-split, shuck-fall, first, and second cover sprays are most critical for control.

Rosy Apple Aphid (RAA) and Apple/Spirea Aphids

Overwintered rosy apple aphid eggs commence hatching in early spring, and the peak hatch occurs during the green-tip period. Hatch is generally completed by 0.5 inch green. Superior Oil has little effect on aphid nymphs but will suffocate embryos in unhatched eggs. Most insecticides that are listed in the apple spray tables under Delayed Dormant and Tight Cluster are more effective when combined with oil for aphid control. For best RAA control, start the control program early. Don't wait until petal-fall. Control of apple/spirea aphids is suggested only when 50 percent or more of the terminals are infested with visible colonies. Removal of sucker growth aids control.

San Jose Scale

San Jose scale seems to be more troublesome every year and difficult to control once the immature stages (crawlers) and, particularly adult scales, are noted on twigs and limbs during the growing season. A dormant application of Superior Oil is still the best way to control this pest and is recommended in problem blocks. Best

results are obtained when oil is applied in at least 200 gal of spray/mature A. An organophosphate such as Lorsban or a growth regulator such as Esteem or Centaur may improve control. For postbloom scale control, time sprays at the crawler stage.

Spotted Tentiform Leafminer

Spotted tentiform leafminer has developed resistance to Imidan, and Sevin. In problem orchards, control before bloom is most important. If necessary, the best time to control the second brood is in late-June to mid-July, when there is an average of 0.5 to 1 sap-feeding mines/leaf. Sapfeeding mines are made by the young sap-feeding larvae and are only seen from the bottom side of the leaf, and tissue feeder mines can be seen from the tops of leaves. The third brood should be treated if there is an average of 2 to 3 or more total mines/leaf. The fourth brood should only be treated as an emergency when previous generations have not been controlled. Premature fruit drop can occur when there is an average of 10 or more mines/leaf, or leafminer feeding has been accompanied by heavy mite pressure or leafhopper activity.

Thrips

Several species of thrips can damage tree fruit. The Western flowers thrips and flower thrips can damage apples during bloom and cause scarring or dimpling of the fruit. On nectarine and peach, early season feeding damage can result in russetted fruit while late season damage takes on a silvering appearance. Cold, wet springs are not favorable for this pest because it delays development, and heavy rains can actually kill these frail insects. Mowing ground cover during bloom and harvest should be avoided to prevent thrips from leaving the ground cover for the fruit. Also, eliminating flowering weeds in the orchard should prevent thrips populations from increasing and subsequent movement to the crop.

Tufted Apple Bud Moth and Variegated Leafroller

These insects have similar life histories, habits, and damage. In NJ, tufted apple bud moth usually outnumbers variegated leafroller but both may be found in the same orchard. There are two generations/year. Adults generally begin flying and laying eggs from about mid-June to mid-July and from about mid-August through mid-September. In recent years, most damage has come from the second generation of moths because either spraying has stopped, fruit is tightly clustered, insufficient spray volume was used, or because of resistance development. Damage appears as a “shotgun” type of scarring on the upper and side surfaces of the fruit. Heavier crops are most likely to sustain damage. For best results, increase spray volume/A and thin to remove fruit clusters.

Two-spotted Spider Mite

Two-spotted spider mite overwinters as an adult on perennial plants (weeds) and orchard trees. Dormant oil sprays are not effective for controlling this species however, most other miticides are satisfactory. In spring, two-spots serve as food for the predator mite, *Amblyseius fallacis* and *Stethorus punctum* (lady bird beetles) before they climb trees in search of European red mites.

White Apple Leafhopper

The white apple leafhopper has become resistant to commonly used cover spray insecticides such as Imidan. Overwintered eggs begin hatching at pink, and hatching is usually over by petal fall. Whitish nymphs and adults feed on the lower leaf surface, which causes the leaves to appear a mottled yellow to white. Sticky honeydew secretions from leafhopper feeding frequently cover lower fruits. In orchards where leafhoppers have become troublesome, it is important to include an effective leafhopper control in the petal fall to first cover period.

5.5 Insecticides and Miticides

5.5.1 Resistance Management for Tree Fruit Insecticides and Miticides

Many fruit growers have experience with pest resistance to pesticides. Whether it was mite resistance to Plictran or other miticides in the early '80s, tufted apple budmoth resistance to organophosphates (Imidan) in the early '90s, or more recently, codling moth and oriental fruit moth resistance to organophosphates. **Resistance is defined by the Insecticide Resistance Action Committee (IRAC) as "a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for the pest species**". Pest resistance to an active ingredient usually results from the repeated use or over-use of that product against a pest, leading to resistant gene forms surviving and reproducing in that environment, resulting in the evolution of a pesticide resistant population. As pest resistance to pesticides became more common, the pesticide industry formed its own working group to help coordinate resistance management efforts. Much of what follows is also available at: *https://irac-online.org/*.

IRAC was formed in 1984 and works as a specialist technical group of the industry association CropLife providing a coordinated industry response to prevent or delay the development of resistance in insect and mite pests. There are IRAC country group committees in many parts of the world researching and responding to local resistance issues as well as IRAC International which operates at a global level. The IRAC Mission is: 1. Facilitate communication and education on insecticide resistance. 2. Promote the development of insecticide resistance management strategies to maintain efficacy and support sustainable agriculture and improved public health.

MoA, Target-site resistance and Cross-resistance

In the majority of cases, not only does resistance render the selecting compound ineffective but it also confers cross-resistance to other chemically related compounds. This is because compounds within a specific chemical group usually share a common target site within the pest, and thus share a common **mode of action (MoA)**. It is common for resistance to develop that is based on a genetic modification that affects this target site. When this happens, the interaction of the selecting compound with its target-site is impaired and the compound loses its pesticidal efficacy. Because all compounds within the chemical sub-group share a common MoA, there is a high risk that the resistance that has developed will automatically confer cross-resistance to all the compounds in the same sub-group. **It is this concept of cross-resistance within chemically related insecticides or miticides (acaricides) that is the basis of the IRAC mode of action classification**.

Managing Resistance

Successful resistance management programs should delay or prevent the occurrence of resistance to insecticides or miticides. Effective programs will maintain the efficacy of existing pesticide products. An active program which prevents resistance is always easier than trying to regain susceptibility. Growers should seek a program that alternates, or uses a sequence of rotations of compounds from different MoA groups, while minimizing materials from any one MoA group. The IRAC companies have developed a classification system that includes 28 categories and sub-groups, plus a category for materials with unknown modes of action, and has been internationally recognized. For a complete list by active ingredients and more information go to: *https://irac-online.org/*.

5.5.2 IRAC Classification for Tree Fruit Insecticides and Miticides

The IRAC class is now published at the beginning of most pesticide labels. The classification system avoids the end user trying to figure out if an active ingredient is the same or similar, or has the same MoA as another product. The user simply refers to the **IRAC class on the label**, and integrates various classes into a pest management program. In the event that the IRAC class is not published on the label, and for ease of grower use, Tables 5.5 and 5.6 summarize the IRAC classes as defined for tree fruit insecticides and miticides. As examples of similar chemistries, note that all pyrethroids are in class 3A, and that all neonicotinoids are in class 4A.

Table 5.5 IRAC Classification for Tree Fruit Insecticides

Product	Active Ingredient	Chemical Group/Sub-group	IRAC Class
Actara	thiamethoxam	Neonicotinoids	4A
Admire Pro	imidacloprid	Neonicotinoids	4A
Agri-Flex	abamectin + thiamethoxam	Avermectin + Neonicotinoid	6, 4A
Altacor	chlorantraniliprole	Ryanodine receptor modulators, Diamides	28
Ambush25W	permethrin	Pyrethroids, Pyrethrins	3A
Apta/Bexar	tolfenpyrad	mitochondrial complex I electron transport inhibitors (METI)	21A
Asana	esfenvalerate	Pyrethroids, Pyrethrins	3A
Assail	acetamiprid	Neonicotinoids	4A
Avaunt	indoxicarb	Sodium channel blockers, Indoxacarb	22
Battalion	deltamethrin	Pyrethroids, Pyrethrins	3A
Baythroid	beta-cyfluthrin	Pyrethroids, Pyrethrins	3A
Belay	clothianidin	Neonicotinoids	4A
Beleaf	flonicamid	Feeding blockers, Flonicamid	9C
Besiege	lambda-cyhalothrin chlorantraniliprole	Pyrethroids Diamides	3A 28
Brigade/Bifenture	bifenthrin	Pyrethroids, Pyrethrins	3A
B.t.s	Bacillus thuringiensis	Microbial disrupters of midgut, B.t.s and assc. proteins	11
Closer SC	sulfloxaflor	Neonicotinoid-like	4C
Centaur	buprofezin	Chitin biosynthesis inhibitors Type 1	16
Cormoran	novaluran + acetamiprid	Benzoylurea IGR + Neonicotinoid	15,4A
Danitol	fenpropathrin	Pyrethroids, Pyrethrins	3A
Decis	deltamethrin	Pyrethroids, Pyrethrins	3A
Delegate	spinetoram	Spinosyns	5
Diazinon	diazinon	Organophosphates	1B
Esteem	pyriproxifen	Juvenile hormone mimics, Pyriproxyfen	7C
Exirel	cyantraniliprole	Diamide	28
Imidan	phosmet	Organophosphates	1B
Intrepid	methoxyfenozide	Ecdysone receptor agonists, Diacylhydrazines	18
Lannate	methomyl	Carbamates	1A
Leverage	imidacloprid cyfluthrin	Neonicotinoids Pyrethroids, Pyrethrins	4A 3A
Lorsban	chlorpyrifos	Organophosphates	1B
Movento	spirotetramat	tetramic acid	23
Mustang MAXX	zeta-cypermethrin	Pyrethroid	3A
Proaxis/Declare	gamma-cyhalothrin	Pyrethroid	3A
Proclaim	emamectin benzoate	Chloride channel activators, Avermectins	6
Renounce/Tombstone	cyfluthrin	Pyrethroid	3A
Rimon	novaluron	Chitin biosynthesis inhibitors, Benzoylureas (IGR)	15
Scorpion 35SL/Venom	dinotefuran	Neonicotinoid	4A
Senstar	spirotetramat + pyriproxyfen	Tetramic acid + Juvenile hormone mimic	23, 7C
Sevin	carbaryl	Carbamates	1A
Vydate	oxamyl	Carbamates	1A
Voliam-Flexi	thiamethoxam, chlorantraniliprole	Neonicotinoids Diamides	4A 28
Warrior II	lambda-cyhalothrin	Pyrethroids, Pyrethrins	3A
Versys	afidopyropen	Feeding blocker	9D
Verdepryn 100SL	cyclaniliprole	Diamides	28

Table 5.6 IRAC Classification for Tree Fruit Miticides

Product	Active Ingredient	Chemical Group/Sub-group	IRAC Class
Acramite	bifenazate	Unknown	Un
Agrimek	abamectin	Chloride channel activators, Avermectins	6
Apollo	clofentazine	Mite growth inhibitor, Clofentezine/Hexythiazox	10A
Carzol	formetanate hydrochloride	Carbamates	1A
Envidor	spirodiclofen	Lipid synthesis inhibitors, Tetronic & Tetramic acids	23
Kanemite	acequinocyl	Mitochondrial electron transport inhibitors 3, Acequinocyl	20B
Kelthane	dicofol	Unknown	Un
Nealta	cyflometofen	Mitochondrial complex II electron transport inhibitor	25
Nexter	chloropyridazin	Mitochondrial electron transport inhibitors 1 (METI acaricides)	21
Portal XLO	fenpyroximate	Mitochondrial electron transport inhibitors 1 (METI acaricides)	21A
Savey	hexythiazox	Mite growth inhibitor, Clofentezine/Hexythiazox	10A
Vendex	fenbutatin-oxide	Mitchondrial ATP inhibitors, Organotins	12B
Zeal	etoxazole	Mite growth inhibitor, Etoxazole	10B

5.5.3 Insecticides and Miticides (in Alphabetical Order)

Acramite (bifenazate) (50WS) is a miticide in the carbazate class that has a novel mode-of-action. It is effective against ERM and TSM. It is affected by hard water and should have a conditioner added to the spray tank.

Actara (thiamethoxam) (25WG) is a foliar-applied insecticide containing the active ingredient thiamethoxam. Thiamethoxam is a second-generation neonicotinoid insecticide, belonging to the thianicotinyl subclass of chemistry and possessing unique chemical properties that result in excellent control of many sucking and chewing pests.

Admire Pro (imidacloprid) (1.6) (Pasada 1.6F) is a systemic and contact insecticide for post-bloom use on apples and pear. It is effective against leafhoppers, leafminers, aphids, and San Jose scale crawlers. It is toxic to bees so do not allow it to drift onto blooming weeds. Allow 7 days between last application and harvest.

Agrimek (abamectin) (0.15 EC) (ABBA 0.15EC) is a miticide/insecticide labeled for control of mites, tentiform leafminer, and first-generation white apple leafhoppers on apple, and mites and pear psylla on pears. It is very effective when timed properly. Agrimek penetrates quickly into leaves to form a reservoir of active material. Agrimek must be applied with a minimum 1% or 1.0 gal of oil/A before leaves harden-off.

Altacor (Rynaxypyr®/chlorantraniliprole) (WDG) is one of two anthranilic diamide classes of insecticides registered in tree fruit. The material is most effective on Lepidopteran larvae such as codling moth and oriental fruit moth. While there is some contact activity, Altacor is most effective when treated plant material is consumed. Exposed insects quickly stop feeding, become paralyzed and die within 1-3 days. Applications should be timed at or just prior to egg laying. Depending on the insect species, Altacor has both ovicidal and ovi-larvicidal (killing neonate larvae before they completely hatch) properties, as well as larvicidal properties from ingestion. Altacor is rain fast and has long residual activity.

Ambush – see **permethrin.**

Apollo (clofentizine) (42SC). Apollo is a tetrazine compound for mite control on apples, pears, peaches, nectarines, cherries, and apricots. It is primarily an ovicide, but also controls young motile stages. It has no direct effect on adult pest mites but is safe against natural enemies. Best results are achieved in spring, when red mite eggs are hatching, and before adults are present. If many adult mites are present, Apollo can be combined with other adulticides. Thorough coverage is essential for control. Apply only once/year. Do not rotate Apollo and Savey with each other.

Apta/Bexar (tolfenpyrad) is a group 21A insecticide with fungicidal properties. This is the same class as some miticides. It labeled on both pome and stone fruits. In apples and pears it is effective against leafhoppers, aphids (but not woolly apple aphids), apple maggot, leafrollers, plum curculio and rust mites. In stone fruit it is also effective against mealybugs and aphids found in stone fruit. This product is highly toxic to aquatic organisms and bees. Do not apply where there are blooming weeds.

Asana (esfenvalerate) (XL-0.66EC) (Adjourn) is a pyrethroid insecticide labeled for control of many insects on pome and stone fruit. On pears, it is frequently used prebloom against pear psylla. It can also be used against several stone fruit pests including Oriental fruit moth, plum curculio, periodical cicada, plant bugs, and as a trunk spray for controlling peach tree and lesser peach tree borers. It is also effective against pests of apple including oblique banded leafroller, codling moth, variegated leafroller, white apple leafhopper, tentiform leafminer, apple aphid (green), tufted apple bud moth, plum curculio (suppression), apple maggot, red-banded leafroller, green fruitworm, rosy apple aphid, and plant bugs. Asana, like other pyrethroids, is toxic to mite predators and its use probably will encourage mite build up. Therefore, Asana is not generally recommended for post-bloom application. Do not apply Asana closer than 21 days before harvest for apples, 28 days for pears, and 14 days for peaches. See the label for other restrictions.

Assail (acetamiprid) (30SG) is the first neonicotinyl registered on apples and pears that provides codling moth and Oriental fruit moth control. It has a 12 hour REI and a 7 day PHI. Practical resistance management would suggest that growers should limit the number of neonicotinyl applications in a season, so care must be taken when adding Assail to a program that is already using Provado or Actara.

Avaunt (indoxacarb) has a unique mode of action. It affects insects from direct exposure to spray droplets and through ingestion of treated foliage/fruit. Indoxacarb is not systemic but does have translaminar movement into the mesophyll. After application, it may be transported into the waxy leaf surface where it is protected from weathering. Once absorbed or ingested, nerve function is impaired, resulting in feeding cessation, paralysis, and death. Feeding cessation occurs almost immediately even though it may take several days for insects to die. It is effective on a wide range of insects, including Lepidopteran larvae such as codling moth and Oriental fruit moth, in addition to leafhoppers (suppression) sawfly, and plum curculio.

Bacillus thuringensis (B.t.) (Biobit, Dipel, Javelin, MVP, SOK, Thuricide, and Xentari) (wettable powder) are safe, biological insecticides labeled for control of cankerworms, gypsy moth, variegated and redbanded leafrollers, tufted apple bud moth, and tent caterpillars at the rate of 0.5 to 1.0 lb/A. These materials are nontoxic to bees and mite predators and may be applied up to harvest.

Baythroid (cyfluthrin) (2EC) is a pyrethroid that is effective against many fruit pests. It is recommended for use during the prebloom period on pome fruits, and through petal fall on stone fruits. Use after petal fall is more likely to cause outbreaks of mites and other secondary pests such as woolly apple aphids and scale.

Belay 2.13SC (clothianidin) is a neonicotinoid insecticide registered for use on pome and stone fruit. It has activity against aphids, leaf-hoppers, leafminers, plum curculio, apple maggot, pear psylla, BMSB, and Oriental fruit moth. Like other neonicotinoid insecticides, it is highly systemic, but should only be used in limited amounts when other neonicotinoid materials are used.

Beleaf (Flonicadmid) is a selective Homopteran feeding inhibitor, and is a unique MOA with its own subgroup and is a good solution for resistance management and natural enemy protection. Beleaf at labeled rates provides excellent control of both wooly apple aphid and rosy apple aphid. In pome and stone fruit, Beleaf has a blanket label covering all aphids and plant bugs.

Besiege (lambda-cyhalothrin and chlorantraniliprole) is a premix consisting of 4.63% lambda-cyhalothrin and 9.26% chlorantraniliprole, the same active ingredients in Warrior II and Altacor. Because it has both a synthetic pyrethroid and a diamide, it is very effective on a wide range of pests. Since the diamide component is slightly less than 1/3 of that in Altacor, you will need about 3 times the Altacor rate for similar control. This material should not be rotated with repeated use of pyrethroids or other diamide compounds (Altacor, Voliam Flexi, Exirel and Verdepryn).

TREE FRUIT PESTS AND CONTROLS

Brigade/Bifenture (bifenthrin) (WSB, 10DF or 2EC) is a pyrethroid insecticide that is labeled on pears, but not apples and stone fruit. It can only be used on those crops under section 18 labeling. Like other pyrethroids it has a wide spectrum of pest activity, but is especially effective on plant bugs and stink bugs.

Carzol (formetanate hydrochloride) (92SP) is a carbamate insecticide/miticide registered for control of mites, plum curculio, and plant bugs on peaches; mites and thrips on nectarines; and mites, leafhoppers, leafminers, and thrips on apple. Carzol is recommended at 12.0 to 20.0 oz/A. This material is most effective on European red mite and least damaging to predator mites when applied during pink and petal fall. Carzol cannot be applied after petal fall.

Centaur (buprofezin) is an insect growth regulator (IGR) with a unique mode of action that acts on nymphal stages of insects by inhibiting chitin biosynthesis. It also suppresses egg laying of adults and reduces egg viability. Centaur is labeled on pome and stone fruits for control of Scale Insects, Mealybugs, Leafhoppers and Pear Psylla. It is not disruptive to beneficial insects and mites.

Closer (sulfoxaflor)(SC) is related to the neonicotinoid group of insecticides but is in a different IRAC class (4C). It is labeled for pome fruits and stone fruits. In apples it is effective for aphids and leafhoppers at the low rate and will control plant bugs and wooly apple aphids at the high rate, and will suppress scale. For peaches it can be used to target aphids only, but will suppress scale insects and thrips.

Codling Moth granulosis virus (Madex HP, CYD-X) is a naturally occurring disease of the codling moth, but has been formulated for agricultural applications. It has no effect on other insects or animals. It must be ingested by codling moth larvae, and will kill larvae in 3-5 days. Because of its mode of action, it must be applied early as larvae are starting to hatch. Carpovirusine is used at the rate of 7.0-13.5 oz/A, while CYD-X is used at 1.0-6.0 oz/A. Some stings may still be visible. In New Jersey, the virus has been used as a resistance management tool in combination with insecticides and/or mating disruption. Madex will control both codling moth and oriental fruit moth.

Confirm (tebufenozide) (2F) controls codling moth and many leafrollers on apples and pears. It works best against tufted apple budmoth and codling moth when applied according to degree-day models starting at early egg hatch.

Cormoran (novaluron + acetamiprid) is a new premix containing an insect growth regulator (novaluron group 15) and a neonicotinoid, acetamiprid (group 4A). These are the same ingredients as in Rimon and Assail. Therefore it has a wide spectrum of pest activity that includes aphids, apple maggot, internal worms, leafhoppers and Japanese beetle. Plum curculio is listed on the label, but while it controls this pest it is not a quick knockdown material. This product can be toxic to bee larvae, so do not use where there are flowering weeds.

Danitol (fenpropathrin) (2.4EC) is a broad-spectrum pyrethroid that controls many pests and suppresses European red mite on apple. It fits into the spray program prebloom, at petal fall - first cover, and again as harvest approaches.

Decis (deltamethrin) (Battalion 0.2EC) is a broad-spectrum insecticide registered for use on pome fruit but not stone fruit. It is toxic to fish and bees and should be used primarily prebloom to minimize impacts to integrated mite management programs.

Delegate (spinetoram) (25WG) is a more persistent and effective product than Entrust, and has a wider pest spectrum. It is useful against internal feeders, leafrollers, pear psylla, and thrips.

Diazinon (50WP) is an organophosphate insecticide with broad-spectrum insecticidal activity labeled for pests of stone and pome fruit. Do not apply within 21 days of harvest. Diazinon is moderately toxic to *Stethorus punctum* larvae and adults.

Entrust (Spinosad) is derived from *Saccharopolyspora spinosa* bacteria. The naturally occurring active ingredients are fermentation products *spinosyn A* and *spinosyn D*. Originally trade named Spintor, Entrust is effective on leafminers, leafrollers, oriental fruit moth, codling moth, cherry fruit fly, thrips (with a spreader sticker), and suppression of apple maggot.

Envidor (spirodiclofen) (2SC) is a miticide registered on apple, pear and stone fruits for the control of European red mite, two- spotted spider mite, apple and pear rust mites, and peach silver mite. Acting as an insect growth regulator by inhibiting lipid biosynthesis, Envidor has activity against mite eggs, immature stages and adult females, but not adult males. Adult males that survive will continue to feed; therefore Envidor should be applied before populations begin to build.

Esteem (pyriproxyfen) (35WP) is an insect growth regulator. It effectively controls San Jose scale when combined with oil in the delayed dormant spray. It can be used in season to control codling moth and San Jose scale. On apple, it suppresses leafrollers, and controls leafminers and apple aphids. On pear, it is an effective delayed dormant through pink spray for pear psylla.

Exirel (cyantraniliprole/Cyaxypyr) (EC) is a second generation diamide insecticide (IRAC 28) that is effective for internal worms, leafrollers, leafminers, leafhoppers and plum curculio when combined with a spreader sticker. In stone fruit it can also be used to control Japanese beetle, cherry fruit fly and spotted wing drosophila. This material is extremely toxic to bees, and can only be used when bees are not present in the orchard. Therefore maintain a weed free groundcover and clean weed free strips under the trees.

Grandevo DF (biopesticide) is a dry flowable insecticide/miticide containing metabolites produced during fermentation of *Chromobacterium subtsugae* strain PRAA4-1^{T}. Grandevo contains no viable bacteria, has a 4 hour REI and a 0 day PHI and is OMRI approved. Grandevo may be useful in both organic and conventional fruit production for insecticide resistance management and residue management.

Imidan (phosmet) (70WP) is an organophosphate insecticide recommended in several cover sprays for control of codling moth, plum curculio, apple maggot, red-banded leafroller, and Oriental fruit moth. It is not effective against mites, aphids, or leafhoppers. White apple leafhopper becomes numerous wherever Imidan is used regularly. Imidan is not highly toxic to mite predators when applied according to schedule.

Intrepid (methoxyfenozide) (2F) is labeled for use on apple, pear, and other pome fruit to control codling moth, Oriental fruit moth, leafrollers, and leafminers.

Kanemite (acequinocyl) (15SC) is a miticide labeled for the control of European red mite and two-spotted spider mite in pome fruit. The miticide works by contact activity only but is active on all spider mite life stages, including eggs. It kills spider mites quickly and provides up to 28-days of residual activity. It is (group 20B) in a different chemical grouping than Nexter and Portal XLO (group 21), so it can be rotated on a limited basis with those materials, as well as other miticides.

Kelthane (dicofol) (50WP) is a chlorinated hydrocarbon, controls both European red and two-spotted mites. Resistance to Kelthane is becoming more widespread each year, so only apply once/year on apple. Mite predators can tolerate this material.

Lannate (methomyl) (LV and 90SP) is a carbamate insecticide labeled for control of apple aphid, rosy apple aphid, codling moth, tufted apple bud moth, white apple leafhopper, fruit tree leafroller, tentiform leafminer, green fruitworm, tarnished plant bug, oblique-banded, variegated, and red-banded leafrollers, Oriental fruit moth, green peach aphid, catfacing insects, thrips, and stink bugs. Lannate LV is not registered for nectarines. Do not apply to early 'McIntosh' and 'Wealthy' cultivars. Lannate is damaging to mite predators; therefore, in pest management programs it should be used sparingly and only in combination with other insecticides.

Leverage (360) is a prepackaged combination of Provado (imidacloprid) and Baythroid (cyfluthrin). The combination gives good sucking insect control, combined with the broad-spectrum activity of a pyrethroid. However resistance management precautions should be used, especially since overuse of pyrethroids can stimulate secondary pest outbreaks.

Lorsban (chlorpyriphos) (4E, 50WP, 75 WG, Advanced) (Chlorpyrifos 4E AG) is a nonsystemic organophosphate insecticide. Lorsban or chlorpyrifos products may be applied either as a dormant/delayed dormant application, or as trunk sprays for borer control. If a delayed dormant application is made, then you are not allowed to make additional applications for borer control. More than one trunk spray may be used on peaches and nectarines, but

only one trunk spray may be used on apples. Therefore, if you wish to use Lorsban for peachtree, lesser peachtree borer, or dogwood borer control, then no dormant or delayed dormant applications can be made for other insects. The 4E formulation is labeled for dormant to tight cluster control of rosy apple aphid, San Jose scale, and cutworm control. For apples, if you elect to use the Lorsban application for pre-bloom control of aphids or scale, then Lorsban may be applied with Superior Oil 1.5 to 2 pt or equivalent of Lorsban 4E only once during the green-tip to 0.5 inch green stage. Do not apply after bloom on apples. For peaches, Lorsban is labeled for peach tree borer control. Apply as a coarse trunk spray during mid- to late September. Thoroughly wet all bark from scaffold limbs down. Do not allow meat or dairy animals to graze in treated orchards. For borer control in apples, treat only the bottom 4 feet of trunk and do not allow Lorsban to come in contact with the fruit.

Malathion (25WP, 57EC, 8EC). This organophosphate aphicide is recommended for growers desiring less toxic insecticides. Wait 3 days between last application and harvest for apples and 7 days for peaches. This material is labeled for control of aphids, codling moth, leafhoppers, mites, plum curculio, red-banded leafroller, San Jose scale, lesser peach tree borer, and Oriental fruit moth.

Movento (spirotetramat) is an aphid and scale material in the same chemical grouping as Envidor miticide. It is registered for use on apples, pears, and all stone fruit. It controls pear psylla on pears. Care should be taken not to use this material in combination or in sequence with Envidor for mites.

M-Pede insecticide/fungicide is a contact insecticide, miticide and fungicide for control of soft-bodied insects, mites and powdery mildew. The formulation is based on potassium salts of naturally derived fatty acids. This product can be applied up to harvest. M-pede may cause russetting of pome fruit when applied in heat, and may be phytotoxic to some Asian pear cultivars.

Mustang (zeta-cypermethrin) (Mustang and Mustang Maxx) is a broad spectrum pyrethroid insecticide that is effective for most tree fruit pests except spider mites. Like other pyrethroids, it is not a strong material for aphid control, so should not be used as a rescue treatment against high populations. It is also effective for apple maggot, cherry fruit fly and spotted wing drosophila.

Nealta (cyflumetofen) is a group 25 miticide. It is ovicidal, has knockdown and residual properties for all mite stages, and is effective for both European red mites and two-spotted spider mites, but not rust mites. Thorough spray coverage is required, since it is not a systemic material. It has minimal impact on most mite predators, and like all miticides it must fit into a resistance management program. Therefore, use every row and not alternate row applications, and use only 1 application before alternating to a different chemistry if needed.

Nexter (pyridaben) is a broad-spectrum miticide with some insecticidal properties. It controls spider mites and rust mites, and has activity on leafhoppers, pear psylla and aphids. It is a group 21 METI acaricide, which is the same as fenpyroximate (Fujimite/ Portal XLO), with the same spectrum of activity. These materials should be considered as one material and should not be used in rotation. Reduced efficacy has been reported where this product has not been rotated with different chemistries.

Permethrin (Ambush 2E, 25WP; Perm-up; and Pounce 3.2E, 25WP) is a pyrethroid-type insecticide labeled for control of plum curculio (suppression), rosy apple aphid, spotted tentiform leafminer, tarnished plant bug, oblique-banded leafroller, white apple leafhopper, tarnished plant bug, Oriental fruit moth, and lesser peach tree borer. No more than three applications are permitted/season for apples. Permethrin is not recommended for postbloom application. Do not apply within 7 days of harvest for peaches. Permethrin is extremely toxic to mite predators and has been shown to encourage mite buildup. See the label for other restrictions.

Portal 5EC (fenpyroximate) (5EC) is an insecticide/miticide registered for use on pome fruit and nonbearing deciduous fruit trees. It belongs to the phenoxypyrazole class of insecticides. Its mode of action is as a mitochondrial electron transport inhibitor (METI), blocking cellular respiration (similar to Nexter and Kanemite). Practical resistance management would suggest that the use of METI (group 21 miticides (either Nexter, Portal XLO) be limited to one application/year. It will provide some control of low to moderate levels of pear psylla.

Pounce (3.2E and 25WP) – see **permethrin**.

Proaxis (gamma-cyhalothrin) is a pyrethroid insecticide with broad spectrum activity labeled in both pome and stone fruits. This insecticide is weak on aphid control, but is active on most other pests.

Proclaim (emamectin benzoate) (5SG) is an insecticide registered for use on pome fruit. It provides protection against leafrollers and leafminers in addition to suppressing codling moth, Oriental fruit moth, and pear psylla.

Rimon (novaluron) (0.83EC) is an insect growth regulator effective against codling moth, Oriental fruit moth and leafrollers on apple. Because it acts as a chitin biosynthesis inhibitor (disrupts molting), primary activity is against larval stages. However, there is some toxicity to eggs, especially when laid on treated surfaces. Rimon must be applied before egg laying occurs. Route of insect entry is primarily through ingestion with some contact activity. Rimon is rated excellent for codling moth and good for Oriental fruit moth. It sometimes causes mite problems.

Savey (hexythiazox) (50WP, 50DF) is an ovicide/miticide registered for use on apples, pear and stone fruit. Apply during the cover season on pear, but make applications before mite populations build. Do not rotate Apollo and Savey with each other.

Scorpion/Venom (dinotefuran) (35SL, 70W) are neonicotinoid insecticides that are labeled in peach and nectarine but not apples. They are effective against aphids, leafhoppers, plum curculio and stink bugs. Pest activity can be rate dependent, so the higher rates should be used on stink bugs and plum curculio. The chemistry is extremely toxic to bees, so should only be used when bees are not present, and in orchards with a weed free turf groundcover and a weed free strip under the trees.

Senstar (spirotetramat + pyriproxyfen) is a premix of the same active ingredients found in Movento and Esteem (group 23+7C). Therefore the mix contains a systemic material with all the properties of Movento plus an insect growth regulator with the same properties as Esteem. However on a liquid formulation basis, Senstar has less pyriproxyfen than the Esteem liquid formulation, so be aware of this if trying to control scales.

Sevin (carbaryl) (80S, XLR) is a broad-spectrum carbamate insecticide. It is highly toxic to bees and should not be used near bloom. It also acts as a fruit thinner on many cultivars (see Plant Growth Regulators in the Apple chapter). For peaches, Sevin is satisfactory for control of plum curculio, Oriental fruit moth, catfacing insects, Japanese beetle, and scales. Normally, aphid and mite populations build up rapidly following Sevin applications because it is toxic to predators. For this reason, it is not generally recommended. Sevin may be applied up to 3 days before harvest.

Superior Oil is still one of the most effective materials available for European red mite and scale control in New Jersey. Oil can be applied safely between the 0.25 inch green and tight-cluster stages of bud development. After pink, there is an increasing risk of phytotoxicity. Oil applied during silver tip to 0.25 inch green is not nearly as effective as when applied during the period between 0.5 inch green and full pink. Oil controls mites by smothering the developing embryo within the overwintering egg. Because eggs are laid on recessed areas of spurs, twigs, limbs, and trunk bark, thorough coverage is required.

Tombstone/Renounce (cyfluthrin) (2E) is a pyrethroid insecticide consisting of cyfluthrin, as opposed to Baythroid which is beta-cyfluthrin. Like other pyrethroids, it is a broad spectrum material controlling internal worms, leafrollers, plant bugs, plum curculio, aphids and fruit flies, and spotted wing drosophila.

Vendex (fenbutatin-oxide) (50WP) is an organotin miticide that is nontoxic to honeybees and relatively nontoxic to beneficial mites. It is registered for mite control on apples, pears, peaches, nectarines, prunes, plums, and cherries. Do not apply more than twice/season or more than 4.0 lb/A. Vendex is relatively slow acting, so apply before mite infestations increase. Vendex tends to be more effective early in the season when temperatures are relatively cool.

Venerate XC (biopesticide) is a liquid insecticide/miticide containing metabolites produced during fermentation of *Burkholderia spp*. strain A396. Venerate contains no viable bacteria, has a 4 hour REI and a 0 day PHI and is OMRI approved. Venerate may be useful in both organic and conventional fruit production for insecticide resistance management and residue management.

Verdepryn 100SL (cyclaniliprole) is a diamide group 28 insecticide. In apples and pears it is effective on internal

worms, leafrollers, leafminers, leafhoppers, European apple sawfly, plum curculio, and pear psylla. In stone fruits it is effective for the same insects plus cherry fruit fly spotted wing drosophila and Japanese beetle. The material is highly toxic to aquatic organisms and bees. Do not use this product if there are flowering weeds in your orchard.

Versys (afidopyropen) is a new chemistry type in group 9D, and was designed for sucking insects. It is labeled for both pome fruits and stone fruits. It is effective against rosy apple aphids, spirea aphids and green apple aphids in apples, but only suppressive against woolly apple aphids. In stone fruit it is effective against all aphid species.

Voliam Flexi (thiamethoxam and chlorantraniliprole) is Syngenta's prepackaged combination of the active ingredients in Actara and Altacor (Dupont). This gives effective pest activity for sucking insects from the neonicotinoid, combined with the Lepidopteran worm activity from Altacor. Care should be taken not to overuse Actara or other neonicotinoid materials, especially since there may be only a few times when both products are needed together.

Vydate (oxamyl) (2L) is a systemic carbamate insecticide-miticide labeled for control of white apple leafhopper, spotted tentiform leafminer, and mites. Do not apply within 30 days after petal fall because of possible fruit thinning. Do not apply more than 400 gal/A. Wait 14 days between application and harvest.

Warrior II (lambda-cyhalothrin) (1SC) (Silencer 1EC) is a micro-encapsulated pyrethroid that provides additional safety to handlers and longer field life. It is labeled for use on pome and stone fruit. Use after petal fall is more likely to cause outbreaks of mites and other secondary pests such as woolly apple aphids and scale.

Zeal (etoxazole) is a miticide registered for use in pome fruit and stone fruit. It is effective for spider mites, but not labeled for rust mites. It is in a similar chemical grouping (10B as opposed to 10A) as Apollo and Savey, and therefore should not be rotated with those materials. It is a growth regulator and is effective on the egg, larvae and nymphs. There is very little activity on adults. Treated females do not reproduce, but will continue to feed therefore Zeal should be applied before populations begin to build.

5.5.4 Third Party and Generic Labels

Patents have expired for many older insecticides and miticides, or licensing rights have been sold to formulators other than those companies who first developed and sold their better known traditional products. Many of these new products are now less expensive than the originals, yet still have similar labels. Product names may also be less familiar. Since this book commonly refers to the better known traditional trade name, it may be confusing when new products with the same active ingredient are available in their place. To help clarify what many of the generic products are in relation to the original trade names see the list of selected insecticides in Table 5.7.

Table 5.7 Active Ingredient, New Trade Names and Traditional Trade Names of Selected Insecticides

Active Ingredient	New Trade Names	Traditional Trade Names	Labeled for			Manufacturer
			Apple	Pear	Peach	
abamectin	Abamectin E-AG 0.15 EC	AgriMek	X	X		Nufarm Americas
	Abba 0.15 EC	AgriMek	X	X		Adama
	Reaper 0.15 EC	AgriMek	X	X		Loveland Products
	Temprano EC	AgriMek	X	X		Chemtura Corp.
	Zoro	AgriMek	X	X		Cheminova, Inc.
bifenthrin	Fanfare 2EC, Bifenture EC	Brigade		X		Adama
carbaryl	Carbaryl 4L	Sevin	X	X	X	Drexel Chemical Co.,
	Carbaryl 4L	Sevin	X	X	X	Loveland Products
	Carbaryl 80S	Sevin 80S	X	X	X	Drexel Chemical Co.
	Prokoz Sevin SL	Sevin	X	X	X	Prokoz inc.

Table 5.7 - continued on next page

Table 5.7 - continued

chlorpyrifos	Chlorpyrifos 4E	Lorsban 4E	X	X	X	Adama
	Chlorpyrifos 4E	Lorsban 4E	X	X	X	Micro Flo Products
	Govern 4E	Lorsban 4EC	X	X	X	Tenkoz, Inc.
	Nufos 4E	Lorsban	X	X	X	Cheminova, Inc.
	Warhawk 4E	Lorsban	X	X	X	Loveland Products
	Whirlwind	Lorsban	X	X	X	Helena Chemical Co.
	Yuma 4E	Lorsban	X	X	X	Winfield Solutions (Agriliance LLC)
cyfluthrin	Tombstone, Tombstone-Helios	Baythroid	X	X	X	Loveland Products
deltamethrin	Battalion	Decis	X	X		Arysta LifeScience North America LLC
diazinon	Diazinon 50W	Diazinon 50W	X	X	X	Adama
	Dicofol 4 EC	Kelthane	X	X		Adama
esfenvalerate	Adjourn .66EC	Asana	X	X	X	Adama
	S-Fenvalostar	Asana	X	X	X	LG Life Sciences
hexythiazox	Onager	Savey	X	X	X	Gowan Co.
imidacloprid	Advise 2 FL	Admire 2	X	X	X	Winfield Solutions (Agriliance LLC)
	Alias 2F	Admire 2	X	X	X	Adama
	Alias 4F	Admire Pro	X	X	X	Adama
	Couraze 1.6F	Provado	X	X	X	Cheminova, Inc.
	Couraze 2F	Admire 2	X	X	X	Cheminova, Inc.
	Gallant 1.6L	Provado	X	X	X	Agrisolutions
	Imida E-Ag 1.6F	Provado	X	X	X	Nufarm Americas
	Imida E-Ag 2F	Admire 2	X	X	X	Nufarm Americas
	Impulse 1.6 FL	Provado	X	X	X	Albaugh, Inc./Agristar
	Impulse 1.6FL	Provado	X	X	X	Albaugh, Inc./Agristar
	Macho 2FL	Admire 2	X	X	X	Albaugh, Inc./Agristar
	Nuprid 1.6F	Provado	X	X	X	Nufarm Americas
	Nuprid 2F	Admire 2	X	X	X	Nufarm Americas
	Pasada 1.6 FL	Provado	X	X	X	Adama
	Prey 1.6	Provado	X	X	X	Loveland Products
	Widow	Admire 2	X	X	X	Loveland Products
lambda cyhalothrin	Silencer	Warrior II	X	X	X	Adama
malathion	Fyfanon	Malathion 5EC			X	Helena Chemical Co.
	Fyfanon 8E	Malathion 8E			X	Helena Chemical Co.
	Fyfanon ULV	Malathion ULV			X	Cheminova, Inc.
	Malathion 57EC	Malathion 57EC			X	Loveland Products
	Malathion 5EC	Malathion 5EC			X	Micro Flo Co.
	Malathion 8A	Malathion 8A			X	Loveland Products
	Malathion 8EC	Malathion 8EC			X	Arysta LifeScience North America LLC
	Malathion 8F	Malathion 8F			X	Gowan Co.
	Malathion ULV	Malathion ULV			X	Winfield Solutions (Agriliance LLC)
permethrin	Artic 3.2 EC	Ambush/Pounce	X	X	X	Winfield Solutions (Agriliance LLC)
	Permethrin 3.2 EC	Ambush/Pounce	X	X	X	Helena Chemical Co.
	Permethrin 3.2 EC	Ambush/Pounce	X	X	X	Loveland Products
	Permethrin 3.2 EC	Ambush/Pounce	X	X	X	Tenkoz, Inc.
	Perm-Up 25DF	Ambush/Pounce	X	X	X	United Phosphorous (Cerexagri-Nisso)
	Perm-Up 3.2 EC	Ambush/Pounce	X	X	X	United Phosphorous (Cerexagri-Nisso)
potassium salts of fatty acids	Revoke L	M-Pede	X	X	X	Helena Chemical Co.

5.6 Nematode Control

Detection

Whenever nematode damage is suspected, and especially before planting young trees, an examination of both soil and roots is recommended. Soil and root samples must be adequate in size and collected in a manner that will make evaluation possible. The following suggestions are made so those samples will be collected properly and arrive at the Nematode Detection Laboratory in good condition.

Samples for nematode analysis will not be processed unless the following instructions are observed:

1. Collecting. If a large area in an orchard is believed to be involved, collect samples from the edges of the affected area. Take a mixture of roots and soil from at least 10 separate sites at depths of 12 to 15 inches. Collect at least 1.0 qt of soil. Send only a single blended sample from an orchard. Do not mix samples from several orchards. A brief history of the affected area will be helpful to the nematologist when he or she makes the diagnosis.
2. Handling. After collecting, place sample in a plastic freezer bag and close the bag tightly to prevent drying out. It is not necessary to add water to a freshly collected soil and root sample. Protect the sample from high temperatures and from freezing.
3. Submitting. Enclose with the sample, a letter that gives the following information:
   a) date sample was collected; b) crop from which sample was collected; c) name and address of grower;
   d) name and address of person submitting sample; e) description of plant symptoms; f) crop to be planted.

Contact your area fruit agent about submitting samples. All samples should be marked "For Nematode Detection." A reply will be sent as soon as possible, usually about 10 days after the lab receives the sample.

Controlling plant-parasitic nematodes are always a problem where peaches follow peaches. In some instances, they can also be troublesome in sites where peaches have not been grown previously. Where nematodes are troublesome, trees do not grow as vigorously. Further, nematode feeding increases the incidence of peach decline, and it can increase the incidence of stem pitting.

Preplant nematicide treatments are necessary to promote tree vigor and to prevent the replant problem. Postplant treatments are necessary to reduce tree loss from peach decline and stem pitting.

Research has shown that nematodes build up and reach damaging levels by the end of the second growing season when fumigant-type nematicides are used. The nematode buildup may occur at the end of the first growing season with nonfumigant- type nematicides. Research results indicate postplant nematicide treatments are needed yearly to prevent tree loss.

The guidelines in Table 5.8 may be used as a tool to help decide if a nematicide will be economically beneficial (Table 5.8) **These are general guidelines only, and other factors should also be considered before making a treatment decision**. For example, if the orchard has a nematode population just above the treatment guidelines, but the trees are old and production is high, then a nematode treatment would probably not be beneficial. Conversely, if over 40 ring or any root knot nematodes were found in a new planting (peaches), or in ground that was going to be planted the following year, then nematicide use would be advised.

Fumigant-Type Nematicides

Fumigant-type nematicides have been used successfully for many years. Growth response of peach trees to soil fumigation has consistently been recorded where nematicidal rates of soil fumigants were employed. In some instances, an additional growth response was recorded where disease control rates of soil fumigants were employed. Some materials also provide control of weeds and germinating weed seeds. Table 5.9 shows the recommended materials and rates.

Soil fumigants can be applied any time the soil temperature is at least 55°F at the 12-inch depth. Generally, soil temperatures reach this point from mid-April to mid-November in southern counties and from mid-April to early November in northern counties. During mid-summer, soil temperature may become too high for successful treatment (90°F). After making application, cultivate soil shallowly and irrigate with a half-inch of water.

Row Treatment

Successful treatment depends to a large extent on soil preparation and soil moisture. Soil should be worked as thoroughly as possible, with subsoiling considered highly desirable. All crop residues should be decomposed since fumigants do not penetrate sufficiently to provide satisfactory kill of nematodes within plant tissues. Soil moisture should be equivalent to that desired for seeding.

The best placement of soil fumigants is at least 15 inches deep with tractor-mounted subsoil chisel equipment. Injection nozzles should be spaced between 9 to 12 inches, depending on the volatility of the fumigant used, soil moisture, and soil temperature. In areas where peach decline is not troublesome, treat an 8-foot band corresponding to the row. In areas where peach decline is troublesome, a 4- to 6-foot band is sufficient, since these blocks will require postplant treatments.

Delay planting at least 2 weeks after treatment to avoid plant injury. Since this delay may interfere with spring planting, fall treatment is generally preferable.

Table 5.8 Nematode Treatment Guidelines

Thresholds given (no./100 cc) are not based on experimental data, but rather on field experience and observations in commercial orchards.

Nematode	No./100 cc	
	Peach	**Apple**
Lesion	60-80	40-60
Stunt	60-80	60-80
Spiral	40	40
Stubby Root	16	16
Dagger	any - as virus vector 16+ for feeding injury	any - as virus vector 16+ for feeding injury
Ring	24	30
Cyst	not economic	not economic
Sting	8-10	8-10
Lance	40-60	40-60
Root Knot	any in new plantings	not economic

Table 5.9 Fumigant and Non-Fumigant Nematicides

Name	Application Timing	Pests Controlled	Rate/Treated A[1]
Basamid G	Preplant	Nematodes Diseases Weeds	220 - 260 lb 260 - 350 lb 220 - 530 lb
DiTera DF[2]	Preplant Postplant	Nematodes	13.0 - 100 lb
MeloCon WG[2]	Preplant Postplant	Nematodes	2.0 - 4.0 lb
Telone II	Preplant	Nematodes	27.0 - 35.0 gal
Telone C-17[3]	Preplant	Nematodes	32.4 - 55.5 gal
Vapam HL	Preplant	Nematodes Diseases Weeds	37.5 - 75.0 gal
Vydate L	Preplant Postplant	Nematodes	2.0 gal (pre) 2.0 - 4.0 pt (post)

[1] Rates given are for light, sandy soils. Heavier soils require higher rates; always consult label before use.
[2] MeloCon and DiTera are biological nematicides available for use in organic orchards. Both are OMRI listed.
[3] Rate for strip application, untarped shank injection.

Non-Fumigant Nematicides

Several non-fumigant nematicides can be used legally on peaches and other tree fruit. Consult the label and use only as directed. Nonfumigant nematicides can be used successfully as preplant treatments or as postplant treatments.

Non-fumigant nematicides are formulated as sprayable materials. The earlier, granular formulations are no longer legal for use. Sprayable soil-applied nematicides can be applied with a properly calibrated weed sprayer, and they have been successfully used in combination with all of the herbicides commonly used on tree fruit. To prevent injury to non-target organisms, all soil-applied nematicides should be incorporated shallowly into the soil immediately after application.

Since these nematicides are not fumigants, they must enter the soil water and contact the nematode to effect a control. As nonfumigants, soil temperature and soil moisture are not so critical for satisfactory control. Satisfactory control has been obtained with applications any time between mid-March and late November when the ground is not frozen.

The non-fumigant nematicides presently cleared for use on tree fruit all possess some systemic activity. Consequently, when they are applied to soils, the ground should be weed-free for maximum control.

Those that are presently cleared for use include DiTera DF, MeloCon WG, and Vydate L. Vydate L is cleared for use either in a series of foliar sprays or as a preplant soil application. DiTera DF active ingredient consists of dead cells of the fungus *Myrothecium verrucavia* and the liquid in which the fungus was grown. This mixture is the agent that kills nematodes on contact. In contrast, MeloCon WG consists of living viable spores of the the fungus *Paecilomyces lilacinus* strain 251 which parasitizes many species of plant-parasitic nematodes. See Table 5.9 for recommended rates.

Banding nematicides is highly desirable. For preplant treatments, band widths should be 4-10 feet, depending on whether the block is to receive postplant nematicide treatments. Postplant treatments should be applied 1 foot beyond the drip line to as close to the trunk as possible.

5.7 Vole Control

Identification and Habitat

Voles, also known as mice, are small ground-dwelling rodents that occur throughout the North East United States. Meadow voles (*Microtus pennsylvanicus*) and pine voles (*Microtus pinetorum*) are two common types of voles.

Mature voles have stocky bodies and could be 5 to 7 inches long. Though both types of voles can exist in the same orchard, there is a difference in terms of habitat preference. Meadow voles primarily feed in open vegetation as long as there is enough ground cover, while pine voles prefer underground burrow systems just below the ground surface and survive on roots and root bark. Pine voles attack young apple trees during fall and winter when they run out of other food sources.

Damage

Both types of voles are able to cause great damage in orchards, especially to apple and peach trees. Meadow vole damage is often clearly visible in the form of girdling at the base of the trunk. Girdling damage usually occurs in fall and winter when other food sources are scarce and trunks of young apple trees are easily accessed. Pine voles are difficult to notice until the tree growth begins to decline by which time it is difficult to save the tree.

Vole Monitoring

The first step in controlling the damage is to identify vole species and the extent of the damage. The meadow voles create extensive surface runways in the grass which are about 1.5 inch wide and are often visible after close moving. Bits of leaves and vole droppings in pathways are the surest signs of meadow vole presence. To differentiate the species, specifically the pine voles, place 20 traps per orchard close to tree trunks, active runs, and heavily shaded areas. Next day check the traps; if the caught vole has a tail shorter than its hind leg, a pointy nose, sunken eyes, and brownish fur, it is a pine vole. If the tail is longer than the hind leg then it is a meadow

vole. The next step in controlling voles is to determine their population. In a simple apple sign test, place an apple slice at every 20-30 trees and 24 hours after placing them, inspect the teeth marks. Number of apple slices with gnaws in relation to total number of trees gives a percentage index of vole populations.

Vole Management

Non-Rodenticide Methods: Maintaining a vegetation-free zone below the trees discourages voles from living close to the trunk where they can cause great damage. Regularly mowing the ground cover down to 3 to 5 inches is a recommended practice to include as part of an integrated vole damage management program. It not only limits the availability of food for voles' survival, but also make them exposed to predators. Sanitizing the orchard floor by removing leaves and pruned twigs which attract the voles is also helpful.

Cylinder-shaped wire guards made from hardware cloth mesh of 1/4 inch placed around the tree trunks can protect the young apple and peach trees. However, make sure to bury the hardware cloth at least 6 inches below the surface to control both meadow and pine voles. This exclusion method may not be very practical and cost effective in large orchards.

Rodenticides: Sometimes to control large scale vole populations, chemical rodenticides are the only practical option available. Chemical treatment within the herbicide strip near the tree rows is the most effective to control vole population (Table 5.10).

Table 5.10 Vole Control with Rodenticides

Name	Type of bait[1]	Product Formulation	Comment
Zinc Phosphide	Fast acting, acutely toxic	Pellet	More effective against meadow voles. However when applied by coating an apple slice, use about 1 tsp (4 grams) per bait station, it was effective to control pine voles.
Chlorophacinone, Diphacinone	Slow acting anticoagulants	Pellet	More effective against pine voles. Weather resistant hence can be used any season. Several application at 3 weeks interval may be required for effective control.

[1]Make sure you have the necessary pesticide applicator license to handle these chemicals.

For small scale orchards the easiest way is to place baits in the active runs at each hole. Alternatively, baits can be hand broadcasted, however it is not recommended because it can be dangerous to grazing animals and other non-intended species. Applying baits in furrows is more effective for meadow voles and less effective for pine voles. Zinc phosphide is seldom recommended because of its high toxicity to all vertebrates, however bait stations can reduce the chances of bait getting into contact with non-intended animals or humans. Bait stations are easy to make using 2 to 3 inch PVC pipes in 'L' or 'T' shape in which horizontal pipe provides an opening for voles to enter, the vertically connected pipe has bait filled in which gets released in a smaller doses (*http://extension.missouri.edu/p/G9445*). After putting out bait stations or placing baits in active runs or in furrows, perform the apple sign test as mentioned above (see "Monitoring") to confirm control.

6 Pesticide Strategies

6.1 Sprayer Calibration and the Tree Row Volume Method

Foliar pesticide spray applications in tree fruit orchards are made almost exclusively with airblast sprayers. The number and frequency of sprays needed each season represents nearly 20% of seasonal production costs. All aspects of the spraying operation need to be as cost-efficient as possible. Just because a treatment provides good pest control does not mean that it is also efficient. One reason for this inefficiency is that conventional guidelines for pesticide recommendations lack precision, and are frequently misunderstood. **In this section we offer guidelines for defining spray volume and concentration requirements, and for sprayer calibrations to obtain maximum performance and consistent control.**

Tree Row Volume (TRV) and Determining Pesticide Dosage

The required dosage of any pesticide is the amount that must be applied per unit of target area that achieves the desired level of pest control. Determining when a pesticide dosage is too low is relatively easy since more pest damage is seen. It is more difficult to tell when the dosage level exceeds the required amount because there is often little or no difference in the level of pest damage. Using too little or too much pesticide is costly. Excessive rates mean increased costs, excessive worker exposure, unnecessary environmental contamination, and disruption of integrated control programs. Pesticide dosage is determined by two factors:
(1) the concentration of the pesticide in the spray tank (pounds of product per 100 gallons of water)
2) the spray volume applied per target unit (gallons per acre).

Target Definition

Defining the target area as “an acre” is too variable, and may lead to either too much or too little pesticide being applied. House painters determine the amount of paint required for a job by defining the house in more relevant terms. Thus, painting recommendations are never stated on a gallons-per-house basis, but on a gallons-per-1,000-square-foot basis. Fruit growers face a similar problem in determining how much pesticide is needed to treat an acre of orchard. The amount of target area within an orchard acre varies with tree size, planting density, and the degree of canopy development.

The “conventional acre” is a two-dimensional unit of area (43,560 square feet) and is accurate for pesticide dosage in orchards only when applying herbicide sprays to ground areas. For tree spraying, the **“orchard acre”** needs to be redefined in terms that are relevant to a three-dimensional target. This is done by using tree row volume (TRV) to estimate the volume of the target to be treated. Here, adjustments can be made for differences among orchards in tree size and planting density. TRV per acre is calculated by multiplying tree height (H) x foliar canopy width (W) x the row length (L) per acre, therefore:

H x W x L = cubic feet TRV per acre

The row length per acre (L) above is determined by dividing 43,560 square feet per acre by the distance between rows in feet as shown below for a 28 feet row spacing.

$$\frac{43{,}560\ \text{ft}^2\ \text{acre}}{28\ \text{feet between rows}} = 2{,}178\ \text{row feet per acre}$$

Determining High Volume Spray Requirements Based on TRV

The spray volume required for uniform coverage of an orchard depends on the total fruit and foliage surface area. One way good coverage can be obtained is to use high-volume (HV) dilute sprays of 200 to 400 gallons per acre (gpa) to thoroughly wet all target surfaces to a point where excess spray liquid drips to the ground. This is important where absolute coverage of all surfaces is required (for example, oil sprays for mite control and for certain plant growth regulators). Underdosing does not occur because all parts of the tree are thoroughly wetted. Overdosing does not occur because any excess material runs off. Obviously, if the spray volume used is excessive, then much is lost to the ground as drip. For trees with a full canopy of foliage, a dosage volume of about 0.7 gallon

per 1,000 cubic feet TRV will usually reach the drip point. Early in the season however, sprayers should be calibrated to deliver between 0.25 and 0.35 gallon per 1,000 cubic feet TRV to avoid excessive runoff. (An apple tree at green tip has approximately one-fifth the surface area it will have at full leaf.) If applying sprays calibrated for dilute application and not reaching the drip point, the dosage will be less than adequate and control will be reduced. If the drip point is greatly exceeded, control will be adequate, but pesticide use will be excessive both in terms of cost and unnecessary environmental contamination.

Determining Concentrate and Low Volume Spray Requirements Based on TRV

Good coverage can also be obtained using low volume (LV) sprays of 25 to 60 gpa, with which a fine mist of spray droplets are uniformly deposited over all target surfaces without reaching the drip point. LV spraying is now the standard in the fruit industry because it requires less labor, time, and pesticide than HV sprays. However, without a visible gauge to determine when enough material has been applied, such as the drip point for HV sprays, dosage for LV sprays can be controlled only by adjusting the pesticide concentration in the spray tank. An LV rate of 0.09 gallon per 1,000 cubic feet TRV provides adequate coverage in most orchards under most conditions. Applying less than this amount may give less consistent results under variable orchard conditions because few airblast sprayers are designed for very low volumes. Applying more than this rate generally leads to excessive pesticide use and higher spray costs. See Table 6.1 for suggested spray volumes.

This dosage volume can be used to calibrate the sprayer to deliver a spray volume suitable for a three-dimensional orchard target defined by TRV. The conversion to gpa for sprayer calibration is made using the following formulas:

$$\frac{\text{ft}^3\ \text{TRV}}{1{,}000\ \text{ft}^3} \times 0.09\ \text{gallon} = \text{gpa for } \textbf{LV} \text{ sprays}$$

$$\frac{\text{ft}^3\ \text{TRV}}{1{,}000\ \text{ft}^3} \times 0.70\ \text{gallon} = \text{gpa for } \textbf{HV} \text{ sprays}$$

Regardless of the spray volume finally chosen, actual performance is still governed by coverage. This should be checked using water sensitive spray indicator cards, placed in the trees at the full-leaf stage of development. Proper adjustment of the sprayer manifold is paramount. The correct procedure for this is presented in Figure 6.1.

While it is a good idea to compute the TRV for each orchard block, adjusting the sprayer for each of many such blocks is impractical. Therefore, once the calculations are complete, select two or three spray delivery volumes that will be adequate for coverage in most blocks. A variance of plus or minus 20 percent of the calculated TRV spray volume generally affords adequate coverage without being excessive. If your sprayer has “flip over” nozzles, each side may be calibrated for an approximate tree size. If enough nozzles are present to shut off the “extra nozzles” for small trees, then those remaining nozzles used for small trees alone should be recalibrated for TRV.

Pesticide Concentration Factors

Adjusting the spray volume as described above improves the overall efficiency of the spraying operation. However, major reductions in pesticide use and cost savings are not realized until pesticide concentrations are also adjusted to control dosage. Recommendations for LV TRV spraying differ substantially from those provided on most pesticide labels, because many testing procedures do not use LV sprays, and very few use TRV calculations. Most recommendations are calculated based on estimates of HV dilute spraying requirements for trees in the full-leaf stage of canopy development. In addition, most labels state application rates on an amount per acre basis. On smaller trees, this can result in a dosage rate several times greater than actually necessary for control.

Research trials using airblast sprayers to apply LV treatments in mature orchards with a spray volume adequate for coverage clearly demonstrate that concentrating pesticides more than three to four times the normal dilute concentration (pounds of the product per 100 gallons), offers no significant improvement in the control of major tree fruit pests. This rule applies to all fungicides, insecticides, and miticides commonly used in commercial tree fruit production.

Going From Conventional Recommendations To TRV

HV Sprays. Mix the pesticide at the concentration per 100 gal as recommended on the label if stated. Total spray volume per acre should be calibrated based on 0.7 gallon per 1,000 cubic feet of TRV on trees with sufficient foliage, or 0.25 to 0.35 gallon per 1,000 cubic feet of TRV on trees with little or no foliage.

LV Sprays. Most conventional spray recommendations state that the rate should be applied on an amount per acre basis, and have been calculated based on the maximum dilute spray volume required for large trees at full leaf. Traditional LV spray recommendations require the same amount of chemical be applied per acre regardless of the spray volume. This means the spray volume per acre and concentration per 100 gallons for LV spraying must be adjusted proportionately, relative to HV spraying requirements. Thus, if the volume used for an LV spray is one half, one third, or one sixth that of the estimated dilute requirement of 300 gal/A, that is 150, 100, or 50 gal/A, respectively, then the pesticide is concentrated at 2, 3, or 6 times the usual dilute rate per 100 gallons.

By comparison, the defined dosage approach for LV sprays using TRV calibration calls for pesticides to be mixed at only three to four times the normal dilute concentration per 100 gallons and then applying a defined LV gallonage per acre that is adequate for coverage (for example, 0.09 gallon per 1,000 cubic feet TRV). Thus, this approach is similar to dilute spraying, in that a fixed concentration of pesticide is prepared and the spray volume used varies with coverage requirements.

Table 6.1 Approximate Spray Volume for Coverage at the Full-Leaf Stage of Canopy Development

Approximate spray volume needed in gal/A using High-Volume (HV) dilute or Low-Volume (LV) concentrate sprays made with airblast sprayers in orchards

Tree height x width (ft^2)	Type	Spray distance between tree rows (ft)									
		16	18	20	22	24	26	28	30	32	34
80	HV	152	136								
	LV	20[b]	17[b]								
100	HV	191	169								
	LV	25	22[b]	20[1]							
150	HV	256	254	229	208	191					
	LV	37	33	29	27	25					
200	HV			305	277	254	235	218			
	LV			39	36	33	30	28			
250	HV				346	317	293	272	254	238	
	LV				45	41	38	35	33	31	
300	HV				416	381	352	327	305	286	269
	LV				53	49	45	42	39	37	35
350	HV					445	411	381	356	334	314
	LV					57	53	49	46	43	40
400	HV						469	436	407	381	359
	LV						60	56	52	49	46
450	HV							490	457	429	404
	LV							63	59	55	52
500	HV								508	476	448
	LV								65	61	58
550	HV									524	493
	LV									67	63
600	HV										538
	LV										69

[1] LV applications of less than 25 gpa are not recommended because of equipment limitations. **Notes**: 1) gal/A: nearest whole gallon amounts, based on standard dosage volumes of 0.70 gal/1,000 ft^3 TRV for HV and 0.09 gal/1,000 ft^3 TRV for LV sprays. 2) Empty cells in the table: no data because the combination of this tree size on this planting density is unlikely. 3) For early season HV sprays, the 0.70 gallon rate may result in excessive drip. A calibration volume of 0.25 to 0.35 gallons is recommended. Check for drip to ensure coverage.

LV Concentration and LV Limits

Mix pesticides at not less than three and not more than four times the standard dilute concentration per 100 gallons of water, as stated on the product label. Apply this mixture at the rate of 0.09 gallon per 1,000 cubic feet TRV. In no case is a spray volume of less than 25 gallons per acre recommended. Do not use less on a per acre basis than the label recommended amount per 100 gallons.

Examples of Conventional and TRV Rates. Use Table 6.1 as a guide for spray volumes needed for various tree sizes and spacings. Consult actual labels for use rates per 100 gal. We use an orchard planting with trees that are 12.5 ft tall with a canopy diameter of 12 ft (tree ht x width = 150 ft^2). Tree spacing is 18 ft between rows, therefore 43,560 ft^2/18 ft = 2,420 row feet per acre; 150 ft^2 x 2,420 ft = 363,000 ft^3 (TRV); 363 x .09 = 32.7 (33) gal/A. This matches the 33 gal/A rate for this spacing, found in Table 6.1. Using a 4x concentration of the recommended per 100 gal rate, the resulting TRV per acre rates will be one third (33 gal/100 gal) of the 4x rate.

Table 6.2 Comparison of Conventional vs. TRV Pesticide Rates

Chemical	Conventional Rate Amount/Acre	Conventional Rate Amount/100 gal	TRV Rate Amount/Acre
Imidan 70W	34 oz	0.75 lb	0.66 lb or 11 oz
Captan 50W	6 lb	1.5 lb	2 lb

Sprayer Calibration

The purpose of sprayer calibration is to control the pesticide dosage by delivering a known volume of spray liquid and therefore, a fixed amount of pesticide to a specified area of orchard. To do this, the sprayer travel speed in miles per hour (mph), pump discharge rate in gallons per minute (gpm), and area covered (swath = distance between tree rows in feet) must be held constant. Any change in these factors affects the application rate. The following procedures outline the basic steps for calibrating and adjusting airblast sprayers for maximum performance, and should be used in conjunction with the manufacturer's manual for your particular sprayer.

Calculate travel speed. Most tractor speedometers are geared to tachometers and are not accurate under field operating conditions. Use a stopwatch and a measured course to accurately determine the travel speed of your tractor and sprayer unit:

$$\frac{\text{feet traveled in 1 minute}}{\text{88 feet per minute}} = \text{mph}$$

Calculate pump discharge rate. Calculate the pump discharge rate (gpm) needed to deliver the correct number of gallons per acre (gpa) (based on your earlier calculation of TRV or Table 6.1) at a fixed travel speed (mph) and planting distance between rows (swath):

$$\frac{\text{gpa x swath x mph}}{495} = \text{gpm}$$

If the gpm is already known, then the gpa can be determined for various orchards and travel speeds by substituting these values in the following formula:

$$\frac{\text{gpm x 495}}{\text{swath x mph}} = \text{gpa}$$

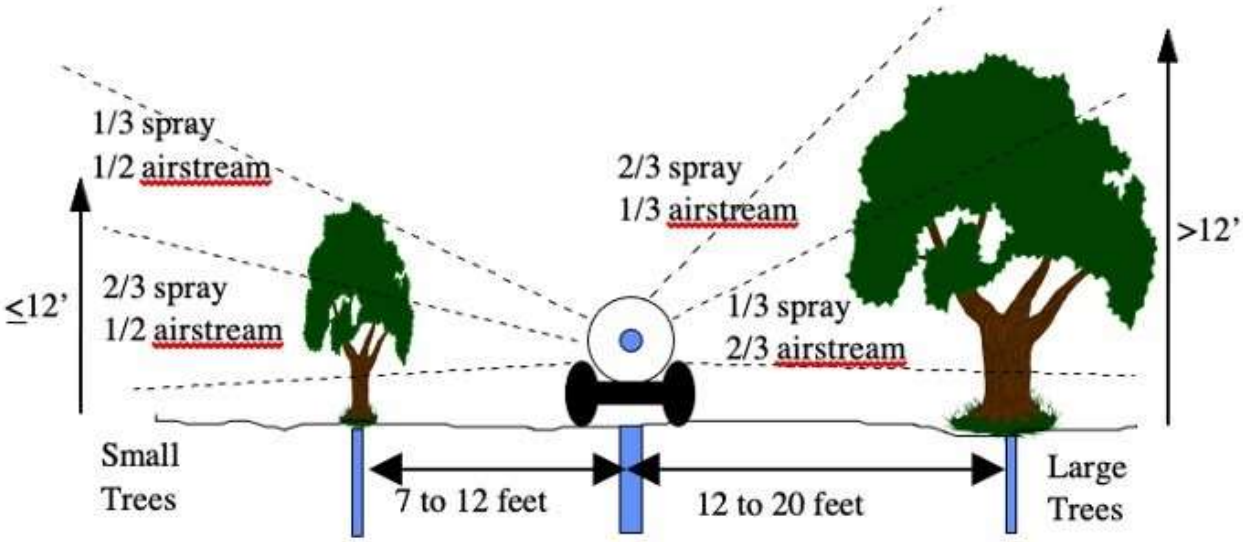
Define the Effective Airblast. The effective airblast of a sprayer is that portion of the spray stream actually involved in covering the trees. It will vary with tree size and distance between the tree and the sprayer manifold (Figure 6.1). Place the machine at the normal spraying distance from a tree of typical size and shape for the orchard, and turn off all nozzles not actually used to cover the tree. The spray stream should just overshoot the top of the tree by a couple of feet.

PESTICIDE STRATEGIES

Measure the Operating Pressure. The operating pressure for a sprayer, measured in pounds per square inch (psi), should be measured at the discharge manifold by replacing one nozzle with a reliable pressure gauge. This pressure value will be needed to select nozzles of the proper size and provide the right discharge rate.

Nozzle the Sprayer. Uniform coverage of large trees requires that two thirds of the spray volume be applied to the top one third of the tree. Figure 6.1 shows the proportions of liquid distribution for large and small trees. Note that for small trees that are less than 12 feet tall, one third of the spray volume is delivered to the top half of the tree. This arrangement is necessary to provide adequate coverage in the tops of trees without depositing excessive amounts on lower limbs. The worst possible arrangement uses the same size nozzle throughout the manifold. Refer to the sprayer manufacturer's tables on nozzle performance at various operating pressures and select the number and size of nozzles needed to obtain the right output at the selected operating pressure. When arranging the nozzles in the air stream, make sure that adjacent nozzle patterns merge before the spray stream reaches the nearest foliage of the tree canopies.

Figure 6.1 Proportional Distribution of Airblast Spray Required for Good Coverage



Test the Calibration Setup. Nozzle one side of the sprayer and determine the number of gallons delivered per minute by operating the machine for 3 to 5 minutes and then measuring the amount of water required to refill the tank to the starting level. For one side, this should be one-half the gpm discharge rate determined earlier. Differences between the desired rate and the measured rate may require only a slight pressure adjustment. Differences of more than 10 percent should be corrected by changing the size of the nozzles. Once you are satisfied with the performance of one side of the sprayer, nozzle the other side in a similar fashion and run a final check, operating the full system.

Check for Coverage. Where a major change in spraying practice is planned, conduct the calibration procedure in the late summer or fall when the setup can be tested on trees with a full complement of foliage that represents the most difficult target for coverage. Spray targets (cards, filmstrips, or water-sensitive papers) should be placed within the tree canopy to assess spray coverage. For a quick assessment of uniform spray distribution in the effective airblast and to see whether travel speed can be adjusted to improve this distribution, use water sensitive spray paper and clothespins. Clip papers to small branches in the lower, middle and top portions of the inside of the tree, then spray with water. Deposits on the paper should be reasonably uniform from top to bottom. If they are not, re-check the nozzle arrangement or the travel speed. Before putting the sprayer away, make a diagram of the sprayer manifold, noting the number, location, and size of all nozzles, and the operating pressure and travel speed used in the test. This written record will save valuable time during the spray season when the sprayer calibration may need adjustment.

Travel Speed Adjustments. The greater the distance between the sprayer and the spray target, the slower the travel speed should be. The same is true for the density of the foliar canopy. Thus, where a travel speed of 3 mph might be adequate for coverage during the prebloom period or when spraying from every row middle, operating at 2 to 2.5 mph will improve coverage when spraying from alternate row middles or when tree canopies become more dense. Spraying in the wind is not advisable but is sometimes necessary. Here again, a slower travel speed than usual is recommended to maintain coverage in the tops of trees. Under low humidity conditions, spray droplets evaporate quickly, reducing their mass and making it more difficult for them to be deposited in the tops of trees. Spraying in the early morning or late evening, when humidity levels are usually higher, can overcome this problem.

Alternate Row Middle (ARM) spraying. Complete sprays are applied to both sides of the tree as the sprayer travels each aisle in an orchard during a single spray application event with both sides of the sprayer on. Alternate row middle (ARM) sprays are applied from only one side of the tree row, or every other aisle, alternating between the odd- and even-numbered row middles with each successive spray treatment. The concentration of spray material in the tank and the sprayer delivery rate remain the same for both ARM and complete sprays. Thus, two ARM sprays equal one complete spray in terms of coverage and the amount of product used per acre. Carefully done, ARM sprays offer the advantages of reduced costs for labor, chemicals, and fuel and closer timing when conditions are critical.

ARM spraying should not be attempted in orchards where conventional spraying has not given consistent control of most pathogens and insect pests. The sprayer should be matched to the tree canopy, in that the sprayer should be able to cover 100% of the side being sprayed and about 75% of the side not being sprayed. Trees should be well pruned to allow spray droplets to penetrate into and through the tree canopy. Travel speeds should never exceed 3 mph, even under calm conditions. ARM spraying programs have been most successful when a conventional application (both sides) is made at the start of the season and then followed at regular intervals with ARM treatments. ARM spray intervals need to be shorter than where both sides of the tree are sprayed. Where conventional spraying recommendations call for sprays at 7-, 10-, or 14-day intervals, the intervals for ARM sprays should be reduced to 3-5, 7, or 10 days, respectively. Be prepared to shorten the spray interval or even to apply a complete spray (both sides) when using plant growth regulators, or when conditions are highly favorable for disease development, or when precise timing is essential. **Do not use ARM methods to apply streptomycin for fire blight control.**

6.2 Effect of pH on Pesticide Stability and Efficacy

Water pH can affect the performance of many pesticides. Some materials have a label cautioning against mixing the pesticide with alkaline materials. The reason for this caution statement is that some materials, in particular the organophosphate insecticides, undergo a chemical reaction known as alkaline hydrolysis. This reaction occurs when the pesticide is mixed with alkaline water, that is, water with a pH greater than 7. The more alkaline the water, the greater the breakdown. In addition to lime sulfur, several other materials provide alkaline conditions: caustic soda, caustic potash, soda ash, magnesia or dolomitic limestone and liquid ammonia.

Manufacturers may provide information on the rate at which their products hydrolyze. This rate is expressed as **half-life**, meaning the time it takes for 50 percent hydrolysis or breakdown to occur. Since a number of chemicals break down quickly under high pH and others under low pH, growers should have their water supply tested to determine its pH. If the pH is above 7, growers may wish to add a nutrient buffer to the spray tank. Trade names of commonly used buffers are: Buffer-X, Mix-Aid, Nutrient Buffer Spray, Spray-Aide, Sorba-Spray and Unite. However the water pH should not be adjusted in all cases. For example, fixed copper fungicides, coppers applied as a Bordeaux mixture, copper oxide, basic copper sulfate, and copper hydroxides should not be acidified. Table 6.3 lists the water pH sensitivity for a number of pesticides (adapted from Agri-Food Canada and the B.C. Ministry of Agriculture).

Table 6.3 Optimum pH and Half-Life at Different pH Values for Selected Pesticides

	Product	Optimum pH	Half Life (=time for 50% hydrolysis or breakdown) at different pH values
Insecticides	**Acramite**	<7	pH 9 (2 h), pH 7 (20 h), pH 5 (5.5 d)
	Actara	4	pH 4 (16 wk), pH 7 (5 wk)
	Admire	7.5	pH 5 to 9 (more than 31 d)
	Agri-Mek	6 - 7	pH 4 to 7.5 (stable)
	Apollo	6 - 7	pH 5 (10 d), pH 7 (34 h), pH 9.2 (4.8 h)
	Assail	5 - 6	below pH 4 and above pH 7 (unstable)
	Avaunt		pH 5 to 10 (stable for 3 d)
	Carzol	5	Not stable in alkaline water; use within 4 h of mixing.
	Dipel	6	pH above 8 (unstable)
	Entrust/Success	7	pH 6 to 9 (stable)
	Envidor	5 - 7	pH 4 (63 d), pH 7 (31 d), pH 9 (5 d)
	GF-120 NF	7	pH 6 to 9 (stable)
	Imidan	5	pH 8 (4 h), pH 7 (< 12 h), pH 5 (7 d)
	Lannate	6-7	pH 9.1 (loses 5 percent effectiveness in 6 h)
	Malathion	5	pH 9 (5 h), pH 8 (19 h), pH 8 (3 d), pH 6 (8 d)
	Nexter	-	pH 4 to 9 (stable)
	Rimon	5 - 7	pH 9 (100 d)
	Sevin XLR	7	pH 9 (24 h), pH 8 (2 to 3 d), pH 7 (24 d), pH 6 (100 d)
Fungicides	**Aliette**	4	pH 4.0 to 8.0 (stable)
	Bravo 500	6 - 7	Stable over a wide range of pH, pH 9 (38 d)
	Captan	5	pH 8 (10 min), pH 7 (8 h), pH 4 (32 h)
	Dithane	6	Most stable at pH 5.5 to 6
	Elevate	5.5 – 6.5	-
	Ridomil	5 - 7	pH 9 (88 d)
	Rovral		pH 7 (1 to 7 d), pH 9 (< 1 h)

6.3 Protecting Pollinators

Insecticides applied at bloom can be toxic to pollinators, including honey bees and wild bees. Due to concerns regarding pollinator health, the EPA has issued a “Pollinator Protection Box” on some labels, containing language in the Directions for Use section of each label that will highlight measures necessary to protect pollinators. This labeling is required on products containing the active ingredients clothianidin, dinotefuran, imidacloprid and thiamethoxam. Many other insecticides also have label statements about bee toxicity. Bees will forage on all flowers found within the farm. Managing row middles by removing wild flowering plants (such as dandelion and clover) will reduce bee mortality. This can be helped by maintaining pure turf aisles and using a mix of 2,4-D and clopyralid (Stinger, Spur and other generics). Be aware that not all generic formulations of clopyralid are labeled for both stone and pome fruit.

Do not apply any insecticides during bloom, unless they are completely non-toxic to bees, and avoid applications of all pesticides during active foraging by pollinators. Recent data show that combinations of DMI FRAC group 3 (DMI fungicides including: Indar, Rally, Orbit, Bumper, Quash, Procure and Vintage) and neonicotinoid insecticides (IRAC code 4 including: Assail, Actara, Admire Pro, Belay, Calypso, Scorpion, Venom, including combinations and generics) cause increased bee mortality. Furthermore, DMI fungicide applications are not recommended during bloom for resistance management. Other recent research continues to show that certain combinations of fungicides mixed with insecticides increases the toxicity of those insecticides to both adult and larval forms of honey bees and some wild bees. In some cases the fungicides by themselves or in combination with other fungicides have shown negative impacts on pollinators. Fruit pesticides that are either moderately or highly toxic to bees are listed in Table 6.4.

For more information on the protection of pollinators and the **New Jersey Beekeeper Notification Regulations** consult the section Protection of Pollinators in the Pesticide Safety chapter.

Table 6.4 Fruit Pesticides Shown to Have Moderate to High Toxicity Effects on Bees

(note: some products may not be labeled for tree fruit use)

	Active Ingredient	Trade Name	Chemical Group	MOA Class	Toxicity Risk[1]
Insecticides & Miticides	acetamiprid	Assail	Neonicotinoid	4A	Moderate
	avermectin/abamectin	Agri-Mek, Avid	Avermectin	6	High
	azadirachtin	Aza-Direct, Neemix	Unknown	UN	Moderate
	bifenazate	Acramite	Unknown	UN	Moderate
	bifenthrin	Brigade, Capture	Pyrethroid	3A	High
	carbaryl	Carbaryl, Sevin	Carbamate	1A	High
	chlorpyrifos	Lorsban	Organophosphate	1B	High
	Chromobacterium subtsugae	Grandevo	Biological	UN	High
	clothianidin	Belay	Neonicotinoid	4A	High
	cyantraniliprole	Exirel	Diamide	28	High
	cyfluthrin	Baythroid	Pyrethroid	3A	High
	cyfluthrin + imidacloprid	Leverage	Pyrethroid + Neonicotinoid	3A, 4A	High
	deltamethrin	Delta Gold	Pyrethroid	3A	High
	diazinon	Diazinon	Organophosphate	1B	High
	dinotefuran	Venom, Scorpion	Neonicotinoid	4A	High
	esfenvalerate	Asana	Pyrethroid	3A	High
	fenpropathrin	Danitol	Pyrethroid	3A	High
	gamma-cyhalothrin	Proaxis	Pyrethroid	3A	High
	imidacloprid	Admire	Neonicotinoid	4A	High
	indoxacarb	Avaunt	Channel blocker	22A	High
	lambda-cyhalothrin	Warrior	Pyrethroid	3A	High
	lambda-cyhalothrin + chlorantraniliprole	Besiege	Pyrethroid + Diamide	3A + 28	High
	malathion	Malathion	Organophosphate	1B	High
	methomyl	Lannate	Carbamate	1A	High
	novaluron	Rimon	Benzoylurea	15	Moderate
	oxamyl	Vydate	Carbamate	1A	High
	permethrin	Ambush, Perm-Up	Pyrethroid	3A	High
	phosmet	Imidan	Organophosphate	1B	High
	pyrethrum + piperonyl butoxide	Evergreen, Crop Protection EC	Pyrethrin	3A	High
	pyrethrum	Pyganic, Evergreen	Pyrethrin	3A	High
	pyridaben	Nexter	METI	21A	High
	spinetoram	Delegate	Spinosyn	5	High
	spinosad	Entrust	Spinosyn	5	High
	thiamethoxam	Actara, Platinum	Neonicotinoid	4A	High
	thiamethoxam + chlorantraniliprole	Voliam Flexi	Neonicotinoid + Diamide	4A + 28	High
	tolfenpyrad	Apta	METI	21A	High
	zeta-cypermethrin	Mustang Maxx	Pyrethroid	3A	High
Fungicides	captan	Captan	Phthalimide	M4	Moderate
	dicloran	Botran	Aromatic hydrocarbon	14	High
	fenarimol	Vintage	DMI	3	Moderate
	hydrogen dioxide	Oxidate	Unclassified	NA	High

[1] Adapted from Michigan State University. Minimizing Pesticide Risk to Bees in Fruit Crops, and recent research data.

6.4 Making the Most of Your Pesticide Dollar

Pesticides can consume a large part of the production budget. There are several things one can do to stabilize or reduce insecticide costs. First, use an IPM program. Treat only when needed, and use the minimum amounts of pesticide required to do the job.

This guide summarizes pesticide products and rates to be used for various pests throughout the season. There are times though, when there are several insect or mite pests present at the same time. These **"mini pest complexes"** are often challenging to manage. Minimizing the number of products and rates used at these times will help reduce potential costs while addressing pest control needs. This issue is addressed in the following paragraphs.

Peaches/Nectarines - Prebloom to Petal-Fall

Aphids and catfacing insects. The first insect activity of any major economic significance usually occurs at petal-fall. Green peach aphids may start emerging at pink, and catfacing insects may start feeding at about the same time. Catfacing insects (tarnished plant bugs and stink bugs) cannot feed and cause physical injury to the fruit until after petal-fall. Previous to that stage, they may cause only a minor amount of thinning. Therefore, the first peach insecticides should be applied at petal-fall, targeted primarily for catfacing insects and possibly for green peach aphids if they are present.

Thrips and Other Petal-Fall to Shuck Split/Shuck Fall Materials. If the orchard has a history of thrips injury or the planting contains nectarines, then treatment for thrips is advisable. Lannate or Delegate will control this insect. Lannate can be used if green peach aphid control is also desired. Delegate is not effective on aphids, but is effective on OFM. If this treatment drags into late petal-fall to the shuck-split period, then Oriental fruit moth (OFM) is also a target, and Plum Curculio at petal-fall. Lannate is not the best material for OFM or PC. The diamides and premixes containing diamide insecticides – Altacor, Voliam Flexi, Besiege, Exirel, MinectoPro, and Verdepryn are all very effective for OFM. Some of these are also effective for PC such as Besiege, Exirel, MinectoPro and Verdepryn. Avaunt is an excellent material for PC if this is a problem. While growers may be tempted to use synthetic pyrethroids early in the season, these may lead to a mite build-up, and should be avoided until later in the season.

Mites. Available materials include Acramite, Apollo, Envidor, Kanemite (registered on cherries but not peaches or nectarines), Onager/Savey, Nealta, Nexter, Portal, Vendex, and Zeal. While most of these are miticides only, Nexter and Portal will also suppress a few other insect species, but none that are key pests in peaches. Envidor, Apollo and Savey/Onager should be used early in the season on immature mites. Savey and Onager are the same active ingredient, so do not rotate them with each other. Try to limit miticide use to one application per material class per season.

Peaches/Nectarines and Pyrethroids

Because of increased insecticide costs, pyrethroids have seen increased use during the past few years. These materials include Ambush/Pounce/Perm-Up (permethrin), Asana (esfenvalerate), Baythroid (cyfluthrin), Danitol (fenpropathrin), Mustang, Proaxis, and Warrior II/Lambda-Cy (lambda-cyhalothrin), as well as several premixes. In general, these materials have a broad spectrum activity, and are comparatively less costly than other insecticides. However, because they kill a wide range of insects, they often kill beneficial predators and parasites. This can lead to increases in other pest populations such as European red mite or San Jose scale populations. Therefore, allowances should be made for these possibilities when planning a pyrethroid program. If using pyrethroids, it is best to limit their use to late in the season. This timing may also coincide with a more intensive management program needed for brown marmorated stink bug (BMSB). Dormant or delayed dormant oil use should be automatic if pyrethroids are used. Finally, if mites were a severe problem the previous year, early season miticides should be added to the program. Do not overuse these materials, since overuse can encourage the selection of resistant pest strains.

Border Spray Applications

Brown Marmorated Stink Bug is an invasive stink bug that is primarily a mid-late season pest of apples. Feeding by BMSB can result in corked or dimpled fruit at harvest . Pressure is highest from the second generation beginning in mid-July. Adult and nymphs can be monitored with clear sticky traps (available from Trece Inc.) on 4' wooden stakes and baited with an aggregation pheromone. Traps should be placed on the perimeter of the orchard. We do not have a trap based threshold for BMSB in peaches yet but they will provide an indication of activity. A full block spray followed by weekly border-based sprays have been effective in peaches in the Mid-Atlantic region and significantly reduce insecticide use. Borders of the crop have the highest injury and bugs can be observed migrating in from neighboring woodlots, wheat, or other crops but peach is a highly attractive crop to BMSB. Insecticide effectiveness against BMSB is listed in Table 6.5.

In recent years we have shown that growers can successfully manage BMSB in peaches and apples through the use of border sprays. This integrates sod management in row middles to remove clover by applying clopyralid/Stinger and 2,4-D along with mating disruption for Oriental Fruit Moth with Isomate-OFM TT (Isomate OFM/CM TT for codling moth and OFM control in apples). Border spray applications begin for BMSB around the last week in May. Borders are defined as peach or apple trees on the border plus the first full row and treated on a 7 day interval. Any surrounding hedgerow was not treated with insecticide, as this is not a practice we recommend. Research has shown that catfacing injury at harvest was equal or lower than comparison blocks using alternate row middle applications (ARM). These practices (IPM- CPR) successfully controlled the target pests and used significantly less active ingredient per acre than conventional practices including ARM sprays. This practice also functions as a resistance management practice for multiple insect pests and likely decreases secondary pest outbreaks, like San Jose scale. We suspect that there is also increased activity of natural enemies in the border-treated blocks.

Apple - Dormant to Prebloom & Petal-Fall

Aphids (Rosy, Apple, Spirea), leafminers and leafhoppers, plum curculio, Oriental fruit moth (OFM), leafrollers and other Lepidoptera. Aphids start hatching at 1/4" green. Spotted tentiform leafminers (STLM) emerge at about the same time, and lay eggs during tight cluster through bloom. White apple leafhopper (WALH) eggs start hatching at petal-fall. Conventional prebloom treatments used to include Lorsban 4E at 1/2" green primarily for rosy aphid control, Vydate at pink for STLM, followed by an OP at petal-fall for WALH and other pests.

New insecticides may not have as broad a spectrum as some older materials, but are much more effective for individual types of insects. For example, several new neonicotinoids or neonicotine compounds have good activity against aphids and other sucking insects, while the newer generation materials have an expanded activity range.

Admire, a first generation neonicotine, has excellent activity against certain sucking insects. It is labeled for aphids, leafhoppers and leafminers. Other neonicotinoids like Actara, Assail, Belay have a broader spectrum of control, but are all effective for aphids and leafhoppers. Other newer chemistries like Sivanto and Closer are also good aphid materials. Closer and some of the neonicotinoids will also control scale crawlers. An OP insecticide like Imidan may be required at petal-fall for plum curculio and leafrollers Avaunt is primarily a PC material, but also has activity on codling moth, leafrollers, European apple sawfly, OFM and leafhoppers . Delegate is an excellent material for codling moth, OFM and leafrollers. The premixes can have very broad spectrums of activity, but some have pyrethroids in the mix, which can be toxic to beneficials.

Synthetic pyrethroids: Asana, Ambush, Declare, Pounce, Baythroid, Danitol, Lambda-Cy, Mustang/ Mustang-Maxx/ Renounce, Proaxis, Tombstone, and Warrior, may be used for prebloom leafminer and leafroller control, and also to control aphids. Aphid control is limited, and not as good as if using a neonicotinoid, Closer, Sivanto, Movento, Bexar or other related materials and premixes designed for sucking insects (see Table 10.12 Efficacy of Selected Apple Insecticides and Acaricides). Early season post bloom applications of pyrethroids are discouraged, since they kill predators and parasitoids, and therefore contribute to increased mite and scale populations. Although Danitol will also kill predators, it can suppress mite populations.

The best petal-fall materials for leafminers include any of the neonicotinoids listed above plus any compound containing avermectin like Agrimek. Most of these materials also control leafhoppers, although this is not usually a recommended target at petal fall. Recent research has demonstrated that treatments for WALH are not needed

unless the population exceeds 3 nymphs per leaf. Since this only happens occasionally, petal-fall spray programs should no longer revolve around leafhopper control. It is more economical to control the key pests and leave leafhoppers for later in the season or until a treatment threshold is reached. If you were planning to use an Imidan plus a leafhopper material, then consider dropping the leafhopper material, and using the Imidan alone.

If aphids and leafminers are not an issue at petal-fall, then Avaunt may be used for leafrollers, OFM, plum curculio, leafhopper, and plant bugs. No OP insecticide is needed in this case, unless sawflies are also an issue. Premixes that also provide sucking insect control may also function as the main insecticide at petal-fall. Several of these like Voliam -Flexi, and Besiege are diamide based products so provide excellent control of leafrollers and other 'worms'.

Apple - Early Season Post Bloom

Codling moth, plum curculio, tufted apple budmoth, and other leafrollers. Plum curculio (PC) management in NJ typically requires weekly sprays for 3-4 weeks beginning at petal-fall. In apples, management is needed through approximately 300 DD50 after petal-fall. Materials that cover PC and other key pests encountered at this time include Avaunt, Imidan, Endigo and Voliam Flexi. Proper timing for the first codling moth treatment needs a strong CM material like repeated use of Madex HP, or diamide product (Altacor, Besiege, Voliam-Flexi, Verdepryn, Exirel) or Delegate. Imidan can still work, as do some pyrethroids. Madex HP and CydX are codling moth virus that are specific for codling moth, applied at degree-day timing for egg hatch and then again 5 days later. Because of their specificity, they are safe against natural enemies and pollinators.

Apple - Mid and Late Season

STLM, aphids and leafhoppers (rose leafhopper, potato leafhopper) and leafrollers (TABM). If second generation treatment for STLM is needed, consider that most of the same materials that control leafminers (STLM) also control aphids and leafhoppers, but some materials like Closer or some pyrethroids like Mustang do not control leafminers. Lannate may also be used for tufted apple budmoth where it is a problem. However, Delegate and Intrepid are more effective for TABM. Intrepid is also effective for leafminer control (at a slightly higher rate), as long as it is used during peak egg hatch. When used for TABM control, Intrepid can be used for both, as long as it is timed for egg hatch of both pests. Rimon is also very effective for leafrollers (and codling moth), and will also control leafminers at this time. As with other pests, Rimon must be applied at egg hatch, which is usually during the peak adult flight for STLM, or when young sap feeders are starting to appear on the undersides of the leaves.

Mites. Available materials include Acramite, Apollo, Envidor, Kanemite, Onager/Savey, Portal, Nealta, Nexter, Vendex, and Zeal. Nexter, Fujimite and Kanemite block cellular respiration and have similar modes of action. Therefore, all 3 materials should be treated as a group, and not be rotated with each other in the same season. Onager/Savey, Apollo, Envidor and Zeal are meant for young populations are best used early when mites first start to build. Make sure to use only 1 application of a specific miticide during the season and rotate with another chemical class. Treat Onager/Savey, Apollo and Zeal as one class since they have a related mode of action, although Zeal is slightly different.

Brown Marmorated Stink Bug (BMSB) is an invasive stink bug that is primarily a mid-late season pest of apples. Feeding by BMSB can result in corked or dimpled fruit at harvest . Pressure is highest from the second generation beginning in mid-July. Adult and nymphs can be monitored with clear sticky traps (available from Trece Inc.) on 4' wooden stakes and baited with an aggregation pheromone. Traps should be placed on the perimeter of the orchard. In apples, a cumulative threshold of 4-10 adult BMSB is used to trigger insecticide management. A full block spray followed by weekly border-based sprays have been effective in apples in the Mid-Atlantic region and significantly reduce insecticide use. Beginning around Labor Day populations in apples will be highest through the first frost. This is especially true in plots along wood lines. Borders of the crop have the highest injury and bugs can be observed migrating in from soybeans or peaches after they are no longer attractive. Insecticide effectiveness against BMSB is listed in Table 6.5.

Table 6.5 Efficacy and Use of Insecticides to Control Brown Marmorated Stink Bug

	PEACH & NECTARINES					POME FRUIT					
Product Name	**BMSB Rating**	**Rate**	**Seasonal No. apps or material**	**PHI**	**Interval (days)**	**Rate**	**Seasonal No. apps or material**	**PHI**	**Interval (days)**	**IRAC**	**Class**
Actara [1]	+++	5.5oz	11.0 oz	14	7	5.5oz	16.5 oz	35 [1]	10	4A	Neonicotinoid
Perm-up [2]	+++	10.0 oz	3	14	10	N/A	N/A	N/A	N/A	3A	Pyrethroid
Asana	++	14.5 oz	5	14	N/A	14.5 oz	7	21	N/A	3A	Pyrethroid
Assail 30 SG	+++	8 oz	4	7	10	8 oz	4	7	12	4A	Neonicotinoid
Azera	++	16.0-56.0 oz	10	0	3	16.0-56.0 oz	10	0	3		Pyrethrin + Neem extract
Baythroid XL	+++	2.4 fl oz	5.6 fl oz	7	14	2.4 fl oz	2.8 fl oz	7	14	3A	Pyrethroid
Belay	++++	6.0 fl oz	2	21	10	6.0 fl oz	12.0 fl oz	7	14	4A	Neonicotinoid
Besiege	+++	12.0 oz	31.0 oz	14	7	12.0 oz	31.0 oz	21	10	3A +28	Pyrethroid + Diamide
Bifenture Brigade Capture *(SECTION 18 required)*	++++	12.8 oz	28.8 oz after PF, season total 32.0 oz	14	30	12.8 oz	28.8 oz after PF, season total 32.0 oz	14	30	3A	*Pyrethroid*
Danitol	+++	21.3 oz	2	3	10	21.3 oz	2	14	10	3A	Pyrethroid
Dimate	+++	1.0 lb	1	28	N/A	1.0 lb	1	28	N/A	1B	Organophosphate
Endigo ZC	++++	5.5 oz	19.0 oz	14	7	6.0 oz	28.0 oz	35	10	3A	Pyrethroid
Lambda-Cy	++	5.12 oz	25.6 oz 20.48 oz postbloom	14	5	5.12 oz	25.6 oz 20.48 oz postbloom	21	5	3A	Pyrethroid
Lannate SP	++	1.0 lb	6	4 [3]	7	1.0 lb	5	14	7	1A	Carbamate
Leverage 360	+++	4.4	10.2 oz	7	14	4.4 oz	5.1 oz	7	14	4A +3A	Neonicotinoid + Pyrethroid
M-Pede	++	2% v/v	3 sequen-tial apps		7	2% v/v	3 sequen-tial apps		7		Potassium salt
Mustang Max	+++	4.0 oz	24.0 oz	14	7	4.0 oz	24.0 oz	14	7	3A	Pyrethroid
Pyganic 1.4 EC	++	16.0 oz	N/A	0.5	N/A	16.0 oz	N/A	0.5	N/A		Pyrethrin
Scorpion	+++	7.0 oz	10.5 oz	3	7	N/A	N/A	N/A	N/A	4A	Neonicotinoid
Surround	++	25.0-50.0 lb	N/A	1	7	25.0-50.0 lb	N/A	1	7		Particle film
Venom	+++	4.0 oz	8.0 oz	3	7	N/A	N/A	N/A	N/A	4A	Neonicotinoid
Voliam Flexi	+++	7.0 oz	14.0 oz	14	10	7.0 oz	16.0 oz	35	10	4A +28	Neonicotinoid + Diamide
Warrior II	+++	2.56 oz	12.8 oz, 10.24 oz postbloom	14	5	2.56 oz	12.8 oz, 10.24 oz postbloom	21	5	3A	Pyrethroid

[1] If used at ≤2.75 oz, PHI is 14 days in pome fruit. [2] Not allowable after petal-fall in pome fruit. We do not recommend applications for BMSB prior to petal-fall in apples. [3] PHI in nectarines is 1 day.

Note: The amount allowable in premixed products holds true for the single compound as well. For example, Actara (thiamethoxam) is limited to 11.0 oz (0.172 lb a.i.) per season. If using another product, such as Voliam Flexi or Endigo that also contains thiamethoxam, the seasonal limit applies to the use of this material as well.

7 Peaches and Nectarines

7.1 Peaches and Nectarines Cultivars

A comparison chart of peaches and nectarine cultivars, listed by ripening date in southern New Jersey, is provided in Table 7.1.

Table 7.1 Comparison Chart of Peaches and Nectarine Cultivars

Abbreviations: RH=Redhaven, (W) = White-Flesh, (WF) = White Fleshed Flat Peach, (YF) = Yellow-Fleshed Flat Peach.

Ripening Date in Southern NJ	Best Peach Cultivars	Best Nectarine Cultivars	Promising Peach Cultivars for Trial	Promising Nectarine Cultivars
June 25 to July 5 - 22 to 32 days before RH	Desiree NJ 350, Flamin' Fury PF5B, Spring Prince, Sugar May (W), Sunbrite Spring Snow (W)	Mayfire	Carored Manon (W), Flamin' Fury PF 5Big, Queencrest, Rich May , Sugar May (W)	Westbrook
July 6 to 12 - 15 to 21 days before RH	Harrow Dawn, Ruby Prince, Sentry	ArcticStar (W)	Early Star, Scarlet Pearl (W)	Jade (W)
July 13 to 19 - 8 to 14 days before RH	Flamin' Fury PF7, Glenglo, Ruby Prince Sentry, Summer Serenade	Arctic Glo (W), Arctic Sweet (W), Easternglo, Honeyblaze	Flamin' Fury PF8 Ball, Galaxy (FW), NJ F 18 (FY), Snowbrite (W), Vulcan	Arrington Silver Gem (W)
July 20 to 26 - 1 to 7 days before RH	Arctic Sweet (W), Flamin' Fury PF11, Flavorcrest, Gala, Saturn (W)	Flamin' Fury PF11, Harblaze	Country Sweet, NJF 15 (FY), Raritan Rose (W), SnowBrite (W), Vinegold, While Cloud (W)	Brigantine, Honeykist, Silverglo (W)
July 27 to August 3 +1 to 7 days after RH	Early Loring, Flamin' Fury PF 15A, Flamin' Fury PF Lucky 13, John Boy, Redhaven Redstar, Starfire, White Lady (W)	Harflame, Summer Beaut	Blaze Prince, Blazing Star, Evelynn, Felicia, Flamin' Fury PF 9A-007, Salem, Snow Beauty (W), TangOs NJF 16 (FY)	Bradley
August 4 to 10 + 8 to 14 days after RH	Bounty , Coralstar, Flamin' Fury PF17, Harrow Beauty, July Prince, Klondike (W), Loring	Arctic Jay (W), Flavortop, Sunglo	Anna Rose (W), Carolina Belle (W), Flamin' Fury PF19-007, Flavrburst, Harrow Fair, Scarlet Prince, TangOsll NJ F17 (FW)	Emeraude (W)
August 11 to 18 + 15 to 22 days after RH	Allstar, Contender, Flamin' Fury PF23, Flamin' Fury PF24-007, Glowing Star	Redgold	Blushingstar (W), Flamin' Fury PF 22-007, Glowingstar, Redkist, Sweet N Up	Arctic Belle (W), Honey Royale
August 19 to 26 + 23 to 30 days after RH	Cresthaven, Flamin' Fury PF Lucky 24B, Flamin' Fury PF25, Gloria NJ 351, Messina NJ 352	Fantasia	Benedicte (W), Early August Prince, Opale (W), Sugar Giant (W), Sweet Breeze	Arctic Gold (W)
August 27 to September 3 + 31 to 35 days after RH	Fayette, Flamin' Fury PF27A, Flamin' Fury PF28-007, Jerseyqueen, Redskin		August Prince, Lady Nancy (W), Selena, Summerfest, Tiana	Stark Ovation, Zephyr (W)

Table 7.1 Comparison Chart of Peaches and Nectarine Cultivars - continued on next page

Table 7.1 Comparison Chart of Peaches and Nectarine Cultivars - continued

Ripening Date in Southern NJ	Best Peach Cultivars	Best Nectarine Cultivars	Promising Peach Cultivars for Trial	Promising Nectarine Cultivars
September 3 to September 10 + 36 to 43 days after RH	Flameprince, Laurol, Flamin' Fury PF35-007 Fat Lady		Autumn Star, September Rose (W), Snow Giant (W), Yukon King (W)	Arctic Pride (W)
September 10 and later, 44 days or later after RH	Victoria NJ 353		Big Red (CVN #3)	

7.2 Peaches and Nectarines Rootstocks

Seedlings of 'Bailey', 'Halford' and 'Lovell' are available from many nurseries and are planted by commercial orchardists in New Jersey. Self-pollinated seedlings of 'Lovell' are susceptible to peach-tree borers, mice, oak root fungus, Phytophthora root and collar rot, crown gall, and root knot and lesion nematodes. Peach and nectarine cultivars have excellent compatibility with these seedlings. Trees on self-pollinated 'Lovell' seedlings grow well on all well-drained soils with good anchorage.

Self-pollinated seedlings of 'Halford' have characteristics similar to those of Lovell. Trees perform similarly to those on 'Lovell' seedlings.

Most nurseries procure 'Lovell' seeds from self-pollinated orchard blocks. 'Halford' is often procured by commercial nurseries from western canneries that extract seeds from fruit collected in cross-pollinated orchards. The performance of seedlings from cross-pollinated 'Halford' or 'Lovell' trees will vary from seedlings collected from seed in self-pollinated blocks. 'Bailey', 'Tennessee Natural' and 'Guardian' seedlings are available from some nurseries. Experience with these rootstocks in other peach-producing areas has been good. 'Bailey' was found in Iowa and has done well in commercial plantings in the Upper Midwestern United States and in Ontario, Canada because of its superior hardiness. Trees on 'Bailey' seedlings have performed well in New Jersey and are similar to 'Lovell' in vigor. 'Tennessee Natural' was found as a wild seedling in the mountains of Tennessee, selected and indexed for viruses. 'Tennessee Natural' selections were used as rootstocks for many peach orchards in the eastern United States during the last century. A seed orchard of 'Tennessee Natural' has been established and is being sold by one nursery in Pennsylvania.

The USDA in Byron, Georgia and Clemson University in Clemson, South Carolina have released the seedling rootstock 'Guardian', which is planted in many orchards in New Jersey. 'Guardian' produces a vigorous tree with most cultivars and is more tolerant of peach tree short life in southern U.S. test plantings. 'Guardian' has also produced well in growers' plantings in southern New Jersey.

7.3 Thinning and Harvest Mangement

Blossom Thinning

The removal of blossoms, either by chemicals or by hand, during bloom is very effective in increasing fruit size. The procedure is costly, but can result in as much as 0.25 inch increase in size by the time of normal hand thinning. Blossoms can be removed by hand, with brushes or chemicals, or by the use of tractor mounted hanging ropes and straps. Blossom thinning is expensive, and the risk of crop loss is increased because thinning is done during the season when the occurrence of freezing temperatures is common.

Hand Thinning

The greatest benefit of early fruit thinning is an increase in fruit size. Hand thinning should proceed at bloom, or as soon after bloom as possible. It is common to see padded bats used to dislodge fruit. Bat thinning can lighten

crop load after the fruit has set, and is often followed by hand thinning to provide the best results. Hand thinning is preferred since it offers greater control and less limb damage.

A good rule for most cultivars is to space fruit 6 to 8 inches apart. The amount of fruit left on the tree is the key to thinning, not the amount of fruit removed. A mature tree can usually produce 4.0 to 6.0 bushels of large fruit. A bushel of 2.5 inch peaches contains about 150 fruits. Therefore, the average tree can carry 600 to 900 peaches. Count a few limbs as the thinning proceeds, to get an estimate of the job being done.

Mechanical Thinning

The first and most important means of fruit thinning is pruning. Pruning can adjust crop load and increase fruit size. Retaining fewer shoots during spring, and selection of quality shoots can reduce thinning time and increase fruit size. Most years, it is harder to remove fruit from the tree than it is to grow new fruiting wood. Pruning dramatically reduces blossoms as well as encourages the development of new growth that will be next year's flower buds. It is more economical to handle entire fruiting limbs than it is to thin individual fruit.

Portable hydraulic or pneumatic limb shakers are available, which operate at about 1,000 strokes/minute, and will do a satisfactory thinning job because many limbs are thinned independently. Some hand thinning must follow mechanical shaking if the job is to be complete. Prune to remove willowy fruiting branches that do not transmit shaker vibrations. These practices reduce hand thinning and improve fruit size.

Chemical Thinning

A number of materials have been tried on peaches as blossom thinners, but there are currently no plant growth regulators (PGRs) labeled for this use. Those materials that have been used in the past work by burning off the pollen, anthers or stigmas in the flowers, causing blossom thinning. These materials have included the use of the fertilizer/foliar nutrient, ammonium thiosulfate (ATS). While some growers have successfully used ATS for blossom thinning, results are often irregular and my result in overthinning. Mechanical blossom thinning with string or rope thinning has been proven to be more reliable (Table 7.2).

Table 7.2 Peach Chemical Thinning

Spray Timing	Chemical Name	Trade Name	Rate
Spray 1: 30%, Bloom Spray 2: 90% Bloom	Ammonium Thiosulfate	ATS (foliar nutrient)	4-6 qt/100 gal and 100 gal per acre
Ammonium Thiosulfate is a fertilizer often used for peach blossom thinning. Because **it is phytotoxic** by nature, it can over-thin under certain slow drying weather conditions, and at high rates.			

Harvest Management

Retain has been recently labeled for stone fruit use. In some cases on some varieties, it has been shown to reduce the rate of fruit drop, prolong harvest and increase fruit firmness and size. **Results have been irregular, and it is not commonly used in New Jersey** (Table 7.3).

Table 7.3 Peach Harvest Management

Spray Timing[1]	Chemical Name	Trade Name	Rate
One to two weeks prior to anticipated harvest	Aminoethoxyvinylglycine Hydrochloride	ReTain®[2,3]	One pouch per acre, generally 100 gal per acre.

[1]Timing is dependent on cultivar. [2]Use with a 100% organosilicone surfactant at a final concentration of 0.05 to 0.1% (v/v). [3]Note Retain® is labeled on other stone fruit including apricot, and plums.

7.4 Peach Winter Injury

Injury as a result of cold temperature is common in most orchards. There are three general types of injury to consider:

1. Late-fall cold temperatures.

Since trees harden-off from the twig tips to the trunk, a cold period before the trees become dormant is likely to cause injury to the trunk of the tree. This type of injury is most severe in trees that are growing vigorously late in the summer and fall. Orchard practices that assist the trees in hardening-off properly, such as avoiding late season fertilization and cultivation, and permitting cover crop growth, can control this type of injury.

2. Winter cold temperatures.

The exact temperatures at which damage occurs to dormant trees depend on many factors, including tree vigor, variety, and age. Generally, a temperature of -10°F is sufficient to injure and kill fruit buds. Temperatures colder than -10°F usually injure or kill cambium and bark tissues. This type of injury is somewhat reduced if low areas and areas exposed to north winds are avoided. Cultivars are tested in New Jersey for tolerance to this problem.

3. South-West Injury.

This is by far the most common type of injury. The injury is caused by water and sap movement in the cambium, when bark tissue is warmed by the sun. A sudden drop in temperature results in freeze injury to this tissue. Injury occurs most frequently to the trunk area, but major scaffold limbs are also frequently injured. Although the injury is most prevalent on the southwest side of the trees, all sides can be injured. Death of the trees from this type of injury is most prevalent in 4- to 6-year-old trees, but 2- and 3-year-old-trees are frequently injured, and a decline in vigor usually occurs. Such damage can occur any time after the rest period is completed (January). Treating the trunks with reflective material can control injury from fluctuating temperatures. Use inexpensive interior white latex with low acrylic content. It should be mixed with at least 50% water to form a white wash. This treatment should be used on all peach trees 2- to 8-years-old. For best results, all sides of the trunk should receive the reflective material. During many winters, treatment of the southwest side of the tree is sufficient.

7.5 Integrated Pest Management (IPM)

7.5.1 Mating Disruption Technology for Key Insect Pests in Peaches

Oriental Fruit Moth (OFM)

Pheromone mediated mating disruption

Pheromone mediated mating disruption is a method to control insect populations by preventing mating and reproduction. Because the immature worm or larva is the stage that damages fruit, prevention of this stage is the goal in any pest management program. Mating disruption uses the same pheromones, or sex attractants, that are used in pheromone traps for monitoring purposes. For mating disruption, pheromones are placed in special longterm release dispensers. Pheromone dispensers are placed throughout the orchard in a manner which ‘saturates‘ the orchard with the pheromone ‘scent.‘ Male insects normally cue in on a plume of pheromone scent emitted by an unmated female. By saturating an area with a synthetic female pheromone, males are prevented from locating the females thus mating is delayed or never takes place.

Use and placement.

Mating disruption works only if populations are low to moderate to start with, if mated females are prevented from entering the orchard area under treatment, and if mating is prevented by any adults that emerge within a treated area. Under very high pest pressure, mating disruption can be one of the tactics in addition to insecticides. Use the following guidelines to ensure mating disruption success:

1. The area(s) under treatment must be a certain minimum size, usually at least 5 acres. Larger areas under treatment will increase the level of control, especially around orchard borders.

2. Pheromone dispensers should be placed in the orchard before moth emergence.
3. Remember, there are 4 full generations of Oriental fruit moth in New Jersey, and the first or overwintering generation usually starts to emerge in mid-March to early April. Products on the market now (Isomate and Trece) are season-long and can be placed during pruning or bloom and will disrupt activity throughout the season. If, because of pruning or other management practices, early placement is not possible, then insecticides should be used for the first generation, and mating disruption relied upon for the remaining generations.
4. Dispensers should be evenly placed throughout the orchard based on the number of dispensers/acre on the outsides of the trees, as high up in the tree as possible. Extra dispensers can be placed on border trees.
5. Orchards should be monitored with pheromone traps and other scouting procedures.
6. If tree density has been decreased due to dead trees and open spaces, extra dispensers should be placed on the trees bordering the open spots. It is also helpful to place extra dispensers around the border of mating disrupted areas.
7. To minimize immigration of pests into mating disruption blocks, consider creating an "insecticide barrier" by applying insecticides to the perimeter of the mating disruption block.
8. There are multiple brands of dispensers commonly available and tested in eastern states: Trécé CIDETRAK® OFM-L and OFM-L MESO™, Checkmate (Suterra), Checkmate OFM Dispenser, and Checkmate OFM SL, and Isomate-OFM TT (Pacific Biocontrol). The Checkmate OFM Dispenser will release pheromone for 90 to 100 days when placed at a density of 108 dispensers/A. Isomate-OFM TT will release pheromone for 180+ days and can be placed immediately after pruning at 70 dispensers/A except where pressure is high (100 dispensers/A). Trécé CIDETRAK® OFM-L MESO™, a neoprene-like clip in dispenser will release pheromone for 180 days and can placed at 35 dispensers/acre. Trécé CIDETRAK® OFM-L will last up to 150 days but needs to be replaced after 120 days if used in late maturing varieties.
9. Because broad-spectrum insecticides are not frequently used in mating disruption orchards, it is important that any orchard under mating disruption should be regularly monitored for the presence of other pests, as well as Oriental fruit moth.

Sprayable pheromone.

Mating disruption may also be accomplished by the use of sprayable formulations of pheromone. Checkmate OFM-F (Suterra) can be applied at 1.32 to 2.93 oz./A. The Suterra product works best if applied just prior to each adult flight, and again during the flight. Research has shown that sprayable pheromone should be used with a sticker such as Lastic or Nu-Film-17. As with hand applied dispensers, the orchard should be monitored for OFM and other pests. Application timing and frequency will depend, in part, on the population density, temperature and amount of rainfall.

Lesser Peachtree Borers (LPB) and Peachtree Borers (PTB)

Growers who wish to control both the lesser peachtree borer and peachtree borer, may use the Isomate PTBDual. This dispenser contains both pheromone components for lesser and peachtree borers; (E,Z)-3,13 Octadecadien-1-yl Acetate - 43.46 %, and (Z,Z)-3,13 Octadecadien-1-yl Acetate - 43.07 %. This dispenser is to be used at the rate of 150/A, for low to medium populations or infestations, and up to 250 dispensers/A for high populations. Dispensers should be placed prior to moth flight. Under high pest pressure, use extra dispensers at the edge of the border. Keep in mind that there are 2 generations/year of lesser peachtree borer, and 1 generation/year of peachtree (greater) borer.

The first summer generation LPTB emerges first, and usually starts around early-May. Mating disruption for borers works the same way as it does for oriental fruit moth, but with different pheromones. When using mating disruption dispensers for control of borers, the dispensers should be placed in trees just prior to adult emergence in order to prevent the occurrence of mated females flying in the orchard. Therefore, Isomate PTB-Dual should be placed early-May. Dispensers should be placed in the center of the tree at chest height. There is no sprayable formulation of pheromone available for these insects. Use of mating disruption for borers has been shown to be more effective when it is started in young orchards (2nd year trees), and carried through as a management practice for a number of years. High populations will require a Lorsban treatment in the first year of mating disruption to kill larvae in the trees. Populations at all densities need to be monitored with pheromone traps.

7.5.2 Peach IPM Treatment Guidelines

The following guidelines can be used for key arthropod pests. Because other pests are also present, orchards should be regularly scouted for insects and diseases. Most pests that are not listed here should be treated based on proper timing. Most direct pests, or those that directly damage the fruit, should be managed so that no more than 1% of the fruit shows damage from that pest.

Monitoring and Timing Oriental Fruit Moth Sprays

First generation and degree day timing: Place at least 2 Pherocon 1C type pheromone traps in the orchard by late-March and check every day for first moth emergence. Record the day of the first sustained catch. The day of first sustained catch is defined as the Biofix point. Start recording degree day (DD) accumulation (base 45°F) after biofix. The timing of sprays or spray targets will be defined in part on what type of insecticide you are using. Ideally, full cover, every middle sprays should be used. If using alternate middle applications, then sprays should be bracketed as closely as possible to the stated timing. Timing may also be influenced by temperature, rainfall and pest pressure. Table 7.4 may be helpful in determining spray timing.

During some seasons when days are very warm, degree days accumulate rapidly, and may dictate that for a specific generation (brood) both the first and second sprays may need to be applied less than a week apart. If the weather is relatively dry, and complete sprays were used, then delay that treatment since sufficient pesticide residue should still remain for the second treatment to be applied 10+ days after the first spray, regardless of degree day accumulations. Be aware that some newer materials are not effective for PC. Make sure to apply a material that is effective for PC at this time.

Second, third and fourth generations: If using Intrepid, remember that it is an insect growth regulator (IGR), and should be used in full cover, every middle sprays, and at a slightly earlier timing than conventional materials. Use 2 sprays/generation (2nd or 3rd), with the initial treatment being timed by degree day accumulation. A second application should be applied 10-14 days after the previous spray, or may be timed with degree day counts. In addition to monitoring degree days, maintain pheromone traps and monitor once a week. Trap catches of more than 6 to 8 moths/trap/week mean moth populations could be a problem. Treat when trap catches exceed this level, after the expected residue from the previous spray wears out, or about 6-7 days for alternate middle sprays and about 10 days for full cover applications.

Flagging: Larval entry into growing shoots causes terminal flagging. Flags should not be present under normal conditions. Any flagging means that larvae are present, and indicates that changes may be needed in the spray program.

Fruit counts: Weekly examinations should be made of about 200 fruit in each block. Scan the fruit for the presence of entry holes and frass, especially near the stem end. The presence of any entries means the management program needs to be changed. Changes may include recalibrating the sprayer, slowing tractor speed to 2 mph, decreasing the spray interval, increasing spray volume, increasing the insecticide rate, or changing materials.

Table 7.4 Oriental Fruit Moth (OFM) Timing

Degree Day (DD) Spray Targets From Biofix				
	Degree Day Timings and Insecticide Type			
Generation	**Conventional**	**Intrepid, Rimon (IGR[1])**	**Diamides/Virus**	**MD**
1	170-200 350-375	use conventional insecticides	100-150 300-325	apply at first flight
2	1150-1200 1450-1500	1050-1150 1350-1450	1075-1150 1375-1450	n/a
3	2100-2200 2450-2500	2000-2100 2350-2450	2025-2150 2375-2450	n/a
4	monitor traps, if needed, late season chemicals for BMSB may manage populations			

[1] IGR = Insect Growth Regulator. **Note**: The diamides should be applied closer to 100-150 DD after biofix for the first treatment, and about 50-75 DD earlier for all additional treatments compared to the OP/carbamate timing. If Madex HP virus is used, apply at Diamide timing +5 days.

Plum Curculio (PC)

Plum curculio adults become active in early spring when temperature rise above 45°F and activity within the orchard begin when temperatures are within 50-60°F for a few days, typically around the same time as bloom. Adults feed on developing fruit and females oviposit, leaving crescent shaped scars. Injury begins at petal fall and can continue for a few weeks, depending on temperature. In the last few years with cool springs NJ growers have experienced high PC populations. Hot weather may slow down populations. Injury is generally highest along orchard edges, especially those with a wooded border. Monitoring can be done with a baited black pyramid trap or through visual inspection of fruit for scars. Imidan (followed by Delegate), Exirel, Actara and Avaunt are effective chemicals. If using Actara keep in mind the use restrictions as it is also an effective material against BMSB and will not target OFM which is typically active at this time. A phenology model was developed at Rutgers University to time management of PC in peaches (*https://plant-pest-advisory.rutgers.edu/plum-curculio-phenology-model/*), starting degree-day accumulations on January 1 using a base temperature of 50°F (Table 7.5). Management against the adults should target at minimum 199, 290, 520-730 DD_{50}.

Table 7.5 Degree Development of Plum Curculio

	Biofix at January 1 and base 50°F
Phenological event	**Mean**
First trap catch	199
First peak trap catch	290
First egg lay in fruit	520
Peak egg laying	730
Peak larval emergence	985
Peak trap catch of second generation	2025

Tarnished Plant Bug and Stink Bugs

Monitor the ground cover with a sweep net, taking 2 sets of 25 sweeps. There is no standard treatment threshold, but past experience has shown that when the total count exceeds 3-4 combined tarnished plant bugs and stink bugs, potential problems exist. Weedy ground covers and woods borders exacerbate the problem. Greater than 1 to 2% fresh catfacing injury on the fruit means that adjustments have to be made in the spray program.

Brown Marmorated Stink Bug

Brown Marmorated Stink Bug (BMSB) is an invasive species whose populations have become damaging in New Jersey since its introduction. For identification and to distinguish from native stink bug species, visit *http://www.stopbmsb.org/stink-bug-basics/life-stages/* or *http://njaes.rutgers.edu/stinkbug/similar.asp*. BMSB is a highly mobile pest that feeds on many agricultural crops including tree fruit as well as woody shrubs and trees found in the wood borders on a farm. Unlike some orchard pests, BMSB can cause damage throughout its life cycle and is present for much of the growing season. There are a large number of compounds that are effective against BMSB, however many have short residual activity and require multiple applications. Be cautious about over use of pyrethroid insecticides, which may cause secondary pest (scale, mites, and aphids) outbreaks.

Monitoring: Unlike native stink bug species, BMSB is not found in the ground cover. Monitoring to detect populations is best made through either aggregation pheromone traps. BMSB moves into an orchard from either the woods edge or disperses from other crops. Initial monitoring on host plants can be done on the orchard perimeter. Additional inspections of fruit will help to determine damage, as this pest can be difficult to detect. We currently do not have economic or treatment thresholds but can use 1 to 2% catfacing injury on fruit as guidelines. Based on phenology, management is not necessary until the end of May or ~160 DD_{57}.

Phenology: Rutgers has developed and is testing a phenological model to predict populations in the field. Termination of overwintering state requires a lengthening of photoperiod and thus, early warming periods will not speed up activity. Adults disperse to the orchard, especially peach, at ~100-160 DD (accumulations starting April 22), generally the second to third week of May. The adults dispersing into the orchard are becoming

reproductively mature and egg masses can be found in about 1 week or 160-300 DD. The first adults appearing in the orchard are generally found in peach, which is a highly suitable host plant. BMSB requires 1000 DD (base 57°F) to complete development from egg to adult. Adults will move in and out of peach orchards and eventually into apple throughout the season. Nymphs can complete their development in peach. We have two generations of BMSB with second generation adults peaking in mid-late July.

Tufted Apple Budmoth

Place pheromone traps in early April and record first moth catch as with oriental fruit moth. Record degree days (base 45°F). Use Table 7.6 as a guide for timing.

When this insect is present, second generation larvae are usually more problematic than first generation larvae. Therefore, if spraying for this insect, concentrate on those varieties that ripen after mid-August. If orchards have a history of tufted apple budmoth problems, be sure to treat the first generation.

Table 7.6 Tufted Apple Budmoth (TABM) Timing

Degree Day (DD) Spray Targets from Biofix based on Insecticide Type				
Brood	**Op's, Carbamates, Delegate, Pyrethroids (Conv.), Diamides[1]**		**Intrepid**	***Bacillus thuringensis* (Bt)**
	ALT. MID.	**COMPLETE**	**COMPLETE**	**COMPLETE**
1	475-505	530-585	500-650	585-640
	610-640			
	750-775	805-855	805-850	805-855
	885-910			
2	2210-2245	2280-2355	2355-2435	2355-2435
	2395-2435			
	2585-2625	2665-2740	2665-2740	2585-2665
	2775-2815			2815-2890

[1] Diamides (Altacor, Besiege, Exirel, Verdepryn, and Voliam should be applied @500-525 DD complete sprays or about 30-60 DD earlier than other complete sprays compared to OP/carbamte/pyrethroid timing.

Green Peach Aphid

Conduct whole tree exams between pink bud to about 3 weeks after petal fall for the number of aphid colonies/tree. For mature peach trees, treat if colonies exceed 2 colonies/tree by petal fall to shuck-split, or 5 to 6 colonies/ tree by mid- to late May. Tolerate no more than 1 colony/tree on nectarines.

European Red Mite and Two Spotted Spider Mite

Collect at least 20 older leaves from several trees throughout the fruit canopy. Peaches tolerate more mites than apples, so higher populations can be allowed. Treat if there are more than 10 mites/leaf during early to mid-season, and 20 mites/leaf during the late season, or up to 3 weeks preharvest.

7.6 Efficacy of Selected Pesticides for Disease, Insect and Mite Control

Table 7.7 Efficacy of Fungicides and Bactericides for Peach and Nectarine Disease Control

(++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated)

Note: Fungicide Resistance Management: Risk of resistance development in FRAC groups 1, 11, and 41 is high; group 2 is medium to high; groups 3, 7, and 9 medium; groups 14 and 17 low to medium; and groups M1-M5 low. Resistance management is reccommended for group M7. All materials, except for those in groups M1-M5, should be alternated or mixed with fungicides of a different chemistry. For example, for preharvest brown rot control, alternate with materials from groups 1, 17, 3, 11, and 7.

Chemistry (FRAC)	Fungicide or Bactericide	Bacterial Spot	Brown Rot		Leaf Curl	Peach Scab	Rhizopus Rot	Rusty Spot
			Blossom Blight	Fruit Rot				
BIORATIONAL (NC)	Serenade MAX 14.6WP[1]	-	-	-	-	-	-	+++
	Arimicarb 100 85SP[1],							
	Kaligreen 82SP[1]							
INORGANIC COPPER (M1)	Copper, fixed	+++	-	-	++	-	-	-
INORGANIC SULFUR (M2)	Sulfur	-	++	++	+	+++	-	++
DITHIOCARBAMATE (M3)	Ferbam 76WDG	-	++	-	++++	-	-	-
	Thiram 75WDG	-	++	-	-	++	-	-
	Ziram 76DF	-	++	++	++++	++	-	-
PHTHALIMIDE (M4)	Captan 80WDG	-	++	+++	+	+++	+	-
CHLORONITRILE (M5)	Bravo Weather Stik 6F	-	++	-	++++	+++	-	-
MBC (1)	Topsin M WSB	-	++++	++++	+	+++	-	+
DICARBOXIMIDE (2)	Rovral 4F, Meteor 4F	-	++++	-	-	-	-	+
DMI (3)	Indar 2F	-	++++	++++	-	+	-	++
	Bumper, PropiMax, Tilt	-	+++	++++	-	-	-	++
	Cevya 3.34SC	-	+++	++++	-	-	-	+++
	Orius AQ 1.67F	-	++++	++++	-	-	+++	++
	Quash 50WDG	-	+++	++++	-	++	-	++
	Rally 40WSP	-	++	+++	-	-	-	++++
	Topguard, Rhyme 2.08SC	-	-	++	-	-	-	-
DMI + QoI (3 +11)	Quadris Top 2.72SC	-	++++	++++	-	++++	+	+++
AP (9)	Vangard 75WG	-	+++	-	-	-	-	-
SDHI (7)	Fontelis 1.67SC	-	++++	+++	-	++	+	++
	Miravis 1.67SC	-	++	+++	-	-	-	-
DMI + AP (3 + 9)	Inspire Super 2.82EW	-	++++	+++	-	+++	-	+++
DMI + SDHI (3 + 7)	Luna Experience 3.34SC	-	++++	+++	-	+	-	++
QoI (11)	Abound 2F	-	+++	+++	+	+++	-	++
	Flint Extra 4.05SC	-	+++	+++	+++	+++	-	+++
QoI + SDHI (11 + 7)	Luna Sensation 4.2SC	-	++++	++++	-	+++	-	+++
	Merivon 4.18SC	-	++++	++++	-	++	+++	++
	Pristine 38WG	-	++++	++++	+++	++	-	++
AROMATIC (14)	Botran 75WP	-	+	+	-	-	+++	-
HYDROXYANILID (17)	Elevate 50 WDG	-	++	++	-	-	-	-
POLYOXIN (19)	Oso 5%SC	-	-	+++	-	-	-	-
ANTIBIOTIC, TETRACYCLINE (41)	FlameOut 17WP, Mycoshield 17WP, FireLine 17WP	+++	-	-	-	-	-	-

[1] Rusty spot ratings pertain to usage with Rally in an integrated rusty spot program.

Table 7.8 Efficacy of Selected Peach Insecticides and Acaricides

(++++ = excellent, +++ = good, ++ = fair, + = poor/not recommended, S = suppressive, – = ineffective or not rated)

INSECTICIDE/ACARICIDE AND FORMULATION	INSECTS[1]											MITES[2]		
	FT	GPA	JB	LR	OFM	PC	LPTB	PTB	BMSB	SB/ TPB	WP/ SJS	ERM	PSM	TSM
Acramite 50WS	–	–	–	–	–	–	–	–	–	–	–	++++	+++	++++
Actara 25WDG	–	++++	+	–	–	+++	–	–	+++	+++	–	–	–	–
Admire Pro	–	++++	+++	–	–	+++	–	–	+++	–/+	++	–	–	–
Altacor	–	–	–	++++	++++	–	–	–	–	–	–	–	–	–
Ambush 25W	–	+	+++	++++	++++	++	+++	+++	++	++	–	–	–	–
Apollo SC	–	–	–	–	–	–	–	–	–	–	–	++++	++	++++
Apta/Bexar	–	+++	–	++	–	+++	–	–	S	S	–	–	–	–
Asana XL	–	+	+++	–	++++	+++	+++	++	++	+++	–	–	–	–
Assail 30SG	–	++++	+++	–	+++	++	–	–	++	++/+++	+++	–	–	–
Avaunt	–	–	+++	+++	+++	++++	++	–	+	++	–	–	–	–
Bacillus thuringiensis	–	–	–	+++	+	–	–	–	–	–	–	–	–	–
Baythroid XL	–	+	+++	–	++++	+++	+++	–	+++	++++	–	–	–	–
Belay	–	++++	–	–	–	+++	–	–	++++	++++	–	–	–	–
Beleaf 50SG	–	+++	–	–	–	–	–	–	+	+++	–	–	–	–
Besiege	–	+	+++	++++	++++	++	–	–	+++	+++	–	–	–	–
Centaur	–	–	–	–	–	–	–	–	–	–	++++	–	–	–
Closer SC	++	++++	–	–	–	–	–	–	++	–	+++	–	–	–
Cormoran	–	++++	++	+++	++++	++	++	++	++	+++	+++	–	–	–
Danitol 24EC	–	–	–	–	+++	++	–	–	++	++++	–	++	++	++
Delegate 25WG	+++	–	–	++++	++++	+	–	–	+	–	–	–	–	–
Diazinon 50W	–	–	+++	–	–	–	–	–	–	++	++++	–	–	–
Endigo ZC	–	++++	+++	++++	++++	++	–	–	++++	+++	–	–	–	–
Entrust SC	++++	–	–	++++	+++	–	–	–	–	–	–	–	–	–
Envidor 2SC	–	–	–	–	–	–	–	–	–	–	–	+++	+++	+++
Esteem 35WP	–	+++[3]	–	–	+++[4]	–	–	–	+	–	++++	+	–	+
Exirel	–	–	–	–	++++	+++	–	–	–	–	–	–	–	–
Gladiator	–	++	++++	++	++++	+++	+++	++	+++	++/+++		+++	–	+++
Imidan 70W	–	+	+++	–	+++	++++	–	–	–	+++	+	–	–	–
Intrepid 2F	–	–	–	+++	+++	–	–	–	–	–	–	–	–	–
Lambda-Cy	–	+	+++	++++	++++	++	–	–	+++	+++	–	–	–	–
Lannate	+++	+++	+++	+++	+++	++	+	+	++	+++	–	–	–	–

Table 7.8 Efficacy of Selected Peach Insecticides and Acaricides - continued on next page

PEACHES AND NECTARINES

Table 7.8 Efficacy of Selected Peach Insecticides and Acaricides - continued

INSECTICIDE/ACARICIDE AND FORMULATION	INSECTS[1]											MITES[2]		
	FT	GPA	JB	LR	OFM	PC	LPTB	PTB	BMSB	SB/ TPB	WP/ SJS	ERM	PSM	TSM
Leverage 360	–	+++	+++	++++	++++	++	–	–	+	++++	+++	–	–	–
Lorsban-4E	–	–	–	–	–	–	++++	++++	–	–	++++	–	–	–
Madex HP	–	–	–	–	++++	–	–	–	–	–	–	–	–	–
Minecto Pro	–	–	–	–	++++	+++	–	–	–	–	–	++++	–	++++
Movento	–	++++	–	–	–	–	–	–	–	–	++++	–	+++	–
Mustang Maxx	–	+	++++	++++	++++	+++	–	–	+++	+++	–	–	–	–
Nealta	–	–	–	–	–	–	–	–	–	–	–	++++	–	++++
Nexter 75WP	–	–	–	–	–	–	–	–	–	–	–	++++	++	++
Oil 70 sec	–	–	–	–	–	–	–	–	–	–	++++	++++	–	–
Onager EC	–	–	–	–	–	–	–	–	–	–	–	++++	+	++++
Perm-UP	–	+	+++	++++	++++	++	+++	+++	++	++	–	–	–	–
Portal XLO	–	–	–	–	–	–	–	–	–	–	–	+++	–	+++
Pounce 25WP	–	+	+++	++++	++++	++	+++	+++	++	++	–	–	–	–
Proaxis	–	+	++++	++++	++++	+++	–	–	–	++++	–	–	–	–
Rimon 0.83EC	–	–	–	++++	++++	–	++	++	–	–	–	–	–	–
Savey 50DF	–	–	–	–	–	–	–	–	–	–	–	++++	+	++++
Scorpion	–	+	–	–	–	–	–	S	+++	++++	–	–	–	–
Sevin XLR Plus	–	+	++++	–	+++	++	+	+	+	–	–	–	–	–
Sivanto Prime	–	+	–	–	–	–	–	–	–	–	++	–	–	–
Vendex	–	–	–	–	–	–	–	–	–	–	–	+++	+++	+++
Venerate	–	–	–	–	–	–	–	–	+++	–	++++	–	–	–
Venom	–	+	–	–	–	–	–	S	+++	++++	–	–	–	–
Verdepryn 100SL	–	–	+++	++++	++++	+++	–	–	+	+	–	–	–	–
Versys	–	++++	–	–	–	–	–	–	–	–	–	–	–	–
Voliam Flexi WG	–	+++	–	++++	++++	+++	–	–	+++	+++	–	–	–	–
Warrior II	–	+	+++	–	++++	++	–	–	+++	+++	–	–	–	–
Zeal	–	–	–	–	–	–	–	–	–	–	–	++++	–	++++

[1] **FT** = Flower Thrips	**LPTB** = Lesser Peachtree Borer	[2] **ERM** = European Red Mite
GPA = Green Peach Aphid	**PTB** = Peachtree Borer	**PSM** = Peach Silver Mite
JB = Japanese Beetle	**BMSB** = Brown Marmorated Stink Bug	**TSM** = Two-Spotted Spider Mite
LR = Leafrollers	**SB** = Stink Bugs (native species only)	[3] When applied pink-bloom
OFM = Oriental Fruit Moth	**TPB** = Tarnished Plant Bug	[4] Early season
PC = Plum Curculio	**WP/SJS** = White Peach/San Jose Scale	

7.7 Peach and Nectarine Pest Management

Peach and Nectarine Disease Management Program – Fungicide and Bactericide Timing

Disease	Dor-mant	Pink	Bloom	Petal Fall	Shuck Split	Covers[1]						Preharvest			Post-harvest
						1	2	3	4	5	6	PH3	PH2	PH1	
Leaf Curl[2]	■	▒	▒	▒											■
Brown Rot Blossom Blight		■	■	▒											
Rusty Spot[3]				■	■	■	■	▒							
Scab[4]				▒	■	■	■	■	■						
Bacterial Spot				▓	■	■	■	■	▓	▓	▓				
Anthracnose Fruit Rot[5]										■	■	■	■	■	
Brown Rot Fruit Rot												■	■	■	
Rhizopus Fruit Rot												■	■	■	■
Constriction Canker[6]	■														■

Key: ■ = Optimim timing ▒ = Some control possible ▓ = Highly susceptible cultivars

[1] Late maturing cultivars will require additional cover sprays; [2] Leaf curl can be controlled by either a fall application (after all leaf drop) or spring application just prior to bud swell; [3] Rusty spot is controlled with sprays from PF-2C; in early warm seasons, a 3C spray is advised for susceptible cultivars; [4] A petal fall spray with an anti-sporulant fungicide is advised if scab was previously problematic in block; [5] Only spray for anthracnose if disease occurred during previous seasons and conditions warm and wet; [6] Postharvest and dormant sprays provide about 70% control; remove cankers during mid-late summer for greater control

Peach and Nectarine Arthropod Management Program – Insecticide and Acaracide Timing

Insect and Mite Pests	Dormant	Delayed Dormant	Pink-Bud	Bloom	Petal-Fall (100%)	Shuck-Split	1st Cover	2nd Cover	3rd and	4thh Cover	5th Cover	6th & later Covers	Pre-Harvest	Post-Harvest
White Peach/San Jose Scale	▒	■	▒	Do not apply insecticides during bloom!		▒	■		■		▒			
Native Stink Bugs					■	■	■	■	■		■	■	■	
Tarnished Plant Bug			▒		■	■	■	■	■		■	■	■	
Green Peach Aphid					▒	■	▒							
Leafrollers, Tufted Apple Budmoth					▒	▒	■	■			■	■		
Oriental Fruit Moth					■	■		■	■		■	■		
Plum Curculio					■	■	■	▒	▒					
Thrips					▒	▒							■	
Brown Marmorated Stink Bug							▒	▒	■	■	■	■	■	
Japanese/June Beetle									■	■	▒	▒	▒	
Lesser Peach Tree Borer								■	■					■
Peach Tree Borer														■
European Red Mite	eggs	eggs			▒	▒	▒	▒	■	■	■			▒
Peach Silver Mite					▒	▒	▒	▒	■	■	■			▒
Two Spotted Spider Mite							▒	▒	■	■	■			▒

Key: ■ = Optimim timing ▒ = Some control possible

The following Pest Management Tables are listed for individual cover sprays but growers should think about whole season approaches, see the chapter Pesticide Strategies.

Abbreviations			
Stone Fruit Preharvest Interval Key		**Units of Measurement**	
D	Dormant application only	/A	per acre
PB	No later than prebloom	d	day(s)
FB	No later than full bloom	fl oz	fluid ounce(s)
PF	No later than petal-fall	gal	gallon(s)
SS	No later than shuck-split	h	hour(s)
SF	No later than shuck-fall	lb	pound(s)
FC	No later than first cover	oz	ounce(s)
NTL	No time limit (usually up to the day of harvest) - consult label	pt	pint(s)
		qt	quart(s)
NA	Not applicable		

DORMANT					PEACHES AND NECTARINES
DISEASE	**Leaf Curl[1]**				
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Bordeaux mixture (lb/100 gal)	++ 4, 6				24 h NA
Bravo Weather Stik 6F[4] (pt)	++++ 3.0-4.0				12 h SS
Copper, fixed[5]	++ various rates				12-48 h various
Ferbam 76WDG (lb)	++++ 4.0				24 h 21 d
Lime Sulfur 10.6F[6] (gal)	+ 6.0-8.0				48 h NTL
Ziram 76DF (lb)	++++ 3.75-8.0				48 h 14 d

[1] This leaf curl spray is not needed if an application was made after leaf fall during the previous season.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Generic products and/or other formulations are available.
[5] Copper may also help reduce epiphytic inoculum for bacterial spot; some available materials are Champ, Kocide, Nu-Cop, and Cuprofix.
[6] Lime sulfur best applied as a dilute spray.

DORMANT AND DELAYED DORMANT					PEACHES AND NECTARINES
INSECT OR MITE PEST	**INSECTS**	**MITES**			
	White Peach/ San Jose Scale	**European Red Mite Eggs**			
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Superior Oil (gal)	++++ 4.0-6.0	++++ 4.0-6.0			4 h 0 d
Venerate XC (qt)	+++ 1-2	–			4 h 0 d
PLUS ONE OF THE FOLLOWING					
Centaur WDG (oz)	++++ 34.5	–			12 h 14 d
Diazinon 50W[4] (lb)	+++ 2.0-3.0	–			96 h 21 d
Esteem 35WP (oz)	++++ 4.0-5.0	–			12 h 14 d
Lorsban-4E[1] (pt)	++++ 2.0-4.0	–			96 h 14 d, PB[5]
Lorsban 75W[1] (lb)	++++ 2.0-2.67	–			96 h 14 d, PB[5]

[1] When noted, generic products are available. Only one application type (dormant/delayed dormant vs. borer control) may be made/year of any chlorpyrifos product.

[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[4] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.

[5] PHI Key: PB = No later than prebloom.

PINK-BUD AND BLOOM					PEACHES AND NECTARINES
DISEASE	**Brown Rot Blossom Blight**				
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Abound 2F (fl oz)	+++ 12.0-15.5				4 h 0 d
Bravo Weather Stik 6F[4] (pt)	++ 3.0-4.0				12 h SS[6]
Bumper/Tilt[4] (fl oz)	+++ 4.0				24 h 0 d
Captan 80WDG[4] (lb)	++ 2.5				24 h 0 d
Cevya 3.34SC (fl oz)	+++ 3.0-5.0				12 h 0 d
Elevate 50WDG (lb)	++ 1.5				12 h 0 d
Ferbam 76WDG (lb)	++ 4.0				24 h 21 d
Fontelis 1.67SC (fl oz)	++++ 14.0-20.0				12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-3.8				12 h 1 d
Indar 2F (fl oz)	++++ 6.0				12 h 0 d
Inspire Super 2.82EW (fl oz)	++++ 16.0-20.0				12 h 2 d
Luna Experience 3.34SC (fl oz)	++++ 6-10				12 h 0 d
Luna Sensation 4.2SC (fl oz)	++++ 5-7.6				12 h 1 d
Merivon 4.18SC (oz)	++++ 4.0-6.7				12 h 0 d
Miravis 1.67SC (fl oz)	++ 3.4-5.1				4 h 0 d
Orius AQ 1.67F (fl oz)	++++ 8.6-17.2				12 h 0 d
Pristine 38WG (fl oz)	++++ 10.5-14.5				12 h 0 d
Quadris Top 2.72SC (fl oz)	++++ 12.0-14.0				12 h 0 d
Quash 50WDG (oz)	+++ 2.5-3.5				12 h 14 d
Rally 40WSP (oz)	++++ 2.5-6.0				24 h 0 d
Rovral 4F (pt)	++++ 1.0-2.0				24 h PF[6]
Sulfur, actual[5] (lb)	++ 10.0-12.0				24 h NTL[6]
Topsin M WSB (lb) plus Captan 80WDG (lb)	+++ 0.5-0.75 plus 1.25-2.5				48 h 1 d
Topsin M WSB (lb) plus Sulfur, actual[5] (lb)	+++ 0.5-0.75 plus 6.0-12.0				48 h 1 d
Vangard 75WG (oz)	+++ 5.0				12 h 2 d
Ziram 76DF (lb)	++ 4.5-8.0				48 h 14 d

Pink Bud and Bloom DISEASE footnotes - see next page

Pink Bud and Bloom DISEASE footnotes

[1] Alternate products of different chemistry for resistance management; see Table 7.7 for details. [2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, urwise noted. [4] Generic products and/or other formulations are available. [5] Do not use sulfur if temperature is expected to exceed 90°F after spraying. [6] PHI Key: NTL = No time limit (usually up to the day of harvest) - consult label, PF = No later than petal-fall, SS = No later than shuck-split.

PINK-BUD[1]					PEACHES AND NECTARINES
INSECT PEST	**Native Stink Bugs[1]**	**Tarnished Plant Bug[1]**	**White Peach/ San Jose Scale**		
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Ambush 25W[4] (oz)	++ 6.4-19.2	++ 6.4-19.2	–		12 h 14 d
Asana XL[4] (fl oz)	+++ 8.0-10.0	+++ 6.0-10.0	–		12 h 14 d
Besiege (fl oz)	+++ 9.0-12.0	+++ 9.0-12.0	–		24 h 14 d
Baythroid XL (fl oz)	++++ 2.0-2.4	++++ 2.0-2.4	–		12 h 7 d
Danitol 2.4 EC (fl oz)	+++ 10.6-21.3	++++ 10.6-21.3	–		24 h 3 d
Imidan 70W[5] (lb)	+++ 2.5-3.0	+++ 2.5-3.0	–		4/14 d[5] 14 d
Lambda-Cy (fl oz)	+++ 2.56-5.12	+++ 2.56-5.12	–		24 h 14 d
Perm-UP 3.2EC (fl oz)	++ 4.0-10.0	++ 4.0-10.0	–		12 h 14 d
Pounce 25WP[4] (oz)	++ 6.4-16.0	++ 6.4-16.0	–		12 h 14 d
Sivanto Prime (fl oz)	–	–	++ 10.5-14.0		4 h 14 d
Warrior II[4] (fl oz)	+++ 1.28-2.56	+++ 1.28-2.56	–		24 h 14 d

[1] Insecticides are generally not recommended for the catfacing insect complex pre-bloom. Prebloom catfacing control may be advisable under circumstances where cropping is light due to frost or blossom thinning and populations are found to be high through orchard scouting. [2] Efficacy rating: ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] When noted, generic products are available. [5] Imidan REI 4 days for farm labor, but 14 days for u-pick operations.

BLOOM	PEACHES AND NECTARINES
INSECT PEST	**Do not apply insecticides during bloom!**

PETAL-FALL (100% PETAL FALL)					PEACHES AND NECTARINES
DISEASE	**Brown Rot Blossom Blight[1]**	**Rusty Spot[2]**			
Product and Formulation[3]	**Product Efficacy Rating[4] and Rate/A[5]**				**REI PHI**
Abound 2F (fl oz)	++++ 12.0-15.5	++ 12.0-15.5			4 h 0 d
Bravo Weather Stik 6F[6] (pt)	++ 3.0-4.0	–			12 h SS[8]

PETAL-FALL (100% PETAL FALL) - DISEASE - continued on next page

PETAL-FALL (100% PETAL FALL) - DISEASE - continued

PETAL-FALL (100% PETAL FALL)					PEACHES AND NECTARINES
DISEASE	**Brown Rot Blossom Blight[1]**	**Rusty Spot[2]**			
Bumper/Tilt[6] **(fl oz)**	+++ 4.0	++ 4.0			24 h 0 d
Captan 80WDG[6] **(lb)**	++ 2.5	–			24 h 0 d
Cevya 3.34SC **(fl oz)**	+++ 3.0-5.0	+++ 4.0-5.0			12 h 0 d
Elevate 50WDG **(lb)**	++ 1.5	–			12 h 0 d
Ferbam 76WDG **(lb)**	++ 4.0	–			24 h 21 d
Flint Extra 4.05SC **(fl oz)**	++++ 2.5-3.8	+++ 2.5-3.8			12 h 1 d
Fontelis 1.67SC **(fl oz)**	++++ 14.0-20.0	++ 14.0-20.0			12 h 0 d
Indar 2F **(fl oz)**	++++ 6.0	++ 6.0			12 h 0 d
Inspire Super 2.82EW **(fl oz)**	++++ 16.0-20.0	+++ 16.0-20.0			12 h 2 d
Luna Experience 3.34SC **(fl oz)**	++++ 6-10	++ 6-10			12 h 0 d
Luna Sensation 4.2SC **(fl oz)**	++++ 5-7.6	+++ 5-7.6			12 h 1 d
Merivon 4.18SC **(fl oz)**	++++ 4.0-6.7	++ 4.0-6.7			12 h 0 d
Miravis 1.67SC **(fl oz)**	++ 3.4-5.1	–			4 h 0 d
Orius AQ 1.67F **(fl oz)**	++++ 8.6-17.2	++ 8.6-17.2			12 h 0 d
Pristine 38WG **(oz)**	++++ 10.5-14.5	++ 10.5-14.5			12 h 0 d
Quadris Top 2.72SC **(fl oz)**	++++ 12.0-14.0	+++ 12.0-14.0			12 h 0 d
Quash 50WDG **(oz)**	+++ 2.3-3.5	+ 2.3-3.5			12 h 14 d
Rally 40WSP[2] **(oz)**	++ 2.5-6.0	++++ 2.5-6.0			24 h 0 d
Rovral 4F **(pt)**	++++ 1.0-2.0	–			24 h PF[8]
Sulfur, actual[6, 7] **(lb)**	++ 10.0-12.0	++ 10.0-12.0			24 h NTL[8]
Topsin M WSB (lb) **plus Captan 80WDG (lb)[6]**	+++ 0.5-.075 plus 1.25-2.5	–			48 h 1 d
Topsin M WSB (lb) **plus Sulfur, actual (lb)[6, 7]**	+++ 0.5-0.75 plus 6.0-12.0	+ 0.5-0.75 plus 6.0-12.0			48 h 1 d
Ziram 76DF **(lb)**	++ 4.5-8.0	–			48 h 14 d

[1] If weather conditions are favorable, a third blossom blight spray should be applied. Some materials are only registered for two bloom sprays. [2] Integrated biorational rusty spot program: Alternate Rally at petal fall and first cover with a potassium bicarbonate product (*e.g.*, Kaligreen, Armicarb "O", Carb-O-Nator, etc…) or Serenade Max at shuck-split and second cover. [3] Alternate products of different chemistry for resistance management; see Table 7.7 for details. [4] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [5] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [6] Generic products and/or other formulations are available. [7] Do not use sulfur if temperature is expected to exceed 90°F after spraying. [8] PHI Key: NTL = No time limit (usually up to the day of harvest) - consult label, PF = No later than petal-fall, SS = No later than shuck-split.

PETAL FALL (100% PETAL FALL) PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Do NOT apply insecticides during bloom.

INSECT PEST	Green Peach Aphid	Leaf roller	Oriental Fruit Moth	Plum Curculio	Native Stink Bugs	Tarnished Plant Bug	Thrips	
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**							**REI PHI**
Actara 25WG (oz)	++++ 4.0	–	–	+++ 5.5	+++ 5.5	+++ 5.5	–	12 h 14 d
Admire Pro[3] (fl oz)	++++ 1.4-2.8	–	–	–	–	+ 1.4-2.8	–	12 h 0 d
Altacor (oz)	–	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	–	4 h 10 d
Ambush 25W[3] (oz)	+ 6.4-19.2	++++ 6.4-19.2	++++ 6.4-19.2	+++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	–	12 h 14 d
Apta/Bexar (fl oz)	+++ 17.0-27.0	++ 21.0-27.0	–	+++ 21.0-27.0	S 21.0-27.0	S 21.0-27.0	S 21.0-27.0	12 h 14 d
Asana XL[3] (fl oz)	+ 10.0-14.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	+++ 6.0-14.0	+++ 4.8-8.0	–	12 h 14 d
Assail 30SG (oz)	++++ 2.5-5.3	–	+++ 6.0-8.0	++ 6.0-8.0	+++ 6.0-8.0	+++ 6.0-8.0	–	12 h 7 d
Avaunt (oz)	–	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	++ 6.0	++ 5.0-6.0	–	12 h 14 d
Baythroid XL (fl oz)	+ 2.4-2.8	++++ 1.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	++++ 2.0-2.4	++++ 2.0-2.4	–	12 h 7 d
Besiege (fl oz)	–	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	+++ 9.0-12.0	+++ 6.0-12.0	–	24 h 14 d
Danitol 2.4 EC (fl oz)	–	++++ 10.6-21.3	+++ 10.6-21.3	+++ 10.6-21.3	++++ 10.6-21.3	++++ 10.6-21.3	–	24 h 3 d
Delegate 25WG (oz)	–	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	–	–	+++ 4.5-7.0	4 h 1 d
Entrust SC (fl oz)	–	++++ 4.0-8.0	+++ 8.0	–	–	–	++++ 4.0-8.0	4 h 1 d
Imidan 70W[7] (lb)	+ 2.5-3.0	+++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+++ 2.5-3.0	+++ 2.5-3.0	+ 2.5-3.0	4/14 d[7] 14 d
Lambda-Cy (fl oz)	+ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56 -5.12	+++ 2.56-5.12	+++ 2.56-5.12	–	24 h 14 d
Lannate LV[4] (pt)	+++ 3.0	+++ 3.0	+++ 3.0	++ 3.0	++++ 3.0	++++ 3.0	+++ 3.0	96 h 4 d
Lannate SP[5,6] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	+++ 0.5-1.0	++ 0.5-1.0	++++ 0.5-1.0	++++ 0.5-1.0	+++ 0.5-1.0	72/96 h[5] 1/4 d[6]
Leverage 360 (fl oz)	++++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)	–	–	++++ 0.5-3.0	–	–	–	–	4h 0 d
Perm-UP 3.2EC[3] (fl oz)	+ 4.0-10.0	++++ 4.0-10.0	++++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	–	12 h 14 d
Pounce 25WP[3] (oz)	+ 6.4-16.0	++++ 6.4-16.0	++++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	–	12 h 14 d
Voliam Flexi WG (oz)	++++ 4.0-7.0	–	++++ 4.0-7.0	+++ 6.0-7.0	+++ 6.0-7.0	+++ 6.0-7.0	–	12 h 14 d
Warrior II (fl oz)	+ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28--2.56	+++ 1.28-2.56	+++ 1.28-2.56	–	24 h 14 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [3] When noted, generic products are available. [4] Lannate LV is not registered for nectarines. [5] Lannate SP REI: 72 h for nectarine, 96 h for peach. [6] Lannate SP PHI: 1 d for nectarine, 4 d for peach. [7] Imidan REI 4 d for farm labor, but 14 d for u-pick operations.

SHUCK-SPLIT					PEACHES AND NECTARINES
DISEASE	**Bacterial Spot**	**Rusty Spot[1]**	**Scab**		
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F (fl oz)	–	++ 12.0-15.5	+++ 12.0-15.5		4 h 0 d
Armicarb 100 85SP[1] (lb)	–	+++ 2.5-5.0	–		4 h 0 d
Bravo Weather Stik 6F[5] (pt)	–	–	+++ 3.0-4.0		12 h SS[7]
Captan 80WDG[5] (lb)	–	–	+++ 2.5-3.75		24 h 0 d
Cevya 3.34SC (fl oz)	–	+++ 4.0-5.0	–		12 h 0 d
Fontelis 1.67SC (fl oz)	–	++ 14.0-20.0	++ 14.0-20.0		12 h 0 d
Flint Extra 4.05SC (fl oz)	–	+++ 2.5-3.8	+++ 2.5-3.8		12 h 1 d
Inspire Super 2.82EW (fl oz)	–	+++ 16.0-20.0	+++ 16.0-20.0		12 h 2 d
Kaligreen 82SP[1] (lb)	–	+++ 2.5-3.0	–		4 h 1 d
Kocide 3000 30DF[5] (oz)	+++ 1.0-1.7	–	–		24 h 0 d
Luna Experience 3.34SC (fl oz)	–	++ 6.0-10.0	+ 6.0-10.0		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	+++ 5.0-7.6	+++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	–	++ 4.0-6.7	++ 4.0-6.7		12 h 0 d
Mycoshield 17WP[5] (lb)	+++ 1.0-1.5	–	–		12 h 21 d
Pristine 38WG (oz)	–	++ 10.5-14.5	++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	+++ 12.0-14.0	++++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	+ 2.5-3.5	++ 2.5-3.5		12 h 14 d
Rally 40WSP (oz)	–	++++ 2.5-6.0	–		24 h 0 d
Serenade MAX 14.6WP[1] (lb)	–	+++ 1.0-3.0	–		4 h 0 d
Sulfur, actual[5, 6] (lb)	–	+ 10.0-12.0	++ 10.0-12.0		24 h NTL[7]
Topsin M WSB (lb) plus Captan 80WDG (lb)[5]	–	–	+++ 0.5-0.75 plus 1.25-2.5		48 h 1 d
Topsin M WSB (lb) plus Sulfur, actual (lb)[5,6]	–	+ 0.5-0.75 plus 6.0-12.0	++ 0.5-0.75 plus 6.0-12.0		48 h 1 d
Ziram 76DF (lb)	–	–	++ 4.5-8.0		48 h 14 d

[1] Integrated biorational rusty spot control program: see note at petal fall stage.
[2] Alternate products of different chemistry for resistance management; see Table 7.7 for details.
[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Generic products and/or other formulations are available.
[6] Do not use sulfur if temperature is expected to exceed 90°F after spraying.
[7] PHI Key: NTL= No time limit (usually up to the day of harvest) - consult label, SS=No later than shuck-split.

SHUCK-SPLIT PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Green Peach Aphid	Leaf-roller	Oriental Fruit Moth	Plum Curculio	Native Stink Bugs	Tarnished Plant Bug	Thrips	White Peach/ San Jose Scale	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**								**REI PHI**
Actara 25WG (oz)	++++ 4.0	–	–	+++ 5.5	+++ 5.5	+++ 5.5	–	+++ 5.0	12 h 14 d
Admire Pro[1] (fl oz)	++++ 1.4-2.8	–	–	S 2.8	S 2.8	S 2.8	–	–	12 h 0 d
Altacor (oz)	–	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	–	–	4 h 10 d
Ambush 25W[1] (oz)	+ 6.4-19.2	++++ 6.4-19.2	++++ 6.4-19.2	+++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	–	–	12 h 14 d
Apta/Bexar (fl oz)	+++ 17.0-27.0	++ 21.0-27.0	–	+++ 21.0-27.0	S 21.0-27.0	S 21.0-27.0	S 21.0-27.0	–	12 h 14 d
Asana XL[1] (fl oz)	+ 4.8-8.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	+++ 6.0-14.0	+++ 4.8-8.0	–	–	12 h 14 d
Assail 30SG (oz)	++++ 2.5-5.3	–	+++ 6.0-8.0	++ 6.0-8.0	+++ 6.0-8.0	+++ 6.0-8.0	–	–	12 h 7 d
Avaunt (oz)	–	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	++ 6.0	++ 5.0-6.0	–	–	12 h 14 d
Baythroid XL (fl oz)	+ 2.4-2.8	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	++++ 2.0-2.4	++++ 2.0-2.4	–	–	12 h 7 d
Beleaf 50SG (oz)	+++ 2.0	–	–	–	+++ 2.8	++++ 2.0-2.8	–	–	12 h 14 d
Besiege (fl oz)	–	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	+++ 9.0-12.0	+++ 6.0-12.0	–	–	24 h 14 d
Cormoran (fl oz)	++++ 20.0	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	+++ 20.0-28.0	+++ 20.0-28.0	-	+++ 20.0-28.0	12 h 8 d
Danitol 2.4 EC (fl oz)	–	++++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++++ 10.6-21.3	++++ 10.6-21.3	–	–	24 h 3 d
Delegate 25WG (oz)	–	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	–	–	+++ 4.5-7.0	–	4 h 1 d
Entrust SC (fl oz)	–	++++ 4.0-6.0	+ 8.0	–	–	–	++++ 6.0-8.0	–	4 h 1 d
Exirel (fl oz)	–	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	–	–	12 h 3 d
Imidan 70W[8] (lb)	+ 2.5-3.0	++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+++ 2.5-3.0	+++ 2.5-3.0	–	–	4/14 d[8] 14 d
Intrepid 2F[4] (fl oz)	–	++++ 8.0-16.0	+++ 12.0-16.0	–	–	–	–	–	4 h 7 d
Lambda-Cy (fl oz)	+ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12	–	–	24 h 14 d
Lannate LV[5] (pt)	+++ 3.0	+++ 3.0	+++ 3.0	++ 3.0	++++ 3.0	++++ 3.0	+++ 3.0	–	96 h 4 d
Lannate SP[6,7] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	+++ 0.5-1.0	++ 0.5-1.0	++++ 0.5-1.0	++++ 0.5-1.0	+++ 0.5-1.0	–	72/96 h[6] 1/4 d[7]
Leverage 360 (fl oz)	++++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	–	–	12 h 7 d
Madex HP (fl oz)	–	–	++++ 0.5-3.0	–	–	–	–	–	4 h 0 d
Movento (fl oz)	–	–	–	–	–	–	–	++++ 6.0-9.0	24 h 7 d

Shuck-Split INSECT PESTS - continued on next page

Shuck-Split INSECT PESTS - continued

SHUCK-SPLIT									PEACHES AND NECTARINES
See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.									
INSECT PEST	**Green Peach Aphid**	**Leaf-roller**	**Oriental Fruit Moth**	**Plum Curculio**	**Native Stink Bugs**	**Tarnished Plant Bug**	**Thrips**	**White Peach/ San Jose Scale**	**REI PHI**
Perm-UP 3.2EC[1] (fl oz)	+ 4.0-10.0	++++ 4.0-10.0	++++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	–	–	12 h 14 d
Pounce 25WP[1] (oz)	+ 6.4-16.0	++++ 6.4-16.0	++++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	–	–	12 h 14 d
Verdepryn 100SL (fl oz)	–	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	+ 5.5-11.0	+ 5.5-11.0	–	–	4 h 7 d
Versys (fl oz)	++++ 1.5	–	–	–	–	–	–	–	12 h 7 d
Voliam Flexi WG (oz)	++++ 4.0-7.0	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	+++ 6.0-7.0	+++ 6.0-7.0	–	–	12 h 14 d
Warrior II[1] (fl oz)	+ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56	–		24 h 14 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated, S = suppression.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Apply before egg hatch.
[5] Lannate LV is not registered for nectarines.
[6] Lannate SP 72 h REI for nectarine, 96 h for peach.
[7] Lannate SP 1 d PHI for nectarine, 4 d for peach.
[8] Imidan REI 4 d for farm labor, but 14 d for u-pick operations.

FIRST COVER					PEACHES AND NECTARINES
DISEASE	**Bacterial Spot**	**Rusty Spot[1]**	**Scab**		
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F (fl oz)	–	++ 12.0-15.5	+++ 12.0-15.5		4 h 0 d
Captan 80WDG[5] (lb)	–	–	+++ 2.5-3.75		24 h 0 d
Cevya 3.34SC (fl oz)	–	+++ 4.0-5.0	–		12 h 0 d
Flint Extra 4.05SC (fl oz)	–	+++ 2.5-3.8	+++ 2.5-3.8		12 h 1 d
Fontelis 1.67SC (fl oz)	–	++ 14.0-20.0	++ 14.0-20.0		12 h 0 d
Inspire Super 2.82EW (fl oz)	–	+++ 16.0-20.0	+++ 16.0-20.0		12 h 2 d
Kocide 3000 30DF[5] (oz)	+++ 1.0-1.7	–	–		24 h 0 d
Luna Experience 3.34SC (fl oz)	–	++ 6.0-10.0	+ 6.0-10.0		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	+++ 5.0-7.6	+++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	–	++ 4.0-6.7	++ 4.0-6.7		12 h 0 d
Mycoshield 17WP[5] (lb)	+++ 1.0-1.5	–	–		12 h 21 d
Pristine 38WG (oz)	–	++ 10.5- 14.5	++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	+++ 12.0-14.0	++++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	+ 2.5-3.5	++ 2.5-3.5		12 h 14 d
Rally 40WSP[1] (oz)	–	++++ 2.5-6.0	–		24 h 0 d
Sulfur, actual[5,6] (lb)	–	+ 10.0-12.0	++ 10.0-12.0		24 h NTL[7]
Topsin M WSB (lb) plus Captan 80WDG (lb)[5]	–	–	+++ 0.5-0.75 plus 2.5		48 h 1 d
Topsin M WSB (lb) plus Sulfur, actual (lb)[5,6]	–	+ 0.5-0.75 plus 6.0-12.0	++ 0.5-0.75 plus 6.0-12.0		48 h 1 d
Ziram 76DF (lb)	–	–	++ 4.5-8.0		48 h 14 d

[1] Integrated biorational rusty spot control program: see note at petal fall stage.
[2] Alternate products of different chemistry for resistance management; see Table 7.7 for details.
[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Generic products and/or other formulations are available.
[6] Do not use sulfur if temperature is expected to exceed 90°F after spraying.
[7] PHI Key: NTL= No time limit (usually up to the day of harvest) - consult label.

FIRST COVER — PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Green Peach Aphid	Leaf-roller	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**							**REI PHI**
Actara 25WG (oz)	++++ 3.0-4.0	–	–	+++ 4.5-5.5	+++ 4.5-5.5	+++ 4.5-5.5	+++ 5.0	12 h 14 d
Admire Pro[1] (fl oz)	++++ 1.4-2.8	–	–	S 2.8	–	+ 1.4-2.8	++ 1.4-2.8	12 h 0 d
Altacor (oz)	–	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	–	4 h 10 d
Apta/Bexar (fl oz)	+++ 17.0-27.0	++ 21.0-27.0	–	+++ 21.0-27.0	S 21.0-27.0	S 21.0-27.0	–	12 h 14 d
Ambush 25W[1] (oz)	+ 6.4-19.2	++++ 6.4-19.2	++++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	–	12 h 14 d
Asana XL[1] (fl oz)	+ 4.8-8.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	++ 14.0-14.5	+++ 10.0-14.4	–	12 h 14 d
Assail 30SG (oz)	++++ 2.5-5.3	–	+++ 6.0-8.0	++ 6.0-8.0	++ 5.3-8.0	+++ 5.3-8.0	+++ 6.0-8.0	12 h 7 d
Avaunt (oz)	–	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	+ 6.0	++ 5.0-6.0	–	12 h 14 d
Baythroid XL (fl oz)	+ 2.4-2.8	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	+++ 2.4	++++ 2.0-2.4	–	12 h 7 d
Belay (fl oz)	++++ 3.0-6.0	–	–	+++ 6.0	++++ 6.0	+++ 6.0	+++ 6.0	12 h 21 d
Beleaf 50SG (oz)	+++ 2.0	–	–	–	+ 2.0-2.8	+++ 2.0-2.8	–	12 h 14 d
Besiege (fl oz)	–	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	+++ 9.0-12.0	+++ 6.0-12.0	–	24 h 14 d
Centaur WDG (oz)	–	–	–	–	–	–	++++ 34.5	12 h 14 d
Closer SC (fl oz)	++++ 1.5-2.75	–	–	–	++ 5.75	++ 2.75-5.75	+++ 5.75[11]	12 h 7 d
Cormoran (fl oz)	++++ 20.0	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	++ 20.0-28	+++ 20.0-28	+++ 20.0-28	12 h 8 d
Danitol 2.4 EC (fl oz)	–	++++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 16-21.3	++++ 10.6-21.3	–	24 h 3 d
Delegate 25WG (oz)	–	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	–	–	–	4 h 1 d
Diazinon 50W[9] (lb)	–	++ 2.0-3.0	+++ 3.0-4.0	+++ 3.0-4.0	+ 3.0-4.0	++ 3.0-4.0	+++ 3.0-4.0	96 h 21 d
Endigo ZC (fl oz)	++++ 5.5-6.0	++++ 5.5-6.0	++++ 5.5-6.0	S 5.5-6.0	++++ 3.4-5.5	+++ 5.0-5.5	–	24 h 14 d
Entrust SC (fl oz)	–	++++ 4.0-8.0	+++ 4.0-8.0	–	–	–	–	4 h 1 d
Esteem 35WP (oz)	+++ 4.0-5.0	–	+++ 4.0-5.0	–	–	–	++++ 4.0-5.0	12 h 14 d
Exirel (fl oz)	–	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	–	12 h 3 d
Imidan 70W[10] (lb)	+ 2.5-3.0	++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+ 2.5-3.0	+++ 2.5-3.0	+ 2.0-3.0	4/14 d[10] 14 d
Intrepid 2F[4] (fl oz)	–	++++ 8.0-16.0	+++ 12.0-16.0	–	–	–	–	4 h 7 d

First Cover INSECT PESTS - continued on next page

First Cover INSECT PESTS - continued

FIRST COVER **PEACHES AND NECTARINES**

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Green Peach Aphid	Leaf-roller	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale	REI PHI
Lambda-Cy (fl oz)	+ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12	-	24 h 14 d
Lannate LV[5] (pt)	+++ 3.0	+++ 3.0	+++ 3.0	++ 3.0	++ 3.0	+++ 3.0	–	96 h 4 d
Lannate SP[6,7] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	+++ 0.5-1.0	++ 0.5-1.0	++ 1.0	+++ 1.0	–	72/96 h[6] 1/4 d[7]
Leverage 360 (oz)	++++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)	–	–	++++ 0.5 -3.0	–	–	–	–	4 h 0 d
Movento (fl oz)	++++ 6.0-9.0	–	–	–	–	–	++++ 9.0	24 h 7 d
Mustang Maxx (fl oz)	+ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	–	12 h 14 d
Perm-Up 3.2EC[1] (fl oz)	+ 4.0-10.0	++++ 4.0-10.0	++++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	–	12 h 14 d
Pounce 25WP[1] (oz)	+ 6.4-16.0	++++ 6.4-16.0	++++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	–	12 h 14 d
Sivanto Prime (fl oz)	–	–	–	–	–	–	++ 10.5-14.0	4 h 14 d
Venerate XC[8] (qt)	–	–	–	–	–	–	++++ 1-2	4 h 0 d
Verdepryn 100SL (fl oz)	–	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	+ 5.5-11.0	+ 5.5-11.0	– –	4 hr 7 d
Versys (fl oz)	++++ 1.5	–	–	–	–	–		12 h 7 d
Voliam Flexi WG (oz)	++++ 4.0-7.0	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	+++ 4.0-7.0	+++ 6.0-7.0	–	24 h 14 d
Warrior II[1] (fl oz)	+ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56	-	24 h 14 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated, S = suppression.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Apply before egg hatch.
[5] Lannate LV is not registered for nectarines.
[6] Lannate SP 72 h REI for nectarine, 96 h for peach.
[7] Lannate SP 1 d PHI for nectarine, 4 d for peach.
[8] Make 2 Applications of Venerate 7 d apart starting a week after crawler emergence.
[9] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.
[10] Imidan REI 4 d for farm labor, but 14 d for u-pick operations. [11]Closer SC applied to White Peach/San Jose Scale crawler stage.

SECOND COVER					PEACHES AND NECTARINES
DISEASE	**Bacterial Spot**	**Rusty Spot**	**Scab**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Abound 2F (fl oz)	–	++ 12.0-15.5	+++ 12.0-15.5		4 h 0 d
Armicarb 100 85SP[4] (lb)	–	+++ 2.5-5.0	–		4 h 0 d
Captan 80WDG[5] (lb)	–	–	+++ 2.5-3.75		24 h 0 d
Cevya 3.34SC (fl oz)	–	+++ 4.0-5.0	–		12 h 0 d
Flint Extra 4.05SC (fl oz)	–	+++ 2.5-3.8	+++ 2.5-3.8		12 h 1 d
Fontelis 1.67SC (fl oz)	–	++ 14.0-20.0	++ 14.0-20.0		12 h 0 d
Inspire Super 2.82EW (fl oz)	–	+++ 16.0-20.0	+++ 16.0-20.0		12 h 2 d
Kaligreen 82SP[4] (lb)	–	+++ 2.5-3.0	–		4 h 1 d
Kocide 3000 30DF[5] (oz)	+++ 1.0-1.7	–	–		24 h 0 d
Luna Experience 3.34SC (fl oz)	–	++ 6.0-10.0	+ 6.0-10.0		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	+++ 5.0-7.6	+++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	–	++ 4.0-6.7	++ 4.0-6.7		12 h 0 d
Mycoshield 17WP[5] (lb)	+++ 1.0-1.5	–	–		12 h 21 d
Pristine 38WG (oz)	–	++ 10.5-14.5	++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	+++ 12.0-14.0	++++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	+ 2.5-3.5	++ 2.5-3.5		12 h 14 d
Rally 40WSP[4] (oz)	–	++++ 2.5-6.0	–		24 h 0 d
Serenade MAX 14.6WP[4] (lb)	–	+++ 1.0-3.0	–		4 h 0 d
Sulfur, actual[5,6] (lb)	–	+ 10.0-12.0	++ 10.0-12.0		24 h NTL[7]
Topsin M WSB (lb) plus Captan 80WDG (lb)[5]	–	–	+++ 0.5-0.75 plus 1.25-2.5		48 h 1 d
Topsin M WSB (lb) plus Sulfur, actual (lb) [5,6]	–	+ 0.5-0.75 plus 6.0-12.0	++ 0.5-0.75 plus 6.0-12.0		48 h 1 d
Ziram 76DF (lb)	–	–	++ 4.5-8.0		48 h 14 d

[1] Alternate products of different chemistry for resistance management; see Table 7.7 for details.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Integrated biorational rusty spot control program: see note at petal-fall stage.
[5] Generic products and/or other formulations are available.
[6] Do not use sulfur if temperature is expected to exceed 90°F after spraying.
[7] PHI Key: NTL= No time limit (usually up to the day of harvest) - consult label.

SECOND COVER — PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Leaf-roller	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**							**REI PHI**
Actara 25WG (oz)	–	–	+++ 4.5-5.5	+++ 4.5-5.5	+++ 4.5-5.5	+++ 5.0		12 h 14 d
Admire Pro[1] (fl oz)	–	–	S 2.8	–	+ 1.4-2.8	+++ 1.4-2.8		12 h 0 d
Altacor (oz)	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	–		4 h 10 d
Ambush 25W[1] (oz)	++++ 6.4-19.2	++++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	–		12 h 14 d
Apta/Bexar (fl oz)	++ 21.0-27.0	–	+++ 21.0-27.0	S 21.0-27.0	S 21.0-27.0	–		12 h 14 d
Asana XL[1] (fl oz)	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	++ 14.0-14.5	+++ 10.0-14.4	–		12 h 14 d
Assail 30SG (oz)	–	+++ 6.0-8.0	++ 6.0-8.0	++ 5.3-8.0	+++ 5.3-8.0	+++ 6.0-8.0		12 h 7 d
Avaunt (oz)	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	+ 6.0	++ 5.0-6.0	–		12 h 14 d
Baythroid XL (fl oz)	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	+++ 2.4	++++ 2.0-2.4	–		12 h 7 d
Belay (fl oz)	–	–	+++ 6.0	++++ 6.0	+++ 6.0	+++ 6.0		12 h 21 d
Beleaf 50SG (oz)	–	–	–	+ 2.0-2.8	+++ 2.0-2.8	–		12 h 14 d
Besiege (fl oz)	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	+++ 9.0-12.0	+++ 6.0-12.0	–		24 h 14 d
Centaur WDG (oz)	–	–	–	–	–	++++ 34.5		12 h 14 d
Closer SC (fl oz)	–	–	–	++ 5.75	++ 2.75-5.75	+++ 5.75[11]		12 h 7 d
Cormoran (fl oz)	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	++ 20.0-28	+++ 20.0-28	+++ 20.0-28		12 h 8 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 16-21.3	++++ 10.6-21.3	–		24 h 3 d
Delegate 25WG (oz)	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	–	–	–		4 h 1 d
Diazinon 50W[9] (lb)	++ 2.0-3.0	+++ 3.0-4.0	+++ 3.0-4.0	+ 3.0-4.0	++ 3.0-4.0	+++ 3.0-4.0		96 h 21 d
Endigo ZC (fl oz)	++++ 5.5-6.0	++++ 5.5-6.0	++ 5.5-6.0	++++ 3.4-5.5	+++ 5.0-5.5	–		24 h 14 d
Entrust SC (fl oz)	++++ 4.0-8.0	+++ 4.0-8.0	–	–	–	–		4 h 1 day
Esteem 35WP (oz)	–	+++ 4.0-5.0	–	–	–	++++ 4.0-5.0		12 h 14 d
Exirel (fl oz)	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	–		12 h 3 d
Imidan 70W[10] (lb)	++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+ 2.5-3.0	+++ 2.5-3.0	+ 2.0-3.0		4/14 d[10] 14 d
Intrepid 2F[4] (fl oz)	++++ 8.0-16.0	+++ 12.0-16.0	–	–	–	–		4 h 7 d

Second Cover INSECT PESTS - continued on next page

Second Cover INSECT PESTS - continued

SECOND COVER **PEACHES AND NECTARINES**

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Leaf-roller	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale		
Lambda-Cy (fl oz)	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12	–		24 h 14 d
Lannate LV[5] (pt)	+++ 3.0	+++ 3.0	++ 3.0	++ 3.0	+++ 3.0	–		96 h 4 d
Lannate SP[6,7] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	++ 0.5-1.0	++ 1.0	+++ 1.0	–		72/96 h[6] 1/4 d[7]
Leverage 360 (oz)	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8		12 h 7 d
Madex HP (fl oz)	–	++++ 0.5-3.0	–	–	–	–		4 h 0 d
Movento (fl oz)	–	–	–	–	–	++++ 9.0		24 h 7 d
Mustang Maxx (fl oz)	++++ 1.28-4.0	++++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	–		12 h 14 d
Perm-Up 3.2EC[1] (fl oz)	++++ 4.0-10.0	++++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	–		12 h 14 d
Pounce 25WP[1] (oz)	++++ 6.4-16.0	++++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	–		12 h 14 d
Sivanto Prime (fl oz)	–	–	–	–	–	++ 10.5-14.0		4 h 14 d
Venerate XC[8] (qt)	–	–	–	–	–	++++ 1-2		4 h 0 d
Verdepryn 100SL (fl oz)	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	+ 5.5-11.0	+ 5.5-11.0	–		4 hr 7 d
Voliam Flexi WG (oz)	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	+++ 4.0-7.0	+++ 6.0-7.0	–		24 h 14 d
Warrior II[1] (fl oz)	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56	–		24 h 14 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated, S = suppression.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Apply before egg hatch.
[5] Lannate LV is not registered for nectarines.
[6] Lannate SP 72 h REI for nectarine, 96 h for peach.
[7] Lannate SP 1 d PHI for nectarine, 4 d for peach.
[8] Make 2 Applications of Venerate 7 d apart starting a week after crawler emergence.
[9] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.
[10] Imidan REI 4 d for farm labor, but 14 d for u-pick operations.
[11] Closer SC applied to White Peach/San Jose Scale crawler stage.

THIRD AND FOURTH COVERS					PEACHES AND NECTARINES
DISEASE	**Bacterial Spot**	**Scab[1]**			
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F (fl oz)	–	+++ 12.0-15.5			4 h 0 d
Captan 80WDG[5] (lb)	–	+++ 2.5-3.75			24 h 0 d
Flint Extra 4.05SC (fl oz)	–	+++ 2.5-3.8			12 h 1 d
Fontelis 1.67SC (fl oz)	–	++ 14.0-20.0			12 h 0 d
Inspire Super 2.82EW (fl oz)	–	+++ 16.0-20.0			12 h 2 d
Kocide 3000 30DF[5] (oz)	+++ 1.0-1.7	–			24 h 0 d
Luna Experience 3.34SC (fl oz)	–	+ 6.0-10.0			12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	+++ 5.0-7.6			12 h 1 d
Merivon 4.18SC (fl oz)	–	++ 4.0-6.7			12 h 0 d
Mycoshield 17WP[5] (lb)	+++ 1.0-1.5	–			12 h 21 d
Pristine 38WG (oz)	–	++ 10.5-14.5			12 h 0 d
Quadris Top 2.72SC (fl oz)	–	++++ 12.0-14.0			12 h 0 d
Quash 50WDG (oz)	+ 2.5-3.5	++ 2.5-3.5			12 h 14 d
Sulfur, actual[5,6] (lb)	–	++ 10.0-12.0			24 h NTL[7]
Topsin M WSB (lb) plus Captan 80WDG (lb)[5]	–	+++ 0.5-0.75 plus 1.25-2.5			48 h 1 d
Topsin M WSB (lb) plus Sulfur, actual (lb)[5,6]	–	++ 0.5-0.75 plus 6.0-12.0			48 h 1 d
Ziram 76DF (lb)	–	++ 4.5-8.0			48 h 14 d

[1] Continue scab control if much scab occurred in the previous year or weather remains wet.
[2] Alternate products of different chemistry for resistance management; see Table 7.7 for details.
[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Generic products and/or other formulations are available.
[6] Do not use sulfur if temperature is expected to exceed 90°F after spraying.
[7] PHI Key: NTL= No time limit (usually up to the day of harvest) - consult label.

THIRD AND FOURTH COVERS — PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Japanese/ June Beetle	Leafrollers	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**							**REI PHI**
Actara 25WG (oz)	+ 5.5	–	–	+++ 4.5-5.5	+++ 4.5-5.5	+++ 4.5-5.5	+++ 5.0	12 h 14 d
Admire Pro[1] (fl oz)	+++ 1.4-2.8	–	–	S 2.8	–	+ 1.4-2.8	+++ 1.4-2.8	12 h 0 d
Altacor (oz)	–	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	–	4 h 10 d
Ambush 25W[1] (oz)	+++ 6.4-19.2	++++ 6.4-19.2	++++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	–	12 h 14 d
Apta/Bexar (fl oz)	–	++ 21.0-27.0	–	+++ 21.0-27.0	S 21.0-27.0	S 21.0-27.0	–	12 h 14 d
Asana XL[1] (fl oz)	+++ 6.0-10.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	++ 14.0-14.5	+++ 10.0-14.4	–	12 h 14 d
Assail 30SG (oz)	+++ 5.3-8.0	–	+++ 6.0-8.0	++ 6.0-8.0	++ 5.3-8.0	+++ 5.3-8.0	+++ 6.0-8.0	12 h 7 d
Avaunt (oz)	+++ 6.0	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	+ 6.0	++ 5.0-6.0	–	12 h 14 d
Baythroid XL (fl oz)	+++ 2.4-2.8	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	+++ 2.4	++++ 2.0-2.4	–	12 h 7 d
Belay (fl oz)	+++ 2.0-4.0	–	–	+++ 6.0	++++ 6.0	+++ 6.0	+++ 6.0	12 h 21 d
Beleaf 50SG (oz)	–	–	–	–	+ 2.0-2.8	+++ 2.0-2.8	–	12 h 14 d
Besiege (fl oz)	+++ 6.0-12.0	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	+++ 9.0-12.0	+++ 6.0-12.0	–	24 h 14 d
Centaur WDG (oz)	–	–	–	–	–	–	++++ 34.5	12 h 14 d
Closer SC (fl oz)	–	–	–	–	++ 5.75	++ 2.75-5.75	+++ 5.75[11]	12 h 7 d
Cormoran (fl oz)	++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	++ 20.0-28	+++ 20.0-28	+++ 20.0-28	12 h 8 d
Danitol 2.4 EC (fl oz)	–	++++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 16-21.3	++++ 10.6-21.3	–	24 h 3 d
Delegate 25WG (oz)	–	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	–	–	–	4 h 1 d
Diazinon 50W[9] (lb)	+++ 3.0-4.0	++ 2.0-3.0	+++ 3.0-4.0	+++ 3.0-4.0	+ 3.0-4.0	++ 3.0-4.0	+++ 3.0-4.0	96 h 21 d
Endigo ZC (fl oz)	+++ 5.5-6.0	++++ 5.5-6.0	++++ 5.5-6.0	++ 5.5-6.0	++++ 3.4-5.5	+++ 5.0-5.5	–	24 h 14 d
Entrust SC (fl oz)	–	++++ 4.0-8.0	+++ 4.0-8.0	–	–	–	–	4 h 1 d
Esteem 35WP (oz)	–	–	+++ 4.0-5.0	–	–	–	++++ 4.0-5.0	12 h 14 d
Exirel (fl oz)	–	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	–	12 h 3 d
Imidan 70W[10] (lb)	+++ 2.0-3.0	++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+ 2.5-3.0	+++ 2.5-3.0	+ 2.0-3.0	4/14 d[10] 14 d
Intrepid 2F[4] (fl oz)	–	++++ 8.0-16.0	+++ 12.0-16.0	–	–	–	–	4 h 7 d

Third and Fourth Covers INSECT PESTS - continued on next page

Third and Fourth Covers INSECT PESTS - continued

THIRD AND FOURTH COVERS — PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Japanese/ June Beetle	Leafrollers	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale	REI PHI
Lambda-Cy (fl oz)	+++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12	–	24 h 14 d
Lannate LV[5] (pt)	+++ 3.0	+++ 3.0	+++ 3.0	++ 3.0	++ 3.0	+++ 3.0	–	96 h 4 d
Lannate SP[6,7] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	+++ 0.5-1.0	++ 0.5-1.0	++ 1.0	+++ 1.0	–	72/96 h[6] 1/4 d[7]
Leverage 360 (oz)	+++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)	–	–	++++ 0.5-3.0	–	–	–	–	4 h 0 d
Movento (fl oz)	–	–	–	–	–	–	++++ 9.0	24 h 7 d
Mustang Maxx (fl oz)	+++ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	–	12 h 14 d
Perm-Up 3.2EC[1] (fl oz)	+++ 4.0-10.0	++++ 4.0-10.0	++++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	–	12 h 14 d
Pounce 25WP[1] (oz)	+++ 6.4-16.0	++++ 6.4-16.0	++++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	–	12 h 14 d
Sivanto Prime (fl oz)	–	–	–	–	–	–	++ 10.5-14.0	4 h 14 d
Venerate XC[8] (qt)	–	–	–	–	–	–	++++ 1-2	4 h 0 d
Verdepryn 100SL (fl oz)	+++ 5.5-11.0	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	+ 5.5-11.0	+ 5.5-11.0	–	4 h 7 d
Voliam Flexi WG (oz)	–	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	+++ 4.0-7.0	+++ 6.0-7.0	–	24 h 14 d
Warrior II[1] (fl oz)	+++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56	–	24 h 14 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated, S = suppression.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Apply before egg hatch.
[5] Lannate LV is not registered for nectarines.
[6] Lannate SP 72 h REI for nectarine, 96 h for peach.
[7] Lannate SP 1 d PHI for nectarine, 4 d for peach.
[8] Make 2 Applications of Venerate 7 d apart starting a week after crawler emergence.
[9] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.
[10] Imidan REI 4 d for farm labor, but 14 d for u-pick operations.
[11] Closer SC applied to White Peach/San Jose Scale is for the crawler stage only, consult newsletter for timing.

FIFTH, SIXTH AND LATER COVERS					PEACHES AND NECTARINES
DISEASE	**Anthracnose[1]**	**Bacterial Spot**	**Scab[2]**		
Product and Formulation[3]	**Product Efficacy Rating[4] and Rate/A[5]**				**REI PHI**
Abound 2F (fl oz)	–	–	+++ 12.0-15.5		4 h 0 d
Captan 80WDG[6] (lb)	+++ 2.5	–	+++ 2.5-3.75		24 h 0 d
Flint Extra 4.05SC (fl oz)	–	–	+++ 2.5-3.8		12 h 1 d
Fontelis 1.67SC (fl oz)	–	–	++ 14.0-20.0		12 h 0 d
Inspire Super 2.82EW (fl oz)	–	–	+++ 16.0-20.0		12 h 2 d
Kocide 3000 30DF[6] (oz)	–	+++ 1.0-1.7	–		24 h 0 d
Luna Experience 3.34SC (fl oz)	–	–	+ 6.0-10.0		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	–	+++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	–	–	++ 4.0-6.7		12 h 0 d
Mycoshield 17WP[6] (lb)	–	+++ 1.0-1.5	–		12 h 21 d
Pristine 38WG (oz)	–	–	++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	–	++++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	–	++ 2.5-3.5		12 h 14 d
Sulfur, actual[6,7] (lb)	–	–	++ 10.0-12.0		24 h NTL[8]
Topsin M WSB (lb) plus Captan 80WDG (lb)[6]	–	–	+++ 0.5-0.75 plus 1.25-2.5		48 h 1 d
Topsin M WSB (lb) plus Sulfur, actual (lb)[6,7]	–	–	++ 0.5-0.75 plus 6.0-12.0		48 h 1 d
Ziram 76DF (lb)	+++ 4.5-8.0	–	++ 4.5-8.0		48 h 14 d

[1] Only spray for anthracnose if disease has occurred during previous seasons.
[2] Continue scab control if more than 40 d prior to harvest.
[3] Alternate products of different chemistry for resistance management; see Table 7.7 for details.
[4] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[5] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[6] Generic products and/or other formulations are available.
[7] Do not use sulfur if temperature is expected to exceed 90°F after spraying.
[8] PHI Key: NTL = No time limit (usually up to the day of harvest) - consult label.

FIFTH, SIXTH AND LATER COVERS — PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Japanese/ June Beetle	Leafrollers	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**							**REI PHI**
Actara 25WG (oz)	+ 5.5	–	–	+++ 4.5-5.5	+++ 4.5-5.5	+++ 4.5-5.5	+++ 5.0	12 h 14 d
Admire Pro[1] (fl oz)	+++ 1.4-2.8	–	–	S 2.8	–	+ 1.4-2.8	+++ 1.4-2.8	12 h 0 d
Altacor (oz)	–	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	–	4 h 10 d
Ambush 25W[1] (oz)	+++ 6.4-19.2	++++ 6.4-19.2	++++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	++ 6.4-19.2	–	12 h 14 d
Apta/Bexar (fl oz)	–	++ 21.0-27.0	–	+++ 21.0-27.0	S 21.0-27.0	S 21.0-27.0	–	12 h 14 d
Asana XL[1] (fl oz)	+++ 6.0-10.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	++ 14.0-14.5	+++ 10.0-14.4	–	12 h 14 d
Assail 30SG (oz)	+++ 5.3-8.0	–	+++ 6.0-8.0	++ 6.0-8.0	++ 5.3-8.0	+++ 5.3-8.0	+++ 6.0-8.0	12 h 7 d
Avaunt (oz)	+++ 6.0	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	+ 6.0	++ 5.0-6.0	–	12 h 14 d
Baythroid XL (fl oz)	+++ 2.4-2.8	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	+++ 2.4	++++ 2.0-2.4	–	12 h 7 d
Belay (fl oz)	+++ 2.0-4.0	–	–	+++ 6.0	++++ 6.0	+++ 6.0	+++ 6.0	12 h 21 d
Beleaf 50SG (oz)	–	–	–	–	+ 2.0-2.8	+++ 2.0-2.8	–	12 h 14 d
Besiege (fl oz)	+++ 6.0-12.0	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	+++ 9.0-12.0	+++ 6.0-12.0	–	24 h 14 d
Centaur WDG (oz)	–	–	–	–	–	–	++++ 34.5	12 h 14 d
Closer SC (fl oz)	–	–	–	–	++ 5.75	++ 2.75-5.75	+++ 5.75[11]	12 h 7 d
Cormoran (fl oz)	++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	++ 20.0-28	+++ 20.0-28	+++ 20.0-28	12 h 8 d
Danitol 2.4 EC (fl oz)	–	++++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 16-21.3	++++ 10.6-21.3	–	24 h 3 d
Delegate 25WG (oz)	–	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	–	–	–	4 h 1 d
Diazinon 50W[9] (lb)	+++ 3.0-4.0	++ 2.0-3.0	+++ 3.0-4.0	+++ 3.0-4.0	+ 3.0-4.0	++ 3.0-4.0	+++ 3.0-4.0	96 h 21 d
Endigo ZC (fl oz)	+++ 5.5-6.0	++++ 5.5-6.0	++++ 5.5-6.0	++ 5.5-6.0	++++ 3.4-5.5	+++ 5.0-5.5	–	24 h 14 d
Entrust SC (fl oz)	–	++++ 4.0-8.0	+++ 4.0-8.0	–	–	–	–	4 h 1 d
Esteem 35WP (oz)	–	–	+++ 4.0-5.0	–	–	–	++++ 4.0-5.0	12 h 14 d
Exirel (fl oz)	–	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	–	12 h 3 d
Imidan 70W[10] (lb)	+++ 2.0-3.0	++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+ 2.5-3.0	+++ 2.5-3.0	+ 2.0-3.0	4/14 d[10] 14 d
Intrepid 2F[4] (fl oz)	–	++++ 8.0-16.0	+++ 12.0-16.0	–	–	–	–	4 h 7 d

Fifth, Sixth, and Later Covers INSECT PESTS - continued on next page

Fifth, Sixth, and Later Covers INSECT PESTS - continued

FIFTH, SIXTH AND LATER COVERS **PEACHES AND NECTARINES**

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Japanese/ June Beetle	Leafrollers	Oriental Fruit Moth	Plum Circulio	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Peach/ San Jose Scale	REI PHI
Lambda-Cy (fl oz)	+++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12	–	24 h 14 d
Lannate LV[5] (pt)	+++ 3.0	+++ 3.0	+++ 3.0	++ 3.0	++ 3.0	+++ 3.0	–	96 h 4 d
Lannate SP[6,7] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	+++ 0.5-1.0	++ 0.5-1.0	++ 1.0	+++ 1.0	–	72/96 h[6] 1/4 d[7]
Leverage 360 (oz)	+++ 2.4-2.8	++++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)	–	–	–	++++ 0.5-3.0	–	–	–	4 h 0 d
Movento (fl oz)	–	–	–	–	–	–	++++ 9.0	24 h 7 d
Mustang Maxx (fl oz)	+++ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	+++ 1.28-4.0	–	12 h 14 d
Perm-Up 3.2EC[1] (fl oz)	+++ 4.0-10.0	++++ 4.0-10.0	++++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	++ 4.0-10.0	–	12 h 14 d
Pounce 25WP[1] (oz)	+++ 6.4-16.0	++++ 6.4-16.0	++++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	++ 6.4-16.0	–	12 h 14 d
Sivanto Prime (fl oz)	–	–	–	–	–	–	++ 10.5-14.0	4 h 14 d
Venerate XC[8] (qt)	–	–	–	–	+++ 1-2	–	++++ 1-2	4 h 0 d
Verdepryn 100SL (fl oz)	+++ 5.5-11.0	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	+ 5.5-11.0	+ 5.5-11.0	–	4 h 7 d
Voliam Flexi WG (oz)	–	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	+++ 4.0-7.0	+++ 6.0-7.0	–	24 h 14 d
Warrior II[1] (fl oz)	+++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56	–	24 h 14 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated, S = suppression.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Apply before egg hatch.
[5] Lannate LV is not registered for nectarines.
[6] Lannate SP 72 h REI for nectarine, 96 h for peach.
[7] Lannate SP 1 d PHI for nectarine, 4 d for peach.
[8] Make 2 Applications of Venerate 7 d apart starting a week after crawler emergence. Venerate has shown efficacy as a pre-harvest treatment against BMSB in peach.
[9] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.
[10] Imidan REI 4 d for farm labor, but 14 d for u-pick operations.
[11] Closer SC applied to White Peach/San Jose Scale crawler stage.

PREHARVST					PEACHES AND NECTARINES
DISEASE	**Anthracnose[1]**	**Brown Rot Fruit Rot[2]**	**Rhizopus Rot[3]**		
Product and Formulation[4]	**Product Efficacy Rating[5] and Rate/A[6]**				**REI PHI**
Abound 2F (fl oz)	– 12.0-15.5	+++ 12.0-15.5	–		4 h 0 d
Botran 75WP (lb)	–	+ 1.33-5.33	+++ 1.5-5.0		12 h 10 d
Bumper/Tilt[7] (fl oz)	–	+++ 4.0	–		24 h 0 d
Captan 80WDG[7] (lb)	+++ 2.5	+++ 3.75	–		24 h 0 d
Cevya 3.34SC (fl oz)	–	++++ 3.0-5.0	–		12 h 0 d
Elevate 50WDG (lb)	–	++ 1.0-1.5	–		4 h 0 d
Flint Extra 4.05SC (fl oz)	–	+++ 2.5-3.8	–		12 h 1 d
Fontelis 1.67SC (fl oz)	–	+++ 14.0-20.0	+ 14.0-20.0		12 h 0 d
Indar 2F[8] (fl oz)	–	++++ 6.0-12.0	–		12 h 0 d
Inspire Super 2.82EW (fl oz)	–	+++ 16.0-20.0	–		12 h 2 d
Luna Experience 3.34SC (fl oz)	–	+++ 6.0-10.0	–		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	++++ 5.0-7.6	–		12 h 1 d
Merivon 4.18SC (fl oz)	–	++++ 4.0-6.7	+++ 4.0-6.7		12 h 0 d
Miravis 1.67SC (fl oz)	–	+++ 3.4-5.1	–		4 h 0 d
Orius AQ 1.67F (fl oz)	–	++++ 8.6-17.2	+++ 8.6-17.2		12 h 0 d
Oso 5%SC (fl oz)	–	+++ 6.5-13.0	–		4 h 0 d
Pristine 38WG (oz)	–	++++ 10.5-14.5	–		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	++++ 12.0-14.0	++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	++++ 3.5-4.0	–		12 h 14 d
Topguard (fl oz)	–	++ 14.0	–		12 h 7 d
Topsin M WSB (lb) plus Captan 80WDG (lb)[7]	–	+++ 0.5-0.75 plus 1.25-2.5	–		48 h 1 d

[1] Only spray for anthracnose if disease has occurred during previous seasons.
[2] A total of two-three fruit rot sprays are needed. Apply the first spray at 14-21 d preharvest and the second 7-14 d later. Apply a third spray just prior to harvest if label allows; this spray can also be applied between pickings.
[3] Typically no preharvest sprays are necessary for Rhizopus rot control. However, in very wet seasons and on later maturing cultivars, rot can become problematic. Under these conditions, higher application rates are advised.
[4] Alternate products of different chemistry for resistance management; see Table 7.7 for details.
[5] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[6] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[7] Generic products and/or other formulations are available.
[8] In New Jersey, an EPA 24c special local need registration allows use of Indar 2F at a maximum 12.0 fl oz/A. rate.

PREHARVEST — PEACHES AND NECTARINES

See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.

INSECT PEST	Japanese/ June Beetle	Oriental Fruit Moth	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	Tufted Apple Bud Moth, Leafrollers	Thrips	White Peach/ San Jose Scale	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**							**REI PHI**
Admire Pro (fl oz)	++++ 6.0-8.0	–	–	S 2.8	–	+++ 6.0-8.0	+++ 6.0-8.0	12 h 0 d
Assail 30SG (oz)	+++ 5.3-8.0	+++ 6.0-8.0	++ 8.0	+++ 6.0-8.0	–	–	+++ 6.0-8.0	12 h 7 d
Baythroid XL (fl oz)	+++ 2.4-2.8	++++ 2.0-2.4	+++ 2.0	++++ 2.0-2.4	++++ 2.4-2.8	–	–	12 h 7 d
Cormoran (fl oz)	++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28	+++ 20.0-28	++++ 20.0-28.0	–	+++ 20.0-28	12 h 8 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	+++ 10.6-21.3	+++ 21.3	+++ 10.6-21.3	++++ 10.6-21.3	–	–	24 h 3 d
Delegate 25WG (oz)	–	++++ 6.0-7.0	+ 4.5-8.0	–	++++ 4.5-7.0	+++ 4.5-7.0	–	4 h 1 d
Intrepid 2F[4] (fl oz)	–	+++ 12.0-16.0	–	–	++++ 8.0-16.0	–	–	4 h 7 d
Lannate LV[5] (pt)	+++ 3.0	+++ 3.0	++++ 3.0	+++ 3.0	+++ 3.0	+++ 3.0	–	96 h 4 d
Lannate SP[6,7] (lb)	+++ 0.5-1.0	+++ 0.5-1.0	++++ 1.0	+++ 0.5-1.0	+++ 0.5-1.0	+++ 0.5-1.0	–	72/96 h[6] 1/4 d[7]
Leverage 360 (oz)	+++ 2.4-2.8	++++ 2.4-2.8	–	++++ 2.4-2.8	++++ 2.4-2.8	–	+++ 2.4-2.8	12 h 7 d
Movento (fl oz)	–	–	–	–	–	–	++++ 8.0-9.0	24 h 7 d
Sevin 80WSB (lb)	++++ 2.0-3.0	+++ 2.5-3.0	–	–	++ 2.0-3.0	–	–	12 h 3 d
Sevin XLR Plus (qt)	++++ 2.0-3.0	+++ 2.0-3.0	–	–	++ 2.0-3.0	–	–	12 h 3 d
Venerate XC[8] (qt)	–	–	–	–	+++ 1-2	–	++++ 1-2	4 h 0 d
Verdepryn 100SL (fl oz)	+++ 5.5-11.0	++++ 5.5-11.0	+ 5.5-11.0	+ 5.5-11.0	++++ 5.5-11.0	–	–	4 hr 7 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated, S = suppression.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Apply before egg hatch.
[5] Lannate LV is not registered for nectarines.
[6] Lannate SP 72 h REI for nectarine, 96 h for peach.
[7] Lannate SP 1 d PHI for nectarine, 4 d for peach.
[8] Make 2 Applications of Venerate 7 d apart starting a week after crawler emergence.

POSTHARVEST					PEACHES AND NECTARINES
DISEASE	**Leaf Curl[1]**				
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Bordeaux mixture (lb/100 gal)	++ 4, 6				24 h NA[5]
Bravo Weather Stik 6F[4] (pt)	++++ 3.0-4.0				12 h NA[5]
Copper, fixed[4]	++ various rates				12-48 h various
Ferbam 76WDG (lb)	++++ 4.0				24 h NA[5]
Lime Sulfur 10.6F (gal)	+ 6.0-8.0				48 h NA[5]
Ziram 76DF (lb)	++++ 3.75-8.0				48 h NA[5]

[1] Apply fungicides for leaf curl control after most leaves have fallen. If no spray is applied at this time, a dormant application should be made in spring just prior to bud-break.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Generic products and/or other formulations are available.
[5] NA=not applicable

POSTHARVEST					PEACHES AND NECTARINES
See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.					
INSECT PEST	**Lesser Peach Tree Borer**	**Peach Tree Borer[1]**			
Product and Formulation	**Product Efficacy[2] and Rate (per acre rate by handgun in minimum of 100 gal/A)**				**REI PHI**
Asana XL (fl oz/100 gal)	+++ 5.8	++ 5.8			12 h 14 d
Cobalt or Cobalt Advanced (qt/100 gal)	++++ 4.7	++++ 4.7			96 h 14 d
Lorsban-4E (qt/100 gal)	++++ 1.5-3.0	++++ 1.5-3.0			96 h 14 d
Lorsban 75WG (lb)	++++ 3.0-4.0	++++ 3.0-4.0			96 h 14 d

[1] Apply just after harvest in early September in southern counties, slightly later in the northern part of the state.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

MITICIDES FOR POSTBLOOM USE					PEACHES AND NECTARINES
MITE PEST	**European Red Mite**	**Peach Silver Mite**	**Two-Spotted Spider Mite**		
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**			**IRAC Class**	**REI PHI**
Acramite 50WS[3] (lb)	++++ 0.75-1.0	+++ 0.75-1.0	++++ 0.75-1.0	20D	12 h 3 d
Agri-Mek SC (fl oz) plus Paraffinic Spray Oil	++++ 2.25-4.25	–	++++ 2.25-4.25	6	12 h 21 d
Apollo SC[4] (oz)	++++ 2.0-8.0	++ 2.0-8.0	++++ 2.0-8.0	10A	12 h 21 d
Envidor 2SC (fl oz)	++++ 16.0-18.0	++++ 16.0-18.0	++++ 16.0-18.0	23	12 h 7 d
Nealta (fl oz)	++++ 13.7	–	++++ 13.7	25	12 h 7 d
Nexter 75WP (oz)	++++ 4.4-5.2	++ 5.2-10.67	++ 5.2-10.67	21A	12 h 7 d
Onager EC (oz)	++++ 12.0-24.0	–	++++ 12.0-24.0	10A	12 h 28 d
Portal XLO (pt)	+++ 1.0-2.0	–	+++ 1.0-2.0	21A	12 h 7 d
Savey 50DF (oz)	++++ 3.0-6.0	–	++++ 3.0-6.0	10A	12 h 28 d
Vendex 50WP (lb)	+++ 1.0-2.0	+++ 1.0-2.0	+++ 1.0-2.0	12B	48 h 14 d
Zeal (oz)	++++ 2.0-3.0	–	++++ 2.0-3.0	10B	12 h 7 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] Acramite requires spray water to be corrected for pH and hardness. See label.
[4] Less than 4.0 oz/A Apollo is recommended only in established IPM programs and only when adequate numbers of predator mites are present.

7.8 Peach and Nectarine Pest Management, Non-Bearing Trees

NON-BEARING TREES	PEACHES AND NECTARINES
INSECT OR MITE PESTS	
Choose insecticides and miticides from Insect Spray Guide tables, and Miticides for Postbloom Use table above.	

NON-BEARING TREES					PEACHES AND NECTARINES
DISEASE	**Brown Rot Blossom Blight[1]**	**Scab[2]**			
Product and Formulation	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Bravo Weather Stik 6F[5] (pt)	+++ 3.0-4.0	++++ 3.0-4.0			12 h SS[7]
Captan 80WDG[5] (lb)	++ 2.5	+++ 2.5			24 h 0 d
Sulfur, actual[5,6] (lb)	++ 8.0	++ 8.0-12.0			24 h NTL[7]
Ziram 76DF (lb)	++ 4.5-8.0	++ 4.5-8.0			48 h 14 d

[1] Make one application during early bloom on 2-year-old trees. Remove fruit on young trees to avoid formation of brown rot mummies.
[2] Scab control is very important during season prior to first year of harvest. Minimize build-up of inoculum on twigs with sprays at petal fall, shuck-split, and first through fourth cover.
[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Generic products and/or other formulations are available.
[6] Do not use sulfur if temperature is expected to exceed 90°F after spraying.
[7] PHI Key: NTL=No time limit (usually up to the day of harvest) - consult label, SS=No later than shuck-split.

8 Cherries

8.1 Limitations to Cherry Production in New Jersey

There are a number of limitations to growing cherries in New Jersey. Despite these limitations, meticulous growers have had success in growing them throughout the state.

Bacterial Canker

Bacterial Canker can be a serious bacterial disease of sweet cherry in New Jersey. Bacterial canker or bacterial gummosis of sweet cherry is caused by a *Pseudomonas* bacterium.

Pruning practices can be modified to reduce the risk of canker. Only summer pruning should be done. Immediately after harvest, perform dormant pruning. Refer to the spray schedule for special control measures. Also, see "Diseases of Stone Fruit in the Tree Fruit Pests and Controls" chapter for a description of Bacterial Canker. Multiple applications of Bordeaux mix and additional copper sprays have been found to help manage bacterial canker infections.

Cracking of Cherry Fruit

Aside from bacterial canker, and bird damage, fruit cracking is one of the most significant limitations to cherry production in the Eastern United States. Fruit cracking is more prevalent in sweet than in sour cherries. There are two primary reasons why fruit cracking occurs:, rain/standing water on fruit and over-saturated soil.

1) Standing water on fruit

Standing water on fruit, as the fruit nears harvest is one cause of fruit cracking. The longer the water sits on the fruit the greater the chance that cracking will occur. Control methods include:

a) Varieties and rootstocks less susceptible to cracking

b) High tunnels or row covers: Both can help reduce fruit damage by preventing water from raining down and sitting on fruit. However, there are a number of downsides to consider before installing these systems. High tunnels can be expensive, and they can cause disease issues, notably powdery mildew and brown rot. If tunnels are covered during flowering, it can result in poor pollination unless hives are placed close to the tunnel entrance.

c) Foliar nutrient sprays: Applications of iron III chloride or calcium chloride as fruit grow have been shown to decrease cracking.

d) Cuticle protectants: These products prevent water from being taken up into the fruit skin, and have been shown to reduce rain cracking by up to 50%. When using these products it is critical to ensure that the entire fruit surface is covered. This can be achieved by keeping tractor speeds low and droplet sizes large. The following cuticle protectants are used:

RainGard®: RainGuard® is an inelastic cuticle protectant coating. However, as fruit grows, small cracks occur in the coating thus it must be re-applied several times through a season according to the label.

Parka™: Parka™ is an elastic cuticle coating that will expand as fruit grows, thus fewer applications are needed throughout a season than for RainGuard.

2) Over-saturated soil

Over-saturated soil is the other primary cause of fruit cracking. This occurs as increased saturation of the soil creates pressure build-up in fruit. The following control methods are specific to preventing over-saturated soil:

a) Gutters on high tunnels

b) Raised beds

Both measures can aid in directing rain away from the tree root zone.

For more details on fruit cracking prevention see 'Understanding and Preventing Sweet Cherry Fruit Cracking' OSU EM 9227 (2019) *https://catalog.extension.oregonstate.edu/em9227/html*

8.2 Cultivar and Pollinator Choices for Sweet Cherries

Sweet cherries can be more challenging to grow than sour cherries in part due to cracking (described above) and pollination requirements. In addition, NJ growers should be mindful that many new self-fertile cultivars that were bred in dry environments (*i.e.*, Washington and British Columbia) may have a greater tendency to crack in NJ. The harvest season for sweet cherries grown in NJ is approximately early June through mid-July.

Pollination

Nearly all older cherry varieties are self-unfruitful. However, recent breeding advances have resulted in a number of self-fruitful (also called self-fertile) sweet cherry cultivars available for commercial production. If a pollenizer is required for a cultivar to fruit, it is critical to ensure that the pollenizer is both compatible with the cultivar of interest and that it blooms at the same time as the cultivar of interest. Consult with a local county agricultural agent prior to purchasing sweet cherries to ensure the cultivars chosen will provide adequate pollination.

Note: Compatible pollenizer lists are not exclusive. In the table below, each cultivar may be pollinated by a number of other cultivars not listed.

Recommended White or Yellow Fleshed Sweet Cherry Cultivars

Cultivar	Notes	Self-Fruitful	Compatible Pollenizers
Blushing Gold (NY 8182)	yellow skinned mid-season cherry; good resistance to cracking	No	Black Pearl, Burgundy Pearl, Ebony Pearl, Hartland, Kristin, Sandra Rose
Gold	exceptionally hardy cultivar; pollination compatibility with many other cultivars; tends to produce small fruit	No	Hartland, Royalton, Sandra Rose, Skeena
White Gold	**White Gold:** late bloomer harvested during the early to mid-growing season; universal pollinator for many other sweet cherries; resistance to cracking, bacterial canker and leaf spot	Yes	Not Required

Recommended Red or Black Fleshed Sweet Cherry Cultivars

Cultivar	Notes	Self-fruitful	Compatible Pollenizers
Atika	dark red to black skinned cherry with red flesh; vigorous growth habit that blooms later in the season. Late blooms aid in spring frost avoidance	No	Benton, Tamara
Benton	dark red skin that resembles a 'Bing'; self-fruitful, but lower yielding: some resistance to cracking; late season bloom which aids in frost avoidance	Yes	Not Required
Black Gold™ (NY 13791)	dark red skinned and fleshed variety; late season bloom; frost hardiness; heavy producer	Yes	Not Required
Black Pearl	dark mahogany fruit; moderate resistance to cracking; harvested early in the season; very productive tree, heavy pruning required for more vigorous rootstocks	No	Burgundy Pearl
Burgundy Pearl	large mahogany fruit with mild sweet flavor; harvested early in the season; moderate resistance to cracking; some bacterial canker resistance; very productive tree that requires heavy pruning on vigorous rootstocks	No	Burgundy Pearl, Ebony Pearl
Ebony Pearl	mahogany fruit that ripen in the middle of the season; excellent flavor and very large fruit; bacterial canker and rain cracking resistance	No	Black Pearl, Ebony Pearl
Hartland	dark red cultivar with crack resistant skin; flowers in early to mid-season; winter hardiness	No	Gold, Hudson, Kristin, Sweetheart

Recommended Red or Black Fleshed Sweet Cherry Cultivars - continued on next page

Recommended Red or Black Fleshed Sweet Cherry Cultivars - continued

Cultivar	Notes	Self-fruitful	Compatible Pollenizers
Hudson	dark red skin, with resistance to cracking; productive cultivar and one of the latest ripening varieties; cold hardiness and rot resistance	No	Gold, Kristin, Sweetheart
Kristin	dark red/black skinned cultivar with very large fruit; productive trees; some resistance to fruit cracking; late ripening variety; very winder hardy	No	Gold, Hudson, Sweetheart
Regina	late ripening; large mahogany colored fruit; tends to have lower productivity but moderate resistance to powdery mildew; excellent rain cracking resistance	No	Attika
Royalton (NY 11390)	exceptionally large fruit that ripen mid-season; vigorous growth habit	No	Black Pearl, Burgundy Pearl, Ebony Pearl, Hartland, Kristin, Sandra Rose
Sandra Rose	large mahogany colored fruit with excellent flavor; mid-late season bloomer; good pollinizer; somewhat low productivity	Yes	Not Required
Selah	large, firm mahogany fruit; early to mid-season bloomer; moderate yields ripen late in the season	Yes	Not Required
Skeena™	large, firm and flavorful mahogany colored fruit harvested in the mid- to late season; moderate productivity; moderate rain cracking	Yes	Not Required
Sweetheart	bright red cherries with good flavor; harvested late in the season; heavy crops and spreading branches; moderately susceptible to rain cracking	Yes	Not Required

Recommended Blush Sweet Cherry Cultivars

Cultivar	Notes	Self-Fruitful	Compatible Pollenizers
Stardust	heart shaped fruit with clear flesh and yellow skin with a light red overcolor; late blooming; harvested late in the season; some cracking tolerance; excellent pollenizer	Yes	Not Required

8.3 Cultivar Choices for Tart Cherries

Tart or sour cherries are a different species than sweet cherries. Tart cherries are all self-fertile and do not require cross pollination to produce fruit. Sour cherries are harvested from mid-June to mid-July. The vast majority of sour cherries produced in North America are Montmorency.

Tart Cherries Cultivars

Cultivar	Notes
Balaton	large red fleshed fruit with intense red/purple skin; cherries reach 16% sugar content, making it more of a semi-tart variety; harvested later in the season; very vigorous variety, but slightly more susceptible to winter injury than other sour cherries
Danube	a cross between a sweet and a tart cherry; large dark red fruit with some sweetness; harvested early to mid-season
Jubileum	dark red variety with very high sugar content (18-19%) making it a semi-tart cultivar; harvested early to mid-season
Montmorency	productive cultivar with bright red skin and white flesh, harvested mid- to late season

Tart Cherries Cultivars - continued on next page

Tart Cherries Cultivars - continued

Cultivar	Notes
Meteor	bright red fruit; semi-dwarf, hardy and vigorous variety; harvested in the late season
North Star	mahogany red fruit with yellow juicy tender flesh; smaller tree but still productive; harvested mid- to late season; some resistance to leaf spot and brown rot
Surefire™	medium sized bright red fruit with classic tart cherry flavor; harvested mid- to late season

8.4 Cherry Rootstocks

Both tart and sweet cherries have historically been grafted to seedlings of 'Mahaleb' *Prunus mahaleb L.* or 'Mazzard', *Prunus avium*. Both have grown out of favor due after the introduction of a number of precocious, dwarfing, and disease resistant rootstocks.

Gisela rootstocks have gained a significant amount of notoriety in the industry. The Gisela series of rootstocks were bred at the Justus Liebig University in Germany. A number of these rootstocks are suitable for both sweet and tart cherry production in New Jersey, and are widely commercially available in the United States. It is important to note though that Gisela rootstocks require intense cultural management. This includes, regular irrigation, and consistent annual training and pruning, to retain fruit size and yields.

Gisela Series Rootstocks to consider in New Jersey

Rootstock	Notes
Gisela 5	Gisela 5 grows to 40-50% the size of seedling rootstocks, and is not suitable for sandy or dry soils. Production is heavy in the early years, thus heavy pruning is necessary early to ensure the trees to not runt out. Trees have nice wide lateral branch angles. This rootstock is also tolerant to many viruses and heavy soils.
Gisela 6	Gisela 6 grows to 65-95% the size of seedling rootstocks. It is adapted to a wide range of soil types. It is a heavy early producer so care must be taken to ensure desired shoot extension is maintained. This rootstock has good wide and lateral branching in addition to excellent resistance to viruses
Gisela 12	Gisela 12 grows to about 60% the size of seedling rootstocks. It is slightly more vigorous, and anchors slightly better than Gisela 6, and adapted to a wide range of soils. This rootstock has an open spreading branch structure and good virus resistance
Gisela 3	Gisela 3 is best adapted to be grown in covered orchards or high tunnels. It requires deep moist fertile soils to attain its dwarfing capabilities. Yields are high early in the season and it produces wide branch angles.

8.5 References Cherry Cultivation

Iezzoni, A., J. Nugent. Growing Balaton® - Horticultural Considerations, Michigan State University *https://www.canr.msu.edu/uploads/files/Research_Center/NW_Mich_Hort/Training_Pruning_Varities/Growing Balaton.pdf*

Long, L., A. Thompson, M. Whiting. Sweet Cherry Cultivars for the Fresh Markets 2021. PNW 604

Long, L.E., M. Whiting, R. Nunez-Elisea. 2007. Sweet cherry cultivars for the fresh Market. Pacific Northwest Extension Publication PW 604.

Long, L. E., C. Kaiser. 2010. Sweet Cherry Rootstocks. Pacific Northwest Extension Publication PW 619.

Marini, R. P., S. Sherif, A. Smith. 2020. Growing Cherries in Virginia. VA Cooperative Extension Publication 422-018.

Penn State Tree Fruit Production Guide 2020-2021. Penn State Extension

University of Minessota Hardy Stone Fruit *https://mnhardy.umn.edu/varieties/fruit/stone-fruit*

Washington State University Tree Fruit. 2021. *http://treefruit.wsu.edu/varieties-breeding/cultivar-guide/*

8.6 Cherry Pest Management

Abbreviations			
Stone Fruit Preharvest Interval Key		**Units of Measurement**	
D	Dormant application only	/A	per acre
PB	No later than prebloom	d	day(s)
FB	No later than full bloom	fl oz	fluid ounce(s)
PF	No later than petal-fall	gal	gallon(s)
SS	No later than shuck-split	h	hour(s)
SF	No later than shuck-fall	lb	pound(s)
FC	No later than first cover	oz	ounce(s)
NTL	No time limit (usually up to the day of harvest) - consult label	pt	pint(s)
		qt	quart(s)
NA	Not applicable		

DELAYED DORMANT					CHERRY
DISEASE	**Bacterial Canker**				
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Bordeaux mixture[3] (lb/100 gal)	++ 5, 7.5				24 h D
Copper, fixed[3]	++ various rates				12-48 h various

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] Some copper materials only labeled for sour cherry (see postharvest for sweet cherry). Apply first spray at bud break and weekly thereafter. To reduce phytotoxicity, decrease concentration as leaves emerge.

DELAYED DORMANT					CHERRY
INSECT PEST	**Scale Insects**				
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Centaur WDG (oz)	++++ 34.5-46.0				12 h 14 d
Esteem 35WP (oz)	++++ 4.0-5.0				12 h 14 d
Superior Oil, 60 or 70 second viscosity (gal)	++++ 4.0				4 h 0 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

PREBLOOM					CHERRY
DISEASE	**Bacterial Canker**	**Botrytis Blossom Blight**	**Brown Rot Blossom Blight**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Abound 2F[4] (fl oz)	–	–	+++ 12.0-15.5		4 h 0 d
Bravo Weather Stik 6F[5,7] (pt)	–	++ 3.0-4.0	++ 3.0-4.0		12 h SS[8]
Bumper/Tilt[5] (fl oz)	–	–	+++ 4.0		24 h 0 d
Cabrio 20EG (oz)	–	–	++ 9.5		12 h 0 d
Captan 80WDG[5] (lb)	–	++ 2.5	++ 2.5		24 h 0 d
Cevya 3.34SC (fl oz)	–	–	+++ 3.0-5.0		12 h 0 d
Copper, fixed	++ various rates	–	–		12-48 h various
Cuprofix Ultra 40DF[6] (lb)	++ 5.0-8.0	–	–		12 h FC[8]
Elevate 50WDG (lb)	–	++++ 1.0-1.5	+++ 1.0-1.5		12 h 0 d
Fontelis 1.67SC (fl oz)	–	++++ 14.0-20.0	++++ 14.0-20.0		12 h 0 d
Flint Extra 4.05SC (fl oz)	–	–	+++ 2.5-3.8		12 h 1 d
Indar 2F (fl oz)	–	–	++++ 6.0		12 h 0 d
Luna Experience 3.34SC (fl oz)	–	–	+++ 6.0 - 10.0		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	–	++++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	–	++++ 4.0-6.7	++++ 4.0-6.7		12 h 0 d
Miravis 1.67SC (fl oz)	–	–	++ 3.4-5.1		4 h 0 d
Orius AQ 1.67F (fl oz)	–	++ 8.6-17.2	+++ 8.6-17.2		12 h 0 d
Pristine 38WG (oz)	–	+++ 10.5-14.5	++++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	–	++++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	–	+++ 2.5-3.5		12 h 14 d
Rovral 4F[5] (pt)	–	+++ 1.0-2.0	++++ 1.0-2.0		24 h PF[8]
Sulfur, actual (lb)	–	–	++ 10.0-12.0		24 h NTL[8]
Topguard EQ (fl oz)	–	–	++ 6.0-8.0		12 h 7 d
Topsin M WSB (lb)	–	++++ 1.5	++++ 1.5		48 h 1 d
Topsin M WSB (lb) plus Captan 80WDG (lb)[7]	–	–	++++ 0.5-0.75 plus 1.25-2.5		48 h 1 d

Prebloom DISEASE - continued on next page

Prebloom DISEASE - continued

PREBLOOM					CHERRY
DISEASE	**Bacterial Canker**	**Botrytis Blossom Blight**	**Brown Rot Blossom Blight**		
Vangard 75WG[6] (oz)	–	++++ 5.0	+++ 5.0		12 h 2 d
Ziram 76DF (lb)	–	–	++ 5.0-6.0		48 h 14 d

[1] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Abound is very phytotoxic on apples. Do not use near apple orchards.
[5] Generic products and/or other formulations available.
[6] Vangard and Cuprofix are labeled for sour cherry only; do not apply to sweet cherry, as phytotoxicity may occur. Spray copper at bud break and weekly thereafter. To reduce phytotoxicity, decrease concentration as leaves emerge.
[7] If Black Knot is present, use Bravo or Topsin M + Captan combination sprays.
[8] PHI Key: PF=No later than petal-fall, FC=No later than first cover, NTL= No time limit (usually up to the day of harvest) - consult label.

PREBLOOM	CHERRY
INSECT PEST	**Do not apply insecticides during prebloom!**

BLOOM					CHERRY
DISEASE	**Bacterial Canker**	**Botrytis Blossom Blight**	**Brown Rot Blossom Blight**	**Leaf Spot[1]**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F[5] (fl oz)	–	–	+++ 12.0-15.5	+++ 12.0-15.5	4 h 0 d
Bravo Weather Stik 6F[6,8] (pt)	–	++ 3.0-4.0	++ 3.0-4.0	++++ 3.0-4.0	12 h SS[9]
Bumper/Tilt[6] (fl oz)	–	–	+++ 4.0	++ 4.0	24 h 0 d
Cabrio 20EG (oz)	–	–	++ 9.5	–	12 h 0 d
Captan 80WDG[6] (lb)	–	++ 2.5	++ 2.5	++ 2.5	24 h 0 d
Cevya 3.34SC (fl oz)	–	–	+++ 3.0-5.0	–	12 h 0 d
Copper, fixed	++ various rates	–	–	++ various rates	12-48 h various
Cuprofix Ultra 40DF[7] (lb)	++ 5.0-8.0	–	–	++ 4.0-5.0	12 h FC[9]
Elevate 50WDG (lb)	–	++++ 1.0-1.5	+++ 1.0-1.5	–	12 h 0 d
Fontelis 1.67SC (fl oz)	–	++++ 14.0-20.0	++++ 14.0-20.0	+ 14.0-20.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	–	–	+++ 2.5-3.8	++++ 2.5 - 3.8	12 h 1 d
Indar 2F (fl oz)	–	–	++++ 6.0	+++ 6.0	12 h 0 d
Luna Experience 3.34SC (fl oz)	–	–	+++ 6.0 - 10.0	–	12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	–	++++ 5.0-7.6	++++ 5.0-7.6	12 h 1 d
Merivon 4.18SC (fl oz)	–	++++ 4.0-6.7	++++ 4.0-6.7	++++ 4.0-6.7	12 h 0 d
Miravis 1.67SC (fl oz)	–	–	++ 3.4-5.1	–	4 h 0 d
Orius AQ 1.67F (fl oz)	–	+ 8.6-17.2	+++ 8.6-17.2	+++ 8.6-17.2	12 h 0 d
Pristine 38WG (oz)	–	+++ 10.5-14.5	++++ 10.5-14.5	++++ 10.5-14.5	12 h 0 d
Quadris Top 2.72SC (fl oz)	–	–	++++ 12.0-14.0	–	12 h 0 d
Quash 50WDG (oz)	–	–	+++ 2.5-3.5	–	12 h 14 d
Rally 40WSP (oz)	–	–	++++ 2.5-6.0	+++ 2.5-6.0	24 h 0 d
Rovral 4F[6] (pt)	–	+++ 1.0-2.0	++++ 1.0-2.0	–	24 h PF[9]
Sulfur, actual (lb)	–	–	++ 10.0-12.0	–	24 h NTL[9]
Topguard EQ (fl oz)	–	–	++ 6.0-8.0	–	12 h 7 d
Topsin M WSB (lb)	–	++++ 1.5	++++ 1.5	+++ 1.5	48 h 1 d

Bloom DISEASE - continued on next page

Bloom DISEASE - continued

BLOOM					CHERRY
DISEASE	**Bacterial Canker**	**Botrytis Blossom Blight**	**Brown Rot Blossom Blight**	**Leaf Spot[1]**	
Topsin M WSB (lb) **plus Captan 80WDG (lb)[8]**	–	–	++++ 0.5-0.75 plus 1.25-2.5	++++ 0.5-0.75 plus 1.25-2.5	48 h 1 d
Vangard 75WG[7] **(oz)**	–	++++ 5.0	+++ 5.0	+++ 6.0-12.0	12 h 2 d
Ziram 76DF **(lb)**	–	–	++ 5.0-6.0	+ 5.0-6.0	48 h 14 d

[1] Applications for Leaf Spot should begin as first leaves unfold. Sour Cherry is much more susceptible to Leaf Spot than Sweet Cherry.
[2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Abound is very phytotoxic on apples. Do not use near apple orchards.
[6] Generic products and/or other formulations available.
[7] Vangard and Cuprofix are labeled for sour cherry only; do not apply to sweet cherry, as phytotoxicity may occur. Spray copper at bud break and weekly thereafter. To reduce phytotoxicity, decrease concentration as leaves emerge.
[8] If Black Knot is present, use Bravo or Topsin M + Captan combination sprays.
[9] PHI Key: PF=No later than petal-fall, FC=No later than first cover, SS=No later than shuck-split, NTL= No time limit (usually up to the day of harvest) - consult label.

BLOOM	CHERRY
INSECT PEST	**Do not apply insecticides during bloom!**

PETAL-FALL					CHERRY
DISEASE	**Botrytis Blossom Blight**	**Brown Rot Blossom Blight**	**Leaf Spot[1]**		
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F[5] (fl oz)	–	+++ 12.0-15.5	+++ 12.0-15.5		4 h 0 d
Bravo Weather Stik 6F[6,8] (pt)	++ 3.0-4.0	++ 3.0-4.0	++++ 3.0-4.0		12 h SS[9]
Bumper/Tilt[6] (fl oz)	–	+++ 4.0	++ 4.0		24 h 0 d
Cabrio 20EG (oz)	–	++ 9.5	–		12 h 0 d
Captan 80WDG[6] (lb)	++ 2.5	++ 2.5	++ 2.5		24 h 0 d
Cevya 3.34SC (fl oz)	–	+++ 3.0-5.0	–		12 h 0 d
Copper, fixed	–	–	++ various rates		12-48 h various
Cuprofix Ultra 40DF[7] (lb)	–	–	++ 4.0-5.0		12 h FC[9]
Elevate 50WDG (lb)	++++ 1.0-1.5	+++ 1.0-1.5	–		12 h 0 d
Fontelis 1.67SC (fl oz)	++++ 14.0-20.0	++++ 14.0-20.0	+ 14.0-20.0		12 h 0 d
Flint Extra 4.05SC (fl oz)	–	+++ 2.5 - 3.8	++++ 2.5 - 3.8		12 h 1 d
Indar 2F (fl oz)	–	++++ 6.0	+++ 6.0		12 h 0 d
Luna Experience 3.34SC (fl oz)	–	+++ 6.0-10	–		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	++++ 5.0-7.6	++++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	++++ 4.0-6.7	++++ 4.0-6.7	++++ 4.0-6.7		12 h 0 d
Miravis 1.67SC (fl oz)	–	++ 3.4-5.1	–		4 h 0 d
Orius AQ 1.67F (fl oz)	++ 8.6-17.2	++++ 8.6-17.2	+++ 8.6-17.2		12 h 0 d
Pristine 38WG (oz)	+++ 10.5-14.5	++++ 10.5-14.5	++++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	++++ 12.0-14.0	–		12 h 0 d
Quash 50WDG (oz)	+++ 2.5-3.5	+++ 2.5-3.5	–		12 h 14 d
Rally 40WSP (oz)	–	++++ 2.5-6.0	+++ 2.5-6.0		24 h 0 d
Rovral 4F[6] (pt)	+++ 1.0-2.0	++++ 1.0-2.0	–		24 h PF[9]
Sulfur, actual (lb)	–	++ 10.0-12.0	–		24 h NTL[9]
Topguard EQ (fl oz)	–	++ 6.0-8.0	–		12 h 7 d
Topsin M WSB (lb)	++++ 1.5	++++ 1.5	+++ 1.5		48 h 1 d

Petal-Fall DISEASE - continued on next page

Petal-Fall DISEASE - continued

PETAL-FALL					CHERRY
DISEASE	**Botrytis Blossom Blight**	**Brown Rot Blossom Blight**	**Leaf Spot[1]**		
Topsin M WSB (lb) plus Captan 80WDG (lb)[8]	–	++++ 0.5-0.75 plus 1.25-2.5	++++ 0.5-0.75 plus 1.25-2.5		48 h 1 d
Vintage 1SC (oz)	–	–	+++ 6.0-12.0		24 h 0 d
Ziram 76DF (lb)	–	++ 5.0-6.0	+ 5.0-6.0		48 h 14 d

[1] Applications for Leaf Spot should begin as first leaves unfold. Sour Cherry is much more susceptible to Leaf Spot than Sweet Cherry.
[2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Abound is very phytotoxic on apples. Do not use near apple orchards.
[6] Generic products and/or other formulations available.
[7] Cuprofix is labeled for sour cherry only; do not apply to sweet cherry, as phytotoxicity may occur. Spray copper at bud break and weekly thereafter. To reduce phytotoxicity, decrease concentration as leaves emerge.
[8] If Black Knot is present, use Bravo or Topsin M + Captan combination sprays.
[9] PHI Key: PF=No later than petal-fall, FC=No later than first cover, SS=No later than shuck-split, NTL= No time limit (usually up to the day of harvest) - consult label.

PETAL-FALL Avoid killing bees on blooming ground cover.					CHERRY
INSECT PEST	**Black Cherry Aphid**	**Leafrollers**	**Plum Curculio**		
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI/PHI**
Actara (oz)	++++ 3.0-4.0	–	+++ 4.5-5.5		12 h 14 d
Admire Pro (fl oz)	++++ 4.0-8.0	–	–		12 h 7 d
Altacor (oz)	–	++++ 3.0-4.5	–		4 h 10 d
Ambush 25W (oz)	++ 8.0-12.8	++++ 8.0-12.8	++ 10.0-12.8		12 h 3 d
Apta/Bexar (fl oz)	+++ 17.0-27.0	++ 21.0-27.0	+++ 21.0-27.0		12 h 14 d
Asana XL[1] (fl oz)	++ 8.0-14.0	++++ 4.8-10.0	++ 8.0-14.0		12 h 14 d
Assail 30SG (oz)	++++ 2.5-5.3	–	++ 5.3-8.0		12 h 7 d
Avaunt (oz)	–	+++ 5.0-6.0	++++ 5.0-6.0		12 h 14 d
Baythroid XL (fl oz)	+ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8		12 h 7 d
Beleaf 50SG (oz)	+++ 2.0	–	–		12 h 14 d
Besiege (fl oz)	+ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0		24 h 14 d
Cormoran (fl oz)	++++ 20.0	+++ 20.0-28.0	++ 20.0-28.0		12 h 8 d
Danitol 2.4 EC (fl oz)	–	++++ 10.6-21.3	+++ 10.6-21.3		24 h 3 d
Delegate 25WG (oz)	–	++++ 4.5-6.0	+ 6.0-7.0		4 h 7 d

Petal-Fall INSECT PESTS - continued on next page

Petal-Fall INSECT PESTS - continued

PETAL-FALL Avoid killing bees on blooming ground cover.					CHERRY
INSECT PEST	**Black Cherry Aphid**	**Leafrollers**	**Plum Curculio**		
Diazinon 50W[9] **(lb)**	– 	++ 2.0-3.0	+++ 3.0-4.0		96 h 21 d
Endigo ZC **(fl oz)**	++++ 5.5-6.0	++++ 5.5-6.0	++ 5.5-6.0		24 h 14 d
Entrust SC **(fl oz)**	– 	++++ 4.0-8.0	– 		4 h 1 d
Exirel **(fl oz)**	– 	– 	+++ 13.5-20.5		12 h 3 d
Imidan 70W[4] **(lb)**	+ 2.0-2.5	+++ 2.0-2.5	+++ 2.0-2.5		3/14 d[4] 7 d
Intrepid 2F **(fl oz)**	– 	++++ 8.0-16.0	– 		4 h 7 d
Lambda-Cy **(fl oz)**	+ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12		24 h 14 d
Leverage 360 **(fl oz)**	+++ 2.4-2.8	++++ 2.4-2.8	++ 2.4-2.8		12 h 7 d
Malathion 5EC **(pt)**	+++ 2.8 pt	– 	+++ 2.8 pt		12 h 3 d
Movento **(fl oz)**	++++ 6.0-9.0	– 	– 		24 h 7 d
Mustang Maxx **(fl oz)**	+ 1.28-4.0	++++ 1.28-4.0	+++ 1.28-4.0		12 h 14 d
Perm-UP 3.2EC **(fl oz)**	++ 6.0-8.0	++++ 4.0-8.0	++ 8.0		12 h 3 d
Verdepryn 100SL **(fl oz)**	– 	++++ 5.5-11.0	+++ 5.5-11.0		4 h 7 d
Versys **(fl oz)**	++++ 1.5	– 	– 		12 h 7 d
Voliam Flexi WG **(oz)**	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0		12 h 14 d
Warrior II[1] **(fl oz)**	+ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56		24 h 14 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Imidan not labeled for sweet cherries, for tart cherries only. REI 3 d for farm labor, but 14 d for u-pick operations.

SHUCK-FALL					CHERRY
DISEASE	**Brown Rot**	**Leaf Spot**			
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Abound 2F[4] (fl oz)	+ 12.0-15.5	+++ 12.0-15.5			4 h 0 d
Bumper/Tilt[5] (fl oz)	+++ 4.0	++ 4.0			24 h 0 d
Cabrio 20EG (oz)	++ 9.5	–			12 h 0 d
Captan 80WDG[5] (lb)	++ 2.5	++ 2.5			24 h 0 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	-			12 h 0 d
Copper, fixed	–	++ various rates			12-48 h various
Cuprofix Ultra 40DF[6] (lb)	–	++ 3.75			12 h FC[8]
Elevate 50WDG (lb)	++ 1.0-1.5	–			12 h 0 d
Fontelis 1.67SC (fl oz)	+++ 14.0-20.0	+ 14.0-20.0			12 h 0 d
Flint Extra 4.05SC (fl oz)	+++ 2.5-3.8	++++ 2.5-3.8			12 h 1 d
Indar 2F (fl oz)	++++ 6.0	+++ 6.0			12 h 0 d
Luna Experience 3.34SC (fl oz)	+++ 6.0-10	–			12 h 0 d
Luna Sensation 4.2SC (fl oz)	++ 5.0-7.6	++++ 5.0-7.6			12 h 1 d
Merivon 4.18SC (fl oz)	+++ 4.0-6.7	++++ 4.0-6.7			12 h 0 d
Miravis 1.67SC (fl oz)	+++ 3.4-5.1	–			4 h 0 d
Orius AQ 1.67F (fl oz)	++++ 8.6-17.2	+++ 8.6-17.2			12 h 0 d
Pristine 38WG (oz)	++++ 10.5-14.5	++++ 10.5-14.5			12 h 0 d
Quadris Top 2.72SC (fl oz)	++++ 12.0-14.0	–			12 h 0 d
Rally 40WSP (oz)	+++ 2.5-6.0	+++ 2.5-6.0			24 h 0 d
Sulfur, actual (lb)	+ 10.0-12.0	–			24 h NTL[8]
Topguard EQ (fl oz)	++ 6.0-8.0	–			12 h 7 d
Topsin M WSB (lb)	+++ 1.5	+++ 1.5			48 h 1 d
Topsin M WSB (lb) plus Captan 80WDG (lb)[7]	+++ 0.5-0.75 plus 1.25-2.5	++++ 0.5-0.75 plus 1.25-2.5			48 h 1 d
Vintage 1SC (oz)	–	+++ 6.0-12.0			24 h 0 h
Ziram 76DF (lb)	++ 5.0-6.0	+ 5.0-6.0			48 h 14 d

[1] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

Shuck-Fall DISEASE - footnotes continued

[4] Abound is very phytotoxic on apples. Do not use near apple orchards.

[5] Generic products and/or other formulations available.

[6] Cuprofix is labeled for sour cherry only; do not apply to sweet cherry, as phytotoxicity may occur. Spray copper at bud break and weekly thereafter. To reduce phytotoxicity, decrease concentration as leaves emerge.

[7] If Black Knot is present, use Topsin M + Captan combination sprays.

[8] PHI Key: FC=No later than first cover, NTL= No time limit (usually up to the day of harvest) - consult label.

SHUCK-FALL Avoid killing bees on blooming ground cover.					**CHERRY**
INSECT PEST	**Leafrollers**	**Plum Curculio**			
Product and Formulation[1]	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Actara (oz)	–	+++ 4.5-5.5			12 h 14 d
Altacor (oz)	++++ 3.0-4.5	–			4 h 10 d
Ambush 25W[3] (oz)	++++ 8.0-12.8	++ 10.0-12.8			12 h 3 d
Asana XL[3] (fl oz)	++++ 4.8-10.0	++ 8.0-14.0			12 h 14 d
Assail 30SG (oz)	–	++ 5.3-8.0			12 h 7 d
Avaunt (oz)	+++ 5.0-6.0	++++ 5.0-6.0			12 h 14 d
Baythroid XL (fl oz)	++++ 2.4-2.8	++ 2.4-2.8			12 h 7 d
Besiege (fl oz)	++++ 6.0-12.0	++ 9.0-12.0			24 h 14 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	+++ 10.6-21.3			24 h 3 d
Delegate 25WG (oz)	++++ 4.5-6.0	+ 6.0-7.0			4 h 7 d
Imidan 70W[4] (lb)	+++ 2.0-2.5	+++ 2.0-2.5			3/14 d[4] 7 d
Intrepid 2F (fl oz)	++++ 8.0-16.0	–			4 h 7 d
Lambda-Cy (fl oz)	++++ 2.56-5.12	++ 2.56-5.12			24 h 14 d
Leverage 360 (fl oz)	++++ 2.4-2.8	++ 2.4-2.8			12 h 7 d
Malathion 5EC (pt)	–	+++ 2.8			12 h 3 d
Perm-UP 3.2EC (fl oz)	++++ 4.0-8.0	++ 8.0			12 h 3 d
Voliam Flexi WG (oz)	++++ 4.0-7.0	+++ 6.0-7.0			12 h 14 d
Warrior II[3] (fl oz)	++++ 1.28-2.56	++ 1.28-2.56			24 h 14 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[3] When noted, generic products are available.

[4] Imidan not labeled for sweet cherries, for tart cherries only. REI 3 d for farm labor, but 14 d for u-pick operations.

COVERS					CHERRY
DISEASE	**Brown Rot**	**Leaf Spot[1]**			
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F[5] (fl oz)	+ 12.0-15.5	+++ 12.0-15.5			4 h 0 d
Bumper/Tilt[6] (fl oz)	+++ 4.0	++ 4.0			24 h 0 d
Cabrio 20EG (oz)	++ 9.5	–			12 h 0 d
Captan 80WDG[6] (lb)	++ 2.5	++ 2.5			24 h 0 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	–			12 h 0 d
Copper, fixed	–	++ various rates			12-48 h various
Cuprofix Ultra 40DF[7] (lb)	–	++ 4.0-5.0			12 h FC[8]
Elevate 50WDG (lb)	++ 1.0-1.5	–			12 h 0 d
Fontelis 1.67SC (fl oz)	+++ 14.0-20.0	+ 14.0-20.0			12 h 0 d
Flint Extra 4.05SC (fl oz)	+++ 2.5-3.8	++++ 2.5-3.8			12 h 1 d
Indar 2F (fl oz)	++++ 6.0	+++ 6.0			12 h 0 d
Luna Experience 3.34SC (fl oz)	+++ 6.0-10	–			12 h 0 d
Luna Sensation 4.2SC (fl oz)	+++ 5.0-7.6	++++ 5.0-7.6			12 h 1 d
Merivon 4.18SC (fl oz)	+++ 4.0-6.7	++++ 4.0-6.7			12 h 0 d
Miravis 1.67SC (fl oz)	+++ 3.4-5.1	–			4 h 0 d
Orius AQ 1.67F (fl oz)	++++ 8.6-17.2	+++ 8.6-17.2			12 h 0 d
Pristine 38WG (oz)	++++ 10.5-14.5	++++ 10.5-14.5			12 h 0 d
Quadris Top 2.72SC (fl oz)	++++ 12.0-14.0	–			12 h 0 d
Rally 40WSP (oz)	+++ 2.5-6.0	+++ 2.5-6.0			24 h 0 d
Sulfur, actual (lb)	+ 10.0-12.0	–			24 h NTL[8]
Topguard EQ (fl oz)	++ 6.0-8.0	–			12 h 7 d
Topsin M WSB (lb)	+++ 1.5	+++ 1.5			48 h 1 d
Topsin M WSB (lb) plus Captan 80WDG (lb)	+++ 0.5-0.75 plus 1.25-2.5	++++ 0.5-0.75 plus 1.25-2.5			48 h 1 d
Vintage 1SC (oz)	–	+++ 6.0-12.0			24 h 0 h
Ziram 76DF (lb)	++ 5.0-6.0	+ 5.0-6.0			48 h 14 d

[1] If Leaf Spot pressure is high, apply sprays at 7-14 day intervals to provide continual coverage of foliage.

Covers DISEASE - footnotes continued on next page

Covers DISEASE - footnotes continued

[2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.

[3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Abound is very phytotoxic on apples. Do not use near apple orchards.

[6] Generic products and/or other formulations available.

[7] Cuprofix is labeled for sour cherry only; do not apply to sweet cherry, as phytotoxicity may occur. Spray copper at bud break and weekly thereafter. To reduce phytotoxicity, decrease concentration as leaves emerge. [8] PHI Key: FC=No later than first cover, NTL= No time limit (usually up to the day of harvest) - consult label.

COVERS						CHERRY
INSECT OR MITE PEST	**INSECTS**			**MITES**		
	Leafrollers	**Plum Curculio**	**Spotted Wing Drosophila**	**European Red Mite**	**Two-Spotted Spider Mite**	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**					**REI PHI**
Acramite 50WS (oz)	–	–	–	++++ 12.0-16.0	++++ 12.0-16.0	12 h 3 d
Admire Pro[1] (fl oz)	–	–	+++ 2.0-2.8	–	–	12 h 7 d
Altacor (oz)	++++ 3.0-4.5	–	–	–	–	4 h 10 d
Ambush 25W[1] (oz)	++++ 8.0-12.8	++ 10.0-12.8	+++ 8.0-10.0	–	–	12 h 3 d
Apollo SC (oz)	–	–	–	++++ 4.0-6.0	++++ 4.0-6.0	12 h 21 d
Apta/Bexar (fl oz)	++ 21.0-27.0	+++ 21.0-27.0	–	–	–	12 h 14 d
Asana XL[1] (fl oz)	++++ 4.8-10.0	++ 8.0-14.0	+++ 4.8-10.0	–	–	12 h 14 d
Assail 30SG (oz)	–	++ 5.3-8.0	++++ 2.5-5.3	–	–	12 h 7 d
Avaunt (oz)	+++ 5.0-6.0	++++ 5.0-6.0	–	–	–	12 h 14 d
***Bacillus thuringiensis*[1,4] (lb)**	++++ 0.5-2	–	–	–	–	4 h –[4]
Baythroid XL (fl oz)	++++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	–	–	12 h 7 d
Besiege (fl oz)	++++ 6.0-12.0	++ 9.0-12.0	+++ 6.0-12.0	–	–	24 h 14 d
Cormoran (fl oz)	+++ 20.0-28.0	++ 20.0-28.0	++ 20.0	–	–	12 h 8 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 10.6-21.3	24 h 3 d
Delegate 25WG (oz)	++++ 4.5-7.0	+ 6.0-7.0	+++ 4.5-7.0	–	–	4 h 7 d
Endigo ZC (fl oz)	++++ 5.5-6.0	S 5.5-6.0	+++ 5.5-6.0	–	–	24 h 7 d
Entrust SC (fl oz)	++++ 4.0-8.0	–	+++ 4.0-8.0	–	–	4 h 7 d
Envidor 2SC (fl oz)	–	–	–	++++ 16.0-18.0	++++ 16.0-18.0	12 h 7 d
Exirel (fl oz)	+++ 13.5-20.5	+++ 13.5-20.5	++++ 13.5-20.5	–	–	12 h 3 d

Covers INSECT OR MITE PESTS - continued on next page

CHERRIES

Covers INSECT OR MITE PESTS - continued

COVERS						CHERRY
INSECT OR MITE PEST	**INSECTS**			**MITES**		
	Leafrollers	**Plum Curculio**	**Spotted Wing Drosophila**	**European Red Mite**	**Two-Spotted Spider Mite**	
Imidan 70W[5] (lb)	+++ 2.0-2.5	+++ 2.0-2.5	++++ 2.0-2.5	–	–	3/14 d[5] 7 d
Intrepid 2F (fl oz)	+++ 8.0-16.0	–	–	–	–	4 h 7 d
Lambda-Cy (fl oz)	++++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12	–	–	24 h 14 d
Leverage 360 (fl oz)	+++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	–	–	12 h 7 d
Malathion 5EC (pt)	++ 2.8	+++ 2.8	++++ 2.8	–	–	12 h 3 d
Mustang Maxx (fl oz)	++++ 1.28-4.0	+++ 1.28-4.0	++++ 1.28-4.0	–	–	12 h 14 d
Perm-UP 3.2EC (fl oz)	++++ 4.0-8.0	++ 8.0	+++ 4.0-8.0	–	–	12 h 3 d
Pounce 3.2EC[1] (oz)	++++ 4.0-8.0	++ 4.0-8.0	+++ 4.0-8.0	–	–	12 h 3 d
Savey 50DF (oz)	–	–	–	++++ 3.0-6.0	++++ 3.0-6.0	12 h 28 d
Sevin XLR Plus (lb)	++ 2.0-3.0	+++ 2.0-3.0	+++ 2.0-3.0	–	–	12 h 1 d
Vendex 50WP (lb)	–	–	–	+++ 1.5-3.0	+++ 1.5-3.0	48 h 14 d
Verdepryn 100SL (fl oz)	++++ 5.5-11.0	+++ 5.5-11.0	+++ 5.5-11.0	–	–	4 hr 7 d
Voliam Flexi (oz)	++++ 4.0-7.0	+++ 6.0-7.0	+++ 4.0-7.0	–	–	12 h 14 d
Warrior II[1] (fl oz)	++++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56	–	–	24 h 14 d
Zeal (oz)	–	–	–	++++ 2.0-3.0	++++ 2.0-3.0	12 h 7 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Various products are available. See label.
[5] Imidan not labeled for sweet cherries, for tart cherries only. REI 3 d for farm labor, but 14 d for u-pick operations.

PREHARVEST					CHERRY
DISEASE	**Brown Rot**	**Leaf Spot**			
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Abound 2F[4] (fl oz)	+++ 12.0-15.5	+++ 12.0-15.5			4 h 0 d
Bumper/Tilt[5] (fl oz)	++++ 4.0	++ 4.0			24 h 0 d
Cabrio 20EG (oz)	++ 9.5	–			12 h 0 d
Captan 80WDG[5] (lb)	++ 2.5	++ 2.5			24 h 0 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	–			12 h 0 d
Elevate 50WDG (lb)	++ 1.0-1.5	–			12 h 0 d
Fontelis 1.67SC (fl oz)	+++ 14.0-20.0	+ 14.0-20.0			12 h 0 d
Flint Extra 4.05SC (fl oz)	+++ 2.5-3.8	++++ 2.5-3.8			12 h 1 d
Indar 2F (fl oz)	++++ 6.0	+++ 6.0			12 h 0 d
Luna Experience 3.34SC (fl oz)	+++ 6.0-10	–			12 h 0 d
Luna Sensation 4.2SC (fl oz)	+++ 5.0-7.6	++++ 5.0-7.6			12 h 1 d
Merivon 4.18SC (fl oz)	+++ 4.0-6.7	++++ 4.0-6.7			12 h 0 d
Miravis 1.67SC (fl oz)	+++ 3.4-5.1	–			4 h 0 d
Orius AQ 1.67F (fl oz)	++++ 8.6-17.2	+++ 8.6-17.2			12 h 0 d
Pristine 38WG (oz)	++++ 10.5-14.5	++++ 10.5-14.5			12 h 0 d
Quadris Top 2.72SC (fl oz)	++++ 12.0-14.0	–			12 h 0 d
Rally 40WSP (oz)	+++ 2.5-6.0	+++ 2.5-6.0			24 h 0 d
Sulfur, actual (lb)	+ 10.0-12.0	–			24 h NTL[6]
Topguard EQ (fl oz)	++ 6.0-8.0	–			12 h 7 d
Topsin M WSB (lb)	+++ 1.5	+++ 1.5			48 h 1 d
Topsin M WSB plus Captan 80WDG	+++ 0.5-0.75 plus 1.25-2.5	++++ 0.5-0.75 plus 1.25-2.5			48 h 1 d
Vintage 1SC (oz)	–	+++ 6.0-12.0			24 h 0 h
Ziram 76DF (lb)	++ 5.0-6.0	+ 5.0-6.0			48 h 14 d

[1] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Abound is very phytotoxic on apples. Do not use near apple orchards.
[5] Generic products and/or other formulations available.
[6] PHI Key: NTL= No time limit (usually up to the day of harvest) - consult label.

PREHARVEST Avoid killing bees on blooming ground cover.						CHERRY
INSECT OR MITE PEST	INSECTS			MITES		
	Leafrollers	Plum Curculio	Spotted Wing Drosophila	European Red Mite	Two-Spotted Spider Mite	
Product and Formulation[1]	Product Efficacy Rating[2] and Rate/A[3]					REI PHI
Acramite 50WS (oz)	–	–	–	++++ 12.0-16.0	++++ 12.0-16.0	12 h 3 d
Altacor (oz)	++++ 3.0-4.5	–	–	–	–	4 h 10 d
Admire Pro[1] (fl oz)	–	–	+++ 2.0-2.8	–	–	12 h 7 d
Ambush 25W[1] (oz)	++++ 8.0-12.8	++ 10.0-12.8	+++ 8.0-10.0	–	–	12 h 3 d
Apollo SC (oz)	–	–	–	++++ 4.0-6.0	++++ 4.0-6.0	12 h 21 d
Assail 30SG (oz)	–	++ 5.3-8.0	++++ 2.5-5.3	–	–	12 h 7 d
Bacillus thuringiensis [1,4]	++++ various rates	–	–	–	–	4 h –[4]
Baythroid XL (fl oz)	++++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	–	–	12 h 7 d
Cormoran (fl oz)	+++ 20.0-28.0	++ 20.0-28.0	++ 20.0	–	–	12 h 8 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	+++ 10.6-21.3	–	++ 10.6-21.3	++ 10.6-21.3	24 h 3 d
Delegate 25WG (oz)	++++ 4.5-7.0	+ 6.0-7.0	+++ 4.5-7.0	–	–	4 h 7 d
Entrust SC (fl oz)	++++ 4.0-8.0	–	–	–	–	4 h 7 d
Endigo ZC (fl oz)	++++ 5.5-6.0	S 5.5-6.0	+++ 5.5-6.0	–	–	24 h 7 d
Envidor 2SC (fl oz)	–	–	–	++++ 16.0-18.0	++++ 16.0-18.0	12 h 7 d
Exirel (fl oz)	+++ 13.5-20.5	+++ 13.5-20.5	++++ 13.5-20.5	–	–	12 h 3 d
Imidan 70W[5] (lb)	+++ 2.0-2.5	+++ 2.0-2.5	+++ 2.0-2.5	–	–	3/14 d[5] 7 d
Intrepid 2F (fl oz)	++++ 8.0-16.0	–	–	–	–	4 h 7 d
Leverage 360 (fl oz)	+++ 2.4-2.8	++ 2.4-2.8	+++ 2.4-2.8	–	–	12 h 7 d
Malathion 5EC (pt)	++ 2.8	+++ 2.8	++++ 2.8	–	–	12 h 3 d
Onager EC (oz)	–	–	–	+++ 12.0-24.0	++++ 12.0-24.0	12 h 28 d
Perm-UP 3.2EC (fl oz)	++++ 4.0-8.0	++ 8.0	+++ 4.0-8.0	–	–	12 h 3 d
Pounce 3.2EC[1] (oz)	++++ 4.0-8.0	++ 4.0-8.0	+++ 4.0-8.0	–	–	12 h 3 d
Savey 50DF (oz)	–	–	–	++++ 3.0-6.0	++++ 3.0-6.0	12 h 28 d
Sevin 80S (lb)	++ 2.5 -3.75	+++ 2.5 -3.75	+++ 2.5	–	–	12 h 1 d
Vendex 50WP (lb)	–	–	–	+++ 1.5-3.0	+++ 1.5-3.0	48 h 14 d

Preharvest INSECT OR MITE PESTS - continued on next page

Preharvest INSECT OR MITE PESTS - continued

PREHARVEST Avoid killing bees on blooming ground cover.						CHERRY
INSECT OR MITE PEST	**INSECTS**			**MITES**		
	Leafrollers	**Plum Curculio**	**Spotted Wing Drosophila**	**European Red Mite**	**Two-Spotted Spider Mite**	
Verdepryn 100SL (fl oz)	++++ 5.5-11.0	+++ 5.5-11.0	+++ 5.5-11.0	–	–	4 hr 7 d
Zeal (oz)	–	–	–	++++ 2.0-3.0	++++ 2.0-3.0	12 h 7 d

[1] When noted, generic products are available.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Various products are available. See label.
[5] Imidan not labeled for sweet cherries, for tart cherries only. REI 3 d for farm labor, but 14 d for u-pick operations.

POSTHARVEST					CHERRY
DISEASE	**Bacterial Canker**	**Leaf Spot[1]**			
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Bravo Weather Stik 6F[5] (pt)	–	++++ 3.0-4.0			12 h SF[7]
Captan 80WDG[5] (lb)	–	++ 2.5			24 h 0 d
Copper, fixed[6]	++ various rates	++ various rates			12-48 h various
Indar 2F (fl oz)	–	+++ 6.0			12 h 0 d
Orius AQ 1.67F (fl oz)	–	+++ 8.6-17.2			12 h 0 d
Pristine 38WG (oz)	–	++++ 10.5-14.5			12 h 0 d
Rally 40WSP (oz)	–	+++ 2.5-6.0			12 h 0 d

[1] Apply postharvest spray within 7 days after fruit removal. If incidence is high, apply a second spray 10-14 days later. [2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details. [3] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [5] Generic products and/or other formulations available. [6] Apply two sprays at 10% and 80% leaf drop. If canker has been a problem, apply 4 sprays at 14 day intervals. [7] PHI Key: SF= No later than shuck-fall

POSTHARVEST Avoid killing bees on blooming ground cover.					CHERRY
INSECT OR MITE PEST	**INSECTS**		**MITES**		
	Lesser Peach Tree Borer	**Peach Tree Borer**	**European Red Mite**	**Two-Spotted Spider Mite**	
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Acramite 50WS (oz)	–	–	++++ 12.0-16.0	++++ 12.0-16.0	12 h 3 d
Apollo SC (oz)	–	–	++++ 4.0-6.0	++++ 4.0-6.0	12 h 21 d
Asana XL[3] (fl oz/100 gal)	+++ 5.8	+++ 5.8	–	–	12 h 14 d
Envidor 2SC (fl oz)	–	–	++++ 16.0-18.0	++++ 16.0-18.0	12 h 7 d
Isomate PTB Dual[4] (dispenser)	++++ 150-250	++++ 150-250	–	–	NA[5] NA[5]
Lorsban-4E[3] (qt/100 gal)	++++ 1.5-3.0	++++ 1.5-3.0	–	–	96 h 21 d
Savey 50DF (oz)	–	–	++++ 3.0-6.0	++++ 3.0-6.0	12 h 28 d
Vendex 50WP (lb)	–	–	+++ 1.5-3.0	+++ 1.5-3.0	48 h 14 d
Zeal (oz)	–	–	++++ 2.0-3.0	++++ 2.0-3.0	12 h 7 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [3] Per acre rate by handgun in minimum of 100 gal/A; apply after harvest during early September in south Jersey, slightly later in the northern parts of the state. Thoroughly wet trunks and scaffold limbs. Avoid contact with sweet cherry foliage to prevent defoliation. [4] Various formulations available. See product label for instructions. [5] Not Applicable.

9 Plums

The plums adapted to New Jersey are of great diversity. All species and various horticultural varieties have distinct tree and fruit characteristics. The two most important species are *Prunus salicina*, Lindl., the Oriental varieties, and *Prunus domestica*, L., the garden or European varieties. Varieties of *Prunus americana*, Marsh, the common wild or American plum, and other interspecific types have been hybridized with *Prunus salicina* varieties to produce some excellent-flavored plum varieties for planting in New Jersey. Plum culture has not been widespread in New Jersey because of limited research on fruit set, and varieties and rootstocks adapted to our climate.

Generally, the Oriental plum varieties are upright spreading to drooping trees and produce round to chordate shaped fruit (heart-shaped with pounced apex) with yellow to red, to almost black skin color. Plumcots are interspecific hybrids of Japanese plums *Prunus salicina* and apricots *Prunus armeniaca*. Plumcot is a generic term for these hybrids.

Pluots® are later-generations that show more plum than apricot characteristics; the fruit's exterior has smooth skin closely resembling that of a plum. Pluots were developed Floyd Zaiger, and "Pluot" is a registered trademark of Zaiger Genetics.

Apriums® are complex plum-apricot hybrids that show more apricot traits, genetically they are one-fourth plum and and three-fourths apricot. Aprium varieties were developed in the later 1980s by Floyd Zaiger, and "Aprium" is a registered trademark of Zaiger's Genetics.

The European, or common garden plum varieties are more upright in growth habit and produce oval- to ovate-shaped plums with blue to black skin color. Some varieties have a dry texture, very high sugar content, and are processed into prunes.

9.1 Plum Varieties

Oriental Types

The Oriental type varieties grown on available rootstocks are generally shorter-lived and irregularly to moderately productive. The trees are stressed by many of the same problems affecting peach trees, namely winter injury, spring frost, moisture stress, nematodes, root rots, and other unknown short life characteristics. Some Oriental type varieties also experience latent incompatibility with available rootstocks and decline slowly.

Fruitfulness is also a problem in Oriental type plums because of variability in time of bloom, incompatibility, and sensitivity to variation in temperatures during the dormant season. The Oriental type varieties bloom earlier than European type varieties. Plumcots generally bloom earlier than most Japanese type plums. The following varieties are suggested for small commercial plantings.

Early-Season:

'Early Golden' – Small to medium, globose, golden-yellow, yellow fleshed clingstone ripening in early July about 7 days before 'Shiro'. The flesh is soft and juicy with very good flavor. The tree is spreading, vigorous, and moderately productive with low susceptibility to bacterial spot. It is self incompatible and needs to be pollinated with 'Methley' or other early blooming varieties.

'Methley' – Small, globose, reddish purple, red fleshed clingstone ripening in early July. The flesh is soft, juicy and of fair to good flavor. The tree is upright spreading, vigorous, and productive with low susceptibility to bacterial spot. The tree is self compatible and self-fruitful and it is an Oriental X American hybrid.

'Shiro' – Medium, globose, yellow, yellow-fleshed clingstone ripening in early to mid-July. The flesh is soft and very juicy, with excellent flavor. The tree is vigorous, spreading, large, and moderately productive with low susceptibility to bacterial spot. It is pollinated by 'Methley', 'Vanier' and other Oriental type varieties.

'Black Ruby' – Medium, globose, reddish black to purple black, yellow-fleshed freestone ripening in mid-July. The flesh is semi- juicy with very good flavor. The tree is spreading medium, vigorous, and lightly productive, with moderate susceptibility to bacterial spot. It is a good pollinator for other early blooming varieties. It is pollinated by other oriental type varieties including 'Methley'.

Mid-Season:

'Santa Rosa' – Medium size, globose, purple red, yellow fleshed, ripening in late July. The flesh is firm, juicy, and sweet with very good flavor. The tree is spreading, vigorous, irregularly productive with medium susceptibility to bacterial spot. It is self- incompatible and must be cross-pollinated with other Oriental type varieties.

'Red Ace' ('Ace') – Medium, globose to slightly oval, light red, yellowish-red fleshed semi- freestone, ripening in late July. The flesh is moderately firm and sweet with very good flavor. The tree is spreading, vigorous and moderately productive with moderate susceptibility to bacterial spot.

'Redheart' – Medium-large, globose to heart-shaped, yellowish-red fleshed semi-freestone, ripening in early August. The flesh is firm, crisp, and fine-grained with very good flavor. The tree is upright spreading, vigorous, and moderately productive. It is self- incompatible and is pollinated by 'Red Ace', 'Shiro', 'Santa Rosa', or other early blooming Oriental types.

'Ozark Premier' – Medium-large, globose, reddish blush, yellow-fleshed clingstone ripening in early August. The flesh is moderately firm and juicy with good to very good flavor. The tree is spreading vigorous, moderately productive with moderate susceptibility to bacterial spot.

Late-Season:

'Vanier' – Medium size, globose, bluish-red, yellow-fleshed clingstone, ripening in early August. The flesh is moderately firm, juicy with good flavor. The fruit hangs on the tree well. The tree is upright-spreading, vigorous, and moderately productive with low susceptibility to bacterial spot. It is self-incompatible and pollinated by 'Ozark Premier' and 'Santa Rosa'.

'South Dakota' – Medium to small, globose to ovate, yellow with slight red blush, yellow-fleshed freestone, ripening in early August. The flesh is soft and juicy, with very good flavor. The tree is spreading, very vigorous, and productive. This Oriental x American plum hybrid is winter hard and produces many blooms. It is partially self fruitful and an excellent pollinizer for other Oriental x American hybrids.

'Ruby Queen' – Large, globose, dark reddish purple, red-fleshed, clingstone ripening in mid-August. The flesh is firm, and juicy with excellent flavor. The fruit hangs on the tree well. The tree is medium, spreading, vigorous, and productive with moderate susceptibility to bacterial spot. It is pollinated with other mid-season blooming varieties. Tested as USDA BY8155-70.

'Fortune' – Large, globose, reddish purple blush over yellow ground color, yellow fleshed clingstone, ripening in late August. The flesh is firm, juicy and sweet with very good flavor. The tree is upright-spreading, vigorous and productive. It is pollinated by other Oriental type varieties.

There are many other Oriental and Oriental X American hybrid varieties that have not been observed or tested in New Jersey. More evaluative research needs to be done to select recommended best plumcot varieties. **Flavorich** is a very late dark blue pluot® but its quality had been disappointing on a tree that consistently sets light crops. **Flavor Kin**g, Flavor Queen, and Flavor Supreme pluots® have consistently produced light crops after 15 years of evaluative research. All have very good eating quality.

European Types

European plums are generally longer-lived, more productive, and more consistent in cropping than Oriental varieties. They do experience many of the same problems as many oriental varieties.

Early-Season:

'Earliblue' – Medium, slightly oblong to ovate, blue, greenish-yellow-fleshed semi freestone, ripening in early August. The flesh is soft with very good flavor. The tree is upright spreading, vigorous, and moderately productive. It needs cross pollination from other European varieties.

'Castleton' – Medium size, slightly oval, purplish blue, greenish-yellow-fleshed freestone ripening in mid-August. The flesh is firm and juicy, with good flavor. The tree is upright spreading, vigorous, and productive. It looks very much like 'Stanley' and is best pollinated by 'Stanley'.

Mid-Season:

'Mohawk' – Medium-large, oval, blue, amber yellow flesh, semi freestone, ripening in mid- to late August. The

flesh is sweet and firm with very good flavor. The tree is upright spreading and productive. It benefits from cross pollination like 'Stanley'.

'Richards Early Italian' – Medium-large, oval, blue, greenish-yellow-fleshed, freestone ripening in late August. The flesh is firm, with excellent flavor. The tree is upright spreading, vigorous, and moderately productive.

Late-Season:

'Italian' – Large, oval, purplish blue, greenish-yellow-fleshed, freestone ripening in early September. The flesh is firm and sweet with excellent flavor. The tree is upright spreading, vigorous, and moderately productive. It is self-fruitful but benefits from cross pollination.

'Brooks' – Large, oval, dark blue, ovate, greenish-yellow-fleshed freestone, ripening in early September just after Italian. The flesh is firm and slightly tart with excellent flavor. The tree is upright-spreading, vigorous and has been productive, more than 'Italian'. Self-fruitful.

'Valor' – Medium-large, dark bluish-purple, greenish-yellow-fleshed freestone, ripening in early September. The flesh is moderately firm with very good flavor. The tree is upright- spreading, vigorous, and productive.

'Bluefre' – Large, ovate, dark blue, greenish-yellow freestone, ripening in mid-September. The flesh is firm with very good flavor. The tree is spreading, vigorous, and moderately productive. It has been an inconsistent cropper in southern New Jersey. It is self-fruitful but benefits from cross pollination with other European varieties.

'Long John' – Large to very large, oblong to ovate, purplish blue, amber-yellow-fleshed freestone, ripening with 'Stanley'. The flesh is firm, with excellent flavor better than 'Stanley'. The tree is upright-spreading, vigorous, and productive. The tree benefits by pollination with 'Stanley' or 'Castleton'.

'Stanley' – Medium-large, oval, blue, greenish-yellow freestone, ripening in mid-September just after 'Bluefre'. The flesh is firm with good flavor. The tree is of medium vigor, upright-spreading and productive. 'Stanley' has always been a consistent cropper in Southern Jersey. 'Stanley' is Self-fruitful.

There are many other European varieties not tested or observed in New Jersey.

9.2 Plum Rootstocks

Myrobalan (*Prunus divaricata*) seedlings and *Myrobalan 29C* clonal stocks are the recommended rootstocks for all European plum varieties. They are also compatible with many Japanese and Japanese X American hybrid varieties, but tend to be shorter-lived on sandy or drought sensitive soils. They are more adapted and longer-lived on loamy or clay-loam soils. **Lovell and Halford peach seedlings** are used on many Japanese plum varieties. Trees are short-lived and susceptible to most problems experienced with peach varieties. Japanese plum varieties on Lovell and Halford peach seedlings are better adapted to sandy soils than European varieties on Lovell or Halford peach seedlings.

Mariana 2624 clonal rootstock is compatible with most plum varieties. Trees of all varieties are more sensitive to low winter temperatures on this rootstock than other rootstocks.

Citation appears to be promising rootstock for semi-dwarf plum trees *Krymsk 1*. A new rootstock from Russia has not been tested in New Jersey but is being offered with Japanese plums as very winter hardy and producing a semi-dwarf tree.

Pumiselect is a dwarfing clonal selection of *Prunus pumila* sold with Japanese type plums.

9.3 Plum Pollination

All Oriental type plums need cross-pollination. 'Methley' and 'South Dakota' will set heavy crops in some years without cross- pollination. All other varieties should be planted as a design with at least three varieties for cross-pollination.

Most European varieties require cross-pollination. Varieties described as self-fruitful will set better and more consistent crops with cross-pollination.

Oriental hybrid varieties do not pollinate or set fruit of European plum varieties.

9.4 Plum Pest Management

Abbreviations			
Stone Fruit Preharvest Interval Key		**Units of Measurement**	
D	Dormant application only	/A	per acre
PB	No later than prebloom	d	day(s)
FB	No later than full bloom	fl oz	fluid ounce(s)
PF	No later than petal-fall	gal	gallon(s)
SS	No later than shuck-split	h	hour(s)
SF	No later than shuck-fall	lb	pound(s)
FC	No later than first cover	oz	ounce(s)
NTL	No time limit (usually up to the day of harvest) - consult label	pt	pint(s)
		qt	quart(s)
NA	Not applicable		

DELAYED DORMANT					PLUMS
DISEASE	**Bacterial Canker**				
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Bordeaux mixture (lb/100 gal)	++ 5, 7.5				24 h D
Copper, fixed	++ various rates				12-48 h various

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

DELAYED DORMANT					PLUMS
INSECT PEST	**Scale Insects**				
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Centaur WDG (oz)	+++ 34.5-46.0				12 h 14 d
Esteem 35WP (oz)	++++ 4.0-5.0				12 h 14 d
Superior Oil (gal)	++++ 4.0				4 h 0 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

PREBLOOM THROUGH BLOOM					PLUMS
DISEASE	**Black Knot[1]**	**Brown Rot Blossom Blight**			
Product and formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F[5] (fl oz)	–	++++ 12.0-15.5			4 h 0 d
Bravo Weather Stik 6F[6] (pt)	++++ 3.0-4.0	++ 3.0-4.0			12 h PF[8]

Prebloom Through Bloom DISEASE - continued on next page

Prebloom Through Bloom DISEASE - continued

PREBLOOM THROUGH BLOOM					PLUMS
DISEASE	**Black Knot[1]**	**Brown Rot Blossom Blight**			
Bumber/Tilt[6,8] (fl oz)	–	+++ 4.0			24 h 0 d
Captan 80WDG[6,7] (lb)	++ 2.5	++ 2.5			24 h 0 d
Cevya 3.34SC (fl oz)	–	+++ 3.0-5.0			12 h 0 d
Copper, fixed	+ various rates	+ various rates			12-48 h various
Elevate 50WDG (lb)	–	++ 1.0-1.5			12 h 0 d
Fontelis 1.67SC (fl oz)	–	++++ 14.0-20.0			12 h 0 d
Flint Extra 4.05SC (fl oz)	–	++++ 2.5-3.8			12 h 1 d
Indar 2F (fl oz)	+++ 6.0	+++ 6.0			12 h 0 d
Luna Experience 3.34SC (fl oz)	–	++++ 6.0 - 10.0			12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	++++ 5.0-7.6			12 h 1 d
Merivon 4.18SC (fl oz)	–	++++ 4.0-6.7			12 h 0 d
Miravis 1.67SC (fl oz)	–	++ 3.4-5.1			4 h 0 d
Pristine 38WG (oz)	++ 10.5-14.5	++++ 10.5-14.5			12 h 0 d
Quadris Top 2.72SC (fl oz)	–	++++ 12.0-14.0			12 h 0 d
Quash 50WDG (oz)	–	+++ 2.5-3.5			12 h 14 d
Rally 40WSP (oz)	–	+++ 2.5-6.0			24 h 0 d
Rovral 4F[6] (pt)	–	++++ 1.0-2.0			24 h PF[8]
Sulfur, actual[9] (lb)	–	++ 10.0			24 h NTL[8]
Topguard EQ (fl oz)	–	++ 6.0-8.0			12 h 7 d
Topsin M WSB (lb) plus Captan 80WDG[7] (lb)	+++ 1.0 plus 1.25	+++ 0.5-0.75 plus 1.25-2.5			48 h 1 d
Vangard 75WG (oz)	–	+++ 5.0			12 h 2 d

[1] Bravo is most effective material against Black Knot and should be used from pre-bloom through petal-fall in severe cases. [2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details. [3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [5] Abound is very phytotoxic to apples, do not use near apples. [6] Generic products and/or other formulations are available. [7] Continuous use of Captan can cause leaf spotting and fruit injury. [8] Do not apply to Stanley plums prior to 21 days before harvest. [9] Avoid sulfur if temperatures are above 90°F; lower rates are less phytotoxic. [10] PHI Key: FB=No later than full bloom; PF=No later than petal-fall, NTL= No time limit (usually up to the day of harvest) - consult label.

PREBLOOM THROUGH BLOOM	PLUMS
INSECT PEST	**Do not apply insecticides prebloom through bloom!**

PETAL-FALL					PLUMS
DISEASE	**Bacterial Spot[1]**	**Black Knot[2]**	**Brown Rot Blossom Blight**		
Product and Formulation[3]	**Product Efficacy Rating[4] and Rate/A[5]**				**REI PHI**
Abound 2F[6] (fl oz)	–	–	++++ 12.0-15.5		4 h 0 d
Bravo Weather Stik 6F[7] (pt)	–	++++ 3.0-4.0	++ 3.0-4.0		12 h PF[12]
Bumber/Tilt[7,10] (fl oz)	–	–	+++ 4.0		24 h 0 d
Captan 80WDG[8] (lb)	–	++ 2.5	++ 2.5		24 h 0 d
Cevya 3.34SC (fl oz)	–	-	+++ 3.0-5.0		12 h 0 d
Copper, fixed	+++ 0.5-1.0 oz MCE[9]	+ various rates	+ various rates		12-48 h various
Elevate 50WDG (lb)	–	–	++ 1.0-1.5		12 h 0 d
Fontelis 1.67SC (fl oz)	–	–	++++ 14.0-20.0		12 h 0 d
Flint Extra 4.05SC (fl oz)	–	–	++++ 2.5-3.8		12 h 1 d
Indar 2F (fl oz)	–	+++ 6.0	+++ 6.0		12 h 0 d
Luna Experience 3.34SC (fl oz)	–	–	++++ 6.0 - 10.0		12 h 0 d
Luna Sensation 4.2SC (fl oz)	–	–	++++ 5.0-7.6		12 h 1 d
Merivon 4.18SC (fl oz)	–	–	++++ 4.0-6.7		12 h 0 d
Miravis 1.67SC (fl oz)	–	-	++ 3.4-5.1		4 h 0 d
Pristine 38WG (oz)	–	++ 10.5-14.5	++++ 10.5-14.5		12 h 0 d
Quadris Top 2.72SC (fl oz)	–	–	+++ 12.0-14.0		12 h 0 d
Quash 50WDG (oz)	–	–	+++ 2.5-3.5		12 h 14 d
Rally 40WSP (oz)	–	–	+++ 2.5-6.0		24 h 0 d
Rovral 4F[7] (pt)	–	–	++++ 1.0-2.0		24 h PF[12]
Sulfur, actual[11] (lb)	–	–	++ 10.0		24 h NTL[12]
Topguard EQ (fl oz)	–	–	++ 6.0-8.0		12 h 7 d
Topsin M WSB (lb) plus Captan 80WDG[8] (lb)	–	+++ 1.0 plus 1.25	+++ 0.5-0.75 plus 1.25-2.5		48 h 1 d

[1] Japanese plums are susceptible to bacterial spot. [2] Bravo is most effective material against Black Knot and should be used from pre-bloom through petal fall in severe cases. [3] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details. [4] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [5] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [6] Abound is very phytotoxic to apples, do not use near apples. [7] Generic products and/or other formulations are available. [8] Continuous use of Captan can cause leaf spotting and fruit injury. [9] Metallic Copper Equivalent (Actual Copper). [10] Do not apply to Stanley plums prior to 21 days before harvest. [11] Avoid sulfur if temperatures are above 90°F; lower rates are less phytotoxic. [12] PHI Key: PF=No later than petal-fall, NTL= No time limit (usually up to the day of harvest) - consult label.

SHUCK-FALL					PLUMS
DISEASE	**Bacterial Spot[1]**	**Black Knot**			
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Captan 80WDG[5] (lb)	–	++ 2.5			24 h 0 d
Copper, fixed	+++ 0.5-1.0 oz MCE[6]	+ various rates			12-48 h various
Topsin M WSB (lb) plus Captan 80WDG[5] (lb)	–	+++ 1.0 plus 1.25			48 h 1 d

[1] Japanese plums are susceptible to bacterial spot. [2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details. [3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [5] Continuous use of Captan can cause leaf spotting and fruit injury. [6] Metallic Copper Equivalent (Actual Copper).

SHUCK-FALL Avoid killing bees on blooming ground cover.					PLUMS
INSECT PEST	**Leafrollers**	**Plum Curculio**			
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Altacor (oz)	++++ 3.0-4.5	–			4 h 10 d
Apta/Bexar (fl oz)	++ 21.0-27.0	+++ 21.0-27.0			12 h 14 d
Asana XL[3] (fl oz)	++++ 4.8-10.0	++ 8.0-14.0			12 h 14 d
Avaunt (oz)	+++ 5.0-6.0	++++ 5.0-6.0			12 h 14 d
Baythroid XL (fl oz)	++++ 2.4-2.8	++ 2.4-2.8			12 h 7 d
Besiege (fl oz)	++++ 6.0-12.0	++ 9.0-12.0			24 h 14 d
Cormoran (fl oz)	+++ 20.0-28.0	++ 20.0-28.0			12 h 8 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	+++ 10.6-21.3			24 h 3 d
Delegate 25WG (oz)	++++ 4.5-7.0	+ 7.0			4 h 7 d
Endigo ZC (fl oz)	++++ 5.5-6.0	S 5.5-6.0			24 h 7 d
Entrust SC (fl oz)	++++ 4.0-8.0	–			4 h 7 d
Envidor 2SC (fl oz)	–	–			12 h 7 d
Exirel (fl oz)	+++ 13.5-20.5	+++ 13.5-20.5			12 h 3 d
Imidan 70W (lb)	+++ 1.5-3.0	++++ 1.5-3.0			7/14 d[4] 14 d
Intrepid 2F (fl oz)	++++ 8.0-16.0	–			4 h 7 d
Lambda-Cy (fl oz)	++++ 2.56-5.12	++ 2.56-5.12			24 h 14 d
Leverage 360 (fl oz)	+++ 2.4-2.8	++ 2.4-2.8			12 h 7 d

Shuck-Fall INSECT PESTS - continued on next page

Shuck-Fall INSECT PESTS - continued

SHUCK-FALL Avoid killing bees on blooming ground cover.					PLUMS
INSECT PEST	**Leafrollers**	**Plum Curculio**			
Sevin XLR Plus (qt)	++ 2.0-3.0	+++ 2.0-3.0			12 h 3 d
Verdepryn 100SL (fl oz)	++++ 5.5-11.0	+++ 5.5-11.0			4 hr 7 d
Warrior II[3] (fl oz)	++++ 1.28-2.56	++ 1.28-2.56			24 h 14 d

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] Generic products and/or other formulations are available.
[4] Imidan REI 7 d for farm labor, but 14 d for u-pick operations.

COVERS					PLUMS
DISEASE	**Bacterial Spot[1]**	**Black Knot**			
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Captan 80WDG[5] (lb)	–	++ 2.5			24 h 0 d
Copper, fixed	+++ 0.5-1.0 oz MCE[6]	–			12-48 h various
Topsin M WSB (lb) plus Captan 80WDG[5] (lb)	–	+++ 1.0 plus 1.25			48 h 1 d

[1] Japanese plums are susceptible to bacterial spot.
[2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Continuous use of Captan can cause leaf spotting and fruit injury.
[6] Metallic Copper Equivalent (Actual Copper).

COVERS Avoid killing bees on blooming ground cover.					PLUMS
INSECT OR MITE PEST	**INSECTS**			**MITES**		
	Leafrollers	**Oriental Fruit Moth**	**Plum Curculio**	**European Red Mite**	**Two-Spotted Spider Mite**	
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**					**REI PHI**
Acramite 50WS (oz)	–	–	–	++++ 12.0-16.0	++++ 12.0-16.0	12 h 3 d
Actara 25WG (oz)	–	–	+++ 4.5-5.5	–	–	12 h 14 d
Altacor (oz)	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	4 h 10 d
Apollo SC (oz)	–	–	–	++++ 4.0-6.0	++++ 4.0-6.0	12 h 21 d
Asana XL[3] (fl oz)	++++ 4.8-8.0	++++ 4.8-8.0	++ 8.0-14.0	–	–	12 h 14 d
Assail 30SG (oz)	–	+++ 5.3-8.0	++ 7.0-8.0	–	–	4 h 7 d
Avaunt (oz)	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	–	–	12 h 14 d

Covers INSECT PESTS - continued on next page

Covers INSECT PESTS - continued

COVERS Avoid killing bees on blooming ground cover.						PLUMS
INSECT OR MITE PEST	**INSECTS**			**MITES**		
	Leafrollers	**Oriental Fruit Moth**	**Plum Curculio**	**European Red Mite**	**Two-Spotted Spider Mite**	
Apta/Bexar (fl oz)	++ 21.0-27.0	–	+++ 21.0-27.0	–	–	12 h 14 d
***Bacillus thuringiensis*[3,4] (lb)**	++++ 0.5-2	–	–	–	–	4 h –
Baythroid XL (fl oz)	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	–	–	12 h 7 d
Besiege (fl oz)	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	–	–	24 h 14 d
Cormoran (fl oz)	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	–	–	12 h 8 d
Danitol 2.4 EC (fl oz)	++++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 10.6-21.3	++ 10.6-21.3	24 h 3 d
Delegate 25WG (oz)	++++ 4.5-7.0	+++ 6.0-7.0	+ 6.0-7.0	–	–	4 h 7 d
Endigo ZC (fl oz)	++++ 5.5-6.0	++++ 5.5-6.0	++ 5.5-6.0	–	–	24 h 14 d
Entrust SC (fl oz)	++++ 4.0-8.0	+++ 4.0-8.0	–	–	–	4 h 1 d
Envidor 2SC (fl oz)	–	–	–	++++ 16.0-18.0	++++ 16.0-18.0	12 h 7 d
Esteem 35WP (oz)	–	+++ 4.0-5.0	–	–	–	12 h 14 d
Exirel (fl oz)	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	12 h 3 d
Imidan 70W (lb)	+++ 1.5-3.0	+++ 1.5-3.0	++++ 1.5-3.0	–	–	7/14 d[5] 14 d
Intrepid 2F (fl oz)	++++ 8.0-16.0	+++ 10.0-16.0	–	–	–	4 h 7 d
Lambda-Cy (fl oz)	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	–	–	24 h 14 d
Leverage 360 (fl oz)	++++ 2.4-2.8	+++ 2.4-2.8	++ 2.4-2.8	–	–	12 h 7 d
Mustang Maxx (fl oz)	++++ 1.28-4.0	++++ 1.28-4.0	+++ 1.28-4.0	–	–	12 h 14 d
Onager EC (oz)	–	–	–	++++ 12.0-24.0	++++ 12.0-24.0	12 h 28 d
Savey 50DF (oz)	–	–	–	++++ 3.0-6.0	++++ 3.0-6.0	12 h 28 d
Vendex 50WP (lb)	–	–	–	+++ 1.0-2.0	+++ 1.0-2.0	48 h 14 d
Verdepryn 100SL (fl oz)	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	–	–	4 hr 7 d
Voliam Flexi (oz)	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	–	–	12 h 14 d
Warrior II[3] (fl oz)	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	–	–	24 h 14 d
Zeal (oz)	–		–	++++ 2.0-3.0	++++ 2.0-3.0	12 h 7 d

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] When noted, generic products are available.
[4] Various products. See label.
[5] Imidan REI 7 d for farm labor, but 14 d for u-pick operations.

PLUMS

PREHARVEST					PLUMS
DISEASE	**Brown Rot[1]**				
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
Abound 2F[5] (fl oz)	+++ 12.0-15.5				4 h 0 d
Bumber/Tilt[6,8] (fl oz)	++++ 4.0				24 h 0 d
Captan 80WDG[6,7] (lb)	+++ 3.0-3.75				24 h 0 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0				12 h 0 d
Elevate 50WDG (lb)	++ 1.0-1.5				12 h 0 d
Fontelis 1.67SC (fl oz)	++++ 14.0-20.0				12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-3.8				12 h 1 d
Indar 2F (fl oz)	++++ 6.0				12 h 0 d
Luna Experience 3.34SC (fl oz)	++++ 6.0 - 10.0				12 h 0 d
Luna Sensation 4.2SC (fl oz)	++++ 5.0-7.6				12 h 1 d
Merivon 4.18SC (fl oz)	++++ 4.0-6.7				12 h 0 d
Miravis 1.67SC (fl oz)	+++ 3.4-5.1				4 h 0 d
Oso 5%SC (fl oz)	+++ 6.5-13.0				4 h 0 d
Pristine 38WG (oz)	++++ 10.5-14.5				12 h 0 d
Quadris Top 2.72SC (fl oz)	++++ 12.0-14.0				12 h 0 d
Rally 40WSP (oz)	+++ 2.5-6.0				24 h 0 d
Topguard EQ (fl oz)	++ 6.0-8.0				12 h 7 d
Topsin M WSB (lb) plus Captan 80WDG[7] (lb)	+++ 0.5-0.75 plus 1.25-2.5				48 h 1 d

[1] Apply two-three preharvest sprays starting 21-14 days before harvest.
[2] Alternate products of different chemistry for resistance management; see peach and nectarine efficacy Table 7.7 for details.
[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Abound is very phytotoxic to apples, do not use near apples.
[6] Generic products and/or other formulations are available.
[7] Continuous use of Captan can cause leaf spotting and fruit injury.
[8] Do not apply to Stanley plums prior to 21 days before harvest.

PREHARVEST Avoid killing bees on blooming ground cover.						PLUMS
INSECT OR MITE PEST	**INSECTS**			**MITES**		
	Leafrollers	**Oriental Fruit Moth**	**Plum Curculio**	**European Red Mite**	**Two-Spotted Spider Mite**	
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**					**REI PHI**
Acramite 50WS (oz)	–	–	–	++++ 12.0-16.0	++++ 12.0-16.0	12 h 3 d
Altacor (oz)	++++ 3.0-4.5	++++ 3.0-4.5	–	–	–	4 h 10 d
Assail 30SG (oz)	–	+++ 5.3-8.0	++ 7.0-8.0	–	–	4 h 7 d
***Bacillus thuringiensis*[3,4]**	++++ various rates	–	–	–	–	4 h –
Baythroid XL (fl oz)	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	–	–	12 h 7 d
Cormoran (fl oz)	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	–	–	12 h 8 d
Danitol 2.4 EC (fl oz)	+++ 10.6-21.3	+++ 10.6-21.3	++ 10.6-21.3	++ 10.6-21.3	++ 10.6-21.3	24 h 3 d
Delegate 25WG (oz)	++++ 4.5-7.0	+++ 6.0-7.0	+ 6.0-7.0	–	–	4 h 7 d
Entrust SC (fl oz)	++++ 4.0-8.0	+++ 4.0-8.0	–	–	–	4 h 1 d
Exirel (fl oz)	–	++++ 10.0-20.5	+++ 13.5-20.5	–	–	12 h 3 d
Intrepid 2F (fl oz)	++++ 8.0-16.0	+++ 10.0-16.0	–	–	–	4 h 7 d
Leverage 360 (fl oz)	+++ 2.4-2.8	+++ 2.4-2.8	++ 2.4-2.8	–	–	12 h 7 d
Verdepryn 100SL (fl oz)	++++ 5.5-11.0	++++ 5.5-11.0	+++ 5.5-11.0	–	–	4 hr 7 d

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] When noted, generic products are available.
[4] Various products. See label.

POSTHARVEST					PLUMS
DISEASE	**Bacterial Canker[1]**				
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Bordeaux mixture (lb/100 gal)	++ 4, 7				24 h NA
Copper, fixed	++ various rates				12-48 h various

[1] Apply two sprays at 10% and 80% leaf drop. If canker has been a problem, apply four sprays at 14 day intervals.
[2] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

POSTHARVEST **Avoid killing bees on blooming ground cover.**					PLUMS
INSECT PEST	**Lesser Peach Tree Borer**	**Peach Tree Borer**			
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Asana XL[3] (fl oz/100 gal)	+++ 5.8	+++ 5.8			12 h 14 d
Danitol 2.4EC (fl oz)	++ 10.6-21.3	++ 10.6-21.3			24 h 3 d
Lorsban-4E[3] (qt/100 gal)	++++ 1.5-3.0	++++ 1.5-3.0			96 h 14 d

[1] ++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] Per acre rate by handgun in minimum of 100 gal/A; apply after harvest during early September in south Jersey, slightly later in the northern parts of the state. Thoroughly wet trunks and scaffold limbs. Avoid contact with sweet cherry foliage to prevent defoliation.

10 APPLES

10.1 Apple Cultivars

Selection of Apple Cultivars Is One of the Most Important Management Decisions for Growers

Growers are encouraged to plant a cultivar test block with several trees of each of the best new apple cultivars to evaluate on your site. Some NJ growers have expanded their retail marketing efforts into "Pick-Your-Own" (PYO), and many growers have also expanded into the numerous tailgate marketing opportunities in the New York City Greenmarket system and in the eighty markets located in NJ cities. These growers continue to plant newer, higher quality eating apples. Taste and texture continue to be important quality factors in retail apple marketing.

Ordering Apple Trees

There is an extreme shortage of apple trees, specifically apple rootstocks nationwide, primarily because growers have rapidly moved to tall spindle systems at 1000 trees per acre over the past 5 years. There are not enough rootstock nurseries/and stool bed capacity to keep up. Growers should plan to replace 10% of your apple acreage on an annual basis.

Growers must order custom budded trees 2-4 years out and pay a deposit per tree up front. Consider thinking of your needs for the next 2-6 years and at least reserve the rootstock you want with your nursery for years 2-6. You can determine the cultivar you wish propagated later.

Suggested Cultivars for New Jersey

The NE-183 Regional Apple Project identified several outstanding cultivars that perform well in NJ. Many NJ growers have already adopted these, including 'Cameo'®, 'Gala Supreme', 'Ginger Gold'®, 'Goldrush', 'Honeycrisp'™, 'Suncrisp'® (NJ55), 'Sunrise', and 'Zestar!'™. They have fit into the retail-oriented apple marketing mix that our NJ industry has continued to move toward to. For more detailed information on these cultivars, visit the NE-183 website at: *http://virtualorchard.com/ne183/cultivars/cultivars.html*.

Table 10.1 Suggested Apple Cultivars for New Jersey

All ripening dates are for the Rutgers Snyder Research & Extension Farm, Hunterdon County, Northwest NJ. Maturity dates can vary +/- 5-7 days in a given year.

Ripening Date	Best Fresh Market Cultivars	Cultivars for Trial or Limited Planting	Scab-resistant Cultivars
Aug. 1-15	**Sunrise**	**Akane**	**Pristine®**
Aug. 15-31	**Gingergold®, Silken, Zestar!™**	**Dandee Red®, Sansa**	**Redfree**
Sept. 1-15	**Gala, Honeycrisp™,** **Mcintosh**: *Rubyred*	**Early Honeycrisp** **Mollie's Delicious**	**Crimson Crisp™**
Sept. 15-25	**Cortland**: *Redcort, Royal Court™*, **Early Fuji**		
Sept. 25-30	**Empire, Liberty, Macoun**		**Liberty**
Oct. 1-10	**Cameo®, Jonagold** *plant improved color strains*, **Golden Delicious**: *Gibson, Smoothee, Crispin (Mutsu)*		
Oct. 11-20	**Fuji**: *including various strains – Aztec Fuji, Fuji Select, Fuji Suprema, Mishima* **Suncrisp®** *(Nj55)*		**Enterprise**
Oct. 21-31	**Braeburn**: *plant new improved strains,* **Stayman**: *Snapp™ Stayman, 201 Stayman*	**Red Winesap**	
Nov. 1-20	**Cripps Pink, Granny Smith, Goldrush**		**Goldrush**

Cultivar Descriptions (in ripening order)

‘**Pristine‘®** An early summer, disease-resistant apple that ripens just after ‘Lodi‘. ‘Pristine‘ is a yellow apple with smooth, glossy skin. Fruit is high in sugar content with excellent keeping quality for an early season cultivar. It is scab immune, but susceptible to fire blight.

‘Sunrise‘ An early ripening selection from British Columbia, Canada. ‘Sunrise‘ was developed at the Summerland Research Station Apple Breeding Program. Its parents are ‘McIntosh‘ and ‘Golden Delicious‘ X PCF-3-120. It has a unique, highly attractive red/pink color that catches your eye. It ripens August 5. For fresh market sales only, as it has a short storage life.

‘Dandee Red‘® A new apple that is highly attractive, bright red, and ripens 8 days before ‘Paulared‘. It is an early ‘McIntosh‘ type that stores well in its season. It has cropped extremely well at the Rutgers Snyder Research & Extension Farm for two seasons.

‘Zestar!‘™ From the Minnesota breeding program. ‘Zestar!‘ has ‘Honeycrisp‘-like flavor and texture, but ripens a month earlier, around August 19. This cultivar remains one the best dessert apples in this early season at our trials at the Rutgers Snyder Research & Extension Farm. It can be prone to drop and should not be held in long-term storage. Many view this apple as a replacement for ‘Paulared‘.

‘Silken‘ A new apple from British Columbia with very high eating quality, ripens around Aug 21. It is known for its unique white gold porcelain color with a slight pink blush in some years in Northern New Jersey. Fruit is medium in size with excellent flavor and texture and has rated extremely high in taste tests at the Rutgers Snyder Research & Extension Farm.

‘RedFree‘ An early August disease-resistant apple with tart flavor similar to ‘McIntosh‘; resistant to apple scab and cedar apple rust and moderately resistant to fireblight and powdery mildew; good cropper and annual bearer.

‘Sansa‘ Sansa ripens August 30. A ‘Gala‘ X ‘Akane‘ cross developed in Japan, maturing one week before ‘Gala‘. Excellent dessert apple with good keeping quality. Resembles ‘Gala‘ in fruit color and firmness.

‘Mollie’s Delicious‘ A Rutgers cultivar that is an old-time favorite. It has no ‘Delicious‘ parentage in its heritage. It was named for its flavor, delicious. It is a very large, conically shaped, attractive apple with pinkish red skin over yellow. It has excellent flavor and can be stored for up to 10 weeks.

‘Early Fuji‘ Cultivars. Ripen 30-35 days before regular ‘Fuji‘, around September 10-15, and include ‘Rising Sun Fuji‘, ‘Benishogun Fuji‘, ‘Auvil Early Fuji‘, ‘September Wonder Fuji’, ‘Daybreak Fuji,’ ‘Morning Mist Fuji,’ These are all true ‘Fuji‘s with good color, flavor, and other ‘Fuji‘ characteristics.

‘Gingergold‘® Gingergold ripens August 29. Discovered as a chance seedling in VA. It is a high quality, yellow apple with good finish and crispness for its season. The tree is vigorous and productive. It can develop cork spot and can be stored for several months if harvested at the correct maturity.

‘Gala‘ Gala ripens September 7-10. There are numerous high color strains of this cultivar that work well in NJ. For Southern New Jersey, ‘Brookfield‘ and ‘Buckeye‘® are two of the reddest coloring strains. They are too dark for Northern New Jersey if you want a blushed gala. ‘Fulford‘, ‘Crimpson‘, and ‘Royal‘ have performed well. There are many new strains that have not been evaluated in NJ.

‘Honeycrisp‘™ Honeycrip has outstanding eating quality, but needs careful thinning. This cultivar continues to be a consumer favorite, with retail prices exceeding $3.00-3.99/lb ‘Honeycrisp‘™ appears to benefit greatly from use of ReTain®. In Northern New Jersey, it develops good red color 3 out of 5 years, about the same as ‘McIntosh‘. Choose the new red strains. In Southern New Jersey, red color will develop less. Growers who sample this cultivar with taste testing at the retail level find that color is not an issue, texture and varietal flavor sell.

‘Cortland‘ Cortland has very white, crisp flesh does not brown, very high eating quality, tart. Ripens mid-September, a week after ‘McIntosh‘. Works very well in slender spindle production systems.

'Empire' Released from the New York State Agricultural Experiment Station. Very high quality eating apple, must be thinned well for good size. Fruit is creamy, white and subacid. Spur type tree that is easy to train.

'Liberty' One of the highest quality, disease-resistant cultivars. It should be planted in limited acreage for fresh market. The 'Liberty' tree has many desirable qualities. It is an annual bearer, heavy producer, has compact, spur-type growth, and is easy to train and manage. Fruit quality is very high, with 'Macoun' as one parent. It has white flesh with unique flavor. Spraying with Retain® evens out the non-uniform harvest. 'Liberty' taste and flavor continues to improve in storage, reaching its peak in 4-6 weeks.

'Macoun' A NJ favorite. We call it the "Cult Apple", as consumers love it and will do anything to get it. It is well adapted to Northern New Jersey through the Hudson Valley, basically anywhere you can get good color on 'McIntosh'. It has a striped red skin, highly attractive, with a purplish tinge. Very white, juicy flesh that has a unique flavor. Does not store more than 4-6 weeks. Must be thinned heavily to get size. Tree is very upright and is difficult to train.

'Jonagold' Large fruit is striped, red over yellow background. A cross of 'Golden Delicious' X 'Jonathan', developed at the NYAES. Many newer higher colored strains are available and should be planted. Flesh is firm and juicy with excellent eating quality and full rich flavor.

'Cameo'® Originated as a chance seedling in a block of 'Delicious'. Many feel this cultivar has the taste and fruit characteristics of the old fashioned original 'Delicious'. Because of the high quality of the fruit; creamy white flesh, and excellent flavor, this cultivar has become a favorite of roadside market and PYO orchardists. It is being heavily planted as an alternative to 'Delicious'.

'Suncrisp'® A Rutgers release that was tested as NJ55. An outstanding eating apple, ripening October 10-20 (25-30th with Retain). This apple always appears at the top of the list in sensory evaluation, and keeps the customers coming back. It is a compact, spur type tree that is easy to train, but requires early heavy thinning, to reduce biennial bearing. It is susceptible to calcium disorders and blister spot, and benefits from ReTain®. It can also get surface soft scald in storage.

'Golden Delicious' An old-time favorite, and a standard for the season in early-October. It originated as a chance seedling of 'Grimes Golden' in West Virginia. It has a mild, sweet flavor and crisp, juicy flesh. Its' skin can shrivel in storage.

'Fuji' Ripens October 15-20. There are numerous high colored strains available. It is a very vigorous tree that can be very biennial, and therefore requires very early chemical thinning and judicious use of PGRs to break this cycle. 'Sun Fuji', 'Desert Rose Fuji', and 'Autumn Rose Fuji' are three that have performed well at the Rutgers Snyder Research & Extension Farm.

'Stayman' A NJ old-time favorite, that fell out of favor after the removal of Alar from the market because the fruit can crack. Use of ProVide and ReTain® PGR's have allowed it to make a comeback. It is a late-October, red apple that is hard and has excellent sweet/tart flavor. The strains listed in Table 10.1 have performed well in Northern NJ.

'Braeburn' A hard, red, fall apple, that ripens in late-October. It retains its firmness and excellent eating texture well into January in cold storage. Flesh is cream colored and firm, with subacid flavor. The newer strains have excellent red color. The tree is spur type and extremely precocious. Caution must be used not to allow the trees to "runt out" if overcropped. It performs well in the slender spindle growing system. Prone to mite injury.

'Granny Smith' Granny Smith can be grown and matured in NJ for a high quality, green, tart apple. When mature, it has a red blush on the cheek.

'Goldrush' Goldrush ripens November 7. A later-maturing apple developed by Rutgers, Purdue and the University of Illinois as part of the Co-op series. It is a unique, high-flavored apple, with a very crisp texture. It reaches its best quality if put into storage until early December where it mellows and sweetens.

10.2 Apple Rootstocks

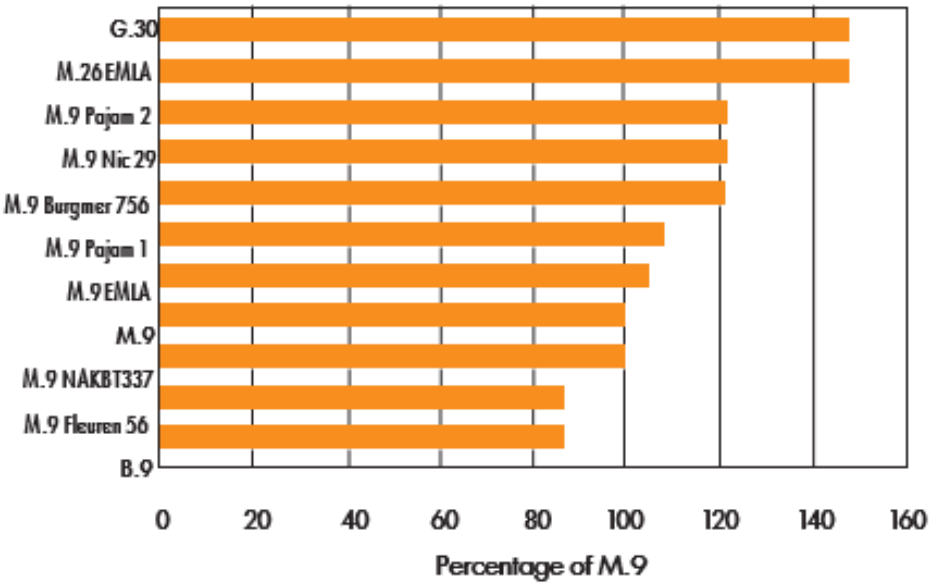
Rootstocks are a key component in the orchard system. They must be matched with the cultivar, soil type and planting system that is to be established. The most important traits to consider are growth control, precocity, and resistance to disease, especially fire blight. Rootstocks can also impact fruit size, yield, and cumulative yield over time. The absolute size and performance of a mature tree on a given rootstock is influenced by soil, climate, scion cultivar, and very importantly, by management and care. After eighty years of testing, only full dwarfing rootstocks in high-density plantings can be recommended to insure an early return on investment. Planting these full dwarfing rootstocks in a supported system is a must.

Research is ongoing to evaluate rootstock performance in New Jersey. We are also identifying rootstocks that are resistant to insects and apple replant disease. The following general characteristics of each rootstock are based on research observations in New Jersey and the NC-140 Rootstock Research Trials located at the Rutgers Snyder Research and Extension Farm in Hunterdon County, NJ (see Figure 10.1). For more information, visit the NC-140 website at *http://www.nc140.org*.

Virus-Free Rootstocks. Trees indexed and maintained free of known harmful apple viruses may be slightly larger, but are healthier and more productive. Only virus-free trees and rootstocks should be planted! For full dwarfing trees, consider reserving the Cornell stocks G41 or G11 rootstock for propagation in future years with your nursery supplier. The availability of these stocks is increasing but cannot meet demand so consider pre-ordering. These are both fireblight resistant and crown rot (Phytophthora) tolerant- see: *http://www.nc140.org*.

Figure 10.1 Size of Apple Trees on Several Rootstocks Relative to M.9

Based on NC-140 data from NJ, PA, NY, MI and MA from 1994-2006.



In the following listing, rootstocks are listed by size (largest tree first) and then by class:

MM.111. This rootstock is propagated by stool beds or layering, and is multiplied from one clone. Vigorous cultivars on MM.111 produce trees semi-dwarf in size, or 70 to 80 percent the size of those on seedling rootstocks. Spur-type trees on MM.111 are smaller. MM.111 is semi-vigorous, well-anchored, and encourages earlier production than seedling rootstocks. MM.111 is tolerant of drought, high soil temperatures, collar and root rot. It is also resistant to woolly apple aphids and does not sucker badly if planted with the bud union 2 inches above the soil line. Because of its tolerance to collar rot, it does better than other clonal stocks on fine-textured and poorly-drained soils. Spur- and standard-bearing cultivars are recommended on MM.111 rootstock under these soil conditions but, will still be large trees.

MM.106. This rootstock is produced by stool beds, layering, or semi-hardwood cuttings, and is multiplied from one clone. Vigorous scion cultivars on MM.106 rootstock produce trees 65 to 75 percent the size of those on seedling rootstock. Spur-bearing and less vigorous cultivars will produce slightly smaller trees. Trees on MM.106 are fairly well-anchored, sturdy, and efficient. This rootstock's biggest advantage is the ability to induce early and heavy production, particularly on slow-bearing cultivars. It also resists woolly apple aphids, and suckers very little if planted with the bud union 2 inches above the soil line.

MM.106 is not recommended for New Jersey because it is susceptible to tomato ring-spot virus, which causes a necrosis and brown line at the bud union which kills 'Delicious', 'Jerseymac', and 'Golden Delicious'. It is also sensitive to collar and root rot. Because of its slow acclimation, early winter low temperatures may injure trees on MM.106.

M.7a. Is not recommended for Northern New Jersey, but is one of the least precocious semi-dwarf rootstocks tested in the NC-140 rootstock trials. Its major downfall is that it suckers extensively. This rootstock is produced by stool beds and layering, and has been multiplied from one clone of M.7, which is virus-free. Vigorous scion cultivars on M.7a rootstock produce trees 55 to 65 percent the size of those on seedling rootstock. Spur-bearing and less vigorous cultivars may produce slightly smaller trees. M.7a is reasonably vigorous,. M.7a is sensitive to some soil conditions and responds very differently with different scion cultivars. 'Delicious', 'Idared', and 'Rome' on M.7a are not well-anchored and are smaller at maturity than well-anchored 'Golden Delicious' or 'McIntosh' trees. M.7a is very responsive to irrigation, particularly on sandy loam and loamy sand soils. M.7a is moderately tolerant of crown and root rot, but susceptible to woolly apple aphids. It should not be planted on the heavier soils of Northern New Jersey.

M.26 This rootstock is produced by layering, stool beds, or semi-hardwood cuttings and is multiplied from one clone. Vigorous scion cultivars produce trees 60 to 70 percent the size of those on seedling rootstock. However, it will reach heights of 12-14 feet on stronger soils. Spur-bearing and less vigorous cultivars on M.26 are smaller and full dwarf in size. 'Spur Red Delicious' on M.26 should not be grown on shallow, sandy, or sandy loam soils, as resulting trees may be small and poorly anchored. 'McIntosh' with M.26 on deep loamy soils in Central and Northern New Jersey may be reasonably large, well-anchored, and semi-vigorous. M.26 should be supported for leader management. With good early management, trees with M.26 rootstock are precocious. M.26 is susceptible to fire blight and woolly apple aphids, and is only moderately tolerant to collar and root rot. Trees on M.26 are not drought-tolerant. M.26 acclimates slowly, and like MM.106, is susceptible to low, early winter temperatures but is very hardy during mid- and late winter.

M.26 rootstock is recommended only with fire blight-tolerant cultivars. It has been the best, most widely planted dwarfing rootstock in New Jersey. Plant it only in deep, well-drained heavier soils. It is not recommended for light, course-textured soils. On fertile soils, it is a very large tree and is not suitable for higher-density plantings. G-30 is a much better choice for this size tree. In several trials at the Rutgers Snyder Research & Extension Farm, G-30 had significantly higher cumulative yields than M26 and was more yield efficient.

M.9 (Malling 9). This is the best-known and most widely planted apple rootstock in high-density apple plantings in the U.S., Europe, and other apple growing regions around the world. While M.9 may be more vigorous on deep, well-drained, loamy soils than on sandy loam or shallow soils, the roots are very brittle, and trees on M.9 are poorly anchored. All cultivars with M.9 need support in the form of stakes or trellis. Trees on this rootstock always require leader support. Trees on M.9 are early bearing and very efficient. Spur cultivars and less vigorous cultivars on M.9 are smaller and can be very dwarf. M.9 is the rootstock most resistant to collar rot, and tolerates low temperatures throughout the winter. It is not drought-tolerant and is very responsive to irrigation. It is susceptible to woolly apple aphids, it can develop burr knots, and it suckers freely. All M.9 clones are considered highly sensitive to fire blight.

Clones of M9. It is important to note that numerous clones of M.9 are now being sold by nurseries. The following is a partial list of M.9 Clones:

M.9 NAKB 337. This is the most widely propagated clone of M.9 today. It is a very good rootstock, but very susceptible to fire blight. In the 1994 NC-140 trial, NAKB 337 proved to be one of the smaller of the M.9 clones. It has one of the highest yield efficiencies, but only average fruit size.

APPLES

M.9 EMLA. A virus-free clone of the original M.9, M.9 EMLA is the oldest and most widely tested of all M.9 clones in the U.S. today. This clone is highly tolerant to Phytophthora root rot, but it is very sensitive to fire blight. It is one of the weaker growing strains of M.9, with a size comparable to NAKB 337.

M.9 RN.29. 'Nicolai' 29 is a Belgian clone of M.9 that has performed very well in Europe. Although its testing is still limited in North America, it has looked good in many national rootstock trials. In the 1994 NC-140 trial at the Rutgers Snyder Research & Extension Farm, RN.29 proved to be the largest of the M.9 clones under evaluation. Its size is comparable to that of M.26. Its 4-year cumulative yield has also been higher than any of the other clones, and its fruit size is outstanding.

M.9 'Fleuren' 56. F.56 is a virus-free Dutch clone, and one of the least vigorous clones of M.9 under test in North America. F.56 has very limited testing in the U.S. It has performed well in the New Jersey NC-140 trial, with the highest cumulative yield efficiency of all the M.9 clones. Fruit size has suffered with trees on this rootstock. Rootstock performance appears to increase as the tree gets older.

M.9 Pajam 1 (Lancep). The authenticity of the Pajam series clones, as to their M.9 progeny, is in question. But, as of now, both Pajam series stocks are treated and evaluated as M.9 clones. Pajam 1 produces a larger tree than most other M.9 clones. Although the tree is larger, it is highly productive and produces large fruit.

M.9 Pajam 2 (Cepiland). Another clone of M.9 originating in France. Pajam 2 produces a tree with more vigor than Pajam 1. Nationally, Pajam 2 has proven superior to M.9 EMLA and NAKB 337 in nearly 100 test trials.

The Budagovsky breeding program out of Russia has been actively pursuing new rootstocks that are tolerant of low minimum winter temperatures. Many of their selections have found their way onto the marketplace in Russia and Europe, and are now entering North American markets.

B.9 or Bud.9 (Budagovsky 9). Currently, this is our recommended rootstock for high-density, dwarfing systems. Trees on this rootstock are slightly smaller than M.9 EMLA. The leaves are a distinctive red, which make it a good identifying trait. It appears resistant to collar rot and is very cold hardy, more so than M.9. **Most importantly, it appears that B.9 is field tolerant to fire blight**. B.9 has performed very well in Northern New Jersey. B.9 trees need to be supported by stakes or trellis and it is the best rootstock for use in a slender spindle production system. B.9 also fits very well into single stake culture for "Pick-Your-Own" (PYO) plantings. Note however, that the in-row tree spacing must be matched to the soil type and cultivar, as B.9 is very precocious. When combined with a precocious cultivar like 'Honeycrisp', it can be extremely dwarfing and trees can "runt out" if planted too far apart and/or are allowed to crop too soon.

Cornell-Geneva (G.16). This is a new rootstock that is slightly larger than M9, but resistant to fire blight. This stock has been tested in three trials at the Rutgers Snyder Research & Extension Farm. In the early years of establishment, both B9 and M9 are smaller trees and are more precocious that G-16. But, over 8-10 years, G16 settles down and the trees become about the same size. Cornell reports this rootstock as being sensitive to latent viruses, so clean budwood is a must for propagation. It is available from commercial nurseries as a fireblight resistant stock. G65 and G41 are better stocks for dwarf plantings if you can get them.

Geneva 65 (G.65). This rootstock was developed by Dr. James Cummins, at Cornell University. It is reported to be about the size of M.9. This stock has not yet had enough testing in NJ or through the NC-140 program. It is M.9 size, extremely resistant to fire blight, collar rot, and burr knots, and is also resistant to woolly apple aphid. It is just becoming available, order trees on it if you can.

G.41- Resulted from a cross between M.27 and Robusta 5 and introduced by the New York State Agricultural Experiment Station, Geneva, NY. Geneva® 41 and has been tested as CG 3041 and is a full dwarf, similar in size to M.9 NAKBT337. It is highly resistant to fire blight and phytophthora and in initial tests; it appears to be tolerant of replant disease. It is being tested in the 2003 NC-140 trial at 12 locations with 'Golden Delicious' as the scion cultivar. After five years, it produces trees similar in size to M.9, but it has higher yield efficiency and produces few root suckers.

G.11- Resulted from a cross of M.26 and Robusta 5 crabapple and introduced in 1993 by the New York State Agricultural Experiment Station, Geneva, NY. G.11 is one of the more vigorous dwarfing rootstocks and produces a tree similar in size to M.26. It is precocious (similar to M.26), moderately resistant to fire blight, moderately susceptible to woolly apple aphid and crown an root rots, and requires trunk support, especially in the early years. It produces few burr knots and root suckers. G.11 has not been widely tested and is being evaluated in an NC-140 trial that was established in 2010.

Supporter 4 (Pi.80 select). Is not recommended for NJ. The Supporter series of rootstocks is out of the Pillnitz breeding program in Germany. Of the rootstocks in this series, Supporter 4 has been touted as the replacement for M.26 by U.S. nurseries. It is a cross between M.9 and M.4. Nurserymen like this rootstock because it is extremely easy to propagate. Information and research trials on this rootstock's performance in the U.S. are very limited. Any plantings at this time should be on a very limited trial basis only. Supporter 4 is also reported to be as sensitive to fire blight as M.26, so growers should avoid using it with sensitive scion cultivars.

Geneva 30 (G.30). This rootstock is a cross between Robusta 5 and M.9, from Cornell University. It is resistant to collar rot and fire blight. Similar in size to M7 and M26, it is more precocious, has fewer burr knots, and suckers less. This rootstock has been evaluated in two trials at the Rutgers Snyder Research & Extension Farm. This rootstock is excellent if you wish to produce a semi- dwarf size tree, but it needs to be supported. 'Gala' on G.30 is brittle at the graft union and is not a good combination unless fully supported. If 'Gala' on G.30 is planted, at minimum, a two-wire support in an axe type system is needed (one at 38-40 inches to prevent twisting and the other at 9 feet.) Other cultivars do not appear to be susceptible to this graft brittleness with G.30. At this time, G30 is the preferred choice for NJ if a mid-size tree is desired.

Ottawa 3 (Ott.3). This rootstock was bred in Canada for its cold hardiness, one parent being M.9. Trees on Ott.3 are about the size of M.9 EMLA, but smaller than M.26. It is precocious and resistant to collar rot, but susceptible to fire blight and woolly apple aphids. It is one of the best small stocks we have. It has been available for many years. However, it is not popular with the nursery industry because it is hard to propagate. Thus, most nurseries have not made this rootstock available. It should be grown with all the limitations of M.9, *i.e*. staking, irrigation and on heavier soils. Ottawa 3 is very susceptible to apple mosaic virus, so only material known to be virus-free should be grown on this rootstock.

M.27. This rootstock is propagated by layering and stool beds. Vigorous scion cultivars are suggested on M.27 because of its dwarfing effect. Most scion cultivars on M.27 are 25%, or less, the size of the same cultivars produced on seedling rootstocks. Less vigorous or spur type cultivars may be "runty," very small, and poorly anchored. Intense management and supplemental soil moisture is needed to grow trees on M.27. All cultivars on M.27 are very precocious, bearing fruit the second year of planting. Trees on M.27 rarely send out root suckers. M.27 is susceptible to woolly apple aphids, powdery mildew, fire blight, and early winter low temperatures. M. 27 is very small, and therefore not recommended for commercial orchards unless special needs apply (*i.e.*, very small trees).

MARK or MAC.9. Trees on MARK are no longer supported by commercial nurseries or recommended by extension fruit programs. No new plantings of MARK should be established in NJ. On existing plantings that have begun to runt, mounding at the graft union has helped in Michigan. Adequate targeted irrigation to these trees will also be essential.

Interstems. Grafting a 10- to 14-inch stem piece in between the rootstock and the scion makes an interstem tree. The interstem piece recommended is Malling 9, and the rootstock is MM.111. The scion cultivar is budded 7 to 12 inches above the union of the interstem piece and the rootstock. The advantages and weaknesses of all three pieces are combined. Interstem trees are more expensive and have not been planted much in NJ. There is little experience with apple interstems in NJ.

Tree Spacing and Rootstock Recommendations for New Jersey

Early yield and return on investment both are affected by the number of trees/A.

- All new orchards should be planted at high density in a tall spindle system.
- Consider a minimum of 1000 trees/A (see Table 10.2). Ideal is usually 12 feet by 3 to 3.5 feet.
- For high-density plantings of 1000 or more trees/A, use B.9., M.9 clones, G.11, G.41. Match the rootstock to the vigor of the scion and the soil.
- For medium-density plantings of 500 trees/A, G.30, M.26, Ottawa 3 and G.11 are second choices. Regardless of density, trees on these rootstocks must be supported.
- For French Axe Systems, match the rootstock to the cultivar and soil type. In Northern NJ soils, these would be M.9 clones. Consider using G.30 with very weak cultivars or on weak soils.
- There are big differences in vigor of trees on the different M.9 clones, so match the clone to the cultivar, soil type, and training system. Some M.9 clones are as vigorous as M.26.
- All dwarf trees must have an adequate trickle or drip irrigation system installed at planting and be utilized correctly.

To determine tree spacing, you must take into account the scion vigor, the rootstock vigor, the soil type, irrigation, the management level that you will be using, and the ultimate height trees will be allowed to attain. One way to calculate spacing is with an online calculator, see:
https://ag.umass.edu/fruit/fact-sheets/apple-scionrootstock-selection-planning

Table 10.2 Some Examples of Tree Spacing

Tree Height should equal Row Width

Density (trees/A)	Between-row spacing (ft)	In-row spacing (ft)
1452	10	3
1210	12	3
1117	13	3
1037	14	3
990	11	4
908	12	4
778	14	4
662	14	5
580	15	5
519	14	6
389	14	8
262	16	10

Table 10.3 Characteristics of Apple Rootstocks and Interstem Combinations

Prepared by Paul Domoto, Dept. of Horticulture, Iowa State University. Resources: The National Apple Rootstock Breeding Program *http://www.ars.usda.gov/Main/docs.htm?docid=15654*, and TRECO Oregon Rootstock and Tree Co., Inc. *https://www.treco.nu/products/apples/*

Rootstock	Size[1]	Fruiting	Anchorage	Soil Hardiness	Adaptability	Crown Rot	Fire Blight	Remarks
Seedling	100%	Slow bearing, yield variable but generally low.	Well anchored	Considered hardy, but variable	Widely adapted	Variable	Tolerant	65-85% size control with spur-type Red Delicious strains; some size control with other spur-type strains. Suckering may be a problem; very few burrknots[2].
Novole	100%	Slow bearing, low productivity	Well anchored	Needs testing	Adapted to most soils	Resistant	Resistant	Tolerant to meadow voles, may be of value in low input production systems.
Polish 18 (P.18)	90 - 100%	Slow bearing, moderately productive	Well anchored	Considered very hardy; may be susceptible in late winter	Widely adapted	Resistant, need further testing	Moderately susceptible	Very little suckering; very few burrknots[2]. Has a horizontal rooting habit; may be suitable on wet soils as an understock for interstem trees.
Antonovka 313 (Ant.313)	90 - 100%	Slow bearing, moderately productive	Well anchored	Considered hardy; suscepti-ble in late winter	Widely adapted	Resistant	Moderately susceptible	Some suckering; few burrknots[2].
Bud.118 (B.118)	85 - 95%	Somewhat early bearing, modera-tely productive	Well anchored	Reported very hardy, needs further testing	Well drained soils	Resistant	Moderately resistant	Needs further testing.
M.4	81 - 90%	Moderately early bearing, good productivity	Well ancho-red, but sub-ject to leaning	Moderate	Widely adapted	Resistant	Tolerant	Most productive vigorous rootstock in regional testing. Moderate to heavy suckering; few burrknots[2].
MM.111	80 - 90%	Somewhat early bearing, moderately productive	Well anchored	Moderate	Adapted to most soils; drought tole- rant, but does not tolerate wet feet	Tolerant on well-drained soils	Tolerant	Tree form is more up-right. Little suckering; prone to burrknots[2]. Semi-dwarf with spur-type Delicious strains. Moderately susceptible to tomato ringspot virus[3].
MM.106	70 - 80%	Moderately early bearing,very good productivity for tree size	Good on most soils	Very susceptible in early winter; hardy in late winter	Best on loam and sandy loam soils. Avoid poorly drained soils	Very susceptible	Moderately susceptible	Very little suckering; prone to burrknots[2]. Very susceptible to tomato ringspot virus[3].
Bud.490 (B.490)	70 - 80%	Moderately early bearing, very good productivity for tree size	Well anchored	Considered hardy, but ap-pears susceptible in late winter	Best on well drained soils	Moderately resistant	Moderately susceptible	May be a replacement of MM.106. Almost no suckering; somewhat prone to burrknots[2].
EMLA 7 M.7a	60 - 70%	Moderately early bearing, moderately productive	Free-standing, but leans with some cultivars	Moderate; roots are tender, snow cover for best protection	Well adapted on most soils except heavy clays	Slightly susceptible on poorly drained soils	Tolerant	Suckers heavily; somewhat prone to burrknots[2]. Fruit size often small. Most widely adapted clonaly propagated rootstock.

Table 10.3 - continued on next page

Table 10.3 Characteristics of Apple Rootstocks and Interstem Combinations - continued

Rootstock	Size[1]	Fruiting	Anchorage	Soil Hardiness	Adaptability	Crown Rot	Fire Blight	Remarks
CG.6210	60 - 65%	Early bearing, very productive	Well anchored	Appears hardy, evaluated in two Iowa trials with no symptoms of winter injury	Needs further testing	Resistant	Resistant	Suckering may be a problem. Being considered for release.
Supporter 4	55 - 60%	Very early bearing, good productivity	Better anchored than M.26	Needs testing	Well drained soils, needs further testing	Moderately resistant	Extremely susceptible	Produces few suckers or burrknots[2]. Performs poorly on re-plant sights.
Geneva 30 (G.30)	55 - 60%	Early bearing, very productive	Weak graft union with some cultivars, support is recommended	Almost as hardy as M.26	Well adapted to most soils	Tolerant	Highly resistant	More productive and much less prone to suckering than M.7a; burrknots[2] are rare. Induces wide crotch angles. Tolerant to re-plant disorder. Susceptible to common latent viruses[4]. Difficulty to propagate has held back its availability.
Geneva 935 (G.935)	50 - 60%	Very early bearing, very productive	May need support in early years	Appears to be very hardy	Well adapted to most soils	Highly resistant	Highly resistant	Promising new rootstock. Produces good fruit size. Induces wide crotch angles. Produces very few suckers or any burrknots[2]. Good replacement for M.26; been more productive than M.26 in the Iowa planting of the 2003 NC-140 rootstock trial, and has not exhibited symptoms of winter injury.
Geneva 202 (G.202)	45 - 55%	Very early, very productive	Well anchored	Hardier than M.7, need further testing	Appears well adapted to most soils.	Resistant	Highly resistant	Moderate suckering, few burrknots[2]. Good resistance to wooly apple aphid. Presently, only available in New Zealand.
M.26 EMLA 26	45 - 55%	Early bearing, good productivity	May need support in early years	Hardiest M. or MM. series rootstock; somewhat slow to harden-off	Well drained soils	Moderately susceptible on poorly drained soils	Extremely susceptible	Very little suckering; very prone to burrknots[2]. Susceptible to tomato ringspot virus[3]. Compatibility problems have been identified with some cultivars.
Geneva 11 (G.11)	40 - 50%	Very early bearing, very productive	Needs support in early years	Needs further testing	Well adapted on most soils	Resistant	Moderately resistant	Promising new rootstock. Little suckering; very few burrknots[2]. Promotes good fruit size.
Ottawa 3 (O.3)	40 - 50%	Early bearing, very productive	Good, but does best with support	Very hardy	Well adapted on most soils	Resistant on most soils	Susceptible	Roots poorly; may be a factor in orchard establishment. Moderate suckering; very few burrknots[2]. Moderately susceptible to tomato ringspot virus[3] and common latent viruses[4].
Geneva 16 (G.16)	35 - 45%	Very early bearing, very productive	Moderately good, support needed for crops	Exhibited winter injury symptoms in an IA planting, needs further testing	Appears well adapted on most soils	Tolerant	Very resistant	Very little suckering; very few burrknots[2]. Very sensitive to common latent viruses[4], only virus-free scion wood should be used to propagate trees. Tends to produce small-sized fruit.

Table 10.3 - continued on next page

Table 10.3 Characteristics of Apple Rootstocks and Interstem Combinations - continued

Rootstock	Size[1]	Fruiting	Anchorage	Soil Hardiness	Adaptability	Crown Rot	Fire Blight	Remarks
M.9 strains	30 - 45%	Very early bearing, very productive	Needs support	Slightly hardier than M.7a	Well adapted on most soils	Resistant on most soils	Very susceptible	In the 1994 NC-140 rootstock trial with Gala as the cultivar, the size range of M.9 strains ranked Pajam2 = RN(Nic)29 (similar to M.26) > EMLA > T337 > Fluren 56. Suckers heavily; somewhat prone to burrknots[2] (variation exists between strains). Promotes good fruit size.
Geneva 41 (G.41)	30 - 45%	Very early bearing, very productive	Needs support	Appears to be very hardy	Well adapted on most soils	Highly resistant	Highly resistant	Promising new rootstock. Produces good fruit size. Induces wide crotch angles. Possible replacement for M.9; has been more productive than M.9 Pajam 2 and T337 in the Iowa planting of the 2003 NC-140 rootstock trial, and has not exhibited symptoms of winter injury.
Bud. 9 (B.9)	30 - 40%	Very early bearing, very productive	Needs support	Hardier than M.9, but susceptible in late winter	Well drained soils; does not tolerate wet soils	Very resistant	More tole-rant to field infection than M.9	Moderate suckering, very few burrknots[2]. Drought susceptible. Susceptible to tomato ringspot virus[3]. Iowa observations suggest it is very susceptible to voles.
Polish 2 (P.2)	30 - 40%	Very early bearing, very productive	Needs support	Very hardy mid-winter, but susceptible in late winter	Best on well drained soils	Resistant	Susceptible	Very little suckering; few burrknots[2]. Susceptible to tomato ringspot virus[3].
Mark	20 - 30%	Very early bearing, very productive	Roots are brittle, needs support	Hardy early, but susceptible in late winter	Best on well drained soils; drought susceptible	Resistant on most soils	Susceptible	Suitable for vigorous cultivars on fertile soils. Very prone to abnormal swelling at the ground lime (root mass proliferation) that stunts the tree & reduced fruit size. Moderate suckering; prone to burrknots[2]. Moderately susceptible to tomato ringspot virus[3].
Bud. 146 (B.146)	20 - 30%	Very early bearing, very productive	Roots are brittle, needs support	Reported very hardy mid-winter; needs further testing	Well drained soils; needs further testing	Needs further testing	Susceptible	Several strains have been identified with variability existing between strains. Suitable for vigorous cultivars on fertile sites. Mode-rately prone to suckering and burrknots[2]. Consider for planting on a limited trial basis.
Bud.491 (B.491)	20 - 30%	Very early bearing, very productive	Needs support	Reported very hardy mid-winter; needs further testing	Well drained soils	Susceptible	Susceptible	Suitable for vigorous cultivars on fertile soils. Produces few suckers or burrknots[2]. Consider for planting on a limited trial basis.
Polish 16 (P.16)	20 - 30%	Very early bearing, very productive	Needs support	Appears very hardy; needs further testing	Well adapted on most soils	Resistant	Susceptible	Suitable for vigorous cultivars on fertile soils. Prone to suckering; produces few burrknots[2]. Consider for planting on a limited trial basis.

Table 10.3 - continued on next page

Table 10.3 Characteristics of Apple Rootstocks and Interstem Combinations - continued

Rootstock	Size[1]	Fruiting	Anchorage	Soil Hardiness	Adaptability	Crown Rot	Fire Blight	Remarks
Geneva 65 (G.65)	10 - 20%	Very early bearing, very productive	Well anchored, support needed for crop	Appears hardy, needs further testing	Well adapted on most soils	Highly resistant	Very resistant	Too dwarfing for most high density orchards; has potential of very vigorous cultivars on fertile sites. Some suckering; nearly no burr-knots[2]. Susceptible to tomato ringspot[3]& common latent viruses[4]. Tends to produce small-sized fruit. Difficult to propagate in stool beds.
M.27 EMLA 27	10 - 20%	Very early bearing, very productive	Needs support	Moderately hardy, slow to harden-off	Well adapted on most soils	Resistant on most soils	Susceptible	Too dwarfing for most high density orchards; has potential of very vigorous cultivars on fertile sites. Almost no suckering or burrknots[2]. Susceptible to tomato ringspot[3]. Tends to produce small-sized fruit.
Polish 22 (P.22)	10 - 20%	Very early bearing, very productive	Needs support	Very hardy mid-winter; appears susceptible in late winter	Well adapted on most soils	Resistant	Moderately susceptible	Too dwarfing for most high density orchards; has potential of very vigorous cultivars on fertile sites. Very little suckering or burrknots[2].
Interstem / Rootstock Combinations[5]								
M.27, M.9 / MM.106	45 - 60%	Early bearing, productive	Good on most soils; may need support on light soils or when the interstem-rootstock graft union is above ground	Slightly hardier with the interstem-rootstock graft union below ground	Well drained soils; better adapted with the interstem-rootstock graft union below ground	More tolerant with the interstem-rootstock graft union below ground	Susceptible as M.27 or M.9	Suckering is a problem; can be reduced by planting with the interstem-rootstock graft union below ground.
M.27, M.9 / MM.111	45 - 60%	Early bearing, productive	Good on most soils; may need support on light soils or when the interstem-rootstock graft union is above ground	Moderate	Widely adapted to most soils	Tolerant on most soils	Susceptible as M.27 or M.9	Suckering is a problem; can be reduced by planting with the interstem-rootstock graft union below ground.

[1] Size control as a percentage of the size of a cultivar on a seedling rootstock. Remember that the vigor of the scion, site conditions and management practices also influence the ultimate size of the tree on any rootstock. [2] Burrknots are above root primordia that form under shaded conditions (either from a trunk wrap or excessive shading). They are very sensitive to winter injury, and potential point of entry for fire blight bacteria and bores. [3] Tomato ringspot virus is a nematode-transmitted virus that can induce Apple Union Necrosis and Decline when a sensitive cultivar is propagated on a sensitive rootstock. It has not yet been found in Iowa, but as a precaution, purchase virus-free trees. If the disease is ever found in your orchard, avoid combinations of a sensitive cultivar propagated on a sensitive rootstock. Cultivars sensitive to tomato ringspot virus include: Red Delicious, McIntosh, Paulared, Spartan, Tydeman's Red and Stayman. [4] Virus problems can be greatly reduced by selecting virus-free cultivars. [5] Used as interstems, M.27 and M.9 produce similar sized trees. With the present propagation practice of using 6- to 8-inch interstem sections, relative tree size is more dependent upon planting depth: With the interstem-rootstock graft union above ground, tree size is between M.9 and M.26; with the interstem- rootstock graft union below ground, tree size is between M.26 and M.7a and depends on how much of the interstem is exposed.

10.3 Specific Issues for Apple Orchard Nutrition

Calcium-Related Disorders

Calcium-related disorders are caused by many factors. Cork spot and bitter pit appear in 'Honeycrisp', 'Delicious', 'Golden Delicious', 'Braeburn' and other apple cultivars. These, along with other calcium-deficiency physiological disorders, continue to cause economic losses for apple producers. These disorders appear to be specifically related to low levels of calcium and sometimes, to high levels of nitrogen in the fruit flesh. However, fruit flesh calcium content is influenced by many factors. Good horticultural management techniques that improve soil conditions, and encourage uniform annual cropping and moderate tree vigor, will decrease calcium-related fruit disorders.

Cork spot, characterized by spherical dead areas in the flesh, is an orchard disorder; while bitter pit is primarily a storage disorder and usually attacks the skin and adjacent cells. However, symptoms vary according to area, cultivar, and environmental conditions, making this distinction less than clear-cut.

For the control of bitter pit and cork spot in apple, foliar sprays of calcium chloride or equivalent calcium products have been used effectively in NJ. For long-term maintenance and prevention of calcium disorders, maintaining an optimum soil pH of 6.5 with regular applications of high calcium limestone, applied according to soil test results, is essential.

Calcium chloride foliar sprays have been studied in the apple growing regions of the world, for a number of years, for the control of cork spot and bitter pit. Some of the newer apple cultivars, Honeycrisp specifically, require more attention to calcium-related disorders than even the old standbys of 'Delicious' and 'Golden Delicious '. Foliar sprays can be effective if begun at first cover and adequate soil calcium is present. Calcium chloride tree sprays appear to be the most cost-effective, quickest cultural practice for reducing low-calcium physiological disorders in apples. Penn State and Rutgers recommend applying 4.0 to 14.0 lb of actual calcium/A/season in six to eight cover sprays. Honeycrisp needs the full 14.0 lb and then some. Honeycrisp benefits from weekly CaCl sprays.

Calcium, in the form of calcium chloride, is recommended because of its proven effectiveness and lower cost. Many other products are available that supply calcium, but in general, they supply a much lower rate of calcium than is needed to correct the deficiency. The Penn State Tree Fruit Production Guide web site, listed below, has a page that describes the amount of calcium in individual products and their cost-effectiveness. Always keep in mind the target of 4.0 to 14.0 lb of actual calcium/A/ season. Growers experiencing severe problems may even find calcium sprays in addition to the cover sprays to be beneficial.

$CaCl_2$ increases the pH of the spray solution, so 2/3 ounce of vinegar (5%) should be added per pound of $CaCl_2$. The addition of a surfactant may reduce the potential for leaf injury and increase uptake. There are no restrictions on the gallons of water/A needed. Sprays with as little as 20.0 gal of water/A have been effective. Tree row volume calculations should be used to determine the volume of water/A on each block. See the section: "Sprayer Calibration and the Tree Row Volume Method" in the Pesticide Strategies chapter.

Warning: Do not premix calcium chloride with Solubor (Boron) before adding to the tank. At the rates recommended, calcium chloride and/or Solubor may be mixed with spray oil (Superior 70 Sec.), with WP formulations, or with EC formulations of the more common fruit pesticides. Compatibility of other calcium materials is uncertain.

Some leaf injury may occur from calcium chloride sprays following wet, cool springs or hot, dry summers. When injury is noticed, cut the calcium chloride rate in half in the next spray, or delete until one half inch of rain has fallen.

A minimum of 2.0 lb of calcium chloride/100 gal of spray water should be used in each cover spray until harvest. Research at the Rutgers Snyder Research & Extension Farm indicates that calcium chloride can be used effectively at higher rates on certain cultivars. Application rates should begin at 2.0 to 2.75 lb of calcium chloride/100 gal, and can be increased on a sliding scale in each cover spray up to 3.0 to 5.0 lb/100 gal late in the season. 'Enterprise' is a scab-resistant cultivar that benefits from the higher rates of calcium chloride. The rate of calcium chloride for other cultivars will depend on your historical experience with calcium-related disorders in your individual blocks. For more discussion on calcium-related disorders visit the Penn State Extension web page at: *https://extension.psu.edu/apple-fruit-disorders-calcium-deficiency*. *(continued on next page)*

APPLES

Dip before Storage. Calcium chloride can be included in the postharvest scald dip solution. One combination that has been used successfully contains 50.0 lb of calcium chloride (food grade) in 500 gal of water plus diphenylamine (DPA) for scald (No Scald DPA EC 283). Calcium in the dip solution provides protection against bitter pit developing in storage, and generally improves the condition of the fruit in storage. More information on scald can be found in the "Diseases of Apples" section in the "Tree Fruit Pests and Controls" chapter.

Foliar Nutrient Sprays on Apple

Foliar applications of nutrient sprays should be applied as dilute sprays - 1X for maximum effect. Prebloom applications of boron and zinc enhance cropping by increasing retention of flower buds that would otherwise abscise during early bud development. The most obvious use of these treatments (N, B, Zn) would be on apple blocks where cropping is expected to be light. There is potential to increase fruit size as long as aggressive thinning practices are followed.

Nitrogen (N). Applied as urea, foliar nitrogen is beneficial to apples for improving fruit set and increasing size on cultivars that are low in nitrogen, as indicated by leaf tissue analysis. Use 2.0-3.0 lb of urea/100 gal of water at pink bud, full bloom, and/or at petal fall, to improve fruit set and tree vigor. Use 5.0 lb/100 gal in cover sprays after petal fall only on nitrogen-deficient trees. Foliar nitrogen is not a replacement for ground applied nitrogen, but rather aids fruit set and fruit sizing.

Boron (B). Solubor sprays of 1.0 lb in 100 gal of water, applied at full bloom and at 1 week after full bloom, may reduce cork spot in apple flesh if boron is deficient. Boron aids calcium movement into fruit. Adequate boron is essential; excessive boron hastens apple maturity and increases fruit drop. Both soil and leaf analyses are essential in determining the need for boron. Apply no more than two sprays/season. **Note**: Boron may be added to cover sprays. Do not premix Solubor with calcium chloride. Do not apply boron with oil or when trees are wet with oil, as an increased uptake of boron may result in boron toxicity.

Zinc (Zn). Use EBDC fungicides containing zinc. If zinc level is low, as indicated by leaf tissue sample, apply zinc chelate (EDTA) at 1.0 qt liquid formulation/100 gal dilute equivalent at tight cluster to pink. Avoid applications after bloom until harvest is complete. Additional applications can be made after harvest to the foliage and the soil. Apply 3.2 lb actual zinc, as zinc sulfate/A, while the leaves are still green and active. Caution is advised with the zinc chelate formulations. Apparently, there are different standards of quality in the chelation process and not all zinc products are chelated to the same standard. There are many formulations and not all have been evaluated. At this point, our recommendation is not to use after bloom while the fruit is on the tree to be safe. Russeting and fruit finish damage may occur. **Soil applications** can also be used to correct long-term deficiencies, especially if soil tests low in zinc. Broadcast soil applications of Zn at 6.4-12.8 lb/A of actual zinc.

Calcium (Ca). Soil and plant tissue analyses show that a high percentage of apple orchards in New Jersey are below the desired ranges for good quality fruit production. These low calcium levels are associated with bitter pit and cork spot in the apple fruit, which reduces its quality and value. Long-term corrective treatment recommendations suggested for reducing or controlling these nutritional disorders:

- Lime soils prior to planting new orchards, and top-dress existing orchards to maintain a soil pH of 6.5. In Northern New Jersey, approximately 1000 lb CCE are needed annually to maintain soil pH.
- Apply agricultural gypsum to soils that show deficient soil and leaf tissue levels of calcium or magnesium when the soil pH is at the desired level. Use 1000 to 2000 lb/A before establishing new plantings, and 1.0 to 2.0 lb of gypsum/year of tree age, spread under the drip area of established trees, preferably during the fall months.

For additional information on calcium, see the "Soil Management for New and Established Plantings" section in the "Orchard Nutrition" chapter.

Manganese (Mn). Manganese deficiency is most often observed on well-drained soils having a slightly acid to alkaline pH. However, soils abnormally high in organic matter may exhibit the deficiency within a slightly to moderately acid pH range. Manganese deficiency in tree fruits is generally characterized by interveinal chlorosis, which begins near the leaf margins and extends toward the mid-rib, and finally only the veins remain green. The deficiency symptoms are most prominent in the older portions of the current season's growth. One or more foliar

applications of manganese, as manganese sulfate (MnSO4), will usually correct the deficiency in tree fruits. Apply at the rate of 1.0 lb of Mn/100 gal of water/A/application. Manganese chelates used according to manufacturers' recommendations may also be effective in correcting manganese deficiencies in tree fruits.

Manganese toxicity, commonly referred to as 'measles', is a physiological disorder brought on by excessive uptake of manganese. The bark on fruit shoots and laterals appears pitted. It is very common in 'Delicious' strains, but is seen in other cultivars as well. Manganese toxicity is usually associated with very low soil pH in the subsoil and/or topsoil. It is vital that the pH range be adjusted to 6.5 in both layers of soil prior to orchard establishment to prevent this condition.

10.4 Apple Pollination

All apple cultivars grown require cross-pollination to set a good commercial crop of fruit. Cultivars vary in degree of self-fruitfulness. For example, 'Rome Beauty' is considered one of the most self-fruitful cultivars, whereas 'Delicious' is one of the least self-fruitful. Regardless of the degree of self-fruitfulness, mixtures of cultivars to provide cross-pollination should be used in every planting.

In general, all cultivars with satisfactory pollen are pollinizers for each other. 'Cortland' and 'Early McIntosh' are an exception. These two cultivars together require a third cultivar for pollination. See Table 10.4.

The following five conditions are necessary to obtain satisfactory cross-pollination:

1. Cultivars must bloom together or the blooming periods must overlap.
2. The pollinizer must have viable pollen.
3. Cultivars must be planted close together in the orchard. A recommended practice is to have a cultivar no farther than two rows from a pollinizer. Another practice is to have every third tree in every third row a pollinizer.
4. Bees and other pollinators must be active in the orchard at the time of bloom.
5. Weeds, such as dandelion, mustard, and wild radish, should not be present in large quantity since they attract bees when they are in bloom.

Certain cultivars have a tendency toward biennial bearing when proper crop thinning has not been successful. During an "off year", the pollinizer has a dramatically reduced number of flowers and therefore, reduced pollen availability. The adjacent cultivar, although it bears annually, may lose a crop because of the lack of cross-pollination. This is not so serious where one cultivar is rather self-fruitful, but the problem of crop loss must be considered with all other factors affecting pollination and fruit set.

Table 10.4 Cultivars with Satisfactory or Unsatisfactory Pollen

	Cultivars Early- to Mid-Season Blossoming			**Cultivars Mid-Season to Late-Blossoming**
Satisfactory Pollen	Cortland	Jerseymac	Paulared	Golden Delicious
	Delicious	Jonathan	Starr	Granny Smith
	Empire	Lodi	Twenty Ounce	Macoun
	Grimes Golden	Mcintosh		Rome Beauty
	Idared	Mollie's Delicious		Spartan
Unsatisfactory Pollen	Gravenstein	Mutsu (Crispin)		Stayman
	Jersey Red	R.I. Greening		Turley
	Jonagold			Winesap

Flower/Fruit Growth and Development

Pollination and fertilization are separate events that are necessary for the development of a fruit. Pollination is the deposition of pollen on the stigma of the apple flower. After the pollen is deposited, it germinates, and the pollen tube develops and elongates. When the pollen tube reaches the ovary, fertilization occurs. The time it takes for the pollen tube to reach the ovary is quite variable and is dependent upon temperature and pollen vigor, as well as genetic factors. The average duration of cell division in the apple fruit is 30 days after fertilization. Growth of the fruit that occurs after this time is primarily due to cell enlargement. Dependent upon the seasons (*i.e.*, weather); the period of cell division in the apple can take longer than 30 days.

There are many fungicides and insecticides that exhibit plant growth regulator (PGR) activity, such as thinning of fruit. Most of these types of PGRs clearly state on their labels that these compounds should not be sprayed until 30 days after full bloom, or potential thinning of fruit may result. If the season is slow or prolonged by weather, then there must be some added precautions that growers must take into consideration. If bloom is delayed and/or prolonged, CAUTION should be advised with the use of any chemical that has potential plant growth regulator activity. When in doubt, growers should contact their area Fruit Extension Agent. This could prevent some potentially catastrophic problems (*i.e.*, overthinning). See "Use of Plant Growth Regulators in Apple Orchards" below.

Honeybees for Orchard Pollination

Beekeeper Relations. Never use an insecticide on open bloom. Give beekeepers at least 48 hours notice when you need bees moved in or out (at least 24 hours notice before spraying is required by law in several cases, see "New Jersey Beekeeper Notification Regulations" in the "Pesticide Safety" chapter, section "Protection of Pollinators"). Keep beekeeper telephone numbers handy and warn them if there is danger of spraying. A written grower-beekeeper contract may protect both parties. Such a contract should include hive-quality guarantees, delivery and removal dates, rental fees, and protection to the beekeeper against colony damage. For the most up to date information regarding laws affecting pesticide applications and beekeeper notification, contact your County Agricultural Extension Agent or the DEP.

Renters of bees should know that a certificate of inspection must accompany all bees coming into the state. The certificate must indicate that the accompanying bees are free from contagious bee diseases. Also, the certificate must show the colonies are free of acarine mites. Bee inspection officers are also given the right of entry to inspect any hives, combs or other beekeeping equipment. Copies of bee laws may be obtained from your County Agricultural Extension Agent.

Bee Colonies. Honeybee colonies should be provided for pollination in almost all orchards where cultivars requiring cross-pollination are grown. Strong hives may furnish 20 times as many field bees as weak hives when conditions are cool, wet, or windy. Bee colonies are usually substandard for pollination unless they have at least 800 square inches of brood (eggs, larvae, and pupae) and enough adult bees to care for this brood, regardless of the weather. One to two strong colonies of bees/A are recommended for apple pollination. Due to poor pollination weather, early blooming cultivars require more bees than later blooming cultivars. Mature orchards, with a maximum number of flowers/A, require more bees than young orchards. Small orchards, where wild bees are common, require fewer honeybees than large orchards. Inadequate pollination causes misshapen fruit or dropping of immature fruit.

Hive Placement. For best results, delay hive placement in orchards until there is about 10 percent bloom. This tends to orient bee activity to the target bloom rather than to competing plants such as dandelions. Competing bloom in the orchard should be eliminated. This helps reduce bee foraging on non-crop hosts, and reduces the adverse effects that some pesticides have on bee health. Groups of 6 to 10 hives can be placed at 200 to 300 yard intervals throughout the orchard. For peak efficiency, they should be set about 100 yards inside the orchard edge in full sunlight. Hive entrances should be facing south or southeast to take advantage of sunshine on cool days. The hives should sit on boxes or at least have weeds removed from in front of the entrances. Wind protection is desirable. There should be a plentiful pesticide-free source of water within one-fourth mile of the bees; eliminate all water contaminated with insecticides.

Pollinizers. Trees providing sufficient compatible pollen for the main crop trees are necessary. The minimum planting arrangement of pollinizers is every third tree in every third row. Every other tree in every other row would be more ideal. Where pollinizers have not been planted, a remedial practice is to graft a pollinizer branch in each producing tree. Care must be taken not to prune out the pollinizer branch during regular pruning operations. Annual blooming at the same time as the producing tree is important in the selection of the pollinizer cultivar. Large bouquets of pollinizer branches in drums of water near each tree can be used when no other source of pollen is available. The nearer the pollen source to the cropping trees, the better the distribution of pollen to all blossoms by bees.

10.5 Use of Plant Growth Regulators in Apple Orchards

10.5.1 Crop Load Management and Precision Thinning

Optimizing crop load greatly impacts and enhances crop value. Using PGR's for chemical fruit thinning is done to obtain the optimal crop load per tree, return bloom (annual bearing) and larger fruit size. However, many factors must be considered prior to application of PGR's for fruit thinning, including:

- **Frost Damage:** Frost damage can result in a reduced fruit set.
- **Sunlight prior to application:** Sunny weather tends to lead to a lower thinning response. Cloudy weather during this time tends to lead to a greater thinning response. Thinners applied just before, during, or after a three-day cloudy period, especially when temperatures are above 65°F, will likely increase the thinning response. In Michigan, and the Northeast thinning activity has been related to temperature, with more activity when materials are applied in a warming trend.
- **Weather after Application:** Weather in the 5 days after application is a major factor affecting thinning response. Cool weather tends to lead to less of a thinning response, while hot weather leads to a greater thinning response.

When applied during poor drying conditions, thinners will generally have increased activity. Dew or light rain following treatment may redistribute the chemical and cause additional uptake and more thinning response to occur. The effects of light intensity, moisture and temperature on thinning response are complex. It is **STRONGLY** suggested that growers use the Cornell University **Carbohydrate Thinning Model** available at: *www.newa.cornell.edu* to estimate the thinning response based upon weather patterns each year. Note: The carbohydrate balance and supply in the tree at any given time will affect the activity that results from any thinning sprays that are applied. This balance has been found to correlate well with a tree's sensitivity to chemical thinners, and has been modeled to guide the grower in the use and timing of thinning materials. These models should be used as a real time guide during the thinning period.

- **Pollination:** Poor pollination (fewer than 5 seeds per fruit) can lead to a greater thinning response.
- **Fruit Set:** Heavier fruit sets tend to be harder to thin while lighter fruit sets tend to be easier to thin.
- **Fruit Size at Time of Application:** Plant growth regulators should be applied from petal fall through 20 mm fruit size. Beyond 20 mm fruit size, the efficacy of plant growth regulators decreases significantly.

No single thinning program is applicable to all orchards because of the many variables. Past experience combined with detailed records of materials, rates, crop performance, crop management practices, yield and weather conditions is your best guide. It is essential to understand which thinning materials are available, how they work, and the different windows of opportunity available for their application. Knowing the cultivar response to these different materials will greatly increase the success of your thinning program.

In general, early applications of high rates thin aggressively. Moderate and mild thinning occurs at lower rates and/or at later timings. Rates of individual thinners and/or combinations should be based on past grower experience with individual cultivars in each fruit block.

Chemical Choice

Auxins are our oldest and most reliable thinners. They are available in two main formulations: 1-Napthaleneacetic Acid Sodium Salt (NAA), and Napthaleneacetamide (NAD). **Caution:** Do not use NAA or NAD on any trees that are to be treated with 6-Ba PGR materials, including Maxcel, Promalin, or ProVide in the same year, or pygmy fruits may result.

NAA can be applied from petal fall to 13 mm fruit size at rates of 5 to 10 ppm in at least 100 gal/A. **Caution**: Do not apply concentrations more than 5 ppm on 'Delicious', to avoid pygmy fruits.

NAD is a mild form of NAA and is used at PF and early fruit set (8-13 mm) only. It is very effective on summer cultivars such as 'Paulared', 'Jerseymac', 'Macintosh' cultivars and 'Macoun'. **Caution**: It should not be applied to 'Delicious', as pygmy fruits may result.

Cytokinins The primary cytokinin used for apple thinning is 6-Benzyladenine (6-BA), which is sold under a number of different trade names/formulations with label rates ranging from 10 ppm to 200 ppm depending on

use, timing, and combinations. The best results for thinning are attained at the 8-13 mm stage (10 is optimal), and at temperatures between 70-80°F, followed by a warming trend for the 3 days following application. If temperatures are forecast to remain in the 80's or higher following application, reduce the rate of 6BA materials. Do not apply 6-BA if the temperature is to be 85°F or higher at application or 3 days following application. For most uses, rates should not exceed 100 ppm Use **Caution** when combining with carbaryl, since this creates a synergistic effect. For later thinning (15-20 mm), a combination with carbaryl will increase efficacy. **Caution**: The combination of MaxCel™ and Sevin on the cultivar 'Gala' can over thin.

Carbaryl Carbaryl is a carbamate insecticide that is a standard thinner for apples. Only the formulation of Sevin XLR-Plus or Sevin 4F should be used to thin apples. Sevin is a mild thinner at the full rate of 1.0 qt/A. For most cultivars, it is best used in combination with other thinners (NAA or 6-Ba). Sevin alone is adequate for easy to thin cultivars like Cortland, Braeburn, and Granny Smith.

Oxamyl Oxamyl is a carbamate insecticide that works in the same manner as Sevin. (**DO NOT USE CARBARYL IN COMBINATION WITH OXAMYL**). It too, is a mild thinner like Sevin, and should be used in combination with another thinner (NAA or 6-Ba) for best results if only one applications is being made. At 1.0-2.0 pt/100 gal, it should be applied tree row volume dilute between PF and 15 mm. Up to two applications can be made/season. Oxamyl may be less toxic to mite predators than carbaryl.

Ethephon A plant growth regulator marketed in various formulations. It is rate dependent and sensitive to temperature at both the time of application and for several days following application. The rate depends on both the timing of the application and the cultivar. It is labeled on apple for thinning at 1.5 to 6.0 pt/A and works better as a late rescue treatment for thinning in the 20 mm window. It should not be used on 'Macoun' as a rescue treatment, as it has over thinned. The ethephon label lists rates as per acre and not per 100 gal. However it is assumed to be a high volume spray.

Windows of Application for Thinning Apples

In general, earlier thinning will result in larger fruit size at a comparable crop load. Use of multiple thinning treatments may improve thinning results in difficult to thin blocks, in addition to enhancing return bloom.

Bloom Thinning Window. Bloom thinning is recommended in apple production because the earlier fruit are thinned, the larger the fruit will size. Early thinning also allows for additional applications with other materials at petal fall or later if necessary. Effective thinners to use at bloom include ATS and NAA (Table10.5).

Petal Fall Window (PF up to 8 mm size).
Thinners to use at this time: NAA, NAD, Carbaryl, and Oxamyl (Table 10.5). If fruit is not adequately thinned at petal-fall, then additional applications may be required.

Fruit Set Window (8 mm to up to 13 mm).
This is the traditional time for chemically thinning apples. All labeled thinning materials are effective at this time, including NAA (*i.e.*, Fruitone, PoMaxa, Refine), 6-Ba (*i.e.*, Maxcel, RiteWay, Exilis) and the carbamates (*i.e.*, Vydate or Sevin) (Table 10.5). Combination treatments with a carbamate + either NAA or 6-Ba have generally been more effective than single materials. The carbamates are synergistic with NAA or 6-Ba. Target applications by the air temperatures in the 70's, during a warming trend with the temperatures are rising to, or remaining in the 70's for 2-3 days following application.

Late Fruit Set Window (15-20 mm).
All labeled materials are much less effective at this time, including NAA, 6-BA, and carbamates- Higher rates and combinations of more than one material must be used to achieve a thinning response (Table 10.5).

Rescue Thinning - (20-25 mm) At this size the only material that will thin is Ethephon or Ethephon combined with Carbaryl. Please refer to the UMass Fact Sheet F-129R Late Season "Rescue" Thinning With Ethephon *https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/f-129.pdf* and Table 10.6. **Note**: this treatment can over-thin, especially if the temperatures are above 80°F. Note also that the rate used is variety dependent. Make sure to review the label completely. Rescue treatments may also be combined with Sevin XLR based on research work done at NJ and UMASS in 2007 through 2011.

Table 10.5 Summary of Apple Thinning Timing and Materials

Spray Timing	Chemical Name	Trade Name	Rate per 100 gal dilute TRV[1]	Maximum rate per acre per application
Bloom (2 applications may be necessary)	Ammonium Thiosulfate[4]	ATS (foliar nutrient)	2 gal or 2% solution, do not concentrate	–
	Naphthaleneacetic Acid-Sodium (NAA)	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	3-4 oz (8-10 ppm)	24 oz
Petal Fall[2,3] and up to 8 mm Fruit Size	Naphthaleneacetamide[3] (NAD)	Amid-Thin® W	4-8 oz (25-50 ppm)	2 lb
	Naphthaleneacetic Acid-Sodium[3] (NAA)	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	2-4 oz (5-10 ppm)	16 oz
	Carbaryl	Sevin® XLR Plus, Sevin® 4F	1.0 – 2 pt	6 pt
	Oxamyl	Vydate L	2 pt	4 pt
	6-Benzyladenine (6-BA)	MaxCel®, RiteWay®	48-200 oz (75-100 ppm)	308 fl oz
		Exilis® Plus, Exilis® 9.5 SC	See label (75-150 ppm)	See label
Fruit Set 8-13 mm Fruit Size	Naphthaleneacetic Acid-Sodium (NAA)	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	2-4 oz (5-10 ppm)	24 oz
	Naphthaleneacetamide[3] (NAD)	Amid-Thin W	4-8 oz (25-50 ppm)	2 lb
	Carbaryl	Sevin® XLR Plus	1-2 pt	6 pt
	Oxamyl	Vydate L	2 pt	4 pt
	6-Benzyladenine (6-BA)	MaxCel®, RiteWay®	See label (75-150 ppm)	308 fl oz
		Exilis® Plus, Exilis® 9.5 SC	See label (75-150 ppm)	See label
Late Fruit Set 15-20 mm Fruit Size	Carbaryl + 6-Benzyladenine (6-BA)	Sevin® XLR+ MaxCel®, RiteWay®, Exilis® Plus, Exilis® 9.5 SC	See label (100-150 ppm)	6 pt
"Rescue" Thinning	Ethephon	See recommendation for different varieties in Table 10.6.		

[1]All PGR chemical thinning applications should be applied on a per acre basis calculated via TRV irrespective of the water volume applied. Tree Row Volume Gallonage (TRV) = (Tree Height X Tree Width X 43,560 X 0.7)/(Between Row Spacing X 1,000). See the tree row volume section of this book. [2]From petal fall stage onward there are many combinations of thinners that are optimal for specific cultivars, contact your local county agent and/or crop consultant for recommendations. [3]Do not use Naphthaleneacetamide or Naphthaleneacetic Acid-sodium on Red Delicious or Fuji from petal fall or later pygmy or misshapen fruit may occur, see cautions on label. [4] **Ammonium Thiosulfate is phytotoxic and can over-thin** under certain slow drying weather conditions, and at high rates.

Table 10.6 Recommendations for "Rescue" Thinning with Ethephon[1]

Recommendations for "Rescue" Thinning with Ethephon (Concentration and Amount/A Dilute TRV) **Fruit 15-2 5 mm diameter (0.8-1 inch)** Treat when temperatures are 70-80°F (day of treatment + 2 days). Do not treat when below 70°F or above 80°F (day of treatment + 2 days).		
Varietal recommendations based on Massachusetts research and observations (per 100 gal dilute spray, with 0.5 lb carbaryl a.i. and a surfactant):	McIntosh and Macoun	200-300 ppm (0.7 - 1 pt)
Varietal recommendations based on Mid-Atlantic research and observations (per 100 gal dilute spray, with 0.5 lb carbaryl a.i. and a surfactant):	Spur-type Delicious	300-375 ppm (1-1.25 pt)
	Fuji	300-375 ppm (1-1.25 pt)
	Golden Delicious	120 ppm (0.4 pt)
	Rome Beauty	120 ppm (0.4 pt)
	Gala	225 ppm (0.75 pt)
	Cameo	225 ppm (0.75 pt)
	Enterprise	150 ppm (0.5 pt)
	Goldrush	225 ppm (0.75 pt)
	Jonagold	150-225 ppm (0.5-0.75 pt)
	August varieties	120 ppm (0.4 pt)
Cautions: Ethephon can defruit trees, particularly with high temperatures. Response may be less than ideal, particularly with low temperatures. ***Benefits:*** Reduced or eliminated hand thinning. Enhanced fruit size. Increased return bloom - 30-50%		

[1] From: UMass Fact Sheet F-129R at: *https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/f-129.pdf*

10.5.2 Other Uses For Plant Growth Regulators in Apple

Growth Control and Fire blight Suppression

Apogee® is a growth control product with the added benefit of reducing the tree's susceptibility to shoot fire blight. Apogee® is a unique production management tool that will suppress vegetative growth by blocking gibberellin synthesis, the plant hormones that stimulate vegetative growth. Blocks that have a light crop and apple cultivars that are particularly sensitive to fire blight are good candidates for Apogee®. Please review F-133 An Annual Fire Blight Management Program at: *http://njaes.rutgers.edu/pubs/publication.asp?pid=F-133*.

In NJ, 3 to 5 applications of 3.0-4.0 oz/100 gal or 9-12 oz/A at 10 to 17 days apart will be needed for full season growth control; using the lower rates and will not interfere with chemical thinning. Multiple applications of the lower rate have worked best with minimal interference with fruit set. The rate and number of applications should be determined by evaluating tree vigor. Refer to the Apogee® label for details on application rates, vigor ratings, and safety precautions. Optimum timing for the first application is 1-3" of new shoot growth (roughly bloom to petal fall). The active ingredient in Apogee® is calcium based, and therefore hard water should be buffered for Apogee® applications. Other calcium products (*i.e.*, calcium chloride, calcium nitrate) should also be avoided when applying Apogee®. If you know that your water contains high levels of calcium carbonate, a water-conditioning agent should be added to the tank-mix to help "soften" the water. The only labeled conditioner is high quality spray grade Ammonium Sulfate (AMS). **Note**: Apogee® needs an eight-hour rain free period following application.

Watersprout and Sucker Control

Tre-Hold A-112 Sprout Inhibitor (a.i.: Ethyl 1-naphthaleneacetate) is registered for bearing and nonbearing apple and pear trees to control watersprouts and root suckers.

- Add 10 fl oz Tre-Hold to 1 qt interior-grade latex paint and fill with water to a total volume of 1.0 gal.
- Prune watersprouts and suckers during the dormant season, then paint or spray cut surfaces with the Tre-Hold solution. Effective control of root suckers can also be obtained when Tre-Hold is applied in the spring. Thoroughly spray new suckers when they are 6 to 12 inches high.

Fruit Elongation and Fruit Size Enhancement

Promalin® (a.i.: 6-Benzyladenine or 6-BA and Gibberillins A_4A_7) is a growth regulator that has been used to increase the length thereby improving the shape of 'Delicious' fruit. Research results from different areas are variable, and unwanted fruit thinning may occur if the material is misused.

- Apply 1.0 pt/100 gal at king bloom petal fall (do not apply more than 1.5 pt/A).
- 100 to 200 gal of water/A is recommended.
- Over-application, or application when temperatures exceed 85°F, may result in excessive fruit thinning.
- Apply while king blossoms are open.
- Adding surfactants increases the effects on fruit shape and fruit thinning.
- To determine if there was any effect on fruit shape or thinning, be sure to leave a few trees untreated for comparison.

MaxCel™ (a.i.: 6-Benzyladenine or 6-BA) In addition to its use as a fruit thinner, it can be used for fruit size enhancement. Applied at petal fall of king bloom and repeated 2-4 times, it has been shown to result in increased fruit size of hard-to-size cultivars like 'Gala' and 'Empire'.

- Rate – apply 10-50 ppm/application at 3 to 10 day intervals. Apply in a sufficient amount of water to ensure thorough coverage without excessive run-off. Use calibrated spray equipment to ensure uniform coverage of leaves and fruit. Adjust water volumes based on tree size and spacing. In many cases, spray volumes of approximately 100 gal/A have been shown to be adequate.
- Direct 80% of the spray into the upper 2/3 of the tree canopy.
- Applications will be most effective when the maximum temperature is above 65°F on the day of application, and the following 2-3 days.

Improving Fruit Quality and Preharvest Fruit Cracking Suppression

ProVide® use for suppressing skin russeting and cracking

- Apply 4-6 applications (16 oz/A each), starting the first application 2 weeks before cracking begins. This is typically early to mid-July. Intervals between applications should be 14 to 21 days. When conditions favor heavy cracking, better results are obtained by using a greater number of applications and closer spray intervals. Research in Virginia has shown 6 applications at 14-day intervals to provide the best crack suppression.
- Do not use a surfactant. Where captan is not being used, oils, at the rate of 1.0 qt/100 gal, improve the penetration of ProVide.

Testing Fruit Cracking Potential. A water bath, developed by Dr. Ross Byers of Virginia Tech, is very effective in testing the crack potential of Stayman fruit. The following is the procedure:

1) Sample 5 non-cracked fruit from around 4 trees/block;
2) Submerge the 20-fruit sample in a 5.0 gal pail containing a solution of 1.0 fl oz of X-77 surfactant;
3) Count the cracked fruit after one and three days;
4) If half the fruit cracks, then fruit on the trees will likely crack when exposed to the proper weather conditions and preventative treatment should be applied;
5) Since the cracking potential of fruit changes throughout the season, the test should be repeated every 2 weeks.

Table 10.7 Improved Fruit Quality

Spray Timing	Chemical Name	Trade Name	Concentration (Rate)	Use
Apply first spray at petal fall and continue at 7-10 day intervals for 4 app.	Gibberellic Acid (4+7)	ProVide® 10SG	15-25 ppm (60-100 g/A) in 100 gal of water	Suppresses skin russeting and enhances fruit growth
Early king bloom to 50% bloom	6-Benzyladenine plus Gibberellic Acid (4+7)	Promalin®, Perlan®, Typy™	25 ppm at a rate of 1pt/100 gal apply at 50-100 gal per acre. No more than 2 pt/A.	Improvement of shape in delicious and gala cultivars

Return Bloom

Twenty five to thirty days after full bloom is the beginning of the flower bud development stage for the following years crop. This is a rough guideline, actual physiological responses are a result of degree day accumulations. Beginning approximately 35 days after full bloom, or 30-35 mm fruit size, growers should consider using NAA and ethephon for the primary purpose of return bloom. One approach to influencing return bloom is to consider the use of NAA at 30 days after full bloom at 5 ppm and repeat weekly for 4 applications.

A more aggressive approach to return bloom consists of the use of ethephon. When used during the time of flower bud development, ethephon can be highly effective in influencing return bloom. However, use **CAUTION** and refer to Rutgers/UMASS Fact Sheet F-131 Enhancing Return Bloom on Apple with Plant Growth Regulators at: *https://ag.umass.edu/sites/ag.umass.edu/files/fact-sheets/pdf/returnbloom.pdf*

When used 30 days after full bloom, ethephon can have a dramatic thinning effect on some of the easier to thin cultivars such as 'GingerGold', 'McIntosh' and 'Delicious'. On early season cultivars such as 'Gingergold', 'Gala', and 'McIntosh', growers should not use more than 4 sprays of ethephon at 7 day intervals for return bloom beginning 45 days after full bloom, or undesirable fruit quality may result at harvest. Ethephon on nonbearing apples can be used at 2.0-8.0 pt/A beginning 2-4 weeks after full bloom. However, these trees should have filled their space and be ready to bear the following year, as tree growth will be reduced by ethephon.

A summarized guide for the use of PGRs for return bloom can be found in Table 10.8.

Table 10.8 Return Bloom Enhancement

Spray Timing	Chemical Name	Trade Name	Rate per 100 gal dilute TRV[1]	Max rate per acre
First spray at 30 mm fruit size then up to 5 weekly subsequent applications[2]	Naphthaleneacetic Acid-Sodium [4]	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	2.0 oz (5 ppm)	8 oz
First spray at 35mm fruit size then 3-4 weekly applications[3]	Ethephon	Ethephon 2	0.5 pt (150 ppm)	2 pt

[1] All PGR chemical thinning applications should be applied on a per acre basis calculated via TRV irrespective of the water volume applied. Tree Row Volume Gallonage (TRV)= (Tree Height X Tree Width X 43,560 X 0.7)/(Between Row Spacing X 1,000) or see *https://ag.umass.edu/fruit/fact-sheets/block-specific-sprayer-calibration-worksheet* [2] If NAA is already being used for chemical thinning at bloom, petal fall, and 8-15 mm fruitlet size, the spray will also encourage return bloom. [3] Do not use prior to 35 mm fruit size, if temperatures are forecasted to exceed 85°F the day of application or if temperatures are forecasted above 85°F 4 days following application. [4] NAA can reduce fruit size, use cation when applying on cultivars with small fruit size.

Preharvest Drop Control

NAA (Naphthaleneacetic Acid-Sodium) can be used for preharvest drop control of all cultivars. It becomes active within a few days of application and may be used at 10 or 20 ppm. At 10 ppm, drop is controlled for about 1 week; and at 20 ppm, drop is controlled for about 10 to 14 days.

ReTain® (aminoethoxyvinyl-glycine Hydrochloride or AVG) is a harvest management tool labeled for both apples and pears. ReTain® was evaluated in eight grower orchards and at the Rutgers Snyder Research and Extension Farm on 'McIntosh', 'Cortland', 'Liberty', 'Macoun', 'Stayman', 'Mutsu' and 'Empire' cultivars. ReTain® works as a stop drop material, and is also effective preventing early fruit drop. In addition, it delays maturity an average from 7-10 days. Fruit treated with ReTain® can be picked during the normal harvest period for enhanced retention of firmness in storage, or harvest may be delayed, allowing the fruit to continue to grow and develop red color.

Research in NJ shows that ReTain® reduces preharvest drop on 'McIntosh' from 10-30%. It is our observation that while labeled for application at 28 days PHI, it may be more effective if applied at 5 weeks before anticipated harvest. This is especially true on drought stressed blocks.

For cultivars with a narrow harvest windows, such as 'Liberty', ReTain® allows growers to delay harvest up to two weeks and pick larger, firmer fruit with improved coloring. ReTain® is also effective in reducing stem cracking in 'Gala'.

Important considerations to follow with ReTain® applications in New Jersey:

- Use the full rate of ReTain®, 1 pouch or 333 gram/A of formulated product with an organosilicone surfactant at 0.10 % (v/v).
- Use only **ONE** of the following organosilicone surfactants:
  Silwet L77 at 13.0 fl oz/100 gal **OR**
  Sylgard 309 at 13.0 fl oz/100 gal
- Apply 4 weeks before anticipated harvest (28 day PHI). It is better to apply slightly earlier rather than later.
- ReTain® should be applied with a sufficient amount of water to ensure thorough wetting of the fruit while avoiding spray run- off. Adjust water volume based on tree size and spacing.
- For optimum results, apply during periods of slow drying weather conditions.
- Do not tank mix ReTain with other agricultural chemicals.

Harvista (1-Methyl-cyclopropane or 1-MCP)

- Use between 3-21 days prior to normal harvest.
- Allow a minimum of 3 days between application and harvest.

Note: It is important to distinguish between Harvista and SmartFresh, a.i. 1-MCP for both, but used differently

A summary of harvest management and stop drop controls can be found in Table 10.9.

Table 10.9 Harvest Management

Spray Timing	Chemical Name	Trade Name	Concentration	Rate[1]	Use
Apply as apples begin to loosen	Naphthaleneacetic Acid-Sodium[2]	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	10 or 20 ppm, good coverage at tree row volume dilute (TRV) application	4 or 8 oz dry or liquid /100 gal applied TRV dilute	Stop Drop
Apply 28 to 7 days prior to anticipated harvest	Aminoethoxyvinyl-glycine Hydrochloride (AVG)	ReTain®[3]	–	1-2 pouches per acre, follow label for detailed instructions. Retain can retard red color. It is dose dependent. Consider reduced rates on Honeycrisp and Gala	Stop Drop and Harvest Management (delayed harvest)
Apply 3-21 days prior to anticipated harvest[4]	1-Methyl-cyclopropane (1-MCP)	Harvista[4]	–	48-242 fl oz/acre, but no more than 242 fl oz/crop	Stop Drop

[1] All PGR chemical thinning applications should be applied on a per acre basis calculated via TRV irrespective of the water volume applied. Tree Row Volume Gallonage (TRV)= (Tree Height X Tree Width X 43,560 X 0.7) / (Between Row Spacing X 1,000) or see *https://ag.umass.edu/fruit/fact-sheets/block-specific-sprayer-calibration-worksheet* [2] Note that NAA can ripen fruit and should not be used on fruit destined for mid-long term storage. [3] Retain is dose dependent, variety and application time sensitive. Seek guidance from your local Extension Agent or Crop Consultant prior to use. [4] Harvista requires a specialized sprayer, or custom application by Agrofresh-contact your Agrofresh sales representative for more information.

Fruit Ripening

In most cases, ethephon has hastened maturity, increased color development, and made it possible to harvest an entire crop in one picking. Ethephon has been used on ‘Julyred‘, ‘Raritan‘, ‘Jerseymac‘, ‘Britemac‘, ‘Paulared‘, ‘Opalescent‘, ‘Wealthy‘, ‘Mollie‘s Delicious‘ and ‘McIntosh‘ (see note about ‘McIntosh’ below). The use of ethephon on summer-ripening apples should be confined mainly to fruit to be sold at retail markets within a week or two of harvest. Storage of ethephon treated apples beyond 2 weeks is not recommended.

- Wet fruit by applying ethephon at 0.5 pt/100 gal of dilute spray. The 0.5 pt rate is recommended for the summer-ripening cultivars and ‘McIntosh‘ to reduce the possibility of over maturity.
- Begin spraying 2 to 3 weeks before the normal harvest period, and about 1 to 2 weeks before desired harvest date.
- Ethephon is most effective at temperatures between 60 and 85°F. Color improvement may be minimal when high temperatures prevail.
- Do not apply ethephon to more trees than can be harvested in 2 days. A 1-day delay in harvest can result in fruit drop and loss of fruit quality.

‘McIntosh‘ has not responded consistently well to ethephon sprays. In some instances, red color has been slow to develop, and fruit drop has been excessive. In contrast, many ‘Delicious‘ cultivars have responded well to ethephon..

The response in ‘Stayman‘ has been much the same as ‘Delicious‘, but the use of ethephon will probably not be as extensive as with ‘Delicious‘ because immediate fresh market sale of ‘Stayman‘ is not as great as ‘Delicious‘.

Postharvest Quality Maintenance

SmartFresh™ (1-methylcyclopropene or 1-MCP) is a postharvest plant growth regulator product used to enhance post harvest quality of apples. It is used at very low rates (parts/billion) and has been favorably rated for its low toxicity.

SmartFresh™ is used in apple storage facilities to maintain harvest quality by temporarily slowing the apple's internal ripening. It works by slowing the effects of internal ethylene and by protecting the apple from outside sources of ethylene as well. In plant tissue, 1-MCP has a far greater affinity (10x) for ethylene receptors than ethylene and therefore, essentially halts the ripening process. The creation of new ethylene binding sites or long-term exposure to warmer temperatures eventually induces the ripening process again.

SmartFresh™ is formulated as a powder that when mixed with water, releases 1-MCP gas. SmartFresh™ is added to the air in the storage facility and is compatible with both controlled atmosphere (CA) and regular air storage regimes. Fruit is exposed to 1-MCP gas in an airtight storage room for 12-24 hours at 32 to 75°F (0 to 24°C). Timing is important to maintain harvest quality. This product will not make "bad" fruit good.

SmartFresh™ has wide usage in major apple-producing areas in the U.S. Fruit storage reports indicate that treated fruit stored for 6 months under refrigeration were 3.0 lb firmer than untreated fruit stored under the same conditions. In addition, treated fruit has a much longer shelf life once removed from storage than untreated fruit.

Other Uses for PGRs – Increasing apple branching in young trees, Summarized in Table 10.10.

Table 10.10 Branching

Research has resulted in a number of options for enhanced branching in young nursery trees. Products, timing and concentrations are listed below.

Spray Timing		Chemical Name	Trade Name	Concentration
1 year old wood	Prior to spring budbreak	6-Benzyladenine	MaxCel®, Exilis® Plus, Exilis® 9.5 SC	5,000 -7,500 ppm See label for rate and use instructions
		6-Benzyladenine plus Gibberellic Acid (4+7)	Promalin®, Typy™	5,000-7,500 ppm See label for rate and use instructions
	After spring budbreak	6-Benzyladenine	MaxCel®, Exilis® Plus, Exilis® 9.5 SC	400 to 500 ppm See label for rate and use instructions
		6-Benzyladenine plus Gibberellic Acid (4+7)	Promalin®, Typy™	400 to 500 ppm See label for rate and use instructions
2 year old wood	At budbreak	6-Benzyladenine	MaxCel®	1,500 ppm (9.2 fl oz per gal of water) See label for rate and use instructions

Defruiting Young Apple Trees

Sometimes 2- and 3-year-old apple trees set a heavy crop of fruit. This is undesirable because the fruit compete with vegetative growth and delay good production in the future. Also, the leader may bend over and the tree may develop a poor framework.

A mixture of 2.0 lb of Sevin XLR-Plus + 20 ppm Fruitone N or L (NAA) + 1.0 pt of 70 second Superior Oil/100 gal of water applied at petal fall to 14 days after full bloom (6-12 mm) will remove most of the fruit. MaxCel™ (6-BA) at 150 ppm may be substituted for Fruitone N or L. This spray combination will not remove all of the apples. Hand remove any fruit remaining by June 15.

10.6 Integrated Pest Management (IPM)

10.6.1 Mating Disruption Technology for Key Insect Pests in Apples

Codling Moth (CM)

Just as Oriental Fruit Moth (OFM) is the key insect pest in peaches, Codling Moth (CM) is the key insect pest in apple. Like OFM, CM may be managed with mating disruption technology. There are several brands available. All hand placed dispensers for CM should be placed in the upper third of the canopy during the pink to petal fall period. Application of dispensers should be completed by petal fall which is when Codling moth typically begins to fly and mate. For mature trees on M-111 and other large trees, this means that a pole must be used to place the dispensers near the tops of the trees. If placed too low in the canopy, mating disruption will not be effective.

Pacific Biocontrol markets an Isomate CM/OFM TT in the eastern USA. –C+ and an Isomate – C TT. The product is formulations are hand applied and contains the same pheromone active ingredients for disrupting both Codling moth and oriental fruit moth.

The Isomate C + must be placed at the rate of 400 dispensers/A, while the Isomate CM/OFM TT is used at a rate of 200 dispensers/A and are placed in the upper 1/3 of the tree, ideally in the top 2-3'. CTT is placed at the rate of 200 dispensers/A. Isomate CTT dispensers are similar to Isomate C in performance, general appearance & packaging. Compared to Isomate C+, the CTT dispensers are applied at half the number/A, and contain 5% more pheromone permitting them to last 20 days longer. Use 200 of the CTT dual-lures/A every 140 days. Isomate's TT (twin tube) dispenser consists of 2 parallel tubes filled with pheromone and joined and sealed at the end. The gap in the middle allows the TT dispenser to form a loop that can be placed over the end of tree limbs or fruiting spurs. Hercon Environmental markets Disrupt CM-Xtra, which is a clip-on dispenser used at the rate of 200 dispensers/A. Suterra markets Checkmate CM-XL 1000 used at the rate of 120 to 200 dispensers/A, and Checkmate CM- OFM Duel dispensers, used at the rate of 150 to 200 dispensers/A (110 days of release for OFM and 150 days of release for CM). ISCA Technologies markets a hand applied wax matrix type of pheromone, called 'Specialized Pheromone and Lure Application

Technology – SPLAT'. The pheromone must be applied with a special application device. Trécé carries 'Cidetrak CM', a neoprene-like clip-on. Sprayable pheromone is also available through Suterra as Checkmate CM-F, used at the rate of 2.4-4.8 oz/A, providing 2-3 weeks of release/application.

Mating disruption for Codling Moth does not work as well as mating disruption for Oriental Fruit moth in peaches. However, where growers have populations that are resistant to conventional insecticides, or very high population pressure, mating disruption can be an important tool to use in combination with other management strategies, such as timed sprays, alternative chemistries, granulosis virus, and insect growth regulators. Once Codling moth populations are reduced, a reduction in dispenser levels and supplemental insecticide sprays are options, but as with any IPM practice, regular trapping and field monitoring is strongly recommended and supplemental insecticide applications should be applied as needed.

Dogwood Borer

Similar to the other borer pests, mating disruption technologies are available for dogwood borer, a pest in apples. Dogwood borer attacks burr knots, common in high density plantings. Mating disruption is available through Pacific Biocontrol (CBC America).

Pacific Biocontrol Isomate DWB should be applied at a minimum rate of 100 dispensers per acre with an initial recommended rate of 150 dispensers. Dispensers should be placed before the end of May, prior to adult emergence. As with all management strategies, pheromone traps should be placed (2/acre) to monitor male moth populations. Mating disruption is more successful when used for successive years. This is an acceptable practice for organic operations.

10.6.2 Apple IPM Treatment Guidelines

Pest	Time of Season or Generation	Monitoring and Treatment Levels		
Apple Maggot	Late June or early July in Southern Jersey; early to mid-July in Northern New Jersey	Start treatment when flies are found in excess of 2 to 5/red sticky ball trap/week. Continue as long as flies are found.		
Codling Moth	There are two (and a partial third) generations/year. Insecticide applications should be timed with a degree day model based on accumulating degree days (base 50) from the first sustained moth catch (biofix). The first spray will roughly coincide with 2-3 weeks after petal fall. Once treatments are applied for either generation, supplemental sprays may be needed if pheromone trap captures exceed 5 moths/trap/week. Use the following table as a guide for timing insecticide applications. Under heavy populations, spray timing may have to be earlier than table guidelines. Timing depends in part on the type of insecticide being used.	**Codling Moth (CM) Timing in Apple**		
		Degree Day (DD) Targets from Biofix		
		Brood	**Avaunt, Neonicotinoids, Carbamates, OP's, Pyrethroids**	**Altacor, Besiege, Esteem*, Intrepid, Rimon*, Verdepryn, Voliam**
		1	250	100-150
			550	450
		2	1250	1150-1200
			1550-1600	1450-1500
		3	2300	2200
		*Rimon 1st appl. @75-100 DD, Esteem 1st appl. @ 100 DD		
Oriental Fruit Moth	Timing is similar to peach with some adjustments.	**Oriental Fruit Moth (CM) Timing in Apple**		
		Degree Day (DD) Targets from Biofix		
		Brood	**OP's, Carbamates, Pyrethroids (Conv.), Broad-spectrum materials, Neonicotinoids, Diamides***	**Intrepid, Rimon**
		1	Pink or 150-Timing falls 1st bloom	Pink
			350-375	250-300
		2	1450-1500	1300-1400
		3	2450-2500	2300-2400
			2900-3000	2750-2900
		4	By trap count if > 10-15 moths/trap/week	
		*Diamides should be applied about 50-75 DD earlier for all treatments, compared to the OP/carbamite timing		
European Apple Sawfly	PETAL FALL	Total cumulative capture of 4 to 7 per trap		
European Red Mite	May to Early June	2 mites/leaf		
	Late June to Mid-July	5 mites/leaf		
	Mid- to Late July	7.5 mites/leaf		
	Late July to Mid-August	10 mites/leaf		
	Late August onwards	at least 20 mites/leaf		

Apple IPM Treatment Guidelines continued on next page

Pest	Time of Season or Generation	Monitoring and Treatment Levels
Apple Aphid, Spirea Aphid	May - June Early July	When 50 percent or more of the terminals are infested with visible colonies
Rosy Apple Aphid	May	1 or more colonies/tree
San Jose Scale	DORMANT to DELAYED DORMANT or 1st generation crawlers	300-350 DD (base 50°F) after 1st adult catch in pheromone traps (about early to mid-June), or when 1st crawlers have been caught on sticky tape (about early to mid-June).
Spotted Tentiform Leafminer	First generation: PINK or PINK and PETAL FALL.	If leafminers were a severe problem the previous season.
	Second generation: late June to mid-July	If there is an average of 0.5-1 mine/leaf.
	Third generation: late July to early August.	If there is an average of 2 to 3 or more mines/leaf.
	Fourth generation: late August to mid-September	Only in an emergency – usually if the first through third generations have not been controlled. Fruit drop may occur if there is an average of 10 mines/leaf.
Tufted Apple Bud Moth	First generation: early to mid-June (SECOND and THIRD COVERS). Second generation: SIXTH and SEVENTH covers.	When pheromone trap counts are high, if injury was noted last year, or if leaf shelters and fruit feeding are easily found. This applies to both generations. Pheromone traps and degree-day records may be used for more precise timing. See table below:

Degree Day (DD) Spray Targets from Biofix

Brood	**Carbamates, OP's, Pyrethroids, Delegate, Diamides***		**Intrepid, Rimon**	***Bacillus thuringensis* (Bt)**
	Alt. Mid.	Complete	Complete	Complete
1	475-505	530-585	500-650	585-640
	610-640			
	750-775	805-855	805-850	805-855
	885-910			
2	2210-2245	2280-2355	2355-2435	2355-2435
	2395-2435			
	2585-2625	2665-2740	2665-2740	2585-2665
	2775-2815			2815-2890

*Diamides (Besiege, Exirel, Voliam, Verdepryn) should be applied @500-525 DD complete sprays or about 30-60 DD earlier than other complete sprays compared to OP/carbamate/pyrethroid timing.

White Apple Leafhopper (WALH), Rose Leafhopper (RLH) (July-Sept.)	First generation WALH: PETAL FALL, FIRST, SECOND COVER (last of May, early June)	3-4 leafhopper nymphs/leaf.
	Second generation WALH: FIFTH, SIXTH COVER (early to mid-August). This includes various generations of RLH and PLH.	3-4 leafhopper nymphs/leaf (WALH and/or RLH).
Potato Leafhopper (PLH) (July-Sept.)	June through September	Treat young plantings when PLH populations are increasing.

10.7 Efficacy of Selected Pesticides for Disease, Insect and Mite Control

Table 10.11 Efficacy of Fungicides and Bactericides for Apple and Pear Disease Control

(++++ = excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated)

Note: Fungicides in all groups except M1-M4 are at risk for resistance development. These materials should be alternated or mixed with fungicides of a different chemistry. See labels for details.

Chemistry (FRAC)	Fungicide or Bactericide	Bitter Rot	Black Rot and White Rot	Fire Blight	Powdery Mildew	Rusts	Scab	Sooty Blotch and Flyspeck
COPPER COMPOUND (M1)	Copper, fixed	-	-	++	-	-	-	-
INORGANIC, SULFUR (M2)	Sulfur	+	+	-	+++	+	+	+
DITHIOCARBAMATE (M3)	Ferbam 76WDG	+++	++	-	-	+++	++	++
	Ziram 76DF	++	-	-	+	++	++	+++/++
ETHYLENEBISDITHIO-CARBAMATE (M3)	Dithane, Manzate, Penncozeb 75DF	+++	++	-	-	+++	+++	++
	Polyram 80DF	+++	++	-	-	+++	+++	++
PHTHALIMIDE (M4)	Captan 80WDG	+++	+++	-	+	++	+++	+++ / ++
GUANIDINE (M7)	Syllit 3.4F	-	-	-	-	-	+++	+
MBC (1)	Topsin M WSB	+	+++	-	+++	-	++++	+++
DMI (3)	Cevya 3.34SC	+	-	-	++	++++	++++	++++
	Indar 2F	-	-	-	+++	++++	++++	+++
	Procure 50WS	-	-	-	++++	++++	++++	-
	Rally 40WSP	-	-	-	++++	++++	+++	-
	Topguard	-	-	-	++++	++++	++++	-
	Vintage 1SC	-	-	-	++++	++++	++++	-
DMI + AP (3 + 9)	Inspire Super 2.82EW	++	++	-	+++	++++	++++	++++
SDHI (7)	Aprovia 0.83EC	++	+++	-	++	-	+++	+++
	Fontelis 1.67SC	++	++	-	++	-	+++	+
	Miravis 1.67SC	-	-	-	++	-	++++	-
	Sercadis 2.47SC	-	-	-	++	-	+++	+++
AP (9)	Scala 5SC	-	-	-	+++	-	+++	-
	Vangard 75WG	-	-	-	++	-	+++	-
SDHI + AP (7 + 9)	Luna Tranquility 4.16SC	+++	+++	-	++	+++	++	+++
QoI (11)	Flint Extra 4.05SC	++	++	-	+++	+	++++	+++
	Sovran 50WG	++	++	-	+++	+	++++	++++
QoI + SDHI (11+ 7)	Luna Sensation 4.2SC	+++	++++	-	+++	+++	+++	++++
	Merivon 4.18SC	+++	++++	-	+++	++++	++++	++++
	Pristine 38WG	+++	++++	-	+++	++++	+++	++
UOP (29)	Omega 4.17F	++	++		-	++	++	+++/++++
Phosphonates (33)	ProPhyt, Aliette, etc…	+	+++	-	+	-	+++	++
ANTIBIOTIC, aminoglycoside (24)	Kasumin 2L	-	-	+++	-	-	-	-
ANTIBIOTIC, glucopyranosyl (25)	Agri-Mycin, Firewall, Streptrol 17WP	-	-	+++	-	-	-	-
ANTIBIOTIC, tetracycline (41)	Mycoshield 17WP, FireLine 17WP	-	-	+++	-	-	-	-

Table 10.12 Efficacy of Selected Apple Insecticides and Acaricides

(++++ = excellent, +++ = good, ++ = fair, + = poor, - = not rated, S=suppression only)

INSECTICIDE/ ACARICIDE AND FORMULATION	INSECTS[1]														MITES[2]		
	AM	CM	EAS	GAA	GFW	LR	OFM	PC	RAA	BMSB	SB/ TPB	SJS	STLM	WALH	ARM	ERM	TSM
Acramite 50WS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++++	++++
Actara WG	–	–	++	++++	–	–	–	+++	++++	+++	+++	–	+++	++++	–	–	–
Admire Pro	+	–	–	++++	–	–	–	–	++++	+++	–	+++	++++	++++	–	–	–
Agri-Flex	–	–	++	++++	–	–	–	+++	–	–	–	–	–	–	++	++++	++++
Agri-Mek SC	–	–	–	–	–	–	–	–	–	–	–	–	++++	+++	++	++++	++++
Altacor	+	++++	–	–	++++	++++	++++	+	–	–	–	–	++++	–	–	–	–
Ambush 25W	–	–	–	–	–	–	++++	–	+++	–	–	–	+++	–	–	–	–
Apollo SC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	++++	++++
Apta/Bexar	+++	–	–	++++	–	++	–	+	++++	–	–	–	–	++++	–	–	–
Asana XL	+++	+++	+++	–	+++	–	–	–	+++	–	+++	–	–	+++	–	–	–
Assail 30SG	++++	+++	+++	++++	–	–	+++	++	++++	++	+++	+++	++++	++++	–	–	–
Avaunt	++	+++	+++	–	+++	+++	+++	++++	–	+	+++	–	+	+++	–	–	–
Bacillus thuringiensis	–	–	–	–	–	++++	+++	–	–	–	–	–	–	–	–	–	–
Baythroid XL	+++	++++	++	++	+++	++++	++++	++	+++	+++	++++	+	++++	+++	–	–	–
Belay	+++	++	–	++++	–	+	++	++	++++	++++	–	–	++++	++++	–	–	–
Beleaf 50SG	–	–	–	+++	–	–	–	–	–	+	+++	–	–	–	–	–	–
Besiege	+++	++++	+++	–	+++	++++	++++	++	+++	+++	+++	–	+++	+++	–	–	–
Carpovirusine	–	+++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Centaur WDG	–	–	–	–	–	–	–	–	–	–	–	++++	–	–	–	–	–
Closer SC	–	–	–	++++	–	–	–	–	++++	–	+++	+++	–	++++	–	–	–
Cobalt	–	–	–	–	–	–	–	–	++++	–	–	–	–	–	–	–	–
Cormoran	++++	++++	+++	++++	-	++++	++++	++	++++	++	+++	+++	++++	++++	-	-	-
Cyd-X	–	+++	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Danitol 2.4EC	+++	+++	++++	–	+++	++++	++++	++	++	+++	+++	+	++++	+++	+++	+++	+++
Declare	++++	+++	–	+	++	++++	++++	++	++	+++	++++	+	++++	++++	–	–	–
Delegate 25WG	++	++++	–	–	++++	++++	++++	+	–	+	–	–	++++	–	–	–	–
Diazinon 50W	+++	+++	–	++	++	–	++	+++	++	–	+++	+++	+	++	–	–	–
Dicifol 4E	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+++	+++	+++
Endigo ZC	+++	+++	+++	+++	–	–	++++	+++	++++	++++	++++	–	++++	++++	–	–	–
Envidor 2SC	–	–	–	–	–	–	–	–	–	–	–	–	–	++	++++	++++	++++
Esteem 35WP	–	+++	–	–	–	–	–	–	+++	+	–	++++	+++	–	–	–	–
Exirel	–	+++	+++	–	–	+++	++++	++	-	–	–	–	+++	+++	–	–	–
Gladiator	+	+	+++	+++	–	++++	++++	+	–	+++	++++	–	+	++++	–	+++	++++
Imidan 70W	++++	++++	+++	+	+++	+++	++++	+++	+	–	++	–	+	+	–	–	–
Intrepid 2F	–	+++	–	–	++++	++++	+++	–	–	–	–	–	+++	–	–	–	–

Table 10.12 Efficacy of Selected Apple Insecticides and Acaricides - continued on next page

APPLES

Table 10.12 Efficacy of Selected Apple Insecticides and Acaricides - continued

INSECTICIDE/ ACARICIDE AND FORMULATION	INSECTS[1]														MITES[2]		
	AM	CM	EAS	GAA	GFW	LR	OFM	PC	RAA	BMSB	SB/ TPB	SJS	STLM	WALH	ARM	ERM	TSM
Kanemite 15SC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++++	++++	++++
Lambda-Cy	+++	++++	+++	+	+++	++++	++++	++	+++	+++	++++	+	++++	+++	–	–	–
Lannate	++	+++	+	+++	+++	++++	+++	++	++	+++	++++	–	+++	+++	–	–	–
Leverage 360	+++	+++	+++	++++	+++	+++	+++	++	+++	+++	+++	++	++++	++++	–	–	–
Lorsban-4E	–	–	–	–	–	–	–	–	+++	–	–	++++	–	–	–	++	+
Madex HP		++++					++++										
Minecto Pro	S	+++	–	–			++++	++	–	–	–	–	+++		++	++++	++++
Movento	–	–	–	++++	–	–	–	–	++++	–	–	++++	–	–	–	–	–
Mustang Maxx	+	+	+++	+++	–	++++	++++	+	–	+++	++++	–	+	++++	–	–	–
Nealta	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++	++++	++++
Nexter 75WP	–	–	–	–	–	–	–	–	–	–	–	–	–	++	++++	++++	+++
Oil, 70 second	–	–	–	+++	–	–	+	–	++	–	–	++++	–	–	+	++++	+
Onager EC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++++	++++
Perm-UP 3.2EC	–	–	–	–	–	–	++++	–	+++	–	–	–	+++	–	–	–	–
Portal XLO	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++++	++++
Pounce	–	–	–	–	–	–	++++	–	+++	–	–	–	+++	–	–	–	–
Proaxis	++++	–	–	–	–	++++	++	++	–	–	–	+	++++	+++	–	–	–
Proclaim SG	–	++	–	–	+++	++++	++	–	–	–	++++	+	+++	+++	–	+	+
Renounce	++++	++++	–	–	–	++++	++	–	–	–	–	+	++++	+++	–	–	–
Rimon 0.83EC	–	++++	–	–	–	++++	++++	–	–	–	–	–	++++	–	–	–	–
Savey 50DF	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++++	++++
Sevin XLR	+++	+++	–	++	++	+	+++	+++	+	–	++	++	++	++	+++	–	–
Sivanto 200 SL	–	–	–	++++	–	–	–	–	–	–	–	++	–	++++	–	–	–
Tombstone	++++	++++	++	–	–	++++	++	++	–	–	–	+	++++	+++	–	–	–
Vendex 50WP	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+++	+++	+++
Verdepryn 100SL	-	++++	+++	-	-	++++	++++	+++	-	-	+	+	+++	+++	-	-	-
Versys	-	-	--	++++	-	-	-	-	++++	-	-	-	-	-	-	-	-
Voliam Flexi WG	–	++++	–	++++	–	++++	++++	+++	++++	+++	+++	–	+++	++++	–	–	–
Vydate 2L	+	–	–	+++	–	–	++	+	+++	–	+++	–	++++	+++	+	+	+
Warrior II	+++	++++	+++	+	+++	++++	++++	++	+++	+++	++++	+	++++	+++	–	–	–
Zeal	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	++++	++++

[1] **AM**	= Apple Maggot	**OFM**	= Oriental Fruit Moth	**SJS**	= San Jose Scale
CM	= Codling Moth	**PC**	= Plum Curculio	**STLM**	= Spotted Tentiform Leafminer
EAS	= European Apple Sawfly	**RAA**	= Rosy Apple Aphid	**WALH**	= White Apple Leafhopper
GAA	= Green Apple Aphid	**BMSB**	= Brown Marmorated Stink Bug	[2] **ARM**	= Apple Rust Mite
GFW	= Green Fruit Worm	**SB**	= Stink Bugs (Native Only)	**ERM**	= European Red Mite
LR	= Leafrollers	**TPB**	= Tarnished Plant Bug	**TSM**	= Two-Spotted Spider Mite

10.8 Apple Pest Management

Apple Disease Management Program – Fungicide and Bactericide Timing

Disease	Dormant	Delayed Dormant - ½ Inch Green	Tight Cluster, Pre-Pink	Pink	Bloom	Petal-Fall	First Cover	Second Cover	Third and Fourth Covers	Fifth, Sixth, and Later Covers
Fire Blight										
Apple Scab										
Powdery Mildew										
Cedar Apple Rust										
Fire Blight										
Bitter Rot										
Black and White Rots										
Sooty Blotch/Flyspeck										

Apple Arthropod Management Program – Insecticide and Acaracide Timing

Insect and Mite Pests	Dormant	Delayed Dormant - ½ Inch Green	Tight Cluster, Pre-Pink	Pink	Bloom	Petal-Fall	First Cover	Second Cover	Third and Fourth Covers	Fifth, Sixth, and Later Covers
Rosy Apple Aphid					Do not apply insecticides during Bloom!					
Scale Insects										
Spotted Tentiform Leafminer										
European Apple Sawfly										
Oriental Fruit Moth										
Apple Aphid										
Woolly Apple Aphid										
Codling Moth										
Leafrollers/ Tufted Apple Budmoth										
Plum Curculio										
Native Stink Bugs										
Tarnished Plant Bug										
White Apple Leafhopper										
Brown Marmorated Stink Bug										
Apple Maggot										
European Red Mite		eggs	eggs	eggs/ nymphs						
Apple Rust Mite										
Two-Spotted Spider Mite										

Key: = Optimim timing = Some control possible

The following Pest Management Tables are listed for individual cover sprays but growers should think about whole season approaches, see the chapter Pesticide Strategies.

Abbreviations			
Pome Fruit Preharvest Interval Key		**Units of Measurement**	
D	Dormant application only	/A	per acre
DD	Delayed dormant application only	d	day(s)
TC	No later than tight cluster	fl oz	fluid ounce(s)
P	No later than pink	gal	gallon(s)
PB	No later than prebloom	h	hour(s)
FB	No later than full bloom	lb	pound(s)
PF	No later than petal-fall	oz	ounce(s)
NTL	No time limit (usually up to the day of harvest) - consult label	pt	pint(s)
		qt	quart(s)
NA	Not applicable		

DORMANT					APPLES
DISEASE	**Fire Blight**				
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Bordeaux mixture (lb/100 gal)	++ 8, 8				24 h D
Champ Formula (gal)	++ 0.66-1.33				24 h D
Cuprofix Ultra 40DF[4] (lb)	++ 5.0-7.5				24 h D
Kocide 3000 30DF[4] (lb)	++ 5.25-7.0				24 h D
Nu-Cop 50DF (lb)	++ 8.0-16.0				24 h D

[1] Copper materials cause injury if applied beyond half-inch green. Kocide, Champ, Nu-Cop are copper hydroxide products; Cuprofix is basic copper sulfate. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available. **Note:** For nonbearing and processing apples, a protectant-based program is recommended. A standard fire blight program, however, will be required for susceptible cultivars.

DELAYED DORMANT - 1/2-INCH GREEN					APPLES
DISEASE	**Apple Scab**	**Powdery Mildew**			
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
PROTECTANT FUNGICIDES[4]					
Captan 80WDG[5] (lb)	+++ 2.5-5.0	+ 2.5-5.0			24 h 0 d
Ferbam 76WDG (lb)	++ 4.0-6.0	–			24 h 7 d
Mancozeb 75DF[6] (lb)	+++ 6.0	–			24 h FB
Polyram 80DF[6] (lb)	+++ 6.0	–			24 h FB
Ziram 76DF (lb)	++ 3.0-6.0	+ 3.0-6.0			48 h 14 d

Delayed Dormant - ½ Inch Green DISEASE Resistance Risk Fungicides - on next page

Delayed Dormant - ½ Inch Green DISEASE Resistance Risk Fungicides

DELAYED DORMANT - 1/2-INCH GREEN					APPLES
DISEASE	**Apple Scab**	**Powdery Mildew**			
RESISTANCE RISK FUNGICIDES					
Aprovia 0.83EC **(fl oz)**	+++ 5.5-7.0	++ 5.5-7.0			12 h 30 d
Cevya 3.34SC **(fl oz)**	++++ 3.0-5.0	++ 3.0-5.0			12 h 0 d
Flint Extra 4.05SC **(fl oz)**	++++ 2.5-2.9	+++ 2.5-2.9			12 h 14 d
Fontelis 1.67SC **(fl oz)**	+++ 16.0-20.0	++ 16.0-20.0			12 h 28 d
Indar 2F **(fl oz)**	++++ 6.0-8.0	+++ 6.0-8.0			12 h 14 d
Inspire Super 2.82EW **(fl oz)**	++++ 12.0	+++ 12.0			12 h 14 d
Luna Sensation 4.2SC **(fl oz)**	+++ 4.0-5.8	+++ 5.0-5.8			12 h 14 d
Luna Tranquility 4.16SC **(fl oz)**	++ 11.2-16.0	++ 11.2-16.0			12 h 72 d
Merivon 4.18SC **(fl oz)**	++++ 4.0-5.5	+++ 4.0-5.5			12 h 0 d
Miravis 1.67SC **(fl oz)**	++++ 3.4	++ 3.4			4 h 30 d
Omega 4.17F **(fl oz)**	++ 10-13.8	– 10-13.8			12 h 28 d
Pristine 38WG **(oz)**	+++ 14.5-18.5	+++ 14.5-18.5			12 h 0 d
Procure 50WS **(oz)**	++++ 8.0-16.0	++++ 8.0-16.0			12 h 14 d
ProPhyt[7] **(pt)**	+++ 3.0-4.0	+ 3.0-4.0			4 h 0 d
Rally 40WSP **(oz)**	+++ 4.0-6.0	++++ 4.0-6.0			24 h 14 d
Scala 5SC **(fl oz)**	++ 7.0-10.0	++ 7.0-10.0			12 h 72 d
Sercadis 2.47SC **(fl oz)**	+++ 3.5-4.5	++ 3.5-4.5			12 h 0 d
Sovran 50WG **(oz)**	++++ 5.0-6.0	+++ 5.0-6.0			12 h 30 d
Syllit 3.4F **(pt)**	+++ 1.5	–			48 h P
Topguard **(fl oz)**	++++ 13.0	++++ 8.0-12.0			12 h 14 d
Topsin M WSB **(lb)**	++++ 0.75-1.0	+++ 0.75-1.0			48 h 1 d
Vangard 75WG **(oz)**	+++ 3.0-5.0	++ 3.0-5.0			12 h 0 d
Vintage 1SC **(fl oz)**	++++ 8.0-12.0	++++ 8.0-12.0			24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available. [5] Do not Combine Captan or Sulfur with Oil products. See specific product label precautions for additional crop safety precautions. [6] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Extended schedule allows applications at half rate up to 77 days before harvest. Do not combine or integrate prebloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide). [7] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

DELAYED DORMANT - 1/2-INCH GREEN					APPLES
INSECT OR MITE PEST	INSECTS		MITES		
	Rosy Apple Aphid	Scale Insects	European Red Mite Eggs		
Product and Formulation[1]	Product Efficacy Rating[2] and Rate/A[3]				REI PHI
Superior Oil[1] (gal)	–	++++ 6.0	++++ 6.0		4 h 0 d
OR					
Superior Oil (gal) PLUS one of the following:	+ 1.0	++++ 4.0	++++ 4.0		
Ambush 25W[4] (oz)	+++ 6.4-25.6	–	–		12 h PF[8]
Apollo SC[5] (oz)	–	–	++++ 4.0-8.0		12 h 45 d
Asana XL[4] (fl oz)	+++ 5.0-8.0	–	–		12 h 21 d
Baythroid XL (fl oz)	+++ 2.0-2.8	–	–		12 h 7 d
Besiege (fl oz)	+++ 6.0-12.0	–	–		24 h 21 d
Centaur WDG[7] (oz)	–	++++ 34.5	–		12 h 14 d
Cobalt (pt)	+++ 4.0-6.25	++++ 4.0-6.25	–		96 h D, DD[8]
Danitol 2.4EC (fl oz)	++ 10.0-21.0	–	–		24 h 14 d
Diazinon 50W[9] (lb)	++ 2.0-3.0	++++ 2.0-3.0	–		96 h 21 d
Esteem 35WP[6] (oz)	+++ 4.0-5.0	++++ 4.0-5.0	–		12 h 45 d
Lambda-Cy (fl oz)	+++ 2.56-5.12	–	–		24 h 21 d
Lorsban-4E[4] (pt)	+++ 2.0-4.0	++++ 2.0-4.0	–		96 h 28 d, PB[8]
Perm-UP 3.2EC (fl oz)	+++ 4.0-16.0	–	–		12 h PB[8]
Pounce 25WP[4] (oz)	+++ 6.4-16	–	–		12 h 14 d
Versys (fl oz)	++++ 1.5	–	–		12 h 7 d
Warrior II[4] (fl oz)	+++ 1.28-2.56	–	–		24 h 21 d

[1] Prebloom oil applications facilitate integrated mite management. If no oil is used, check for mites and San Jose scale during foliar season. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] When noted, generic products are available. Only one application of any chlorpyrifos product may be made/year. [5] Apply Apollo alone or add 1.0 gal oil/A to improve control. [6] Apply at 0.25 inch green. [7] Centaur can also be used at pink or petal fall or at the crawler stage for scale control, but only one application may be made/season. [8] PHI key: D=Dormant application only, DD=Delayed dormant application only, PB=No later than prebloom, PF=No later than petal fall. [9] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.

TIGHT CLUSTER, PREPINK					APPLES
DISEASE	**Apple Scab**	**Powdery Mildew**			
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI, PHI**
PROTECTANT FUNGICIDES[1,4]					
Captan 80WDG[5] **(lb)**	+++ 2.5-5.0	+ 2.5-5.0			24 h 0 d
Ferbam 76WDG **(lb)**	++ 4.0-6.0	–			24 h 7 d
Mancozeb 75DF[6] **(lb)**	+++ 6.0	–			24 h FB[8]
Polyram 80DF[6] **(lb)**	+++ 6.0	–			24 h FB[8]
Sulfur 80WP[4,7] **(lb)**	+ 10.0-20.0	+++ 10.0-20.0			24 h NTL[8]
Ziram 76DF **(lb)**	++ 3.0-6.0	+ 3.0-6.0			48 h 14 d
RESISTANCE RISK FUNGICIDES[1]					
Aprovia 0.83EC **(fl oz)**	+++ 5.5-7.0	++ 5.5-7.0			12 h 30 d
Cevya 3.34SC **(fl oz)**	++++ 3.0-5.0	++ 3.0-5.0			12 h 0 d
Flint Extra 4.05SC **(fl oz)**	++++ 2.5-2.9	+++ 2.5-2.9			12 h 14 d
Fontelis 1.67SC **(fl oz)**	+++ 16.0-20.0	++ 16.0-20.0			12 h 28 d
Indar 2F **(fl oz)**	++++ 6.0-8.0	+++ 6.0-8.0			12 h 14 d
Inspire Super 2.82EW **(fl oz)**	++++ 12.0	+++ 12.0			12 h 14 d
Luna Sensation 4.2SC **(fl oz)**	+++ 4.0-5.8	+++ 5.0-5.8			12 h 14 d
Luna Tranquility 4.16SC **(fl oz)**	++ 11.2-16.0	++ 11.2-16.0			12 h 72 d
Merivon 4.18SC **(fl oz)**	++++ 4.0-5.5	+++ 4.0-5.5			12 h 0 d
Miravis 1.67SC **(fl oz)**	++++ 3.4	++ 3.4			4 h 30 d
Omega 4.17F **(fl oz)**	++ 10-13.8	– 10-13.8			12 h 28 d
Pristine 38WG **(oz)**	+++ 14.5-18.5	+++ 14.5-18.5			12 h 0 d
Procure 50WS **(oz)**	++++ 8.0-16.0	++++ 8.0-16.0			12 h 14 d
ProPhyt[9] **(pt)**	+++ 3.0-4.0	+ 3.0-4.0			4 h 0 d
Rally 40WSP **(oz)**	+++ 4.0-6.0	++++ 4.0-6.0			24 h 14 d
Scala 5SC **(fl oz)**	+++ 7.0-10.0	++ 7.0-10.0			12 h 72 d
Sercadis 2.47SC **(fl oz)**	+++ 3.5-4.5	++ 3.5-4.5			12 h 0 d
Sovran 50WG **(oz)**	++++ 5.0-6.0	+++ 5.0-6.0			12 h 30 d
Syllit 3.4F **(pt)**	+++ 1.5	–			48 h P[7]

Tight Cluster, Prepink DISEASE Resistance Risk Fungicides - continued on next page

Tight Cluster, Prepink DISEASE Resistance Risk Fungicides - continued

TIGHT CLUSTER, PREPINK					APPLES
DISEASE	**Apple Scab**	**Powdery Mildew**			
RESISTANCE RISK FUNGICIDES[1]					
Topguard **(fl oz)**	++++ 13.0	++++ 8.0-12.0			12 h 14 d
Topsin M WSB **(lb)**	++++ 0.75-1.0	+++ 0.75-1.0			48 h 1 d
Vangard 75WG **(oz)**	+++ 3.0-5.0	++ 3.0-5.0			12 h 0 d
Vintage 1SC **(fl oz)**	++++ 8.0-12.0	++++ 8.0-12.0			24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available. [5] Do not Combine Captan or Sulfur with Oil products. See specific product label precautions for additional crop safety precautions. [6] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Extended schedule allows applications at half rate up to 77 days before harvest. Do not combine or integrate prebloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide). [7] Wettable sulfur is recommended at the tight cluster stage for mildew susceptible cultivars. Do not apply to Stayman or Delicious, as this may reduce bud set if applied too close to bloom. Avoid drift on sensitive D'Anjou pears or apricots. [8] PHI Key: FB=No later than full bloom, P=No later than pink, NTL= No time limit (usually up to the day of harvest) - consult label.). [9] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

TIGHT CLUSTER, PREPINK					APPLES
INSECT OR MITE PEST	**INSECTS**		**MITES**		
	Rosy Apple Aphid	**Spotted Tenti-form Leafminer**	**European Red Mite Eggs**		
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI, PHI**
Superior Oil (gal)	–	–	++++ 2.0-3.0		4 h 0 d
OR					
Superior Oil (gal) PLUS one of the following			++ 1.0		
Actara 25WG[6] (oz)	++++ 4.5	+++ 4.5	–		12 h 14/35 d[6]
Ambush 25W[1,4] (oz)	+++ 6.4-25.6	+++ 6.4-25.6	–		12 h PF[7]
Apollo SC[5] (oz)	–	–	++++ 4.0-8.0		12 h 45 d
Asana XL[1,4] (fl oz)	+++ 4.0-8.0	++++ 4.0-8.0	–		12 h 21 d
Assail 30SG (oz)	++++ 2.5-4.0	++++ 2.5	–		12 h 7 d
Baythroid XL[4] (fl oz)	+++ 2.0-2.4	++++ 2.0-2.4	–		12 h 7 d
Belay (fl oz)	++++ 4.0-6.0	++++ 4.0-6.0	–		12 h 7 d
Besiege (fl oz)	++++ 9.0-12.0	+++ 9.0-12.0	–		24 h 21 d
Closer SC (fl oz)	++++ 1.5-2.75	–	–		12 h 7 d
Cormoran (fl oz)	++++ 20.0-28.0	++++ 20.0-28.0	–		12 h 14 d
Danitol 2.4 EC[4] (fl oz)	++ 10.6-21.3	+++ 10.6-21.3	–		24 h 14 d
Diazinon 50W[8] (lb)	++ 1.0-2.0	++ 1.0-2.0	–		96 h 21 d
Lambda-Cy (fl oz)	+++ 2.56-5.12	++++ 2.56-5.12	–		24 h 21 d
Leverage 360 (fl oz)	++++ 2.4-2.8	++++ 2.4-2.8	–		12 h 7 d
Perm-UP 3.2EC (fl oz)	+++ 4.0-16.0	+++ 4.0-16.0	–		12 h PB[7]
Pounce 25WP[1,4] (oz)	+++ 6.4-16	+++ 6.4-16	–		12 h 14 d
Savey 50DF (oz)	–	–	++++ 3.0		12 h 28 d
Sivanto Prime (oz)	++++ 10.5-14.0	++++ 10.5-14.0	–		4 h 14 d
Verdepryn 100SL (fl oz)	–	+++ 5.5-11.0	–		4 hr 7 d
Versys (fl oz)	++++ 1.5	–	–		12 h 7 d
Vydate 2L (pt)	+++ 2.5-3.0	++++ 2.5-3.0	+ 2.5-3.0		48 h 14 d
Warrior II[1,4] (fl oz)	+++ 1.28-2.56	++++ 1.28-2.56	–		24 h 21 d

[1] When noted, generic products are available. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] The use of these

Footnotes Tight Cluster, Prepink INSECT OR MITE PEST - continued
materials (pyrethroids) may exacerbate mite problems. [5] Apply Apollo alone or add 1.0 gal oil/A to improve control. [6] 35 day PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A. [7] PHI Key: PB=No later than prebloom, PF=No later than petal fall. [8] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application.

PINK					APPLES
DISEASE	**Apple Scab**	**Cedar Apple Rust**	**Powdery Mildew**		
Product and Formulation	**Product Efficacy Rating[2] and Rate/A[3]**				**REI, PHI**
PROTECTANT FUNGICIDES[1,4]					
Captan 80WDG[5] **(lb)**	+++ 2.5-5.0	++ 2.5-5.0	+ 2.5-5.0		24 h 0 d
Ferbam 76WDG **(lb)**	++ 4.0-6.0	+++ 3.0-8.0	–		24 h 7 d
Mancozeb 75DF[6] **(lb)**	+++ 6.0	+++ 6.0	–		24 h FB[7]
Polyram 80DF[6] **(lb)**	+++ 6.0	+++ 6.0	–		24 h FB[7]
Ziram 76DF **(lb)**	++ 3.0-6.0	++ 3.0-6.0	+ 3.0-6.0		48 h 14 d
RESISTANCE RISK FUNGICIDES[1]					
Aprovia 0.83EC **(fl oz)**	+++ 5.5-7.0	–	++ 5.5-7.0		12 h 30 d
Cevya 3.34SC **(fl oz)**	++++ 3.0-5.0	++++ 3.0-5.0	++ 3.0-5.0		12 h 0 d
Flint Extra 4.05SC **(fl oz)**	++++ 2.5-2.9	+ 2.5-2.9	+++ 2.5-2.9		12 h 14 d
Fontelis 1.67SC **(fl oz)**	+++ 16.0-20.0	-	++ 16.0-20.0		12 h 28 d
Indar 2F **(fl oz)**	++++ 6.0-8.0	++++ 6.0-8.0	+++ 6.0-8.0		12 h 14 d
Inspire Super 2.82EW **(fl oz)**	++++ 12.0	++++ 12.0	+++ 12.0		12 h 14 d
Luna Sensation 4.2SC **(fl oz)**	+++ 4.0-5.8	+++ 4.0-5.8	+++ 5.0-5.8		12 h 14 d
Luna Tranquility 4.16SC **(fl oz)**	++ 11.2-16.0	+++ 11.2-16.0	++ 11.2-16.0		12 h 72 d
Merivon 4.18SC **(fl oz)**	++++ 4.0-5.5	+++ 4.0-5.5	+++ 4.0-5.5		12 h 0 d
Miravis 1.67SC **(fl oz)**	++++ 3.4	–	++ 3.4		4 h 30 d
Omega 4.17F **(fl oz)**	++ 10-13.8	+++ 10-13.8	– 10-13.8		12 h 28 d
Pristine 38WG **(oz)**	+++ 14.5-18.5	+++ 14.5-18.5	+++ 14.5-18.5		12 h 0 d
Procure 50WS **(oz)**	++++ 8.0-16.0	++++ 8.0-16.0	++++ 8.0-16.0		12 h 14 d
ProPhyt[8] **(pt)**	+++ 3.0-4.0	–	+ 3.0-4.0		4 h 0 d
Rally 40WSP **(oz)**	+++ 4.0-6.0	++++ 4.0-6.0	++++ 4.0-6.0		24 h 14 d
Scala 5SC **(fl oz)**	+++ 7.0-10.0	–	++ 7.0-10.0		12 h 72 d
Sercadis 2.47SC **(fl oz)**	+++ 3.5-4.5	–	++ 3.5-4.5		12 h 0 d

Pink DISEASE Resistance Risk Fungicides- continued on next page

Pink DISEASE Resistance Risk Fungicides - continued

PINK					APPLES
DISEASE	**Apple Scab**	**Cedar Apple Rust**	**Powdery Mildew**		
RESISTANCE RISK FUNGICIDES[1]					
Sovran 50WG (oz)	++++ 5.0-6.0	++ 5.0-6.0	+++ 5.0-6.0		12 h 30 d
Syllit 3.4F (pt)	+++ 1.5	–	–		48 h P[6]
Topguard (fl oz)	++++ 13.0	++++ 8.0-12.0	++++ 8.0-12.0		12 h 14 d
Topsin M WSB (lb)	++++ 0.75-1.0	–	+++ 0.75-1.0		48 h 1 d
Vangard 75WG (oz)	+++ 3.0-5.0	–	++ 3.0-5.0		12 h 0 d
Vintage 1SC (fl oz)	++++ 8.0-12.0	++++ 8.0-12.0	++++ 8.0-12.0		24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available. [5] Do not Combine Captan or Sulfur with Oil products. See label precautions for additional crop safety precautions. [6] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Extended schedule allows applications at half rate up to 77 d before harvest. Do not combine or integrate prebloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide). [7]PHI Key: FB=No later than full bloom; P=No later than pink.). [8] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

PINK					APPLES
INSECT OR MITE PEST	**INSECTS**		**MITES**		
	European Apple Sawfly	**Oriental Fruit Moth**	**European Red Mite Eggs and Nymphs**		
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Note: Other insecticides as listed under prepink may also be used here					
Apollo SC[3] (oz)	–	–	++++ 4.0-8.0		12 h 45 d
Assail 30SG (oz)	+++ 2.5-4.0	+++ 2.5-4.0	–		12 h 7 d
Avaunt (oz)	+++ 5.0-6.0	+++ 5.0-6.0	–		12 h 14 d
Envidor 2SC (fl oz)	–	–	++++ 16.0-18.0		12 h 7 d
Esteem 35WP (oz)	–	+++ 4.0-5.0	–		12 h 14 d
Onager EC (oz)	–	–	++++ 12.0-24.0		12 h 28 d
Savey 50DF (oz)	–	–	++++ 3.0		12 h 28 d
Vydate 2L (pt)	–	++ 2.5-3.0	+ 2.5-3.0		48 h 14 d
Zeal (oz)	–	–	++++ 2.0-3.0		12 h 14 d

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] Apply Apollo alone or add 1 gal oil/A to improve control.

BLOOM					APPLES
DISEASE	**Apple Scab**	**Cedar Apple Rust**	**Fire Blight[1]**	**Powdery Mildew**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
BACTERICIDES					
Agri-Mycin 17WP[1] (oz)	–	–	+++ 24.0-48.0	–	12 h 50 d
Agri-Mycin 17WP[1] (oz) plus Glycerin (qt)	–	–	+++ 12.0-24.0 plus 4.0	–	12 h 50 d
Agri-Mycin 17WP[1] (oz) plus Regulaid (oz)	–	–	+++ 12.0-24.0 plus 8.0	–	12 h 50 d
FireLine 17WP[1] (oz)	–	–	+++ 16.0-24.0	–	12 h 60 d
Kasumin 2L[1] (fl oz)	–	–	+++ 64	–	12 h PF[7]
Mycoshield 17WP[1] (oz)	–	–	+++ 16.0	–	12 h 60 d
PROTECTANT FUNGICIDES[5]					
Captan 80WDG[5] (lb)	+++ 2.5-5.0	++ 2.5-5.0	–	+ 2.5-5.0	24 h 0 d
Ferbam 76WDG (lb)	++ 4.0-6.0	+++ 3.0-8.0	–	–	24 h 7 d
Mancozeb 75DF[6] (lb)	+++ 6.0	+++ 6.0	–	–	24 h FB[7]
Polyram 80DF[6] (lb)	+++ 6.0	+++ 6.0	–	–	24 h FB[7]
Ziram 76DF (lb)	++ 3.0-6.0	++ 3.0-6.0	–	+ 3.0-6.0	48 h 14 d
RESISTANCE RISK FUNGICIDES					
Aprovia 0.83EC (fl oz)	++++ 5.5-7.0	–	–	++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	++++ 3.0-5.0	–	++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-2.9	+ 2.5-2.9	–	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	+++ 16.0-20.0	–	–	++ 16.0-20.0	12 h 28 d
Indar 2F (fl oz)	++++ 6.0-8.0	++++ 6.0-8.0	–	+++ 6.0-8.0	12 h 14 d
Inspire Super 2.82EW (fl oz)	++++ 12.0	++++ 12.0	–	+++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ 4.0-5.8	–	+++ 5.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	++ 11.2-16.0	+++ 11.2-16.0	–	++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	++++ 4.0-5.5	+++ 4.0-5.5	–	+++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	++++ 3.4	–	–	++ 3.4	4 h 30 d
Omega 4.17F (fl oz)	++ 10-13.8	+++ 10-13.8	–	– 10-13.8	12 h 28 d
Pristine 38WG (oz)	+++ 14.5-18.5	+++ 14.5-18.5	–	+++ 14.5-18.5	12 h 0 d
Procure 50WS (oz)	++++ 8.0-16.0	++++ 8.0-16.0	–	++++ 8.0-16.0	12 h 14 d

Bloom DISEASE Resistance Risk Fungicides - continued on next page

Bloom DISEASE Resistance Risk Fungicides - continued

BLOOM					APPLES
DISEASE	**Apple Scab**	**Cedar Apple Rust**	**Fire Blight[1]**	**Powdery Mildew**	
RESISTANCE RISK FUNGICIDES					
ProPhyt[8] **(pt)**	+++ 3.0-4.0	–	–	+ 3.0-4.0	4 h 0 d
Rally 40WSP **(oz)**	+++ 4.0-6.0	++++ 4.0-6.0	–	++++ 4.0-6.0	24 h 14 d
Scala 5SC **(fl oz)**	+++ 7.0-10.0	–	–	++ 7.0-10.0	12 h 72 d
Sercadis 2.47SC **(fl oz)**	+++ 3.5-4.5	–	–	++ 3.5-4.5	12 h 0 d
Sovran 50WG **(oz)**	++++ 5.0-6.0	++ 5.0-6.0	–	+++ 5.0-6.0	12 h 30 d
Topguard **(fl oz)**	++++ 13.0	++++ 8.0-12.0	–	++++ 8.0-12.0	12 h 14 d
Topsin M WSB **(lb)**	++++ 0.75-1.0	–	–	+++ 0.75-1.0	48 h 1 d
Vangard 75WG **(oz)**	+++ 3.0-5.0	–	–	++ 3.0-5.0	12 h 0 d
Vintage 1SC **(fl oz)**	++++ 8.0-12.0	++++ 8.0-12.0	–	++++ 8.0-12.0	24 h 30 d

[1] Apply when first blossoms open; repeat sprays at 3-7 day intervals during bloom. Use dilute, complete sprays to obtain thorough coverage. Firewall 17WP and Streptrol 17WP can be substituted at similar rates for Agri-Mycin. Rotate materials with different active ingredients for resistance management. Kasumin not labeled after Petal Fall.

[2] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination.

[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Generic products and/or alternate formulations available.

[6] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Extended schedule allows applications at half rate up to 77 d before harvest. Do not combine or integrate prebloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide).

[7] PHI Key: FB=No later than full bloom; PF= No later than petal fall

[8] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

BLOOM	APPLES
INSECT PEST	**Do not apply insecticides during bloom!**

PETAL FALL					APPLES
DISEASE	**Apple Scab**	**Cedar Apple Rust**	**Fire Blight[1]**	**Powdery Mildew**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
BACTERICIDES					
Agri-Mycin 17WP[1] (oz)	–	–	+++ 24.0-48.0	–	12 h 50 d
Agri-Mycin 17WP[1] (oz) plus Glycerin (qt)	–	–	+++ 12.0-24.0 plus 4.0	–	12 h 50 d
Agri-Mycin 17WP[1] (oz) plus Regulaid (oz)	–	–	+++ 12.0-24.0 plus 8.0	–	12 h 50 d
FireLine 17WP[1] (oz)	–	–	+++ 16.0-24.0	–	12 h 60 d
Kasumin 2L[1] (fl oz)	–	–	+++ 64	–	12 h PF[7]
Mycoshield 17WP[1] (oz)	–	–	+++ 16.0	–	12 h 60 d
PROTECTANT FUNGICIDES[5]					
Captan 80WDG[5] (lb)	+++ 2.5-5.0	++ 2.5-5.0	–	+ 2.5-5.0	24 h 0 d
Ferbam 76WDG (lb)	++ 4.0-6.0	+++ 3.0-8.0	–	–	24 h 7 d
Mancozeb 75DF[6] (lb)	+++ 6.0	+++ 6.0	–	–	24 h FB[7]
Polyram 80DF[6] (lb)	+++ 6.0	+++ 6.0	–	–	24 h FB[7]
Ziram 76DF (lb)	++ 3.0-6.0	++ 3.0-6.0	–	+ 3.0-6.0	48 h 14 d
RESISTANCE RISK FUNGICIDES					
Aprovia 0.83EC (fl oz)	++++ 5.5-7.0	–	–	++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	++++ 3.0-5.0	–	++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-2.9	+ 2.5-2.9	–	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	+++ 16.0-20.0	–	–	++ 16.0-20.0	12 h 28 d
Indar 2F (fl oz)	++++ 6.0-8.0	++++ 6.0-8.0	–	+++ 6.0-8.0	12 h 14 d
Inspire Super 2.82EW (fl oz)	++++ 12.0	++++ 12.0	–	+++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ 4.0-5.8	–	+++ 5.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	++ 11.2-16.0	+++ 11.2-16.0	–	++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	++++ 4.0-5.5	+++ 4.0-5.5	–	+++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	++++ 3.4	–	–	++ 3.4	4 h 30 d
Omega 4.17F (fl oz)	++ 10-13.8	+++ 13.8	–	–	12 h 28 d
Pristine 38WG (oz)	+++ 14.5-18.5	+++ 14.5-18.5	–	+++ 14.5-18.5	12 h 0 d
Procure 50WS (oz)	++++ 8.0-16.0	++++ 8.0-16.0	–	++++ 8.0-16.0	12 h 14 d

Petal Fall DISEASE Resistance Risk Fungicides- continued on next page

Petal Fall DISEASE Resistance Risk Fungicides - continued

PETAL FALL					APPLES
DISEASE	**Apple Scab**	**Cedar Apple Rust**	**Fire Blight[1]**	**Powdery Mildew**	
RESISTANCE RISK FUNGICIDES					
ProPhyt[8] (pt)	+++ 3.0-4.0	–	–	+ 3.0-4.0	4 h 0 d
Rally 40WSP (oz)	+++ 4.0-6.0	++++ 4.0-6.0	–	++++ 4.0-6.0	24 h 14 d
Scala 5SC (fl oz)	+++ 7.0-10.0	–	–	++ 7.0-10.0	12 h 72 d
Sercadis 2.47SC (fl oz)	+++ 3.5-4.5	–	–	++ 3.5-4.5	12 h 0 d
Sovran 50WG (oz)	++++ 5.0-6.0	++ 5.0-6.0	–	+++ 5.0-6.0	12 h 30 d
Topguard (fl oz)	++++ 13.0	++++ 8.0-12.0	–	++++ 8.0-12.0	12 h 14 d
Topsin M WSB (lb)	++++ 0.75-1.0	–	–	+++ 0.75-1.0	48 h 1 d
Vangard 75WG (oz)	+++ 3.0-5.0	–	–	++ 3.0-5.0	12 h 0 d
Vintage 1SC (fl oz)	++++ 6.0-12.0	++++ 6.0-12.0	–	++++ 6.0-12.0	24 h 30 d

[1] Apply when first blossoms open; repeat sprays at 3-7 d intervals during bloom. Use dilute, complete sprays to obtain thorough coverage. Firewall 17WP and Streptrol 17WP can be substituted at similar rates for Agri-Mycin. Where pressure is high and/or Cultivar is highly susceptible continue rotating active ingredients through second cover. Kasumin Not Labeled after Petal Fall.

[2] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination.

[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Generic products and/or alternate formulations available.

[6] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Extended schedule allows applications at half rate up to 77 d before harvest. Do not combine or integrate prebloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide).

[7] PHI Key: FB=No later than full bloom; PF= No later than petal fall

[8] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

PETAL FALL See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.											APPLES
INSECT PEST	**Apple Aphid**	**Woolly Apple Aphid**	**Codling Moth[1]**	**European Apple Sawfly**	**Leaf-roller**	**Oriental Fruit Moth**	**Plum Curculio**	**Spotted Tentiform Leafminer**	**Tarnished Plant Bug**	**White Apple Leafhopper**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**										**REI PHI**
Actara 25WG[5] (oz)	++++ 4.5-5.5	–	–	++ 4.5-5.5	–	–	+++ 4.5-5.5	+++ 4.5-5.5	+++ 5.5	++++ 2.0-2.75	12 h 14/35 d[5]
Admire Pro - foliar (fl oz)	++++ 1.4-2.8	–	–	–	–	–	–	–	–	++++ 1.4-2.8	12 h 7 d
Admire Pro - soil (fl oz)	+++ 7.0-10.5	++ 7.0-10.5	–	–	–	–	–	++++ 4.0-6.0	–	++++ 7.0-10.5	12 h 21 d
Agri-Flex (fl oz)	++++ 5.5-8.0	–	–	++ 5.5-8.0	–	–	+++ 5.5-8.0	+++ 5.5-8.0	+++ 5.5-8.0	++++ 5.5-8.0	12 h 35 d
Agri-Mek SC [2,6] (fl oz)	–	–	–	–	–	–	–	++++ 2.25-4.25	–	+++ 2.25-4.25	12 h 28 d
Altacor (oz)	–	–	++++ 2.5-4.5	–	++++ 2.5-4.5	++++ 2.5-4.5	+ 2.5-4.5	++++ 2.5-4.0	–	–	4 h 5 d
Apta/Bexar (fl oz)	++++ 17.0-21.0	–	–	–	++ 21.0-27.0	–	+++ 21.0-27.0	–	–	++++ 14.0-21.0	12 h 14 d
Asana XL[2] (fl oz)	–	–	+++ 8.0-10	+++ 8.0-10.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	++++ 6.0-14.0	+++ 4.8-8.0	+++ 8.0-14.0	12 h 21 d
Assail 30SG (oz)	++++ 2.5-4.0	–	+++ 5.0-8.0	+++ 5.0-8.0	–	+++ 5.0-8.0	++ 8.0	++++ 2.5	+++ 6.0-8.0	++++ 2.5-4.0	12 h 7 d
Avaunt (oz)	–	–	+++ 5.0-6.0	+++ 5.0-6.0	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	+(++)[7] 6.0	+++ 5.0-6.0	+++ 6.0	12 h 14 d
***Bacillus thuringiensis* (lb)**	–	–	–	–	++++ 0.5-2	–	–	–	–	–	4 h 0 d
Baythroid XL (fl oz)	++ 2.4-2.8	–	++++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	++++ 2.0-2.4	++++ 2.0-2.4	+++ 1.4-2.0	12 h 7 d
Belay 2.13SC[8] (fl oz)	++++ 4.0-6.0	–	++ 6.0-12.0	–	+ 6.0-12.0	+++ 6.0-12.0	++ 6.0	++++ 6.0	–	++++ 4.0-6.0	12 h 7 d
Besiege (fl oz)	–	–	++++ 6.0-12.0	+++ 9.0-12.0	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	++++ 9.0-12.0	+++ 9.0-12.0	+++ 9.0-12.0	24 h 21 d
Cormoran (fl oz)	++++ 20.0-28.0	–	++++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	++++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	12 h 14 d
Danitol 2.4EC (fl oz)	–	–	+++ 16.0-21.3	++++ 16.0-21.3	++++ 16.0-21.3	++++ 16.0-21.3	++ 16.0-21.3	+++ 10.6-21.3	+++ 10.6-21.3	+++ 10.6-21.3	24 h 14 d
Declare (fl oz)	+ 1.02-2.05	–	++ 1.02-2.05	–	++++ 1.02-2.05	++ 1.02-2.05	++ 1.02-2.05	++++ 1.02-2.05	++ 1.02-2.05	+++ 1.02-2.05	24 h 21 d

Petal Fall INSECT PESTS - continued on next page

Petal Fall INSECT PESTS- continued

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Codling Moth[1]	European Apple Sawfly	Leaf-roller	Oriental Fruit Moth	Plum Curculio	Spotted Tentiform Leafminer	Tarnished Plant Bug	White Apple Leafhopper	REI PHI
Delegate 25WG (oz)	–	–	++++ 4.5-7.0	–	++++ 4.5-7.0	++++ 4.5-7.0	+ 6.0-7.0	++++ 4.5-7.0	–	–	4 h 7 d
Endigo ZC (fl oz)	+++ 5.0-6.0	–	+++ 5.0-6.0	+++ 5.0-6.0	–	++++ 5.0-6.0	+++ 5.0-6.0	–	++++ 5.0-6.0	++++ 5.0-6.0	24 h 35 d
Entrust SC (fl oz)	–	–	+++ 6.0-10.0	–	++++ 6.0-10.0	++++ 6.0-10.0	–	++ 6.0-10.0	–	–	4 h 7 d
Esteem 35WP (oz)	–	–	+++ 4.0 – 5.0	–	–	–	–	+++ 3.0-5.0	–	–	12 h 45 d
Exirel (fl oz)	–	–	+++ 8.8-17.0	–	+++ 8.8-17.0	++++ 8.8-17.0	++ 13.5-20.5	+++ 8.8-17.0	–	+++ 8.8-17.0	12 h 3 d
Imidan 70W (lb)	–	–	++++ 2.5-3.0	+++ 2.0-3.0 lb	+++ 2.5-3.0	++++ 2.5-3.0	+++ 2.5-3.0	+ 2.5-3.0	++ 2.5-3.0	+ 2.5-3.0	4/14 d[9] 7 d
Intrepid 2F (fl oz)	–	–	+++[1] 16.0	–	++++ 8.0-16.0	+++[1] 12.0-16.0	–	+++ 8.0-12.0	–	–	12 h 14 d
Lambda-Cy (fl oz)	–	–	++++ 2.56-5.12	+++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	24 h 21 d
Leverage 360 (fl oz)	++++ 2.4-2.8	–	+++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	12 h 7 d
Movento (fl oz)	++++ 6.0-9.0	+++ 6.0-9.0	–	–	–	–	–	–	–	–	24 h 7 d
Mustang Maxx (fl oz)	+++ 1.28-4.0	–	+ 1.28-4.0	+++ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	+ 1.28-4.0	+ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	12 h 14 d
Rimon 0.83EC (fl oz)	–	–	++++[1] 20.0-30.0	–	++++ 20.0-30.0	++++ 20.0-30.0	–	++++ 20.0-30.0	–	–	12 h 14 d
Sivanto Prime (fl oz)	++++ 10.5-14.0	–	–	–	–	–	–	–	–	–	4 h 14 d
Tombstone (fl oz)	–	–	++++ 2.0-2.4	++ 2.4-2.8	++++ 2.4-2.8	++ 2.0-2.4	++ 2.4-2.8	++++ 2.0-2.4	++++ 2.0-2.4	+++ 1.4-2.0	12 h 7 d
Verdepryn 100SL (fl oz)	–	–	++++ 5.5-11.0	+++ 5.5-11.0	++++ 5.5-11.0	++++ 5.5-11.0	++ 5.5-11.0	+++ 5.5-11.0	+ 5.5-11.0	+++ 5.5-11.0	4 h 7 d
Voliam Flexi WG (oz)	++++ 6.0-7.0	–	++++ 4.0-7.0	–	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	+++ 4.0-7.0	+++ 6.0-7.0	++++ 4.0-7.0	12 h 35 d
Warrior II[2] (fl oz)	–	–	++++ 1.28-2.56	+++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	+++ 1.28-2.56	24 h 21 d

[1] Special timing: Apply Rimon at 75-100 Degree Days (DD) after bio-fix (usually late petal-fall); Apply Intrepid at 150 DD; Typical timing for most other products is 250 Degree Days (DD) after bio-fix (see first cover). [2] When noted, generic products are available. [3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [5] 35 day PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A. [6] For best results, apply with at least 1 gal of horticultural oil/A within 10 days of petal-fall. Other silicone-based penetrants may be substituted but may not be as effective. [7] Control of Spotted Tentiform Leafminer with Avaunt goes to"+++" with the addition of 0.5% spray oil. [8] Efficacy is better for first brood. [9] Imidan REI 4 d for farm labor, but 14 d for u-pick operations.

FIRST COVER							APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rot**	**Cedar Apple Rust**	**Fire Blight[1]**	**Powdery Mildew**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**						**REI PHI**
BACTERICIDES							
Agri-Mycin 17WP[1] (oz)	–	–	–	–	+++ 24.0-48.0	–	12 h 30 d
Agri-Mycin 17WP[1] (oz) plus Glycerin (qt)	–	–	–	–	+++ 12.0-24.0 plus 4.0	–	12 h 30 d
Agri-Mycin 17WP[1] (oz) plus Regulaid (oz)	–	–	–	–	+++ 12.0-24.0 plus 8.0	–	12 h 30 d
Mycoshield 17WP[1] (oz)	–	–	–	–	+++ 16.0	–	12 h 60 d
PROTECTANT FUNGICIDES[5]							
Captan 80WDG (lb)	+++ 2.5-5.0	+++ 2.5-5.0	+++ 2.5-5.0	++ 2.5-5.0	–	+ 2.5-5.0	24 h 0 d
Ferbam 76WDG[6] (lb)	++ 4.0-6.0	+++ 3.0-8.0	++ 3.0-8.0	+++ 3.0-8.0	–	–	24 h 7 d
Mancozeb 75DF[7] (lb)	+++ 3.0	+++ 3.0	++ 3.0	+++ 3.0	–	–	24 h 77 d
Polyram 80DF[7] (lb)	+++ 3.0	+++ 3.0	++ 3.0	+++ 3.0	–	–	24 h 77 d
Ziram 76DF (lb)	++ 3.0-6.0	++ 3.0-6.0	– 3.0-6.0	++ 3.0-6.0	–	+ 3.0-6.0	48 h 14 d
RESISTANT RISK FUNGICIDES							
Aprovia 0.83EC (fl oz)	++++ 5.5-7.0	++ 5.5-7.0	+++ 5.5-7.0	–	–	++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	+ 3.0-5.0	–	++++ 3.0-5.0	–	++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-2.9	++ 2.9	++ 1.5[8]	+ 2.5-2.9	–	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	+++ 16.0-20.0	++ 16.0-20.0	++ 16.0-20.0	–	–	++ 16.0-20.0	12 h 28 d
Indar 2F (fl oz)	++++ 6.0-8.0	–	–	++++ 6.0-8.0	–	+++ 6.0-8.0	12 h 14 d
Inspire Super 2.82EW (fl oz)	++++ 12.0	++ 12.0	+++ 12.0	++++ 12.0	–	+++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ 4.0-5.8	++++ 4.0-5.8	+++ 4.0-5.8	–	+++ 5.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	++ 11.2-16.0	+++ 11.2-16.0	+++ 11.2-16.0	+++ 11.2-16.0	–	++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	++++ 4.0-5.5	+++ 4.0-5.5	++++ 4.0-5.5	+++ 4.0-5.5	–	+++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	++++ 3.4	+ 3.4	–	–	–	++ 3.4	4 h 30 d
Omega 4.17F (fl oz)	++ 10-13.8	++ 10-13.8	++ 10-13.8	+++ 10-13.8	–	–	12 h 28 d
Pristine 38WG (oz)	+++ 14.5-18.5	+++ 14.5-18.5	++++ 14.5-18.5	+++ 14.5-18.5	–	+++ 14.5-18.5	12 h 0 d
Procure 50WS (oz)	++++ 8.0-16.0	–	–	++++ 8.0-16.0	–	++++ 8.0-16.0	12 h 14 d
ProPhyt[9] (pt)	+++ 3.0-4.0	+ 3.0-4.0	+++ 3.0-4.0	–	–	+ 3.0-4.0	4 h 0 d

First Cover DISEASE Resistant Risk Fungicides- continued on next page

First Cover DISEASE Resistant Risk Fungicides - continued

FIRST COVER							APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rot**	**Cedar Apple Rust**	**Fire Blight[1]**	**Powdery Mildew**	
RESISTANT RISK FUNGICIDES							
Rally 40WSP (oz)	++++ 4.0-6.0	–	–	++++ 4.0-6.0	–	++++ 4.0-6.0	24 h 14 d
Scala 5SC (fl oz)	+++ 7.0-10.0	–	–	–	–	++ 7.0-10.0	12 h 72 d
Sercadis 2.47SC (fl oz)	+++ 3.5-4.5	+ 3.5-4.5	–	–	–	++ 3.5-4.5	12 h 0 d
Sovran 50WG (oz)	++++ 5.0-6.0	++ 5.0-6.0	+++ 5.0-6.0	++ 5.0-6.0	–	+++ 5.0-6.0	12 h 30 d
Topguard (fl oz)	++++ 13.0	–	–	++++ 8.0-12.0	–	++++ 8.0-12.0	12 h 14 d
Topsin M WSB (lb)	++++ 0.75-1.0	–	+++ 0.75-1.0	–	–	+++ 0.75-1.0	48 h 1 day
Vangard 75WG (oz)	+++ 3.0-5.0	–	–	–	–	++ 3.0-5.0	12 h 0 d
Vintage 1SC (fl oz)	++++ 8.0-12.0	–	–	++++ 8.0-12.0	–	++++ 8.0-12.0	24 h 30 d

[1] If disease pressure is high, spray after petal fall at 10-14 day intervals to control twig blight. Continue alternating active ingredients for resistance management through second cover. FireLine 17WP can be substituted for Mycoshield at similar rates; both contain oxytetracycline. FireWall 17WP or Streptrol 17WP can be substituted for Agri-Mycin 17WP at similar rates; all contain streptomycin.

[2] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. Use full rate listed under fruit rots if using in combination.

[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Generic products and/or alternate formulations available.

[6] Do not apply Ferbam for late cover sprays, residues may affect finish.

[7] EBDC fungicides can only be used with extended schedule (half rate).

[8] Tank mix with Captan, see label.

[9] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

FIRST COVER INSECT PESTS: See First through Second Covers Insects

FIRST THROUGH SECOND COVERS See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover. **APPLES**

NOTE: Plum Curculio occurs mostly in Petal Fall through First and Second Covers.
Apple Maggot occurs mostly in Third through Seventh Covers.

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Codling Moth	Leaf-rollers	Oriental Fruit Moth	Plum Curculio	San Jose Scale	Spotted Tentiform Leafminer	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Apple Leaf-hopper	
Product and Formulation[1]	Product Efficacy Rating[2] and Rate/A[3]											REI PHI
Actara 25WG[4] (oz)	++++ 4.5-5.5	–	–	–	–	+++ 4.5-5.5	–	+++ 4.5-5.5	+++ 5.5	+++ 5.5	++++ 2.0-2.75	12 h 14/35 d[4]
Admire Pro-foliar (fl oz)	++++ 1.4-2.8	–	–	–	–	–	+++ 2.8	++++ 2.8	+++ 2.8	–	++++ 1.4-2.8	12 h 7 d
Admire Pro-soil (fl oz)	+++ 7.0-10.5	++ 7.0-10.5	–	–	–	–	–	–	–	–	++++ 7.0-10.5	12 h 21 d
Agri-Flex (fl oz)	++++ 5.5-8.5	++++ 5.5-8.5	–	++ 5.5-8.5	–	–	+++ 5.5-8.5	–	–	+++ 5.5-8.5	+++ 5.5-8.5	12 h 35 d
Agri-Mek SC[1,5] (fl oz)	–	–	–	–	–	–	–	++++ 2.25-4.5	–	–	+++ 2.25-4.5	12 h 28 d
Altacor (oz)	–	–	++++ 2.5-4.5	++++ 2.5-4.5	++++ 2.5-4.5	+ 2.5-4.5	–	++++ 2.5-4.0	–	–	–	4 h 5 d
Apta/Bexar (fl oz)	++++ 17.0-21.0	–	–	++ 21.0-27.0	–	+++ 21.0-27.0	–	–	–	–	++++ 14.0-21.0	12 h 14 d
Asana XL[1] (fl oz)	–	–	+++ 4.8-8.0	++++ 4.8-8.0	++++ 4.8-8.0	++ 10.0-14.0	–	++++ 6.0-14.0	++ 14.5	++++ 4.8-8.0	+++ 4.8-8.0	12 h 21 d
Assail 30SG (oz)	++++ 2.5-4.0	–	+++ 5.0-8.0	–	+++ 5.0-8.0	++ 8.0	+++ 8.0	++++ 2.5	++ 8.0	+++ 6.0-8.0	++++ 2.5-4.0	12 h 7 d
Avaunt (oz)	–	–	+++ 5.0-6.0	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	–	+(++)[6] 6.0	+ 6.0	+++ 5.0-6.0	+++ 6.0	12 h 14 d
Bacillus thuringiensis (lb)	–	–	–	–	++++ 0.5-2	–	–	–	–	–	–	4 h 0 d
Baythroid XL (fl oz)	++ 2.4-2.8	–	++++ 2.0-2.4	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	+ 2.4-2.8	++++ 2.0-2.4	+++ 2.4	++++ 2.0-2.4	+++ 1.4-2.0	12 h 7 d
Belay 2.13SC[7] (fl oz)	++++ 4.0-6.0	–	++ 6.0-12.0	+ 6.0-12.0	++ 6.0-12.0	++ 6.0	–	++++ 6.0	++++ 6.0-12.0	–	++++ 6.0	12 h 7 d
Besiege (fl oz)	–	–	++++ 6.0-12	++++ 6.0-12.0	++++ 6.0-12.0	++ 9.0-12.0	–	+++ 9.0-12.0	+++ 9.0-12.0	++++ 6.0-12.0	+++ 9.0-12.0	24 h 21 d
Carpovirusine (fl oz)	–	–	+++ 6.8-13.5	–	–	–	–	–	–	–	–	12 h 0 d
Centaur WDG (oz)	–	–	–	–	–	–	++++ 34.5	–	–	–	–	12 h 14 d

First through Second Covers INSECT PESTS - continued on next page

First through Second Covers INSECT PESTS - continued

FIRST THROUGH SECOND COVERS See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover. **APPLES**

NOTE: Plum Curculio occurs mostly in Petal Fall through First and Second Covers.
Apple Maggot occurs mostly in Third through Seventh Covers.

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Codling Moth	Leaf-rollers	Oriental Fruit Moth	Plum Curculio	San Jose Scale	Spotted Tentiform Leafminer	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Apple Leaf-hopper	REI PHI
Closer SC (fl oz)	++++ 1.5-2.75	–	–	–	–	–	+++ 5.75[11]	–	++ 5.75	++ 2.75-5.75	++++ 1.5-2.75	12 h 7 d
Cormoran (fl oz)	++++ 20.0-28.0	–	++++ 20.0-28.0	++++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	12 h 14 d
Cyd-X (fl oz)	–	–	+++ 1.0-6.0	–	–	–	–	–	–	–	–	4 h 0 d
Danitol 2.4 EC (fl oz)	–	–	+++ 16.0-21.3	++++ 16.0-21.3	++++ 16.0-21.3	++ 16.0-21.3	+ 16.0-21.3	+++ 10.6-21.3	+++ 16-21.3	+++ 10.6-21.3	+++ 10.6-21.3	24 h 14 d
Declare (fl oz)	+ 1.02-2.05	–	+++ 1.02-2.05	++++ 1.02-2.05	++++ 1.02-2.05	++ 1.02-2.05	+ 1.02-2.05	++++ 1.02-2.05	+++ 1.02-2.05	++++ 1.02-2.05	++++ 1.02-2.05	24 h 14 d
Delegate 25WG (oz)	–	–	++++ 4.5-7.0	++++ 4.5-7.0	++++ 4.5-7.0	+ 6.0-7.0	–	++++ 4.5-7.0	+ 4.5-7.0	–	–	4 h 7 d
Diazinon 50W[8] (lb)	–	++++ 2.0-3.0	+++ 2.0-3.0	++ 2.0-3.0	++ 2.0-3.0	+++ 2.0-3.0	+++ 2.0-3.0	+ 2.0-3.0	–	+++ 2.0-3.0	++ 2.0-3.0	96 h 21 d
Endigo ZC (fl oz)	+++ 5.0-6.0	–	+++ 5.0-6.0	–	++++ 5.0-6.0	+++ 5.0-6.0	–	++++ 5.0-6.0	++++ 6.0	++++ 5.0-6.0	++++ 5.0-6.0	24 h 35 d
Entrust SC (fl oz)	–	–	+++ 6.0-10.0	++++ 6.0-10.0	++++ 6.0-10.0	–	–	++ 6.0-10.0	–	–	–	4 h 7 d
Esteem 35WP (oz)	–	–	+++ 4.0-5.0	–	–	–	++++ 4.0-5.0	+++ 3.0-5.0	–	–	–	12 h 45 d
Exirel (fl oz)	–	–	+++ 8.5-17.0	+++ 8.5-17.0	++++ 10.0-17.0	++ 13.5-20.0	–	+++ 8.5-17.0	–	–	+++ 8.5-17.0	12 h 3 d
Imidan 70W (lb)	–	+ 2.5-3.0	++++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	+++ 2.5-3.0	–	+ 2.5-3.0	–	++ 2.5-3.0	–	4/14 d[10] 7 d
Intrepid 2F (fl oz)	–	–	+++[9] 16.0	++++ 8.0-16.0	+++[9] 12.0-16.0	–	–	+++ 8.0-12.0	–	–	–	12 h 14 d
Lambda-Cy (fl oz)	–	–	++++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	–	++++ 2.56-5.12	+++ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	24 h 21 d
Lannate LV (pt)	+++ 2.0-3.0	+ 2.0-3.0	+++ 2.0-3.0	++++ 2.0-3.0	+++ 2.0-3.0	++ 2.0-3.0	–	+++ 2.0-3.0	+++ 3.0	++++ 2.0-3.0	++ 2.0-3.0	72 h 14 d
Lannate SP (lb)	+++ 0.5-1.0	+ 1.0	+++ 1.0	++++ 1.0	+++ 1.0	++ 1.0	–	+++ 1.0	+++ 1.0	++++ 0.5-1.0	++ 1.0	72 h 14 d

First through Second Covers INSECT PESTS - continued on next page

FIRST THROUGH SECOND COVERS **See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.** **APPLES**

NOTE: Plum Curculio occurs mostly in Petal Fall through First and Second Covers.
Apple Maggot occurs mostly in Third through Seventh Covers.

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Codling Moth	Leaf-rollers	Oriental Fruit Moth	Plum Curculio	San Jose Scale	Spotted Tentiform Leafminer	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Apple Leaf-hopper	REI PHI
Leverage 360 (fl oz)	++++ 2.4-2.8	–	+++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)	–	–	++++ 0.5-3.0	–	++++ 0.5-3.0	–	–	–	–	–	–	4 h 0 d
Minecto Pro (fl oz)			+++ 8.0-12.0	–	++++ 8.0-12.0	++ 10.0-12.0	–	+++ 8.0-12.0				12 h 28 d
Movento (fl oz)	++++ 6.0-9.0	+++ 6.0-9.0	–	–	–	–	++++ 8.0-9.0	–	–	–	–	24 h 7 d
Mustang Maxx (fl oz)	+++ 1.28-4.0	–	+ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	+ 1.28-4.0	–	+ 1.28-4.0	+++ 4.0	++++ 1.28-4.0	++++ 1.28-4.0	12 h 14 d
Proaxis (fl oz)	–	–	++++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	+ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	24 h 14 d
Proclaim (oz)	–	–	++ 4.8	++++ 3.2-4.8	++ 4.8	–	–	+++ 3.2-4.8	–	–	–	48 h 14 d
Renounce 20WP (oz)	–	–	++++ 2.5-3.0	++++ 3.0-3.5	++++ 2.5-3.0	++ 3.0-3.5	+ 3.0-3.5	++++ 2.5-3.0	+++ 3.0-3.5	++++ 2.5-3.0	+++ 1.8-2.5	12 h 7 d
Rimon 0.83EC (fl oz)	–	+ 20.0-30.0	++++[9] 20.0-30.0	++++ 20.0-30.0	++++[9] 20.0-30.0	–	–	++++ 20.0-30.0	–	–	–	12 h 14 d
Sivanto Prime (fl oz)	++++ 10.5-14.0	–	–	–	–	–	++++ 10.5-14.0	++++ 10.5-14.0	–	–	++++ 10.5-14.0	4 h 14 d
Tombstone (fl oz)	–	–	++++ 2.0-2.4	++++ 2.4-2.8	++++ 2.0-2.4	++ 2.4-2.8	+ 2.4-2.8	++++ 2.0-2.4	+++ 2.4-2.8	++++ 2.0-2.4	+++ 1.4-2.0	12 h 7 d
Voliam Flexi WG (oz)	++++ 6.0-7.0	–	++++ 4.0-7.0	++++ 4.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	–	+++ 4.0-7.0	+++ 7.0	+++ 6.0-7.0	++++ 4.0-7.0	12 h 35 d
Warrior II[1] (fl oz)	–	–	++++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	–	++++ 1.28-2.56	+++ 1.28-2.56	++++ 1.28-2.56	+++ 1.28-2.56	24 h 21 d

[1] When noted, generic products are available. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] 35 day PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A. [5] For best results, apply with at least 1.0 gal of horticultural oil/A within 10 days of petal-fall. Other silicone-based penetrants may be substituted but may not be as effective. [6] Control of Spotted Tentiform Leafminer with Avaunt goes to"+++" with the addition of 0.5% spray oil. [7] Efficacy is better for first brood. [8] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application. [9] Special timing: Apply Rimon at 75-100 Degree Days (DD) after bio-fix (usually late petal-fall); Apply Intrepid at 150 DD; Typical timing for most other products is 250 Degree Days (DD) after bio-fix. [10] Imidan REI 4 d for farm labor, but 14 d for u-pick operations. [11] Closer SC applied to San Jose Scale crawler stage.

SECOND COVER					APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rot**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
PROTECTANT FUNGICIDES[4]					
Captan 80WDG (lb)	+++ 2.5-5.0	+++ 2.5-5.0	+++ 2.5-5.0		24 h 0 d
Ferbam 76WDG[5] (lb)	++ 4.0-6.0	+++ 3.0-8.0	++ 3.0-8.0		24 h 7 d
Mancozeb 75DF[6] (lb)	+++ 3.0	+++ 3.0	++ 3.0		24 h 77 d
Polyram 80DF[6] (lb)	+++ 3.0	+++ 3.0	++ 3.0		24 h 77 d
Ziram 76DF (lb)	++ 3.0-6.0	++ 3.0-6.0	– 3.0-6.0		48 h 14 d
RESISTANCE RISK FUNGICIDES					
Aprovia 0.83EC (fl oz)	++++ 5.5-7.0	++ 5.5-7.0	+++ 5.5-7.0		12 h 30 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	+ 3.0-5.0	–		12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-2.9	++ 2.9	++ 1.5[7]		12 h 14 d
Fontelis 1.67SC (fl oz)	+++ 16.0-20.0	++ 16.0-20.0	++ 16.0-20.0		12 h 28 d
Indar 2F (fl oz)	++++ 6.0-8.0	–	–		12 h 14 d
Inspire Super 2.82EW (fl oz)	++++ 12.0	++ 12.0	+++ 12.0		12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ 4.0-5.8	++++ 4.0-5.8		12 h 14 d
Luna Tranquility 4.16SC (fl oz)	++ 11.2-16.0	+++ 11.2-16.0	+++ 11.2-16.0		12 h 72 d
Merivon 4.18SC (fl oz)	++++ 4.0-5.5	+++ 4.0-5.5	++++ 4.0-5.5		12 h 0 d
Miravis 1.67SC (fl oz)	++++ 3.4	+ 3.4	–		4 h 30 d
Omega 4.17F (fl oz)	++ 10-13.8	++ 10-13.8	++ 10-13.8		12 h 28 d
Pristine 38WG (oz)	+++ 14.5-18.5	+++ 14.5-18.5	++++ 14.5-18.5		12 h 0 d
Procure 50WS (oz)	++++ 8.0-16.0	–	–		12 h 14 d
ProPhyt[8] (pt)	+++ 3.0-4.0	+ 3.0-4.0	+++ 3.0-4.0		4 h 0 d
Rally 40WSP (oz)	+++ 4.0-6.0	–	–		24 h 14 d
Scala 5SC (fl oz)	+++ 7.0-10.0	–	–		12 h 72 d
Sercadis 2.47SC (fl oz)	+++ 3.5-4.5	+ 3.5-4.5	–		12 h 0 d
Sovran 50WG (oz)	++++ 5.0-6.0	++ 5.0-6.0	+++ 5.0-6.0		12 h 30 d
Topguard (fl oz)	++++ 13.0	–	–		12 h 14 d
Topsin M WSB (lb)	++++ 0.75-1.0	–	+++ 0.75-1.0		48 h 1 d

Second Cover DISEASE - continued on next page

Second Cover DISEASE - continued

SECOND COVER					APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rot**		
RESISTANCE RISK FUNGICIDES[4]					
Vangard 75WG (oz)	+++ 3.0-5.0	–	–		12 h 0 d
Vintage 1SC (fl oz)	++++ 6.0-12.0	–	–		24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. Use full rate listed under fruit rots if using in combination. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available. [5] Do not apply Ferbam for late cover sprays, residues may affect finish. [6] EBDC fungicides can only be used with extended schedule (half rate). [7] Tank mix with Captan, see label.). [8] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

SECOND COVER INSECT PESTS: See First through Second Covers Insects

THIRD AND FOURTH COVERS					APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rots**	**Sooty Blotch and Flyspeck**	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
PROTECTANT FUNGICIDES[4]					
Captan 80WDG[5] (lb)	+++ 2.5-5.0	+++ 2.5-5.0	+++ 2.5-5.0	+++ / ++ 2.5-5.0	24 h 0 d
Ferbam 76WDG[6] (lb)	++ 3.0-8.0	+++ 3.0-8.0	++ 3.0-8.0	++ 3.0-8.0	24 h 7 d
Mancozeb 75DF[7] (lb)	+++ 3.0	+++ 3.0	++ 3.0	++ 3.0	24 h 77 d
Polyram 80DF[7] (lb)	+++ 3.0	+++ 3.0	++ 3.0	++ 3.0	24 h 77 d
Ziram 76DF[5] (lb)	++ 3.0-6.0	++ 3.0-6.0	– 3.0-6.0	+++ / ++ 3.0-6.0	48 h 14 d
RESISTANCE RISK FUNGICIDES					
Aprovia 0.83EC (fl oz)	++++ 5.5-7.0	++ 5.5-7.0	+++ 5.5-7.0	+++ / ++++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	+ 3.0-5.0	–	++++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-2.9	++ 2.9	++ 1.5[8]	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	+++ 16.0-20.0	++ 16.0-20.0	++ 16.0-20.0	+ / - 16.0-20.0	12 h 28 d
Inspire Super 2.82EW (fl oz)	++++ 12.0	++ 12.0	+++ 12.0	++++ / ++++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ 4.0-5.8	++++ 4.0-5.8	+++ / ++++ 4.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	++ 11.2-16.0	+++ 11.2-16.0	+++ 11.2-16.0	++ / ++++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	++++ 4.0-5.5	+++ 4.0-5.5	++++ 4.0-5.5	++++ / ++++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	++++ 3.4	+ 3.4	–	–	4 h 30 d

Third and Fourth Covers DISEASE - continued on next page

Third and Fourth Covers DISEASE - continued

THIRD AND FOURTH COVERS					APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rots**	**Sooty Blotch and Flyspeck**	
RESISTANCE RISK FUNGICIDES					
Omega 4.17F (fl oz)	++ 10-13.8	++ 10-13.8	++ 10-13.8	+++ / ++++ 10-13.8	12 h 28 d
Pristine 38WG (oz)	+++ 14.5-18.5	+++ 14.5-18.5	++++ 14.5-18.5	++ / ++ 14.5-18.5	12 h 0 d
Procure 50WS (oz)	++++ 8.0-16.0	–	–	–	12 h 14 d
ProPhyt[9] (pt)	+++ 3.0-4.0	+ 3.0-4.0	+++ 3.0-4.0	+++ / ++ 3.0-4.0	4 h 0 d
Rally 40WSP (oz)	+++ 1.25-2.0	–	–	–	24 h 14 d
Scala 5SC (fl oz)	+++ 7.0-10.0	–	–	–	12 h 72 d
Sercadis 2.47SC (fl oz)	+++ 3.5-4.5	+ 3.5-4.5	–	+++ / +++ 3.5-4.5	12 h 0 d
Sovran 50WG (oz)	++++ 5.0-6.0	++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	12 h 30 d
Topguard (fl oz)	++++ 13.0	–	–	–	12 h 14 d
Topsin M WSB (lb)	++++ 0.75-1.0	–	+++ 0.75-1.0	++++ 0.75-1.0	48 h 1 d
Vangard 75WG (oz)	+++ 3.0-5.0	–	–	–	12 h 0 d
Vintage 1SC (fl oz)	++++ 8.0-12.0	–	–	–	24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. Use full rate listed under fruit rots and Brook's Spot if using in combination. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available. [5] Can usually be applied at reduced rates during the summer. [6] Do not apply Ferbam for late cover sprays, residues may affect finish. [7] EBDC fungicides can only be used with extended schedule (half rate). [8] Tank mix with Captan, see label.). [9] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

THIRD AND FOURTH COVERS INSECT PESTS: See Third through Seventh Covers Insects

FIFTH, SIXTH, AND SEVENTH COVERS					APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rots**	**Sooty Blotch and Flyspeck**	
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
PROTECTANT FUNGICIDES					
Captan 80WDG[4,5] (lb)	+++ 2.5-5.0	+++ 2.5-5.0	+++ 2.5-5.0	+++ / ++ 2.5-5.0	24 h 0 d
Ferbam 76WDG[6] (lb)	+ 3.0-8.0	+++ 3.0-8.0	++ 3.0-8.0	++ 3.0-8.0	24 h 7 d
Ziram 76DF[5] (lb)	++ 3.0-6.0	++ 3.0-6.0	– 3.0-6.0	+++ / ++ 3.0-6.0	48 h 14 d
RESISTANCE RISK FUNGICIDES					
Aprovia 0.83EC (fl oz)	++++ 5.5-7.0	++ 5.5-7.0	+++ 5.5-7.0	+++ / ++++ 5.5-7.0	12 h 30 d

Fifth, Sixth, and Seventh Covers DISEASE Resistance Risk Fungicides - continued on next page

Fifth, Sixth, and Seventh Covers DISEASE Resistance Risk Fungicides - continued

FIFTH, SIXTH, AND SEVENTH COVERS					APPLES
DISEASE	**Apple Scab**	**Bitter Rot**	**Black and White Rots**	**Sooty Blotch and Flyspeck**	
RESISTANCE RISK FUNGICIDES					
Cevya 3.34SC (fl oz)	++++ 3.0-5.0	+ 3.0-5.0	–	++++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	++++ 2.5-2.9	++ 2.9	++ 1.5[8]	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	+++ 16.0-20.0	++ 16.0-20.0	++ 16.0-20.0	+ / - 16.0-20.0	12 h 28 d
Inspire Super 2.82EW (fl oz)	++++ 12.0	++ 12.0	+++ 12.0	++++ / ++++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ 4.0-5.8	++++ 4.0-5.8	+++ / ++++ 4.0-5.8	12 h 14 d
Merivon 4.18SC (fl oz)	++++ 4.0-5.5	+++ 4.0-5.5	++++ 4.0-5.5	++++ / ++++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	++++ 3.4	+ 3.4	–	–	4 h 30 d
Omega 4.17F (fl oz)	++ 10-13.8	++ 13.8	++ 13.8	+++ / ++++ 10-13.8	12 h 28 d
Pristine 38WG (oz)	+++ 14.5-18.5	+++ 14.5-18.5	++++ 14.5-18.5	++ / ++ 14.5-18.5	12 h 0 d
Procure 50WS (oz)	++++ 8.0-16.0	–	–	–	12 h 14 d
ProPhyt[9] (pt)	+++ 3.0-4.0	+ 3.0-4.0	+++ 3.0-4.0	+++ / ++ 3.0-4.0	4 h 0 d
Rally 40WSP (oz)	++++ 1.25-2.0	–	–	–	24 h 14 d
Scala 5SC (fl oz)	+++ 7.0-10.0	–	–	–	12 h 72 d
Sercadis 2.47SC (fl oz)	+++ 3.5-4.5	+ 3.5-4.5	–	+++ / +++ 3.5-4.5	12 h 0 d
Sovran 50WG (oz)	++++ 5.0-6.0	++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	12 h 30 d
Topguard (fl oz)	++++ 13.0	–	–	–	12 h 14 d
Topsin M WSB (lb)	++++ 0.75-1.0	–	+++ 0.75-1.0	++++ 0.75-1.0	48 h 1 d
Vangard 75WG (oz)	+++ 3.0-5.0	–	–	–	12 h 0 d
Vintage 1SC (fl oz)	++++ 8.0-12.0	–	–	–	24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. Use full rate listed under fruit rots and Brook's Spot if using in combination. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] Generic products and/or alternate formulations available.). [5] Can usually be applied at reduced rates during the summer. [6] Do not apply Ferbam for late cover sprays, residues may affect finish. [7] EBDC fungicides can only be used with extended schedule (half rate). [8] Tank mix with Captan, see label. [9] Other available phosponate materials are Aliette, Phostrol, Rampart, etc…

FIFTH, SIXTH, AND SEVENTH COVERS INSECT PESTS: See Third through Seventh Covers Insects

THIRD THROUGH SEVENTH COVERS See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover. **APPLES**

NOTE: Plum Curculio occurs mostly in Petal Fall through First and Second Covers.
Apple Maggot occurs mostly in Third through Seventh Covers.

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Apple Maggot	Codling Moth	Leaf-rollers	Oriental Fruit Moth	San Jose Scale	Spotted Tentiform Leafminer	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Apple Leaf-hopper	
Product and Formulation[1]	Product Efficacy Rating[2] and Rate/A[3]											REI PHI
Actara 25WG[4] (oz)	++++ 4.5-5.5	–	–	–	–	–	–	+++ 4.5-5.5	+++ 5.5	+++ 5.5	++++ 2.0-2.75	12 h 14/35 d[4]
Admire Pro - foliar (fl oz)	++++ 1.4-2.8	–	–	–	–	–	+++ 2.8	++++ 2.8	+++ 2.8	–	++++ 1.4-2.8	12 h 7 d
Admire Pro-soil (fl oz)	+++ 7.0-10.5	++ 7.0-10.5	–	–	–	–	–	–	–	–	++++ 7.0-10.5	12 h 21 d
Agri-Flex (fl oz)	++++ 5.5-8.5	++++ 5.5-8.5	–	–	++ 5.5-8.5	–	+++ 5.5-8.5	–	–	+++ 5.5-8.5	+++ 5.5-8.5	12 h 35 d
Agri-Mek SC[1,5] (fl oz)	–	–	–	–	–	–	–	++++ 2.25-4.5	–	–	+++ 2.25-4.5	12 h 28 d
Altacor (oz)	–	–	+ 2.5-4.5	++++ 2.5-4.5	++++ 2.5-4.5	++++ 2.5-4.5	–	++++ 2.5-4.0	–	–	–	4 h 5 d
Apta/Bexar (fl oz)	++++ 17.0-21.0	–	+++ 21.0-27.0	–	++ 21.0-27.0	–	–	–	–	–	++++ 14.0-21.0	12 h 14 d
Asana XL[1] (fl oz)	–	–	+++ 10.0-14.0	+++ 4.8-8.0	++++ 4.8-8.0	++++ 4.8-8.0	–	++++ 6.0-14.0	++ 14.5	++++ 4.8-8.0	+++ 4.8-8.0	12 h 21 d
Assail 30SG (oz)	++++ 2.5-4.0	–	++++ 8.0	+++ 5.0-8.0	–	+++ 5.0-8.0	+++ 8.0	++++ 2.5	++ 8.0	+++ 6.0-8.0	++++ 2.5-4.0	12 h 7 d
Avaunt (oz)	–	–	++ 6.0	+++ 5.0-6.0	+++ 5.0-6.0	+++ 5.0-6.0	–	+(++)[6] 6.0	+ 6.0	+++ 5.0-6.0	+++ 6.0	12 h 14 d
Bacillus thuringiensis (lb)	–	–	–	–	–	++++ 0.5-2	–	–	–	–	–	4 h 0 d
Baythroid XL (fl oz)	++ 2.4-2.8	–	++++ 2.4-2.8	++++ 2.0-2.4	++++ 2.4-2.8	++++ 2.0-2.4	+ 2.4-2.8	++++ 2.0-2.4	+++ 2.4	++++ 2.0-2.4	+++ 1.4-2.0	12 h 7 d
Belay 2.13SC[7] (fl oz)	++++ 4.0-6.0	–	+++ 6.0	++ 6.0-12.0	+ 6.0-12.0	++ 6.0-12.0	–	++++ 6.0	++++ 6.0-12.0	–	++++ 6.0	12 h 7 d
Besiege (fl oz)	–	–	+++ 9.0-12.0	++++ 6.0-12	++++ 6.0-12.0	++++ 6.0-12.0	–	+++ 9.0-12.0	+++ 9.0-12.0	++++ 6.0-12.0	+++ 9.0-12.0	24 h 21 d
Carpovirusine (fl oz)	–	–	–	+++ 6.8-13.5	–	–	–	–	–	–	–	12 h 0 d
Centaur WDG (oz)	–	–	–	–	–	–	++++ 34.5	–	–	–	–	12 h 14 d

Third through Seventh Covers INSECT PESTS - continued on next page

THIRD THROUGH SEVENTH COVERS **See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.** **APPLES**

NOTE: Plum Curculio occurs mostly in Petal Fall through First and Second Covers.
Apple Maggot occurs mostly in Third through Seventh Covers.

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Apple Maggot	Codling Moth	Leaf-rollers	Oriental Fruit Moth	San Jose Scale	Spotted Tentiform Leafminer	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Apple Leaf-hopper	REI PHI
Closer SC (fl oz)	++++ 1.5-2.75	–	–	–	–	–	+++ 5.75[11]	–	++ 5.75	++ 2.75-5.75	++++ 1.5-2.75	12 h 7 d
Cormoran (fl oz)	++++ 20.0-28.0	–	++ 20.0-28.0	++++ 20.0-28.0	++++ 20.0-28.0	++++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	++ 20.0-28.0	+++ 20.0-28.0	++++ 20.0-28.0	12 h 14 d
Cyd-X (fl oz)	–	–	–	+++ 1.0-6.0	–	–	–	–	–	–	–	4 h 0 d
Danitol 2.4 EC (fl oz)	–	–	++++ 16.0-21.3	+++ 16.0-21.3	++++ 16.0-21.3	++++ 16.0-21.3	+ 16.0-21.3	+++ 10.6-21.3	+++ 16-21.3	+++ 10.6-21.3	+++ 10.6-21.3	24 h 14 d
Declare (fl oz)	+ 1.02-2.05	–	++++ 1.02-2.05	+++ 1.02-2.05	++++ 1.02-2.05	++++ 1.02-2.05	+ 1.02-2.05	++++ 1.02-2.05	+++ 1.02-2.05	++++ 1.02-2.05	++++ 1.02-2.05	24 h 14 d
Delegate 25WG (oz)	–	–	++ 6.0-7.0	++++ 4.5-7.0	++++ 4.5-7.0	++++ 4.5-7.0	–	++++ 4.5-7.0	+ 4.5-7.0	–	–	4 h 7 d
Diazinon 50W[8] (lb)	–	++++ 2.0-3.0	+++ 2.0-3.0	+++ 2.0-3.0	++ 2.0-3.0	++ 2.0-3.0	+++ 2.0-3.0	+ 2.0-3.0	–	+++ 2.0-3.0	++ 2.0-3.0	96 h 21 d
Endigo ZC (fl oz)	+++ 5.0-6.0	–	+++ 5.0-6.0	+++ 5.0-6.0	–	++++ 5.0-6.0	–	++++ 5.0-6.0	++++ 6.0	++++ 5.0-6.0	++++ 5.0-6.0	24 h 35 d
Entrust SC (fl oz)	–	–	++ 6.0-10.0	+++ 6.0-10.0	++++ 6.0-10.0	++++ 6.0-10.0	–	++ 6.0-10.0	–	–	–	4 h 7 d
Esteem 35WP (oz)	–	–	–	+++ 4.0-5.0	–	–	++++ 4.0-5.0	+++ 3.0-5.0	–	–	–	12 h 45 d
Exirel (fl oz)	–	–	++ 13.5-20.0	+++ 8.5-17.0	+++ 8.5-17.0	++++ 10.0-17.0	–	+++ 8.5-17.0	–	–	+++ 8.5-17.0	12 h 3 d
Imidan 70W[10] (lb)	–	+ 2.5-3.0	++++ 2.5-3.0	++++ 2.5-3.0	+++ 2.5-3.0	++++ 2.5-3.0	–	+ 2.5-3.0	–	++ 2.5-3.0	–	4/14 d 7 d
Intrepid 2F (fl oz)	–	–	–	+++[9] 16.0	++++ 8.0-16.0	+++[9] 12.0-16.0	–	+++ 8.0-12.0	–	–	–	12 h 14 d
Lambda-Cy (fl oz)	–	–	+++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	–	++++ 2.56-5.12	+++ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	24 h 21 d
Lannate LV (pt)	+++ 2.0-3.0	+ 2.0-3.0	+ 2.0-3.0	+++ 2.0-3.0	++++ 2.0-3.0	+++ 2.0-3.0	–	+++ 2.0-3.0	+++ 3.0	++++ 2.0-3.0	++ 2.0-3.0	72 h 14 d
Lannate SP (lb)	+++ 0.5-1.0	+ 1.0	+ 1.0	+++ 1.0	++++ 1.0	+++ 1.0	–	+++ 1.0	+++ 1.0	++++ 0.5-1.0	++ 1.0	72 h 14 d

Third through Seventh Covers INSECT PESTS - continued on next page

Third through Seventh Covers INSECT PESTS - continued

THIRD THROUGH SEVENTH COVERS **See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.** **APPLES**

NOTE: Plum Curculio occurs mostly in Petal Fall through First and Second Covers.
Apple Maggot occurs mostly in Third through Seventh Covers.

INSECT PEST	Apple Aphid	Woolly Apple Aphid	Apple Maggot	Codling Moth	Leaf-rollers	Oriental Fruit Moth	San Jose Scale	Spotted Tentiform Leafminer	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	White Apple Leaf-hopper	REI PHI
Leverage 360 (fl oz)	++++ 2.4-2.8	–	+++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	++++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)	–	–	–	++++ 0.5-3.0	–	+++ + 0.5-3.0	–	–	–	–	–	4 h 0 d
Minecto Pro (fl oz)			S 10.0-12.0	+++ 8.0-12.0	-	++++ 8.0-12.0	–	+++ 8.0-12.0	–	–	–	12 h 28 d
Movento (fl oz)	++++ 6.0-9.0	+++ 6.0-9.0	–	–	–	–	++++ 8.0-9.0	–	–	–	–	24 h 7 d
Mustang Maxx (fl oz)	+++ 1.28-4.0	–	–	+ 1.28-4.0	++++ 1.28-4.0	++++ 1.28-4.0	–	+ 1.28-4.0	+++ 4.0	++++ 1.28-4.0	++++ 1.28-4.0	12 h 14 d
Proaxis (fl oz)	–	–	++++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	++++ 2.56-5.12	+ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	24 h 14 d
Proclaim (oz)	–	–	–	++ 4.8	++++ 3.2-4.8	++ 4.8	–	+++ 3.2-4.8	–	–	–	48 h 14 d
Renounce 20WP (oz)	–	–	++++ 3.0-3.5	++++ 2.5-3.0	++++ 3.0-3.5	++++ 2.5-3.0	+ 3.0-3.5	++++ 2.5-3.0	+++ 3.0-3.5	++++ 2.5-3.0	+++ 1.8-2.5	12 h 7 d
Rimon 0.83EC (fl oz)	–	+ 20.0-30.0	–	++++[9] 20.0-30.0	++++ 20.0-30.0	++++[9] 20.0-30.0	–	++++ 20.0-30.0	–	–	–	12 h 14 d
Sivanto Prime (fl oz)	++++ 10.5-14.0	–	–	–	–	–	++++ 10.5-14.0	++++ 10.5-14.0	–	–	++++ 10.5-14.0	4 h 14 d
Tombstone (fl oz)	–	–	++++ 2.4-2.8	++++ 2.0-2.4	++++ 2.4-2.8	++++ 2.0-2.4	+ 2.4-2.8	++++ 2.0-2.4	+++ 2.4-2.8	++++ 2.0-2.4	+++ 1.4-2.0	12 h 7 d
Voliam Flexi WG (oz)	++++ 6.0-7.0	–	–	++++ 4.0-7.0	++++ 4.0-7.0	++++ 4.0-7.0	–	+++ 4.0-7.0	+++ 7.0	+++ 6.0-7.0	++++ 4.0-7.0	12 h 35 d
Warrior II[1] (fl oz)	–	–	+++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	++++ 1.28-2.56	–	++++ 1.28-2.56	+++ 1.28-2.56	++++ 1.28-2.56	+++ 1.28-2.56	24 h 21 d

[1] When noted, generic products are available. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] 35 day PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A. [5] For best results, apply with at least 1.0 gal of horticultural oil/A within 10 days of petal-fall. Other silicone-based penetrants may be substituted but may not be as effective. [6] Control of Spotted Tentiform Leafminer with Avaunt goes to"+++" with the addition of 0.5% spray oil. [7] Efficacy is better for first brood. [8] Only 2 applications allowed per year: 1) A maximum of one may be a dormant application, and 2) A maximum of one may be an in season foliar application. [9] Special timing: Apply Rimon at 75-100 Degree Days (DD) after bio-fix (usually late petal-fall); Apply Intrepid at 150 DD; Typical timing for most other products is 250 Degree Days (DD) after bio-fix. [10] Imidan REI 4 d for farm labor, but 14 d for u-pick operations. [11] Closer SC applied to San Jose Scale crawler stage.

MITICIDES FOR POSTBLOOM USE					APPLES
MITE PEST	**Apple Rust Mite**	**European Red Mite**	**Two-Spotted Spider Mite**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**			**IRAC Class**	**REI PHI**
Acramite 50WS[4] (lb)	–	++++ 0.75-1.0	++++ 0.75-1.0	20D	12 h 7 d
Agri-Flex[8] (fl oz) plus Adjuvant[6]	++ 5.5-8.5	++++ 5.5-8.5	++++ 5.5-8.5	6+4A	12 h 35 d
Agri-Mek 0.15EC[5] (fl oz) plus Adjuvant[6]	++ 2.25-4.25	++++ 2.25-4.25	++++ 2.25-4.25	6	12 h 28 d
Apollo SC[7] (fl oz)	–	++++ 2.0-8.0	++++ 2.0-8.0	10A	12 h 10 d
Danitol 2.4EC (fl oz)	+++ 16.0-21.3	+++ 16.0-21.3	+++ 16.0-21.3	3	24 h 14 d
Envidor 2SC (fl oz)	++++ 16.0-18.0	++++ 16.0-18.0	++++ 16.0-18.0	23	12 h 7 d
Fujimite/Portal 5EC[5] (pt)	++ 1.0-2.0	++++ 1.0-2.0	++++ 1.0-2.0	21A	12 h 14 d
Kanemite 15SC (oz)	++++ 21.0-31.0	++++ 21.0-31.0	++++ 21.0-31.0	20B	12 h 14 d
Nealta	–	++++	++++	25	12 h
(fl oz)		13.7	13.7		7 d
Nexter 75WP[9] (oz)	++++ 5.2-10.67	++++ 4.4-5.2	+++ 6.6-10.67	21A	12 h 25 d
Onager EC (oz)	–	++++ 12-24	++++ 12-24	10A	12 h 28 d
Portal 5EC[2] (pt)	++ 2.0	++++ 1.0-2.0	++++ 1.0-2.0	21A	12 h 14 d
Savey 50DF[7,10] (oz)	–	++++ 3.0-6.0	++++ 3.0-6.0	10A	12 h 28 d
Vendex 50WP (lb)	+++ 1.0-2.0	+++ 1.0-2.0	+++ 1.0-2.0	12B	48 h 14 d
Vydate 2L (pt)	+ 2.0-4.0	+ 2.0-4.0	+ 2.0-4.0	1A	48 h 14 d
Zeal (oz)	–	++++ 2.0-3.0	++++ 2.0-3.0	10B	12 h 14 d

[1] Do not use the same miticide "back-to-back"; rotate with a miticide having a different mode-of-action.
[2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Acramite requires spray water to be corrected for pH and hardness. See label.
[5] When noted, generic products are available.
[6] Apply while leaves are still tender, between petal-fall and first cover. For best results, use a minimum of 1.0 gal oil/A. Other silicone-based penetrants may be substituted, but efficacy may not be as good as adding oil.
[7] Do not rotate Apollo and Savey with each other.
[8] Agri-Flex is a pre-mix of Thiamethoxam (Actara) and Abamectin (Agri-Mek). Apply Agri-Flex at 1.5-2.0 oz/100 dilute, or 5.5-8.5 oz/100 for concentrate sprays. Dilute rate based on 400 GPA. See product label.
[9] Dicofol is the generic Kelthane. See label: Use lower rates of Dicifol for trees less than 10 ft.; higher rates for larger trees.
[10] Use low rate for European Red Mite; higher rates for Two-Spotted Spider Mite.

11 Pears

11.1 European Pears

Pear Cultivars

The bacterial disease fire blight may be a serious problem during some growing seasons. Control measures include dormant copper sprays, antibiotic sprays and the planting of resistant cultivars. The best fire blight-resistant cultivars, in order of ripening, include 'Harrow Delight', 'Potomac', 'Harvest Queen', 'Moonglo', and 'Honeysweet'. They are recommended for commercial planting.

Other cultivars, not resistant to fire blight but popular in wholesale marketing channels, include 'Bartlett', 'Bosc', and 'D'Anjou'. Some nurseries have mutations and selections of 'Bosc' with a brighter and more complete cinnamon-russet color, *e.g.*, 'Bronze Beauty', 'Golden Russet' and 'Noble Russet'. These cultivars may be more desirable than 'Bosc'. Red-skinned mutations of 'Bartlett' and 'D'Anjou' are also available from many fruit tree nurseries. Trees of these red mutations are generally not as vigorous and are more susceptible to low winter temperatures than standard-colored 'Bartlett' and 'D'Anjou'. Red 'Bartlett' cultivars lose their color rapidly when exposed to temperatures above 90°F. They also slowly revert to the standard cultivar when trees are maintained in a vigorous condition. These cultivars are recommended to commercial growers willing to take the exacting steps to control fire blight.

Other fire blight-susceptible cultivars, with excellent dessert quality, recommended for commercial trial plantings are 'Aurora', 'Highland', and 'Seckel'. 'Clapp's Favorite' is an old cultivar with excellent flavor that is early but does not store. 'Red Clapp's', 'Kalle', or 'Starkrimson' is a red mutation that is red color stable and attractive, but very susceptible to fire blight. Contact your local agricultural agent for more information on pears.

Pear Rootstocks

Most fruiting European pear trees sold in the eastern United States are propagated on French domestic seedling rootstocks. These stocks are grown from seed extracted from 'Bartlett' pears by western canneries, or from 'Winter Nelis'. French domestic, or 'Winter Nelis' and 'Bartlett' seedling rootstocks are generally less sensitive to wet and poorly drained soils than any other fruit tree rootstocks, except seedlings of the low-temperature-sensitive *Pyrus betulaefolia* pear. French domestic, or 'Bartlett' seedlings, are fire blight-susceptible and reasonably tolerant to low winter temperatures. *Pyrus betulaefolia* seedlings are tolerant to wet and poorly drained soils, and with most pear cultivars, will produce more vigorous trees. French domestic, 'Winter Nelis', and 'Bartlett' seedling rootstocks have performed well in New Jersey.

Some commercial fruit tree nurseries offer various quince rootstocks. Most pear cultivars on quince rootstock are full dwarf or very dwarf trees. Quince rootstocks are very poorly anchored, sensitive to low winter temperatures, fire blight-susceptible and incompatible with 'Bartlett', 'Bosc', 'Seckel' and 'D'Anjou' cultivars. **Quince rootstocks are not recommended in commercial plantings.**

Pyrus calleryana seedling rootstocks are generally used on Ornamental pears in New Jersey. They are vigorous and produce sturdy, long-lived, winter-hardy, well-anchored trees. *Pyrus calleryana* seedlings are resistant to fire blight. They are compatible with fruiting pear cultivars but are more sensitive to low, winter temperatures in the late fall and early winter because they acclimate slowly.

Various 'Old Home' x 'Farmingdale' (OH X F) clonal pear rootstocks are grown from cuttings and are offered by a few commercial nurseries. OH X F87 and OH X F97 have vigor similar to French domestic, or 'Winter Nelis' and 'Bartlett' seedlings. OH X F87 is more precocious and slightly smaller than OH X F97. OH X F40 has replaced OH X F51 as the most dwarfing stock to be planted. Most of the OH x F rootstocks are tolerant or resistant to fire blight. These rootstocks are recommended.

Pyrodwarf®, a very precocious and dwarf rootstock of *Pyrus communis* from Germany, has looked very good in Pacific Northwest orchards where OH X F51 is too small and lacks production. European cultivars on Pyrodwarf® are suggested for trial plantings because of their early bearing and smaller tree size.

Pear Pollination

European pears require honeybees for adequate pollination. Because pears have so little sugar in their nectar, honeybees prefer to visit other flowers. Therefore, it is especially important to eliminate dandelions, mustard, and other competing flowers from the vicinity of pear orchards. Growers should supply two to three colonies of bees for each acre of pears. For general comments on honeybee pollination, see the section Apple Pollination.

All recommended pear cultivars require cross-pollination. Some cultivars like 'Honeysweet' and 'Seckel' are considered self-fruitful, but set better crops with cross-pollination. Red 'Bartlett' cultivars will not pollinate 'Bartlett'. Red 'D'Anjou' cultivars will not pollinate 'D'Anjou'. 'Russet Bosc' will not pollinate 'Bosc'. 'Red Clapp's will not pollinate 'Clapp's Favorite'. Asian pear cultivars will not pollinate any of the recommended European cultivars.

Plant Growth Regulators for pears

European pear trees can frequently set more fruit than the tree can size and mature. If too many fruit set and stay on the tree, they may be small and have lower sugar levels. Pear wood is brittle, and with over-cropping, limbs may break. Over-cropping also reduces vigor and flower bud differentiation for next year's crop.

Thinning research and experiences in this guide are limited to the eastern United States. The use of materials at rates recommended in other parts of the country is not supported by Eastern data.

Like apples, vigorous trees are more difficult to thin, and weak-growing trees thin more easily. The optimal temperature for applying chemical thinners to pears is 70 to 80°F (similar to apples), when temperatures are expected to remain in that range for 3 to 4 days. Other environmental conditions may also affect consistency of thinners on pears. Please refer to the following tables that summarize the use of plant growth regulators in pears for fruit thinning, managing harvest and fruit quality, and branching.

Table 11.1 Plant Growth Regulators for Pear Fruit Thinning

Spray Timing	Chemical Name	Trade Name	Rate per 100 gal dilute TRV[1]	Special Considerations
Petal fall through 5 to 7 days after petal fall	Naphthalene acetamide	Amid-Thin® W	1.6-8 oz (10-50 ppm)	Labeled on Bartlett and Bosc
14 to 21 days after full bloom	Naphthaleneacetic Acid-Sodium	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	4-6 oz (10-15 ppm)	Labeled for use on Bartlett, Bosc, and Comice. Apply as soon as fruit set is apparent.
8-14 mm fruit size (7-28 days after bloom)	6-Benzyladenine	MaxCel®, RiteWay®	80-128 fl oz (75-200 ppm)	Recommended rate on Bartlett is 150 ppm and Bosc 75 ppm. Recommended rate on Hosui and Kosui Asian pears is 200 ppm.
		Exilis® Plus	46-122 fl oz (75-200 ppm)	
		Exilis® 9.5 SC	9.6-25.6 fl oz (75-200 ppm)	

[1]Tree Row Volume Gallonage (TRV)= (Tree Height X Tree Width X 43,560 X 0.7) / (Between Row Spacing X 1,000).

Table 11.2 Plant Growth Regulators for Pear Harvest Management and Fruit Quality

Spray Timing	Chemical Name	Trade Name	Concentration	Rate	Special Considerations
7- 14 days before anticipated harvest	Aminoethoxyvinylglycine Hydrochloride	ReTain®	–	1 pouch per acre	–
5-7 days before harvest	Naphthaleneacetic Acid-Sodium	Fruitone®-N, Fruitone®-L, PoMaxa®, Refine™ 3.5 WSG, Refine® 3.5L	10-15 ppm	4-6 oz per 100 gal	Apply 7 days before harvest to D'Anjou, Bosc, and Bartlett.
Apply 3-21 days prior to anticipated harvest	1-Methylcyclopropene	Harvista™[1]	–	48-242 fl oz/A, but no more than 242 fl oz/crop	–

[1] Harvista requires a specialized sprayer, or custom application by Agrofresh- contact your Agrofresh sales representative for more information.

Table 11.3 Plant Growth Regulators for Pear Branching

Spray Timing	Chemical Name	Trade Name	Concentration
Apply to 1 year old wood prior to budbreak	6-Benzyladenine	MaxCel®, Exilis® Plus, Exilis® 9.5 SC	5,000 ppm, see label for rate
	6-Benzyladenine plus Gibberellic Acid (4+7)	Promalin®, Typy®	
Apply to 1 year old wood after budbreak	6-Benzyladenine	MaxCel®, Exilis® Plus, Exilis® 9.5 SC	500 ppm, see label for rate
	6-Benzyladenine plus Gibberellic Acid (4+7)	Promalin®, Typy®	

11.2 Asian Pears

Cultivated Asian pears were developed from the species *Pyrus ussuriensis* and *Pyrus pyrifolia*. Most of our cultivars have not been subjected to low winter temperatures, so care should be taken to plant on sites with good air drainage and a low temperature history.

Asian Pear Cultivars

There are many Asian pear cultivars; some that may do very well in New Jersey. The following cultivars have been grown and tested in southern New Jersey. **The cultivars are listed in order of ripening**.

'Hosui'. The fruit is large, 3¼ to 3½ inches in diameter, and globular. Ripening in early to mid-August, the fruit has a cinnamon bronzed russet skin. The flesh is coarse, white and juicy. The flavor is very pleasing, with excellent quality. This cultivar has a medium storage life of about three months. The tree is vigorous, spreading, precocious and productive on *Pyrus betulaefolia* rootstock. It is susceptible to fire blight.

'Yoinashi'. The fruit is large, about 3¼ to 3½ inches in diameter, globular, with a light bronze skin. It ripens in early September with smooth, fine-grained, off-white flesh that is juicy and sweet, with a very good quality. It is a good keeper and handles well. The tree is upright to spreading, precocious and heavy bearing on *Pyrus betulaefolia* rootstock. This cultivar is susceptible to fire blight.

'Niitaka'. This fruit is medium sized, about 2½ to 3 inches in diameter, and globular in southern New Jersey. The fruit has an attractive bronze russet skin. Ripening in mid-September to early October, the flesh is coarse, juicy and mildly sweet, with fair to good quality. It is a good keeper and handles well. The tree is more upright and moderately vigorous on *Pyrus betulaefolia* rootstock. This cultivar is moderately susceptible to fire blight. Pollen is sterile, and therefore, not suitable as a pollinizer and will not pollinize other cultivars.

'Shin Li'. This fruit is large to very large, about 3½ to 4 inches in diameter, and globular in southern New Jersey. It ripens about a week before 'Shinko'. The fruit is green to green-yellow, with heavy lenticels and some russeting. The flesh is white, crispy, juicy and of excellent flavor and quality. It handles and keeps well. The tree is precocious, heavy bearing, moderately vigorous, and upright in growth habit. This cultivar is susceptible to fire blight, although it has not been observed to be a problem in southern New Jersey.

'Seuri'. The fruit is large and globular, with a yellow-green color overlaid with streaks of russeting and prominent lenticels. It ripens just before 'Shinko'. The flesh is coarse, crisp, and aromatic, with a mild, sweet flavor of excellent quality. The tree is moderately precocious, heavy bearing and upright in growth habit. This cultivar is moderately tolerant of fire blight. In New Jersey, this cultivar will bloom very early.

'Shinko'. This fruit is large to very large, 3¼ to 4 inches in diameter, with a rich bronze russeted skin. It ripens in early to mid-October in southern New Jersey. The flesh is coarse, juicy, very sweet and aromatic, and of excellent quality. The fruit hangs and keeps very well. The tree is early bearing, productive and grows upright and vigorously on most rootstocks. This is one of the most fire blight tolerant cultivars.

'Korean Giant'. (Ar Ri Rang) Also known as 'Olympic' in commercial nursery catalogs. This late maturing cultivar looks and grows very much like 'Shinko', but is larger. The flesh is coarse, juicy, sweet, and of excellent quality if left on the tree to mature. It has one of the best flavors in our taste tests. It also has excellent storage life.

The cultivars **'Chojuro', 'Tsi Li'** and **'Ya Li'** have been tested in southern New Jersey but are not suggested for planting. The following cultivars are available for planting, but have not been tested. They are listed in order of ripening: '**Ichiban''Nashi', 'Kosui', 'Seigyoko', 'Kikusui', 'Daisui Li'** and **'Okusankichi'**.

Asian Pear Rootstocks

Asian pears are grown on *Pyrus communis* rootstocks throughout the southeast, with some young plantings in New Jersey. Most of these rootstocks, as described earlier, are grown from seeds of 'Winter Nelis', 'Bartlett' and others. These rootstocks are not recommended for Asian pears in New Jersey because they are susceptible to fire blight and do not grow well with some Asian pear cultivars.

A number of clonal selections of 'Old Home' x 'Farmingdale' are available from nurseries. Only the most vigorous cultivars are recommended on OH x F40, and only with irrigation. The vigorous OH x F clones are recommended where the soil is well drained and early winter, low temperatures may be a problem. The OH x F clones do not do well in heavy or poorly drained soils. Some of the commercial plantings in southern New Jersey are on *Pyrus betulaefolia* seedling rootstocks. As mentioned previously, these rootstocks are widely compatible with Asian pears and tolerate wet or poorly drained soils. Trees on this rootstock are also deep rooted on sandy soils and tolerate drought.

Most Asian pears are also graft-compatible with *Pyrus calleryana* seedlings. These stocks are adapted to a wide range of soils. *Pyrus calleryana*, *Pyrus betulaefolia*, and the OH x F clones are all tolerant of fire blight. P. calleryana and *P. betulaefolia* can render cultivars more susceptible to early low winter temperatures.

Asian Pear Pollination

Cross-pollination is recommended for commercial orchardists. Any two cultivars with overlapping bloom periods will be cross compatible, although some cultivars produce more compatible pollen. Asian pears are not generally compatible with *Pyrus communis* cultivars. The placement of pollinizers should be similar to apple orchards, with at least one pollinizer per 8 trees to pollinate. Note that trees to pollinate should not be more than two trees or rows from the pollinizer. 'Hosui', 'Shinseiki' and 'Twentieth Century' are the best pollinizers because they bloom during the middle of the bloom period and are compatible with other cultivars. Much more must be learned about compatibility.

Asian Pear Fruit Thinning

This cultural practice is a must, because many Asian pear cultivars have a tendency to set up heavily and require thinning to get the good fruit size that the market demands. Fruit set can be as high as twelve pears per fruit spur, or 3-6 per flower cluster. Fruit should be thinned, as early as possible, to one per cluster. Recommendations for the thinning of European pears DO NOT hold up for Asian pears. Hand thinning of fruit should be started after bloom and completed by 6 weeks after bloom.

MaxCel at 200 ppm has been successful in providing some chemical thinning in 'Hosui' pears. It should be applied between 10-15 mm average fruit diameter during a warming trend. MaxCel plant growth regulator can provide up to 50% of the thinning needed and increase fruit size. Follow-up hand thinning may have to be undertaken to get the desired spacing, which will affect fruit shape and size. MaxCel has not been evaluated on all Asian pear cultivars. Follow the label directions and precautions.

The maximum label rate of 200 ppm for pears should be used for Asian Pears. MaxCel should not be applied at temperatures of 80°F or warmer or if 80°F temperatures are forecast for the 3 days following application or over thinning may occur. See: *https://www.sare.org/wp-content/uploads/Cost-Effective-Asian-Pear-Thinning-for-Productivity-and-Fruit-Quality.pdf*

Asian Pear Pest Problems

A pear spray schedule, similar to the schedule listed for European pears, should be followed. However, some of the problems experienced with European pears are not seen at the same levels on certain varieties of Asian pears.

Bacterial Blossom Blast. The pathogen that causes this disease, *Pseudomonas syringae*, does not cause the blossom blast phase in New Jersey. However, the bacterium can infect spurs and branches. Cankers may result from low temperature injury and bark cracking during late fall. Avoid late fertilization or cultural practices that will reduce acclimation to winter temperature. Infected cankers should be pruned out of wood.

Codling Moth. This has been reported to be a problem in Maryland and Oregon. We have not seen codling moth on Asian pears in southern New Jersey.

Fabraea Leaf Spot. This has been observed in plantings of 'Korean Giant' and 'Shinko'. In periods of heavy pressure, follow the pear guidelines for leaf spot.

Fire Blight. Most Asian pear cultivars are susceptible and should be sprayed, particularly in periods of heavy pressure. The relative susceptibility or resistance is listed under each cultivar description (see above).

Pear Psylla. Many Asian pear cultivars are resistant to pear psylla. However, pear psylla has been observed in Asian pear blocks in southern New Jersey. If the pears are planted near blocks of *Pyrus communis*, follow the pear spray guidelines.

Phytophthora Root Rot. Asian pears are susceptible to crown and root rot and should be planted on a raised berm or row to improve soil drainage.

San Jose Scale. This has been observed in Asian pear orchards in New Jersey. Follow the oil spray guidelines.

11.3 Pear Pest Management

See also Table 10.11
Efficacy of Fungicides and Bactericides for Apple and Pear Disease Control

Abbreviations			
Pome Fruit Preharvest Interval Key		**Units of Measurement**	
D	Dormant application only	/A	per acre
DD	Delayed dormant application only	d	day(s)
TC	No later than tight cluster	fl oz	fluid ounce(s)
P	No later than pink	gal	gallon(s)
PB	No later than prebloom	h	hour(s)
FB	No later than full bloom	lb	pound(s)
PF	No later than petal-fall	oz	ounce(s)
NTL	No time limit (usually up to the day of harvest) - consult label	pt	pint(s)
		qt	quart(s)
NA	Not applicable		

DORMANT					PEARS
DISEASE	**Fire Blight**				
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Bordeaux mixture (lb/100 gal)	++ 8, 8				24 h D
Champ Formula 2.79F[4] (gal)	++ 0.66-1.33				24 h D
Cuprofix Ultra 40DF[4] (lb)	++ 7.5-10.0				24 h D
Kocide 3000 30DF[4] (lb)	++ 5.25-7.0				24 h D
Nu-Cop 50DF (lb)	++ 8.0-16.0				24 h D

[1] Copper materials cause injury if applied beyond half-inch green. Kocide, Champ, Nu-Cop are copper hydroxide products; Cuprofix is basic copper sulfate.
[2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Generic products and/or alternate formulations available.

DORMANT					PEARS
INSECT OR MITE PEST	**INSECTS**		**MITES**		
	Pear Psylla	**Scale**	**European Red Mite**		
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**				**REI PHI**
Superior Oil[3] (gal)	++++ 6.0	++++ 6.0	++++ 6.0		4 h 0 d

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] Oil inhibits pear psylla egg laying. Good coverage is essential.

DELAYED DORMANT					PEARS
INSECT OR MITE PEST	**INSECTS**		**MITES**		
	Pear Psylla	**Scale Insects**	**European Red Mite**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Superior Oil (gal)[4]	++++ 4.0-6.0	++++ 4.0-6.0	++++ 4.0-6.0		4 h 0 d
PLUS ONE OF THE FOLLOWING:					
Agri-Flex (fl oz)	++++ 5.5-8.5	–	++++ 5.5-8.5		12 h 35 d
Ambush 25W[1] (oz)	+++ 13.0-25.0	–	–		12 h PB[7]
Asana XL[1] (fl oz)	+++ 12.0-16.0	–	–		12 h 28 d
Assail 30SG (oz)	+++ 4.0-8.0	–	–		12 h 7 d
Besiege (fl oz)	+++ 6.0-12.0	–	–		24 h 21 d
Delegate 25WG (oz)	+++ 6.0-7.0	–			4 h 7 d
Esteem 35WP (oz)	+++[5] 4.0-5.0	++++ 4.0-5.0	–		12 h 45 d
Gladiator (fl oz)	++++ 19	–	++ 19		12 h 28 d
Lambda-Cy (fl oz)	+++ 2.56-5.12	–	–		24 h 21 d
Minecto Pro (fl oz)	++++ 8.0-12.0	–	++++ 8.0-12.0		12 h 28 d
Perm-UP (fl oz)	+++ 8.0-16.0	–	–		12 h PB[7]
Pounce 3.2EC[1] (oz)	+++ 10.0-14.0	–	–		12 h DD[7]
Surround WP (lb)	+++[6] 50.0	–	–		4 h 0 d
Voliam Flexi (oz)	+++ 7.0	–	–		12 h 35 d
Warrior II[1] (fl oz)	+++ 1.28-2.56	–	–		24 h 21 d

[1] When noted, generic products are available. Only one application of any chlorpyrifos product may be made per year.
[2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[4] Oil inhibits pear psylla egg laying. Good coverage is essential.
[5] Use 5.0 oz application Delayed Dormant through Pink or two applications of 4.0-5.0 oz Delayed Dormant through Petal-Fall
[6] Prebloom: 3 applications 7-10 days apart starting at DD through Green Cluster Bud.
[7] PHI Key: DD= Delayed dormant application only, PB=No later than prebloom

TIGHT CLUSTER BUD THROUGH WHITE BUD TO POPCORN; AFTER BUD SEPARATION BUT BEFORE PETALS SHOW					PEARS
DISEASE	**Fabraea Leaf Spot**	**Pear Scab**	**Powdery Mildew**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
PROTECTANT FUNGICIDES[1]					
Ferbam 76WDG (lb)	–	++ 4.5	–		24 h 7 d
Mancozeb 75DF[4] (lb)	++++ 6.0	+++ 6.0	–		24 h FB[6]
Ziram 76DF (lb)	++++ 6.0	++ 6.0	–		48 h 14 d
RESISTANCE RISK FUNGICIDES[1]					
Aprovia 0.83EC (fl oz)	–	+++ 5.5-7.0	–		12 h 30 d
Cevya 3.34SC (fl oz)	–	++++ 3.0-5.0	++ 3.0-5.0		12 h 0 d
Flint Extra 4.05SC (fl oz)	+++ 2.5-2.9	++++ 2.5-2.9	+++ 2.5-2.9		12 h 14 d
Fontelis 1.67SC (fl oz)	–	+++ 16.0-20.0	++ 16.0-20.0		12 h 28 d
Inspire Super 2.82EW (fl oz)	–	++++ 12.0	+++ 12.0		12 h 14 d
Luna Sensation 4.2SC (fl oz)	–	+++ 4.0-5.8	+++ 5.0-5.8		12 h 14 d
Luna Tranquility 4.16SC (fl oz)	–	++ 11.2-16.0	++ 11.2-16.0		12 h 72 d
Merivon 4.18SC (fl oz)	–	++++ 4.0-5.5	+++ 4.0-5.5		12 h 0 d
Miravis 1.67SC (fl oz)	–	++++ 3.4	++ 3.4		4 h 30 d
Pristine 38WG (oz)	++++ 15.0-18.5	+++ 15.0-18.5	+++ 15.0-18.5		12 h 0 d
Procure 50WS (oz)	–	++++ 8.0-16.0	++++ 8.0-16.0		12 h 14 d
Sovran 50WG (oz)	+++ 5.0-6.0	+++ 5.0-6.0	+++ 4.0-6.0		12 h 30 d
Syllit 3.4F (pt)	+++ 3.0	+++ 1.5-3.0	–		48 h 7 d
Topsin M WSB (lb)	+++ 1.0	+++ 1.0	+++ 1.0		48 h 1 d
Vangard 75WG[5] (oz)	–	+++ 3.0-5.0	++ 3.0-5.0		12 h 0 d
Vintage 1SC (fl oz)	–	++++ 8.0-12.0	++++ 8.0-12.0		24 h 30 d

[1] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination. Generic products and/or alternate formulations available.

[2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[4] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Do not combine or integrate pre-bloom schedule with the extended schedule (mixture of ½ rate of protectant and resistance risk fungicide). Mancozeb products: Dithane, Manzate, and Penncozeb. See label for rates.

[5] Only apply Vangard to pears as a tank-mix combination with another fungicide, typically a protectant fungicide.

[6] PHI Key: FB=No later than full bloom.

WHITE BUD TO POPCORN; AFTER BUD SEPARATION BUT BEFORE PETALS SHOW					PEARS
INSECT PEST	**Pear Psylla**	**Native Stink Bugs**	**Tarnished Plant Bug**		
Product and Formulation[1]	**Product Efficacy Rating[2] and Rate/A[3]**				**REI PHI**
Actara WG[4] (oz)	++++ 4.5-5.5	–	–		12 h 14/35 d
Ambush 25W[1] (oz)	+++ 13.0-25.0	+++ 13.0-25.0	+++ 13.0-25.0		12 h PB[5]
Asana XL[1] (fl oz)	+++ 12.0-16.0	+++ 12.0-16.0	+++ 12.0-16.0		12 h 28 d
Assail 30SG (oz)	+++ 4.0-8.0	+++ 4.0-8.0	+++ 4.0-8.0		12 h 7 d
Beleaf 50SG (oz)	–	+++ 2.0-2.8	++++ 2.0-2.8		12 h 21 d
Besiege (fl oz)	+++ 6.0-12.0	+++ 6.0-12.0	+++ 6.0-12.0		24 h 21 d
Brigade/Bifenthrin 2EC (fl oz)	–	++ 2.6-12.8	++ 2.6-12.8		12 h 14 d
Centaur WDG (oz)	+++ 34.5	–	–		12 h 14 d
Danitol 2.4EC (fl oz)	+++ 16.0-21.0	++++ 16.0-21.0	++++ 16.0-21.0		24 h 14 d
Delegate 25WG (oz)	++++ 6.0-7.0	–	–		4 h 7 d
Endigo ZC (fl oz)	++ 5.0-6.0	++++ 5.0-6.0	++++ 5.0-6.0		24 h 35 d
Lambda-Cy (fl oz)	+++ 2.56-5.12	+++ 2.56-5.12	+++ 2.56-5.12		24 h 21 d
Perm-UP 3.2EC (fl oz)	+++ 8.0-16.0	+++ 8.0-16.0	+++ 8.0-16.0		12 h PB[5]
Pounce 3.2EC[1] (oz)	+++ 10.0-14.0	+++ 10.0-14.0	+++ 10.0-14.0		12 h DD[5]
Sivanto Prime (fl oz)	+++ 10.5-14.0	–	–		4 h 14 d
Voliam Flexi (oz)	+++ 7.0	+++ 6.0-7.0	+++ 6.0-7.0		12 h 35 d
Warrior II[1] (fl oz)	+++ 1.28-2.56	+++ 1.28-2.56	+++ 1.28-2.56		24 h 21 d

[1] When noted, generic products are available. [2] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated. [3] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval. [4] 35 day PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A.

[5] PHI Key: DD= Delayed dormant application only, PB=No later than prebloom

BLOOM					PEARS
DISEASE	**Fabraea Leaf Spot**	**Fire Blight[1]**	**Pear Scab**	**Powdery Mildew**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
BACTERICIDES					
Agri-Mycin 17WP[5] (oz)	–	+++ 24.0-48.0	–	–	12 h 30 d
Agri-Mycin 17WP[5] (oz) plus Glycerin (qt)	–	+++ 12.0-24.0 plus 4.0	–	–	12 h 30 d
Agri-Mycin 17WP[5] (oz) plus Regulaid (oz)	–	+++ 12.0-24.0 plus 8.0	–	–	12 h 30 d
Kasumin 2L (fl oz)	–	+++ 64	–	–	12 h PF[7]
Mycoshield 17WP[5] (oz)	–	+++ 16.0	–	–	12 h 60 d
PROTECTANT FUNGICIDES[2]					
Ferbam 76WDG (lb)	–	–	++ 4.5	–	24 h 7 d
Mancozeb 75DF[1,8] (lb)	++++ 6.0	–	+++ 6.0	–	24 h FB[7]
Ziram 76DF (lb)	++++ 6.0	–	++ 6.0	+ 6.0	48 h 14 d
RESISTANCE RISK FUNGICIDES[2]					
Aprovia 0.83EC (fl oz)	–	–	++++ 5.5-7.0	++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	–	–	++++ 3.0-5.0	++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	+++ 2.5-2.9	–	++++ 2.5-2.9	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	–	–	+++ 16.0-20.0	++ 16.0-20.0	12 h 28 d
Inspire Super 2.82EW (fl oz)	–	–	++++ 12.0	+++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	–	–	+++ 4.0-5.8	+++ 5.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	–	–	++ 11.2-16.0	++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	–	–	++++ 4.0-5.5	+++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	–	–	++++ 3.4	++ 3.4	4 h 30 d
Pristine 38WG (oz)	++++ 15.0-18.5	–	+++ 15.0-18.5	+++ 15.0-18.5	12 h 0 d
Procure 50WS (oz)	–	–	++++ 8.0-16.0	++++ 8.0-16.0	12 h 14 d
Sovran 50WG (oz)	+++ 5.0-6.0	–	+++ 5.0-6.0	+++ 4.0-6.0	12 h 30 d
Syllit 3.4F (pt)	+++ 3.0	–	+++ 1.5-3.0	–	48 h 7 d
Topsin M WSB (lb)	+++ 1.0	–	+++ 1.0	+++ 1.0	48 h 1 d
Vangard 75WG[6] (oz)	–	–	+++ 3.0-5.0	++ 3.0-5.0	12 h 0 d
Vintage 1SC (fl oz)	–	–	++++ 8.0-12.0	++++ 8.0-12.0	24 h 30 d

*Bloom DISEASE **footnotes** - see next page*

Bloom DISEASE footnotes

[1] Apply sprays for fire blight when first blossoms open; repeat sprays at 3-7 day intervals during bloom. Use dilute, complete sprays for thorough coverage. Alternate Argri-mycin with Mycoshield for resistance management. Some Asian pears are sensitive to Mycoshield or FireLine and may show injury. FireLine 17WP can be substituted for Mycoshield at similar rates; both contain oxytetracycline. FireWall 17WP or Streptrol 17WP can be substituted for Agri-Mycin 17WP at similar rates; all contain streptomycin.

[2] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination.

[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Generic products and/or alternate formulations available.

[6] Only apply Vangard to pears as a tank-mix combination with another fungicide, typically a protectant fungicide.

[7] PHI Key: FB=No later than full bloom; PF= No later than petal fall

[8] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Do not combine or integrate pre-bloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide). Mancozeb products: Dithane, Manzate, and Pencozeb. See label for rates.)

BLOOM	PEARS
INSECT PEST	**Do not apply insecticides during bloom!**

PETAL FALL					PEARS
DISEASE	**Fabraea Leaf Spot**	**Fire Blight[1]**	**Pear Scab**	**Powdery Mildew**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**				**REI PHI**
BACTERICIDES					
Agri-Mycin 17WP[5] (oz)	–	+++ 24.0-48.0	–	–	12 h 30 d
Agri-Mycin 17WP[5] (oz) plus Glycerin (qt)	–	+++ 12.0-24.0 plus 4.0	–	–	12 h 30 d
Agri-Mycin 17WP[5] (oz) plus Regulaid (oz)	–	+++ 12.0-24.0 plus 8.0	–	–	12 h 30 d
Kasumin 2L (fl oz)	–	+++ 64	–	–	12 h PF[7]
Mycoshield 17WP[5] (oz)	–	+++ 16.0	–	–	12 h 60 d
PROTECTANT FUNGICIDES[2]					
Ferbam 76WDG (lb)	–	–	++ 4.5	–	24 h 7 d
Mancozeb 75DF[1,8] (lb)	++++ 6.0	–	+++ 6.0	–	24 h FB[7]
Ziram 76DF (lb)	++++ 6.0	–	++ 6.0	+ 6.0	48 h 14 d
RESISTANCE RISK FUNGICIDES[2]					
Aprovia 0.83EC (fl oz)	–	–	++++ 5.5-7.0	++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	–	–	++++ 3.0-5.0	++ 3.0-5.0	12 h 0 d
Flint Extra 4.05SC (fl oz)	+++ 2.5-2.9	–	++++ 2.5-2.9	+++ 2.5-2.9	12 h 14 d
Fontelis 1.67SC (fl oz)	–	–	+++ 16.0-20.0	++ 16.0-20.0	12 h 28 d
Inspire Super 2.82EW (fl oz)	–	–	++++ 12.0	+++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	–	–	+++ 4.0-5.8	+++ 5.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	–	–	++ 11.2-16.0	++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	–	–	++++ 4.0-5.5	+++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	–	–	++++ 3.4	++ 3.4	4 h 30 d
Pristine 38WG (oz)	++++ 15.0-18.5	–	+++ 15.0-18.5	+++ 15.0-18.5	12 h 0 d
Procure 50WS (oz)	–	–	++++ 8.0-16.0	++++ 8.0-16.0	12 h 14 d
Sovran 50WG (oz)	+++ 5.0-6.0	–	+++ 5.0-6.0	+++ 4.0-6.0	12 h 30 d
Syllit 3.4F (pt)	+++ 3.0	–	+++ 1.5-3.0	–	48 h 7 d
Topsin M WSB (lb)	+++ 1.0	–	+++ 1.0	+++ 1.0	48 h 1 d
Vangard 75WG[6] (oz)	–	–	+++ 3.0-5.0	++ 3.0-5.0	12 h 0 d
Vintage 1SC (fl oz)	–	–	++++ 8.0-12.0	++++ 8.0-12.0	24 h 30 d

*Petal Fall DISEASE **footnotes** - see next page*

Petal Fall DISEASE footnotes

[1] Apply sprays for fire blight when first blossoms open; repeat sprays at 3-7 day intervals during bloom. Use dilute, complete sprays for thorough coverage. Alternate Argri-mycin with Mycoshield for resistance management. Some Asian pears are sensitive to Mycoshield or FireLine and may show injury. FireLine 17WP can be substituted for Mycoshield at similar rates; both contain oxytetracycline. FireWall 17WP or Streptrol 17WP can be substituted for Agri-Mycin 17WP at similar rates; all contain streptomycin.

[2] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination.

[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Generic products and/or alternate formulations available.

[6] Only apply Vangard to pears as a tank-mix combination with another fungicide, typically a protectant fungicide.

[7] PHI Key: FB=No later than full bloom; PF= No later than petal fall

[8] EBDC fungicides: Prebloom schedule allows applications at full rate through bloom. Do not combine or integrate pre-bloom schedule with the extended schedule (mixture of 1/2 rate of protectant and resistance risk fungicide). Mancozeb products: Dithane, Manzate, and Pencozeb. See label for rates.)

PETAL FALL **See also table: Miticides for Postbloom Use.** **PEARS**
Avoid killing bees on blooming ground cover.

INSECT PEST	Aphids	Codling Moth	Mealy-bug	Pear Psylla	Plum Curculio	San Jose Scale	
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**						**REI PHI**
Actara WG[3] (oz)	++++ 4.5-5.5	–	++++ 4.5-5.5	++++ 5.5	+++ 4.5-5.5	–	12 h 14/35 d[3]
Admire Pro - foliar[4] (fl oz)	++++ 1.4-2.8	–	++++ 1.4-2.8	+++ 1.4-2.8	–	++ 1.4-2.8	12 h 7 d
Agri-Flex (fl oz)	++++ 5.5-8.5	–	–	++++ 5.5-8.5	+++ 5.5-8.5	–	12 h 35 d
Altacor (oz)	–	++++ 2.5-4.5	–	–	+ 2.5-4.5	–	4 h 5 d
Assail 30SG (oz)	++++ 2.5-4.0	+++ 4.0-8.0	++++ 4.0-8.0	+++ 4.0-8.0	+++ 8.0	+++ 8.0	12 h 7 d
Avaunt (oz)	–	+++ 5.0-6.0	–	–	++++ 5.0-6.0	–	12 h 28 d
Baythroid XL (fl oz)	–	++++ 2.0-2.4	–	–	++ 2.4-2.8	+ 2.4-2.8	12 h 7 d
Belay 2.13SC (fl oz)	++++ 4.0-6.0	–	–	+++ 6.0-12.0	++ 6.0	–	12 h 7 d
Beleaf 50SG (oz)	+++ 2.0-2.8	–	++++ 2.0-2.8	–	–	–	12 h 21 d
Brigade/Bifenthrin2EC (fl oz)	++ 2.6-12.8	++ 2.6-12.8	–	++ 2.6-12.8	++ 2.6-12.8	+ 2.6-12.8	12 h 14 d
Cormoran (fl oz)	++++ 20.0-28.0	++++ 20.0-28.0	–	+ 20.0-28.0	++ 20.0-28.0	+++ 20.0-28.0	12 h 14 d
Danitol 2.4EC (fl oz)	–	+++ 16.0-21.3	–	++++ 16.0-21.3	++ 16.0-21.3	–	24 h 14 d
Delegate 25WG (oz)	–	++++ 4.5-6.0	–	++++ 6.0-7.0	++ 6.0-7.0	–	4 h 7 d
Endigo ZC (fl oz)	++ 5.0-6.0	+++ 5.0-6.0	+ 5.0-6.0	++ 5.0-6.0	++ 5.0-6.0	++ 5.0-6.0	24 h 35 d
Esteem 35WP (oz)	–	+++[5] 4.0-5.0	–	+++ 4.0-5.0	–	++++ 4.0-5.0	12 h 45 d
Exirel (fl oz)	–	+++ 8.8-17.0	–	+ 13.5-20.5	++ 13.5-20.5	–	12 h 3 d

Petal Fall INSECT PESTS - continued on next page

Petal Fall INSECT PESTS - continued

PETAL FALL See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover.							PEARS
INSECT PEST	**Aphids**	**Codling Moth**	**Mealy-bug**	**Pear Psylla**	**Plum Curculio**	**San Jose Scale**	
Gladiator (fl oz)	+ 19	–	–	++++ 19	++ 19	–	12 h 28 d
Imidan 70W (lb)	–	++++ 3.0	–	–	++++ 3.0	–	7/14 d[7] 7 d
Intrepid 2F (fl oz)	–	+++[5] 16.0	–	–	–	–	4 h 14 d
Lambda-Cy (fl oz)	–	++++ 2.56-5.12	–	++++ 2.56-5.12	++ 2.56-5.12	–	24 h 21 d
Leverage 360 (fl oz)	++++ 2.4-2.8	+++ 2.4-2.8	–	–	++ 2.4-2.8	+++ 2.4-2.8	12 h 7 d
Madex HP (fl oz)		++++ 0.5-3.0					4 h 0 d
Minecto Pro (fl oz)	+ 8.0-12.0	+++ 8.0-12.0	–	++++ 8.0-12.0	++ 8.0-12.0	–	12 h 28 d
M-Pede[6] (1 part product to 50 parts water)	+++ 1 / 50	–	+++ 1 / 50	++++ 1 / 50	–	+++ 1 / 50	12 h 0 d
Movento (fl oz)	++++ 6.0-9.0	–	+++ 6.0-9.0	++++ 6.0-9.0	–	+++ 8.0-9.0	24 h 7 d
Sivanto Prime (fl oz)	++++ 10.5-14.0	–	–	+++ 10.5-14.0	–	+++ 10.5-14.0	4 h 14 d
Versys (fl oz)	++++ 1.5	–	–	–	–	–	12 h 7 d
Warrior II[4] (fl oz)	–	++++ 1.28-2.56	–	++++ 1.28-2.56	++ 1.28-2.56	–	24 h 21 d

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] 35 d PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A.
[4] When noted, generic products are available.
[5] Esteem and Intrepid are ovicides and need to be applied at 75-100 degree-days (about petal-fall) after first codling moth (Biofix).
[6] M-Pede may russet fruit. It has caused phytotoxicity on Asian pear cultivars in southern New Jersey.
[7] Imidan REI 7 d for farm labor, but 14 d for u-pick operations.

COVERS								PEARS
DISEASE	**Bitter Rot**	**S. Blotch / Flyspeck**	**Fabraea Leaf Spot**	**Fire Blight[1]**	**Pear Scab**	**Powdery Mildew**	**Black Rot and White Rot**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**							**REI PHI**
BACTERICIDES								
Agri-Mycin 17WP[5] (oz)	–	–	–	+++ 24.0-48.0	–	–	–	12 h 30 d
Agri-Mycin 17WP[5](oz) plus Glycerin (qt)	–	–	–	+++ 12.0-24.0 plus 4.0	–	–	–	12 h 30 d
Agri-Mycin 17WP[5](oz) plus Regulaid (oz)	–	–	–	+++ 12.0-24.0 plus 8.0	–	–	–	12 h 30 d
PROTECTANT FUNGICIDES[2]								
Ferbam 76WDG[6] (lb)	+++ 4.0-6.0	++ 4.0-6.0	–	–	++ 4.5	–	++ 4.0-6.0	24 h 7 d
Mancozeb 75DF[7] (lb)	+++ 3.0	++ 3.0	++++ 3.0	–	+++ 3.0	–	++ 3.0	24 h 77 d[7]

Covers DISEASE Protectant Fungicides contined on next page

Covers DISEASE Protectant Fungicides continued

COVERS								PEARS
DISEASE	**Bitter Rot**	**S. Blotch / Flyspeck**	**Fabraea Leaf Spot**	**Fire Blight[1]**	**Pear Scab**	**Powdery Mildew**	**Black Rot and White Rot**	
Product and Formulation[2]	**Product Efficacy Rating[3] and Rate/A[4]**							**REI PHI**
PROTECTANT FUNGICIDES[2] - *continued*								
Mycoshield 17WP[5] (oz)	–	–	–	+++ 16.0	–	–	–	12 h 60 d
Ziram 76DF (lb)	++ 6.0	+++ / ++ 6.0	++++ 6.0	–	++ 6.0	+ 6.0	- 6.0	48 h 14 d
RESISTANT RISK FUNGICIDES[2]								
Aprovia 0.83EC (fl oz)	++ 5.5-7.0	+++ / ++++ 5.5-7.0	–	–	++++ 5.5-7.0	++ 5.5-7.0	+++ 5.5-7.0	12 h 30 d
Cevya 3.34SC (fl oz)	+ 3.0-5.0	++++ 3.0-5.0	–	–	++++ 3.0-5.0	++ 3.0-5.0	-	12 h 0 d
Flint Extra 4.05SC (fl oz)	++ 3.0	+++ 2.0-2.5	+++ 2.5-2.9	–	++++ 2.5-2.9	+++ 2.5-2.9	++ 2.0-2.5	12 h 14 d
Fontelis 1.67SC (fl oz)	++ 16.0-20.0	+ / - 16.0-20.0	–	–	+++ 16.0-20.0	++ 16.0-20.0	++ 16.0-20.0	12 h 28 d
Inspire Super 2.82EW (fl oz)	++ 12.0	++++/++++ 12.0	–	–	++++ 12.0	+++ 12.0	+++ 12.0	12 h 14 d
Luna Sensation 4.2SC (fl oz)	+++ 4.0-5.8	+++ / ++++ 4.0-5.8	–	–	+++ 4.0-5.8	+++ 5.0-5.8	++++ 4.0-5.8	12 h 14 d
Luna Tranquility 4.16SC (fl oz)	+++ 11.2-16.0	++ / ++++ 11.2-16.0	–	–	++ 11.2-16.0	++ 11.2-16.0	+++ 11.2-16.0	12 h 72 d
Merivon 4.18SC (fl oz)	+++ 4.0-5.5	++++/++++ 4.0-5.5	–	–	++++ 4.0-5.5	+++ 4.0-5.5	++++ 4.0-5.5	12 h 0 d
Miravis 1.67SC (fl oz)	+ 3.4	–	–	–	++++ 3.4	++ 3.4	–	4 h 30 d
Pristine 38WG (oz)	+++ 15.0-18.5	++ / ++ 15.0-18.5	++++ 15.0-18.5	–	+++ 15.0-18.5	+++ 15.0-18.5	++++ 15.0-18.5	12 h 0 d
Procure 50WS (oz)	–	–	–	–	++++ 8.0-16.0	++++ 8.0-16.0	–	12 h 14 d
Sovran 50WG (oz)	++ 4.0-6.0	++++ 4.0-6.0	+++ 5.0-6.0	–	+++ 5.0-6.0	+++ 4.0-6.0	+++ 4.0-6.0	12 h 30 d
Syllit 3.4F (pt)	–	–	+++ 3.0	–	+++ 1.5-3.0	–	–	48 h 7 d
Topsin M WSB (lb)	–	++++ 1.0	+++ 1.0	–	+++ 1.0	+++ 1.0	+++ 1.0	48 h 1 d
Vangard 75WG[8] (oz)	–	–	–	–	+++ 3.0-5.0	++ 3.0-5.0	–	12 h 0 d
Vintage 1SC (oz)	–	–	–	–	++++ 8.0-12.0	++++ 8.0-12.0	–	24 h 30 d

[1] If disease pressure is high and/or cultivar is highly susceptible, apply antibiotics from petal fall through 2nd cover at 10-14 d intervals to control twig blight. Rotate Argri-mycin, Mycoshield, and Kasumin for resistance management. Some Asian pears are sensitive to Mycoshield or FireLine and may show injury. FireLine 17WP can be substituted for Mycoshield at similar rates; both contain oxytetracycline. FireWall 17WP or Streptrol 17WP can be substituted for Agri-Mycin 17WP at similar rates; all contain streptomycin.

[2] Combine or alternate protectant fungicides and resistance risk fungicides. Use half rate of protectant fungicides when using in combination.

[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.

[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.

[5] Generic products and/or alternate formulations available.

[6] Use of Ferbam on late cover sprays (third cover and beyond) may affect fruit finish on light colored pear cultivars.

[7] When extended schedule is used, Mancozeb can be applied at half rate through second cover. Do not combine pre-bloom schedule with extended schedule.

[8] Only apply Vangard to pears as a tank-mix combination with another fungicide, typically a protectant fungicide.

[9] PHI Key: FB=No later than full bloom; PF= No later than petal fall.

COVERS See also table: Miticides for Postbloom Use. Avoid killing bees on blooming ground cover. **PEARS**

INSECT PEST	Aphids	Codling Moth	Mealy-bug	Oriental Fruit Moth	Pear Psylla	Plum Curculio	Red-banded Leafrollers	San Jose Scale	Brown Marmo rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	
Product and Formulation	**Product Efficacy Rating[1] and Rate/A[2]**										**REI PHI**
Actara WG[3] (oz)	++++ 4.5-5.5	–	++++ 4.5-5.5	–	++++ 5.5	+++ 4.5-5.5	–	–	+++ 5.5	+++ 5.5	12 h 14/35 d[3]
Admire Pro - foliar (fl oz)	++++ 2.8	–	++++ 7.0	–	+++ 7.0	–	–	++ 2.8	+++ 2.8	–	12 h 7 d
Admire Pro - soil (fl oz)	++++ 7.0-10.5	–	–	–	–	–	–	– –	–	–	12 h 21 d
Agri-Flex (fl oz)	++++ 5.5-8.5	–	–	–	++++ 5.5-8.5	+++ 5.5-8.5	–	–	+ 5.5-8.5	+++ 5.5-8.5	12 h 35 d
Altacor (oz)	–	++++ 2.5-4.5	–	++++ 2.5-4.5	–	+ 2.5-4.5	++++ 2.5-4.5	–	–	–	4 h 5 d
Apta/Bexar (fl oz)	++++ 17.0-21.0	–	++ 21.0-27.0	–	+++ 21.0-27.0	+++ 21.0-27.0	++ 21.0-27.0	–	–	–	12 h 14 d
Assail 30SG (oz)	++++ 2.5-4.0	+++ 4.0-8.0	++++ 4.0-8.0	+++ 4.0-8.0	+++ 4.5-5.5	++ 8.0	–	+++ 8.0	++ 8.0	+++ 6.0-8.0	12 h 7 d
Avaunt (oz)	–	+++ 5.0-6.0	–	+++ 5.0-6.0	–	++++ 5.0-6.0	+++ 5.0-6.0	–	+ 6.0	++ 5.0-6.0	12 h 28 d
Baythroid XL (fl oz)	–	++++ 2.0-2.4	–	++++ 2.0-2.4	–	++ 2.4-2.8	++++ 2.4-2.8	+ 2.4-2.8	+++ 2.4	++++ 2.0-2.4	12 h 7 d
Belay 2.13SC (fl oz)	++++ 4.0-6.0	++ 6.0-12.0	–	++ 6.0-12.0	+++ 6.0-12.0	++ 6.0	+ 6.0-12.0	–	++++ 6.0-12.0	–	12 h 7 d
Beleaf 50SG (oz)	+++ 2.0-2.8	–	–	–	–	–	–	–	–	+++ 2.0-2.8	12 h 21 d
Besiege (fl oz)	+ 9.0-12.0	++++ 6.0-12.0	–	++++ 6.0-12.0	++ 9.0-12.0	++ 9.0-12.0	++++ 6.0-12.0	+ 9.0-12.0	+++ 6.0-12.0	+++ 6.0-13.0	24 h 21 d
Brigade/Bifenthrin2EC (fl oz)	++ 2.6-12.8	+++ 2.6-12.8	–	+++ 2.6-12.8	+++ 2.6-12.8	+ 2.6-12.8	+++ 2.6-12.8	+ 2.6-12.8	++++ 12.8	+++ 2.6-12.8	12 h 14 d
Centaur WDG (oz)	–	–	–	–	+++ 34.5	–	–	+++ 34.5	–	–	12 h 14 d
Cormoran (fl oz)	++++ 20.0-28.0	++++ 20.0-28.0	+ 20.0-28.0	++++ 20.0-28.0	+++ 20.0-28.0	++ 20.0-28.0	++++ 20.0-28.0	+++ 20.0-28.0	++ 20.0-28.0	+++ 20.0-28.0	12 h 14 d
Danitol 2.4EC (fl oz)	–	+++ 16.0-21.3	–	+++ 16.0-21.3	++++ 16.0-21.3	++ 16.0-21.3	++++ 16.0-21.3	–	+++ 16.0-21.3	+++ 16.0-21.3	24 h 14 d
Delegate 25WG (oz)	–	++++ 4.5-7.0	–	++++ 4.5-7.0	++++ 6.0-7.0	+ 6.0-7.0	++++ 4.5-7.0	–	+ 4.5-7.0	–	4 h 7 d

Covers INSECT PESTS - continued on next page

Covers INSECT PESTS - continued

INSECT PEST	Aphids	Codling Moth	Mealy-bug	Oriental Fruit Moth	Pear Psylla	Plum Curculio	Red-banded Leafrollers	San Jose Scale	Brown Marmo-rated Stink Bug	Native Stink Bugs, Tarnished Plant Bug	REI PHI
Endigo ZC (fl oz)	++++ 5.0-6.0	+++ 5.0-6.0	+++ 5.0-6.0	++++ 5.0-6.0	++++ 5.0-6.0	+++ 5.0-6.0	–	++ 5.0-6.0	++++ 6.0	+++ 5.0-6.0	24 h 35 d
Entrust SC (fl oz)	–	+ 6.0-8.0	–	+ 8.0	–	–	++++ 4.0-6.0	–	–	–	4 h 7 d
Gladiator (fl oz)	+ 19	–	–	–	++++ 19	++ 19	+++ 19	–	++ 19	–	12 h 28 d
Imidan 70W (lb)	–	++++ 3.0	–	++++ 3.0	–	+++ 3.0	+++ 3.0	+ 3.0	–	++ 3.0	7/14 d[6] 7 d
Intrepid 2F (fl oz)	–	+++ 16.0	–	+++ 16.0	–	–	++++ 10.0	–	–	–	4 h 14 d
Lambda-Cy (fl oz)	–	++++ 2.56-5.12	–	++++ 2.56-5.12	++++ 2.56-5.12	++ 2.56-5.12	++++ 2.56-5.12	–	+++ 2.56-5.12	+++ 2.56-5.12	24 h 21 d
Lannate SP (lb)	+++ 0.5-1.0	+++ 1.0	–	+++ 1.0	++ 1.0	++ 1.0	++++ 1.0	–	+++ 1.0	++++ 1.0	72/96 h 7 d
Leverage 360 (fl oz)	++++ 2.4-2.8	+++ 2.4-2.8	–	+++ 2.4-2.8	+++ 2.4-2.8	++ 2.4-2.8	++++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	+++ 2.4-2.8	12 h 7 d
M-Pede[4] (1 part pro-duct to 50 parts water)	+++ 1 / 50	–	+++ 1 / 50	–	++++ 1 / 50	–	–	+++ 1 / 50	++ 1 / 50	–	12 h 0 d
Madex HP (fl oz)	–	++++ 0.5-3.0	–	++++ 0.5-3.0	–	–	–	–	–	–	4 h 0 d
Minecto Pro (fl oz)	+ 8.0-12.0	+++ 8.0-12.0	–	++++ 8.0-12.0	++++ 8.0-12.0	++ 8.0-12.0	++++ 8.0-12.0	–	–	–	12 h 28 d
Movento (fl oz)	++++ 6.0-9.0	–	+++ 6.0-9.0	–	++++ 6.0-9.0	–	–	++++ 8.0-9.0	–	–	24 h 7 d
Mustang Maxx (fl oz)	++ 1.28-4.0	+++ 1.28-4.0	–	++++ 1.28-4.0	+++ 1.28-4.0	+ 1.28-4.0	++++ 1.28-4.0	–	+++ 4.0	++++ 1.28-4.0	12 h 14 d
Proaxis (fl oz)	++ 2.56-5.12	+++ 2.56-5.12	–	++++ 2.56-5.12	++++ 2.56-5.12	+++ 2.56-5.12	++++ 2.56-5.12	–	++ 2.56-5.12	+++ 2.56-5.12	24 h 21 d
Sivanto Prime (fl oz)	++++ 10.5-14.0	–	–	–	+++ 10.5-14.0	–	–	++ 10.5-14.0	–	–	4 h 14 d
Swagger (fl oz)	++++ 7.6-25.6	+++ 10.2-25.6	–	–	–	+ 10.2-25.6	+++ 7.6-25.6	–	–	+++ 7.6-25.6	12 h 14 d
Voliam Flexi WG (oz)	++++ 6.0-7.0	++++ 4.0-7.0	+++ 6.0-7.0	++++ 4.0-7.0	++++ 7.0	+++ 6.0-7.0	++++ 4.0-7.0	–	+++ 7.0	+++ 6.0-7.0	12 h 35 d
Warrior II[5] (fl oz)	–	++++ 1.28-2.56	–	++++ 1.28-2.56	++++ 1.28-2.56	++ 1.28-2.56	++++ 1.28-2.56	–	+++ 1.28-2.56	+++ 1.28-2.56	24 h 21 d

Covers INSECT PESTS - footnotes on next page

PEARS

Covers INSECT PESTS - footnotes

[1] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[2] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[3] 35 d PHI for use rates greater than 2.75 oz/A; 14 day PHI for rates equal to or less than 2.75 oz/A.
[4] M-Pede may russet fruit. It has caused phytotoxicity on Asian pear cultivars in southern New Jersey.
[5] When noted, generic products are available.
[6] Imidan REI 7 d for farm labor, but 14 d for u-pick operations.

MITICIDES FOR POSTBLOOM USE						PEARS
INSECT OR MITE PEST	**INSECTS**	**MITES**				
	Pear Psylla	**European Red Mite**	**Pear Rust Mite**	**Two-Spotted Spider Mite**		
Product and Formulation[1,2]	**Product Efficacy Rating[3] and Rate/A[4]**				**IRAC Class**	**REI PHI**
Acramite 50WS[5] (lb)	–	++++ 12.0-16.0	–	++++ 12.0-16.0	20D	12 h 7 d
Agri-Flex[8] (fl oz) plus Adjuvant[6]	++++ 5.5-8.5	++++ 5.5-8.5	++++ 5.5-8.5	++++ 5.5-8.5	6 + 4A	12 h 35 d
Agri-Mek SC (fl oz) plus Paraffinic Spray Oil	++++ 2.25-4.25	++++ 2.25-4.25	++++ 2.25-4.25	++++ 2.25-4.25	6	12 h 28 d
Apollo SC[9] (oz)	–	++++ 4.0-8.0	–	++++ 4.0-8.0	10A	12 h 21 d
Envidor (oz)	–	++++ 16.0-18.0	++++ 16.0-18.0	++++ 16.0-18.0	23	12 h 14 d
Kanemite 15SC (oz)	–	++++ 21.0-31.0	–	++++ 21.0-31.0	20B	12 h 14 d
Nealta (fl oz)	–	++++ 13.7	–	++++ 13.7	25	12 h 7 d
Nexter 75WP[7] (oz)	++ 6.6-10.6	++++ 4.4-10.6	++++ 5.2-10.6	+++ 6.6-10.6	21A	12 h 7 d
Onager EC (oz)	–	++++ 12.0-24.0	–	++++ 12.0-24.0	10A	12 h 28 d
Portal XLO[2] (pt)	+++ 2.0	++++ 1.0-2.0	+++ 1.0-2.0	++++ 1.0-2.0	21A	12 h 14 d
Savey 50DF[9] (oz)	–	++++ 3.0-6.0	–	++++ 3.0-6.0	10A	12 h 28 d
Vendex 50WP (lb)	–	+++ 1.0-2.0	++++ 1.0-2.0	+++ 1.0-2.0	12B	48 h 14 d
Vydate 2L[8] (pt)	+ 2.0-3.0	+++ 2.0-3.0	++ 2.0-3.0	+++ 2.0-3.0	1A	48 h 14 d
Zeal (oz)	–	++++ 2.0-3.0	–	++++ 2.0-3.0	10B	12 h 14 d

[1] Do not use the same miticide "back-to-back"; rotate miticides with different modes-of-action.
[2] When noted, generic products are available.
[3] ++++ =excellent, +++ = good, ++ = fair, + = poor, – = ineffective or not rated.
[4] Rates are in amount of formulated product per acre, unless otherwise noted. REI=Restricted Entry Interval. PHI=Preharvest Interval.
[5] Acramite requires spray water to be corrected for pH and hardness. See label.
[6] For Agri-Mek, use a minimum of 1.0 gal of oil/A, and apply no later than 6 weeks after petal-fall. Oil or oil based products may cause phytotoxicity on Asian pear cultivars. Other silicone-base penetrants may be substituted, but efficacy may not be as good as adding oil.
[7] Use higher rates if Two-Spotted Spider Mites are present.
[8] Do not apply Vydate within 30 days of bloom to avoid thinning.
[9] Do not rotate Apollo and Savey with each other.

12 Additional Resources

Newest Pesticide Labels

http://www.cdms.net/LabelsMsds/LMDefault.aspx

Weather Information and Pest Modeling *http://newa.cornell.edu/*

Network for Environment and Weather Applications (NEWA). Delivers weather information and timing for fungicide and insecticide applications based on weather data collected that support and advance integrated pest management (IPM) and best management practices for agricultural and green industries.

Rutgers Fact and Information Sheets

Available at: *https://njaes.rutgers.edu/pubs/* or from your Rutgers Cooperative Extension County Office; phone number can be found in the blue pages of the phone book under "county government" or at: *www.njaes.rutgers.edu/county*.

Farm Safety

FS619 Farm Machinery and Equipment Safety Part I: Recognizing and Understanding the Hazards
FS620 Farm Machinery and Equipment Safety Part II: Preventing Machinery Accidents during Operation

Food Safety

FS571 The Cider House Rules
FS1230 Worker Health and Hygiene; FS1230SP Salud e higiene del trabajador
FS1261 What Is On-Farm Food Safety?

Marketing

FS800 Farmer-to-Consumer Direct-Marketing Operations: Issues and Analysis
FS914 Characteristics and Needs of Direct Marketing Consumers in New Jersey
FS931 Cooperative Marketing Associations in New Jersey

Pest Management

FS002 Brown Marmorated Stinkbug-A Non-Native Insect in New Jersey
FS936 Getting Started with an Effective Integrated Pest Management Program
FS1246 Spotted Wing Drosophila: a Key Pest of Small Fruits in New Jersey
FS1270 Ecological and Economic Importance of Bats in Integrated Pest Management
FS1315 Best Management Practices for Copper Fungicide Use

Pesticide Use and Safety

CPA000CORE Pesticide Applicator Training Manual: Core
CPA000PRIV Pesticide Applicator Training Manual: Private
E358 Respiratory Protection for Occupational Users of Pesticides
FS052 Pesticide Applicator Certification in New Jersey
FS197 Toxicity of Pesticides
FS198 Disposal of Pesticides
FS209 Pesticide Service Vehicles
FS603 Pesticide Storage Facilities
FS628 Cleaning and Storage of Pesticide Sprayers
FS673 Contaminacion por Medio de los Pesticidas (Toxicity of Pesticides)
FS761 Cleaning Pesticide-Contaminated Clothing

Right to Farm Act

FS1253 New Jersey's Right to Farm Act - What It Is and How It Works

ADDITIONAL RESOURCES

Tree Fruit Production

E363 Active Frost Protection Methods for Your Orchard
F-129R Late-season Rescue Thinning with Ethephon
F-130 Apple Tree Pruning and Training (English and Spanish)
F-131 Enhancing Return Bloom on Apple with Plant Growth Regulators
F-133 An Annual Fire Blight Management Program
FS155 Laboratories for Soil Testing and Plant Analysis
FS319 Turfgrass for Orchard and Nursery Floor Management
E359 Think Twice, Plant Once: Does a Tree Fruit Orchard Make Sense for your Farm?
FS627 Leaf Analysis for Fruit Trees
FS682 Cherry Varieties for New Jersey
FS685 Nurseries and Nursery Dealers with Fruit Trees for New Jersey
FS719 Soil Fertility Test Interpretation: P, K, Mg & Ca
FS871 Understanding Fertilizer Labels
FS902 Liming New Jersey Soils for Fruit Crops
FS905 Agricultural Liming Materials
FS1201 Yellow-Fleshed Peach Varieties for New Jersey Commercial and Home Orchards
FS1074 Flat Peach Varieties for New Jersey
FS1083 Plum Varieties for New Jersey
FS1203 White-Fleshed Peach Varieties for New Jersey Commercial and Home Orchardists
FS1204 Nectarine Varieties For New Jersey Commercial and Home Orchardists
FS1300 Five New Peach and Nectarine Varieties for New Jersey Commercial and Home Orchards
FS1303 Classic and Novel Dessert Apple Varieties for Commercial Orchards in New Jersey
FS1306 Irrigating Your Orchard-Water Monitoring with a Tensiometer

Wildlife Management

FS888 Portable Electric Fencing for Preventing Wildlife Damage
FS889 High-Tensile Woven Wire Fences for Reducing Wildlife Damage
FS1017 Regulations Governing the Management of New Jersey Wildlife
FS1293 Voles in the Orchard

Other Publications

NJ Dept. of Agriculture: (609)292-8896 - *http://www.state.nj.us/agriculture/publ.htm*
Farmland Stewardship Deer Fencing Program. Application for Cost-Share Grant Funding for the Installation of Deer Fencing on Permanently Preserved Farmland
https://nj.gov/agriculture/sadc/farmpreserve/postpres/deerfencingapplication.pdf

NJ State Horticultural Society, **Horticultural News**. A quarterly publication of the NJ Horticultural Society, serving the fruit and vegetable growers of NJ. Annual subscription and membership $50.00. *http://www.njshs.org/*

The following and many more publications are available from eCommons Open Scholarship at Cornell, Cornell University Library at: *https://ecommons.cornell.edu/*

- Tree Fruit Field Guide to Insect, Mite, and Disease Pests and Natural Enemies of Eastern North America NRAES-169
- Mid-Atlantic Orchard Monitoring Guide, 1995, NRAES-75, H. Hogmire (editor), 361pp
- Refrigeration and Controlled Atmosphere Storage for Horticultural Crops, 1990, NRAES-22, 45 pp
- Bacterial Canker of Stone Fruit, J. Carroll, 2020
- Orchard Nutrition Management, 1991, 22 pp, W.C. Stiles and W. Shaw Reid
- Training and Pruning Apple Trees, 1999, 23pp, C.G. Forshey

Southeastern Peach, Nectarine and Plum Pest Management and Culture Guide 2021. D. Horton, et al. (eds.). Ext. Bulletin 1171. - *https://secure.caes.uga.edu/extension/publications/files/pdf/B%201171_14.PDF*

Compendium of Apple and Pear Diseases and Pests, 2nd ed.
http://my.apsnet.org/ItemDetail?iProductCode=44303

Compendium of Stone Fruit Diseases. - *http://my.apsnet.org/ItemDetail?iProductCode=41744*

Smartphone Apps on Google Play and the App Store

MYIPM Fruits (Clemson University) - MyIPM fruits provides Integrated Pest Management (IPM) information for conventional and organic production of important small fruits, stone fruits and pome fruits. The target audience is commercial growers (conventional and organic), farm advisors, and specialists, but homeowners may also find useful information.

Mix My Sprayer - Mix My Sprayer was created to aid with quick, accurate calculations of product mixes to be applied with spraying equipment. Users can create custom lists of favorite products by category. Simply add or select a product, insert values in each input box, and the app automatically calculates the amount of product to include in the user-defined mix size. Units for each input can be customized by tapping the unit buttons. Products are saved with the user settings last used.

Calibrate My Sprayer - Improperly calibrated pesticide spraying equipment may cause either too little or too much pesticide to be applied. This free mobile app was created to aid in the proper calibration of spraying equipment. Simply select the type of sprayer you want to calibrate (Broadcast or Banded), insert values in each input box, select what you want the app to calculate (Volume/Area or Catch/Nozzle), and tap 'Calculate'. Each input's units can be customized by tapping the units. Sprayers can be saved with user-defined names.

Reduce Bee Poisoning from Pesticides (Oregon State University) - Farmers and beekeepers can now remotely consult the publication's pesticide tables on their phones or tablets. The popular guide lists 150 insecticides, fungicides, miticides, slug killers and growth disruptors—all of them now searchable by trade name or chemical name in the app.

Malusim (Cornell University) - The Malusim app lets apple growers record, retrieve and analyze data to optimize fruit production. For a specific growing location, data on irrigation and fruit growth rates can be used to predict fruit yields. The app uses voice recognition to make it easier for growers to record fruit measurements in the field, even when offline.

Internet E-mail Discussion Group

Apple-Crop. Discussion group, with topics focusing on apple crop production since January, 1994. - *http://virtualorchard.com/applecrop.html*

Fruit Related Websites

Cornell Fruit Resources, Resources for Commercial Growers - *http://fruit.cornell.edu/*

Crop and Pest Management Guidelines, Cornell Cooperative Extension -
https://cropandpestguides.cce.cornell.edu/

International Fruit Tree Association - *http://www.ifruittree.org*

NC-140 Regional Rootstock Research Project - *http://www.nc140.org/*

NEtreefruit.org. The Online New England Tree Fruit Management Guide - *https://netreefruit.org/*

ADDITIONAL RESOURCES

New Jersey Peach Promotion Council. This website contains information from the "Wholesale Buyers Guide" and other important information. - *http://jerseypeaches.com*

Penn State Extension, Fruit Resources - *https://extension.psu.edu/forage-and-food-crops/fruit*

Penn State Fruit Research and Extension Center - *http://frec.cas.psu.edu*

Pesticides for New Jersey - *https://njaes.rutgers.edu/pubs/pesticides-for-nj/*

Rutgers Agricultural Research and Extension Center (RAREC) - *https://njaes.rutgers.edu/centers/rarec/*

Rutgers Cooperative Extension Pest Management Office - *https://pestmanagement.rutgers.edu/*

Rutgers Peach Science - *https://njaes.rutgers.edu/peach/*

Rutgers Plant and Pest Advisory. The blog for growers from the New Jersey Agricultural Experiment Station. Provides timely information and updates for events, horticulture, pest management, regulations, and opportunities. - *https://plant-pest-advisory.rutgers.edu/*

Snyder Research and Extension Farm - *https://snyderfarm.rutgers.edu*

The Mid-Atlantic Regional Fruit Loop. Information on all aspects of tree fruit production in the Mid-Atlantic region. - *http://www.virginiafruit.ento.vt.edu*

USDA National Invasive Species Information Center - NJ - *https://www.invasivespeciesinfo.gov/us/new-jersey*

Washington State University Tree Fruit Research and Extension - *http://treefruit.wsu.edu/*

West Virginia University, Kearneysville Tree Fruit Research and Education Center - *https://www.davis.wvu.edu/about-davis-college/farms-and-forests/kearneysville-tree-fruit-research-and-education-center*

Tree Fruit, Virginia Cooperative Extension, Virginia Tech, The State University of Virginia - *https://ext.vt.edu/agriculture/commercial-horticulture/tree-fruit.html*

WHAT TO DO WHEN (APPLES AND PEACHES)

Month	Apples	Peaches
January	Vole control; Prune	Vole control
February	Vole control; Prune Weed control: Apply Norosac if using for perennial/ biennial weeds	Vole control Weed control: Apply Norosac if using for perennial/ biennial weeds
March	Apply half of the season's N fertilizer Calibrate sprayer Weed control: Apply 2,4-D to sod in South Jersey (late March)	Prune older trees Apply half of the season's N fertilizer Calibrate sprayer Weed control: Apply 2,4-D to sod in South Jersey (late March)
April	Boron spray (full bloom); Bees for pollination Grafting Weed control: 1) Apply 2,4-D to sod in North Jersey (early April) 2) Apply residual herbicides to established blocks that were NOT treated in fall	Prune younger trees Weed control: 1) Apply 2,4-D to sod in North Jersey (early April) 2) Apply residual herbicides to established blocks that were NOT treated in fall
May	Boron spray (petal fall) Chemical thinning Apply the remainder of the N fertilizer Weed control: 1) Apply residual herbicides to newly-planted blocks 2) Apply residual herbicides to blocks treated in fall	Thin earliest varieties Apply the remainder of the N fertilizer Weed control: 1) Apply residual herbicides to newly-planted blocks 2) Apply residual herbicides to blocks treated in fall
June	Check Preharvest Intervals on sprays Apply Calcium sprays Weed control: Spot application of Glyphosate	Complete thinning; Summer prune Check Preharvest Intervals on sprays Weed control: Spot application of Glyphosate
July	Calibrate sprayer Apply Calcium sprays Summer prune Sample leaves for nutrient analysis (July 15-Aug 15) Weed control: Spot application of Glyphosate	Calibrate sprayer Summer prune Sample leaves for nutrient analysis (July 15-Aug. 15), South Jersey Weed control: Spot application of Glyphosate
August	Apply Calcium sprays Weed control: Spot application of Glyphosate	Analyze soil and roots for nematodes Sample leaves for nutrient analysis (Aug. 1-15), North Jersey Weed control: Spot application of Glyphosate
September	Weed control: 1) Spot application of Glyphosate 2) Seed perennial grass to establish sod between rows	Analyze soil and roots for fertility and nematodes Control lesser peach tree borers and peach tree borers (early to mid-Sept) Fumigate new blocks if needed Weed control: 1) Spot application of Glyphosate 2) Seed perennial grass to establish sod between rows
October	Vole control Take soil samples Weed control: Apply 2,4-D to sod (late October)	Vole control Take soil samples Fumigate new blocks if needed Weed control: Apply 2,4-D to sod (late October)
November	Vole control Weed control: Apply 2,4-D and residual herbicides in tree row	Vole Control Paint tree trunks to prevent Southwest injury Weed control: Apply 2,4-D and residual herbicides in tree row
December	Vole control if not done earlier	Vole control if not done earlier

For Immediate Medical Attention
Call 911

For a Pesticide Exposure Poisoning
Emergency Call

POISON Help®

1-800-222-1222

For All States

This number will automatically connect you to the poison center nearest to you.
Anyone with a poisoning emergency can call the toll-free telephone number for help.
Personnel at the Center will give you first-aid information and direct you to local treatment centers if necessary.

RUTGERS

THE STATE UNIVERSITY
OF NEW JERSEY