Tarım Makinaları Bilimi Dergisi (Journal of Agricultural Machinery Science)
2017, 13 (1), 33-38

Effects of Different Tillage Methods on the Nutrient Contents of Organically Grown Sultani Çekirdeksiz Grape

Fadime ATEŞ[1], Bülent YAĞMUR[2], Engin ÇAKIR[3], Harun YALÇIN[3]
[1] Viticulture Research Institute, Manisa, Turkey
[2] Ege University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, İzmir, Turkey
[3] Ege University, Faculty of Agriculture, Department of Agricultural Engineering & Technology, İzmir, Turkey
Corresponding author: fadimeates2@yahoo.com

Received (Geliş Tarihi): 16.02.2017 Accepted (Kabul Tarihi): 18.04.2017

Abstract: This study was carried out in Alaşehir-Yeşilyurt Enterprise of Manisa Viticulture Research Institute in the western part of Turkey from 2006 to 2007. In this study, effects of the three different tillage methods: conventional tillage and two conservation tillage methods; Mulch tillage and reduced tillage on nutrient contents of organically grown Sultani Çekirdeksiz grape variety were investigated. Experiments were undertaken using randomized block design with three replicates consisting of 12 vines per parcel.
According to the results, it was found that there was highest average nitrogen(N), phosphorus (P) potassium (K), calcium (Ca), magnesium (Mg) and iron (Fe) and copper (Cu) contents of the leaf blade and petiole in mulch tillage; highest average magnesium contents of the leaf blade and petiole in mulch tillage; highest average Cu and manganese (Mn) contents of the leaf blade and petiole in conventional tillage; highest average manganese zinc (Zn) contents of the leaf blade and petiole in reduced tillage at 5 % significant level.
Key words: Sultani Çekirdeksiz, organic grape, tillage methods, leaf blade and petiole, nutrient content

INTRODUCTION

Turkey is a major producer of grapes in the world and viticulture is one of the major branches of agriculture with respect to production area and it has one of largest share of income in the Turkish national economy. Grapevine is grown in almost all parts of Turkey and has 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, 2015).

In the world, organic grapes are grown in 311595 hectares and this constitutes 4.6 %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. In Turkey, 8418 hectares grape are grown organically which constitutes 1.8 % of the total grape production area (Anonymous, 2016).

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 to maximize the long-term health and productivity of the ecosystem, enhance the quality of the products and protect the environment. Proponents of organic methods believe that it is a more sustainable and less damaging approach to agriculture (Morgera et al., 2012).

Plant analysis is often the most reliable method of assessing crop nutritional status, currently being the basis of the fertilizer recommendation programs for tree crops and vines. Several studies have been done in order to establish the most appropriate tissue for analysis. Leaf blade and petiole have been the major competing ones (Brunetto et al., 2007; Assimakopoulou and Tsougrianis, 2012; Benito et al., 2013).

The results of plant analysis are usually interpreted by comparing actual data with previous established critical values or sufficiency ranges (Mills and Jones, 1996). In order to improve the accuracy of the diagnosis of the nutritional status of crops, other forms of interpretation have been developed. DRIS (Diagnosis and Recommendation Integrated System) has probably been the most popular. DRIS uses ratios of nutrients, which reduces the sensitivity of tissue analysis to plant age (Römheld, 2012).

Deep tillage method used before vine plantation to remove old vine roots and loosen subsoil may induce physical soil degradation that could affect soil structure and vine water supply. The deep tillage study results showed that (i) a significant soil compaction was observed after wet conditions only, (ii) deep ploughing produced more soil compaction than ripper because of a greater volume of soil affected by wheeling in the former operation and (iii) a specific response of soils is significantly observed in the case of deep ploughing only with an increase of compacted zones fragmentation in relation to a decrease of clay content (Coulouma, et. al., 2006).

Göblyös and Ulcz (2008) studied the effect of several cultivation methods on the yield and the quality of grape. They found that different cultivation methods have higher effect on the yield than on the grape quality. Especially in the dry season they observed that straw mulch proved to be the best solution regarding the yield and the grape quality. Although they found no significant differences in the sugar and titratable acidity content of the must, the ratio of noble rotted berries was higher on the straw mulched plots. Straw mulch could conserve the moisture content of the soil.

The effect of conventional and no tillage and 3 leaf removal treatments on leaf water potential (Ψleaf), yield, cluster and berry characteristics of cv. Syrah were investigated by Korkutal and Bahar (2013). Different soil tillage applications affected cluster length and berry fresh and dry mass. The leaf removal treatments affected only total leaf area per vine (m^2.$vine^{-1}$). They concluded that under these soil and climatic conditions, it could be advised conservative soil tillage alternatively to conventional soil tillage as to be more economical.

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 effect of different tillage methods: conventional tillage, mulch tillage and reduced tillage on the nutrient contents of the leaf blade and petiole from Sultani Çekirdeksiz grape variety in organic grape parcels during organic production year of 2006 and 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 in 15 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 available 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 on the Trial Vineyard

Soil properties	Soil Depth (cm)	
	0-30	**30-60**
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	155
Available Calcium (ppm)	2160	2400
Available Magnesium (ppm)	934	938
Available Sodium (ppm)	20,8	19,0
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

Table 2. Applied tillage methods

Method	**Application**
Conventional Method	Plough + Disk Harrow (two passes)
Mulch Tillage	Plough + Disk Harrow (two passes) (No tillage in Spring)
Reduced Tillage	Disk Harrow (one pass) + Reduced tillage combination (two passes)

The effect of different tillage methods on organic grape production was examined. In this research, conventional tillage, mulch tillage and reduced tillage were used (Table 2).

For conventional tillage method, rows were initially ploughed and then harrowed by disc harrow. In mulch tillage, conventional tillage was applied but spring tillage was not performed instead, planted mulch material was chopped and laid in the row. Cultivator with rotary harrow was used as a reduced tillage.

Common vetch (Vicia sativa L.), Rye (Hordeum vulgare L.), and broad beans (fava beans) were used as mulch plants. In November, the soil was tilled using conventional method before planting mulch plants. The mix was planted by using fertilizer spreader. After planting, the soil was disked to incorporate the seeds into the soil. The soil was tilled in spring and autumn in both conventional and cultivator plots, whereas, tillage was applied only in spring for mulch tillage system. In the experiment Massey 240 S (Engine Power 50 hp) tractor was used.

Fresh grape yield (kg/vine) was calculated by weighing the vines obtained from the parcels and dividing it with the number of vines.

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

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

RESULTS and DISCUSSION

Result and discussion on fresh grape yield (kg/vine):

Fresh grape yield obtained from each parcel under different tillage methods are given in Table 4. According to the results of the statistical analysis, it was determined that tillage methods over the years had different important effects on fresh grape yield at 5 % significant level (Table 3).

As can be seen from Table 3, mulch tillage method as compared to other tillage methods had the highest fresh grape yield.

Table 3. The effects of different tillage methods on fresh grape yield (kg/vine) (average of from 2006 to 2007)

Tillage methods	Fresh grape yield (kg/vine)
Conventional tillage	14,74 b*
Reduced tillage	13,78 b
Mulch tillage	16,58 a

*Means within columns followed by the same letter are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test

Results and Discussion on the Petiole and Leaf Blade

Macro mineral contents as obtained from each parcel under different tillage methods are tabulated in Table 4. According to the results of the statistical analysis, it was determined that tillage methods over the years had different important effects on available nitrogen (N), phosphorus (P) potassium (K), calcium (Ca) and magnesium (Mg) contents of the leaf blade and petiole at 5 % significant level (Table 4).

As can be seen from Table 4, mulch tillage method as compared to other tillage methods, had the highest amount of average nitrogen on the leaf blade and petiole (%2,72 and % 0,92), phosphorus (% 0,39 and %0,32) potassium (%1,05 and %2,71), calcium (% 1,99 and %1,34), and magnesium (%0,51 and %0,89). The N, P, and Ca contents of the leaf blade were found to be more than the petiole.

On the other hand, nitrogen content of the leaf blade in all tillage methods were adequate at the fruit setting period according to the 2% total nitrogen limit value as suggested for the leaf blade by Fregoni (1984) and proposed to 2.0-2.3 % total nitrogen limit value was recommended by Mills and Jones (1996). P content of the leaf blade in all tillage methods were found to be adequate at the fruit setting period according to 0.15% the critical P value was suggested by Fregoni (1984). At the fruit setting period, all tillage methods was found to be adequate in terms of K content on the leaf blade according to classification by Fregoni (1984), Levy (1970) and Bergmann (1988) (%1.20-1.40; %1.40; %1.20-1.60) whereas it was not sufficient on petiole. Ca content of

Table 4. The effects of different tillage methods on macronutrient contents of the petiole and leaf blade of organıcally grown Sultani Çekirdeksiz grape variety (average from 2006 to 2007)

Tillage methods	N(%)		P(%)		K(%)		Ca(%)		Mg(%)	
	Leaf Blade	Petiole	Leaf Blade	Petiole	Leaf Blade	Petiole	Leaf Blade	Petiole	Leaf Blade	Petiole
Conventıonal tillage	2,57 c*	0,58 c	0,28 b	0,27 b	0,97 c	2,28 c	1,70 c	1,19 c	0,45 b	0,77 b
Reduced tillage	2,67 b	0,71 b	0,24 c	0,23 c	1,03 b	2,67 b	1,77 b	1,29 b	0,35 c	0,69 c
Mulch tillage	2,72 a	0,92 a	0,39 a	0,32 a	1,05 a	2,71 a	1,99 a	1,34 a	0,51 a	0,89 a

*Means within columns followed by the same letter are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test

Table 5. The effects of different tillage methods on micronutrient contents of on the petiole and leaf blade of organically grown Sultani Çekirdeksiz grape variety (average from 2006 to 2007)

Tillage methods	Fe (ppm)		Cu (ppm)		Zn (ppm)		Mn (ppm)	
	Leaf Blade	Petiole	Leaf Blade	Petiole	Leaf Blade	Petiole	Leaf Blade	Petiole
Conventıonal tillage	142,85 b*	80,20 b	32,8 a	49,91 a	48,83 a	32,83 a	48,43 a	33,11 a
Reduced tillage	154,12 a	77,33 c	19,05 b	28,95 b	49,49 a	33,02 a	46,24 a	32,75 a
Mulch tillage	154,43 a	97,43 a	19,34 c	26,52 c	35,12 b	26,64 b	34,97 b	19,11 b

*Means within columns followed by the same letter are not significantly different at $p < 0.05$ according to Duncan's Multiple Range Test

the leaf blade of all tillage methods were not found to be adequate level according to 2.5-3.5% Ca limit value, which was suggested by Fregona (1984) whereas they were adequate level as classification according to Ca limit value 1.27-3.19% which was suggested by Chapmann (1965) at the fruit setting period. Mg content of Both the blades and petioles in all tillage methods were found to be in the high level, according to the limited value of %0.20; %0.23-0.29; %0.25-0.50 as suggested by Levy (1970), Chapmann (1965); Mills and Jones (1996) respectively (Table 4).

Micro mineral contents of each parcel under different tillage methods are given in Table 5.

According to the results of the statistical analysis, it was determined that tillage methods over the years had different important effects on the contents of iron (Fe), copper zinc (Zn), manganese (Mn) copper (Cu) contents of the leaf blade and petiole at 5 % significant level (Table 5).

Micronutrient contents on the petiole and leaf blade under different tillage methods are given in Table 5. Mulch tillage method as compared to conventional tillage methods, had the highest level of total Fe content of the leaf blade and petiole at the fruit setting period (154,43 ppm and 142,85 ppm). However, conventional tillage method had the highest level of Cu, Zn and Mg on the leaf blade and petiole at the fruit setting period comparing other tillage methods. And also Fe, Zn and Mn contents of the leaf blade were found to be more than the petiole. Total Fe content of the leaf blade at the fruit setting period, comparing limit value, which was suggested by Anonymous (1967); Fregoni (1984); Mills and Jones (1996) as critical value (60-150 ppm; 50-300 ppm; 60-175 ppm, respectively, were generally among limits value in all tillage methods. Total Fe content of the leaf petiole in all tillage methods shows that there were no nutritional problems at the fruit setting period according to 35 ppm critical Fe value suggested by Bergmann (1988). Cu content of the leaf blade and petiole at the fruit setting period, comparing limit value, which was stated by Chapmann (1966) and Bergman (1988) as critical value (5-20 ppm and 6-12 ppm respectively, shows that they are in generally among limits value in all tillage methods. Zn content of the leaf blade in all tillage methods were found to be adequate at the fruit setting period according to 35 ppm as the critical Zn value suggested by Alexander and Woodham (1964) and Fregoni (1984). For the leaf petiole samples at the fruit setting period, it was determined that all tillage methods were above the critical value of 26 ppm suggested by Christensen et al., (1984).

At the fruit setting period, all tillage methods were determinate to adequate according to 20-400 ppm as the critical Mn value was suggested by Fregoni (1984) and also on the leaf blade and leaf petiole and also stated by Christensen et al. (1984) as 25 ppm the critical Mn value (Table 5).

CONCLUSIONS

According to the overall results of this research; mulch tillage method as compared to other tillage methods was determined to make a positive impact on not only yield but also macro and micronutrient contents (N, P, K, Ca, Mg and Fe) of the petiole and leaf blade. Mulch tillage method had the highest level of yield as compared to other tillage methods. And mulch tillage had the highest amount of average nitrogen on the leaf blade and petiole (%2,72 and % 0,92), phosphorus (% 0,39 and %0,32) potassium (%1,05 and %2,71), calcium (% 1,99 and %1,34), and magnesium (%0,51 and %0,89). The N, P, and

Ca contents of the leaf blade were found to be more than the petiole.

Generally, nitrogen content of the leaf blade in all tillage methods were adequate at the fruit setting period according to the 2% total nitrogen limit value as suggested for the leaf blade by Fregoni (1984) and by Mills and Jones (1996).

On the other hand, conventional tillage method had the highest level of Cu, Zn and Mg on the leaf blade and petiole at the fruit setting period comparing other tillage methods.

Generally, it can be concluded that mulch tillage not only gives higher yield but also provides for an adequate level of macro and micro elements for organically grown Sultani Çekirdeksiz grape.

REFERENCES

Alexander, D. Mc. E. and Woodham, R.C., 1964. Yield responses by sultanas to application Zn and super phosphate, A. J.of Expt. Agric. and Animal Husbandry 4, 169-172.

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

Anonymous, 2015. FAO Statistical Yearbook 2013 World Food and Agriculture. http://www.fao.org/docrep/018/i3107e/i3107e.PDF. (Available from: 25.06.2016)

Anonymous, 2016. FIBLE and IFOAM Organic International The World of Agriculture. Statistics and Emerging Terns. https://shop.fibl.org/fileadmin/documents/shop/1698-organic-world-2016.pdf (Available from: 25.06.2016)

Assimakopoulou, A., Tsougrianis, C., 2012. Correlation between yields, must attributes and nutritional status of the Greek red wine grape variety Agiorgitiko.J. Plant Nutr. 35, 1022–1036.

Bergmann, W., 1988. Ernahrungsstörungen bei kulturpflanzen. VEB Gustav Eisher Verlag, Jena 373-382.

Benito, A., Romero, I., Domínguez, N., García-Escudero, E., Martín, I., 2013. Leaf bladeand petiole analysis for nutrient diagnosis in Vitis vinifera L. cv. Garnacha tinta.Aust. J. Grape Wine Res. 19, 285–298.

Brunetto, G., Ceretta, C.A., Kaminski, J., Melo, G.W.B., Lourenzi, C.R., Furlanetto, V.,Moraes, A., 2007. Application of nitrogen in grapevines in the campaign of the Rio Grande do Sul: productivity and chemical characteristics of the grape must.Cienc. Rural 37 (2), 389–393.

Cahoon, G. A. 1970. Survey of foliar content of American and French hybrid grapes in fourteen research demonstration vineyards in Southern Ohio Rest. Ohio Agric. Res. Dev. Cent. 44: 24-27.

Chapmann, H. D., 1965. Diagnostic criteria for plant and soils. Department of soils and plant nutrition, University of California citrus research center and agricultural experiment station, Riverside, USA.

Christensen, L. P., Kasimatis, A.N. and Jensen. F.L., 1984. Grapevine nutrition and fertilization San jonqiun Valley Arg. Sci. Pub. Univ. Of Calif. Div. of Arg. Sci. Berkley, 33-37.

Coulouma, G., Boizard, H., G. Trotoux, Lagacherie P. and Richard,G., 2006. Effect of deep tillage for vineyard establishment on soil structure. Soil and Tillage Research, doi:10.1016/j.still.2005.05.002

Fregoni, M.,1984. Nutrient needs in vine production, pages 319-332, 18th coll. Ins. Bern, 319-332.

Göblyös, J. & Ulcz, A. 2008. Comparison of several soil cultivation methods in the Tokaj-wine region. International Journal of Horticultural Science 2008, 14 (3): 35–37, Agroinform Publishing House, Budapest, Printed in Hungary, ISSN 1585-0404

Kacar, B., 1972. Bitki ve toprağın kimyasal analizleri II. Bitki analizleri, A. Ü. Ziraat Fak. Yayınları 453-Uygulama klavuzu 155.

Korkutal, I. and E. Bahar, 2013. Influence of different soil tillage and leaf removal treatments on yield, cluster and berry characteristics in cv. Syrah (Vitis vinifera L.). Bulg. J. Agric. Sci., 19: 647-658

Levy, J. F., 1970. Vingt annees d' apllication du diognostic foliaire ala vigne. Atti dell acc. It. Della vite edel vino. t. Xx 11,1-21.

Lott, W. L., Nery, J. P., Medcaff. J.C., 1956. Leaf Analysis Technique in Coffe Research. EC., Res. Inst., Bulletin, No:9.

Mills, A. H., and Jones. J. B., 1996. Plant analysis handbook 11, a practical sampling, preparation, analysis and interpretation guide, 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

Römheld, V., 2012. Diagnosis of deficiency and toxicity of nutrients. In: Marschner,P. (Ed.), Marschner's

Slavin, W., 1968. Atomic absorption spectroscopy: New York, Intersci. Pubs., 307 p.