American-Eurasian J. Agric. & Environ. Sci., 5 (5): 599-602, 2009
ISSN 1818-6769

Reserve Nutrient Contents of the 5 BB Grape Rootstock Canes

[1]*Zeliha Gökbayrak,* [1]*Alper Dardeniz,* [2]*Nuray Mücellâ Müftüoğlu,*
[2]*Cafer Türkmen,* [1]*Arda Akçal and* [1]*Rukiye Tunçel*

[1]Department of Horticulture, Faculty of Agriculture,
Çanakkale Onsekiz Mart University, 17020 Çanakkale, Turkey
[2]Department of Soil Science, Faculty of Agriculture,
Çanakkale Onsekiz Mart University, 17020 Çanakkale, Turkey

Abstract: Rootstock cuttings prepared for preparation of grafted grapevines were profiled for their mineral contents during two dormant seasons. Cuttings of 5 BB were taken from intact mother vines in a single vineyard located in Umurbey, Çanakkale, Turkey. Cuttings were sampled at four different times starting from leaf fall and divided into four-node sections from bottom to top. Mineral content changes in the dormant season and along the length of the canes were found to be significant to a limited extent. These results showed that rootstock 5 BB does not undergo physiological processes that will greatly influence its mineral content in one year old woods.

Key words: Grapevine · Rootstock · Cutting · Mineral nutrient

INTRODUCTION

Hardwood cuttings of grapevine are made by sectioning shoots and obtaining different number of cuttings. Variations in root production on cuttings taken from different portions of the shoot are often observed, with the highest rooting, in many cases found in cuttings taken from the basal portions of the shoot [1]. Since choice of cuttings to be used as a graft material is important, how can a grower assess the quality of the material?

Genetic characteristics of the plant [2], environmental conditions [3, 4], the exogenous supply of hormones [5,6], endogenous hormonal variations [7] and other treatments such as temperature and hot water, etc. [8, 9] affect rooting ability of a plant. Carbohydrates stored in the canes are an indication of the health and vigor of the previous season's growth [10]. High quantities of carbohydrates and nitrogen reserves such as starch increase the potential for callusing. Accumulation is enhanced amongst others good sunlight exposure and judicious fertilization of mother material [11]. The mineral content of the wood will eventually affect growth of stocks in the nursery. As Kliewer [12] expressed, since the initial growth of emerging shoots in the spring is at the expense of carbohydrates, proteins and other nutrient reserves in the canes, an evaluation of their content becomes important to assess the capacity of the vine for bearing economic crop. This research was carried out to ascertain if there were significant differences in the mineral contents of one-year old 5 BB canes collected during two successive dormant periods.

MATERIAL AND METHOD

Cuttings of 5BB rootstock were taken during two dormant periods from the Fruit Propagation Station, located in Umurbey, Çanakkale, Turkey. All mother rootstock vines were managed the same in irrigation, fertilization, soil management, pruning and disease controlling. The vines were on the ground and spaced 2x2 m apart. The trial was designed in randomized parcels with four replicates and three vines per replicate were selected. Canes were randomly chosen on the basis of equal thickness. 8 canes about 4-6 meters long per vine were selected and sectioned into 4-node segments from base to tip (1–4, 5–8, 9–12, 13–16 and 17-20) at four different times starting from the leaf fall (80% defoliation and three more times 15 days apart). A soil profile feature of the rootstock foundation block is given in Table 1.

Corresponding Author: Zeliha Gökbayrak, Department of Horticulture, Faculty of Agriculture, Çanakkale Onsekiz Mart University, TR-17020 Çanakkale, Turkey

Table 1: Soil profile features of the 5 BB rootstock foundation block

Depth (cm)	Texture	Salinity (%) (1:2.5) with water	pH(1:2.5) with water	Calcareous ($CaCO_3$, %)	P (kg da^{-1} P_2O_5)	K (kg da^{-1} K_2O)	Organic matter (%)
0-30	Loamy	None	7.5-8.0	Low	High	Adequate	Low
30-60	Loamy	None	7.5-8.0	High	Low	Adequate	Low
60-90	Loamy	None	7.5-8.0	High	Low	Adequate	Very low

Samples were dried, ground and dried again according to [13] and P, K, Cu, Fe, Mg, Mn, Na and Zn readings were done in ISP-AES after wet digestion with CEM Microwave Digestion System in a microwave oven with nitric acid (HNO_3 65%, d=1.42) and hydrogen peroxide (30%). Carbon and nitrogen was read in LECO CN-2000 (LECO Corporation, St. Joseph, MI) elemental C/N analyzer according to Dumas method ([14]. Calibration was done with standard EDTA at the beginning and every other 30 samples. The carbon/nitrogen (C/N) ratio was derived using the respective values for carbon and nitrogen. Reducing sugar content analysis was performed according to the dinitrophenol method [15]. Sugar content (g/100 g) was obtained from the readings at 600 nm in a UV-VIS spectrophotometer (model UV-1208, Shimadzu Inc., Japan). Control was a solution containing 6 ml dinitrophenol and 2 ml distilled water.

Data obtained in the two dormant seasons were pooled before analysis for the determination of the effects of the collection time and nodal sections. Analysis of variance test was performed with Minitab statistics program (version 14) and differences among the means were tested with Duncan's multiple comparison analysis. Interaction between time of collection and nodal sections was found insignificant and therefore, not shown here.

RESULTS

Statistical analysis showed that mineral contents of the 5 BB cuttings differed significantly to a limited extent throughout the dormant season, except for the phosphor (Table 2). N, K, Cu, Fe, Zn and reducing sugar contents were pretty much the same in all collection times. Na, C, Mg contents and C/N ratio increased and Mn decreased as the time progressed. C and C/N ratio showed more statistically different groups as the time progressed into the dormant season. However, there were not great enough differences in the mean value of a given mineral.

There were no significant statistical differences among the nodal sections for P, Cu, Fe, Zn, Na, sugars and C levels (Table 3). N and Mg were higher in the middle and apical nodes. K content stayed unchanged at all sections of the canes. Here again, the difference was not great enough between the nodal sections. The C/N ratio was more changing along the sections of the canes, being greatest between the 5th and 9th nodes and later decreasing towards to the tip.

DISCUSSION

The values obtained during the dormancy over two seasons and sections along the cane cuttings

Table 2: Effects of the collection time during the two dormant seasons on the mineral content of the 5 BB cuttings

Sampling time	N(%)	P(%)	K(%)	C(%)	Fe(mg/L)	Mg(mg/L)	Zn(mg/L)	Na(mg/L)	Mn(mg/L)	Cu((mg/L)	Reducing Sugar(g/100ml)	C/N
Leaf Fall	0.64±0.01 a	0.12±0.01	0.38±0.01b	44.91±0.1 bc	99.20±9.51 a	1106.29±21 b	8.34±0.32 a	75.22±2.98b	24.99±1.67 a	6.75±0.34 a	0.229±0.02 a	101.17±7.30 c
15 dalf*	0.58±0.02 ab	0.12±0.002	0.40±0.01 ab	45.43±0.1b	68.51±7.56b	1069.87±11 b	7.03±0.14 b	74.04±3.40 b	20.32±1.75 ab	4.96±0.03 b	0.235±0.02 a	110.55±2.75bc
30 dalf	0.51±0.02 b	0.12±0.003	0.38±0.01b	44.28±0.23 c	82.61±6.51ab	1105.69±15 b	7.53±0.41 ab	78.95±3.90 ab	19.98±1.05 b	5.33±0.38 b	0.165±0.03b	152.81±15.1 a
45 dalf	0.58±0.03 ab	0.13±0.002	0.41±0.01a	46.57±0.2a	89.94±7.85ab	1156.08±29 a	6.78±0.30 b	87.29±3.81 a	20.01±0.55 b	7.44±0.51 a	0.168±0.01 ab	133.16±6.06ab
P value	0.05	NS	0.05	0.01	0.050	0.05	0.05	0.05	0.05	0.01	0.05	0.05

*dalf=days after leaf fall

The values are mean±SE of four replicates and those marked with different letters in the same column are significantly differed

Table 3: Effects of the 4-node cane sections during the two dormant seasons on the mineral content of the 5 BB cuttings

Sampled sections	N(%)	P(%)	K(%)	C(%)	Fe(mg/L)	Mg(mg/L)	Zn(mg/L)	Na(mg/L)	Mn((mg/L)	Cu((mg/L)	Reducing Sugar(g/100ml)	C/N
Nodes 1-4	0.54±0.08 bc	0.13±0.01	0.381±0.01ac	45.42±0.12	87.05±5.75	1082.52±13b	7.73±0.45	75.63±8.53	18.57±0.55b	6.04±0.29	0.22±0.02	130.63±3.38ab
Nodes 5-8	0.53±0.02c	0.12±0.01	0.376±0.01 b	45.15±0.63	86.35±5.09	1079.62±8 b	7.24±0.18	76.30±4.74	21.91±1.85 ab	5.85±0.44	0.22±0.05	134.49±6.90a
Nodes9-12	0.58±0.04abc	0.12±0.01	0.396±0.02ab	45.29±0.13	82.20±10	1112.90±44ab	7.04±0.23	79.26±9.27	22.35±0.34a	5.91±0.41	0.18±0.01	120.58±3.91bc
Nodes13-16	0.61±0.04ab.	0.13±0.01	0.388±0.02ab	45.09±0.35	86.54±9.17	1104.58±23ab	7.40±0.31	79.57±11.8	23.20±0.89 a	6.47±0.66	0.17±0.02	112.23±4.05cd
Nodes17-20	0.62±0.02a	0.12±0.01	0.422±0.02 a	45.54±0.16	82.12±8.55	1169.62±27a	7.97±0.64	83.67±5.55	21.15±0.96ab	6.28±0.77	0.21±0.02	107.88±4.44d
P value	0.05		0.05			0.05			0.05			

The values are mean±SE of four replicates and those marked with different letters in the same column are significantly differed showed that, although there were statistically important differences for some of the nutrient elements, the differences were not great enough to positively conclude that dormant vines undergo important physiological process. Vines generally conserved their mineral status pretty much at the same level as the time progressed into the dormant period or along the length of the canes.

As the physiology and biochemistry of rootstocks vary under similar sets of management practices, the physiological and biochemical composition of the mother vines play an important role in the propagation, growth and development of vine, water-use efficiency, pest and disease tolerance, quality of grapes, etc. Each rootstock has its own inherent capacity to synthesize biochemical constituents, which influence scion physiology, either directly or indirectly, after grafting [16]. Lombard [17] stated that "the vine remains metabolically active at a low level, during dormancy". Our findings support this since there were very little changes in the mineral content of the canes.

Dardeniz *et al.* [18] found that rooting performance of 5 BB canes, taken at times exactly the same in this study did not show statistically important differences. At leaf fall and 15 days thereafter, canes rooted 76, 87, 86 and 81%, respectively. However, root fresh weight was significantly lower at leaf fall as opposed to the other three collection times. When rooting performance of the 5 BB canes sectioned into four-node parts from base to apex, Dardeniz *et al.* [19] indicated that rooting was comparatively lowest in the basal nodes (1-4th) and changed between 86.3 to 92.5% in the more apical nodes. Root fresh weight was highest in the middle section of the canes and lowest in the basal part. The researchers [18, 19] concluded that best propagation material from 5 BB comes from the cuttings made from 5th to 16th nodes and could be collected any time starting from leaf fall.

In his study with different rootstock varieties for determination of accumulation of minerals in the wood, Fardossi *et al.* [20] found that potassium, calcium, magnesium and phosphor accumulation depended on variety and season. Hunter *et al.* [11] studied mineral contents of five different rootstock mother materials during the rest period and the mineral content of the rootstocks showed little variation. They also concluded that differences among the rootstocks might lead to differential fertilization in order to ensure optimum soil utilization, cost efficiency and to restrict soil and water pollution. Balasubrahmanyam *et al.* [10] suggested that evaluation of nutrient reserves in canes could be used as an important consideration in limitation of crop level in grapevines, since vines with minimum bud load showed higher accumulation of carbohydrates in the canes of Italian Riesling.

The nutrient status of the vine is very important when it enters dormancy, as this will influence the growth of the vine in the next spring. Firstly, an extensive root growth does not occur before budburst, the initial growth mainly takes place utilizing nutrient reserves. Secondly, carbohydrates stored during fall are used to maintain respiration ([17]. Satisha *et al.* [21] characterized ten grape rootstocks for their morphological, physiological and biochemical parameters using their leaves. They stated that "optimum carbohydrate/nitrogen ratios in the mother vines of these rootstocks helped attain better rooting percentages of hardwood cuttings". Kaserer *et al.* [22] studied the effects of the mineral contents of the canes on the development of shoots and roots of single bud cuttings of different grape cultivars. They recorded some differences in some minerals among the cultivars.

CONCLUSION

Grape rootstock canes were shown to have very little physiological activity and little change in mineral contents along the length of the canes during dormancy. Nevertheless, information on mineral content of the rootstock canes could help growers relate inherent capacities of rootstocks to accumulate mineral contents with lignification and rooting capacity.

ACKNOWLEDGEMENTS

We gratefully thank Ali Kabaoğlu from Atatürk Tea and Horticultural Research Institute, Rize, Turkey, Yazgülü Yılmaz and Abdullah Uslu for their invaluable help in laboratory analyses.

REFERENCES

1. Hartmann, H.T., D.E. Kester, F.T. Jr Davies and R.L. Geneve, 1997. Plant propagation: Principles and practices. Sixth edition. Prentice-Hall, Inc., New Jersey.
2. Haissig, B.E. and D.E. Riemenschneider, 1988. Genetic effects on adventitious rooting. In: Davis, T.D; Haissig, B.E. and Sankhla. A.N. (Eds): Adventitious Root Formation in Cuttings, 47-60. Discorides Press, Portland.
3. Levitt, J., 1980. Responses of plants to environmental stresses (2nd ed.), 185– 191. Acad. Press, New York.

4. Moe, R. and A.S. Anderson, 1988. Stock plant environmental and subsequent adventitious rooting. In: T. D. Davis; B. E. Haissig; A. N. Sankhla (Eds.): Adventitous Root Formation Cuttings, 214-234. Discorides Press, Portland.
5. Mamarov, P., M. Nikolov, S. Belcheva, I. Ivanova and D. Nenuova, 1993. Effect of some growth regulators on root development of grafted and non-grafted grapevine rootstock cuttings. Rastenievudni Nauki, Sofia, 30(7-8): 131-133.
6. Moretti, G., F. Anaclerio, M. Gardiman and L. Lovat, 2001. Effect of treatment with increasing NAA doses on grapevine rootstock cuttings. Vignevini, Bologna, Italy, 28(4): 137-142.
7. Bartolini, G., M.A. Toponi and L. Santini, 1986. Endogenous GA-like substances in dipping waters of cuttings of two cv. *Vitis* rootstocks. Amer. J. Enol. Viticult., 37: 1-6.
8. Wample, RL., 1997. Influence of pre-and post-treatment storage on rooting of hot-water treated cuttings of cabernet sauvignon. Amer. Jou. Enol. Vitic., 48(2): 131-136.
9. Alley, C.J. and J.E. Peterson,, 1977. Grapevine propagation. IX. Effects of temperature, refrigeration and indolebutyric acid on callusing, bud push and rooting of dormant cuttings. Amer. Jou. Enol. Vitic., 28: 1-7.
10. Balasubrahmanyam, V.R., J. Eifert and L. Diofasi, 1978. Nutrient reserves in grapevine canes as influenced by cropping levels. Vitis, 17: 23-29.
11. Hunter, J.J., C.G. Volschenk, D.J. Le Roux, G.W. Fouche and L. Adams, 2004. Plant material quality. ARC Infruitec-Nietvoorbij, Private Bag X5026, 7599 Stellenbosch, South Africa.
12. Kliewer, W.M., 1970. Free amino acids and other nitrogenous fractions in wine grapes. J. Food Sci., 35: 17-21.
13. Kacar, B. and A. Inal, 2008. Bitki analizleri. Nobel Yayın Dağıtım Ltd. Þti. Yayınları, No: 1241; Fen Bilimleri 63, (I. Basım) Ankara.
14. Horneck, D.A. and R.O. Miller, 1998. Determination of total nitrogen in plant tissue. In: Y. P. Karla (Ed.): Handbook of reference methods for plant analysis, pp: 75-83. CRC Pres, New York.
15. Ross, A.F., 1959. Dinitrophenol method for reducing sugar. In: W. F. Tulburt; O. Smith. (Eds.): Potato Processing., pp: 469-470. Tavi Publishing co. Wesport, Connecticut.
16. Satisha, J. and G.S. Prakash, 2006. The influence of water and gas exchange parameters on grafted grapevines under conditions of moisture stress. S. Afr. J. Enol. Vitic., 27: 40-45.
17. Lombard, J., 2003. Dormancy and restbreaking practices for table grapes. www. safj.co.za/pdf/dormancy. PDF. (released 1/12/2003).
18. Dardeniz, A., N.M. Muftuoglu, Z. Gokbayrak and M. Fırat, 2007. Assessment of morphological changes and determination of best cane collection time for 140 RU and 5 BB. Scientia Horticulturae, 113: 87-91.
19. Dardeniz, A., Z. Gokbayrak, N.M. Muftuoglu, C. Türkmen and Beşer, K., 2008. Cane quality determination of 5 BB and 140 Ru grape rootstocks. Europ. J. Hort. Sci., 73(6): 254-258.
20. Fardossi, A., C. Mayer, V. Schober and S. Mayer, 1996. Accumulation of minerals in one-year-old wood of different rootstock varieties. Mitteilungen Klosterneuburg, Rebe und Wein, Obstbau und Fruechteverwertung, 46(3): 97-104.
21. Satisha, J., S.D. Ramteke and G.S. Karibasappa, 2007. Physiological and biochemical characterisation of grape rootstocks. S. Afr. J. Enol. Vitic., 28(2): 163-168.
22. Kaserer, H., A. Fardossi and J. Barna, 1990. Investigations on the effects of the mineral contents of the canes on the development of shoots and roots of single bud cuttings of vine. Mitteilungen Klosterneuburg, Rebe und Wein, Obstbau und Fruechteverwertung, 40: 235-240.