SUSTAINABLE AND DEVELOPMENTAL SYSTEMS IN PRIMARY ORGANIC PLANT PRODUCTION

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Abstract

Surfaces under organic production are constantly increasing, in Serbia as well as in Europe and the World. Organic agriculture uses sustainable systems of production to prevent environmental pollution, enhance biodiversity and efficiently manage natural resources. The implementation of specific cultivation methods such as applying plant extracts and microbiological preparations leads to plant nutrients being secured faster and more efficiently. In field experiments, greater microbiological soil activity was recorded in the organic cultivation system. The increase of the abundance of microorganisms increases biochemical and enzymic activity, which influences the incensement of soil fertility and biodiversity. A certificate for organic products is an important milestone on the path of realizing sustainable agriculture which is based on environmental protection paired with obtaining healthy products. The development of consumer awareness and the values of organically produced food will lead to the further incensement of organic plant production surfaces.

Key words: *biodiversity, microorganisms, organic production, sustainable agriculture*

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Introduction

Agriculture is a primary branch of industry in food production. Market demand for organic products is increasing. Therefore, surfaces under organic production are also being increased, as in the World and Europe, so in Serbia (Table 1) (FiBL, 2021). It is very important for organic production to be certified and controlled, by which data on surfaces and quantity of certified organic products is put on disposal. Organic production combines tradition, innovation and science in the favour of sustaining the environment, it promotes correct relationships and good life qualities for all that are involved in it.

Table 1. Arable land under organic production (ha).

Year	World	Europe	Serbia
2017	69.411.457	14.382.479	13.423
2018	71.172.783	15.607.635	19.254
2019	72.285.658	16.528.677	21.265

Organic agriculture is a system of ecological production management which promotes and enhances biodiversity, matter circulation and biological soil activity (Kovačević and Oljača, 2005). In agricultural production, one of the target and direction measures is integral and organic agriculture, which also implies finding innovative ways of primary plant production as to avoid consequences of soil degradation and microbiological soil activity (Cvijanović et al., 2010). One possible way of organic production is applying aqueous plant extracts (nettle), such as plants that have a fungicidal and insecticidal effect and that, when fermented, present a significant nutrient source of plant nutrition in the form of side dressing. The use of plant extracts is ecologically and economically justifiable. In the long run, by using aqueous plant extracts, lesser soil, air and environmental pollution would be achieved whilst obtaining safe food without decreasing yield quality and quantity. Biopreparations made from other plants and intended for being applied in cultivated crops, beside ensuring a certain amount of plant nutrients are also partially insecticides and fungicides due to bioactive chemicals that can be found in the prepared treatment solution (Kim et al., 2005). Certain plant extracts are being increasingly used for fertilization in organic production. They are simple to prepare in industrial settings, but on smaller farms as well. For that purpose, nettle, common comfrey and a mixture of various plants are most commonly used in Serbia (Mirecki et al., 2011). Nettle is used in biodynamic and organic agriculture for pest control and as a stimulation agent in plant breeding (Di Virgilio et al., 2015). Plant extracts are products that can be a significant source of various elements even in traces, depending on the variety and quality of the soil on which the plant species used for preparing the solution was bred (Popescu et al., 2010). The preparation of nettle (*Urtica dioica*) extracts aims at preventive crop protection from diseases and pests and has a leaf dressing role.

The liquid preparation EM – aktiv with effective microorganisms (EM) is applied before sowing both for soil treatment and foliar. It improves seed germination, root, flower and fruit luxuriance and soil fertility enhancement (Szymanski et al., 2003). EM – aktiv is permitted in organic production.

The total number of microorganisms in the rhizospheral soil segment is an information that indirectly indicates the degree of microbiological soil activity. By increasing the number of microorganisms the biochemical and enzymatic activity also rises, which affects soil fertility and biodiversity (Cvijanović et al., 2012). In every primary production, as well as organic, there is a tendency to achieve great yields, which depends on many factors.

Organic production must be in accord with the Organic production law („Sl. glasnik“, number 30/10 and 17/2019 – another law). The control system of organic products in Serbia is based on the control system established by EU regulations. specifically European Council regulation (EZ) number 834/2007 and European Council regulation (EZ) number 889/2008. An organic product certificate is an important step towards realizing sustainable agriculture that is based on environmental protection whilst obtaining products that are organically certified and health safe in terms of health. Organic producers tend to combine ecological practices with developing customer awareness and organically produced food’s value, which will lead to further increasement of surfaces under organic primary food production (Pascu, 2013).

The goal of this research was to analyze the influence that applying nettle extract and EM on some cultivated plant species has on the number of microorganisms (MO) in the rhizospheral soil segment, as well as on the yield. On the basis of biannial results, a recommendation which would be useful, especially for organic producers, as well as consumers, would be given for organic production advancement and sustainability.

Research material and methods

Nettle (*Urtica dioica*) was used as material in field experiments – it is applied as an insecticide and as fertilizer. It is found in nature and plucked in rudimentary areas in immediate proximity of spontaneously grown high trees and shrubby vegetation. Effective microorganisms (EM) were applied by using the preparation EM – aktiv. EM – aktiv is a liquid concentrate in which there are 80 strains of main anabiotic organisms which can be found in nature within the soil. The preparation does not contain genetically altered microorganisms, but a strong community of aerobic and anaerobic microorganisms. It enhances seed germination, root, flower and fruit luxuriance and betters soil fertility (Szymanski et al., 2003). EM – aktiv is placed on the list of permitted plant nutrition and soil breeders which can be used in organic production (http://www.minpolj.gov.rs/organska/).

The aqueous nettle plant extract was prepared by plucking the young nettle without not including the roots. 1 kg of chopped nettle was placed inside of a barrel and poured with 10 litres of stood out rainwater. It stood inside the barrel for 15 days. The barrel containing nettle was placed on a shadowy spot. The aqueous nettle extract is permitted for use in organic production (http://www.minpolj.gov.rs/organska/).

The field micro experiments in irrigation less breeding technology were set by a randomized block system design in four repetitions. There were four treatment variants: control, nettle use, EM – aktiv and the combination nettle + EM – active. The nettle extract was drained and diluted with water in a ratio of 1:15. The treatments were conducted within reproductive phases (beginning of blooming). Foliar treatments were conducted by a manual back sprayer. In the full-bloom phase, 3 plants were taken (per every variant) including the root and the soil surrounding the root for determining the total number of microorganisms.

The yield was determined on the basis of main parcel yield and recalculated into kg per hectare.

Weather conditions

Temperature and precipitation data was taken from the government's meteorological station of the Agricultural proffesional service in Bačka Topola.

The average temperature in 2018 in every vegetational month was higher than the perannial average (Table 2), whilst precipitation for the entire vegetational period was 6.7% higher than the perannial average. In may of 2019, mean monthly temperatures were lower, while in other months they were above the perannial average. The sum of precipitation within the vegetational periods of soybean and bean was 22.3% higher when compared to the perannial average and 14.6% higher when compared with 2018. In the reproductional phase, there was a substantial amount of precipitation, which positively affected soybean and bean plants. By observing average temperature values and the total sum, as well as the precipitation distribution throughout both of the examined years, it can be concluded that 2018 was more suitable for soybean and bean production because of more suitable precipitation distribution.

Table 2. Weather conditions in the examined years.

Month	**Temperature (°C)**			**Precipitation (lm^{-2})**		
	2018	**2019**	**Long-term average**	**2018**	**2019**	***Long-term average***
IV	17.1	13.4	11.8	12.0	54.1	44.1
V	20.8	14.7	17.2	43.6	147.6	65.4
VI	21.7	23.2	20.5	122.8	63,.	69.4
VII	22.8	23.3	22.2	108.8	21.0	61.6
VIII	24.9	24.4	21.6	39.2	79.1	53.6
IX	18.5	18.2	17.2	38.8	53.1	48.1
Average/ Sum	21.0	19.5	18.4	365.2	418.6	342.2

Research results and discussion

This paper shows the results of the average total number of microorganisms (x10^{7}) value within the rhizospheral soil segment and yield (kgha^{-1}) per treatment with nettle, EM – aktiv and the combination of nettle and EM – aktiv for the 2018-2019 period of soybean and bean research.

Table 3. Influence of plant extract and EM to total number MO (x10^7) and yield (kgha^{-1}) in the period 2018-2019.

Year	Treatment	Plant species			
		Soybean		Bean	
		MO	Yield	MO	Yield
2018	Control	155.6	2890	170.3	1217
	Nettle	173.2	3150	175.4	1252
	EM	227.7	3341	225.2	1344
	Nettle+EM	270.6	3607	257.2	1390
	Average	206.8	3247	207.0	1301
2019	Control	155.2	2659	156.7	1120
	Nettle	170.0	2898	168.6	1152
	EM	220.3	3074	207.2	1236
	Nettle+EM	250.2	3318	236.6	1279
	Average	198.9	2987	192.3	1197
Average 2018-2019		202.9	3117	199.6	1249
Plant species and years	LSD	Treatment			
		MO		Yield	
Soybean 2018	1%	17.5		185	
	5%	15.9		171	
Soybean 2019	1%	14.6		169	
	5%	16.1		178	
Bean 2018	1%	28.6		91	
	5%	27.2		89	
Bean 2019	1%	28.1		82	
	5%	26.9		76	

An average yield of 3117 kgha^{-1} was recorded for both years, considering that in the year 2018 it amounted to 3247, and 2987 kgha^{-1} in the year 2019 (Table 3). In both years of research, a statistically very significant higher total number of MO was determined by applying the treatment. All differences between applied treatments were at a 5% significance level. The greatest number of total MOs was recorded at the combination of the aqueous nettle extract and EM – aktiv (270.06 x10^7) in 2018 and 250.2 x10^7 in 2019. The influence of weather conditions during the year on the total number of MO is suggested by Dozet (2009). A statistically very significantly higher yield was recorded with all of the treatments in comparison with the control. All differences between the treatments were at the statistical significance level of 1%. Also, Dozet et al. (2019) recorded a significant effect of aqueous nettle extract on soybean yield in comparison to the control.

The average bean yield in both examinatory years was 1249 $kgha^{-1}$, with consideration that it was 8.7% higher in 2018 than in 2019 (Table 3). The average total number of MO identified within the bean plants' rhizosphere was 199.6 $x10^7$. In the year 2018, the number of total MO was 7.6% higher than in 2019. In both years, in the contrl treatment, a statistically significantly lower yield was recorded in comparison with all other applied treatments between which there were 5% significance level differences. With the use of EM, a higher number of total MO was determined compared to the use of the aqueous nettle extract. Similar results are noted by Cvijanović et al. (2021) in their researches. In both years, the greatest bean yield was achieved by combining the aqueous nettle extract application with EM. That was statistically very significantly more than the control and the treatment where only the aqueous nettle extract was applied. Also, by applying EM, in both examinatory years a higher yield was achieved compared to the bean yield where only the aqueous nettle extract was applied and compared to the control. Other differences were not at a level of statistical significance. Positive foliar application effects on bean yield are shown by Cvijanović et al. (2021). On average, a greater number of total MO was in the soybean plants' rhizosphere compared to the beans' rhizosphere. It is suggested by Mrkovački et al. (2012) that the total number of MO depends on the plant species

Conclusion

Organic agriculture uses sustainable production systems as to prevent environmental pollution, increase biodiversity and efficiantly manage natural resources. On the basis of the obtained results, it can be concluded that soybean and bean production may succsessfully be lead by applying EM and an aqueous nettle extract. Applying such preparations may significantly improve soybean and bean production in an organic breeding system. A certificate for organic products is an important step on the path of realizing sustainable agriculture.

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