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Weed infestation of soybean (*Glycine max* L. Merr.) under different tillage systems

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Abstract

Direct drilling is one of the methods to reduce tillage costs. Low labor intensity of this system also makes it possible to grow crops in locations where it is a problem to maintain optimal sowing time. However, the use of no-tillage can cause increased weed infestation of crop plants and as a consequence a decline in crop yields. The present study investigated the effect of two tillage systems, plough tillage and direct drilling, on the species composition, density and air-dry weight of weeds in crops of two soybean cultivars ('Aldana' and 'Augusta'). A three-year field experiment was set up on loess-derived gray-brown podzolic soil. The study showed that the use of direct drilling for soybean cropping resulted in a significant increase in the density and dry weight of weeds relative to plough tillage. The study also found richer floristic composition of weeds and an increase in the numbers of dominant species under no-tillage conditions. *Elymus repens*, *Echinochloa crus-galli* and *Chenopodium album* were dominant weed species in all experimental treatments. *Chenopodium album* and *Galinsoga parviflora* were characterized by the highest constancy (constancy classes V and IV) in crops of both soybean cultivars, whereas *Echinochloa crus-galli* showed the highest constancy value in the 'Aldana' crop. Under direct drilling, most weed species were found to exhibit higher constancy compared to plough tillage.

Keywords: *Glycine max* L. Merr.; cultivars; plough tillage; direct drilling; weeds species composition, density; dry weight

Introduction

Reduced tillage is one of the methods to cut down plant production costs. This tillage system involves, among others, a reduction in the number of tillage operations, shallower ploughing, replacing the plough by other implements, or the use of direct drilling. Low labor intensity of this system also makes it possible to grow crops in locations where it is a problem to maintain optimal sowing time. When we abandon many tillage operations, we naturally save on the time necessary to prepare the soil for seeding, which is of special importance in large farms oriented towards maximization of labor productivity. Direct sowing in mulch also has a positive effect on soil structure [1–3] and water content not only in the topsoil, but also at greater depths [4,5]. The negative effects of no-till undoubtedly include increased weed infestation of crop plants and as a consequence a decline in crop yields [6]. Lower yields obtained under direct drilling do not necessarily mean lower profitability nor argue for the abandonment of this tillage system, since lower energy inputs can compensate for the loss resulting from lower crop yields [7].

The interest in the cultivation of soybean has been growing in Poland in recent years. The reason for this, among others, is the breeding of new cultivars well adapted to our climatic conditions as well as the higher nutritional value of soybean and its lower lodging propensity in comparison to other legumes.

The aim of this study was to compare the effect of plough tillage and direct drilling on the species composition, density and air-dry weight of weeds in crops of two soybean cultivars under the conditions of the Lublin Upland.

Material and methods

A field study was carried out over the period 2009–2012 at the Czesławice Experimental Farm (51°18′23″ N, 22° 16′2″ E), belonging to the University of Life Sciences in Lublin. In 2010 the soybean plantation was terminated due to adverse weather conditions and the resultant inhibited plant emergence.

The experiment was set up on loess-derived gray-brown podzolic soil as a split-block design in four replicates. The area of each experimental plot was 96 m^2 (the area of the small plot was 24 m^2). The soil was characterized by slightly acidic pH (6.2 in 1 mole KCl), high phosphorus and potassium availability as well as medium magnesium availability.

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The humus content was 1.2%. The experimental factors were as follows:
I. Soybean cultivars:
A. 'Augusta' (early variety)
B. 'Aldana' (early variety)
II. Tillage systems:
a. Plough tillage – skimming, double harrowing, autumn ploughing to a depth of 25 cm. Spring: harrowing, cultivating, harrowing, sowing.
b. Direct drilling – without mechanical tillage. In the spring, only Roundup Energy 450 SL [active ingredient (a.i.) – glyphosate] was applied at a rate of 3 l ha^{-1}.

Each year, soybean was sown at the turn of April and May in a field after winter wheat. The row spacing was 20 cm, the seeding depth 3 cm, and planned plant density 100 plants per 1 m^2.

Mineral fertilizer rates were determined based the nutritional requirements of soybean and soil nutrient availability. Fertilization was applied before sowing at the following amount: N – 50 kg ha^{-1}; P – 35 kg ha^{-1}; K – 83 kg ha^{-1}.

Soybean seeds were inoculated with *Bradyrhizobium japonicum* bacteria and the seed dressing Vitavax 200 FS (a.i. carboxin, thiuram) was applied at a rate of 400 ml/100 kg of seed with water added at a 1:1 ratio. Immediately after sowing, a mixture of the herbicides Afalon Dyspersyjny 450 SC (a.i. linuron) + Dual Gold 960 EC (a.i. S-metolachlor) was applied at an amount of 1 l + 1.8 l ha^{-1}.

Weed infestation of soybean crops was determined using the dry-weight-rank method at the pod and seed maturation stage (BBCH 81/82). The evaluation involved the determination of the botanical composition of weeds, their density and air-dry weight. The sampling area was delineated with a 1 × 0.5 m quadrat frame in two randomly selected places in each plot.

The results obtained in the years 2009, 2011 and 2012 were statistically analyzed by analysis of variance, and the significance of differences was evaluated by Tukey's test at $\alpha = 0.05$. Constancy classes follow Braun-Blanquet [8] and they were calculated based on a 3-year analysis of weed infestation of soybean.

In the first year of the experiment (2009), the mean air temperature in particular months of the growing season was generally higher than the long-term mean (Fig. 1). A lower temperature was only recorded in May and June. These months were also characterized by the highest amount of rainfall which much exceeded the long-term average (Fig. 2). In 2010 the soybean plantation was terminated, since a rather low temperature in the month of sowing (April) and heavy rainfall prevented crop emergence. The year 2011 proved to be favorable for soybean development in terms of thermal conditions. In particular months of the growing season, the recorded temperatures were generally higher than or similar to the long-term mean (May, July). Lower than average rainfall was recorded in the initial period of soybean growth (April and May) as well as during maturation and harvest (August, September). The last year of the study (2012) was very warm and rather dry. A higher than average temperature was recorded in all months. The total rainfall exceeded the long-term mean in June and July.

Results

On average for the three-year study, the density and dry weight of weeds did not differ significantly depending on soybean cultivar (Tab. 1, Tab. 2). In the 'Aldana' cultivar, a trend was only found towards an increase in weed weight (by 5.4 g m^{-2}) relative to the dry weight of weeds found in the plots sown with cv. 'Augusta'.

Density and dry weight of weeds were significantly modified by the tillage system used. Under direct drilling, compared to the treatment with conventional plough tillage, the density of weeds was higher by 272.8%, whereas the dry weight of weeds by 173.6%.

Echinochloa crus-galli and *Chenopodium album* were annual weed species that occurred in greatest density in crops of both soybean cultivars, whereas among perennial weeds *Elymus repens* was the most numerous (Tab. 3). A slightly higher number of dominant annual and perennial weed species was found in the 'Aldana' cultivar. Throughout the duration of the experiment, both soybean cultivars were characterized by similar floristic composition of weeds. Only two more weed species were observed in the 'Augusta' crop compared to 'Aldana' (Tab. 3).

The tillage systems used significantly modified the floristic composition of weeds in the soybean crop (Tab. 3). In both tillage treatments, *Echinochloa crus-galli* and *Chenopodium album* occurred in greatest density, while among perennial weeds *Elymus repens*. Under the plough system, however, the number of individuals of these dominant weeds was much lower relative to that found under direct drilling. This was most evident in the case of *Elymus repens*, the density of which was 6 times lower in the plots where conventional plough tillage was used compared to the direct drilling treatment. Under direct drilling, the soybean crop was infested with eight more species relative to plough tillage (Tab. 3).

A much higher density of weeds was observed in crops of both soybean cultivars under direct drilling (Tab. 3). In the case of the most numerous species, *Elymus repens*, this density in the 'Aldana' crop was more than 4 times higher and in the 'Augusta' crop almost 9 times higher compared to the one found under plough tillage. In comparison with the plough treatment, in the plots with direct drilling six weed species more occurred in the 'Aldana' crop and ten weed species more in the 'Augusta' cultivar (Tab. 3).

Throughout the duration of the experiment, *Chenopodium album* and *Galinsoga parviflora* were characterized by the highest constancy (constancy classes V and IV) in crops of both soybean cultivars, whereas *Echinochloa crus-galli* showed the highest constancy value in the 'Aldana' cultivar (Tab. 4). Under direct drilling conditions, most weed species were found to exhibit higher constancy compared to plough tillage.

Discussion

The existing research shows that weeds are a factor that most reduces soybean productivity [9]. Gibson et al. [10] report that in soybean and maize crops weeds are a greater problem than diseases, nematodes and insects. Krausz et al.

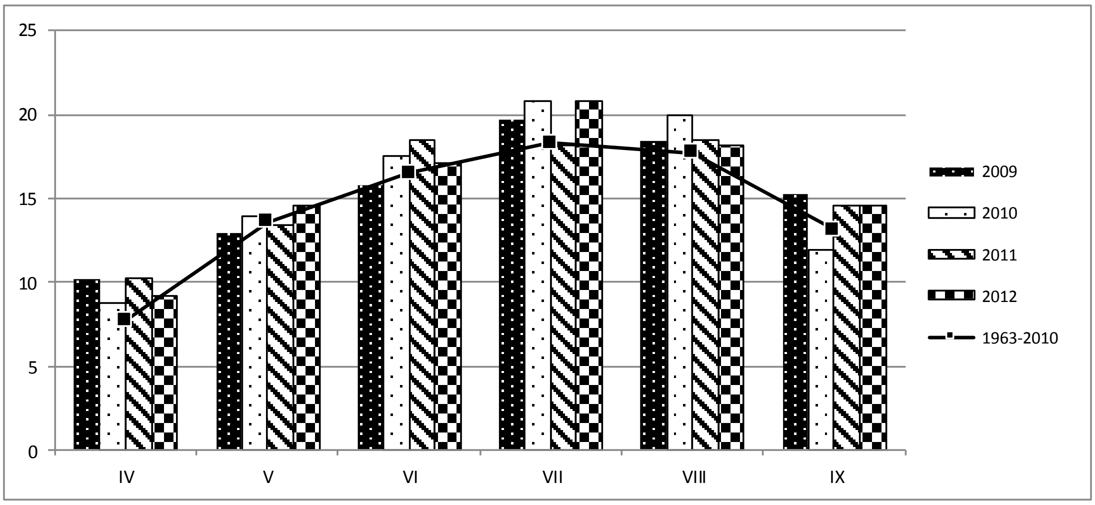

Fig. 1 Mean monthly air temperature (°C) at the Czesławice Meteorological Station in 2009–2012.

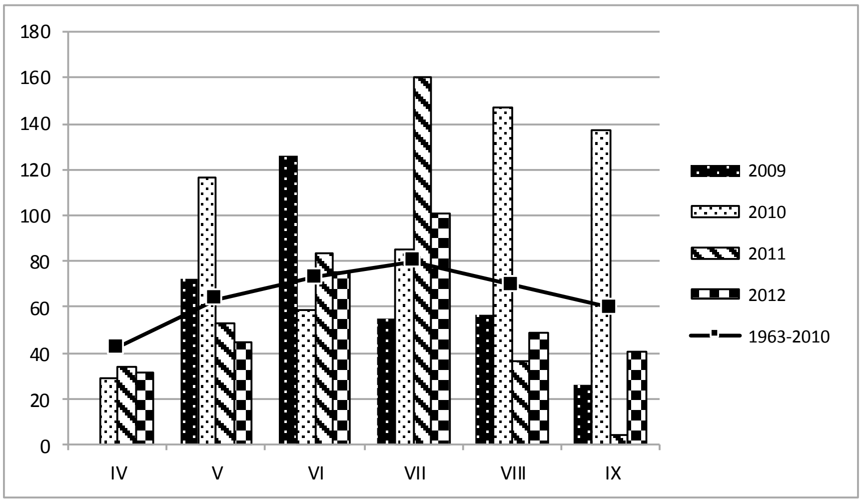

Fig. 2 Total rainfall and rainfall distribution (mm) at the Czesławice Meteorological Station in 2009–2012.

[11] and Vollmann et al. [12] also found that weed competition significantly reduced soybean yields. According to Singh and Jolly [13], a decrease in seed yield of this plant under the influence of weed infestation can be as much as 68%.

The results of the present study show a substantial increase in the density and dry weight of weeds in a soybean crop under direct drilling. In the studies of Bujak et al. [14] and Gawęda [15], reduced tillage under soybean also caused increased weed infestation of the soybean crop. When direct drilling was used, the density and dry weight of weeds were even about twice higher in comparison with the values of these traits found under conventional plough tillage [14]. An increase in dry weight of weeds as a result of the use of reduced tillage has also been proved in other crops by Bujak and Frant [16], Kraska and Pałys [17,18] as well as Andruszczak et al. [19].

The results on soybean yield obtained in the present experiment, which are presented in the paper by Gawęda et al. [20], show lower productivity of soybean under direct drilling conditions (about 12.8%) as compared to the plough system. Higher weed infestation under this tillage system was therefore associated with lower soybean yields. The abandonment of plough tillage was the cause of lower plant density, which probably resulted in worse competitiveness of soybean against weed plants [20]. Likewise, Ciesielska and Rzeźnicki [21] attribute worse grain yields of spring wheat sown using direct drilling technology to its uneven emergence. Under zero tillage, compared to plough tillage, the plant density was particularly unfavorable in the first year of cropping when this tillage system was used. A higher density of weeds was then observed. It was only after a long use of direct drilling that the differences in the density of weeds were insignificant in comparison to plough tillage. According to Boot et al. [22], under direct drilling there is high topsoil compaction which impedes plant emergence. In the present study, this may also have resulted in higher weed infestation and as a consequence in lower yields of both soybean cultivars.

Tab. 1 Density of weeds in soybean (pcs m^{-2}).

Year	Aldana plough tillage	Aldana direct seeding	Cultivar mean	Augusta plough tillage	Augusta direct seeding	Cultivar mean	Tillage mean plough tillage	Tillage mean direct seeding
2009	8.0	31.5	19.8	4.5	40.2	22.4	6.3	35.9
2011	19.8	46.8	33.3	13.3	40.2	26.8	16.6	43.5
2012	5.3	19.5	12.4	4.3	27.5	15.9	4.8	23.5
Mean	11.0	32.6	21.8	7.4	36.0	21.7	9.2	34.3
$LSD_{0.05}$	cultivar – n.s; tillage system – 6.03; cultivar × tillage system – n.s.; cultivar × year – n.s.; tillage system × year – n.s.; cultivar × tillage system × year – n.s.							

Tab. 2 Air-dry weight of weeds in soybean (g m^{-2}).

Year	Aldana plough tillage	Aldana direct drilling	Cultivar mean	Augusta plough tillage	Augusta direct drilling	Cultivar mean	Tillage mean plough tillage	Tillage mean direct drilling
2009	16.6	107.2	61.9	14.5	73.5	44.0	15.6	90.4
2011	37.6	84.6	61.1	35.1	81.6	58.4	36.4	83.1
2012	42.6	50.4	46.5	26.2	75.6	50.9	34.4	63.0
Mean	32.3	80.7	56.5	25.3	76.9	51.1	28.8	78.8
$LSD_{0.05}$	cultivar – n.s; tillage system – 12.25; cultivar × tillage system – n.s.; cultivar × year – n.s.; tillage system × year – n.s.; cultivar × tillage system × year – n.s.							

Tab. 3 Density of weed species in soybean (mean of 3 years).

Species	Aldana plough tillage	Aldana direct drilling	Augusta plough tillage	Augusta direct drilling
I. Short-term				
Amaranthus retroflexus L.	0.1	0.1	0.1	0.2
Apera spica-venti (L.) P.B.	-	0.3	-	0.1
Capsella bursa-pastoris (L.) Medik.	-	0.6	-	1.3
Chenopodium album L.	1.2	4.3	0.9	4.3
Echinochloa crus-galli (L.) P.B.	2.7	3.7	1.8	3.1
Erigeron canadensis L.	0.1	0.3	0.2	0.9
Fallopia convolvulus (L.) Á. Löve	-	-	-	0.1
Galeopsis tetrahit L.	0.2	0.1	0.1	-
Galinsoga ciliata (Raf.) S.F. Blake	-	1.8	-	2.2
Galinsoga parviflora Cav.	1.0	3.0	0.5	3.0
Geranium pusillum Burm. f. ex L.	-	0.3	0.1	0.4
Gnaphalium uliginosum L.	-	0.5	-	1.7
Poa annua L.	-	1.3	-	1.8
Polygonum aviculare L.	0.2	0.2	-	-
Polygonum nodosum Pers.	0.7	1.0	0.7	1.2
Solanum nigrum L. Emend. Mill.	0.1	-	-	0.1
Stellaria media (L.) Vill.	0.1	0.3	-	0.4
Veronica arvensis L.	-	-	0.1	0.2
Veronica persica Poir.	-	-	-	0.1
Viola arvensis Murr.	0.6	0.3	0.6	0.5
Total of short-term weeds	7.0	18.1	5.1	21.6
II. Perennial				
Cirsium arvense (L.) Scop.	1.0	0.3	0.4	0.3
Elymus repens (L.) Gould	2.5	11.7	1.2	10.1
Equisetum arvense L.	0.4	0.9	0.7	2.4
Plantago intermedia Gilib.	-	0.2	-	0.3
Taraxacum officinale F.H. Wigg.	0.1	1.4	-	1.3
Total of perennial weeds	4.0	14.5	2.3	14.4
Total density of species	15	21	13	23

Tab. 4 Constancy of weeds in the soybean depending on cultivars and tillage systems (mean of 3 years).

Species		Aldana	Augusta	Plough tillage	Direct drilling
I. Short-term					
Chenopodium album L.		V	V	IV	V
Echinochloa crus-galli (L.) P.B.		IV	III	II	V
Galinsoga parviflora Cav.		IV	IV	III	V
Galinsoga ciliata (Raf.) S.F. Blake		II	I	-	II
Polygonum nodosum Pers.		II	II	II	II
Viola arvensis Murr.		II	II	II	II
Amaranthus retroflexus L.		I	I	I	I
Apera spica-venti (L.) P.B.		I	I	-	I
Capsella bursa-pastoris (L.) Medik.		I	II	-	II
Erigeron canadensis L.		I	II	I	II
Galeopsis tetrahit L.		I	I	I	I
Geranium pusillum Burm. f. ex L.		I	I	I	I
Gnaphalium uliginosum L.		I	I	-	II
Poa annua L.		I	I	-	II
Polygonum aviculare L.		I	-	I	I
Solanum nigrum L. Emend. Mill.		I	I	I	I
Stellaria media (L.) Vill.		I	I	I	I
Veronica arvensis L.		-	I	I	I
Veronica persica Poir.		-	I	-	I
Fallopia convolvulus (L.) Á. Löve		-	I	-	I
II. Perennial					
Elymus repens (L.) Gould		III	III	II	IV
Cirsium arvense (L.) Scop.		II	II	III	II
Equisetum arvense L.		II	II	II	II
Taraxacum officinale F.H. Wigg.		II	II	I	II
Plantago intermedia Gilib.		I	I	-	I
Number of weed species in constancy classes (C)	V	1	1	-	3
	IV	2	1	1	1
	III	1	2	2	-
	II	6	7	5	10
	I	12	13	9	11

Blecharczyk et al. [23] observed a similar number of weed species in a field pea crop under direct drilling and plough tillage systems. Contrary to this, in the study presented in this paper no-tillage was characterized by much richer floristic composition of weeds.

The research results presented in this paper demonstrate that under direct drilling there was an increase in the number of dominant species in the soybean crop, such as *Echinochloa crus-galli* and *Chenopodium album*, and to the greatest extent *Elymus repens*. Bujak et al. [14] also observed an increase in the numbers of the above-mentioned weed species under the influence of reduced tillage, including direct drilling. Likewise, Buhler et al. [24] showed that long-term use of reduced tillage caused an increase in perennial weeds. Using direct drilling, Ciesielska and Rzeźnicki [21] observed increased incidence of *Echinochloa crus-galli* and a decrease in the proportion of *Chenopodium album* in weed infestation of the crop.

This study proved the effect of direct drilling on increased weed infestation of soybean. Nevertheless, the advisability of using this system should also be considered in the context of its positive impact on the soil environment and of economic savings. The research of Blanchart et al. [25] demonstrated that long-term use of direct drilling positively affected soil biological life. On the other hand, Yalcin end Cakir [26] report that under direct drilling seven times less fuel is used in comparison with conventional tillage, while labor productivity increases as much as nine times.

Conclusions

(***i***) The use of direct drilling resulted in a significant increase in the density and air-dry weight of weeds relative to the plots with plough tillage.

(***ii***) In all experimental treatments, *Echinochloa crus-galli* and *Chenopodium album* were dominant among annual weeds, whereas *Elymus repens* among perennial ones.

(***iii***) Under no-tillage conditions, the study found richer floristic composition of weeds and an increase in the numbers of dominant species.

(***iv***) *Chenopodium album* and *Galinsoga parviflora* were characterized by the highest constancy in crops of both soybean cultivars as well as *Echinochloa crus-galli* in the 'Aldana' cultivar.

(***v***) Most weed species were found to show higher constancy under direct drilling compared to plough tillage.

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Authors' contributions
The following declarations about authors' contributions to the research have been made: conduct of the research, processing of results: DG, RC, EH; development of methodology and scientific oversight of the experiment: KB, MW; statistical analysis of results: DG.

Competing interests
No competing interests have been declared.

References
1. Höppner F, Zach M, Sommer C. Conservation tillage – a contribution to soil protection – effect on plant yields. "Direct sowing in theory and practice" Szczecin-Barzkowice Poland. Szczecin: Zachodniopomorski Uniwersytet Technologiczny w Szczecinie; 1995: 151–158.
2. Reeves DW. The role of soil organic matter in maintaining soil quality in continuous cropping systems. Soil Till Res. 1997;43:131–167. http://dx.doi.org/10.1016/S0167-1987(97)00038-X
3. Derpsch R. Conservation tillage, no-tillage and related technologies. Conservation Agriculture. 2003:181–190.
4. Majchrzak L, Skrzypczak G, Piechota T. Wpływ uproszczenia uprawy roli pod kukurydzę na fizyczne właściwości gleby. Fragm Agron. 2004;3(83):107–119.
5. Shulan Z, Lars L, Grip H, Yanan T, Xueyun Y, Quanijiu W. Effect of mulching and coast cropping on soil temperature, soil moisture and wheat yield on the Loess Plateau of China. Soil Till Res. 2009;102(1):78–86. http:dx.doi.org/10.1016/j.still.2008.07.019
6. Blecharczyk A, Małecka I, Skrzypczak G. Wpływ uproszczonej uprawy roli na plonowanie i zachwaszczenie kukurydzy oraz na właściwości gleby. Acta Sci Pol Agricultura. 2004;3(1):157–163.
7. Dzienia S, Zimny L, Weber R. Najnowsze kierunki w uprawie roli i technice siewu. Fragm Agron. 2006;23(2):227–241.
8. Braun-Blanquet J. Pflanzensoziologie. Grundzüge der Vegetationskunde, Aufl. Vienna: Springer-Verlag; 1964. (vol 3).
9. Norsworthy JK. Use of soybean production surveys to determine weed management needs of South Carolina farmers. Weed Technol. 2003;17(1):195–201. http://dx.doi.org/10.1614/0890-037X(2003)017[0195:UOSPST]2.0.CO;2
10. Gibson KD, Johnson WG, Hillger DE. Farmer perceptions of problematic corn and soybean weeds in Indiana. Weed Technol. 2005;19(4):1065–1070. http://dx.doi.org/10.1614/WT-04-309R.1
11. Krausz RF, Young BG, Kapusta G, Matthews JL. Influence of weed competition and herbicides on glyphosate-resistant soybean (*Glycine max*). Weed Technol. 2001;15(3):530–534. http://dx.doi.org/10.1614/0890-037X(2001)015[0530:IOWCAH]2.0.CO;2
12. Vollmann J, Wagentristl H, Hartl W. The effects of simulated weed pressure on early maturity soybeans. Eur J Agron. 2010;32(4):243–248. http://dx.doi.org/10.1016/j.eja.2010.01.001
13. Singh G, Jolly RS. Effect of herbicides on the weed infestation and grain yield of soybean (*Glycine max*). Acta Agron Hung. 2005;52(2):199–203. http:dx.doi.org/10.1556/AAgr.52.2004.2.11
14. Bujak K, Jędruszczak M, Frant M. Uproszczenie uprawy roli oraz dolistne dokarmianie makro- i mikroelementami a zachwaszczenie soi uprawianej w monokulturze. Ann UMCS Sec E. 2004;59(2):825–832.
15. Gawęda D. Wpływ systemów uprawy roli na zachwaszczenie soi. Acta Agroph. 2007;10(1):59–67.
16. Bujak K, Frant M. Effect of simplified tillage and mineral fertilization on weed infestation of potato growing on loess soil. Acta Agrobot. 2006;59(2):345–352. http:dx.doi.org/http://dx.doi.org/10.5586/aa.2006.088
17. Kraska P, Pałys E. The influence of tillage systems, fertilization and plant protection levels on weed infestation in winter rye cultivated on light soil. Acta Agrobot. 2002;55(2):199–208. http://dx.doi.org/10.5586/aa.2002.055
18. Kraska P, Pałys E. Weed infestation in canopy of spring barley in condition of different tillage systems and fertilization and plant protection levels. Acta Agrobot. 2006;59(2):323–333. http://dx.doi.org/10.5586/aa.2006.086
19. Andruszczak S, Kraska P, Kwiecińska-Poppe E, Pałys E. The effect of tillage system and herbicide application on weed infestation of crops of winter spelt wheat (*Triticum aestivum* ssp. *spelta* L.) cultivars. Acta Agrobot. 2013;66(4):173–184. http://dx.doi.org/10.5586/aa.2013.064
20. Gawęda D, Cierpiała R, Bujak K, Wesołowski M. Soybean yield under different tillage systems. Acta Sci Pol Hortorum Cultus. 2014;13(1):43–54.
21. Ciesielska A, Rzeźnicki B. Wpływ siewu bezpośredniego na plonowanie i zmiany zachwaszczenia pszenicy jarej. Fragm Agron. 2007;1(93):25–32.
22. Botta GF, Pozzolo O, Bomben M, Rosatto H, Rivero D, Ressia M, et al. Traffic alternatives for harvesting soybean (*Glycine max* L.): effect on yields and soil under a direct sowing system. Soil Till. Res. 2007;96:145–154. http://dx.doi.org/10.1016/j.still.2007.05.003
23. Blecharczyk A, Małecka I, Sawinska Z. Zachwaszczenie grochu w siewie bezpośrednim. Prog Plant Prot Post Ochr Roślin. 2010;50(2):775–778.
24. Buhler D, Stoltenberg D, Becker R, Gunsolus J. Perennial weed populations after 14 years of variable tillage and cropping practices. Weed Sci. 1994;42:205–209.
25. Blanchart E, Bernoux M, Sarda X, Neto MS, Cerri CC, Piccolo M, et al. Effect of direct seeding mulch-based systems on soil carbon storage and macrofauna in central Brazil. Agric Conspec Sci. 2007;72(1):81–87.
26. Yalcin H, Cakir E. Tillage effects and energy efficiencies of subsoiling and direct seeding in light soil on yield of second crop corn for silage in western Turkey. Soil Till Res. 2006;90:250–255. http://dx.doi.org/10.1016/j.epsl.2005.10.003

Zachwaszczenie soi (*Glycine max* L. Merr.) w różnych systemach uprawy roli

Streszczenie
Siew bezpośredni jest jednym ze sposobów ograniczenia kosztów ponoszonych na uprawę roli. Mała pracochłonność tego systemu stwarza również możliwość uprawy roślin w stanowiskach, w których problemem jest zachowanie optymalnego terminu siewu. Stosowania uprawy zerowej może jednak powodować wzrost zachwaszczenia roślin uprawnych i w konsekwencji spadek ich plonowania. W niniejszej pracy badano wpływ systemów uprawy roli: płużnego i siewu bezpośredniego na skład gatunkowy, liczbę i powietrznie sucha masę chwastów w łanie dwóch odmian soi ('Aldana' i 'Augusta'). Trzyletni eksperyment polowy założono na glebie płowej wytworzonej z lessu. Wykazano, iż stosowanie siewu bezpośredniego soi skutkowało istotnym wzrostem liczby i powietrznie suchej masy chwastów względem obiektów z uprawą orkową. W warunkach uprawy zerowej stwierdzono również bogatszy skład florystyczny chwastów oraz wzrost liczebności gatunków dominujących. Na wszystkich obiektach doświadczenia dominującymi gatunkami chwastów były *Elymus repens*, *Echinochloa crus-galli* i *Chenopodium album*. Największą stałością występowania (V i IV stopień stałości fitosocjologicznej) charakteryzowały się gatunki – *Chenopodium album* i *Galinsoga parviflora* w obu odmianach soi oraz *Echinochloa crus-galli* w łanie odmiany 'Aldana'. W warunkach siewu bezpośredniego soi zanotowano wyższą stałość występowania większości gatunków chwastów w porównaniu do obiektu z uprawą płużną.