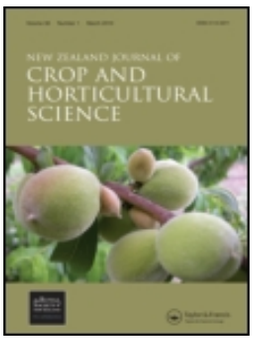

New Zealand Journal of Crop and Horticultural Science

ISSN: 0114-0671 (Print) 1175-8783 (Online) Journal homepage: https://www.tandfonline.com/loi/tnzc20

Effects of auxins and cytokinins on graft union of grapevine *(Vitis vinifera)*

Cafer Köse & Muharrem Güleryüz

To cite this article: Cafer Köse & Muharrem Güleryüz (2006) Effects of auxins and cytokinins on graft union of grapevine *(Vitis vinifera)* , New Zealand Journal of Crop and Horticultural Science, 34:2, 145-150, DOI: 10.1080/01140671.2006.9514399

To link to this article: https://doi.org/10.1080/01140671.2006.9514399

New Zealand Journal of Crop and Horticultural Science, 2006, Vol. 34: 145–150
0014–0671/06/3402–0145

Effects of auxins and cytokinins on graft union of grapevine (*Vitis vinifera*)

CAFER KÖSE
MUHARREM GÜLERYÜZ
Department of Horticulture
Faculty of Agriculture
Atatürk University
25240 Erzurum, Turkey
email: ckose@atauni.edu.tr

Abstract The aim of this study was to determine the effects of some auxins and cytokinins on graft union and root formation of grafted cuttings of four different grapevine (*Vitis vinifera*) graft combinations (41B-Erenköy Beyazi, 41B-Italia, Rupestris du Lot-Erenköy Beyazi, and Rupestris du Lot-Italia). The cut grafting surfaces of both the scion and rootstock were first dipped into either 1-naphthaleneacetic acid (NAA), indole-3-butryic acid (IBA), benzyladenine (BA), or kinetin (Ki) for 20 s. NAA and IBA were applied at concentrations of 500, 1000, and 2000 mg/litre and BA and Ki were applied at rates of 250, 500, and 1000 mg/litre. Following this treatment the cuttings were grafted, stratified, and hardened. Control group cuttings were grafted without any application. Results showed that the physiological effects of cytokinins differed from auxins. In general, Ki and BA stimulated rapid proliferation of callus between the scion and rootstock whereas NAA and IBA increased root formation at the basal end of grafted cuttings compared with the control. The best results were obtained from treating the graft cut-surfaces of graft combinations with 250 and 500 mg/litre Ki or BA. Except for the 1000 mg/litre concentrations, Ki and BA showed better callusing rate and callusing degree at grafting point of all tested graft combinations compared with the control, whereas rooting rate and rooting degree were enhanced by application of IBA and NAA compared with the control. In all graft combinations, the highest success rate (100%) was obtained from 250 mg/litre Ki application. Significant increases in success rate and callus formation as callusing rate and callusing degree at the grafting zone indicated that the Ki and BA may have the potential to improve graft union formation.

Keywords auxins; callusing; cytokinins; grafting; grapevine

INTRODUCTION

A crucial technique of viticulture is the grafting of phylloxera-susceptible *Vitis vinifera* (Weaver 1976) scions onto rootstocks resistant to phylloxera. So, ease of grafting is one of the essential characters in viticulture (Mullins et al. 1992).

Successful grafting of plant species and cultivars is related to the production of callus which is essential for graft union formation (Hartman et al. 1990). In other words, formation of the graft union depends on the process of callus initiation in both rootstock and scion, on the union of callus, and the subsequent differentiation of the callus tissue to form the protective and vascular tissue required to form a functional unit from the two adjacent plant parts, i.e., rootstock and scion (Nickell 1984). Differentiation is not usually considered to be a problem, but there are often difficulties at initiation and proliferation of callus (Panea et al. 1997).

In previous studies, several authors reported that plant growth regulators such as auxins and cytokinins induce the initiation and proliferation of callus and new vascular tissue by promoting cell division and/or cell development (Bonner & Galston 1952; Rost et al. 1984; Raven et al. 1992; Salisbury & Ross 1992; Preece & Read 1993). Thus, several researchers have applied auxins (Khrenovskov & Strakhov 1986; Derendovskaya et al. 1989; Reustle et al. 1993) and plant growth promoting rhizobacteria (PGRB) strains that produce auxin (Köse et al. 2005) on grafted cuttings to increase callus formation and successful grafting. However, there has been no

H04108; Online publication date 12 April 2006
Received 9 December 2004; accepted 16 February 2006

attempt to study the effects of cytokinins applied to the grafting point on graft union of grapevine.

The purpose of this study was to determine effects of the auxins, 1-naphthaleneacetic acid (NAA) and indole-3-butryic acid (IBA) and the cytokinins, benzyladenine (BA) and kinetin (Ki) on the stimulation of callus formation at the grafting point and root formation of the basal end of grafted cuttings for successful grafting of grapevine.

MATERIALS AND METHODS

The experiment was conducted to evaluate the effects of some auxins and cytokinins on the success of grapevine grafting at Atatürk University, Erzurum (39°55′N, 41°61′E), Turkey.

Plant materials

Woody cuttings of *V. vinifera* ('Erenköy Beyazi' and 'Italia') and rootstocks of Chasselas × Berlandieri 41B (41B) and *Rupestris* du Lot were obtained from the vineyard of the Eğirdir Horticulture Research Institute.

Grafting and hormonal application

The samples were cut into lengths of 40 cm for rootstocks and single-bud pieces for scion. Buds of rootstock cuttings were then removed with a knife. Grafting was done by machine (omega type) manufactured by Carlo A. Manaresi®, Italy. The cut grafting surfaces of both the scion and rootstock were first dipped into either NAA, IBA, BA, or Ki for 20 s. NAA and IBA were applied at concentrations of 500, 1000, and 2000 mg/litre and BA and Ki were

Table 1 Effects of different concentrations of cytokinins and auxins on callusing rate, callus degree, rooting rate and root degree in Rupestris du Lot-Erenköy Beyazi and Rupestris du Lot-Italia graft combinations of grapevine (*Vitis vinifera*). (Within each section means displayed with the same letter are not significantly different from each other ($P < 0.01$).) (NAA, 1-naphthaleneacetic acid; IBA, indole-3-butryic acid; BA, benzyladenine; Ki, kinetin.)

Rootstock-scion combination	Application (mg/litre)	Callusing rate (%)	Callus degree (0–4)	Rooting rate (%)	Rooting degree (0–4)
Rupestris du Lot-Erenköy Beyazi					
	Control	72.5 c	2.9 b	40.0 f	1.6 g
	500 IBA	5.0 g	0.2 f	70.0 cd	2.5 d
	1000 IBA	15.5 f	0.6 e	80.0 c	2.8 c
	2000 IBA	18.0 f	0.7 e	90.0 b	3.1 b
	500 NAA	0.0 g	0.0 f	90.0 b	2.8 c
	1000 NAA	2.5 g	0.1 f	90.0 b	3.1 b
	2000 NAA	5.5 g	0.2 f	100.0 a	3.5 a
	250 Ki	95.0 ab	3.8 a	40.0 f	2.1 e
	500 Ki	97.0 a	3.9 a	60.0 de	2.0 ef
	1000 Ki	52.5 d	2.1 c	50.0 ef	1.6 g
	250 BA	97.5 a	3.9 a	40.0 f	2.0 ef
	500 BA	91.5 b	3.7 a	60.0 de	1.8 fg
	1000 BA	41.0 e	1.7 d	50.0 ef	2.0 ef
	LSD 0.01	5.11	0.26	6.74	0.23
Rupestris du Lot-Italia					
	Control	67.5 d	2.7 d	40.0 f	1.8 fg
	500 IBA	32.5 g	1.3 f	80.0 b	2.8 c
	1000 IBA	5.5 h	0.2 gh	80.0 b	2.8 c
	2000 IBA	7.5 h	0.3 g	100.0 a	3.3 b
	500 NAA	0.0 i	0.0 h	100.0 a	3.0 c
	1000 NAA	0.0 i	0.0 h	100.0 a	4.0 a
	2000 NAA	8.5 h	0.3 g	100.0 a	3.9 a
	250 Ki	92.5 a	3.7 a	70.0 c	2.5 d
	500 Ki	75.0 c	3.0 c	40.0 f	1.6 g
	1000 Ki	45.0 f	1.8 e	60.0 d	2.0 ef
	250 BA	90.0 a	3.6 a	50.0 e	2.1 e
	500 BA	82.5 b	3.3 b	40.0 f	1.8 fg
	1000 BA	50.0 e	2.0 e	50.0 e	1.9 ef
	LSD 0.01	3.28	0.20	4.84	0.20

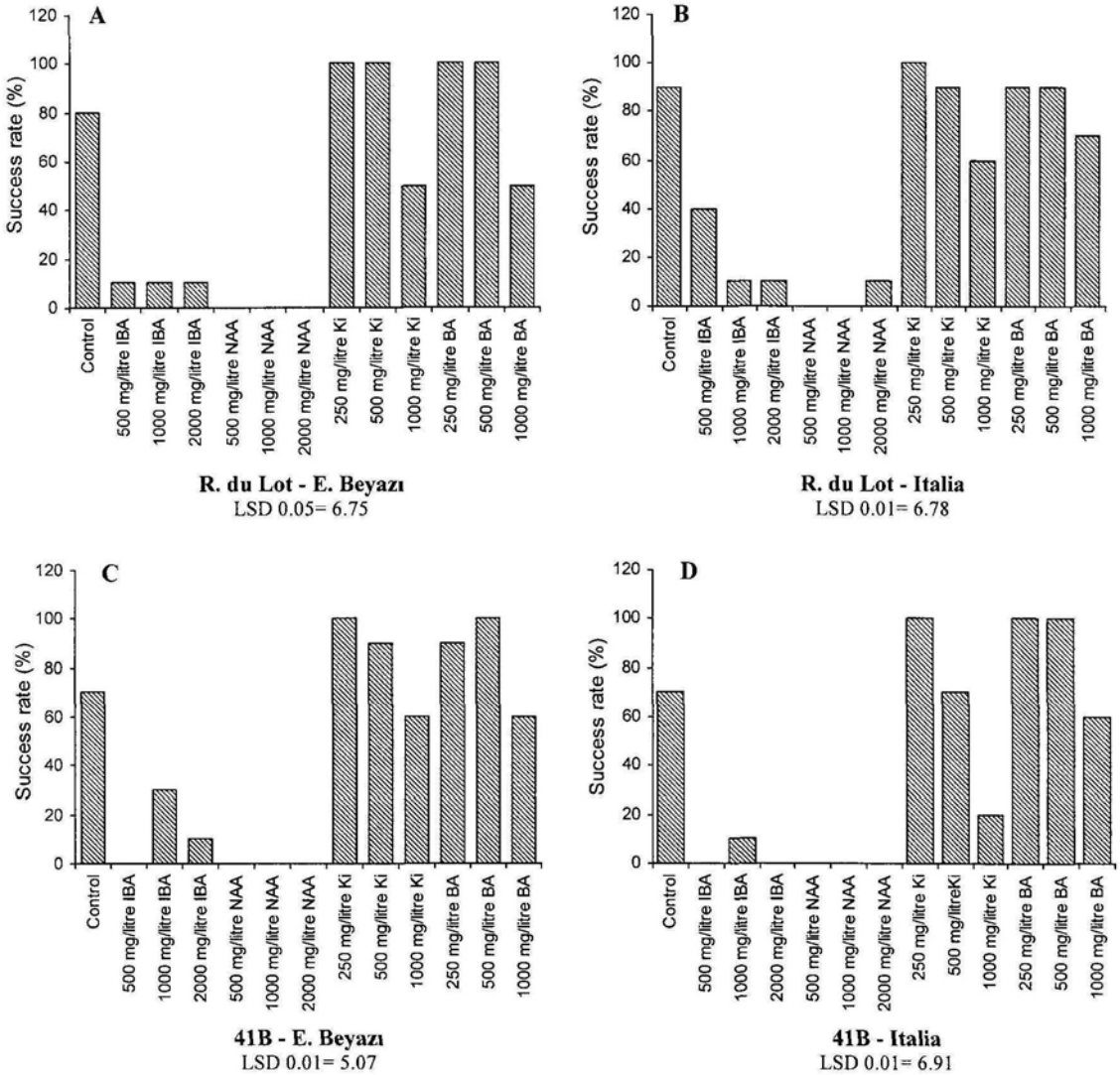

Fig. 1 Effects of different concentrations of cytokinins and auxins on success rate in: **A**, Rupestris du Lot-Erenköy Beyazi; **B**, Rupestris du Lot-Italia; **C**, 41B-Erenköy Beyazi; and **D**, 41B-Italia graft combination of grapevine (*Vitis vinfera*). Within each section least significant differences among means (LSD) are indicated at $P < 0.01$ or $P < 0.05$. (NAA, 1-naphthaleneacetic acid; IBA, indole-3-butryic acid; BA, benzyladenine; Ki, kinetin.)

applied at rates of 250, 500, and 1000 mg/litre (IBA and NAA in 50% ethanol; Ki and BA in 1*N* NaOH). Control group cuttings were grafted without any application. After dipping, cuttings were air-dried for 5 min and cuttings of scions were placed on the cuttings of rootstocks and grafting zones were covered with paraffin. They were placed in moist sawdust and maintained at 24±1°C and 80–85% relative humidity for 21 days (Weaver 1976) and then acclimated for 9 days to field conditions.

Grafted cuttings were then evaluated for the rates (%) of success and callusing, callusing degree, rooting rate (%), and rooting degree 31 days after grafting (Eriş et al. 1989; Hartman et al. 1990; Kamiloğlu & Tangolar 1997). Callusing and rooting degree were determined by using a scale of 0–4 where: 0, no callusing and rooting; 1, 1–25% callusing and rooting; 2, 26–50% callusing and rooting; 3, 51–75% callusing and rooting; and 4, 76–100% callusing at grafting point and rooting

at basal end of the grafted cuttings. Callusing rate was determined as a percentage of attempted grafts that had callusing around the grafting point. Rooting rate was determined as the percentage of grafted cuttings which developed roots (Kamiloğlu & Tangolar 1997). Success rate refers to the percentage of grafted cuttings that had a callusing rate greater than 25% at the grafting point. The data of success rate were transformed by arcsine transformation for statistical analysis.

The experiment used a completely randomised design with three replications and 30 grafts per replicate. This experiment was repeated twice. All data were evaluated by analysis of variance (ANOVA) and means were separated by Tukey's Honestly Significant Differences test at $P \leq 0.05$ and 0.01 using SAS statistical software (SAS 1982).

RESULTS AND DISCUSSION

Effects of plant growth regulators on callusing rate, callusing degree, and rooting rate are summarised in Table 1 and success rate shown in Fig. 1.

Results indicated that cytokinins showed different physiological effects than those of auxins. In general, Ki and BA promoted both initiation and proliferation of callus at the grafting point and the root formation at the basal end of grafted cuttings, whereas IBA and NAA increased only the root formation at the basal end of grafted cuttings compared with the control. On the other hand, it was also determined that in all tested graft combinations, IBA and NAA decreased the callus formation at grafting point (Tables 1, 2) influencing the success rate (Fig. 1). In terms of the effects of plant growth regulators on initiation and

Table 2 Effects of different concentrations of cytokinins and auxins on callusing rate, callus degree, rooting rate and root degree in 41B-Erenköy Beyazi and 41B-Italia graft combinations of grapevine (*Vitis vinifera*). (Within each section means displayed with the same letter are not significantly different from each other ($P < 0.01$).) (NAA, 1-naphthaleneacetic acid; IBA, indole-3-butryic acid; BA, benzyladenine; Ki, kinetin.)

Rootstock-scion combination	Application (mg/litre)	Callusing rate (%)	Callus degree (0–4)	Rooting rate (%)	Rooting degree (0–4)
41B-Erenköy Beyazi	Control	50.0 c	2.2 cd	10.0 f	1.0 g
	500 IBA	5.5 f	0.2 g	30.0 e	1.5 f
	1000 IBA	23.0 e	0.9 f	70.0 c	2.4 d
	2000 IBA	18.0 e	0.7 f	90.0 b	2.8 c
	500 NAA	0.0 f	0.0 g	90.0 b	2.9 c
	1000 NAA	3.0 f	0.1 g	90.0 b	3.4 b
	2000 NAA	2.5 f	0.1 g	100.0 a	4.0 a
	250 Ki	85.0 a	2.7 b	30.0 e	1.4 f
	500 Ki	70.0 b	2.4 bc	30.0 e	1.5 f
	1000 Ki	32.5 d	1.3 e	70.0 c	2.1 e
	250 BA	87.5 a	3.5 a	50.0 d	2.1 e
	500 BA	90.0 a	3.6 a	30.0 e	1.3 f
	1000 BA	50.0 c	2.0 d	50.0 d	2.0 e
	LSD 0.01	5.66	0.33	7.25	0.26
41B-Italia	Control	45.0 e	1.8 d	0.0 e	1.0 e
	500 IBA	5.5 gh	0.2 fg	100.0 a	3.4 ab
	1000 IBA	8.5 g	0.3 ef	100.0 a	3.5 ab
	2000 IBA	3.0 hi	0.1 fg	100.0 a	3.6 a
	500 NAA	2.5 hi	0.1 fg	40.0 b	1.8 cd
	1000 NAA	0.0 i	0.0 g	100.0 a	3.3 b
	2000 NAA	0.0 i	0.0 g	100.0 a	3.6 a
	250 Ki	96.5 a	3.8 a	30.0 c	1.6 d
	500 Ki	65.0 c	2.2 c	40.0 b	1.9 c
	1000 Ki	12.5 f	0.5 e	40.0 b	1.6 d
	250 BA	97.5 a	3.9 a	30.0 c	1.7 cd
	500 BA	85.0 b	3.4 b	30.0 c	1.8 cd
	1000 BA	50.0 d	2.0 cd	20.0 d	1.2 e
	LSD 0.01	3.64	0.23	5.23	0.23

proliferation of callus at the grafting point and root formation 250 and 500 mg/litre Ki and BA yielded the best results.

Ki and BA applications, except for the 1000 mg/litre concentration, produced better callusing rate at the grafting point of all graft combinations compared with the untreated control, whereas all IBA and NAA treatments decreased the callusing rate. The best effects on callusing rate occurred by treatment with 250 mg/litre application of either BA or Ki treatment. It was also observed that Ki and BA application dramatically improved callus structure, with organisation into dense circular layers.

The rooting rate of all graft combinations was significantly influenced by type of plant growth regulator. In general, root formation was promoted more by auxin treatment than by cytokinin. It was also determined that when rooting rate of grafted cuttings was high, callus formation on the grafting point was low in graft combinations treated with IBA and NAA.

In all graft combinations, the highest (100%) and lowest success rates (0.0%) were obtained from 250 mg/litre Ki and 500 and 1000 mg/litre NAA applications, respectively. Among all tested graft combinations, the highest increase in success rate (42.9%) occured in 41B-Erenköy Beyazi and 41B-Italia combinations treated with 250 mg/litre Ki and 500 mg/litre BA, respectively (Fig. 1C,D).

The data illustrated that there were significant differences among the hormonal treatments. Both IBA and NAA applications decreased graft success rate (Fig. 1) and callus formation at the grafting zone. In contrast, auxin application increased root formation compared with the control in all graft combinations (Tables 1, 2) which implies that IBA and NAA applied on graft cut-surfaces were transported to the basal end of the grafted cutting. It is known that auxins move predominantly in basipetal direction (Bleasdale 1984; Rost et al. 1984; Salisbury & Ross 1992). Also, auxins can induce competition between callogenesis and rhisogenesis (Khrenovskov & Strakhov 1986; Hartman et al. 1990; Reustle et al. 1993; Panea et al. 1997). It has been noted that callus formation is negatively influenced by the appearance of great root formation, and that there is a correlation between root initiation and auxin movement (Hartman et al. 1990). Indeed, it was determined that there was a negative correlation ($r = -0.666$) between callusing rate at the grafting point and rooting rate of grafted cuttings in the present study. Reustle et al. (1993) found that rootstocks treated with NAA failed to compensate for the reduced graft take though adventitious root production was promoted by NAA. However, Panea et al. (1997) reported that Calovit® comprising synthetic auxins, applied to grafted cuttings for 1–2 s at a dilute concentration, increased callus formation at the grafting point. Researchers explain that the reason for increased callus formation was the lower concentration of Calovit®, and that Calovit® could not affect root formation which may have antagonist effects for callus formation. On the other hand, it was reported by Fang & Yingzi (1997) that increasing doses of paclobutrazol improved the success rate of green and bench grafting. Similar results were also reported by Svetov & Kushch (1983) for Chlormequat (CCC) application on the grafting point of CO4-Rkatsiteli graft combination. Chlormequat and paclobutrazol may inhibit auxin activity, thus root formation at the basal end of grafted cuttings and callus formation at the grafting point may be reduced (Arteca 1984; Salisbury & Ross 1992). Therefore, the results of the present study confirm reports of these previous studies.

The Ki and BA treatments affected the success rate and callus formation differently depending on dose and graft combination. However, in general the Ki and BA treatments increased success rate and callus formation at the grafting point. Ki and BA also improved callus structure with organisation into dense circular layers. The likely reason for this is that cytokinins promote cell division, cell development and formation of vascular connections among plant parts (Rost et al. 1984; Salisbury & Ross 1992). Derendovskaya et al. (1989) reported that Cartolin as a cytokinin application increased callus formation at the grafting point of grapevine.

In conclusion, significant increases in callus formation and success rate of the graft union showed that Ki and BA treatment may have the potential to improve graft union formation in grapevine. Further studies need to be conducted to find the optimal doses of cytokinins and potential auxin/cytokinin mixtures for improving both graft callus formation and root formation.

ACKNOWLEDGMENTS

This research was supported by the Agriculture Faculty of Atatürk University. We thank Dr Kamil Haliloglu for review and suggestion.

REFERENCES

Arteca RN 1984. Plant physiology in relation to horticulture. London, Macmillan Press. 144 p.

Bleasdale JKA 1984. Principles of plant physiology. San Francisco, W.H. Freeman& Company. 143 p.

Bonner J, Galston AW 1952. Plant growth substances principles and applications. New York, Chapman & Hall Press. 499 p.

Derendovskaya AI, Moroshan EA, Kirillov AF 1989. The comparative effect of Cartolin and heteroauxin on grapevine grafts. Izvestiya Akademii Nauk Moldavskoi SSr, Seriya Biologicheskikhi Khimicheskik Nauk 2: 17–21.

Eriş A, Soylu A, Türkmen C 1989. Effects of some applications on callus formation at graft union and rooting of grafted grapevine production. Bahçe 18: 29–34.

Fang J, Yingzi L 1997. The effect of paclobutrazol on Kyoho grapevine grafting in growing period. Journal of Nanjing Agricultural University 20: 116–118.

Hartman HT, Kester DC, Davis FT 1990. Plant propagation principles and practices. New Jersey, Rajets/Prentice Hall Press. 647 p.

Kamiloğlu Ö, Tangolar S 1997. A comparison of three methods producing grafted vines. Procedings of the Fifth International Symposium on Temperate Zone Fruits in the Tropics and Suptropics. Pp. 395–398.

Khrenovskov EI, Strakhov VG 1986. Application of microelement and heteroauxin complex during grapevine graft production. Vinodelie i Vinogradarstvo SSSR 2: 16–18.

Köse C, Güleryüz M, Şahin F, Demirtaş I 2005. Effects of some plant growth promoting rhizobacteria (PGPR) on graft union of grapevine. Journal of Sustainable Agriculture 26(2): 139–147.

Mullins MG, Bouquet A, Williams LE 1992. Biology of the grapevine. Cambridge, Cambridge University Press. 239 p.

Nickell LG 1984. Plant growth regulating chemicals. Florida, CRC Press. 167 p.

Panea T, Ungur I, Panea I, Varga NV, Mihaiescu TC 1997. The stimulation of callus formation of graft vines cuttings with Romanian bioregulator Calovit. VIII International Symposium on Plant Bioregulation in Fruit Production. Pp. 185–190.

Preece J, Read P 1993. The biology of horticulture. New York, Wiley & Sons. 480 p.

Raven PH, Evert RF, Eichhorn SE 1992. Biology of plants. New York, Worth Publishers. 791 p.

Reustle G, Aleweldt G, Jene B 1993. Green grafting of grapevines. Part 1: The significance of the rootstock and scion leaf. Mitteilungen Klosterneuburg, Rebe und Wein, Obstbau und Früchteverwertung. 43: 1–7.

Rost TL, Barbour MG, Thornton RM, Wiever TE, Stocking CR 1984. Botany. New York, Wiley & Sons. 342 p.

Salisbury FB, Ross CW 1992. Plant physiology. California, Wadsworth Publishing Comp. 682 p.

SAS Institute 1982. SAS Users Quide. Cary, NC, SAS Institute.

Svetov VG, Kushch ID 1983. Production of grapevine grafts using CCC. Vinodeliei Vinogradarstvo SSSR 2: 48–50.

Weaver RJ 1976. Grapevine growing. New York, John Wiley & Sons. 371 p.