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EFFECT OF ORGANIC AND MINERAL FERTILIZATION AND SOIL FERTILIZER ON THE WEED INFESTATION OF POTATO PLANTATION*

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Abstract. The number of weed species occurring in agricultural crops in Poland ranges from 300 to 400, and in potato cultivation this number ranges from 29 to 55 species. Potato is a plant which is heavily grown over with weeds, since it is cultivated in wide row spaces and is characterized by slow initial growth. The aim of the 3-year study was to estimate the effect of cultivation practices such as limited mineral fertilization, the use of farmyard and straw, catch crop cultivation, as well as the use of a soil fertilizer on the occurrence of weeds in a potato plantation. It was shown that the numbers of weeds determined in three growing seasons before row closure stayed at low level (2-9 plants per m^2), and before tuber harvest it was only slightly higher. Among dicotyledonous weed species, the most frequently occurred: white goose-foot (*Chenopodium album* L.), field violet (*Viola arvensis* Murr.), smallflower galinsoga (*Galinsogaparviflora* Cav.) and shepherd's purse (*Capsella bursa-pastoris* L Med.), and of monocotiledonous – barnyard grass (*Echinochloa crus galli* L.) and quack grass (*Elymusrepens* L.). The lowest weed infestation, particularly with dicotyledonous species, was recorded after the application of straw as organic fertilizer. Smallest number of dicotyledonous weeds occurred when the standard rate of mineral fertilizers was reduced by 50%. Whereas the use of the soil fertilizer UGmax caused increase in the numbers of monocotyledonous weeds before potato row closure and of both monocotyledonous and dicotyledonous before tuber harvest. The smallest weed infestation occurred when straw fertilization was used, mineral fertilization was reduced by 50% and the soil fertilizer was not applied.

Key words: catch crop, farmyard manure, species and numbers of weeds, straw, UGmax

INTRODUCTION

Regulating of potato weed infestation isan important and difficult crop protection measure, especially in ecological and integrated production. Weeds, particularly at the

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initial development stages of potato (the first 40-60 days) are very competitive and cause an increase in yield [Wichrowska 2008a]. Secondary weed infestation in turnhinderstuber harvest and worsens their quality [Zarzecka 2000, Zarzecka and Gąsiorowska 2002, Zarzecka and Gugała 2004, Dobrzański 2009, Wichrowska 2008a].

The lack of possibilities for chemical reduction of weed infestation constitutes for many farmers the main obstacle preventing them from conversion from conventional farming into organic [Beveridgeand Naylor 1999]. The number and species compositions of weeds depend, among other things, on weed infestation sources and soil microbiological activity. A source of diaspores might be: farmyard manure, straw, post-harvest residues, catch crop biomass. At the same time organic matter can limit the weed infestation of a plantation through increasing soil microorganisms activity, and catch crop cultivation through their competitive action [Kraska and Pałys 2002, Gawrońska-Kulesza *et al*. 2005, Różyło and Pałys 2007, Płaza *et al*. 2008]. There are no studies concerning the effect of the soil fertilizer on the weed infestation of potato plantations. Soil fertilizer UGmax is a microbiological preparation composed of yeasts, lactic acid bacteria, photosynthetic bacteria, *Azotobacter*, *Pseudomonas* and *Actinobacteria*, and: potassium (3500 $mg \cdot dm^{-3}$), nitrogen (1200 $mg \cdot dm^{-3}$), sulphur (1000 $mg \cdot dm^{-3}$), phosphorus (500 $mg \cdot dm^{-3}$), sodium (200 $mg \cdot dm^{-3}$), magnesium (100 $mg \cdot dm^{-3}$), zinc (20 $mg \cdot dm^{-3}$) and manganese (0.3 $mg \cdot dm^{-3}$) [Trawczyński 2007].The use of the soil fertilizer UGmax aims at improving physicochemical soil properties. It accelerates decomposition of post-harvest residues and organic fertilizers, start nutrients from minerals or insoluble compounds and improves water relations [Długosz *et al*. 2010]. In this way, the utilization of elements from mineral fertilizers by plants is increasing, which in turn allows decreasing their rates and consequently, affects a reduction in emission of harmful substances to surface waters. Its positive effect on the increase in potato tuber yield is known as well [Frąckowiak-Pawlak 2008, Zarzecka *et al*. 2011, Wichrowska *et al*. 2012]. The research hypothesis assumes that through reduction of mineral fertilization, the use of different forms of organic fertilization and the soil fertilizer, it is possible to affect not only the growth of a field crop but also differentiation of weed occurrence in stand.

The aim of this study was to estimate the effect of cultivation practices, such as: limited mineral fertilization, the use of farmyard manure and straw, catch crop cultivation, as well as the application of the soil fertilizer on weed growing in the potato plantation.

MATERIAL AND METHODS

The field experiments were conducted in 2009-2011 in Mochełek at the Research Station of the University of Technology and Life Sciences in Bydgoszcz. They were located in lessive soil, formed of boulder clay classified as the good rye complex, of quality class IVb. The three-factorial experiment was established in the randomized complete block design with three replications. The first factor (A) was the kind of organic matter introduced into soil: cattle farmyard manure, wheat and barley straw, biomass of a stubble catch crop – pea, lack of biomass as the control treatment. The second factor (B) was mineral fertilization (100% and 50% of NPK rate resulting from potato fertilization needs). The third factor (C) was the application of the soil fertilizer UGmax and its lack. The previous crop of potato was cereals, depending on the year of the study, winter wheat or spring barley. The soil fertilizer was used in three rates: in autumn before winter ploughing in an amount of 0.6 $l \cdot ha^{-1}$, in spring before planting tubers in the course of tillage in a dose of 0.3 $dm^3 \cdot ha^{-1}$ and on leaves at a height of potato plants of 15-20 cm in an amount of 0.3 $dm^3 \cdot ha^{-1}$. Mineral fertilizers were applied in spring before potato planting, in rates taking into consideration the soil abundance and plant nutritional needs, and in accordance with the levels of factor B. The full rate of NPK amounted to: 100 kg $N \cdot ha^{-1}$, 43.7 kg $P \cdot ha^{-1}$, 124.5 kg $K \cdot ha^{-1}$. The following fertilizers were applied: ammonium nitrate (34%), triple superphosphate (46%), potassium sulphate (50%). In treatments with stubble catch crop after harvest of the previous crop, field pea was sown (40 $kg \cdot ha^{-1}$), which was ploughed in autumn. Straw in the amount of $Mg \cdot ha^{-1}$ was introduced into soil after the harvest of the previous crop plant and covered with skimming. Before winter, deep ploughing on 25 cm was made in all treatments after previous spread of farmyard manure at a rate of 30 $Mg \cdot ha^{-1}$ according to the experimental scheme. The other cultivation practices were performed according to the cultivation requirements of potato. Crop protection against diseases and pests was made according to the optimal cultivation standards and recommendations of the Institute for Plant Protection, as well as the needs for control depending on the course of the weather conditions. Mechanical cultivation involved harrowing and ridging. Afalon 50WP 2$dm^3 \cdot ha^{-1}$ was applied against weeds. The number and floristic composition of weeds in the potato plantation (in spite of herbicide application) were determined in two Times: before potato row closure and immediately before tuber harvest in three randomly selected areas of each plots determined with a frame of 160 × 31.25 cm (0.5 m^2). The number of dominant species were listed according the 5-degree scale [Walczak *et al*. 2002], where: 1 – denotes a slight number (1 plant per m^2), 2 – small number (2-9 plants per m^2), 3 – moderate number (10-30 plants per m^2), 4 – large number (31-50 plants per m^2), 5 – very large number (>50 plants per m^2). The effect of experimental factors on the real total number of both dicotyledonous and monocotyledonous weeds was verified statistically. Analysis of variance was performed according to the model appropriate for the three-factorial experiment. Significance of differences was assessed with Tukey's test at P = 0.05. Calculations were made using program Statistica 8.0.

RESULTS AND DISCUSSION

As a result of the application of herbicide Afalon 50 WP, the average number of weeds in the potato plantation before row closure stayed at a low level (2-9 plants per m^2), an before tuber harvest it was only slightly higher. According to many Polish [Dobrzański 1999, Szwejkowska and Szwejkowski 2004,Woźnica 2008] and foreign studies [Bridges 1995] weeds are divided into classes of monocotyledonous (*Liliopsida*, former name *Monocotyledones*) and dicotyledonous (*Magnoliopsida Dicotyledones*). During the experiment, dicotyledonous weeds predominated in the potato plantation, both before row closure – on average about 75% of the number of weeds, and before potato tuber harvest – about 76%. Among dicotyledonous weed species, the most frequently occurring before row closure and potato harvest were: white goose-foot (*Chenopodium album* L.), field violet (*Viola arvensis* Murr.), smallflower galinsoga (*Galinsogaparviflora* Cav.) and shepherd's purse (*Capsella bursa-pastoris* L Med.) (Tables 1, 2).

Table 1. Numbers of dominant weed species before row closure depending on experimental factors (mean from 2009-2011) in 5-degree scale, where: 1 – denotes small numbers, 5 – very large numbers

Tabela 1. Liczebność dominujących gatunków chwastów przed zwarciem rzędów w zależności od czynników doświadczenia (średnio z lat 2009-2011) w skali 5- stopniowej, gdzie: 1 – oznacza liczebność nieznaczną, 5 – liczebność bardzo dużą

Factors and treatments Czynniki i obiekty			Dicotyledonous – Dwuliścienne											Monocotyledonous Jednoliścienne		
A	B	C	CHEAL	GASPA	VIOAR	CAPBP	POLCO	THLAR	MATIN	ANTAR	ARTVU	RANRE	MULIN	TEROF	ECHCG	ELRYE	POAAN
KO	50	BU	1.0	1.0	1.6	1.0	–	–	–		–	–	–	–	1.3	–	–
KO	50	ZU	1.0	1.0	2.0	1.3	–	–	–		–	–	–	–	1.6	–	0.3
KO	100	BU	1.0	0.3	1.3	1.6	–	–	–		–	–	–	–	1.3	0.3	–
KO	100	ZU	1.3	0.6	1.6	2.0	–	–	–	0.3	–	–	–	–	1.6	–	–
MŚ	50	BU	1.0	–	–	–	–	–	–	–	–	–	–	–	1.0	1.0	–
MŚ	50	ZU	1.0	–	–	–	–	–	–	–	–	–	–	–	1.6	1.3	–
MŚ	100	BU	1.0	0.3	2.0	2.0	0.3	–	–	–	–	–	–	–	1.6	0.3	–
MŚ	100	ZU	1.0	0.3	2.0	2.0	0.3	0.3	–	–	–	–	–	–	1.0	0.3	–
SŁ	50	BU	1.0	0.6	2.0	1.0	–	–	0.3	0.3	0.3	–	0.3	0.3	0.6	0.0	–
SŁ	50	ZU	1.0	0.6	2.3	1.0	–	–	0.3	0.6	–	0.3	0.3	0.3	1.0	0.3	–
SŁ	100	BU	1.0	0.0	2.0	1.3	0.3	0.3	–	–	–	–	–	–	1.0	–	–
SŁ	100	ZU	1.3	1.0	2.0	1.6	0.6	0.6	–	–	–	–	–	–	1.3	–	–
OB	50	BU	1.0	0.3	1.3	0.6	0.3	–	0.3	–	–	–	–	–	1.0	–	–
OB	50	ZU	1.0	1.0	1.6	0.6	0.3	–	0.6	–	0.3	–	0.3	–	1.0	0.3	–
OB	100	BU	2.0	0.3	2.0	1.0	–	–	–	–	–	–	–	–	1.0	–	–
OB	100	ZU	2.3	0.3	2.0	1.0	0.3	0.3	–	–	–	–	–	–	1.0	–	–

CHEAL – komosa biała *Chenopodium album* L. – whitegoose-foot *Chenopodium album* L., GASPA – żółtlica drobnokwiatowa *Galinsoga parviflora* Cav. – smallflower galinsoga *Galinsoga parviflora* Cav., VIOAR – fiołek polny *Viola arvensis* Murr. – field violet *Viola arvensis* Murr., MATIN – maruna bezwonna *Multicaria indora* L. – scentless mayweed *Multicaria indora* L., POLCO – rdest powojowy *Polygonum convolvulus* L. – black knotgrass *Polygonum convolvulus* L., THLAR – tobołki polne *Thlaspi arvense* L. – field pennycress *Thlaspi arvense* L., CAPBP – tasznik pospolity *Capsella bursa-pastoris* L Med. – shepherd's purse *Capsella bursa-pastoris* L Med., ANTAR – rumian polny *Anthemis arvensis* L. – field mayweed *Anthemis arvensis* L., ARTVU – bylica pospolita *Artemisia vulgaris* L. – common wormwood *Artemisia vulgaris* L., RANRE – jaskier rozłogowy *Ranunculus regens* L. – creeping crowfoot *Ranunculus regens* L., MULIN – maruna bezwonna *Multicaria indora* L. – scentless mayweed *Multicaria indora* L., TEROF – mniszek lekarski *Teraxacum officinale* Web. – common dandelion *Teraxacum officinale* Web., ECHCG – chwastnica jednostronna *Echinochloa crus galli* L. – barnyard grass*Echinochloa crus galli* L., ELRYE – perz właściwy *Elymu srepens* L. – couch grass *Elymus repens* L., POAAN – wiechlina roczna *Poa annua* L. – annual bluegrass *Poa annua* L.

Warianty doświadczenia – Experimental variants:

czynnik A – poziomy czynnika – factor A – factor levels: KO – kontrola (bez materii organicznej) – control (without organic matter), MŚ – międzyplon ścierniskowy (groch) – stubble catch crop (pea), SŁ – słoma – straw, OB – obornik – farmyard manure

czynnik B – poziomy czynnika – factor B – factor levels: 50 – połowa dawki nawożenia mineralnego – half rate of mineral fertilization, 100 – pełna dawka nawożenia mineralnego – full rate of mineral fertilization

czynnik C – poziomy czynnika – factor C – factor levels: BU – bez stosowania użyźniacza glebowego – without the use of soil fertilizer, ZU – z zastosowaniem użyźniacza glebowego – with the use of soil fertilizer

Table 2. Numbers of dominant weed species before tuber harvest, depending on experimental factors (mean from 2009-2011) in 5-degree scale, 1 – marks small numbers, 5 – very large numbers

Tabela 2. Liczebność dominujących gatunków chwastów przed zbiorem bulw w zależności od czynników doświadczenia (średnio z lat 2009-2011) w skali 5-stopniowej, 1 – oznacza liczebność nieznaczną, 5 – liczebność bardzo dużą

Experimental variants Warianty doświadczenia Czynnik Factor			Dicotyledonous – Dwuliścienne												Monocotyledonous Jednoliścienne		
A	B	C	CHEAL	GASPA	VIOAR	CAPBP	POLCO	THLAR	MATIN	ANTAR	ARTVU	RANRE	MULIN	TEROF	ECHCG	ELRYE	POAAN
KO	50	BU	1.3	1.6	2.0	1.3	0.3	0.3	0.3	–	–	–	–	–	1.0	–	–
KO	50	ZU	1.6	1.6	2.3	1.3	0.6	0.6	0.3	0.3	0.6	0.3	0.3	–	1.6	0.6	0.6
KO	100	BU	2.0	1.6	1.6	1.6	1.0	1.0	1.0	–	–	–	–	–	1.6	0.3	–
KO	100	ZU	2.3	2.0	1.6	2.0	1.0	1.0	1.0	0.3	–	–	–	–	1.6	0.3	0.3
MŚ	50	BU	1.3	0.6	–	–	0.3	0.3	–	–	–	–	–	–	1.6	1.0	–
MŚ	50	ZU	1.3	1.0	1.0	0.6	0.3	0.6	0.3	0.6	0.6	0.3	0.3	0.3	2.0	1.6	0.3
MŚ	100	BU	2.0	2.0	2.0	2.0	–	–	1.0	–	1.0	–	1.0	–	2.0	0.6	–
MŚ	100	ZU	2.0	2.6	2.0	2.0	0.3	1.0	1.3	–	0.0	–	1.0	–	2.0	0.6	–
SŁ	50	BU	2.0	1.0	2.0	1.0	0.3	0.3	0.3	0.3	0.3	–	0.3	0.6	1.0	–	–
SŁ	50	ZU	2.0	1.0	2.6	2.0	0.3	0.6	1.0	1.0	1.0	1.0	0.6	0.6	1.3	0.6	0.6
SŁ	100	BU	2.0	2.0	2.0	1.3	–	1.0	1.0	–	–	1.0	–	–	2.0	–	–
SŁ	100	ZU	2.3	2.3	2.0	1.6	–	1.0	1.0	–	–	1.0	–	–	2.3	–	–
OB	50	BU	1.0	1.3	1.6	0.6	0.6	–	0.3	–	–	0.6	0.6	–	2.0	–	0.3
OB	50	ZU	1.3	1.3	1.6	1.6	1.3	0.3	1.0	0.6	0.6	0.3	0.3	0.3	2.0	0.6	0.3
OB	100	BU	3.0	2.6	2.3	1.0	–	–	1.0	–	–	–	–	–	2.0	–	–
OB	100	ZU	3.3	3.0	2.3	1.0	0.3	0.3	1.3	–	–	–	–	–	2.0	–	–

CHEAL – komosa biała *Chenopodium album* L. – white goose-foot *Chenopodium album* L., GASPA – żółtlica drobnokwiatowa *Galinsoga parviflora* Cav. – smallflower galinsoga *Galinsoga parviflora* Cav., VIOAR – fiołek polny *Viola arvensis* Murr. – field violet *Viola arvensis* Murr., MATIN – maruna bezwonna *Multicaria indora* L. – scentless mayweed *Multicaria indora* L., POLCO – rdest powojowy *Polygonum convolvulus* L. – black knotgrass *Polygonum convolvulus* L., THLAR – tobołki polne *Thlaspi arvense* L. – field pennycress *Thlaspi arvense* L., CAPBP – tasznik pospolity *Capsella bursa-pastoris* L Med. – shepherd's purse *Capsella bursa-pastoris* L Med., ANTAR – rumian polny *Anthemis arvensis* L. – field mayweed *Anthemis arvensis* L., ARTVU – bylica pospolita *Artemisia vulgaris* L. – common wormwood *Artemisia vulgaris* L., RANRE – jaskier rozłogowy *Ranunculus regens* L. – creeping crowfoot *Ranunculus regens* L., MULIN – maruna bezwonna *Multicaria indora* L. – scentless mayweed *Multicaria indora* L., TEROF – mniszek lekarski *Teraxacum officinale* Web. – common dandelion *Teraxacum officinale* Web., ECHCG – chwastnica jednostronna *Echinochloa crus galli* L. – barnyard grass *Echinochloa crus galli* L., ELRYE – perz właściwy *Elymus repens* L. – couch gras s*Elymus repens* L., POAAN – wiechlina roczna *Poa annua* L. – annual bluegrass *Poa annua* L.

Pozostałe objaśnienia pod tabelą 1 – Other explanations in Table 1

These are typical taxons occurring in potato cultivation [Rymaszewski *et al*. 1996, Urbanowicz 2004, Wichrowska 2008b]. Monocotyledonous weed species were represented most frequently by barnyard grass (*Echinochloa crus galli* L.) and couch grass (*Elymusrepens* L.), whose numbers in the analysed years amounted to less than 9 plants per m^2. Both before row closure and harvest, dominant weed species occurred most frequently in treatments fertilized with farmyard manure.

The lowest primary weed infestation was observed in treatments fertilized with straw and a rate of mineral fertilizers reduced by half. Secondary weed infestation with those species was the lowest in treatments where straw and 50% of mineral fertilization rate was used and UGmax was not applied.

The use of organic matter significantly differentiated the weed infestation level – expressed with the total number of weeds before potato row closure. The least dicotyledonous weeds occurred after the application of straw and the most in the treatment fertilized with farmyard manure (Table 3). Also reduction of mineral fertilization by half limited the number of dicotyledonous weeds (Table 3). In this treatment the number of dicotyledonous weeds was by about 30% smaller than that in the treatment fertilized with the full rate of NPK. The application of soil fertilizer had a significant effect on the occurrence of monocotyledonous weeds, resulting in an increase in their number (Table 3).

Before potato tuber harvest, the total number of weeds, just as before row closure, was significantly differentiated by organic fertilization. The least dicotyledonous weeds occurred after the use of straw, and monocotyledonous, in treatments fertilized with straw and farmyard manure (Table 4).

The number of dicotyledonous weeds before tuber harvest depended on the mineral fertilization rate. At the full rate, the number of weeds was larger than at the rate reduced by half (Table 4). Also the soil fertilizer had a significant effect on an increase in secondary weed infestation with two-and monocotyledonous species (Table 4).

The lowest primary weed infestation was observed in the treatments fertilized with straw and a rate of mineral fertilizers reduced by a half.

The presence of weeds in stands of cultivated crops is the cause of decrease and worse quality of yield as well as increasing production costs. According to Dobrzański [2009], the amount of losses in yield depends on the species composition of weeds. The greatest threat is species growing rank and occupying much space or rooting deeply, e.g. white goose-foot, green amaranth, barnyard grassor jointed charlock, whereas: field violet, henbit, common stork's bill have a small effect on yields of cultivated crops. Particularly large losses are caused by perennial weeds, especially couch grass. Reduction in the yield of vegetables caused by couch grass may amount to 30-40%, and of very sensitive plants (e.g. onion) even more. Higher weed infestation is usually observed after the application of farmyard manure, similarly to the present study, it may be caused not only by introduction weed seeds into soil, but also by improvement of growth conditions and stimulating seeds to germinate by nitrates generating in the process of farmyard manure decomposition. It was found that in the field where farmyard manure was applied every year for 50 years weed infestation was about two times higher than in the field where only mineral fertilizers were applied [Dobrzański 2009].

Table 3. Total number of weeds on potato plantation before row closure depending on the organic matter used, mineral fertilization rate and soil fertilizer (mean from 2009-2011)

Tabela 3. Łączna liczba chwastów na plantacji ziemniaka przed zwarciem rzędów w zależności od stosowanej materii organicznej, dawki nawożenia mineralnego oraz użyźniacza glebowego (średnio z lat 2009-2011)

Factor – Czynnik		Mineral fertilization – Nawożenie mineralne (B)				Mean – Średnia	
use of organic matter stosowanie materii organicznej (A)	use of soil fertilizer stosowanie użyźniacza (C)	100% of fertilization 100% nawożenia		50% of fertilization 50% nawożenia			
		dicots 2-liścienne	monocots 1-liścienne	dicots 2-liścienne	monocots 1-liścienne	dicots 2-liścienne	monocots 1-liścienne
Control Kontrola	Without fertilizer bez użyźniacza	5.3	1.9	7.0	1.8	6.2	1.9
	with fertilizer z użyźniaczem	5.7	2.0	5.0	2.3	5.4	2.2
Mean – Średnia		5.5	2.0	6.0	2.1	5.8	2.0
Stubble catch crop Międzyplon ścierniskowy	without fertilizer bez użyźniacza	9.0	2.6	1.0	2.3	5.0	2.5
	with fertilizer z użyźniaczem	10.3	2.1	1.0	3.0	5.7	2.6
Mean – Średnia		9.7	2.4	1.0	2.7	5.3	2.5
Straw Słoma	without fertilizer bez użyźniacza	3.3	1.4	3.3	1.2	3.3	1.3
	with fertilizer z użyźniaczem	3.0	1.4	2.7	1.0	2.9	1.2
Mean – Średnia		3.2	1.4	3.0	1.1	3.1	1.3
Farmyard manure Obornik	without fertilizer bez użyźniacza	7.7	1.3	6.7	1.3	7.2	1.3
	with fertilizer z użyźniaczem	8.0	1.3	8.0	1.8	8.0	1.6
Mean – Średnia		7.9	1.3	7.4	1.6	7.6	1.4
Mean Średnia	without fertilizer bez użyźniacza	6.3	1.9	4.5	1.7	5.3	1.7
	with fertilizer z użyźniaczem	6.8	1.8	4.2	2.0	5.5	2.0
Mean – Średnia		6.5	1.9	4.3	1.8	5.4	1.8

$LSD_{0,05}$ (Tukey's test) – $NIR_{0,05}$ (test Tukeya)

dicotyledonous weeds – chwasty 2-liścienne

A	2.370	B	0.535	C	ns – ni
B/A	1.070	A/B	2.464	C/A	0.790
A/C	2.413	C/B	ns – ni	B/C	ns – ni

monocotyledonous weeds – chwasty 1-liścienne

A	ns – ni	B	ns – ni	C	0.187
B/A	ns – ni	A/B	ns – ni	C/A	ns – ni
A/C	ns – ni	C/B	0.265	B/C	0.385

ns – ni – non-significant differences – różnice nieistotne

Table 4. Total number of weeds on potato plantation before tuber harvest depending on the organic matter applied, mineral fertilization rate and soil fertilizer (mean from 2009-2001)
Tabela 4. Łączna liczba chwastów na plantacji ziemniaka przed zbiorem bulw w zależności od stosowanej materii organicznej, dawki nawożenia mineralnego oraz użyźniacza glebowego (średnio z lat 2009--2011)

Factor – Czynnik		Mineral fertilization – Nawożenie mineralne (B)				Mean –Średnia	
use of organic matter stosowanie materii organicznej (A)	use of soil fertilizer stosowanie użyźniacza (C)	100% of fertilization 100% nawożenia		50% of fertilization 50% nawożenia			
		2-liścienne dicots	1-liścienne monocots	2-liścienne dicots	1-liścienne monocots	2-liścienne dicots	1-liścienne monocots
Control Kontrola	without fertilizer bez użyźniacza	7.4	2.0	5.9	2.6	6.7	2.3
	with fertilizer z użyźniaczem	7.2	1.9	7.7	1.4	7.5	1.7
Mean – Średnia		7.3	2.0	6.8	2.0	7.1	2.0
Międzyplon ścierniskowy Stubble intercrop	without fertilizer bez użyźniacza	11.4	2.4	5.1	3.6	8.3	3.0
	with fertilizer z użyźniaczem	10.8	2.9	5.0	2.5	7.9	2.7
Mean – Średnia		11.1	2.7	3.1	3.1	7.1	2.9
Słoma Straw	without fertilizer bez użyźniacza	5.6	1.4	4.8	0.9	5.2	1.2
	with fertilizer z użyźniaczem	5.4	2.0	6.6	1.6	6.0	1.8
Mean – Średnia		5.5	1.7	5.7	1.3	5.6	1.5
Obornik Farmyard manure	without fertilizer bez użyźniacza	8.9	1.6	6.9	1.4	7.9	1.5
	with fertilizer z użyźniaczem	9.3	1.5	9.0	2.1	9.2	1.8
Mean – Średnia		9.1	1.6	8.0	1.8	8.5	1.7
Mean Średnia	without fertilizer bez użyźniacza	8.3	1.9	5.7	2.1	7.0	2.0
	with fertilizer z użyźniaczem	8.2	2.1	7.1	1.9	7.6	2.0
Mean – Średnia		8.3	2.0	6.4	2.0	7.3	2.0

$LSD_{0,05}$ (Tukey's test) – $NIR_{0,05}$ (test Tukeya)

dicotyledonous weeds – chwasty 2-liścienne

A	2.370	B	0.535	C	ns – ni
B/A	1.070	A/B	2.464	C/A	0.790
A/C	2.413	C/B	ns – ni	B/C	ns – ni

monocotyledonous weeds – chwasty 1-liścienne

A	ns – ni	B	ns – ni	C	0.187
B/A	ns – ni	A/B	ns – ni	C/A	ns – ni
A/C	ns – ni	C/B	0.265	B/C	0.385

ns – ni – non-significant differences – różnice nieistotne

CONCLUSIONS

1. The lowest weed infestation, particularly with dicotyledonous species, was observed when straw was used as organic matter.
2. The number of dicotyledonous weeds was smaller after reducing mineral fertilization rates by 50%.
3. The use of the soil fertilizer UGmax increased the numbers of monocotyledonous weeds before potato row closure and mono- and dicotyledonous before tuber harvest.
4. The lowest weed infestation was noted after fertilization with straw, reduction mineral fertilization by 50% and the soil fertilizer UGmax was not applied.

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WPŁYW NAWOŻENIA ORGANICZNEGO I MINERALNEGO ORAZ UŻYŹNIACZA GLEBOWEGO NA ZACHWASZCZENIE PLANTACJI ZIEMNIAKA

Streszczenie. W Polsce liczba gatunków chwastów występujących w uprawach rolniczych wynosi od 300 do 400, a w uprawie ziemniaka liczba ta waha się w granicach od 29 do 55 gatunków. Ziemniak jest rośliną, która silnie się zachwaszcza, gdyż uprawiany jest w szerokiej rozstawie rzędów oraz charakteryzuje się powolnym początkowym wzrostem. Celem 3-letnich badań było określenie wpływu zabiegów agrotechnicznych, takich jak ograniczone nawożenie mineralne, stosowanie obornika i słomy, uprawa międzyplonów, a także stosowanie użyźniacza glebowego na występowanie chwastów na plantacji ziemniaka. Wykazano, że liczebność chwastów oznaczanych w trzech sezonach wegetacyjnych przed zwarciem rzędów kształtowała się na niskim poziomie (2-9 szt. na m^2), a przed zbiorem bulw była tylko nieznacznie wyższa. Wśród dwuliściennych gatunków chwastów najliczniej występowały: komosa biała (*Chenopodium album* L.), fiołek polny(*Viola arvensis* Murr.), żółtlica drobnokwiatowa (*Galinsoga parviflora* Cav.) i tasznik pospolity(*Capsella bursa-pastoris*L Med.), a jednoliściennych chwastnica jednostronna (*Echinochloa crus galli* L.) i perz właściwy(*Elymus repens* L.). Najmniejsze zachwaszczenie, zwłaszcza gatunkami dwuliściennymi, zanotowano po zastosowaniu słomy jako nawozu organicznego. Mniejsza liczba chwastów dwuliściennych występowała wtedy, gdy standardową dawkę nawozów mineralnych zmniejszono o 50%. Stosowanie użyźniacza glebowego UGmax spowodowało natomiast zwiększenie liczby chwastów jednoliściennych przed zwarciem rzędów ziemniaka oraz jedno- i dwuliściennych przed zbiorem bulw. Najmniejsze zachwaszczenie występowało wówczas, gdy stosowano nawożenie słomą, zmniejszono o 50% nawożenie mineralne i nie stosowano użyźniacza glebowego.

Słowa kluczowe: gatunki i liczebność chwastów, międzyplon, obornik, słoma, UGmax

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