

EFFECT OF BIOSTIMULATORS ON ROOT LENGTH AND SHOOT LENGTH OF SEEDLINGS OF SUNFLOWER PARENT LINES

UTICAJ BIOSTIMULATORA NA DUŽINU KORENA I NADZEMNOG DELA PONIKA RODITELJSKIH LINIJA SUNCOKRETA

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ABSTRACT

The aim of this paper was to examine the effects of biostimulators on root and shoot length of sunflower seedling deriving from seeds treated with biostimulators prior to sowing. Experiment was conducted at the Institute of Field and Vegetable Crops on five cytoplasmic male sterile lines: OCMS- 98 (L1), HA-NS-26 (L2), PH-BC2-74 (L3), VL-A-8 (L4), and HA-26-PR (L5). The seed was produced in the period from 2010 to 2012. Two seed variants were tested – non-treated seed and seed which was prior to application of biostimulators treated with metalaxyl-m. Prior to sowing, seed was treated with commercial preparations Slavol S, Bioplant Flora and the combination of the two. Results of this research point out that application of appropriate biostimulator has positive effect on growth and development of roots and shoots of seedling, while inadequate combination of biostimulators leads to inhibitory effect.

Key words: biostimulators, seedling root length, shoot length, sunflower.

REZIME

Cilj rada bio je da se ispita kako biostimulatori deluju na dužinu korena i nadzemnog dela ponika kada se pre setve njima tretira seme. Testiranje je sprovedeno u novosadskom Institutu za ratarstvo i povrtarstvo na semenu pet citoplazmatski muško sterilnih linija suncokreta: OCMS- 98 (L1), HA-NS-26 (L2), PH-BC2-74 (L3), VL-A-8 (L4) i HA-26-PR (L5) koje je proizvedeno u periodu od 2010.-2012. godine. Testirane su dve varijante semena: netretirano seme i seme koje je pre primene biostimulatore tretirano metalaksilom-m. Seme je pre setve tretirano komercijalnim preparatima Slavol S, Bioplant Flora i njihovom kombinacijom. Rezultati ovog istraživanja ukazuju da primena adekvatnog biostimulatore utiče pozitivno na rast i razvoj korena i nadzemnog dela ponika dok neadekvatna kombinacija biostimulatore dovodi do inhibitorynog delovanja. Tretiranje semena pre setve preparatom BIOPLANT FLORA pokazalo je dobre rezultate obzirom da je koren ponika duži u proseku za 2,4 cm kod varijante koja je tretirana ovim preparatom odnosno za 2,2 cm kod varijante semena gde je osim biostimulatore upotrebljen i fungicid na bazi metalaksa-m. Ovaj preparat je imao najbolji uticaj i na dužinu nadzemnog dela ponika povećavši ga u proseku za 1,5 cm odnosno za 1,2 cm u odnosu na kontrolnu varijantu.

Ključne reči: biostimulatori, suncokret, koren ponika, nadzemni deo ponika.

INTRODUCTION

Seed is a complex biological system whose reactions and life span depend on different external factors, which cannot be planned and predicted with certainty (Dević et al. 2007). Destructive processes in seed lead to occurrence of atypical seedlings and if biochemical processes develop too fast, as a result of unfavorable storage conditions, it leads to complete loss of germination (Mladenovski, 2001). The seed is one of the most important factors determining the viability of a plant. Use of good-quality, healthy, large, and viable seeds is of utmost importance in the maintenance of optimum plant density in a crop (Ahmad, 2001). Seed quality depends on numerous factors such as agroecological conditions, applied technology of production, seed cleaning, preservation and storage, etc. Some of them, like growing conditions (stress and similar) can neither be influenced nor controlled (Kostić et al. 2009). Sunflower seed is composed of oil (46-51 %), shell (24-27 %), proteins (16-20 %), carbohydrates (12 %), and fiber (6.3 %) (Todorović and Komljenović, 2013). Due to high level of oil content, sunflower seed has a short life span with regard to other grain cultures. The hydrolysis of oil and oxidation of free fatty acids during the seed storage leads to an increase of acid number and quality deterioration, which is one of the main reasons of decrease in seed germination (Crnobarac and Marinković, 1994).

With the use of biostimulators (plant hormones, vitamins, etc.), seed germination may be stimulated, especially the one growing under stressful conditions (Záborsky S. et al. 2002). They have an effect on better seed germination and stimulate both the plants and microflora of soil (Yildirim et al. 2002, Jelačić et al. 2006). Biostimulators improve immune system of cultivated plants and have positive effect on their metabolism. Application of biostimulators reduces stress in cases of unfavorable temperatures, increases yield, and reduces bad consequences in the event of drought, freezing, mechanical and chemical damage. In case of virus infection of plants (Maini, 2006), quantity of chemicals used in agriculture is reduced (Kolomazik et al. 2012). Many bacteria that are used as biostimulators may synthesize physiologically active substance such as gibberellins, cytokinins, vitamins and in this way stimulate microbiological activity and better growth and development of a plant (Govedarica, 2002). Application of biostimulators which contain organic matter with macro and micro elements, in a particular period of plant growth, is a good technique for optimization of food and health condition of a plant (Paravan, 2013). Those that contain auxins have positive effect on seed germination even in conditions of excess accumulation of salts (Iqbal et al. 2007).

The aim of this paper was to examine how biostimulators influence root length and shoot length on sunflower seedling,

with respect to the genotype and year of seed production, when seed has been treated with biostimulators prior to sowing.

MATERIAL AND METHOD

The study was carried out at the Institute of Field and Vegetable Crops in Novi Sad in October 2013. Testing was conducted on sunflower seed of five cytoplasmic male sterile lines – OCMS-98 (L1), HA-NS-26 (L2), PH-BC2-74 (L3), VL-A-8 (L4) and HA-26-PR (L5), produced in the period from 2010 to 2012, meaning that the tested seed was one, two, and three years old. Two seed variants were used for the research: non-treated seed and seed treated with fungicide (a.m. metalaxyl-m).

Both seed variants were treated with the following commercial preparations - biostimulators:

1. Slavol S (a.m. indol-3-acetic acid), concentration 25 % (S)
2. Indol-3-acetic acid has auxin activity. Auxins are phytohormones which influence the growth of plants by participating in elongation and division of cells, induction of root growth, flowering, and fruit development. Indol-3-acetic acid (IAA) is considered to be the most important auxin in higher plants (Normanly et al. 1995).
3. Bioplant Flora (a.m. humus extract, humic acid, fulvic acid, amino acid, phytohormones, macro and micro elements in chelating form, N, K₂O), concentration 2 % (B)
4. Humic acids mostly affect increased uptake of nutrients in plants due to influence on increased permeability of cell membranes and soil exchange capacity. Complexes of organic biostimulators which contain humic acids, amino acids, vitamins, and mineral matters positively affect plants growth and development, increase the yield and protect the plant from physiological consequences of stress which may be caused by numerous factors (Zeljковић, 2013).
5. Slavol S. + Bioplant Flora (in the above mentioned concentrations) (S+B)
6. Control – seed not treated with biostimulators (C).

After treatment with biostimulators, seeds were sowed in containers with sand being used as a substrate. The seedlings were obtained by seed germination at a temperature of 25 °C and relative humidity of 95 % (ISTA, 2009). Ten days after the sowing, five plants per repetition were taken (sample) and the length of roots and shoot length of seedling was measured.

Obtained results were statistically processed by the variance analysis of trifactorial split-split-plot experiment (A factor - genotype, G factor - seed production year, C factor - biostimulators). Data were processed by a computer software package Statistica 8, while ranking of significance of the obtained differences was determined by Tukey test (Tukey HSD test), with $\alpha=0.05$ (Hadživuković, 1991).

RESULTS AND DISCUSSION

Effect of biostimulators on seedling root length

Analysing the obtained results it can be found that sunflower parent line HA-26-PR had significantly longer seedling root length with regard to other lines, except VL-A-8 line – variant treated with metalaxyl-m. Seedling root length in HA-26-PR line was 12.0 cm respectively 11.6 cm. No significant differences were found between other lines' root length as well as between seed year production. Seed produced in 2011 had the longest root – 10.3 cm and 10.6 cm, respectively (Table 1).

Ten days after treatment with BIOPLANT FLORA, the seedling root length was 12.0 cm, i.e., 12.2 cm, on an average, which is for 2.4 cm, i.e., 2.2 cm more than in the control.

Paradičković (2008) points out that biostimulators based on humic acids, amino acids, proteins, peptides, polysaharids, and vitamin complexes increase the resistivity of the root in the event that the land is treated with pesticides or the saline soil. The joint effect of preparations SLAVOL S and BIOPLANT FLORA had inhibitory effect on the root.

By separate analysis of lines it may be concluded that by application of BIOPLANT FLORA on OCMS-98 line, root length was 12.2 cm, i.e., 11.9 cm, on an average, which is for 3.1 cm, i.e., 3.0 cm more than in the control variant. It was also found that there was the biggest root increase (4.4 cm) with this genotype with respect to seed produced in 2010.

Table 1. Effect of biostimulators on seedling root length

Lines A	Years G	Seed non treated with metalaxyl-m					Seed treated with metalaxyl-m					
		Biostimulators C				Aver. A	Biostimulators C				Aver. A	
		S	B	S+B	K		S	B	S+B	K		
L1	2010	10.6	13.1	9.1	8.7	10.3	10.2	13.0	8.3	9.0	10.0	
	2011	11.1	10.9	10.0	9.2		11.3	10.9	9.2	8.5		
	2012	9.6	12.5	9.0	9.5		9.9	11.7	9.1	9.2		
	A*C	10.6	12.2	9.4	9.1		10.5	11.9	8.9	8.9		
L2	2010	9.9	12.5	7.9	9.5	10.0	10.1	13.3	7.9	10.2	10.2	
	2011	11.1	12.9	7.0	11.1		11.0	12.6	8.0	11.2		
	2012	9.8	11.6	7.1	8.9		9.7	11.4	7.2	9.5		
	A*C	10.3	12.3	7.3	9.8		10.3	12.4	7.7	10.3		
L3	2010	10.9	10.0	7.4	8.6	9.5	11.1	11.0	7.7	9.6	9.9	
	2011	9.5	12.0	8.7	8.8		9.7	12.8	8.8	9.2		
	2012	9.3	10.9	8.2	10.0		9.7	12.3	7.6	9.2		
	A*C	10.9	11.0	8.1	9.1		10.2	12.0	8.0	9.3		
L4	2010	11.0	10.9	7.0	9.7	9.5	11.1	12.8	8.5	10.3	10.8	
	2011	9.6	10.4	8.8	8.2		9.4	10.8	10.7	10.5		
	2012	11.1	11.3	6.4	8.6		11.3	10.8	11.3	10.5		
	A*C	10.6	10.9	7.4	8.8		10.6	11.5	10.2	10.4		
L5	2010	12.1	13.7	11.0	11.1	12.0	12.2	13.1	10.0	10.7	11.6	
	2011	12.3	13.4	10.2	11.3		12.0	13.3	10.1	10.8		
	2012	12.7	13.9	10.7	11.2		12.1	13.7	9.8	11.0		
	A*C	12.4	13.7	10.6	11.2		12.1	13.4	10.0	9.8		
Average C		10.7	12.0	8.6	9.6	Aver. C	10.7	12.2	9.0	10.0		
Aver G	2010	10.2					Aver. G	2010	10.5			
	2011	10.3						2011	10.6			
	2012	10.1						2012	10.4			

Table 2. Difference significance ranking by Tukey test

Factors	Seed non treated with metalaxyl-m	Seed treated with metalaxyl-m
A	1.1	1.2
G	1.3	1.4
C	0.8	1.1
A*C	1.4	1.5

The best effect was accomplished by application of BIOPLANT FLORA on HA-NS-26 genotype – 12.3 cm, i.e., 12.4 cm, on an average, which is for 2.1 cm, i.e., 2.5 cm more than control variant seedling root length (Table 1). Arancon et al. (2006) found that application of humic acids has positive effect on growth of paprika and velvet plant root. Akinci et al. (2009) also came to the same conclusion by examining the influence of biostimulators on broad bean seed. They found that humic acids, beside positive influence on root length, also lead to change in nutrients in this culture. The joint effect of of preparations caused negative effect and with regard to control variant the root was shorter by an average of 3.1 cm. Similar results were obtained with PH-BC2-74 line. Influence of active matter contained in BIOPLANT FLORA preparation made the root to be longer by an average of 1.9 cm and 2.7 cm, respectively. Zeljković et al. (2010) also found the positive effect of biostimulators on root development of sage. Application of combination of preparations led to negative effect on root growth. The root is shorter with regard to control variant for 1.3

cm, but only in case when prior to sowing the seed was treated with fungicide based on metalaxyl-m. Biostimulators had positive effect on VL-A-8 line but only on non-treated seed variant. Using BIOPLANT FLORA the root was longer by an average of 2.1 cm. Treating the seed of HA-26-PR line with BIOPLANT FLORA preparation led to significant increase of seedling root length. Root length, ten days after sowing, was 13.7 cm, respectively, 13.4 cm, which is an average of 2.5 cm, and 3.6 cm more compared to the control (Table 1).

Effect of biostimulators on the shoot length

Analysing the obtained results it can be found that there are no significant differences in length of seedling between lines of both seed variants treated and not treated and not treated with fungicide based on active matter metalaxyl-m. The longest seedling part was found with HA-NS-26 line which was 6.1 cm and 6.2 cm, respectively (Table 3).

Treating seed with biostimulators resulted in different effect on seedling shoot length. Application of BIOPLANT FLORA led to significant increase of length with relation to control variant and other treatments. Length of shoot of seedling had a span from 7.0 cm, i.e., 6.8 cm, on an average, which is for 1.5 cm, i.e., 1.2 cm longer than the control. Combination of preparations had inhibitory effect, thus the shoot length was shorter by an average of 0.5 cm, i.e., 0.6 cm than the control.

Table 3. Effect of biostimulators on the shoot length

Lines A	Years G	Seed non treated with metalaxyl-m				Aver. A	Seed treated with metalaxyl-m				Aver. A
		Biostimulators C					Biostimulators C				
		S	B	S+B	K		S	B	S+B	K	
L1	2010	4.6	7.1	4.0	4.4	5.2	5.0	6.7	4.9	5.1	5.5
	2011	4.9	7.8	4.5	4.4		5.0	7.3	5.5	5.5	
	2012	6.4	6.1	3.7	5.1		5.6	6.0	3.9	5.3	
	A*C	5.3	7.0	5.1	4.6		5.2	6.7	4.8	5.3	
L2	2010	5.6	7.3	5.0	4.6	6.1	5.8	7.0	4.9	5.5	6.2
	2011	5.5	7.4	5.4	5.8		5.6	7.4	5.8	5.3	
	2012	6.8	8.1	5.7	6.1		7.2	8.5	5.8	5.8	
	A*C	6.0	7.6	5.4	5.5		6.2	7.6	5.5	5.5	
L3	2010	4.7	6.6	4.4	6.2	5.6	5.1	6.2	4.3	6.4	5.8
	2011	5.2	6.7	5.3	6.0		6.2	6.1	5.2	5.5	
	2012	6.0	7.6	4.5	5.2		6.5	7.4	4.7	5.6	
	A*C	5.3	7.0	4.7	5.8		5.9	6.6	4.7	5.8	
L4	2010	5.7	4.9	6.0	6.1	5.6	5.2	4.4	5.8	5.7	5.5
	2011	5.4	4.9	4.4	5.4		5.6	4.6	4.5	5.7	
	2012	5.4	7.0	5.9	5.9		5.7	7.6	5.7	5.4	
	A*C	5.5	5.6	5.4	5.8		5.5	5.5	5.3	5.6	
L5	2010	5.3	7.2	4.9	5.5	6.0	6.1	7.1	5.3	5.7	6.1
	2011	5.9	8.1	5.3	5.7		6.0	7.7	5.1	5.6	
	2012	5.9	8.3	4.7	5.4		5.8	8.3	4.9	5.3	
	A*C	5.7	7.9	5.0	5.5		6.0	7.7	5.1	5.5	
Aver. C		5.6	7.0	4.9	5.5	Aver. C	5.8	6.8	5.1	5.6	
Aver. G	2010	5.5					Aver. G	2010	5.6		
	2011	5.7						2011	5.8		
	2012	6.0						2012	6.1		

Table 4. Difference significance ranking by Tukey test

Factors	Seed non treated with metalaxyl-m	Seed treated with metalaxyl-m
A	1.1	1.0
G	0.9	1.0
C	0.5	0.8
A*C	1.0	1.0

Russo and Berlyn (1990) concluded that the application of biostimulators which contain humic and fulvic acids leads to improvement of plant's growth due to increased permeability of cell membranes, transpiration, photosynthesis, oxygen, phosphor and other nutrients. There was no significant difference found between production years. Seed produced in 2012 had the

longest shoot length – 6.0 cm and 6.1 cm, respectively (Table 3). By separate analysis of lines, it may be concluded that application of BIOPLANT FLORA on both seed variants of line OCMS-98 led to obtaining the shoot length by an average of 5.2 cm, i.e., 5.5 cm, which means that the shoot length was longer for 2.4 cm, i.e., 1.4 cm in relation to control variant. The best increase was achieved with this genotype – 3.8 cm with seed produced in 2010. Thi Lua and Böhme (2001) found that the application of biostimulators based on amino and humic acids, next to having positive influence on germination, favorably affect the growth of root and shoot length.

It is similar with HA-NS-26 genotype where the application of preparation based on humic acids had significant effect. Seedling that developed from seed which was treated with BIOPLANT FLORA prior to sowing had the shoot length for 2.1 cm longer than the control variant. Sánchez-Sánchez et al. (2009) also found that humic acids significantly influence not only the growth and development of plants, but also the uptake of iron especially with those plants with lack in this element. Application of BIOPLANT FLORA on genotype PH-BC2-74 led to significant increase of shoot length, but only with seed which was not treated with fungicide prior to application of biostimulators (Table 3). The shoot length was longer for 1.2 cm with regard to control. However, combination of BIPLANT FLORA and SLAVOL S had inhibitory effect on initial rise, thus the shoot length was shorter by an average of 1.1 cm than control with both seed variants. All treatments led to inconsiderable inhibitory effect on shoot elongation of the line VL-A-8. Govedarica (2002) points out that efficiency of biostimulators also depends on the genotype. With the application of biostimulators based on humic acids the shoot length of genotype HA-26-PR was longer for 2.4 cm and 2.2 cm, respectively. Cimrin and Yilmaz (2005) concluded that the application of humic acids has positive effect on growth and development of some grains.

CONCLUSION

Line HA-26-PR had significantly longer root in relation to other variants except the VL-A-8 line variant which was treated with fungicide. No significant difference was determined in the shoot length.

Seed year production did not have significant influence on root length and shoot length.

Treating seeds with preparation BIOPLANT FLORA, prior to sowing, showed good results considering that the seedling root was averagely longer for 2.4 cm with variant which was treated with this preparation, i.e., for 2.2 cm with seed variant where fungicide, based on metalaxyl-m, was used biostimulators. This preparation also had the best influence on the shoot length in an average of 1.5 cm, i.e., 1.2 cm in relation to control variant.

Beside positive influence which can be achieved with the application of certain biostimulators, it may be concluded that the inadequate combination may have inhibitory effect on growth of the seedling.

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