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EFFECT OF COVER CROPS AND PLOUGHLESS TILLAGE ON WEED INFESTATION OF FIELD AFTER WINTER BEFORE PRE-SOWING TILLAGE

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ABSTRACT

In the field experiment the influence of 7 species of cover crops: *Secale cereale, Avena sativa, Vicia sativa, Sinapis alba, Phacelia tanacetifolia, Fagopyrum esculentum, Helianthus annuus* and 4 kinds of pre-winter tillage on weed infestation of field after winter were investigated. The use of cover crops reduced the weed infestation of field as compared to cultivation without cover crop. White mustard, spring rye, and phacelia mulch reduced most strongly the weed amounts. The no-tillage system increased the weed infestation of field as compared to conventional cultivation (mouldboard ploughing). The weed control effect of pre-winter tillage using stubble cultivator did not considerably differ from conventional plough tillage. The largest number of weeds was recorded in no-cover crop cultivation in no-tillage variants and in those cultivated using subsoiler, while the smallest, when the oat, rye, or white mustard biomass was mixed using deep mouldboard ploughing before winter. In ploughless tillage system, the best effect of weed infestation reduction was obtained when white mustard biomass was mixed with the soil before winter, using stubble cultivator (grubber).

Key words: weeds, pre-winter tillage, mulch, catch crops.

INTRODUCTION

Weeds compete with crops for all factors necessary for their existence; therefore to remove them from the field has been one of the cultivation purposes for centuries. The use of herbicides, however, is not without any impact on the environment. In the era of sustainable agriculture, when a man tries to live and farm in harmony with nature, measures to reduce the negative consequences of human activities including the use of chemicals, eject to the fore. With the spreading of organic farming, the importance of cover crop plants increases (Franczuk et al., 2010; Borowy, 2013). Grown as green manures, stubble or winter catch-crops, they bring biodiversity, reduce the incidence of diseases and pests of crops, as well as have weed controlling properties (Błażewicz-Woźniak, 2004; Jodaugiene et al., 2006; Sawicka and Kotiuk, 2007; Stokłosa et al., 2008; Błażewicz-Woźniak and Konopiński, 2009; Isık et al., 2009; Lithourgidis et al., 2011). Their biomass is mixed with the soil or left on the surface, forming live or killed protective layer. Cover crops are not only a rich source of organic matter and minerals, but also protect the soil from erosion, prevent the loss of minerals, contribute to the biological activity of the soil (Dabney et al., 2001; Gaskell and Smith, 2007; Zhang et al., 2007; Błażewicz-Woźniak et al., 2008; Kęsik and Błażewicz-Woźniak, 2010). The impact of cover crops on soil microflora, and also active compounds contained in the biomass, or formed during its decomposition, is of phytosanitary nature and these plants can be used to reduce the weed infestation of crops (Wójcik-Wojtkowiak et al., 1998). Leaving the crop residues on the field, promotes the proliferation of microorganisms, metabolites of which inhibit the germination of weed seeds (Parylak et al., 2006; Golisz et al., 2007; Patkowska and Błażewicz-Woźniak, 2014). Glucosinolates are the active agents at plants

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of *Brassicaceae* family. During their decay, isothiocyanates that are released may reduce the weed seed germination and growth of seedlings (Haramoto and Gallandt, 2005). In studies by Wójcik-Wojtkowiak et al. (1998), the occurrence of allelopathic potential of rye was accompanied by the formation of phenolic compounds. The high allelopathic and herbicidal activity of rye is also related to the content of hydroxamic acids (DIBOA and BOA). It was shown that they inhibit germination and growth of many weed species, e.g.: *Chenopodium album*, *Digitaria sanguinalis*, *Lepidium sativum*, *Panicum miliaceum*, *Ambrosia artemisifolia*, *Echinochloa crus-galli*, and *Amaranthus retroflexus* (Bhowmik and Interjit, 2003). According to Kato-Noguchi et al. (1994, after Wójcik-Wojtkowiak et al., 1998), L-tryptophan is responsible for the allelopathic potential at oats. Buckwheat is recommended as a weed controlling plant due to rapid biomass growth and high allelopathic potential, resulting among others from the rutin (rutoside) content. Studying the allelopathic effect of buckwheat, Iqbal et al. (2003) reported weakening of the growth of roots and shoots of *Trifolium repens*, *Brassica juncea*, *Amaranthus palmeri*, *Echinochloa crus-galli*, and *Digitaria ciliaris*. Research performed by Golisz et al. (2007) demonstrated that buckwheat has high allelopathic potential relative to a number of weed species, particularly to couch grass. Common sunflower, due to its high biomass production and high allelopathic potential confirmed in numerous studies, can be used for some restrictions of weed infestation (Kupidłowska et al., 2006; Anjum and Bajwa, 2008). The main source of the field crops infestation by weeds is the soil seed bank. Tillage differently affects the weed seed reserves in the soil. In organic farming, ploughing using mouldboard plough is replaced by measures that do not cause the furrow inversion. Simplification of tillage and giving up the plough favour the accumulation of weeds in the upper soil layers (Wrzesińska et al., 2013) and often lead to increased weed infestation of the field. A significant increase of weeding was noted, among others, after replacing the pre-winter ploughing with cultivating (Kęsik and Błażewicz-Woźniak, 1994), disking, or no-tillage (Błażewicz-Woźniak et al., 2006). In spring, the period before sowing or planting is very limited, thus there is often a lack of time to fight weeds. Therefore, the weed infestation after winter before the spring field operations is very important. Moving away from conventional tillage, which took into account the deep ploughing in the whole tillage, to reduce the weed infestation, it is advisable to use the impact of cover crops on weeds by choosing the optimal way of their management. The aim of the study was to determine the effect of cover crops biomass and ploughless tillage on weed infestation of the field after winter.

MATERIAL AND METHODS

The field experiment was carried out in 2009-2012 in Felin Experimental Station of the University of Life Sciences in Lublin (Poland, 51o23'N, 22o56'E), on a grey-brown podzolic soil (AP) derived from silty medium loam (BN-78/9180-11). Before cover crops sowing, the soil contained 1.06-1.15% of humus in 0-20 cm layer and was characterized by slightly acidic reaction (pHKCl 5.76-5.90). Amounts in available phosphorus, potassium, and magnesium were: P–146.8; K–111.5; Mg–102.9 mg·kg^{-1} soil. The experiment was set up by means of randomised complete blocks in 4 replicates. The area of single plot (repetition) was 33 m^2. The experimental design included following factors: I. Cover crop species: spring rye *(Secale cereale* L.), common oat (*Avena sativa* L.), common vetch (*Vicia sativa* L.), white mustard (*Sinapis alba* L.), lacy phacelia (*Phacelia tanacetifolia* Benth.), buckwheat (*Fagopyrum esculentum* Moench), and fodder sunflower (*Helianthus annuus* L.); II. Tillage: 1. Conventional plough cultivation with a set of pre-winter ploughing 25-30 cm depth (Oz); 2. Set of pre-sowing measures, sowing the cover crops, subsoiling tillage 30 cm depth (GLz); 3. Set of pre-sowing measures, sowing the cover crops, pre-winter tillage with use of stubble cultivator grubber (25 cm depth) (Gz); 4. Set of pre-sowing measures, sowing the cover crops, no-tillage (NTz). Cultivation without cover crops was the control. Sowing the cover crops was performed after the harvest of forecrop, i.e. winter wheat. Directly after harvesting of wheat, the soil was disc-harrowed, and then ploughed about 15 cm deep and drag-harrowed (the pre-sowing measures). Every year, the cover crops were sown on the same date, i.e. on August 1st. Given the experience of the previous years, the norms of cover crop sowing were as follows: rye – 300 kg, oats – 300 kg, vetch – 200 kg, mustard – 200 kg, phacelia – 50 kg, buckwheat – 200 kg, sunflower – 125 $kg \cdot ha^{-1}$. Before winter, grown mass of cover crops was mixed with ground soil or left on the soil surface as a mulch, according to the experimental scheme. Assessment of the field infestation by weeds after winter was performed annually about April 20, before the spring-tillage. The species composition and amounts of weeds was determined on each plot, in 8 different randomly selected locations, on areas of 1 m × 1 m dimensions. Achieved results were statistically processed using variance analysis (ANOVA). The statistical significance was tested with the use of the Tukey test with p=0.05.

RESULTS AND DISCUSSION

A total of 25 weed species including 17 short-term and 8 perennial ones (Table 1) were involved in the field infestation by weeds after winter, during 3 years of study.

Table 1. Effect of cover crops on the species composition of weed infestation of the field after winter regardless of pre-winter tillage

Crops	Control	*Secale*	*Avena*	*Vicia*	*Sinapis*	*Phacelia*	*Fagopyrum*	*Helianthus*	Mean
Annual weeds:	Number of weeds per 1 m^2								
Stellaria media (L.) Vill.	36.1	10.3	23.5	42.0	17.3	18.4	26.3	24.3	24.8
Poa annua L.	40.7	5.3	8.0	14.5	8.0	10.7	16.9	20.8	15.6
Capsella bursa-pastoris (L.) Medik.	24.0	8.0	9.3	21.5	9.7	8.6	16.6	10.1	13.5
Matricaria chamomilla L.	5.7	9.1	6.1	4.8	2.2	2.9	1.8	2.0	4.3
Thlaspi arvense L.	1.4	11.1	7.0	6.4	2.6	1.9	2.0	0.9	4.2
Chenopodium album L.	4.3	0.4	1.7	2.8	1.2	1.3	3.5	1.5	2.1
Conyza anadensis (L.) Cronquist	2.2	-	2.8	3.5	0.4	0.4	0.7	1.4	1.4
Cerastium holosteoides Fr.em. Hyl.	0.5	0.2	0.8	2.3	0.4	0.8	0.7	0.8	0.8
Veronica persica Poir.	0.1	1.5	1.0	0.7	0.1	0.2	-	0.3	0.5
Matricaria inodora L.	0.1	0.3	0.7	0.1	-	0.1	0.1	0.1	0.2
Lamium purpureum L.	0.3	-	0.2	0.1	-	0.2	0.2	0.1	0.1
Polygonum aviculare L.	*-	-	0.3	0.2	-	0.3	0.1	-	0.1
Viola arvensis Murr.	-	-	0.1	0.4	0.1	0.3	-	-	0.1
Senecio vulgaris L.	-	-	0.3	0.3	0.0	-	-	0.1	0.1
Rorippa sylvestris (L.) Besser	0.2	-	-	-	-	-	-	-	0.0
Spergularia rubra (L.) Presl	-	0.1	-	0.2	-	-	-	-	0.0
Lamium amplexicaule L.	-	-	**0.0	-	-	-	-	0.2	0.0
Perennial weeds:									
Elymus repens (L.) Gould	2.7	0.6	0.2	0.8	0.2	0.6	0.3	0.9	0.8
Taraxacum officinale F.H.Wigg.	0.5	0.3	0.5	0.7	0.4	0.4	0.7	0.7	0.5
Artemisia vulgaris L.	0.1	0.1	0.2	-	0.1	-	0.0	0.9	0.2
Rumex obtusifolius L.	-	-	0.3	0.2	0.1	0.4	-	-	0.1
Sonchus arvensis L.	-	0.2	0.1	0.1	0.0	0.1	0.2	-	0.1
Plantago maior L.	0.1	-	-	-	-	0.0	-	0.1	0.0
Cirsium arvense (L.) Scop.	0.0	-	-	-	-	-	0.2	-	0.0
Tanacetum vulgare L.	-	0.1	-	-	-	-	-	-	0.0
Number of weeds totally	119.4	47.3	62.8	101.4	42.7	47.6	70.2	65.2	69.6

*absent species; **0,0; species with amounts <0.05 per 1 m^2

Dicotyledonous class was represented by 23 species, while monocots only 2: *Poa annua* and *Elymus repens*. In all years, *Stellaria media* was the dominant species in the weed. In addition, *Poa annua* and *Capsella bursa-pastoris* were numerous. Among perennial weeds, *Elymus repens* and *Taraxacum officinale* prevailed. Use of cover crops reduced the weed infestation (Tables 1 and 2).

Table 2. Effect of cover crops and tillage on weed infestation of field after winter (Average for years 2010-2012)

Number of weeds per 1 m^2									
Cover crop	Control	*Secale*	*Avena*	*Vicia*	*Sinapis*	*Phacelia*	*Fagopyrum*	*Helianthus*	Mean
Tillage	Annual weeds								
Oz	53.3	13.0	10.1	35.6	17.0	21.5	49.7	41.2	30,2
GLz	149.8	68.1	77.7	121.6	73.0	46.7	50.7	66.7	81,8
Gz	87.9	28.0	52.5	95.8	18.5	38.9	62.0	24.0	50,9
NTz	172.9	75.4	105.9	145.7	59.0	77.0	113.0	118.3	108,4
Mean	116.0	46.1	61.5	99.7	41.9	46.0	68.8	62.5	67,8
						LSD$_{,05}$ for:			
							cover crop B		40.8
							tillage C		24.2
							B x C		n.s.
	Perennial weeds								
Oz	0.3	1.0	0.0	0.2	0.4	0.3	0.0	2.4	0,6
GLz	6.0	0.8	1.3	2.8	0.7	3.0	1.8	1.4	2,2
Gz	1.4	0.5	0.9	0.0	0.4	0.8	2.0	1.8	1,0
NTz	5.8	2.5	2.9	4.1	1.4	2.2	1.8	5.2	3,2
Mean	3.4	1.2	1.3	1.8	0.7	1.6	1.4	2.7	1,8
						LSD$_{,05}$ for:			
							cover crop B		n.s.
							tillage C		1.9
							B x C		n.s
	Number of weeds totally								
Oz	53.7	14.0	10.1	35.9	17.4	21.9	49.7	43.6	30,8
GLz	155.8	68.8	79.0	124.4	73.7	49.7	52.4	68.1	84,0
Gz	89.3	28.5	53.3	95.8	19.4	39.6	64.0	25.8	52,0
NTz	178.8	78.0	108.7	149.8	60.4	79.2	114.7	123.5	111,6
Mean	119.4	47.3	62.8	101.4	42.7	47.6	70.2	65.2	69,6
						LSD$_{0.05}$ for:			
							cover crop B		41.4
							tillage C		24.5
							B x C		n.s.

Oz – pre-winter ploughing with 25-30 cm depth; GLz – pre-winter tillage with use of subsoiler (30 cm depth); Gz – pre-winter tillage with use of stubble cultivator grubber (25 cm depth); NTz – no-tillage; n.s. – no significant differences.

The lowest number of weeds grew after white mustard, spring rye, or lacy phacelia cover crop, whereas the highest number – in cultivation without cover crops and when vetch was applied as the cover crop. Błażewicz-Woźniak (2004) reported an important reduction in weed infestation before carrots sowing, after applying phacelia and vetch mulch, as compared to no-mulching cultivation. Considering the present study, the largest number of short-term weeds was grown in no-cover crop cultivation (116.0

plants·m^{-2}). The mustard cover crop reduced their mean number to 41.9, while those of phacelia and rye to 46.0 and 46.1 plants·m^{-2}, respectively. Perennial weeds were also the most numerously represented in the control object. Their lowest number was recorded after white mustard cover crop. Gutmański et al. (1999) also reported the reduction in weeds number due to white mustard mulch. The *Brassica* genus species have unique allelopathic and phyto-sanitary features (Haramoto and Gallandt, 2005; Sawicka and Kotiuk, 2007; Boydston et al., 2008). The most weed species were recorded after oat (20) and vetch (19) cover crop, while the least when the cover crop was rye (15), buckwheat (15), or white mustard (16). The study by Dhima et al. (2006) revealed that winter cereal extracts reduced barnyardgrass (*Echinochloa crus-galli*) and bristly foxtail (*Setaria verticillata*) seed germination and growth. In here analysed study, cover crops remarkably reduced the number of annual bluegrass as compared to no-cover crop cultivation, in which the species was the most abundant (Table 1). Rye, white mustard, and oat biomass reduced the most strongly the population of *Poa annua*. In studies carried out by Boydston et al. (2008), mustard seed meal applied to the soil surface of containers at 113, 225, and 450 g·m^{-2} reduced the number of annual bluegrass seedlings by 60, 86, and 98%, respectively, and the number of common chickweed (*Stellaria media* L.) seedlings by 61, 74, and 73%, respectively, at 8 weeks after treatment. Decrease in the seed weeds number after applying the buckwheat mulch was also noted by Borowy (2013). In the analysed experiment, among dicotyledonous species, the short-living *Stellaria media* and *Capsella bursa-pastoris* dominated, and they grew most abundantly after vetch cover crop and in control object. Shepherd's-purse grew quite numerously also after buckwheat cover crop. The rye cover crop to the highest degree reduced the occurrence of *Stellaria media* and *Capsella bursa-pastoris*. Number of shepherd's-purse plants was lower also after phacelia, oat, and mustard cover crops. On the other hand, rye, oat, and vetch biomass favoured the spring occurrence of *Thlaspi arvense* and *Matricaria chamomilla*. Chamomile grew abundantly also in the no-cover crop cultivation. The least of these weed species at the time grew after the cover crop of buckwheat, sunflower, and phacelia. Dabney et al. (2001) found that the rye biomass in a reduced tillage system favoured the occurrence of rough pigweed, lamb's quarters, and black nightshade. In the analysed experiment, the largest number of weed species grew in objects not cultivated before winter (NTz) – 25 taxa and those cultivated using subsoiler (GLz) – a total of 21, of which 15 were monocarp species (Table 3).

The pre-winter ploughing (Oz) almost twice reduced the number of short-living and perennial weed species, as well as dicots and monocots ones as compared with NTz and GLz. Also in objects cultivated using grubber, the number of particular groups of weed species was less than in no-tillage (NTz). This is confirmed in previous studies of the authors (Błażewicz-Woźniak, 2003, 2004; Błażewicz-Woźniak et al., 2006). Similarly in studies by Dabney et al. (2001), weed communities showed higher diversity in the simplified tillage system than in conventional tillage. Pre-winter ploughing significantly reduced the number of *Stellaria media* in comparison with other cultivation methods, especially with NTz (Table 3). Zero-tillage favoured the occurrence of Poa annua that grew the most abundantly here. Pre-winter ploughing (Oz) and cultivating before winter with grubber (Gz) reduced the emergence of *Poa annua* to 4.0 and 5.3 plants·m^{-2}, respectively, as well as decreased the number of *Matricaria chamomilla* and *Conyza canadensis*, that grew more numerously after subsoiling (GLz) or no-tillage (NTz), while favouring the germination of *Capsella bursa-pastoris* and *Thlaspi arvense*. Deep ploughing significantly reduced the degree of weed infestation of the field after winter as compared to NTz and GLz. After cultivating before winter (Gz), although the number of weeds was higher than after ploughing, but it was not a statistically significant difference when compared to pre-winter ploughing, while significant in comparison with NTz and GLz. After zero-tillage (NTz), the population of short-term and perennial weed species was significantly higher than those in objects ploughed before winter (Oz) or grown using grubber (Gz) (Table 2). The grubber application did not significantly increase the number of mono and polycarpic weeds as compared with the traditional plough tillage.

Table 3. Effect of ploughless tillage on the species composition of weed infestation of field after winter regardless of the cover crop compared with the pre-winter ploughing

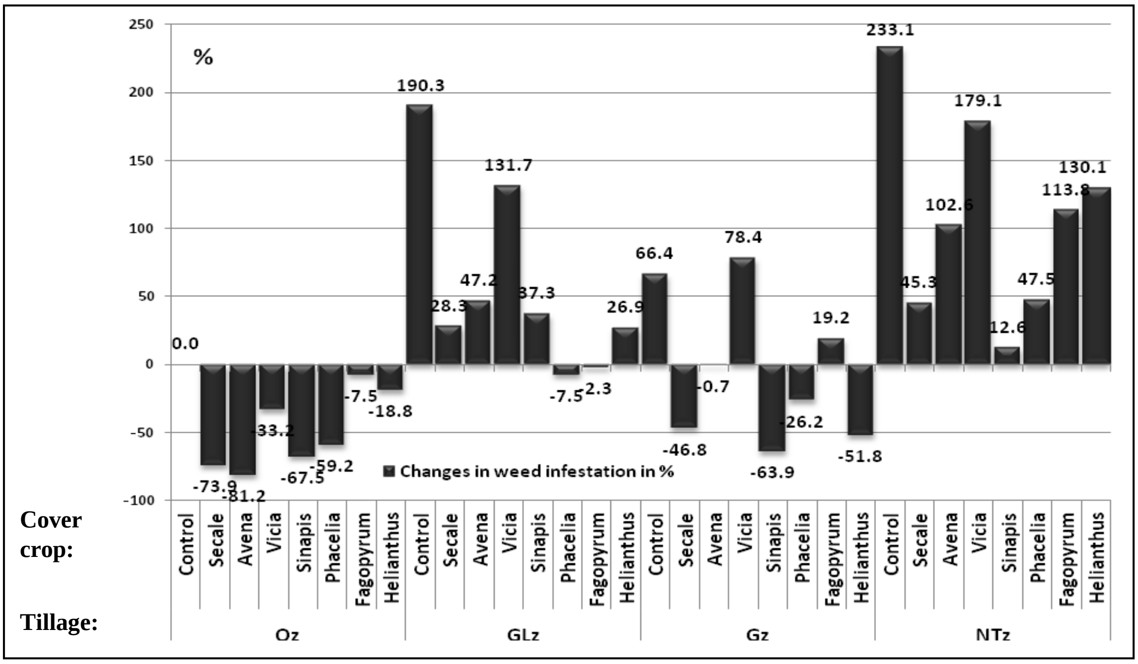
Pre-winter tillage	Oz	GLz	Gz	NTz
Annual weeds:	Number of weeds per 1 m^2			
Stellaria media (L.)Vill.	8.8	30.6	15.6	44.2
Poa annua L.	4.5	20.1	5.3	32.4
Capsella bursa-pastoris (L.)Medik.	9.8	11.6	17.8	14.8
Matricaria chamomilla L.	0.8	6.4	1.7	8.4
Thlaspi arvense L.	3.8	6.2	5.9	0.8
Chenopodium album L.	2.1	2.4	3.7	0.1
Conyza canadensis (L.) Cronquist	*-	2.0	0.2	3.4
Cerastium holosteoides Fr. em. Hyl.	0.3	1.3	-	1.7
Veronica persica Poir.	-	0.5	0.2	1.3
Matricaria inodora L.	-	0.1	-	0.5
Lamium purpureum L.	-	0.2	0.2	0.2
Polygonum aviculare L.	**0.0	0.1	0.0	0.2
Viola arvensis Murr.	-	0.1	0.2	0.2
Senecio vulgaris L.	0.1	0.1	0.2	0.0
Rorippa sylvestris (L.)Besser	-	-	-	0.1
Spergularia rubra (L.) Presl & Presl	-	0.0	-	0.1
Lamium amplexicaule L.	-	-	0.1	0.0
Perennial weeds:				
Elymus repens (L.) Gould	0.1	1.4	0.2	1.5
Taraxacum officinale F.H.Wigg.	0.1	0.5	0.6	0.9
Artemisia vulgaris L.	0.3	0.2	0.1	0.1
Rumex obtusifolius	-	0.1	-	0.4
Sonchus arvensis L.	-	0.0	0.1	0.2
Plantago maior L.	0.0	-	0.1	0.0
Cirsium arvense (L.) Scop.	-	0.0	0.0	0.0
Tanacetum vulgare L.	-	-	-	0.0
Number of weeds totally	30.8	84.0	52.0	111.6

*absent species; **0,0 species with amounts <0.05 per 1 m^2; designations as in Table 2.

Analysing the interaction of experimental factors such as cover crops and tillage, the largest number of weeds was recorded in cultivation without cover crop in no-tillage variants (NTz) and grown using subsoiler (GLz) (Table 2).

The pre-winter ploughing reduced the field weed infestation more than three times, while cultivating with grubber more than two times as compared with NTz and GLz in no-cover crop cultivation. All cover crops contributed to the decrease in weed infestation of the field after winter compared to cultivation without any cover crop. Comparing the crop variants in combinations cover crop + tillage with traditional ploughing cultivation (Oz) without cover crop, the introduction of plant biomass into the soil and mixing it with using the pre-winter ploughing, reduced the weed infestation in the case of all cover crops used.

The best effect was obtained using oat as cover crop (-81.2%), while the weakest – for buckwheat (-7.5%). In other tillage variants, lack of cover crop considerably increased the degree of weed infestation as compared with conventional tillage (Figure 1).

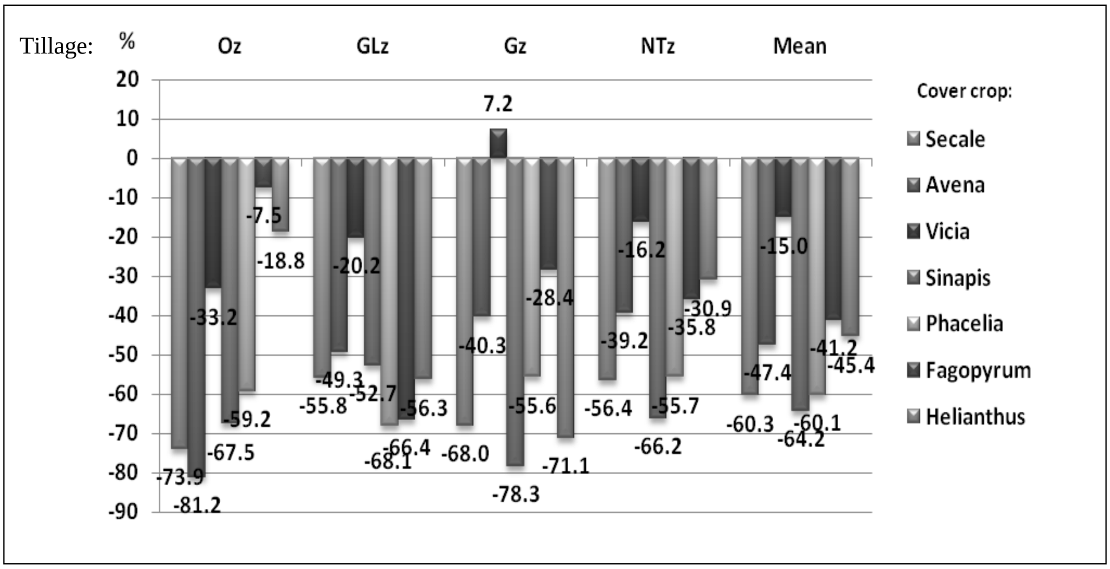


Oz – pre-winter ploughing with 25-30 cm depth; GLz – pre-winter tillage with use of subsoiler (30 cm depth); Gz – pre-winter tillage with use of stubble cultivator grubber (25 cm depth); NTz – no-tillage

Figure 1. Effect of the combination of cultivation on weed infestation on the field after winter compared to conventional tillage (Oz) without cover crops (Control)

The largest increase of weed population (by 233.1%, on average) was observed after zero-tillage and after subsoiling before winter (190.3%). Similarly, in studies by Campiglia et al. (2010), all mulches suppressed weeds in density and aboveground biomass compared to the conventional system. Introducing the cover crop biomass into the ploughless system contributed to the reduction in weed infestation as compared to cultivation without cover crop. The weakest effect was obtained using vetch biomass. The no-tillage resulted in an increased weed infestation of the fields after winter (Figure 1). It should be explained by the fact that most of weed seeds germinate from the surface layer of the soil. Although the plant mulch covering the soil surface during winter reduced the number of weeds in relation to no-mulched soil, the degree of weed infestation was higher than after conventional tillage. Weeds were the strongest inhibited after winter by mulch made of white mustard and spring rye, as well as phacelia, while the least effective appeared to be the vetch mulch. Small vetch mulch efficiency resulted from a small biomass, which was produced that time by plants in comparison with other cover crops (Błażewicz-Woźniak and Wach, 2012).

Among the compared cover crops, regardless of pre-winter soil tillage, the best weed competing effect was recorded for white mustard, which reduced the weed infestation of the fields after winter by 64.2%, on average, in relation to the no-cover crop cultivation (Figure 2). High effect was obtained using cover crop made of rye and phacelia, while the weakest – vetch cover crop (average of 15.0%). The impact of cover crops on weed infestation of the field after winter was modified by pre-winter tillage. Regardless of the tillage, the rye cover crop reduced weed population after winter by 60.3% in relation to cultivation without cover crop. This is confirmed by the inhibitory effect of rye biomass in reducing the weed infestation (Wójcik-Wojtkowiak et al., 1998; Dabney et al., 2001; Bhowmik and Interjit, 2003). The oat cover crop reduced the weed number by 47.4%, on average. After mixing the oats biomass before winter using the deep ploughing, the weed infestation decrease amounted up to 81.2%, which was the greatest weed reduction obtained within three years of the research.



Oz – pre-winter ploughing with 25-30 cm depth; GLz – pre-winter cultivation with use of subsoiler (30 cm depth); Gz – pre-winter tillage with use of stubble cultivator grubber (25 cm depth); NTz – no-tillage

Figure 2. Reduction of weed infestation of field after winter (in %) after the application of cover crops depending on soil tillage

In studies by Campiglia et al. (2010), the oat cover crop was the most effective cover crop for suppressing weeds (on average 93% of weed aboveground biomass compared to other cover crops). In the no-tillage objects, the greatest weed reducing effect was assured by white mustard mulch. Reduction of weed infestation in this combination was 66.2%, on average as compared to cultivations without cover crop. Good effect was also observed by using phacelia mulch, which in no-tillage objects resulted in weed amounts reduction of 55.7%. The mustard biomass strongly limited the field weed infestation after winter, when it was mixed with the soil before winter using grubber (by 78.3%, on average). Worse de-weeding effect was obtained when mustard biomass was mixed with the soil applying pre-winter ploughing (67.5%). Achieved result proves the possibility of replacing the pre-winter ploughing with cultivating with grubber using the white mustard cover crop. The phacelia cover crop, regardless of the tillage system, reduced the weed number by 60.1%, and its effect on weed infestation in particular variants was similar ranging from 55.6% (Gz) to 68.1% (GLz). Effect of buckwheat cover crop on the number of weeds, however, was modified to a large extent by pre-winter tillage. Only after applying the subsoiler, buckwheat strongly reduced the weed infestation (66.4%). Also sunflower cover crop affected in different ways on weed amounts depending on the tillage system. The best weed infestation reducing effect was obtained when sunflower biomass was mixed with the soil before winter using grubber (Gz) – 71.1%, while the worst – after pre-winter ploughing (18.8%). The weakest de-weeding effect was obtained using vetch as the cover crop (average of 15%).

CONCLUSION

The use of cover crops reduced the weed infestation of the field after winter as compared to cultivation without any cover crop. Effect of cover crops on the species composition of weed population depended on the cover crop species. White mustard, spring rye, and phacelia mulch reduced most strongly the weed amounts after winter, while the effect of vetch mulch was the weakest.

The no-tillage system increased the field weed infestation after winter as compared to conventional cultivation and cultivating. The weed control effect of pre-winter tillage using grubber did not considerably differ from conventional tillage with mouldboard ploughing.

The largest number of weeds in spring was recorded in no-cover crop cultivation in no-tillage variants and those cultivated using subsoiler, while the smallest number, when the oat, rye, or white mustard biomass was mixed using deep ploughing before winter.

In ploughless tillage system, the best effect of weed infestation reduction was obtained, when white mustard biomass was mixed with the soil before winter using stubble cultivator (grubber).

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