https://dergipark.org.tr/tr/pub/food
OPEN ACCESS JOURNAL

ISSN 2667-5803

FHTI Journal of Food Health and Technology Innovations
June Vol 2, No 4 (2019)

DergiPark AKADEMİK

Research Article

Effect of Sulfur and Soda ($NaHCO_3$) Applications on Plant Nutrition Content of Grapevine in Organic Grape Growing

Fadime Ateş[1]*, Bülent Yağmur [2]

Abstract

Objective : The objective of this study was to determine the influence of sulfur and soda ($NaHCO_3$) applications on nutrient elements in the leaf blade and petiole of Sultani Çekirdeksiz grape variety growing organically during two years (2006-2007) in the transition zone between continental and Mediterranean climates of West Turkey.

Conclusion : It was found Sulfur application had positive effects, with the exception of Na, on the amount of macroelements and microelements (N, P, K, Ca, Mg, Fe, Zn and Mn) in leaf blade and petiole of Sultani Çekirdeksiz grape variety, when compared with soda (NaHCO3) applications. The highest increase in Na contenst of the leaf blade and petiole was obtained from soda (NaHCO3) application at 5% significant level.

Keywords: Organic grape, sülfür, soda ($NaHCO_3$),nutrition, leaf analysis

Introduction

Grapevines are some of the oldest fruit plants in the world. The grape is also one of the most important horticultural crops in the world with an annual production greater than 74,499,859 tons in 2018 (Anonymous 2019a).

Turkey is a major producer of grapes in the world and viticulture is one of the major branches of agriculture with respect both to the areas of production and the large share of income it provides for the Turkish economy. Grapevines are grown in almost all parts of Turkey and have been produced commercially in many regions of the country for many years.

Turkey is among the largest grapevine growing countries of the world with approximately 468,792 hectares of vineyard area and 4.01 million tons of grape production (5th in area; 6th in production). Grape production mainly consists of 52.8% table grapes, 36.4% raisins and 10.8% must-wine varieties (Anonymous 2019b).

Organic agriculture is a system for crops, livestock and fish farming that emphasizes environmental protection and the use of natural farming techniques. It is concerned not only with the end-product, but with the entire system used to produce and deliver the agricultural product. To this end, the entire farm cycle, from production and processing, to handling and delivery, excludes the use of artificial products such as genetically modified organisms (GMOs) and certain external agricultural inputs such as pesticides, veterinary drugs, additives and fertilizers. Organic farmers rely instead on natural farming methods and modern scientific ecological knowledge in order tomaximize the long-term health and productivity of the ecosystem, enhance the quality of the products and protect the environment. Proponents of organic

1 Manisa Viticulture Research Institute, Republic of Turkey Ministry of Agriculture and Forestry, 45125 Manisa Turkey
2 Department of Soil Science and Plant Nutrition, Faculty of Agriculture Ege University, 35100 Izmir, Turkey
* E-mail: fadime.ates@tarimorman.gov.tr

methods believe that it is a more sustainable and less damaging approach to agriculture (Morgera et al.2012).

In the world, organic grapes are grown in 379 555 hectares and this constitutes 5.3 % of the world's grape growing area. Turkey is a major grape producer in the world. Since 1985, Turkey producing and exporting organic raisins is a world leader in the production of raisins. Vineyards where organic grapes are grown are generally located in the provinces of Izmir and Manisa, and almost all the grapes are dried and exported to European countries in particular. In Turkey, 13 961 hectares grape are grown organically which constitutes 3.2 % of the total grape production area (Willer and Lernoud, 2019).

Processed as both table grapes and raisins, Sultani Çekirdeksiz grape variety is one of the most important export products of the country. Sultani Çekirdeksiz grapes variety is mostly grown using conventional methods in the Aegean Region. Of late years, however, it has been observed that companies of European origin have been making contracts with growers for organic grape production through their agencies in Turkey, which increases production based on organic methods.

A total of 95.89 % of the organic Sultani Çekirdeksiz raisin producers and % 95.55 of the total production area for organic seedless raisins are found in Izmir and Manisa region. According to records of Aegean Exporters Unions, the income earned from organic seedless raisin exports was approximately 3 million $ in 1977; whereas this figure escalated 79 % and reached 5,257,629 $ in 2004 (Kenanoğlu Bektaş and Milan, 2006).

Tissue and soil analysis each have their application for monitoring vineyard mineral nutrition. Of these, tissue analysis is far more useful in determining the grapevines' nutritional status and guiding a fertilizer program (Christensen and Kearney, 2000).

Previous studies with cv. 'Tempranillo' and cv. 'Red Grenache' showed the usefulness of carrying outmonitoring studies throughout the complete crop season in order to determine the reliability of leaf blade and petiole diagnosis and the period of validity of their references (Benito et al., 2013; Romero et al., 2013). According to these and other studies (Fraguas et al., 2003; Wolpert & Anderson, 2007; Benito et al., 2013; Romero et al., 2013), the higher variation for nutrient concentrations in petiole implied, in general, a lower reproducibility for this tissue. Comparing the analysis of blade and petiole, Christensen (1984) and Champagnol (1990) indicated that the variation intervals of phosphorus (P), potassium (K) and magnesium (Mg) in petiole were higher than in leaf blade. Nevertheless, Champagnol (1990) suggested that the significance of a result obtained from both tissues would be identical; also other studies showed that the individual variability for each nutrient was sometimes different between different vine varieties (Benito et al., 2013; Romero et al., 2013).

The present study was conducted on Sultani Çekirdeksiz grape variety, which has an important place in our national economy. The objective of this study was to determine the influence of applied sulfure and sulfur and soda ($NaHCO_3$) on on nutrient elements in the leaf blade and petiole of Sultani Çekirdeksiz grape variety growing organically from 2006 to 2007.

MATERIALS and METHODS

Experimental Site

Field experiments were conducted from 2006 to 2007 in Alaşehir-Yeşilyurt Enterprise of Manisa Viticulture Research Institute in the western part of Turkey (38°20′N, 28°38′W). The area has a transition towards a continental climate from a Mediterranean climate. The annual average temperature of 16.7 ^{0}C and a mean annual rainfall of 598 mm, The summer months, including the harvest period, are quite hot with mean temperatures of 30 ^{0}C.

Experiments were planned as randomized block design with three replicates which were established in15 years old Sultani Çekirdeksiz vineyard under irrigable soil conditions and trained to "T" wire grape trellis training system and can-pruned to 60 buds per vine. The vines had between-row and within-row spacing of 3.3 and 2.4 m, respectively in organic parcel.

Sultani Çekirdeksiz is such a variety that it ripens in midseason. It grows strong with conical clusters, wings, normal density, small oval shaped berries and average berry skin thickness. Although it is a variety for drying, Sultani Çekirdeksiz is also consumed as table grapes through a series of culture practice.

Soil Composition of the Trial Vineyard

There are no salinity problems whatsoever in soil samples demonstrating slight alkaline reaction. Soils with low lime level show a sandy loam texture. Available phosphorus in soils with low humus level and with medium total nitrogen level was found to be medium (0-30 cm) and low (30-60 cm), whereas available potassium was insufficient. In soils with sufficient (high) levels of available calcium and available magnesium, there are no problems with respect to av le sodium. Available micronutrient elements in the soil samples including iron, copper and manganese were sufficient, whereas zinc was insufficient **(Table 1).**

Table 1. Physical analysis and Macronutrient and Micronutrient Contents of the Soil Sample

Soil Depth		**0-30 cm**	**30-60 cm**
pH		7.60	7.65
Soil salinity	(%)	0.025	0.025
Lime	(%)	3.44	3.92
Sandy	(%)	68.40	66.40
Silt	(%)	24.00	25.00
Clay	(%)	7.60	8.60
Texture		Sandy-loam	Sandy-loam
Organic Matter	(%)	1.52	0.95
Total Nitrogen	(%)	0.060	0.038
Available Phosphorus	(ppm)	3.32	1.29
Available Potassium	(ppm)	175.00	155.00
Available Calcium	(ppm)	2160.00	2400.00
Available Magnesium	(ppm)	934.00	938.00
Available Sodium	(ppm)	20.8	19.00
Available Iron	(ppm)	8.51	6.79
Available Copper	(ppm)	6.13	3.48
Available Zinc	(ppm)	0.67	0.52
Available Manganese	(ppm)	7.20	4.09

In the study, after the vine shoots reached 25-30 cm, 80% wp sulfur (400 g/ 100 l water) and soda (2000 g/ 100 l water) were applied to vine canopy six times with 14 days intervals.

Leaves were sampled opposite the first cluster while the fruit was setting and brought to the laboratory. After initial cleaning, the leaves were separated in to blade and petiole (Mills and Jone 1996). Cleaning was conducted by washing the leaves with pure water. The plant samples were later dried at 65 to 70°C and ground. The total amount of N in the leaf sample was measured using the modified Kjeldahl method (Kacar 1972). Then, plant extracts were prepared by applying the wet-burning method and in the plant extracts, P was determined with the colorimeter (Lott et al.1956), K and Ca with the flame photometer and Mg, Fe, Zn, Mn and Cu with the atomic absorption spectrophotometer (AAS) (Slavin 1968; Kacar 1972).

The research was carried out as a randomized block design trial with three replicates consisting of 12 vines per parcel. Variance analysis was performed on the data obtained using the SPSS 20.0 for Windows software package, and the Duncan's Multiple Range Test ($p < 0.05$) was used for comparison of average values.

Results and Discussion

Sulfur and soda (NaHCO3) applications were evaluated with regard to the available N, P, K, Ca, Mg and Na in the leaf blade and petiole of Sultani Çekirdeksiz growing organiclly in the Alaşehir-Yeşilyurt Enterprise of Manisa Viticulture Research Institute during organic production phase from 2006 to 2007. The statistical analysis results for the available N, P, K, Ca, Mg and Na contents of the leaf blade and petiole of Sultani Çekirdeksiz were summarized in Table 4. Sulfur and soda (NaHCO3) applications significantly affected levels of macronutrient elements in the leaf blade and petiole of Sultani Çekirdeksiz ($P < 0.05$).

As can be seen from Table 3, Sulfur application had the highest average amount of N in the leaf blade and petiole (2.58% and 0.73%) P (0.24% and 0.26%); K (0.98% and 2.44%); Ca (1.78% and 1.42%); Mg (0.36% and 1.78%); soda (NaHCO3) application had the highest average amount of Na in the petiole and leaf blade (1.42 ppm and 0.36 ppm).

Table 3. The effects of sulfur and soda ($NaHCO_3$) applications on macronutrient contents of the leaf blade and petiole of the Sultani Çekirdeksiz grape variety (average from 2006 to 2007)*

	N (%)		P (%)		K (%)	
Applications	**Leaf blade**	**Leaf petiole**	**Leaf blade**	**Leaf petiole**	**Leaf blade**	**Leaf petiole**
SULFUR	2.39 b	0.71 b	0.21 b	0.20 b	0.87 b	2.34 b
SODA	2.58 a	0.73 a	0.24 a	0.26 a	0.98 a	2.44 a

	Ca (%)		Mg (%)		Na (ppm)	
Applications	**Leaf blade**	**Leaf petiole**	**Leaf blade**	**Leaf blade**	**Leaf petiole**	**Leaf blade**
SULFUR	1.54 b	1.29 b	0.31 b	1.54 b	1.29 b	0.31 b
SODA	1.78 a	1.42 a	0.36 a	1.78 a	1.42 a	0.36 a

*: Values in the same column with different subscript letters represent significant differences between different level of leaf removal at two periods

In addition, the leaf blade N, P, K and Ca contents of the leaf blade were found to be more than the petiole at the berry set while the petiole was found to have more Mg and Na than the leaf blade at the berry set.

On the other hand, the N content of the leaf blade for all applications was adequate at berry set, according to the 2% total N limit value suggested for the leaf blade by Fregoni (1984) and the 2.0-2.3% total N limit value recommended by Mills and Jones (1996). The P content of the leaf blade for all applications was found to be adequate at berry set according to the critical P value of 0.15% suggested by Fregoni (1984). At berry set, the K content of the leaf blade was found to be adequate for all applications according to the classifications by Fregoni (1984), Levy (1970) and Bergmann, (1988) [1.20-1.40%, 1.40%, and 1.20-1.60% respectively]. The Ca in the leaf blade was not adequate for all levels of leaf removal, according to the 2.5-3.5% Ca limit value suggested by Fregoni (1984), whereas it was adequate according to Ca limit value of 1.27-3.19% suggested by Chapman (1966) at the berry set. The Mg content of both the blades and petioles for all were found to be at a high level, according to the limit values of 0.20%, 0.23-0.29% and 0.25-0.50% suggested by Levy (1970), Chapman (1966) and Mills and Jones (1996) respectively (Table 3).

The micromineral contents of each parcel under sulfur and soda (NaHCO3) applications are given in Table 4. According to the results of the statistical analysis, it was determined that different levels of leaf removal over the course of the year had different and important effects on the amounts of Fe, Zn, Mn in the leaf blade and petiole at a 5% significant level (Table 5). Sulfur application had the highest level

of total Fe Zn and Mn in the leaf blade and petiole (for Fe 159.02 ppm and 95.48 ppm; for Zn 42.84 ppm and 35.66 ppm; for Mn 52.48 ppm and 34.66 ppm) at berry set compared to soda (NaHCO3) application.

Table 4. The effects of sulfur and soda ($NaHCO_3$) applications on micronutrient contents of leaf blade and petiole of Sultani Çekirdeksiz grape variety (average from 2006 to 2007)*

Applications	Fe (ppm)		Zn (ppm)		Mn (ppm)	
	Leaf blade	Leaf petiole	Leaf blade	Leaf petiole	Leaf blade	Leaf petiole
SULFUR	152.46 b	86.60 b	34.64 b	29.49 b	39.32 b	31.56 b
SODA	159.02 a	95.48 a	42.84 a	35.66 a	52.48 a	34.66 a

*: Values in the same column with different subscript letters represent significant differences between different level of leaf removal at two periods

In addition, more Fe, Zn and Mn of the leaf blade were found to be more than the petiole at the berry set. The Fe content of the leaf blade at berry set for all levels of leaf removal were generally between the limit values suggested by Anonymous (1967), Fregoni (1984) and Mills and Jones (1996) as adequate values (60-150 ppm, 50-300 ppm and 60-175 ppm, respectively). The total Fe content of the leaf petiole for all levels of leaf removal showed that there were no nutritional problems at during berry set according to the critical Fe value of 35 ppm suggested by Bergmann (1988).The Zn content of the leaf blade for all applications was found to be adequate during berry set according the critical Zn value of 35 ppm suggested by Alexander and Woodham (1964) and Fregoni (1984). For the leaf petiole samples during berry set, it was determined that all application were above the critical value of 26 ppm suggested by Christensen et al. (1984). At berry set, all application were determined to be adequate according to the critical Mn value of 20-400 ppm suggested by Fregoni (1984) inTable 4.

Conclusion

As a result of this research, when the findings regarding nutrition absorption of grapevine (Vitis vinifera cv. Sultani Çekirdeksiz) after sulfur and soda (NaHCO3) applications are evaluated. When the results are examined, The findings obtained from the study demonstrated that sulfur application had positive effects, with the exception of Na, on the amount of macroelements and microelements (N, P, K, Ca, Mg, Fe, Zn and Mn) in leaf blade and petiole of Sultani Çekirdeksiz grape variety, when compared with soda ($NaHCO_3$) applications. The highest increase in Na contenst of the leaf blade and petiole was obtained from soda (NaHCO3) application in the first two years. Significant increases in nutrient uptake of grapevines can be expected in the following years of the research, which was carried out for 2 years.

Acknowledgements

This work was supported by the TAGEM [Grant number 111.05.2.001].

References

Alexander, D., Mc E., and R.C. Woodham. 1964. Yield responses by sultanas to applications of zinc and superphosphate. Australian Journal of Experimental Agriculture, 4 (13), 169-172.

Anonymous, 2019a. Fao web site. http://www.fao.org/faostat/en/#data (Available from: 29.12.2019)

Anonymous, 2019b. TUİK, 2019. http://biruni.tuik.gov.tr/bitkiselapp/bitkisel.zul., (Available from: 29.03.2019).

Anonymous, 1967. Soil testing and plant analysis, I and II.S.S.S.A, Inc. Mad. Wisconsin.

Benito A, Romero I, Domínguez N, García-Escudero E, Martín I, 2013. Leaf blade and petiole analysis for nutrient diagnosis in Vitis vinifera L. cv. Garnacha tinta. Aust J Grape Wine Res 19: 285-298. http://dx.doi.org/10.1111/ajgw.12022.

Bergmann, W. 1988. Ernährungsstörungen bei Kulturpflanzen. Entstehung, visuelle und analytishe diagnose, Bergmann W. (Ed.), 2e édition, Gustav Fisher Verlag, Stuttgart, New York., 762 p.

Champagnol F, 1990. Rajeunir le diagnostic foliaire. Progrès Agric Vitic 107: 343-351.

Chapman, H. D. 1966. Diagnostic criteria for plants and soils. Citrus Resources Centre and Agriculture Experiment Station, Riverside, California, USA.

Christensen P, 1984. Nutrient level comparisons of leaf petioles and blades in twenty-six grape cultivars over three years (1979 through 1981). Am J Enol Vitic 35: 124-133.

Christensen, P., & Kearney, U. C., 2000. Use of tissue analysis in viticulture. Cooperative Extension Work in Agriculture the University of California, 10, 1-9.

Fraguas J.C., Miele A, Silva E. B., 2003. Grapevine nutricional diagnosis methods for the Serra Gaucha viticultural region, Brazil. J Int Sci Vigne Vin 37: 15-21.

Fregoni, M. 1984. Nutrient needs in wine production, 319-332. In: 18th Colloquium International Potash Institute, Bern, Switzerland.

Kacar, B. 1972. Bitki ve toprağın kimyasal analizleri II. Bitki analizleri, Ankara University, Faculty of Agriculture Publications 453-Application Manual 155.

Kenanoğlu Bektaş, Z ve Miran, B., 2006. Manisa ve Izmir Illerinde Geleneksel ve Organik Çekirdeksiz Kuru Üzümün Karşılaştırmalı Ekonomik Analizi . Tekirdağ Ziraat Fakültesi Dergisi (Journal of Tekirdag Agricultural Faculty), 3 (3)

Levy, J. F. 1970. Vingt années d'application du diagnostic foliaire à la vigne. Vignes et Vins, 194, 195.

Lott, W. L., Nery, J. P., Gallo, J. R., and Metcalf, J. C., 1956. Leaf analysis technique in coffee research. The Institute for Bioengineering of Catalonia (IBEC) Research Institute, Bulletin, No: 9.

Mills, A. H and Jones J. B.. 1996. Plant analysis handbook II: A practical sampling, preparation, analysis, and interpretation guide (No. 581.13 M657), Micro Macro Publishing, Athens, U.S.A. 422.

Morgera, E., Caro E.C. and Durán, G.M., 2012. Organic agriculture and the law. FAO LEGISLATIVE STUDY 107. http://www.fao.org/docrep/016/i2718e/i2718e.pdf.

Romero I, García-Escudero E, Martin I, 2010. Effects of leaf position on blade and petiole mineral nutrient concentration of Tempranillo grapevine (Vitis vinifera L.). Am JEnol Vitic 61:

544-550.

http://dx.doi.org/10.5344/ajev.2010.09091.

Romero I, García-Escudero E, Martin I, 2013. Leaf blade vs. petiole analysis for nutritional diagnosis of Vitis vinifera L cv. Tempranillo. Am J Enol Vitic 64(1): 50-64.

http://dx.doi.org/10.5344/ajev.2012.11004

Slavin, W. 1968. Atomic absorption spectroscopy. lnterscience, New York. 307 p.

Willer, H., and Lernoud, J., 2019. The world of organic agriculture. Statistics and emerging trends 2019. Research Institute of Organic agriculture (FİBL), Frick, and IFOAM- Organics Internatinal, Born.

Wolpert JA, Anderson JM, 2007. Rootstock influence on grapevine nutrition: Minimizing nutrient losses to the environment. Proc California Plant Soil Conf, Sacramento, CA (USA), Feb 6-7. pp: 77-83.