IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 08, Issue 12 (December. 2018), ||V (II) || PP 42-46

Effects of Foliar Fertilizing on the Yield of Pappers Grown in Protected Spaces in Strumica Region

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Abstract: The influence of foliar fertilizing with organic fertilizers on the yield of two pepper cultivars grown in protected spaces in Strumica region was examined. The experiment was set in four variants and three repetitions for each cultivar separately. The variants in the experiment were: Control (untreated); NPK+Ever green (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); NPK+Oligomix (1.20 % B, 0.10 % Cu, 4 % Fe, 1.50 % Mn, 0.10 % Mo, 2 % Zn).
The experiment was set in 18 rows, and in each variant and repetition were included 62 plants separately. During the vegetation were made 7 foliar treatments with named before fertilizers at a concentration of 0.4%.
Before setting up the experiment agrochemical analysis of the soil were made and was determined good soil fertility with available nitrogen and potassium, and medium fertility with available phosphorus.
After harvesting and measuring pepper yield was determined that the foliar fertilizing had a positive influence on both analyzed cultivars. In three variants treated with different foliar organic fertilizers was determined higher yield of peppers in both cultivars compared to control untreated variant. The highest yield of 64.35 $t \cdot ha^{-1}$ for *bela dolga* cultivar and 70.31 $t \cdot ha^{-1}$ for *dora* cultivar were determined in variant 2 (NPK+Ever green (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).

Key words: foliar fertilizing, peppers, yield.

Date of Submission: 29-11-2018 Date of acceptance: 13-12-2018

I. INTRODUCTION

Plant nutrition is one of the most important agrotechnical measures in the agricultural production. Quality and well-balanced nutrition is one of the basic conditions for achieving high, stable and high-quality crop yields (Domagalski et al. 2008, Kannan 2010). Determination of doses and types of fertilizers, timing and method of use are based on the consumed nutrients from the soil (Datnoff et al. 2007). Intake of nutrients through the soil often does not give the expected results due to their unavailability for plants (due to drought, unfavorable soil properties, underdeveloped root system). Hence, foliar nutrition is of great importance for the successful cultivation of agricultural crops (Dzamić and Stevanović 2000). According to numerous authors that plants can give the maximum of their genetic potential, a foliar nutrition is necessary (Jekić and Brković 1986, Saciragić and Jekić 1988). The advantage of foliar fertilizing compared to soil fertilizing is that the utilization of nutrients does not depend on the soil moisture content, the pH of the soil and other chemical and physical properties (Kostadinov and Kostadinova 2014). The effects of foliar nutrition are rapid. After several days of using foliar fertilizers, the plants receive intense green color, their habitus is rapidly increasing, the formation of organic matter accelerates (Kerin and Berova 2003). The development of the root system speed up, thus allowing better utilization of nutrients from the soil. In this way, plants become more resistant to adverse weather conditions, diseases and pests.

For normal growth and development of agricultural crops, many macro and micro biogenic elements are of great importance (Sarić et al. 1989; Taiz and Zeiger, 2006). Each nutrient has its specific influence on the individual parts of the plant. Plant nutrition affects numerous physiological and biochemical processes as growth, development and fruit formation (Vukadinović and Loncarić 1997, El-Bassiony et al 2010). Plants that are timely and properly nourished produce fruits with characteristic shape, color and size, with typical organoleptic properties (Fageria 2007, Fageria et al 2009). The use of foliar fertilizer in the diet of garden crops is of great importance for obtaining higher yields but also products that are characterized with better quality (Epstein and Bloom 2005, Fewzy et al 2012).

The pepper (*Capsicum annuum L*) originates from South America. The Spaniards brought it to Europe in the 15th century, from where it spread to Turkey, and today it is mostly cultivated in Hungary.

In the Republic of Macedonia, pepper is one of the most common vegetable. It is a one-year culture of great economic significance. The fruits of the pepper vary in shape, color, but also in smell and taste. The fruits are characterized by high nutritional value. They are rich in many vitamins, organic and mineral substances (Kolota and Osinska 2001). They also have great technological value.

The pepper contains about 89% water. It contains sugars from the group of monosaccharides and disaccharides. Of the monosaccharides, 90-98% contains glucose, the rest is fructose and sucrose. Of vitamins, the pepper contains mostly vitamin C. In the pepper there are also significant amounts of vitamin B, especially B_1 and B_2. It contains vitamin E, pantothenic acid, and in the form of provitamin contains vitamin A, which is present as beta-carotene and cryptoxanthin (Karakurt et al. 2009, Nassar et al. 2001). Of minerals, pepper is the richest with potassium, phosphorus and iron (Youssef et al. 1996, Fawzy et al. 2005). The fruits are consumed both in fresh and processed form.

The aim of this research was to determine the impact of foliar fertilizing with various organic fertilizers on the yield of fruit peppers grown in protected spaces in Strumica region.

II. MATERIALS AND METHODS

In Strumica region in the area of the village Kuklish, field crop experiment was set in the protected spaces of 300 m^2 during the 2013 and 2014.

The experiment was set in 18 rows. Four variants and three repetitions were included.

The material for the work were the pepper's variety *bela dolga* and *dora*. The seedling was planted in rows with row by row distance of 60 cm, and between plants, 40 cm. The experiment was set in conditions of irrigation. During the vegetation period of peppers, basic agro-technical measures were applied. Before the planting took place, soil fertilization with mineral fertilizer NPK 6-10-30 + 2% MgO in the amount of 12 kg in the hall with an area of 300 m^2 was applied.

The variants in the experiment were:

1. Control (untreated);
2. NPK+Ever green (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).

In each variant and repetitions, 62 plants were involved, and for the entire experiment 1116 plants were involved.

Each variant was treated with tasted foliar fertilizer in concentration of 0.4% solution. The application of fertilizers was done with hand sprayer, by spraying the leaves. During the vegetation seven foliar treatments were conducted, starting from the stage of growth of the first fruits.

The harvest was done when the peppers were 18 cm long, separated in variants and repetitions. During the vegetation five harvests were done. The first harvest was done on the 23th of May, and the last one on the 12th of July.

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

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

III. RESULTS AND DISCUSSION

For the achievement of high and quality yields, the pepper requires favorable soil and climatic conditions. Pepper that is grown in protected spaces has a greater need for nutrients, and in particular requires a greater amount of potassium (Lazić et al 2001, Salama and Zake 2000). In a short time, the pepper creates a massive vegetative mass, but there is a less developed root system. Therefore, it is necessary to grow on good fertile soils (Shafeek et al. 2014).

The best yields are obtained if the pepper is grown on deep and friable soils rich in easily accessible nutrients. The optimum soil reaction for the pepper is slightly acidic with a pH of 5.5 to 6.0.

In Table 1 are shown the results of agrochemical analysis of the soil before setting up the experiment.

Table 1. Agrochemical soil analysis

No.	Plot	Depth cm	pH		Available form (mg/100 g soil)			$CaCO_3$ %
			H_2O	KCl	N	P_2O_5	K_2O	
1	Pepper *bela dolga*	0-20	7.35	6.65	9.55	18.30	21.20	/
2		20-40	7.40	6.64	10.20	14.20	17.00	/
Average		**0-40**	**7.37**	**6.64**	**9.87**	**16.25**	**19.10**	**/**
3	Pepper *dora*	0-20	7.43	6.70	8.90	15.25	23.10	/
4		20-40	7.40	6.60	9.70	17.00	20.50	/
Average		**0-40**	**7.41**	**6.65**	**9.30**	**16.12**	**21.80**	**/**

From the data in Table 1, it can be concluded that the soil on which the experiment was set, has a neutral pH, good fertility with nitrogen and potassium, and medium fertility with available phosphorus. There is no presence of carbonates.

In Table 2 and Table 3 are shown the results of average yield from pepper varieties *bela dolga* and *dora* per variants

Table 2: Average pepper yield (kg) for the variety *bela dolga*

Variant	Total yield per variant (kg)	Average per plant (kg)	Yield ($t \cdot ha^{-1}$)
1	271.56	1.46	54.31
2	321.78	1.73	64.35
3	288.30	1.55	58.03
4	297.60	1.60	59.52

LSD (0.05) = 7.113
LSD (0.01) = 9.972

Table 3: Average pepper yield (kg) for the variety *dora*

Variant	Total yield per variant (kg)	Average per plant (kg)	Average ($t \cdot ha^{-1}$)
1	292.02	1.57	58.40
2	351.54	1.89	70.31
3	314.34	1.69	62.87
4	325.50	1.75	65.10

LSD (0.05) = 7.258
LSD (0.01) = 9.989

From data can be concluded that the foliar fertilizing have been positive effects on the yield of peppers in both examined varieties. In the three variants treated with different organic fertilizers higher yield was obtained compared to control, untreated variant. The highest yield of 64.35 $t \cdot ha^{-1}$ for *bela dolga* variety and 70.31 $t \cdot ha^{-1}$ for *dora* variety was determined in variant 2. The lowest yield of 54.31 $t \cdot ha^{-1}$ for *bela dolga* variety and 58.40 $t \cdot ha^{-1}$ for *dora* variety was determined in the control variant. The differences in the obtained yields between examined variants were small.

The positive foliar effect of the used organic fertilizers on the yield of peppers is the result of their chemical composition. The organic matter in the fertilizer is of great importance for the intensification of all the processes taking place in the individual organs of the plant. It participates in many biochemical and oxidative processes. It affects the migration and redistribution of elements in plants, too. Through these processes it affects the general growth, development and the increase both in yield quantity and quality. The presence of micro elements in the composition of the analyzed fertilizers is of great importance for the correct growth, development and fruit formation of peppers. These elements influence numerous physiological and biochemical processes that are vital in the vegetative cycle of culture.

In both varieties statistical significant differences for LSD (0.05) are obtained in the variant 2, and for LSD (0.01) statistical significant differences are obtained in variants 2, 3 and 4.

IV. CONCLUSION

Based on the obtained results for the influence of foliar fertilizing on the yield of pepper fruits grown in protected spaces, the following conclusions can be made:

- the soil where the experiment were setting had a good fertility with available forms of nitrogen, phosphorus and potassium;
- foliar fertilizing had achieved positive effects in all variants with different organic fertilizers compared to the control variant;
- the highest yield of 64.35 $t \cdot ha^{-1}$ for the variety *bela dolga* and 70.31 $t \cdot ha^{-1}$ for the variety *dona* was obtained in the variant 2 (NPK+Ever green (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);
- in both examined varieties, there are statistical significant difference for LSD (0.05) in the variant 2, and the results in variants 2, 3 and 4 have statistical significant difference on the level LSD (0.01).

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Marina Todor Stojanova. " Effects of Foliar Fertilizing on the Yield of Pappers Grown in Protected Spaces in Strumica Region."IOSR Journal of Engineering (IOSRJEN), vol. 08, no. 12, 2018, pp. 42-46.