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EFFECT OF FOLIAR NUTRITION ON MORPHOLOGICAL CHARACTERISTICS AND SOYBEAN YIELD IN ORGANIC CROPPING SYSTEM

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Abstract

Investigation was conducted with the aim of soybean grain productivity determining in the organic cropping systems on parcel of the Institute of Field and Vegetable Crops, Backi Petrovac (φN45°20', λE19° 40' 89msl). The study object was the Galina variety, 0 maturity group. The effect of foliar nutrition on morphological characteristics and soybean yield was studied. The experiment included two variants: variant without fertilizing (control) and fertilized variant (Slavol was used in fertilized variant).

The average soybean yield in the organic cropping system was 4,622 kg/ha. 1,000 grain weight averaged 173 g. The yield was higher by 258 kg/ha or 5.74% in the fertilized variant and 1,000 grain weight was higher by 13.2 g or 7.9% compared with the control.

The plants height in the treated variant was significantly higher compared with the control ($p < 0.5$). The plants had on an average 81.94 cm stem height and average plant weight was 16.00 g.

Foliar nutrition showed to be a feasible method of soybean productivity improving in organic cropping system.

Key words: Glycine max, organic cropping, morphological characteristics, yield, foliar nutrition

Introduction

In the early 1900s soybean was a little – known plant that was grown in only a handful of countries, but by the end of the 20th century it had developed into a leading field crop on the global scale. Nowadays, soybean is grown in most countries to a greater or lesser extent, but in recent years about 90% of the world´s production have been concentrated in only several counties. Contribution of Europe to world soybean production ranged from 1 to 2%. Soybean (*Glycine max* (L.) Merr.) is an erect annual plant with a hairy stem reaching 30 cm to 130 cm in height depending on environmental factors. Pod contains one to five seeds what is affected by the environmental factors. The soybean plant has many varied usages and importance is multifaceted. The most important components of soybean seed, proteins (about 40%) and oil (about 20%) are the main reasons for soybean cultivation. High soybean yields require the harmony of all production factors. In practical terms, that means the right choices in plot selecting and the most suitable crop rotation, then timely applied tillage measures, fertilizer, necessary weed control, and finally, promptly and efficiently crop harvesting (Miladinovic et al., 2011).

Soy is suitable for growing in organic production. Organic farming put emphasis on the control, quality and safety of the produce, along with the application of ecological principles. Control over the production of organic soybeans is required so customers could obtain high quality produce. High yields and grain quality (Popović et al., 2012) prove that soybeans can be successfully grown in organic production if proper zoning and proper production technology are applied. Organic farming maintains and improves soil fertility in the long run. Soil fertility is maintained by a

production system - crop rotation harmonized with proper soil cultivation, fertilization based on soil fertility level (organic and other permitted fertilizers), and other cultural practices (Bavec, Bavec, 2006).

Organic products are safe because they are subjects of regular production process control, certified production is transparent and traceable, and documents and the logos are guarantee that food is organically produced (Lazic, Lazic, 2008). By organic production methods applying, the level of agricultural soil fertility and resources are protected, preserved and increased. This approach requires continuous planning and multidisciplinary. There are on an average about 30% more butterflies, soil microorganisms, earthworms, insects and various small mammals (Bengtsson et al., 2005) on farms engaged in organic production compared with conventional one.

The aim of this study was to examine the affect of foliar nutrition on soybean productivity by following the organic growing system.

Material and method

The experiment was carried out on the experimental field of Institute of Field and Vegetable Crops in Bački Petrovac, in 2012. The soil type in the experimental plot was chernozem. Soil on the experimental parcel was of weak alkaline reaction (pH in KCl = 7.48), with lot of humus, 2.42%, medium provided with nitrogen, 0.184%, highly provided with available phosphorus (33.7 mg/100 g soil) and well provided with potassium (20.5 mg/100 g of soil). The experiment was done with an NS soybean cultivar, maturity group 0, by usage of organic farming methods, and it was established according to the split plot method with four replications. The experimental unit size was 10 m^2, with the row spacing of 50 cm. The preceding crop was wheat. Primary tillage (deep plowing) was completed on November the 12^{ve}, 2011. Manure was dismantled in the amount of 15 t / ha, on November the 11th, 2011. Seedbed preparation was done on March the 24th, 2012 and April the 30th, 2012. The soybean cultivar Galina was grown in the stand of 500,000 plants/ha. Soybean sowing was performed on May the 5th, 2012. Seed inoculation with NS Nitragin, a microbiological preparation, was done immediately before sowing. The crop was irrigated 2 times with 35 liters of water per m^2, in July and August.

The experiment included two variants:
1 Control variant, without foliar nutrition
2 Nutrition variant, with foliar nutrition (only Slavol)

The Slavol, is organic microbiological fertilizers, product Agrounik d.o.o., Serbia, – a foliar nutrition was applied 2 times in the concentration of 60 ml / 10 l of water at the reproductive stage (R1 and R2) season.

Harvest was carried out by hand, in technological maturity. After harvest, samples were measured for moisture content. The yield was calculated per unit area, on 13% moisture basis. Following parameters were measured on each parcel: the height of 10 plants, plant weight, 1,000 grain weight and first pod height.

The analysis of the experimental data was performed by descriptive and analytical statistics using the statistical package STATISTICA 10 for Windows. The analysis of variance was done with one variability factor (nutrition). Significance of results was estimated by the LSD test for significance levels of 0.5% and 0.1%.

Meteorological conditions: Data for the analysis of the weather conditions were used from the meteorological station of Bački Petrovac, Serbia. During the 2012 growing season, the mean monthly temperature was 20.68°C; 2.80°C higher than the long-term average for Bački Petrovac. The rainfall was 221.5 mm, 200 mm less than the long-term average (Graph. 1).

The main limiting factor in the 2012th was the lack of water in the soil in most of the growing season and high temperatures, especially in June, July and August (23.4 °C, 25.2 °C and 24.5 ° C), Fig. 1.

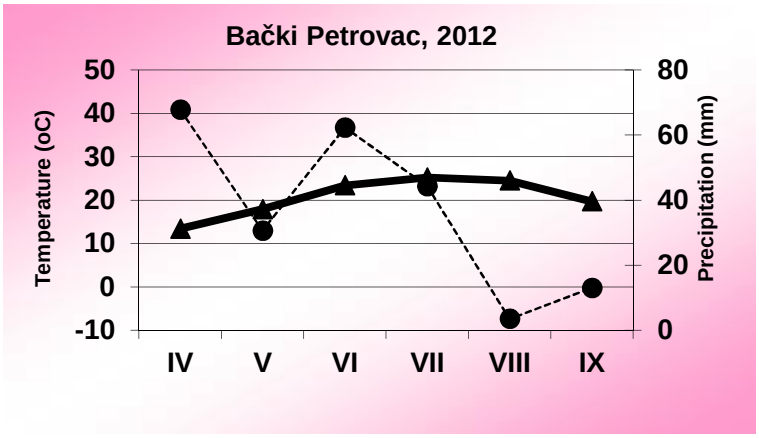

Fig. 1. Average air temperature and precipitation, Bački Petrovac, 2012

On the studied location, the amount and distribution of rainfall during growing season exert the decisive influence on soybean yield (Popovic et al, 2012, 2012a, 2013).

Results and discussion

Grain yield and 1000-grain mass of NS soybean. The average yield of soybean had an average of 4,622 kg/ha and had high stability, Cv =3.94%. The average 1,000-grain mass of soybean had an average of 173.73 g and had high stability, Cv =5.37%, Table 1. The results showed that the foliar nutrition variant had a higher grain yield than the control (4751 kg/ha and 4,493 kg/ha, respectively), however, the difference was not statistically significant ($p > 0.5$). The average yields in the foliar nutrition variant were higher by 258 kg/ha or 5.74 % compared with the control and 1,000-grain mass by 13.2 g or 7.9 % (Table 1, 2). Foliar nutrition proved to be a feasible method for increasing the grain yield and 1,000-grain mass of soybean.

Table 1. Yield (kg/ha) and 1,000 grain mass (g) of NS soybean in organic cropping system

Parameter	Genotype	Control	Nutrition	Average	Rate of change	Cv
Yield	Galina	4,493.33	4,751.33	4,622.33	5.74	3.94
1,000-grain mass		167.13	180.33	173.73	7.89	5.37

Parameter		Yield	1,000-grain mass
LSD test	0.5	481	21.79
	0.1	799	36.14

Table 2. Descriptive Statistics for yield and 1000 grain mass of NS soybean

Descriptive Statistics							
Effect	Level of Factor	Valid No	Mean	Confidence -95,00 %	Confidence +95,00 %	Std. Dev.	Std. Error
Yield							
Total		6	4,622.33	4,373.67	4,870.99	236.95	96.73
Variant	Control	3	4,493.33	4,247.94	4,738.73	98.78	57.03
Variant	Nutrition	3	4,751.33	4,044.73	5,456.93	284.04	163.99
1,000-grain mass							
Total		6	173.73	161.94	185.53	11.24	4.58
Variant	Control	3	167.13	140.72	193.55	10.63	6.14
Variant	Nutrition	3	180.33	159.25	201.41	8.48	4.89

Our results were in agreement with those of Senevirante et al. (2000) who reported that seed inoculation and fertilizer application increased grain yield of soybean.

Soybean morphological characteristics.

The average plant height of soybean had an average of 81.49 cm and had huge stability, Cv =3.01%. The results showed that the foliar nutrition variant had a higher plant height than the control (83.69 cm and 80.20 cm, respectively); however, the difference was statistically significant ($p < 0.05$), Table 3.

Table 3. Morphological characteristics of NS soybean in organic cropping system

Parameter	Genotype	Control	Nutrition	Average	Rate of change	Cv
Plant weight, g	Galina	15.29	16.72	16.00	9.35	6.31
Plant height, cm		80.20	83.69	81.94	4.35	3.01
First pod height, cm		17.88	15.33	16.60	-6.48	4.74

Parameter		Plant weight	Plant height	First pod height
LSD test	0.5	4.20	2.49	7.93
	0.1	6.90	4.14	13.16

The plant weight was 16 g. The plants had on an average first pod height of 16.00 cm and had stability, Table 3, 4. The results showed that the foliar nutrition variant had a higher plant weight than the control (16.72 g and 15.29 g, respectively), however, the difference was not statistically significant ($p > 0.5$), Table 3, 4.

Table 4. Descriptive Statistics for morphological characteristics of NS soybean

Descriptive Statistics							
Effect	Level of Factor	Valid No	Mean	Confidence -95,00 %	Confidence +95,00 %	Std. Dev.	Std. Error
Plant weight							
Total		6	16.00	14.08	17.94	1.84	0.75
Variant	Control	3	15.29	13.04	17.54	0.91	0.52

Variant	Nutrition	3	16.72	10.59	22.84	2.46	1.42
Plant height							
Total		6	81.94	79.68	84.20	2.15	0.88
Variant	Control	3	80.20	78.08	82.32	0.85	0.49
Variant	Nutrition	3	83.69	80.46	86.92	1.30	0.75
First pod height							
Total		6	16.60	13.00	20.21	3.43	1.40
Variant	Control	3	17.88	12.06	23.70	2.34	1.35
Variant	Nutrition	3	15.33	4.46	26.19	4.37	2.53

The average plant weight in the foliar nutrition variant was higher by 1.43 g or 9.35 % compared with the control and plant height by 2.83 cm or 3.5 % (Table 3, 4).
The average first pod height in the foliar nutrition variant was lowest by 2.55 cm or 16.6 % compared with the control, (Table 3, 4).
Based on the investigated results, it was found that soybean produced in organic production system achieved good yields in the year bad for the production of seed crops.
Foliar nutrition proved to be a feasible method for increasing the grain yield and 1000-grain mass, plant weight and plant height of soybean, what is consistent with the results of other researchers (Popovic et al, 2011, 2012b, 2013). Popovic et al. (2011) reported obtaining significantly higher yields of soy grain as a result of foliar dressing with an increased nitrogen fertilizer rate.
Peele (1997) reported that the foliar uptake of macronutrients increased the yield of soybean grains by 30 to 400 kg/ha. In a study by Oko et al. (2003), the foliar application of urea in an early reproductive stage (R2-R3) increased the grain yields of soybean by 6-68%. At Randjelovic's et al. (2006), mineral nutrients had a positive effect on soybean yield levels. The differences in grain yield were statistically significant, with an average increase of 540 to 1,690 kg/ha (20-62.22%) compared with the treatment in which no mineral nutrients were added.

Conclusion

The results obtained in the present study have led to the following conclusions:
The average soybean yield was 4,622 kg/ha and average 1,000-grain weight was 173 g. The results showed that the foliar nutrition variant had a higher grain yield, 1,000-grain mass, plant weight and plant height than the control. The yield in the treated variant was higher by 258 kg/ha or 5.74% and 1,000 grain weight was higher by 13.2 g or 7.9% than in the control.
The plant height in the treated variant was significantly higher than in the control ($p < 0.5$).
Foliar nutrition showed to be a feasible method for soybean produced in organic farming system productivity improving.

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