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THE EFFECT OF DIFFERENT MICROBIAL FERTILIZERS ON THE WEEDINESS OF SOYBEAN

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Abstract

The experiment with low-input technology of soybean was conducted at the research and study field "Radmilovac", Faculty of Agriculture Belgrade in 2022 on the luvic chernozem soil type, in completely randomized blocks. Cropping system included tillage with a disc harrow at 20-25 cm with the complete previous crop residues incorporation and the pre-sowing tillage with a harrow. The basic fertilization was conducted in autumn with 300 kg ha^{-1} NPK (15:15:15). For top dressing in spring, the following microbiological fertilizers were applied: biofertilizer ("Slavol", manufacturer "Agrounik" Serbia) with 5.0 l ha^{-1} in two treatments and Eko lame 10 l ha^{-1} in three treatments. The top dressing in the control variant was done with nitrogen fertilizer AN at the rate of 40 kg ha^{-1} N. The soybean (NS Maximus) cultivars were used. The crop was grown in a six-crop rotation (winter wheat-maize-spring barley+red clover-red clover-soybean-sunflower). Statistical analysis confirmed that top dressing had a greater effect on weediness of soybean. The weed community in investigated crops consisted of 11 weed species, with dominating: *Solanum nigrum* L., *Polygonum aviculare* L. and *Avena fatua* L., (annual species) and *Convolvulus arvensis* L. and *Sorghum halepense* (L.) Pers. (perennial species). The obtained results show that the highest number of weeds, weeds per species, fresh and air-dry biomass were recorded in the control treatment. The statistically lowest values for the number of weed plants per species were recorded in the treatment with Eko lame, but for fresh biomass in the treatment with Slavol. The differences in weediness in the variants with microbiological fertilizers were not statistically significant, while there were statistically very significant differences compared to the control. Application of microbiological fertilizers affected the initial faster growth of soybean plants and increased competitiveness against weeds.

Key words: *competition, weed, soybean, top dressing.*

Introduction

Soybean (*Glycine max* (L.) Merr.) is a legume species of great importance for the seed structure of agriculture in our country. This fact is particularly interesting from the point of view of crop rotation. The dominance of the two crop rotation (maize- winter wheat) could be most likely improved by introducing the three crop rotation by growing this crop. Crop rotation creates a greater diversity of crop residues after harvesting, decomposition, or harvesting, which leads to an increase in the number of saprophytic microorganisms in the soil and improves the biological and enzymatic activity of the soil (Woźniak and Kavecka-Radomska, 2016). In the era of intensive (industrial) agriculture, there was no interest due to the use of large amounts of fertilizers, especially nitrogen, which led to positive results. It was assumed that soybeans would gain more importance by switching to sustainable (low-input) cropping systems, as these systems imply a more rational use of fertilizers, favor crop rotation, and maintain or improve organic matter content. Modern agricultural systems usually tend to minimize energy inputs for tillage and use specific crop rotations that include 2-3 crop species requiring the same or similar cropping technology (Soane et al., 2012; Roche et al., 2017). This approach has resulted in a slight increase in acreage, which has declined over the past decade due to increasing pressure from global climate changes, particularly high air temperatures combined with a lack of summer precipitation, at the time of soybean flowering, when this crop is most vulnerable. In addition, soybean is a late spring sown crop that is very sensitive to weeds in the early stages of growth and development.

Soybeans do not make great demands on cultural practices, especially fertilization, as they can significantly take advantage of previous crops (dense) in terms of reducing weediness or improving the soil after crops (maize), which are known to deteriorate especially soil structure (Dolijanović et al., 2019). To achieve optimal yields, weed control, especially at the beginning, and adequate fertilization are important. Fertilization of soybean is special because this crop meets part of its nitrogen needs from the atmosphere, and larger amounts of mineral nitrogen applied to the soil can also reduce yield (Abduladim et al., 2021). Fertilizer application should be based on the principle of controlling soil fertility, i.e. maintaining or improving soil fertility to achieve high and stable yields (Đukić and Dozet, 2014). In addition to the application of NPK and nitrogen fertilizers, microbiological fertilizers have recently been increasingly used by treating seeds, soil, and/or leaves during the growing season, resulting in increased plant resistance and improved microbiological activity of the soil and plant root system. Microbial fertilizer helps the plants grow healthy and stay strong due to including fertilizer and beneficial microorganisms. Microbial fertilizers (MF), also known as organic fertilizers, are environment friendly because they mainly consisting of food and agricultural waste (animal manure, straw etc.) and beneficial microorganisms (Sahin and Yilmaz, 2023). Seed treatment with microbiological fertilizers generally has the least impact on poorer soils, especially in terms of pH. Low pH, i.e., increased soil acidity, results in lower efficacy, which can be improved to some degree by foliar application of a microbiological preparation.

The objective of this paper is to investigate the influence of applied microbial fertilizers (through seed and foliar treatments) on the weediness of soybean crops, in addition to the base fertilizer applied in the fall.

Material and methods

The experiment with low-input technology of soybean was conducted at the research and study field "Radmilovac", Faculty of Agriculture, University of Belgrade (Serbia) in 2022 on the luvic chernozem soil type, in completely randomized blocks. Cropping system included tillage with a disc harrow at 20-25 cm with the complete previous crop residues incorporation and the pre-sowing tillage with a harrow. The basic fertilization was conducted in autumn with 300 kg ha^{-1} NPK (15:15:15). For top dressing in spring, the following microbial fertilizers were applied: biofertilizer ("Slavol", manufacturer "Agrounik" Serbia) with 5.0 l ha^{-1} in two treatments and Eko lame 10 l ha^{-1} in three treatments. The top dressing in the control variant was done with nitrogen fertilizer AN at the rate of 40 kg ha^{-1} N. The soybean (NS Maximus) cultivars were used. The crop was grown in a six-crop rotation (winter wheat-maize-spring barley+red clover-red clover-soybean-sunflower). The sowing of soybeans took place on 15.04. in 2022. The size of a one crop rotation field (crop) was about 10 ar.

The application of microbial fertilizers and herbicides in soybean cultivation and the evaluation of weediness followed the schedule shown in Table 1. Seeds were treated 24 hours before sowing, and the other treatments were applied over the leaves with a hand sprayer designed for this type of experiment.

Table 1. Schedule of application of microbiological preparations, time of assessment of weediness and application of herbicides

Preparation/ Date	Seed treatment	First treatment-foliar	Weediness evaulation	Herbicide	Second treatment-foliar	Third treatment-foliar
Eko lame	14.04.	17.05.	30.05.	31.05.	03.06	17.06
Slavol	14.04.	17.05.	30.05.	31.05.	03.06	-

One day before applying herbicides in soybeans, we conducted an evaluation of weeds and determined the following parameters: the number of weed species, the number of plants per species, their aboveground fresh and dry weights in the control and investigative treatments. The presence of weeds in soybean was influenced by the fertilizers applied by the seed treatment and the first foliar treatment, while the other foliar treatments (1 or 2) had an influence on the quantity and quality of soybean yield. All parameters of weeds were determined by the method of random squares with an area of 1 m^2.

Obtained data were statistically processed by the analysis of variance, in which microbial fertilizers were factors, while LSD test was applied for the individual comparisons.

Results and discussion

The results of the influence of different types of microbiological preparations on weediness of soybean crops are shown in Table 2. Statistical analysis showed that, in general, there was a statistically significant difference in the number of certain weed species between the applied microbiological preparations and the control variant. There was also a statistically significant difference in the number of weed plants per species between the treatments tested and the control, while the fresh and dry weight of weeds was highest in the control and the differences in weight between the two fertilizers tested were not statistically significant (Table 2).

Table 2. Weediness (No of weed plants m^{-2}) of soybean

Life forms	Weed species	Control	Eko lame	Slavol	Average
T	*Amaranthus retroflexus* L.	3.5^b	2.2^a	2.0^a	2.6
G	*Sorghum halepense* L. Pers.	10.3^b	9.7^a	9.9^a	9.9
T	*Solanum nigrum* L.	11.8^c	8.8^b	7.0^a	9.2
T	*Avena fatua* L.	5.5^c	4.1^a	5.3^b	4.6
T	*Polygonum aviculare* L.	6.3^c	2.7^a	3.2^b	4.1
T	*Amaranthus albus* L.	2.0^a	1.7^a	2.1^a	1.9
T	Agropyrum repens (L.) Beauv.	3.6^b	2.6^a	2.8^a	3.0
G	*Convolvulus arvensis* L.	3.1^b	2.6^a	2.9^a	2.9
T	*Datura stramonium* L.	1.0^b	0.5^a	0.7^a	0.7
G	*Cirsium arvense* L. Scop.	0.7	0.3	-	0.3
G	*Cynodon dactylon* L. Pers.	0.5	-	0.4	0.3
Total number of weed species		11^b	10^a	10^a	10.3
Total number of plants per species		48.0^c	34.0^a	37.0^b	39.7
Aboveground fresh weight of weeds (g m^{-2})		2127.1^b	1705.7^a	1789.3^a	1874.0
Aboveground dry weight of weeds (g m^{-2})		578.9^b	507.6^a	521.4^a	536.0

T-therophytes, G-geophytes; Values of means followed by the same letter are not significant.

The significantly higher weed mass on the control variant was the result of a higher incidence of perennial and annual broadleaf weeds. The application of the two microbiological fertilizers resulted in a reduction of weed emergence in the soybean crops, especially in the most important parameters: the number of weed plants per species and the fresh weight of weeds per unit area. As in previous experiments at this site (Dolijanović et al., 2011), it is important to emphasize that high weed establishment was observed in the six crop rotation. The six crop rotation includes a large number of crops in frequency, which provides more favorable conditions for higher weediness. The weed synusia of soybean consisted of 11 weed species with a dominance of therophytes. The dominant weed species in soybean synusia were: annual *Solanum nigrum* L., *Polygonum aviculare* L. and *Avena fatua* L., and perennial *Convolvulus arvensis* L., *Sorghum halepense* (L.) Pers. and *Agropyrum repens* (L.) Beauv.
There are numerous measures that can reduce weed infestation in soybean crops, such as crop rotation (Dolijanović et al., 2010; 2019), application of herbicides and mulch (Simić et al., 2008), seed rate (Purucker and Steinke, 2020), cultivation of cover crops or by combining soybean crops with grasses (Janošević et al, 2017), and by reducing the tillage system (Kovačević et al, 2008), and there are fewer data on the influence of fertilizers (especially microbiological) on the occurrence of weeds in soybean cultivation.
For fertilizers and fertilization of soybean, the optimal application of fertilizers and the compatibility of the application of base and supplemental fertilizers are important for adequate weed control. Foliar fertilizers have high efficiency in the early stages of application, which affects the accelerated growth and reduced susceptibility of soybeans to weeds at the beginning of the growing season. The results of Liana et al. (2021) showed that basic fertilizer doses had significant effect on soybean growth and competivnes again weeds.

Conclusion

Microbial fertilizers are substances containing microbes that promote plant growth at the beginning of the growing season and increase competitiveness against weeds. They are used to increase crop yields in an environmentally friendly way, based on the principles of sustainable agriculture. As a result of the study, it can be said that the use of microbial fertilizer in optimal dose and timely application can be more profitable. Future studies involving additional fertilizer applications, row spacing, and planting dates under different environmental conditions will provide additional information on weediness in soybeans.

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