Journal of Agricultural Sciences
Vol. 64, No. 3, 2019
Pages 215-224

https://doi.org/10.2298/JAS1903215D
UDC: 631.51:631.559
635.655-155.9
Original scientific paper

PLOUGHING DOWN HARVEST RESIDUES OF PRECEDING CROPS FOR THE PURPOSE OF SOYBEAN YIELD IMPROVEMENT

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Abstract: Soybean yield depends on the choice of cultivar, soil fertility, cultivation practices, and weather conditions in different years. Ploughing down crop residues increases the content of soil organic matter, and thereby positively affects soil fertility. The use of crop residues as an energy source has been promoted in recent years. It would be wrong to refer to this as a renewable energy source as the removal of crop residues from agricultural fields reduces and ultimately damages soil fertility, which in turn leads to reduced yield and a crop residue decrease in the future. Due to the reduced application of manure and organic fertilisers, it is necessary to return crop residues to the soil to preserve soil structure and prevent soil fertility decline. The effect of ploughing down crop residues of preceding crops on soybean yield has been the focus of studies for eleven years. Ploughing down maize crop residues resulted in the soybean yield increase by about 11.69%, i.e. the annual yield increase ranged from 2.89% to 15.94%.

Key words: crop residues, crop rotation, *Glycine max* L., yield.

Introduction

Soybean (*Glycine max* (L.) Merr.) is the most important source of edible oil and high-quality plant protein for feeding both humans and animals worldwide (Friedman and Brandon, 2001). Industrial development placed soybean among the most important industrial plants, serving as a source for 20,000 different products (Давыденко et al., 2004). Aside from its increased production in the 20th century,

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soybean is certainly the plant of the future, gaining its importance due to a world population increase (Đukić, 2009a).

Returning crop residues to the soil is widely recognised as a useful approach to recycle nutrients, increase soil fertility, and prevent the impoverishment of organic carbon in the soil (Rengel, 2007). Crop residues can be returned to the soil for nutrient recycling, and they are an important source of organic matter to improve soil physical, chemical and biological properties (Kumar and Goh, 2003). Ploughing down crop residues contributes to the increase in soil biogenic elements, with a positive effect on the succeeding crop, whereas the application of increased nitrogen doses on preceding crops reduces the number of microorganisms in soybean rhizosphere (Dozet, 2009). The decomposition of crop residues is governed by both quantity and quality of the residue (Yu et al., 2015), climatic conditions such as temperature and moisture (Allmaras et al., 1996), and soil properties (Frouz et al., 2015).

Soybean is the most usually rotated crop with maize, and a yield benefit for rotation has been widely reported, with results from 28 field trial studies on crop rotation exhibiting, on average, a 7.8% increase in yield (Erickson, 2008). Much is known about the principal mechanisms responsible for these benefits, including effects on disease control, improved nitrogen nutrition and water supply, although researchers continue to be challenged by inexplicable “rotation effects” that have yet to be documented or fully understood (Kirkegaard et al., 2008). Maize produces a large number of crop residues, which should be powdered and incorporated into the soil through autumn primary tillage. Crop residues maintain the physicochemical conditions of the soil and improve the overall ecological balance of the crop production system (Tan et al., 2007). Incorporation of crop residues into soil significantly prevents soil erosion and enhances the soil quality (Wilhelm et al., 2007). Bhagat and Verma (1992) showed that the incorporation of crop straws for five years significantly increased the crop yield and improved the soil properties. Incorporation of crop rotation into the soil cannot cause a sudden and rapid increase of the amount of humus, as that process is long and slow, but it can improve soil structure, especially important in soils of heavy mechanical composition. It provides better soil-water-air regime, helps absorb and retain soil moisture, and enables the formation of favourable soil structure and biological maturity, which in turn leads to easier and better tillage with reduced fuel consumption (Jaćimović et al., 2009).

Material and Methods

In order to investigate the effect of ploughing down maize crop residues on soybean yield, the trial was carried in the period 2005 to 2015 at the experimental field of the Institute of Field and Vegetable Crops at Rimski Šančevi (45°20′ N

19°51′ E) near Novi Sad. The trial was organised as the three-crop rotation (maize-soybean-winter wheat) with four replications, where maize was used as a preceding crop to soybean. Trials were conducted using the two variants: ploughing down maize crop residues and removing crop residues from plots. Sowing was conducted mechanically on designated plots, while standard soybean cultivation practices were applied throughout the whole course of the study – autumn primary tillage to the depth of 25 cm, pre-sowing cultivation, inter-row cultivation, inter-row tillage and weeding.

A total of 80 kg ha^{-1} P_2O_5 and K_2O (superphosphate 18%, potassium salt 40%), as well as 100 kg $ha^{-1}$of nitrogen fertilizer KAN (27%) were incorporated into the soil as a primary tillage operation, while 100 kg $ha^{-1}$of nitrogen fertilizer KAN was incorporated in the spring as primary tillage before maize sowing. Fertilisation was not applied during soybean cultivation, except for microbial preparation NS Nitrogen used as a seed inoculant immediately before sowing.

The study included early maturing soybean cultivars from the 0 maturity group, with the vegetation period of 120 days and genetic potential above 4500 kg ha^{-1}. The cultivar Proteinka was sown in the period 2005–2009, whereas the cultivar Valjevka was sown in the period 2010–2015. The recommended planting density for this maturity group is 500,000 plants per hectare.

The basic plot was 5 m long, 3 m wide, i.e. 15 m^2 in size. Planting density was 50 x 3.5 cm, or 571,430 plants per hectare. Mechanical harvesting was conducted with a harvester (Wintersteiger elite). After basic plot harvesting, grain weight and moisture were measured, and yield was calculated (kg ha^{-1}) with the moisture level of 14%.

Research results were statistically analysed by the two-way analysis of variance (ANOVA), while the LSD test was used to check significant differences (the statistical program “Statistica 10.0”).

Weather conditions in the period from 2005 to 2015

Temperature. The average temperature during vegetation in the period from 2005 to 2015 was 18.98°C. It is 0.90°C more than the multiyear average for the period from 1964 to 2015 (18.08ºC). If we observe the average monthly temperatures in the vegetation period by years, it can be noticed that in 2005 average monthly temperatures were lower compared to the multiyear average (17.70°C), while in the remaining years of the research, they were higher. The highest value was recorded in 2012 (20.52°C), which was 2.44°C higher than the annual average (Table 1).

Observed by some months, it can be seen that the average monthly temperature in the eleven-year period was higher than the values for the multiyear period. April and May were the warmest in 2009 (14.6°C and 18.6°C), while in

2012 the highest values were recorded for the average monthly temperatures in June (23.0°C), July (25.2°C) and August (24.6°C).

Table 1. Average monthly temperatures during the soybean vegetation period 2005–2015 (°C).

Mean monthly temperature (C)							
Month / Year	IV	V	VI	VII	VIII	IX	Average
2005	11.8	17.0	19.3	21.4	19.4	17.3	17.70
2006	12.7	16.5	19.7	23.6	19.6	17.9	18.33
2007	13.4	18.5	22.1	23.3	22.7	14.6	19.10
2008	13.0	18.4	21.8	21.7	22.7	15.2	18.80
2009	14.6	18.6	19.6	22.8	22.9	19.2	19.62
2010	12.3	16.9	20.2	23.1	21.9	16.1	18.42
2011	13.2	16.8	20.9	22.1	23.1	20.4	19.42
2012	13.0	17.5	23.0	25.2	24.6	19.8	20.52
2013	13.4	17.4	20.5	22.3	22.9	15.7	18.70
2014	13.2	16.3	20.5	21.9	20.9	17.2	18.33
2015	12.0	18.0	20.7	24.9	24.5	18.7	19.80
Average 2005–2015	12.96	17.45	20.75	22.94	22.29	17.46	18.98
Average 1964–2015	11.70	17.00	20.00	21.70	21.20	16.90	18.08

Precipitation. Mean monthly rainfall during the vegetation period from 2005 to 2015 was 408.33 mm, which is 33.33 mm more than the multiyear average or the period from 1964 to 2015 (375.00 mm). After the sum of precipitation in the vegetation period, it can be seen that the years of 2008 (333.2 mm), 2009 (271.5 mm), 2011 (210.5 mm) and 2012 (226.8 mm) were with a pronounced precipitation deficit. In addition to the amount of rainfall during the growing season, favourable rainfall is important to obtain a high yield of soybean. A critical period in relation to water for achieving high yield of soybean is the period of formation of pods and grains, as well as the filling of soybean, respectively in July and August. Thus, it can be noticed that in addition to the above mentioned years, there was a lack of precipitation in the critical period for soybean in 2013 and 2015 (Table 2).

Evapotranspiration. For a more detailed analysis of meteorological conditions in certain years on the soybean yields achieved, the values of potential and actual evapotranspiration were calculated for the period from emergence to maturity of soybean crops in certain years. These values were calculated on the basis of hydrophytothermic soybean indices, mean daily air temperatures, daily values of precipitation, and the measured soil moisture values at the time of soybean seeding were taken as the baseline. The difference between real and potential evapotranspiration at the time of maturity defines the value of the deficit, i.e. more precipitation as the date when potential evapotranspiration surpasses the value of real evapotranspiration marks the beginning of the drought. All these parameters also affect the length of the vegetation period. There was a decrease in yields in 2013, although no precipitation deficit was identified. The reason for this is the soybean damage caused by hail on June 22 (Table 3).

Table 2. Average monthly rainfall during the soybean vegetation period 2005–2015 (mm).

	Precipitation (mm)						
Month / Year	IV	V	VI	VII	VIII	IX	Total
2005	33.0	38.1	135.4	122.5	133.9	67.0	529.9
2006	66.0	70.1	104.3	30.9	124.9	23.8	420.0
2007	0.0	98.6	71.1	38.8	79.6	78.8	366.9
2008	21.9	46.2	115.9	41.6	14.0	93.6	333.2
2009	3.6	50.4	127.2	58.1	19.1	13.1	271.5
2010	63.7	113.7	171.8	99.0	168.5	67.7	684.4
2011	22.8	62.4	36.9	61.5	1.5	25.4	210.5
2012	82.8	52.2	27.5	47.7	3.5	13.1	226.8
2013	35.8	118.1	125.7	34.1	26.7	107.8	448.2
2014	51.2	202.1	38.2	141.1	78.7	99.7	611.0
2015	15.9	191.7	26.7	2.6	99.7	52.6	389.2
Average 2005–2015	36.06	94.87	89.15	61.63	68.19	58.42	408.33
Average 1964–2015	46.90	67.10	86.50	67.40	59.30	47.80	375.00

Table 3. Potential and actual evapotranspiration during soybean vegetation from 2005 to 2015 (mm).

Year	SM	PV	PE	AE	PD	DS	LVP
2005	46.20	430.1	393	476	83	-	125
2006	41.60	326.7	404	370	-34	03.07.	120
2007	32.00	267.2	390	299	-91	02.07.	113
2008	49.20	207.8	412	256	-156	05.07.	114
2009	36.94	242.5	402	279	-123	23.07.	117
2010	51.32	557.4	436	587	151	-	121
2011	48.66	163.6	381	211	-170	21.06.	114
2012	28.20	127.4	403	156	-247	07.06.	106
2013	37.05	298.6	413	336	-77	04.08.	116
2014	35.32	498.2	416	533	117	-	126
2015	39.17	231.1	381	263	-118	18.07.	105

SM – Soil moisture reserves during the sowing time; PV– Precipitation during the vegetation period; PE – Potential evapotranspiration; AE – Evapotranspiration; PD –Precipitation deficit; DS – Drought start, LVP – Length of the vegetation period.

Results and Discussion

Water is the primary limiting factor controlling production. Loss of water through evaporation (E) is large, especially in less intensive cropping systems (Farahani et al., 1998). One way in which water may be conserved is through crop residue management. It is generally believed that increasing crop residue levels leads to water conservation (van Donk et al., 2012). Ploughing down crop residues of maize preceding crops resulted in a yield increase in all years of study, compared to variants in which crop residues were removed from plots. Average yield was increased by 11.69% over the course of eleven years. The highest average yield (4635.50 kg ha^{-1}) was recorded in the 2014 season in which there was no precipitation deficit resulting in an increase and development of soybean, and the lowest was recorded in 2012 (2107.63 kg ha^{-1}) in which precipitation deficit was 247mm during soybean vegetation (Table 4). Retention of a layer of crop residues following harvesting can have considerable yield responses in low-rainfall areas and few or negative responses in super-humid and low-temperature areas (Kingston et al., 2005). During unfavourable seasons, the highest yield increase was recorded on plots where ploughing down harvest residues was applied (13.43% in 2012, 15.94% in 2015). Considering the average annual yields, no significant difference was observed between 2006 and 2009 (3272.88 kg ha^{-1}and 3291.88 kg ha^{-1}), but highly significant differences in yields were recorded in all other years of study.

Table 4. Average soybean grain yield (kg ha^{-1}).

Factors	Harvest residue (B)		Average (A)	Yield increase (%)
Year (A)	With CR	Without CR		
2005	4009.00	3721.75	3865.38	7.72
2006	3408.75	3137.00	3272.88	8.66
2007	3454.75	3357.75	3406.25	2.89
2008	3711.75	3304.25	3508.00	12.33
2009	3486.00	3097.75	3291.88	12.53
2010	4592.25	4147.25	4369.75	10.73
2011	3507.00	3214.75	3360.88	9.09
2012	2240.25	1975.00	2107.63	13.43
2013	3182.25	2831.25	3006.75	12.40
2014	4793.00	4478.00	4635.50	7.03
2015	3318.25	2862.00	3090.13	15.94
Average (B)	3609.39	3284.25	3446.82	11.69

Factor	$LSD_{0.05}$	$LSD_{0.01}$
A	3062	4123
B	1467	1971
AxB	4866	6538
BxA	4517	6004

The average yield obtained in trials where maize crop residues were ploughed down (3609.39 kg ha^{-1}) had significant differences compared to trials which included crop residue removal (3284.25 $kgha^{-1}$). Ploughing down maize crop residues has a positive effect on soybean yield (Meki et al., 2013). Soybean yield was 24% lower when sorghum residues were removed than when the residue was left on the soil surface. This yield reduction with residue removal is due to low content of available soil water, high soil temperatures on the surface, and poor canopy development (Doran et al., 1984). Yield increases by ploughing down crop residues of preceding crops were evident in each year of research, while oscillations in yield over the years of the study confirm that soybean yield was highly affected by weather conditions during the vegetation period. Organic matter increases microorganism activity in the arable layer which binds nitrogen, thereby reducing the possibility of nutrient leaching into deeper soil layers (Đukić et al., 2009b).

Considering the trials which included ploughing down crop residues across different study years, no significant differences in soybean yields were recorded between 2007 (3454.75 kg ha^{-1}) and 2009 (3486.00 kg ha^{-1}), or between 2009 and 2011 (3507.00 kg ha^{-1}). Maize residue remaining in the field may have reduced soil water evaporation, increased soil water availability, and improved soybean productivity during the drought year (Riedell et al., 2017).

The difference in yields was significant between 2006 (3408.75 kg ha^{-1}) and 2007, while highly significant differences in yields were recorded in all other years of study. Observing the trials where ploughing down harvest residues was not used across different years of study, soybean yields showed no significant difference between 2006 (3137.00 kg ha^{-1}) and 2009 (3097.75 kg ha^{-1}), or between 2013 (2831.25 kg ha^{-1}) and 2015 (2862.00 kg ha^{-1}). The difference in soybean yields was significant between 2007 (3357.75 kg ha^{-1}) and 2008 (3304.25 kg ha^{-1}), while the differences between yields in other years of study were highly significant. Crop residue is also a valuable resource in terms of soil quality (Wilhelm et al., 2007). Research has shown that crop residue is directly related to characteristics beneficial to soil quality and crop yields, including nutrient cycling, soil organic matter, and soil organic carbon (Blanco-Canqui and Lal, 2009). Crop residue is directly related to many soil physical and chemical properties that affect plant growth, and the removal of crop residue may adversely affect these properties.

Conclusion

Ploughing down maize harvest residues had a positive effect on soybean yield. Crop residue removal from plots reduced soybean yield and ultimately disturbed soil structure and soil biogenic elements. Removal of crop residues from the plots reduced the yield of soybean and disrupted soil structure and soil biogenes. In order to obtain high and stable yields, ploughing down harvest residues of preceding crops should be applied as a mandatory soybean cultivation practice.

References

Allmaras, R.R., Copeland, S.M., Copeland, P.J., & Oussible, M. (1996). Spatial relations between oat residue and ceramic spheres when incorporated sequentially by tillage. *Soil Science Society of America Journal, 60,* 1209-1216.

Blanco-Canqui, H., & Lal, R. (2009a). Crop residue removal impacts on soil productivity and environmental quality. *Critical Reviews in Plant Sciences*, *28* (3), 139-163.

Давыденко, О.Г., Голоенко, Д.В., & Розенцвейг, В.Е. (2004). Соя для умеренного климата, "Тэхналогiя" Минск, Беларусь, 173.

Doran, J.W., Wilhelm, W.W., & Power, J.F. (1984). Crop residue removal and soil productivity with no–till corn, sorghum, and soybean. *Soil Science Society of America Journal, 48,* 640-645.

Dozet, G. (2009). Uticaj đubrenja predkulture azotom i primene Co i Mo na prinos i osobine zrna soje. Doktorska disertacija, Megatrend univerzitet Beograd, Fakultet za biofarming Bačka Topola.

Đukić, V. (2009a). Morfološke i proizvodne osobine soje ispitivane u plodoredu sa pšenicom i kukuruzom. Doktorska disertacija, Univerzitet u Beogradu, Poljoprivredni fakultet Zemun.

Đukić, V., Đorđević, V., Popović, V., Kostić, M., Ilić, A., & Dozet, G. (2009b). Uticaj đubrenja na prinos soje. *Zbornik radova Instituta za ratarstvo i povrtarstvo*, *46*, 17-22.

Erickson, B. (2008). Corn/soybean rotation literature summary. Dep. of Agric. Econ., Purdue Univ.,West Lafayette, In. http://www.agecon.purdue.edu/pdf/Crop_Rotation_Lit_Review.pdf.

Farahani, H.J., Peterson, G.A., & Westfall, D.G. (1998). Dryland cropping intensification: A fundamental solution to efficient useof precipitation. *Advances in Agronomy*, *64,* 197-223.

Friedman, M., & Brandon, D.L. (2001). Nutritional and Health Benefits of Soy Proteins. *Journal of Agricultural and Food Chemistry, 49,* 1069-1086.

Frouz, J., Spaldonov, A., Lhotakova, Z., & Cajthaml, T. (2015). Major mechanisms contributing to the macrofauna-mediated slow down of litter decomposition. *Soil Biology* & *Biochemistry, 91,* 23-31.

Jaćimović, G., Malešević, M., Bogdanović, D., Marinković, B., Crnobarac, J., Latković, D., & Aćin, V. (2009). Prinos pšenice u zavisnosti od dugogodišnjeg zaoravanja žetvenih ostataka. *Annals of Agronomy*, *33* (1), 85-92.

Kingston, G., Donzelli, J.L., Meyer, J.H., Richard, E.P., Seeruttun, S., Torres, J., & Van Antwerpen, R. (2005). Impact of green cane harvest and production system on the agronomy of sugarcane. *Proceedings - International Society of Sugar Cane Technologists*, *25,* 184-190.

Kirkegaard, J., Christen, O., Krupinsky, J., & Layzell, D. (2008). Break crop benefits in temperate wheat production. *Field Crops Research*, *107,* 185-195.

Kumar, K., & Goh, K.M. (2003). Nitrogen release from crop residues and organic amendments as affected by biochemical composition. *Communications in Soil Science and Plant Analysis*, *34,* 2441-2460.

Meki, M.N., Atwood, J.D., Norfleet, L.M., Williams, J.R., Gerik, T.J., & Kiniry, J.R. (2013). Corn residue removal effects on soybean yield and nitrogen dynamics in the Upper Mississippi River basin. *Agroecology and Sustainable Food Systems*, *37,* 379-400.

Rengel, Z. (2007). The role of crop residues in improving soil fertility In: Marschner P, Rengel Z, (Eds.), *Nutrient cycling in terrestrial ecosystems.* (pp. 183-214). Spring–Verlag; Berlin Heidelberg.

Riedell, W.E., Osborne, S.L., & Dagel, K.J. (2017). Maize Residue Removal and Cover Crop Effects on Subsequent Soybean Crops. *Agronomy Journal*, *109* (6), 2762-2770.

Seifert, C., Roberts, M., & Lobell, D. (2017). Continuous corn and soybean yield penalties across hundreds of thousands of fields. *Agronomy Journal*, *109* (2), 541-548.

Tan, D.S., Jin, J.Y., Huang, S.W., Li, S.T., & He, P. (2007). Effect of long–term application of K fertilizer and wheat straw to soil on crop yield and soil K under different planting systems. A*gricultural Sciences in China*, *6*, 200-207.

Van Donk, S.J., Shaver, T.M., Petersen, J.L., & Davison, D.R. (2012). Effects of crop residue removal on soil water content and yield of deficit–irrigated soybean. *Transactions the ASABE, 55*, 149-157.

Verma, T.S., & Bhagat, R.M. (1992). Impact of rice straw management practices on yield, nitrogen uptake and soil properties in a wheat-rice rotation in northern India. *Fertilizer Research, 33*, 97-106.

Wilhelm, W., Johnson, J. Karlen, D., & Lightle, D. (2007). Corn stover to sustain soil organic carbon further constrains biomass supply. *Agronomy Journal*, *99* (6), 1665-1667.

Yu, Z., Huang, Z., Wang, M., Liu, R., Zheng, L., Wan, X., Hu, Z., Davis, M.R., & Lin, T-C. (2015). Nitrogen addition enhances home-field advantage during litter decomposition in subtropical forest plantations. *Soil Biology & Biochemistry*, *90*, 188-196.

Received: February 16, 2019
Accepted: August 21, 2019

ZAORAVANJE ŽETVENIH OSTATAKA PREDUSEVA U CILJU POVEĆANJA PRINOSA SOJE

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R e z i m e

Prinos soje zavisi od izbora sorte, plodnosti zemljišta, agrotehničkih mera, kao i od vremenskih uslova u pojedinim godinama. Zaoravanjem žetvenih ostataka preduseva povećava se sadržaj organske materije u zemljištu, što ima pozitivan uticaj na plodnost zemljišta. U jedanaestogodišnjim istraživanjima proučavan je uticaj zaoravanja žetvenih ostataka preduseva kukuruza na prinos soje. Poslednjih nekoliko godina sve više se promoviše korišćenje žetvenih ostataka za dobijanje energije. Pogrešno je nazivati ovaj vid dobijene energije kao obnovljivu energiju, pošto se na duži period odnošenjem žetvenih ostataka sa poljoprivrednih površina pogoršava i trajno narušava plodnost zemljišta, što će dovesti u budućnosti do smanjenja prinosa gajenih biljaka, a samim tim i do smanjenja žetvenih ostataka. Zbog sve manje primene stajnjaka i organskih đubriva, neophodno je bar deo žetvenih ostataka gajenih biljaka vratiti u zemljište, kako bi se sačuvala struktura zemljišta i usporilo opadanje njegove plodnosti. Zaoravanje žetvenih ostataka preduseva kukuruza dovelo je do povećanja prinosa soje u proseku za 11,69%, odnosno po pojedinim godinama povećanje prinosa je bilo od 2,89% do 15,94%.

Ključne reči: predusev, prinos, soja, žetveni ostaci.

Primljeno: 16. febuara 2019.
Odobreno: 21. avgusta 2019.

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