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RESEARCH ARTICLE

THE EFFECT OF FOLIAR FERTILIZING ON YIELD AND THE CHEMICAL COMPOSITION OF KERNELS OF TEXAS ALMOND CULTIVAR GROWN IN VALANDOVO

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ABSTRACT

The effect of foliar fertilizing on the yield and the chemical composition of kernels from texas almond cultivar in Valandovo region in the period from 2012 to 2013 was determined. The experiment was set in four variants and three repetitions. The variants were: Control (untreated); NPK+Ever green co Me (55% organic matter, 2% w/w Mg, 2% w/w Fe, 2% w/w Zn, 2% w/w Mn, 0.5 % w/w Cu, 0.5% w/w B); NPK+Biolinfa (34% organic matter 3% N, 5.80% K_2O) and NPK+Oligomix (1.20% B, 0.10% Cu, 4% Fe, 1.50% Mn, 0.10% Mo, 2% Zn). The distance of fruit planting was 4.5 m row by row and 3.5 m in the rows. In each variant and repetition were included 20 plants, and total in all experiment were involved 240. Three foliar treatments were applied with given above fertilizers at a concentration of 0.4%. In the end of the November, soil fertilizing with the fertilizer Polyfeed NPK 11-44-11 in quantity amount of 450 kg/ha was done. Before setting up the experiment, soil agrochemical analyses were made, and was concluded good fertility with nitrogen, medium fertility with phosphorus and potassium. The foliar fertilizing has a positive influence on the yield and the chemical composition of almond kernels. The highest average content of almond fruit yield (2699 kg ha^{-1}) and the highest average almond kernels yield (1333.50 kg ha^{-1}) was determined in the variant treated with fertilizer NPK+Ever green with Me (55% organic matter, 2%w/w Mg, 2%w/w Fe, 2%w/w Zn, 2% w/w Mn, 0.5 %w/w Cu, 0.5 %w/w B). The lowest almond fruits yield (1841 kg ha^{-1}) and the lowest almond kernels yield (857.25 kg ha^{-1}) was determined in the control variant. The highest average content of nitrogen (3.80%), phosphorus (1.15%), potassium (1.17%) and oils (59,30%) was determined in the kernels from variant NPK+Ever green co Me (55% organic matter, 2% w/w Mg, 2% w/w Fe, 2% w/w Zn, 2% w/w Mn, 0.5 % w/w Cu, 0.5% w/w B). The highest average content of calcium (0.93%) and magnesium (0.40%) were determined in the kernels from variant NPK+Oligomix (1.20% B, 0.10% Cu, 4% Fe, 1.50% Mn, 0.10% Mo, 2% Zn).

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INTRODUCTION

The aim in the modern agriculture is to get higher yield that will characterize with better quality. Plant nutrition is one of the most important agro technical measures, that together with the others have to allow uninterruptible, high and economically production (Kester and Ross, 1996; Datnoff *et al*., 2007). The right plant nutrition regime is necessary for normal growth, yield and getting quality product (Marschner, 1996; Domagalski *et al*., 2008). It means availably of all macro and micro biogenic elements in appropriate phenophase of plant growth. Each biogenic element has its specific influence on different parts of the plants. Plant nutrition has an influence on numerous physiological – biochemical processes, that affecting growth, development and yield (Dzamič and Stevanović, 2000; Glintic and Krstic, 1990). Plants that have timely and right nutrition are getting fruits with characteristic shape, color, size and with typical organoleptic properties. Limited of the nutritious elements is happened because of the different reasons. Intensive agriculture and use of high productivity cultivars led to a continuous decrease in soil micronutrient content (Jekić snd Brković, 1986; Sarić *et al*., 1989). Using of foliar fertilizers in the fruit cultures nutrition, has a big importance in getting higher yields as well as products with better quality (Holevas *et al*., 1985; Weinbaum *et al.,* 1984). Foliar fertilizers allow direct supplying of leafs, flowers and fruits with nutritious elements in a period when they are necessary. Foliar spray with fertilizers is necessary to further activity in the whole system of optimal mineral nutrition of

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plants (Taiz and Zeiger, 2002; Kostadinov and Kostadinova, 2014). It provides more economical water regime of plants and allows overcoming the physiological disturbances caused by adverse soil conditions that hamper mobility and nutrients absorption.

In unregularly soil conditions, unregularly pH value, low or high soil temperature, fixation in different nutrients, the root cannot adopt the nutrients at all (Sarić *et al*., 1986; Šaćiragić and Jekić, 1988). In such cases, the foliar nutrition has an important influence. It is an additional nutrition and measure that allow rapid and efficiency effect of correction of the plant nutrition (Brown *et al*., 2004; Velićković, 2002). The almond, *Amygdalus communis*, is kernel fruit that bellows at the family of *Rosaceae*, and under family *Prunoidae*. It is old fruit culture that is counts in economically importance kernel fruit and has numerous positively characteristic, too. The importance of almond is because of the kernel, which is very reach in fats, proteins, mineral matters, sugars, cellulose, vitamins and amino acids (Bulatović, 1985; Youssefi *et al.,* 2000). On the other hand, the almond has a big value for human nutrition, pharmaceutics, cosmetic industry and so. The aim of this explorations was to obtain the influence of soil and foliar fertilizing on the yield and the chemical composition of kernels from almond cultivar texas grown in Valandovo region.

MATERIALS AND METHODS

The field experiment with almonds was set in Valandovo region, during the 2012 and 2013. During the field experiment setting, the fruits were 7 years old. The material of work was almond cultivar texas. The planting distance was 4.5 m row by row and 3.5 m in the rows. The nutritional area were 15.75 m^2, i.e. 635 fruits ha^{-1}. In the exploration were included 4 variants in 3 repetitions. In each variant and repetition were included 20 plants, or total in whole experiment the number of plants was 240. The field experiment was set in terms of watering in system drip. During the almond vegetation period were applied all basic agricultural measures.

Variants in experiment were:

1. Control (untreated);
2. NPK+Ever green with Me (55% organic matter, 2% w/w Mg, 2% w/w Fe, 2%w/w Zn, 2% w/w Mn, 0.5 %w/w Cu, 0.5 %w/w B);
3. NPK+Biolinfa (34% organic matter, 3 % N, 5.80 % K_2O);
4. NPK+Oligomix (1.20 % B, 0.10 % Cu, 4 % Fe, 1.50 % Mn, 0.10 % Mo, 2 % Zn).

The soil fertilizing was applied in the end of November and the fertilizer Polyfeed NPK 11-44-11 was used in the quantity amount of 450 kg ha^{-1}. Each variant and repetition was treated foliar with 0.4% solution of the tasted fertilizers. The application of fertilizers was done with manually spraying the played leaves. The treatments were made in the evening hours. During the vegetation period were conducted 4 foliar treatments. The first treatment was made 10-15 days before flowering, and the other treatments were made after flowering at a distance of 15-20 days. The harvesting was carried out separately by variants and repetitions.

Before setting up the experiment soil samples were taken for agrochemical analyses and were performed on the following parameters:

- pH value - determined potentiometric with pH meter (Bogdanović *et al*., 1966);
- Content of easy available nitrogen – determined by method of Tjurin and Kononova;
- Content of easy available phosphorus – determined by AL method and reading of spectrophotometer (Bogdanović *et al.,* 1966);
- Content of easy available potassium – determined by AL method and reading of spectrophotometer (Bogdanović *et al.,* 1966);
- Content of humus – determined by permanganese method of Kotzman (Bogdanović *et al*., 1996)
- Content of carbonates– determined with Schaiblerov Calcimeter (Bogdanović *et al*., 1966).

In the kernels were determined the following parameters:

- The content of nitrogen (N) - determined using Kjeldal method (Sarić *et al*., 1989);
- The content of phosphorus (P_2O_5) - determined using atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić *et al.,* 1989);
- The content of potassium (K_2O) - determined by incineration of the material with concentrated H_2SO_4 and phlamenphotometar (Sarić *et al.,* 1989);
- The content of calcium (SAT) - determined using atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić *et al.,* 1989);
- The content of magnesium (Mg) - determined by applying atomic emission spectrometry with inductively coupled plasma (ICP - AEC) (Sarić *et al*., 1989);
- The content of oil - determined with Sokslet method (Sarić *et al*., 1989).

The statistical data processing was performed using statistical analysis program SPSS 20.0. The analytical procedure was performed by a general linear model method and the results were tested with LSD - test, represented by a probability of $p < 0.05$. Among the tested parameters regression analysis and a coefficient of correlation was performed.

RESULTS AND DISCUSSION

Climate is one of the most important environmental factors which affect the success of cultivation of all fruit kinds without excluding the almonds (Šoškić, 1996). The influence of climate elements manifest through the time of vegetation of fruit as well as through the separate phenophases. Valandovo region is known as region with lot of shiny days. Temperature requirements of almond for growth and development in the period of standby are large. It is enough in sequel of 100 hours, temperature variations from 0 to 6^oC for almond awakening. The average year temperature of the air in the Valandovo region is 15^oC. Sensibility of low temperatures is variety characteristic. Almond varieties that blooming early are more

sensitive than others. Bulatović (1989) found that unopened blossoms can be damaged on -3°C to -4°C, opened on -1.5 to -2.8°C, and just planted fruit on - 1 to -1.5°C. Almonds are sensitive on very high atmospheric humidity, suffer from diseases and in that ways don't give good yields. The average year relative humidity in Valandovo region is 71 % with maximum of 80 % in November, December and January. Soil conditions have an especially importance for growing, developing and fruits quality. The almond has the best growth and yield in deep, alluvial - diluvial, loamy - sandy, humus carbonate soils with significant content of lime (Ubavić *et al.,* 2001). Particularly suitable are soils with neutral reaction and good penetration of water and air. Salty and acidic soils or wet and clay are unsuitable for growing almonds.

available phosphorus and potassium. It had medium fertility with humus, too. There was low presence of carbonates. From data shown in Table 2 can be concluded that soil and foliar fertilizing had positive influence on the almond yield. All of the variants treated with different kinds of fertilizers had higher yield compared to the control, untreated variant. The highest average almond fruits yield (2699 kg ha^{-1}) and the highest average almond kernels yield (1333.50 kg ha^{-1}) was obtained in variant 2 where the treatments were made with fertilizer NPK+Ever green with Me (55% organic matter, 2%w/w Mg, 2%w/w Fe, 2%w/w Zn, 2% w/w Mn, 0.5 % w/w Cu, 0.5 % w/w B). The lowest average almond fruit yield (1841 kg ha^{-1}) and the lowest average yield of kernels (857.25 kg ha^{-1}) was determined in control, untreated variant.

Table 1. Agrochemical analyses of soil

Lab. No.	Depth cm	pH		Available mg/100g soil			Humus %	$CaCO_3$ %
		KCl	H_2O	N	P_2O_5	K_2O		
1	0-20	7.14	7.30	7,80	12,50	18,50	1,50	0,70
2	20-40	7.19	7.25	8,30	13,20	19,30	1,70	1,25
3	40-60	7.05	7.40	7,10	8,30	15,00	1,25	0,90
	Average 0-60	7.13	7.32	7.73	11.33	17.60	1.48	0.95

Table 2. Average yield of almond fruits and kernels (2012/2013)

Variant	Fruits kg $stem^{-1}$	Fruits kg ha^{-1}	Kernels kg $stem^{-1}$	Kernels kg ha^{-1}
1	2.90	1841	1.35	857.25
2	4.25	2699	2.10	1333.50
3	3.15	2000	1.60	1016.00
4	4.10	2603	1.95	1238.25

Table 3. Chemical content of kernels in % of dry matter (average 2012/2013)

Variant	N	P_2O_5	K_2O	CaO	MgO	Oils
1	3.31	0.95	1.02	0.75	0.33	54.55
2	3.80	1.15	1.17	0.82	0.37	59.30
3	3.70	1.08	1.11	0.90	0.35	56.70
4	3.60	1.10	1.12	0.93	0.40	55.30

Table 4. Statistical processed data

Variant	N	P_2O_5	K_2O	CaO	MgO	Oils	Fruits kg ha^{-1}	Kernels kg ha^{-1}
1	3.31 c	0.95 b	1.02 bc	0.75 c	0.33a	54.55 b	1841 b	857.25 d
2	3.80 a	1.15 a	1.17 a	0.82 bc	0.37a	59.30 a	2699 a	1333.50 a
3	3.70 ab	1.08 ab	1.11 ac	0.90 ab	0.35a	56.70 b	2000 b	1016.00 c
4	3.60 b	1.10 ab	1.12 ab	0.93 a	0.40a	55.30 b	2603 a	1238.25 b

Table 5. Correlation relationships between tasted parameters

Parameters	N	P_2O_5	K_2O	CaO	MgO	Oils	Fruits	Kernels
N	1	,346	,582*	,183	,064	,545	,556	,733**
P_2O_5		1	,521	,619*	,614*	,693*	,650*	,525
K_2O			1	,600*	,517	,699*	,551	,652*
CaO				1	,832**	,513	,392	,295
MgO					1	,446	,342	,268
Oils						1	,543	,574
Fruits							1	,847**
Kernels								1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

From data shown in Table 1, can be concluded that soil in which the field experiment was set, had neutral pH value, good fertility with available nitrogen, but a medium fertility with

In the variants treated with different fertilizers, the lowest average fruit yield (2000 kg ha^{-1}) and the lowest average kernels yield (1016.00 kg ha^{-1}) was determined in the variant 3

treated with NPK+Biolinfa (34% organic matter, 3 % N, 5.80 % K_2O). From data shown in Table 3, can be concluded that soil and foliar fertilizing had positive influence on the chemical content of kernels. In all of the variants treated with different kinds of fertilizers, tasted parameters had higher value compared to the control, untreated variant. The highest average content of nitrogen (3.80%), phosphorus (1.185), potassium (1.17%) and oils (59.30%) was determined in kernels in variant 2 NPK+Ever green with Me (55% organic matter, 2%w/w Mg, 2%w/w Fe, 2%w/w Zn, 2% w/w Mn, 0.5 % w/w Cu, 0.5 % w/w B). According to Bybordi and Malakouti (2006) the content of nitrogen in almond kernels is between 3.30 - 3.50. Dinesh and Ahmed (2014) found that the average content of phosphorus in almond kernels is 1.15%. On the other hand, Nabi and Issa (2015) reported that the content of phosphorus in almond cultivar Sweet Osku is 5114 ppb and in the almond cultivar Sweet Bonab is 7794 ppb. According to this research article, the content of potassium in almond cultivar Sweet Osku is 398 ppb, but in the almond cultivar Sweet Bonab is 66 ppb. The highest average content of calcium (0.93%) and magnesium (0.40%) was determined in the kernels from variant 4 NPK+Oligomix (1.20% B, 0.10% Cu, 4% Fe, 1.50% Mn, 0.10% Mo, 2% Zn). Nabi and Issa (2015) obtained that the oil yield of almond seed ranged from 39% to 57%.

Statistical significant differences for the content of nitrogen in the kernels were determined in all of the tasted variants, compared to the control one. For the content of phosphorus, potassium and oils, statistical significant differences were obtained in the variant 2 compared to the control variant. Statistical significant differences for the content of calcium were determined in the variants 3 and 4. For the quantity amount of fruits (kg ha^{-1}) statistical significant differences were determined in the variant 2 and 4. For the quantity amount of kernels (kg ha^{-1}) were determined in all of the tasted variants compared to the control variant. Higher content of tested elements in all of the variants, compared to the control variant was a result of the chemical composition of used foliar fertilizers as well as their absorption in the plant organs, i.e. kernels. Macro and micro biogenic elements in the content of used fertilizers had an influence on numerous physiological – biochemical processes that are of vital importance in plant vegetation cycles.

In Table 5 are shown the correlation relationships between the content of the tasted parameters. Strong and medium positive correlation was determined at the level of 0.05 and 0.01. Strong positive correlation was obtained at the level of 0.01 between the content of nitrogen and the kernels ($r=+.733^{**}$), between content of CaO and MgO ($r=+.832^{**}$) as well as between the fruit yield and kernels ($r=+.847^{**}$). At the level of 0.05 was determined medium positive correlation between numerous of the tasted variants ($r=+.0.4^{*}$- 0.7^{*}). The content of phosphorus was in the correlation with the content of calcium ($r=+.619^{*}$) and magnesium ($r=+.614^{*}$). This microelement was in positive correlation with the content of oils ($r=+.693^{*}$) and fruit yield ($r=+.650^{*}$), too. Also, the content of potassium was in the medium positive correlation with the content of calcium ($r=+.600^{*}$), content of oils ($r=+.699^{*}$) and the kernels yield ($r=+.652^{*}$).

Conclusion

Based on the obtained results for the influence of foliar fertilizing on the yield and the chemical compostion of almond kernels from texas cultivar grown in Valandovo region can be concluded that using of foliar and soil fertilizing has an important influence on increasing the yield and the content of all tested elements at all variants with different fertilizers compared to control variant. The highest average almond fruits yield (2699 kg ha^{-1}) and the highest average yield of kernels (1333.50 kg ha^{-1}) was obtained in variant NPK + Ever green with Me (55% organic matter, 2%w/w Mg, 2%w/w Fe, 2%w/w Zn, 2% w/w Mn, 0.5 %w/w Cu, 0.5 %w/w B. The highest average content of nitrogen (3.80%), phosphorus (1.185), potassium (1.17%) and oils (59.30%) was determined in kernels in variant NPK+Ever green with Me (55% organic matter, 2% w/w Mg, 2%w/w Fe, 2%w/w Zn, 2% w/w Mn, 0.5 % w/w Cu, 0.5 % w/w B). The highest average content of calcium (0.93%) and magnesium (0.40%) was determined in the kernels from variant 4 NPK+Oligomix (1.20% B, 0.10% Cu, 4% Fe, 1.50% Mn, 0.10% Mo, 2%

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