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THE INFLUENCE OF THE TIME OF BASIC TILLAGE AND FERTILIZATION ON SOYBEAN YIELD

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Abstract: The time of basic tillage and fertilization are very important agrotechnical measures that have a high impact on soybean yield. Winter basic tillage of the soil reduces the harvest yield by 8.53%, and spring tillage by 21.18%, the application of NPK fertilizers increased the yield by 13.96%, the foliar application of water extract from plant material by 9.57% and the application of AN by 8.44%. Autumn basic tillage is most conducive to achieving high and stable soybean yields, and fertilization has a positive effect on soybean yields.

Keywords: basic tillage, soybean fertilization, NPK fertilizer, water extract of plant material, AN.

Introduction

To achieve high and stable soybean yields, it is necessary to apply all agrotechnical measures correctly and in a timely manner (Đukić i sar., 2018), but we must bear in mind that the most important agronomic and chemical properties of each variety are strongly influenced by external environmental factors and are subject to changes in depending on climate and soil conditions (Miladinović i sar., 2013). Basic tillage and pre-sowing preparation of the soil are very important agrotechnical measures that participate with about 20% in the total amount of yield achieved (Khurshid i sar., 2006) and affect the sustainable use of the soil through the influence on its properties (Lal, 2013). Spring basic tillage affects yield reduction and deterioration of soil quality, while autumn basic tillage reduces soil compaction due to more favorable soil moisture for tillage and more favorable temperature conditions (Al Kaisi i Hanna, 2010). In an unfavorable year for soybean production, when low

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average yields are achieved, spring basic tillage has a very large impact on the reduction of soybean yields, while in favorable years, without a marked lack of precipitation, spring basic tillage has a small impact on reducing soybean yields (Adee, 2018) In the case of spring tillage compared to autumn basic tillage, the yield of soybeans in a favorable year for soybean production was reduced by 7.41%, while in a dry, unfavorable year, the yield was reduced by 36.41% (Dozet i sar., 2018). Autumn basic processing is a prerequisite for achieving high yields of soybeans, and delays in the implementation of this agrotechnical measure statistically significantly reduce the yield, especially in unfavorable years with a pronounced dry period (Bajagić i sar., 2022).

Aqueous extracts of plant material are increasingly used in plant production, floriculture, vegetable growing, but also in agriculture, both in organic and conventional production (Đukić i sar., 2021). Foliar fertilizers contain elements that are easily absorbed by plants, and their effectiveness depends on the amount of nutrients in the soil, the plants' need for certain elements, the condition of the crops and the time of application (Miladinov i sar., 2018; Cvijanović i sar., 2022).

Fertilizing soybeans with different fertilizers continuously represents a research challenge (Miladinov et al., 2018). For the correct fertilization of soybean crops, we must know the characteristics and agrochemical properties of the soil, the plants' nutrient requirements, climatic conditions, crop rotation, application of manure and mineral fertilizers, plowing of the harvest residues of the pre-crops, the intensity of production on the plot in previous years, the yield of the pre-crops and the expected yield of soybeans (Mamlić i sar., 2021). Aqueous extracts of plant material, in addition to macro and microelements, also possess physiologically active substances that stimulate the growth and development of plants, often have fungicidal and insecticidal effects, are easily prepared on the farm, do not require large investments and are suitable for organic production since there is no negative effect on the environment (Mamlić i sar., 2022). Nettle is suitable for making extracts because it has fungicidal and insecticidal effects, and when fermented it becomes a significant source of nutrients for plant nutrition through feeding (Dozet i sar., 2019), it also contains growth stimulators (Di Virgilio 2013), and the banana fruit is rich in potassium, phosphorus, calcium, manganese, magnesium, selenium, contains vitamins C and B and vitamin A.

The aim of these researches is to assess the influence of the time of basic tillage and the influence of fertilization on soybean yield.

Materials and methods

A two-year experiment on the influence of the time of basic tillage and fertilization on soybean yield was conducted in 2020 and 2021 on a private plot in the vicinity of Bač, Bačka region, Vojvodina. In the experiment, there were three variants of the basic processing time: autumn in October, winter in January and spring in March. The four subvariants with fertilization were: the control variant without fertilization, the application of NPK fertilizer formulation 8:15:15 in the amount of 300 $kgha^{-1}$, the application of AN in the amount of 150 $kgha^{-1}$ and the variant with the application of a diluted aqueous extract of nettle, comfrey and banana fruit, in the amount of 450 $litaraha^{-1}$. NPK fertilizer was applied immediately before the basic tillage, and nitrogen fertilizer AN with pre-sowing soil preparation. The aqueous extract was prepared by chopping the above-ground part of nettle (250 g), the above-ground part of comfrey (250 g) and banana fruits (500 g) and 10 l of water was added to the plant material. The container for the fermentation of plant material was placed in the shade and mixing of the plant material in the container was done every day. After 20 days, at the end of fermentation, the aqueous extract was filtered through cheesecloth, and during foliar application, the aqueous extract was diluted in a ratio of 1:15. Foliar application of the aqueous extract was carried out in the vegetative phase, before the flowering of soybean plants. The experiment was set up in 4 repetitions and the mid-late variety Rubin from the II ripening group was used. uring the growing season, the standard technology for growing soybeans was applied, and in the stage of technological maturity, harvesting, measurement of samples and grain moisture, and yield calculation with 14% moisture were performed. The results were processed statistically in the "Statistica 10" program, and the significance of the results was tested using the LSD test. The results are tabulated.

Results and discussion

The influence of the time of basic tillage and fertilization on soybean yield is shown in table 1.

Looking at the years of research, it can be seen that the average yield in 2020 (2853 $kgha^{-1}$) is statistically significantly higher than the yield achieved in 2021 (2485 $kgha^{-1}$).

Observing the average yields according to the time of basic tillage, it can be noted that the highest yield was achieved in the autumn basic tillage (2955 $kgha^{-1}$), which is statistically very significantly higher than the winter basic

tillage (2725 kgha^{-1}) and the spring basic tillage (2329 kgha^{-1}). Statistically very significant differences in yield were also between winter and spring basic tillage.

According to the fertilization variants, it can be observed that the highest soybean yield was achieved with the application of NPK fertilizer (2809 kgha^{-1}), which is statistically very significantly higher than the other fertilization variants (control 2495 kgha^{-1}, foliar application of water extract from plant material 2701 kgha^{-1} and application of nitrogen fertilizer AN 2673 kgha^{-1}). A statistically very significantly higher value for soybean yield was achieved in the variants with the application of aqueous extract from plant material and in the application of nitrogen fertilizer AN compared to the control variant of the experiment.

Table 1. The influence of the time of basic tillage and fertilization on soybean yield (kgha^{-1})

Year (A)	Time of basic tillage (B)	Fertilization (C)				Average AxB	Average A
		Control	NPK	AN	Foliar		
2020	Autumn	2867	3280	3204	3196	3137	2853
	Winter	2643	3014	2905	2907	2867	
	Spring	2408	2646	2591	2574	2555	
	Average AxC	2640	2980	2900	2892		
2021	Autumn	2605	2935	2767	2783	2772	2471
	Winter	2352	2711	2448	2641	2538	
	Spring	1914	2267	2122	2106	2102	
	Average AxC	2291	2638	2446	2510		
Average BxC	Autumn	2736	3107	2985	2989	Average B	2955
	Winter	2498	2862	2676	2774		2703
	Spring	2161	2457	2356	2340		2329
	Average C	2465	2809	2673	2701	-	-
Average 2020-2021							2662

LSD	A	B	C	AxB	AxC	BxC	AxBxC
1%	110,5	57,8	68,8	89,3	106,5	122,0	175,0
5%	48,2	33,0	41,6	50,7	63,8	73,8	105,9

Observing the same year and different time of basic tillage, it can be seen that in 2020 the highest yield was achieved on the trial variants with autumn basic tillage (3137 kgh^{-1}), which is statistically very significantly higher value compared to winter basic tillage (2867 kgha^{-1}) and spring basic tillage (2555

kgha^{-1}). Statistically very significant differences also existed between the values recorded on the variants with winter basic tillage and spring basic tillage. In 2021, the highest yield was achieved on the trial variants with autumn basic tillage (2772 kgh^{-1}), which is statistically very significantly higher value compared to winter basic tillage (2583 kgha^{-1}) and spring basic tillage (2102 kgha^{-1}). Statistically very significant differences also existed between the values recorded on the variants with winter basic tillage and spring basic tillage.

Looking at the same year and different fertilizing variants, it is noted that the highest yield of soybeans in 2020 was achieved on the variant with the application of NPK fertilizer (2980 kgha^{-1}), which is in addition to the yields on the variants with the application of nitrogen fertilizer AN (2900 kgha^{-1}) and foliar application of water extract (2892 kgha^{-1}) statistically very significantly higher value compared to the control variant (2640 kgha^{-1}). With the application of NPK fertilizer, the yield of soybeans was statistically significantly higher compared to the application of nitrogen fertilizer AN and the application of water extract from plant material. In 2021, the yields of soybeans on variants with the application of NPK fertilizer (2638 kgha^{-1}) and water extract from plant material (2510 kgha^{-1}) were statistically very significantly higher compared to the control variant of the experiment (2350 kgha^{-1}), while with the application of nitrogen fertilizer AN yields are statistically significantly higher (2446 kgha^{-1}). A statistically very significantly higher yield was also achieved on the variant with the application of NPK fertilizer compared to the variants with the application of aqueous extract from plant material and nitrogen fertilizer AN, and statistically significantly higher yield was also obtained with the application of aqueous extract from plant material compared to the application of nitrogen fertilizers AN.

Observing the same time of the basic tillage of the soil and different variants of fertilization, it is observed that in the autumn basic tillage the highest yield was recorded with the application of NPK fertilizer (3107 kgha^{-1}), which is statistically very significantly higher yield compared to the control variant of the experiment (2736 kgha^{-1}) and the application of nitrogen fertilizer AN (2985 kgha^{-1}) and a statistically significantly higher yield compared to the application of aqueous extract from plant material (2989 kgha^{-1}). Compared to the control variant of the experiment, a statistically very significantly higher yield was also achieved on the variants with the application of aqueous extract from plant material and nitrogen fertilizer AN. In the winter basic tillage, the lowest yield of soybeans was achieved in the control variant of the trial (2587 kgha^{-1}), which is a statistically very significantly lower value compared to the application of

NPK fertilizers (2862 $kgha^{-1}$), water extract from plant material (2774 $kgha^{-1}$) and nitrogen fertilizer AN (2676 $kgha^{-1}$). A statistically very significantly higher yield was achieved with the application of NPK fertilizer compared to the application of AN nitrogen fertilizer and a statistically significantly higher yield compared to the application of aqueous extract from plant material. In the spring basic tillage with the application of NPK fertilizer (2457 $kgha^{-1}$), a statistically very significantly higher soybean yield was achieved compared to the control variant of the experiment (2161 $kgha^{-1}$) and a statistically significantly higher yield compared to the application of AN nitrogen fertilizer (2356 $kgha^{-1}$) and water extract from plant material (2340 $kgha^{-1}$). A statistically very significantly higher yield was also recorded on the variants with the application of nitrogen fertilizer AN and water extract from plant material compared to the control variant of the experiment.

Conclusion

Based on the analysis of the two-year results of the influence of the time of basic tillage and fertilization on soybean yield, it can be concluded:

The highest yield of soybeans is achieved during the autumn basic tillage of the soil, and during the later basic tillage, the yields of soybeans decrease very significantly.

The application of NPK fertilizer achieves the highest soybean yield, while the foliar application of aqueous extract from plant material and nitrogen fertilizer AN contributes to a significant increase in soybean yield.

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References

Adee, E. A. (2018). Tillage Study for Corn and Soybeans: Comparing Vertical, Deep, and No-Tillage," Kansas Agricultural Experiment Station Research Reports, 4 (7).

Al-Kaisi, M., Hanna, M. (2010). Fall versus spring tillage, which is better. Integrated Crop Management, Iowa State University.

http://crops.extension.iastate.edu/cropnews/2010/09/fall-versus-spring-tillage-which-better

Bajagić, M., Đukić, V., Mamlić, Z., Dozet, G., Cvijanović, G., Miladinović, J., Ranđelović, P. (2022). Uticaj vremena osnovne obrade i folijarne prihrane na prinos soje. Zbornik radova Nacionalnog naučno-stručnog skupa sa međunarodnim učešćem „Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja", 03. novembar 2022., Smederevska Palanka, Srbija, 305-313.

Cvijanović G., Dozet G., Đukić V., Mamlić Z., Bajagić M., Đurić N., Stepić V. (2022): Uticaj primene različitih mikrobioloških preparata na masu 1000 zrna i prinos pasulja, Zbornik radova, Nacionalni naučno-stručni skup sa međunarodnim učešćem „Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja", 03. novembar 2022. Smedervska Palanka, Srbija, 118-128.

Di Virgilio, N. (2013). Stinging nettle: a neglected species with a high potential as multi-purpose crop. National Research Council of Italy. Institut of Biometeorology. Catania, Italy, 23.

Dozet, G., Đukić, V., Miladinov, Z., Cvijanović, G., Đurić, N., Ugrenović, V., Popović, V. (2018). Uticaj međuredne kultivacije i vremena osnovne obrade zemljišta na prinos soje, Zbornik radova XXIII Savetovanje o biotehnologiji sa međunarodnim učešćem, Čačak, 09-10 Mart, 2018. 45-50 str.

Dozet G., Đukić V., Miladinov Z., Đurić N., Ugrenović V., Cvijanović V., Jakšić S, (2019). Prinos soje u organskoj proizvodnji. Zbornik naučnih radova Instituta PKB Agroekonomik, Vol. 25, br. 1-2, 173-180. Beograd, Srbija.

Đukić, V., Miladinov, Z., Balešević-Tubić, S., Miladinović, J., Đorđević, V., Valan, D., Petrović, K. (2018). Kritični momenti u proizvodnji soje, Zbornik referata 52. Savetovanja agronoma i poljoprivrednika Srbije (SAPS), Zlatibor, 21-27. januar 2018. Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija, 34-44.

Đukić, V., Miladinović, J., Mamlić, Z., Dozet, G., Cvijanović, G., Kandelinskaja, O., Miljaković, D. (2021). Uticaj vodenog ekstrakta banane i koprive sa gavezom na prinos soje. Zbornik radova Nacionalnog naučno-stručnog skupa sa međunarodnim učešćem „Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja" 15. decembar 2021. Smederevska Palanka, Srbija, 285-292.

Khurshid, K., Iqbal, M., Arif, M. S., Nawaz, A. (2006). Effect of tillage and mulch on soil physical properties and growth of maize. International Journal of Agriculture and Biological Sciences, 8: 593–596.

Lal, R. (2013). Principles of sustainable soil management in agroecosystems. CRC Press, pp. 568.

Miladinov, Z., Đukić, V., Ćeran, M., Valan, D., Dozet, G., Tatić, M., Ranđelović, P. (2018). Uticaj folijarne prihrane na sadržaj proteina i ulja u zrnu soje, Zbornik radova 59. Savetovanje industrije ulja: „Proizvodnja i prerada uljarica", 17-22. jun 2018, Herceg Novi, Crna Gora, 73-78.

Mamlić Z., Abduladim A., Đukić V., Vasiljević S., Katanski S., Dozet G., Uhlarik A. (2021). Jesenja i prolećna primena NPK đubriva u proizvodnji soje. Zbornik radova Nacionalnog naučno-stručnog skupa sa međunarodnim učešćem „Biotehnologija i savremeni pristup u gajenju i oplemenjivanju bilja", 15. decembar 2021., Smederevska Palanka, 285-292.

Mamlić, Z., Đukić, V., Miladinović, J., Dozet, G., Bajagić, M., Vasiljević, S., Cvijanović, G. (2022). Influence of aquatic extract banana and neetle with common comfrey combination on weight of plants and weight of 1000 grains soybeans. 5th International Scientific Conference „Village and Agriculture", Book of proceedings, 30. September and 01. october 2022. Bijeljina, Republic of Srpska, BIH., 67-74.

Miladinović, J., Vidić, M., Balešević-Tubić, Svetlana, Đukić, V., Đorđević, V. (2013). Soja u 2012. godini. Zbornik referata 47. Savetovanja agronoma Srbije, Zlatibor, 3-9.02.2013. Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija 79-86.