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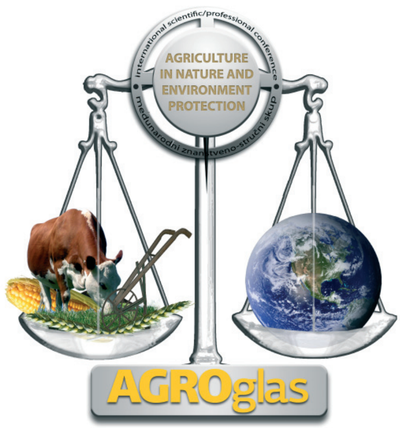

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Poštovani kolegice i kolege,

Ovogodišnji, 13. međunarodni znanstveno-stručni skup specifičan je po mnogočemu, od »najbogatije ponude« znanstvenih i stručnih događanja do sada pa sve do »*lockdowna*« uzrokovanog korona virusom. Iako su uvjeti rada i djelovanja uslijed potonjeg razloga bili znatno otežani, a morao je biti promijenjen i datum održavanja Skupa, za sudjelovanje na Skupu prijavilo se do sada najviše znanstvenika i stručnjaka.Ukupan broj od 68 radova biti će prezentiran kroz pet tematskih sekcija, a osam plenarnih izlaganja prezentirat će respektabilni inozemni i domaći autori. Već tradicionalno, a u okviru Skupa organizira se i okrugli stol, uvijek s drugom i aktualnom problematikom. Tema ovogodišnjeg okruglog stola, koji će se organiziratiu suorganizaciji i pod pokroviteljstvom Akademije poljoprivrednih znanosti (APZ) i Ministarstva zaštite okoliša i energetike (MZOE), je sve aktualnija problematika dezertifikacije, degradacije zemljišta i suše (*Desertification, Land degradation and Drought – DLDD*). Uvodničari okruglog stola bit će eminentni domaći i strani stručnjaci.U okviru međunarodno znanstveno-stručnog skupa bit će integrirano održavanje i međunarodne radionice radne grupe ISTRO-a, WG – CST (*Working Group-Conservation Soil Tillage*),na kojem će sudjelovati eminentni svjetski stručnjaci po pitanju konzervacijske obrade tla. Kao potvrda izvrsnosti i iznimnog doprinosa agronomskoj struci i ove će se godine dodijeliti nagrada »Roberta Sorić« mladim znanstvenicima s najboljim prijavljenim znanstvenim radom. Jednako tako, važnost i ustrajnost u promicanju znanstvenih ideja biti će prepoznata kroz priznanje znanstvenicima koji od samih začetka održavanja ovog Skupa promiču važnost agronomske znanosti i struke i promoviraju Skup.Na kraju bih želio zahvaliti svima koji su svojim angažmanom i kvalitetom doprinijeli uspješnom održavanju i ovogodišnjeg 13. po redu skupa Poljoprivreda u zaštiti prirode i okoliša.

Prof. dr. sc. Danijel Jug
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Izvorni znanstveni rad / Original Scientific Paper

The effects of mulch and bio-fertilizers on soil properties in organic soybean and buckwheat production

Srdjan Šeremešić[1], Maja Manojlović[1], Monika Tomšik[2], Nataša Vujić[3], Boris Đurđević[4], Željko Dolijanović[5], Bojan Vojnov[1] Brankica Babec[6]

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Abstract

Buckwheat and soybean are regarded as important crops in organic production and their production could contribute to achieving farm sustainability. However, this significance derives from a preceding effect, but less research is done on these crops as major crops. The aim of this study is to examine soil properties under different mulches and bio-fertilizers in soybean NS Kaća and buckwheat Novosadska. The experiment was set up in semiarid conditions in the Center for organic production in Selenča with 3 types of mulches: wood chips, straw, living mulch as well as commercial fertilizers and soil enhancers: organic NPK fertilizer, *Ascophyllum nodosum* extract and microbiological stimulator. Mulches were helpful in maintaining the physical properties of soil, but they could not preserve the chemical properties of soil. Buckwheat manifested better chemical and physical soil properties compared to soybean. Our results showed differences regarding mulch application in terms of impact on soil, which could serve as a basis for improving the management of buckwheat and soybean under organic production systems in semiarid conditions.

Key words: organic agriculture, mineral nitrogen, bulk density, soil chemical properties

Introduction

Organic farming is a way of food production that excludes the use of synthetic agrochemicals and lowers the environmental costs of agriculture, delivering numerous other benefits, especially in the spheres of natural resources management and viability of rural areas (Niggli et al., 2017). Observed in a wider sense, it is an ecological system of food production that keeps and improves biodiversity, encourages biological cycles and relies on the use of farm inputs (Šeremešić et al., 2017). Current data showed that the organic sector recorded an overall growth in the surface area, and in 2019 Serbia had 19,254 ha of certified land (MAFWM, 2020). The growing share of areas under organic agricultural system indicates that consumers show a developing interest in food production that favours nature conservation and human health. Still, all these strengths may not be enough, because research shows that yields in organic agriculture are lower compared to conventional agriculture (Seufert et al., 2012). Therefore, yield stability and improving cropping technology are a permanent task. Buckwheat (*Fagopyrum esculentum* Moench.) and soybean (*Glycine max* (L.) Merr.) are regarded as multifunctional crops in organic agriculture and thus could be successfully alternated and combined. Buckwheat can be used as a main (cash) crop, cover crop, stubble crop or green manure, whereby challenges in production include sensitivity to weeds infestation, water shortage, uneven emergence, successive maturation and birds (Glamočlija et al., 2015). On the other hand, soybean can be used as animal feed, human food and green manure. However, the production of soybean depends on relative air humidity, slow initial growth, soil preparation, suppression from weeds and uneven ripening (Miladinović, 2012, Đorđević et al., 2013). Considering limitation and advantages, we can suppose that buckwheat and soybean can enhance organic production systems under adapted management. This is based on the fact that both crops are good preceding crops with a lower demand in nutrients, suitable for combining and mixing with other crops, with short growing period and less susceptible to infestation from diseases. Mulches are often used in organic agriculture mainly in vegetable production. Using mulch in organic production could result in reduced weed germination and suppression, enhanced crop growth and competitiveness by conserving soil moisture and modifying soil temperature, as well as nutrients provision following mineralization. Disadvantages of mulches are related to additional work and labour costs, difficulties when purchasing from organic farms, the required special measures for crop protection and complicated harvest. Combination of mulches and commercial fertilizers in buckwheat and soybean production can eliminate some disadvantages. However, research on that topic is scarce, mainly from conventional agriculture and therefore not fully relevant. Considering that, adaptation of crop management of buckwheat and soybean in organic production could enhance overall sustainability of farms and the integrity of organic production. Therefore, the aim of this study is to examine soil properties after buckwheat and soybean under different mulches and fertilizers.

Material and method

The experiment with soybean and buckwheat was set up on certified organic land of the Center for Organic Production in Selenča as two-factorial experiments (mulching and biopreparation) in three repetitions. The following three types of mulch were used: wood chips (W) 3 kg m^2; wheat straw (S) 4 kg m^2 and living mulch (L): *Matricaria chamomilla* for soybean and field pea for buckwheat. Commercial preparations and fertilizers were simultaneously used: Siforga (Si) – organic NPK (5:3:8) fertilizer; Wuxal Ascofol (Wa) – extract of *Ascophyllum nodosum* 2.3% N; Natur Plasma (Np) – Microbiological stimulator. The preceding crop of soybean and buckwheat was maize. The soil was ploughed in autumn and prepared for sowing on 26 April. The sowing took place on 28 April at a depth of 3 cm, with a distance of 50 x 3 cm (soybean) and 50 x 5 cm (buckwheat). Before sowing, inoculation of soybean seeds with Nitragine was performed. Sowing materials from the Institute of Field and Vegetable Crops from Novi Sad were used – soybean cultivar NS Kaća and buckwheat variety Novosadska. Irrigation was performed at the germination stage and in July. Hand harvesting was performed at full maturity of soybean (August 19) and at 80% of full maturity of seed in buckwheat. Samples were taken for each treatment and control. The arrangement of the treatment is shown in Table 1. Three composite soil samples per treatment were taken with soil auger from the topsoil layer (0-30 cm) for the chemical properties of soil. Whereas for soil bulk density, soil samples in natural, undisturbed condition were taken by Kopecky cylinders (100 cm^3).

Table 1. Arrangement of application on experiment

	Siforga (Si) organic NPK (5:3:8)	Wuxal Ascofol (Wa) – Ascophyllum nodosum 2.3% N	Natur Plasma (Np) – Microbiological stimulator
Sowing	28.04.2015		
Inter-row cultivation I	18.05.2015		
Inter-row cultivation II	28.05.2015		
Mulch application		01.06.2015	01.06.2015
		11.06.2015	11.06.2015

The main climatic factors (temperature and precipitation) for the period from April to August 2015 differ from the long-term average. During the study, the highest rainfall was recorded in May (34 mm), while there was a drought in July. High temperatures and the absence of rainfall made irrigation necessary. In addition, in terms of temperature conditions, the highest average monthly temperature was recorded in August. The average mean daily temperature during the experiment was 18.8 °C, and the total precipitation for the vegetation period of these two crops was 117 mm. In a soil sampled prior to setting up the experiment the pH was moderately alkaline, with a high content of calcium carbonate. The soil is medium provided with organic matter, nitrogen and phosphorus and optimally supplied with available potassium. The obtained data were processed statistically by analysis of variance (ANOVA). For comparison of bulk density and NO_3-N significant F-values ($P < 0.05$) were obtained following the analysis of variance by using Fisher's LSD test.

Results and discussion

In our study, after crop removal, the concentration of NO_3-N at 0-30 cm soil depth was low (Figure 1). This could be explained by a lower amount of added nitrogen, specific crop management in organic farming, and the preceding crop maize (Šeremešić et al., 2009). The obtained values of NO_3-N (4-20 kg N ha^{-1}) correspond with findings of the study by Bogdanović et al. (2010), in which a similar level of NO_3-N was observed at the unfertilized plot of the long-term experiment on Chernozem. Our results showed more NO_3-N under treatments with living mulch compared to control in buckwheat, but a higher amount of NO_3-N in the control plot for soybean. In average buckwheat, more NO_3-N was left compared with soybean, but statistical differences were not significant at such a low NO_3-N content. Wood chips showed higher reduction and decreased the NO_3-N level in soil as a consequence of nitrogen depression.

Control plots were higher in BD because they were compacted and exposed to rainfall (Figure 2). Generally, the applied treatments were able to reduce BD and decrease compaction in both crops. Bulk density showed considerable variability, which was more conditioned by the humidity of the soil layer (Ćirić et al., 2014). The lowest values of BD in soybean were found on the plot with living mulch and Wuxal ascofol, probably because the green cover water uptake, also on the wheat straw + Siforga treatment, could be explained by the fact that wheat straw was decomposed during vegetation. In the average soil under buckwheat, it was statistically significantly higher ($P < 0.05$) in BD compared to the soil under soybean. For buckwheat, a lower BD was observed in the treatment of woodchips and organic fertilizer Siforga. Living mulches were helpful in maintaining the water properties of the soil and weed suppression (Šeremešić at al., 2018). According to Savin et al. (2011), bulk density in organic agriculture is lower because of organic manure application.

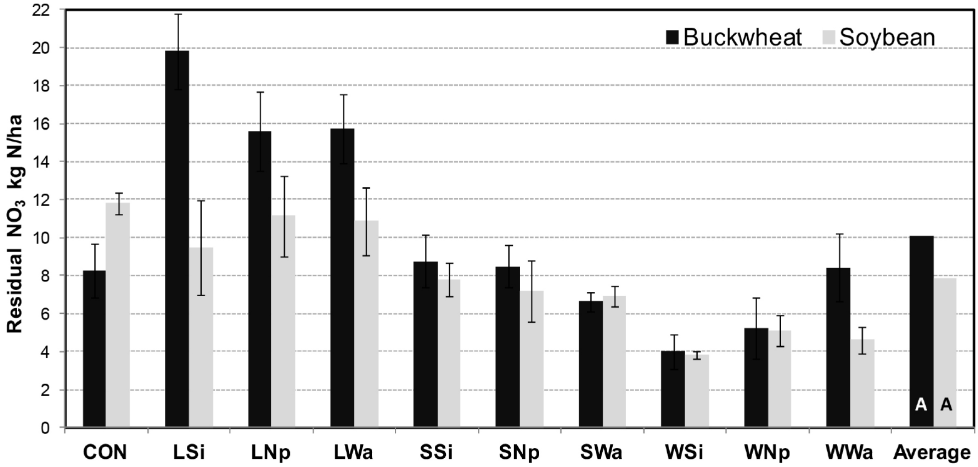

Figure 1. Residual NO3 in soil (0-30cm) after buckwheat and soybean ((W) – Wood chips, (S) – Wheat straw, (L) – Living mulch, (CON) – Control, (Si) – Siforga, (Wa) – Wuxal ascofol, (Np) – Natur plasma)

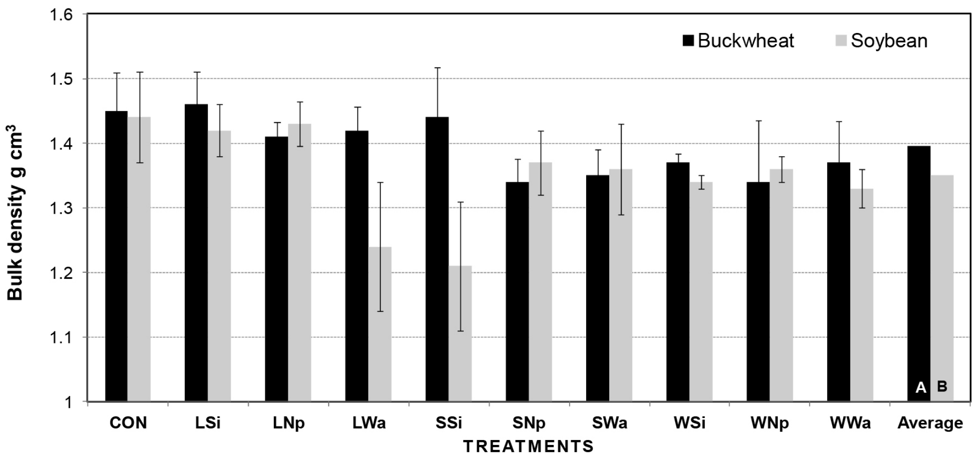

Figure 2. Soil bulk density (0-30 cm) after buckwheat and soybean (W) – Wood chips, (S) – Wheat straw, (L) – Living mulch, (CON) – Control, (Si) – Siforga, (Wa) – Wuxal ascofol, (Np) – Natur plasma)

Table 3. Soil chemical properties after soybean

Nr	Treatments	pH		$CaCO_3$ (%)	Organic matter (%)	Total N (%)	AL-P_2O_5 (mg/100g)	AL-K_2O (mg/100g)
		KCl	**H_2O**					
	Control	7.37	8.49	4,23	2.08	0.10	6.98	19.83
1.	LSi	7.40	8.42	4.23	2.24	0.11	8.20	19.91
2.	LNp	7.37	8.40	4.65	2.26	0.11	8.12	18.61
3.	LWa	7.42	8.47	5.49	2.15	0.11	8.20	17.98
4.	SSi	7.44	8.49	6.76	2.22	0.11	8.88	18.27
5.	SNP	7.47	8.47	7.61	2.26	0.11	8.87	17.89
6.	SWa	7.53	8.47	7.61	2.22	0.11	8.79	17.47
7.	WSi	7.55	8.53	9.72	2.10	0.10	7.78	15.71
8.	WNp	7.57	8.50	7.18	2.29	0.11	10.70	18.27
9.	WWa	7.55	8.49	6.76	2.15	0.11	10.0	17.89
	Average*	7.47	8.47	6.66	2.21	0.10	8.83	18

**Average values for treatments*

Soil analysis after soybean vegetation showed changes in chemical properties across the treatment and compared to the control. The results of agrochemical analyses indicate that the soil pH slightly increased. The $CaCO_3$ content varied widely compared to the pre-sowing value of 5.1% and increased compared to control. The soil remained poorly provided with organic matter with a noticeable increase of average value due to the addition of fresh organic matter, and as a reflection of microbial activity. The total N content was found to decrease from 0.18% at the experiment set up to 0.10%, and the readily available phosphorus content from 12.0 mg 100^{-1}g was reduced to 8.83 mg 100^{-1}g soil. Also, the content of available K_2O decreased from 24.5 mg 100^{-1}g to 15.71 mg 100^{-1}g soil.

Table 4. Soil chemical properties after buckwheat

Nr	Treatments	pH		$CaCO_3$ (%)	Organic matter (%)	Total N (%)	AL-P_2O_5 (mg/100g)	AL-K_2O (mg/100g)
		KCl	**H_2O**					
	Control	7.48	8.35	2.95	2.70	0.13	10.13	23.19
1.	LSi	7.23	8.06	3.37	2.51	0.12	8.98	23.36
2.	LNp	7.10	8.04	3.79	2.50	0.12	8.54	20.79
3.	LWa	7.09	8.13	3.37	2.52	0.12	7.89	20.63
4.	SSi	7.11	8.14	3.79	2.43	0.12	8.34	21.09
5.	SNP	7.16	8.18	2.95	2.47	0.12	7.23	20.92
6.	SWa	7.16	8.21	3.37	2.43	0.12	8.54	21.09
7.	WSi	7.20	8.25	5.06	2.42	0.17	8.28	21.89
8.	WNp	7.18	8.30	3.37	2.55	0.13	9.54	21.42
9.	WWa	7.31	8.30	3.79	2.78	0.14	7.32	19.57
	Average*	7.17	8.17	3.65	2.51	0.12	8.29	21.19

**Average values for treatments*

In the buckwheat experiment, changes in chemical properties across the treatment differ compared with the control. The results of agrochemical analyses indicate that the soil pH slightly decreased. The average $CaCO_3$ content was lower compared to the pre-sowing content and the control. A higher organic matter content was observed at the control compared with the combination of mulches and bio-preparation treatments. The total N content was found to decrease from 0.18% at the experiment set up to 0.12%. N concentrations in soil tend to decrease with addition of material with wider C/N ration such as straw or wood chips (Cabilovski et al., 2014). The readily available phosphorus content decreased from 12.0 mg 100^{-1}g to 8.83 mg 100^{-1}g soil. Likewise, the content of available K_2O decreased from 24.5 mg 100^{-1}g to 21.19 mg 100^{-1}g soil.

Conclusions

Applied treatments have positively affected soil bulk density and higher values were observed after buckwheat compared to soybean. Mineral N was generally low after crop harvest and added mulch material and bio-prepartion contributed to changes in NO_3-N, while living mulch in buckwheat (field pea) has most increased NO_3-N. Higher values were obtained after buckwheat compared to soybean. Soil chemical properties slightly changed. Most pronounced effects were observed for readily available P and K. Our results showed major influence on soil properties could come from mulch application, which could serve as the basis for improving the management of buckwheat and soybean growing in organic systems of the production in semiarid conditions.

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Utjecaj malča i bioloških gnojiva na svojstva tla u organskoj proizvodnji soje i heljde

Sažetak

Heljda i soja smatraju se važnim kulturama u organskoj proizvodnji i njihova proizvodnja mogla bi pridonijeti postizanju održivosti poljoprivrednih gospodarstava. Međutim, ovaj značaj proizlazi iz prethodnog učinka, ali manje je istraživanja provedeno na ovim usjevima kao glavnim usjevima. Cilj istraživanja bio je ispitati svojstava tla pod različitim malčevima i biološkim gnojivima u soji NS Kaća i heljdi Novosadska. Pokus je postavljen u semiaridnim uvjetima u Centru za organsku proizvodnju u Selenči s tri vrste malča: drvnom sječkom, slamom, živim malčem, kao s i komercijalnim gnojivima i ojačivačima tla: organskim NPK gnojivom, ekstraktom *Ascophyllum nodosum* i mikrobiološkim stimulatorom. Malčevi su bili korisni u održavanju fizikalnih svojstava tla, ali nisu mogli sačuvati kemijska svojstva tla. Heljda se očitovala boljim kemijskim i fizikalnim svojstvima tla u odnosu na soju. Naši rezultati pokazali su razlike u primjeni malča u smislu utjecaja na tlo, što bi moglo poslužiti kao osnova za poboljšanje gospodarenja heljdom i sojom u sustavima organske proizvodnje u semiaridnim uvjetima.

Ključne riječi: organska poljoprivreda, mineralni dušik, volumna gustoća, kemijska svojstva tla