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YIELD AND MINERAL COMPOSITION OF GRAPEVINE AS AFFECTED BY MAGNESIUM AND IRON FOLIAR NUTRITION

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Abstract

The aim of this study was to evaluate foliar fertilizers (Magni mag helat and Magni fer helat) effects on yield, quality parameters and nutrient contents of the leaves of vine cultivar Cardinal in comparison to control variant (without foliar fertilizer). Field trials has been organised according the method of random block system with three variants (including control variant I) in three repetitions. Foliar fertilizers were applied in concentration of 0.5 %, four times during the vegetation period (before and after blooming, buckshot berries and version).

Results for 3 years indicated that Mg and Fe fertilizers application affected the yield of grape and its quality. Fertilized Variant III had higher average yield with 14.87 t/ha. Foliar fertilizing with Fe has significant effect on increasing of: total cluster weight, berries weight per cluster and percentage of berries. Treated variants had a lower weight of skin and seeds, compared with the control. A substantial influence of foliar fertilizers on analysed element contents in leaves has been identified, also. The 3-years average content of macro and micro elements showed higher content of P (0.35 %), Ca (3.03 %), N (2.25 %), Mn (133.24 mg/kg) and Cu (18.18 mg/kg), at Variant II. Results of leaf tissue confirmed some antagonistic relations between analysed elements, like: Fe/P, Mg/K and Fe/Mn.

Key words: *Cardinal, berries, element, fertilization, quality*

INTRODUCTION

All plants needs an adequate supply of macro and micro-elements in order to match their normal physiological and biochemical functions. Beside basic mineral nutrients (N, P and K), some other elements (Mg, Fe, Zn, B and etc.) are considered to be essential for plant metabolic processes because they areco-factors and/or activators of many metabolic enzymes (Marschner, 1995).

Nutrient availability can be improved by soil or foliar application of a needed element. Soil fertilization is the most ancient normal fertilization practice, but foliar fertilization, which has been developed in the last 60 years, may improve nutrient uptake when compared with soil application, particularly for nutrients that can be sorbed on the soil minerals (Kannan, 2010; Tejada and Gonzales, 2004). With this type of fertilization, in a short period of time, plants are provided with a adequate amounts of nutrients. The short period of response, allows its applications periods of highest necessity (Duletić & Mijović, 2014), with a major impact on grape yield increase (Shaaban et al., 2007). According Alshaal and El-Ramady (2017), this foliar fertilizing is utilized in agriculture by spraying the foliage with dilute solutions of the desired nutrients. Therefore, foliar fertilization is generally recommended for supplying additional N, magnesium (Mg) and micronutrients as well as P, K and sulphur (S).

Magnesium (Mg) is an important macronutrient with a number of physiological functions in the plant. The importance of magnesium in the plant is in many ways connected with photosynthesis. It is the central atom of chlorophyll and it activates enzymatic processes. Magnesium also favourably influences assimilation (Mengel and Kirkby, 2001).Visually it is seen as chlorosis of leaves, especially older ones and causes premature abscission. Chlorosis is caused either by Mg deficiency, high content of soil Ca (calcareous soils) or a combination of these factors (Gluhić et al., 2009).Foliar spraying with fertilizers containing Mgis a common practice to correct nutrient imbalances in grape, but Mg doses beyond those required for maximum yield rarely induce further improvement of product quality (Gerendás & Führs, 2013).

While Fe is the most common nutrient in soils, 90 to 99.98% of soil Fe is unavailable for plants (Barber, 1995). Iron (Fe) is an important element in crop physiology, because it is essential for the activity of many important enzymes, including cytochrome that is involved in electron transport chain, synthese of chlorophyll, maintaining the chloroplast structure and enzyme activity (Mamatha, 2007). Iron in the soil is the fourth abundant element on earth, but its amount was low or not available for the plants and microorganisms needs, due to low solubility of minerals containing iron in many places the world, especially in arid region with alkaline soils (Eskandari, 2011). Iron (Fe) deficiency induces chlorosis is a major nutritional disorder in in calcareous soils (Álvarez- Fernández et al., 2006).Iron deficiency (iron chlorosis) in fruit trees is results from impaired acquisition and use of the metal by plants, rather than from a low level of Fe in soils. Therefore, Fe fertilizers, either incorporated through soil or applied to the foliage, are used every year to control Fe deficiency (Abadía et al., 2011).

Nutrients management in vineyards requires regular assessment of leaf, petiole and/or soil nutrient content and the application of fertilizers accordingly (Martin, 2012).Thus, the aim of this experiment was to study the effects of foliar applications of fertilizers containing Mgand Fe on the yield, cluster structure and concentration of macro and micro elements in the blades of grapevines variety 'Cardinal' (Vitis viniferaL.), planted on alkaline and high carbonate soil.

MATERIAL AND METHODS

Experimental site description

Three years (2012-2014) of field examinations has been conducted in area of "Tikvesh" vine region, Republic of North Macedonia, which has agro-ecologically favourable conditions for growing table vine varieties with different period of ripening. "Tikvesh" vine region is situated in the central part of the country, characterized with warm and dry climate. The predominant soil type is rendzinic soils (Table 1), formed on recent Pliocene sediments. The vineyard where the experimental site was situated was established 25 years ago, planted with cv. Cardinal, "2-cordon" system, with row spacing of 2,80 x 1,10 m (3247 vine/ha).

Table. 1. Soil properties at experimental site.

Depth (cm)	pH/H_2O	Total %	Active lime %	Total %	Available mg/100g soil		Available mg/kg	
		$CaCO_3$	CaO	N	P_2O_5	K_2O	Mg	Fe
0-30	8.06	17.33	5.50	0,13	22.10	22.52	422,46	4,58
	moderately alkaline	high	low	medium	very high	optimal	optimal	medium
30-50	8.09	17.28	2.0	0,11	19.22	21.46	422,73	3,95
	moderately alkaline	high	low	medium	high	optimal	optimal	medium
50-80	8.10	18.53	3.50	0.10	16.05	19.65	448,66	3,27
	moderately alkaline	high	low	medium	optimal	medium	optimal	medium

Treatments and experimental design

The experiment has been conducted according the method of random block system with three variants and three repetitions. During the period of investigation, all standard agro-technical measures were conducted: cultivation (deep and shallow tillage), soil fertilization (350kg/ha NPK 8-16-24 in autumn and 100kg/ha ammonium nitrate 33 % in spring), irrigation (July- August) and plant protection (up to eight times, due to the bad weather conditions in 2014). The monitored variants were:

1. Control NPK(without foliar fertilizer) in text Variant I;
2. NPK + Magni mag helat Mg EDTA (1.5 % Mg; 24.14 % MgK_2 EDTA; 9.89 % NH_4NO_3) in text Variant II;
3. NPK + Magni fer helat Fe EDTA (3.2 % Fe; 22 % FeK EDTA; 9.18 %. NH_4Cl) in text Variant III.

The fertilizers were foliary applied in concentration of 0.5 %, four times during the growing period, at the stages of: before and after blooming, buckshot berries and version. Applications were performed on mostly dry and cloudy weather, with no precipitation, in early morning hours.

Soil analysis

pH – electrometric, carbonate content, active lime by Drouineau-Galet; total N by Kjeldahl, available forms of P_2O_5 and K_2O by AL method; mobile fraction of Mg after extraction by ammonium acetate solution and mobile fraction of Fe after extraction by DTPA.

Plant analysis- leaf samples consisting of 10 leaves per replicate were taken opposite the basal cluster, every year after harvest. Leaves were gently washed, dried at room temperature and fine grinded. Analysed elements (N, P, K, Ca, Zn, Mn and Cu) in plant tissue were determined with ISP-AES technique after its digestion (Heating Digester DK 20)with concentrated HNO_3 + H_2O_2 (Cvetković, 2002). All tests were performed each year in three replications.

Yield and grape quality

The total yield was calculated by counting of clusters number and its weight per vine. Representative random samples of 24 clusters per variant were analysed to determine: cluster weight, berries and peduncle weight per cluster and percentage of berry's per cluster. Random samples of 100 berries from each replication were analysed to determine the weight of: berries, skin, seeds and pulp. The cluster and berries properties were determined according to the CODE system issued by the International Organization of Vine and Wine (O.I.V, 2011).

Statistical data analysis was carried out with SPSS 20.0 package program.

RESULTS AND DISCUSSION

Effects of Mg and Fe fertilizers on grape yield and cluster structure

There are many factors that influence on grape quantity and quality, as many ampelo technical measures, the growth regulators and proper plant nutrition (Prabhu and Singaram, 2001).

Out of the data presented in Table 2, it can be concluded that the different types of applied fertilizers showed a positive influence even in the first year of research, compared to the control variant. The results showed that all tested variants of fertilizing had a higher yield than the variant without foliar fertilization (control), where the average yield is lowest, with 4,18 kg/vine (13.59 t/ha). The variant III had the highest average yield of 4.58 kg/per vine or 14.87 t/ha. According Bozinović (2010), fruit yields can vary from year-to-year and vineyard to vineyard depending on environmental conditions and management practices, which was confirmed with our results as well (Tab. 2). Grape yield was significantly different in the 3rd year of exemination, when the yield was significantly lower compared to the previous years. The negative influence of high precipitations should be emphasized, especially rainfalls in April (135.8 mm) in a phase of buds opening and shoots growth, and in September (124.0 mm) in the period of intensive harvest. The unfavourable weather conditions during May2014, with appearance of hail in the beginning of the growing season and outburst of Plasmopara viticola, were the main reasons for low grape yield in this growing season, which was significantly lower compared to the previous two growing seasons (2012/2013). Despite the bad weather conditions in 2014, foliar application in variant II and III had a positive effects on grape yield in these two variants. The differences among varieties may be related to the Mg and Fe roles in chlorophyll molecules, directly and photosynthesis indirectly, which increased their ability to recover from hail damages and resistance to infections.

Table 2. Grape yield (2012-2014).

Year	2012		2013		2014		Average	
Variant	kg/vine	t/ha	kg/vine	t/ha	kg/vine	t/ha	kg/vine	t/ha
Control	4.90	15.89[a]	4.94	16.03[a]	2.72	8.83[a]	4.18	13.59[a]
NPK+ MgEDTA	5.50	17.87[a]	5.04	16.35[a]	3.03	9.84[a]	4.52	14.68[a]
NPK+ Fe EDTA	5.40	17.54[a]	5.43	17.63[a]	2.91	9.44[a]	4.58	14.87[a]

Different letters (a, b) indicate significant differences among treatments.

Our results are in correlation with those obtained by Duletić and Mijović (2014) and Zlámalová et al. (2015), who observed that foliar treatment improved grape yield and its parameters.

During Duletić and Mijović (2014) researched, authors noted that foliar fertilization has positive influence on grape yield and cluster weight (cv. Cardinal). All treated variants in his research, had a higher yield (3.38-4.5 kg/vine) and higher cluster weight (363 g) compared with the not treated variant (2.9 kg/vine and 223 g). Zatloukalová et al. (2011) reported a 3.1–6.7% increase in yields of cv. Riesling italico after 5 times repeated 5% foliar nutrition to vine with the fertilizer Epso Top (9.65% Mg, 13% S) and Epso combitop (7.8% Mg, 13% S, 4% Mn and 1% Zn).

During the research period, significant differences were noted in yield components at tasted variants (Tab. 3). Foliar fertilizers have effect on increasing the total cluster weight (CW), berries weight per cluster (BWC) and percentage of berries (PB). Cluster weight and berries weight per cluster were significantly higher in treated variants ($p \leq 0.05$). The average weights have a significantly highest values in Variants III (362.33 g) compared to the control (variant I) with 330.92 g. Additionally, no significant differences were detected in pedical weight and percent of berries per cluster, weight of 100 berries, their skin, seeds and pulp weight. Out of data presented, it can be noted that Variant II has the highest weight of 100 berries (526.77 g) and 506.21 g pulp/100 berries. Treated variants had a lower weight of skin and seeds, compared with the control, where the average weights are higher, with 14.83 g skin/100 berries and 7.17 g seeds/100 berries.

The three main berry chemistry parameters were analysed to evaluate harvest juice quality: total sugar (TSS),pH and total acid (TA). Content of total sugar was significantly higher at Variant III with 165 g/l, compared with other variants. The reason for increase is due to iron serves as activator for enzymes in growth process and assist in soluble solids synthesis in grape vine (Christenson et al. 1982).

Yogeesha (2005) noted that Fe foliar spraying has significant effect on grape yield (quantity and quality). Namely, author obtained: yield of 7.91 kg/vine or 26.32 t/ha, cluster weight of 225.76 g, cluster width of 5.05cm, cluster length of 12.60 cm, number of berry 162 and etc. According the author accumulation of total sugar, reducing sugar and non-reducing sugar increased with increasing the soil iron level with foliar sprays. The highest total (20.08%), reducing (17.90%) and non-reducing sugars (1.63%) were recorded in treatments receiving: 50 kg $FeSO_4$/ha with foliar sprays, 0.2 % $FeSO_4$ at 20 and 40 DAP, which is confirmed with our results, as well. Increasing vine growth, grape yield, mass and volume of the cluster and berry, juice and total soluble solids percentage, during the foliar fertilization, have been noted by many authors, such as Yogeesha (2005) and Nikkhah et al. (2013).

Yield components showed positive and significant correlation with yield such as cluster weight and TSS (0.946**, 0.700**) and cluster weight and TSS (0.562**, respectively).

Effects of Mg and Fe fertilizers on contents of macro and micro elements in grapevine leaves

Leaf analysis (blades or petioles) is widely recognized as the most reliable laboratory method to determine the nutritional status in grapevines. The macro and micronutrient content in leaf blade is directly influenced by the type and dose of the fertilizer and by conditions of nutrition and vegetation. The average values of leaf blades samples from the examined grapevine are given in Table 4.

Nitrogen content was in range between 2.10 and 2.39% depending on the season, but with no statistical difference at 0.05 level. Magnesium fertilizer significantly increased P content. Phosphorus is present in leaf blade in quantities ranging from the lowest 0.32 % P in the control variant and 0.35 % P in the Variant II. Content of this element, at variant III, decreased during the research, which is probably resulting of the antagonistic relations between P and Fe. This phenomenon was also noted between Mg and K content. During the whole research period, Mg spray significantly decreased the potassium content in leaf blade, with significantly lower amount of 0.71%. Potassium has a major importance for grapevine nutrition. To obtain 1 ton of grapes, it's needed 3-3.5 kg K. Therefore, the knowledge of the antagonism between the potassium and the other elements is of great importance for grape fertilizing. It acts as a biocatalyst and is in antagonistic relations with Ca, Mg and Na, as the presence of these ions in large quantities hinders the absorption of potassium (Sala and Blidariu, 2012).

Spraying grapevine plants four times per season with 0.5% of Mg increased content of Ca in leaves. During the research, variant II has the significantly higher concentration of this element, from 2.28 to 3.29 % Ca. These results are opposite of many previous researches, which are based on antagonism between these elements. In the analyses conducted by the authors, a significant reduction was shown for the uptake of calcium cations by leaves, with an increase in the intensity of plant nutrition with magnesium. This might be result to the higher concentration of $CaCO_3$ (in carbonate soils more than 80% is Ca, while 4% is Mg) and Ca in soil, optimal level of Ca in analysed vine leafs, even in control variant and process of Ca reutilization in plant (once translocate Ca into the leaves, is practically immobile). These findings corresponds to the notes reported by Wyszkowski (2001) and Herak et al. (2008). The effect of magnesium in the accumulation of other nutrients is dependent on the species, plant organ and only to a slight degree on the manner of its application (Wyszkowski, 2001). According to the Herak et al. (2008), the amount of calcium in vine leaf varies depending on the amount of physiological active lime in the soil. Due to the unfavourable physical and chemical properties of carbonatesoils and the important role of magnesium in the chlorophyll, foliar application with magnesium has a great advantage over the root (soil) application (Takacs et al. 2007).

Presented results showed that foliar treatments had no influence on vine Zn status, because during the whole period of investigations, control variant has the higher content of this microelement, with average content of 35.85 mg/kg. During the research period, Mn concentration was higher at variant II with average content of 133.24 mg/kg. Our research data, confirmed antagonism between iron and manganese. Application of Fe chelate, during 2013 and 2014, decreased the content of Mn, but without statistical difference at 0.05 level. Results in Table 4, indicates that leaf content of Cu was not affected in vines treated with foliar fertilizers. The differences between treated variants and control are minimal and not significantly. Content of copper was statistically higher in 2014, from 33.28 to 35.07 mg/kg, as a result of copper fungicides application, due to bad weather conditions in that year.

Our results for macro and micro elements content are consistent with the ranges which are suggested by Mills and Jones (1996) and Reuter and Robinson (1997). Mills and Jones (1996) suggested critical leaf values for optimum grapevine growing as follows: 1.6-2.8 % for N, 0.2-0.6 % for P, 1.5-5.0 % for K, 0.4-2.5 % for Ca, 10-100 mg/kg for Zn, 40-600 mg/kg for Mn and 4-20 mg/kg Cu. As a long term of research, the authors Reuter and Robinson (1997) gives range values for the content of macro and micro elements in the grape leaf. According to the authors, grapevine has optimal levels by: 0,8-1,1 % N, 0,25-0,5 % P, 1,8-3,0 % K, 1,2-2,5 % Ca, >0,4

% Mg, 30-60 mg/kgMn, >26 mg/kgZn, 6-11 mg/kgCu, >30 mg/kgFe, 35-70 mg/kgB.

The multiple correlation analysis of the content elements determined in grapevine leaves led to the identification of some significant correlations: Ca/Cu (r=+.519**), Ca/Zn (r=-.591**), Mn/Cu (r=-.755**). Other elements are weakly correlated or not at all.

Table 3. *Cluster structure and content of harvest juice (2012-2014).*

Variant	Parameter									
	Cluster weight (g)	Pedical weight/cluster (g)	Berries weight/cluster (g)	Percent of berries/cluster	Weight of 100 berries (g)	Skin weight/100 berries (g)	Seeds weight/100 berries (g)	Pulp weight/100 berries (g)	Total sugar (g/l)	Total acid (g/l)	pH
I	344^{b}	13.08^{a}	330.92^{b}	96.19^{a}	516.67^{a}	14.83^{a}	7.17^{a}	494.66^{a}	155.55^{b}	5.15^{a}	3.39^{a}
II	371^{a}	12.78^{a}	358.22^{a}	96.55^{a}	526.77^{a}	14.18^{a}	6.38^{a}	506.21^{a}	158.55^{b}	4.95^{a}	3.25^{a}
III	376^{a}	13.67^{a}	362.33^{a}	96.36^{a}	502.31^{a}	13.93^{a}	6.38^{a}	481.96^{a}	165.00^{a}	5.08^{a}	3.36^{a}

Different letters (a, b) indicate significant differences among treatments.

Table 4. *Nutrient composition in leaves.*

Year	2012			2013			2014			average		
Variant	I	II	III	I	II	III	I	II	III	I	II	III
Element	%											
N	2.39^{a}	2.38^{a}	2.31^{a}	2.17^{a}	2.22^{a}	2.10^{a}	2.10^{a}	2.15^{a}	2.14^{a}	2.23^{a}	2.25^{a}	2.21^{a}
P	0.32^{a}	0.35^{a}	0.36^{a}	0.31^{a}	0.31^{a}	0.31^{a}	0.30^{b}	0.38^{a}	0.31^{b}	0.32^{b}	0.35^{a}	0.33^{a}
K	0.84^{a}	0.71^{b}	0.92^{a}	0.82^{a}	0.71^{a}	0.81^{a}	0.82a	0.70^{b}	0.83^{a}	0.82^{a}	0.71^{b}	0.85^{a}
Ca	1.85^{b}	2.28^{a}	1.86^{b}	2.42^{b}	3.20^{a}	3.06^{a}	2.40^{b}	3.61^{a}	3.29^{a}	2.23^{b}	3.03^{a}	2.74^{b}
	mg/kg											
Zn	43.57^{a}	36.02^{a}	34.56^{b}	32.08^{a}	31.95^{a}	32.54^{a}	31.91^{a}	30.29^{a}	31.75^{a}	35.85^{a}	32.75^{a}	32.95^{a}
Mn	134.55^{a}	146.17^{a}	142.79^{a}	147.19^{a}	149.98^{a}	145.41^{a}	101.76^{a}	103.57^{a}	100.62^{a}	127.84^{a}	133.24^{a}	129.61^{a}
Cu	10.94^{a}	10.52^{a}	10.15^{a}	9.37^{a}	9.37^{a}	9.10^{a}	33.28^{a}	34.65^{a}	35.07^{a}	17.86^{a}	18.18^{a}	18.11^{a}

Different letters (a, b) indicate significant differences among treatments.

CONCLUSION:

The experimental and biometric results of this three-year study indicate not only increasing grape yield production, but also some of the quality parameters were positively affected resulting in increased cluster and berries weights, TSS content and concentration of some macro and micro elements in grape leaves, also.

1. The highest average yield was noted at variant III, with 4.58 kg/vine or 14.87 t/ha;
2. Foliar fertilizing with Fe has significant effect on increasing of: total cluster weight, berries weight per cluster and percentage of berries. Treated variants had a lower weight of skin and seeds, compared with the control;
3. The average values from leaf blades samples showed that foliar fertilizing with Mg increased N, P, Ca and Mn, but decreased K and Zn content;
4. Results of leaf tissue confirmed some antagonistic relations between analysed elements, like: Fe/P, Mg/K and Fe/Mn.

REFERENCES

Abadía, J., Vázquez, S., Rellán-Álvarez, R., El-Jendoubi, H., Abadía, A., Álvarez-Fernández, A., López-Millán, A, F. (2011). Towards a knowledge-based correction of iron chlorosis. Plant Physiology and Biochemistry 49: 471-482.

Alshaal T. and El-Ramady H. (2017). Foliar Application: from Plant Nutrition to Biofortification. The Environment, Biodiversity & Soil Security. Vol.1,pp.71-83.

Álvarez-Fernández, A., Abadía, J., Abadía, A. (2006). Iron deficiency, fruit yield and fruitquality. In: L.L. Barton, J. Abadía (Eds.), Iron Nutrition in Plants and Rhizospheric Microorganisms. Springer, Dordrecht, Netherlands, pp. 85-101.

Barber, S. A. (1995). Soil Nutrient Bioavailability-A Mechanistic Approach. 2nded: John Wiley & Sons, Inc.

Bogdanović, M. red. (1966). Soil Chemical methods. JDPZ, Beograd (in Serbian).

Bozinović Z. (2010). Ampelography. University book. Skopje, Republic of Macedonia (in Macedonian).

Christenson L.P, Kasimiates P. and Tense F.L. (1982). Grape vine nutrients and fertilization in San Joaquin valley, University California Publications, 1:4087.

Christenson, L.P. (2005). Foliar fertilization in vinemineral nutrition management programs, p.83–90. In: Christensen, L.P. and D.R. Smart (eds.). Proc. of the Soil Environment and VineMineral Nutrition Symposium. American Societyfor Enology and Viticulture, Davis, CA.

Cvetković J. (2002). Development and modification of methods for heavy metals determination in vine with ETAAC: doctoral dissertation. Faculty of Natural Sciences and Mathematics, Skopje, R. of Macedonia.

Dzamić R., Stevanović D., Jakovljević M. (1996). Handbook for agrochemistry. Agricultural faculty, Beograd (in Serbian).

Duletić D. and Mijović S. (2014). Yield and quality of grapes of the cardinal variety depending on different foliar fertilizers. Agriculture and forestry, Vol.60 Issue 2: 85-91. Podgorica.

Eskandari Hamdollah (2011). The Importance of Iron (Fe) in Plant Products and Mechanism of Its Uptake by Plants. Journal of Applied Environmental and Biological Science 1 (10), pp.448–452.

Gerendás J., Führs H. (2013). The significance of magnesium for crop quality. Plant and Soil, 368: 101–128.

Gluhić D., Herak Ćustić M., Petek M., Čoga L., Slunjski S., Sinčić M. (2009). The content of Mg, K and Ca ions in vine leaf under foliar application of magnesium on calcareous soils. Agriculturae Conspectus Scientificus, 74: 81–84.

Herak Ćustić, Mirjana; Gluhić, David; Čoga, Lepomir; Petek, Marko; Gošćak, Ivan (2008). Vine plantchlorosis on unstructured calcareous soils and leaf Ca, Mg and K content. Cereal research communications. 36, Part 1. Suppl.; 439-442.

Jones, J.B. (2001). Laboratory guide for conducting soil tests and plant analysis. CRC Press LLC.

Kannan, S. (2010). Foliar Fertilization for Sustainable Crop Production. In: E. Lichtfouse (ed). Genetic Engineering, Biofertilization, Soil Quality and Organic Farming. Sustainable Agriculture Reviews 4. Springer Verlag, Springer, pp: 371-402.

Mamatha, N. (2007). Effect of sulphur and micronutrients (iron and zinc) on yield and quality of cotton in a vertisol. Department of soil science and agricultural chemistry college of agriculture, dharwad university of agricultural sciences, dharwad-580 005.

Mills A. H. and J. Benton Jones (1996). Plant analysis handbook II. Jr. MicroMacro Publishing, Athens,Georgia, USA.

Manojlović, S., Rajković, Z., Glintić, M., Sestić, S. (1969). Handbook for systematic control of soil fertility and use of fertilizers, Beogard (in Serbian).

Marschner, H. (1995). Mineral Nutrition of Higher Plants. Second Edition. Academic Press, London,pp: 195-267.

Mengel K., Kirkby E.A. (2001). Principles of Plant Nutrition. 5th Ed. London, Kluwer Academic Publishers.

Martin W. Jonathan (2012). Impact of marine extracts applications on cv. Syrah grape (Vitis vinifera L.) yield components, harvest juice quality parameters, and nutrient uptake. MSc. Diss. Faculty of California Polytechnic State University, San Luis Obispo.

Müftüoğlu N. M., Demirer T., Dardeniz A. (2004). Nutritional problems of cardinal problems grapes grown in Çanakkale, Turkey. Pakistan Journal of Botany, 36(3): 567-575.

Nikkhah Rahim, Nafar Hoda, Rastgoo Sasan, DorostkarMoslem (2013). Effect of foliar application of boron and zinc on qualitative and quantitative fruit characteristics of grapevine (Vitis vinifera L.). International Journal of Agriculture and Crop Sciences. Vol. 6-9. Pp. 485-492.

OIV (2011). Statistical report on world vitiviniculture.

Prabhu P.C, Singaram P. (2001). Effect of micronutrients on growth and yield of grapes CV Muscat. Madras Agriculture Journal. 88 (1-3). P: 45-49.

Reuter, D.J. and Robinson, J.B. (1997). Plant analysis. An interpretation manual. 2nd Edition, CSIRO Publishing, Melbourne.

Sala Florin and Blidariu Cosmin (2012). Macro- and Micronutrient Content in Grapevine Cordons under the Influence of Organic and Mineral Fertilization. Bulletin UASVM Horticulture, 69(1)/2012.pp.317-324.

Shaaban, M. M., Loehnertz, O., El-Fouly, M. M. (2007). Grapevine genotypic tolerance to lime and possibility of chlorosis recovery through micronutrients foliar application. International Journal of Botany, 3(2): 179–187.

Tejada, M., Gonzalez, J.L. (2004). Effects off foliar application of a byproduct of the two step olive oil millprocess on rice yield. European Journal of Agronomy 21, 31-40.

Topalović T.A. (2012). Effect of foliar fertilizing on chemical composition of some grape metabolic's: doctoral dissertation. Faculty of chemistry, Beograd, Serbia (in Serbian).

Vukadinović V., Lončarić Z. (1997). Plant nutrition (Ishrana bilja). University book. Agricultural Faculty, Osijek, Croatia.

Zlámalová, T., Elbl, J., Baroň, M., Bělíková, H., Lampíř, L., Hlušek, J., Lošák, T. (2015). Using foliar applications of magnesium and potassiumto improve yields and some qualitative parameters of vine grapes (Vitis vinifera L.). Plant Soil Environment, Vol. 61, 2015, No. 10: 451–457.

Yogeesha H. (2005). Effect of iron on yield and quality of grape (Vitis vinifera L.) in calcareous vertisol. Th8539. University Library, UAS, Dharwad.

ПРИНОС И МИНЕРАЛЕН СОСТАВ НА ВИНОВА ЛОЗА ПОД ВЛИЈАНИЕ НА ФОЛИЈАРНО ЃУБРЕЊЕ СО МАГНЕЗИУМ И ЖЕЛЕЗО

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Резиме

Цел на ова истражување е да се утврди влијанието на фолијарните ѓубрива (Magni mag helat и Magni fer helat) врз висината на приносот, квалитетот и хемискиот состав на листовите кај сортата кардинал во споредба со контролната варијанта (без фолијарно ѓубрење).

Опитот е поставен по методот на случаен блок систем, со 3 варијанти, во 3 повторувања. Фолијарните ѓубрива со различен хемиски состав се аплицирани во концентрација од 0.5%, четири пати во текот на вегетацијата, во фазите: пред цветање, по цветање, пораст на зрно и прошарок.

Резултатите од тригодишното истражување покажаа дека ѓубривата врз база на магнезиум и железо имаат влијание врз висината на приносот и квалитетот кај виновата лоза. Кај варијантата 3 е утврден највисок просечен принос од 14.87 t/ha. Фолијарното ѓубрење со железо покажа сигнификантно влијание врз зголемувањето на: масата на гроздот, масата на зрна во грозд и процентот за зрна. Третираните варијанти имаат помала маса на покожица и семки, споредено со контролата. Сигнификантно влијание фолијарните ѓубрива имаат и врз содржината на анализираните елементи во листот од лозата. Највисока просечна содржина на P (0.35 %), Ca (3.03 %), N (2.25 %), Mn (133.24 mg/kg) и Cu (18.18 mg/kg) е утврдена кај варијантата 2. Резултатите од лисната анализа истовремено потврдија и антагонизам помеѓу некои од анализираните елементи, како: Fe/P, Mg/K и Fe/Mn.

Клучни зборови: *кардинал, зрна, елемент, ѓубрење, квалитет.*