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THE EFFECT OF DIFFERENT AGROTECHNICAL LEVELS ON WEED INFESTATION IN CROPS OF NAKED AND HUSKED VARIETIES OF OAT (*Avena sativa* L.)

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Abstract

The present study was carried out in the period 2007–2009 in the Experimental Farm in Bezek near the city of Chełm. The aim of the investigation was to compare weed infestation of the husked (Krezus) and naked (Cacko) oat cultivars cultivated under conditions of different weed control treatments. The following weed control levels were compared: A – control object; B – harrowing twice; C – application of the herbicide Mustang 306 SE; D – herbicide Mustang 306 SE + foliar fertilizer Insol 3; E – herbicide Mustang 306 SE + two foliar fertilizers: Insol 3 and FoliCare 18:18:18.

The husked oat cv. Krezus was more competitive against weeds. Number of dicotyledonous weeds and of monocotyledonous weeds, total weeds, and air-dry weight of above-ground parts of weeds in the crop of this cultivar were all significantly lower compared to the naked cv. Cacko. From the group of dicotyledonous species, *Chenopodium album, Galinsoga parviflora, Matricaria maritima ssp. inodora, Polygonum aviculare,* and *Stellaria media* were the dominant species in the crops of the oat varieties under investigation, whereas among the monocotyledonous species *Echinochloa crus-galli, Setaria pumila, Apera spica-venti,* and *Elymus repens* occurred in greatest numbers. The application of the herbicide Mustang 306 SE decreased the number of dicotyledonous weeds and air-dry weight of weeds, compared to the treatment in which mechanical weed control had been used.

Key words: naked oat, husked oat, weed infestation, weed control level

INTRODUCTION

The existing research on weed infestation of spring cereals shows that they are generally less susceptible to weed pressure than winter cereals (Zawiślak and Grejner, 1988). At the same time, oats compete better against weeds than spring barley or spring wheat. Their advantage over other cereals are justified by early sowing time, a dynamic increase in above-ground and root mass as well as rich foliage that shades well the soil (Wanic, 1997; Budzyński, 1999; Deryło et al., 2003; Adamiak and Adamiak, 2004; Idziak et al. 2007).

According to Idziak et al. (2007), under conditions of high level tillage, chemical weed control in oat crops can be dispensed with. It is extremely important since, out of concern for the natural environment, efforts are now undertaken to reduce the use of chemical plant protection agents. Leszczyńska (2007) as well as Sułek and Brzóska (2007) are of opinion that, in weed control treatments used in oat crops, mechanical crop protection is of great importance, as oats are sensitive to most herbicides. However, at the initial growth stages (tillering and shooting) oats promote the abundant emergence of early germinating weeds that germinate in low temperatures (Adamiak and Zawiślak, 1991). That is why, under conditions of strong weed infestation of crops, the application of herbicides is recommended as auxiliary treatment (Leszczyńska, 2002; 2007). The selection of an appropriate herbicide is very important, since an inappropriate chemical agent can cause phytotoxicity, thereby inhibiting plant growth (Skrzypczak and Pudełko, 2001; Krawczyk and Stachecki, 2003).

Most papers on weed infestation in oat crops relate only to the husked form, but there are few studies which also cover the naked forms of this plant (Sadowski and Rychcik, 2008). The aim of the presented study was to compare weed infestation in crops of the naked and husked oat varieties grown under conditions of different weed control treatments.

MATERIALS AND METHODS

The present field experiment was conducted in the period 2007–2009 in the Bezek Experimental Farm near the city of Chełm. The experimental field was located on incomplete podzolic soil lying on marl substrate with the granulometric composition of loamy sand. This soil is classified as soil class IVb and good rye complex. It was characterized by slightly acidic pH (pH in 1 mol KCl 6.0), high phosphorus content (74.6 mg × kg^{-1}), average potassium content (99.6 mg × kg^{-1}), and low magnesium content (22.0 mg×kg^{-1}). The humus content was 1.2%.

Tillage was done following generally accepted agricultural practice recommendations. Winter triticale was a forecrop for oat crops. Oat (*Avena sativa L.*) seeds were sown in the 3rd decade of April at an amount of 500 seeds per 1 m^2. The following doses of mineral fertilizers were applied (in kg of pure component per hectare): N–80; P–26.2; K–66.4.

The two-factor field experiment was set up according to a randomized block design, in 4 replicates. The plot area was 15 m^2. The experiment included two oat varieties (naked oats var. Cacko and husked oats var. Krezus) and five weed control levels: a) control object; b) harrowing twice at the tillering stage; c) application of the herbicide Mustang 306 SE; d) herbicide Mustang 306 SE + foliar fertilizer Insol 3; e) herbicide Mustang 306 SE + foliar fertilizers Insol 3 and FoliCare 18:18:18. The herbicide Mustang 306 SE (florasulam – a compound from the group of triazolopyrimidines – 6.25 g × l; 2,4-D EHE – a compound from the group of phenoxy acids– 300 g × l) was applied at the tillering stage (BBCH 23-29), at a dose of 0.4 l×ha. Spraying with the foliar fertilizers, Insol 3 and FoliCare 18:18:18, was done twice – at the tillering stage (BBCH 23-29) and at the shooting stage (BBCH 33-39), at a dose of 1 l×ha and 20 kg × ha, respectively. The chemical composition of the fertilizers is shown in Table 1.

Weed infestation of the crop was determined using the quantitative gravimetric method about 2 weeks before the harvest of oats. Number of weeds, weed species composition and air-dry weight of the above-ground parts of weeds were determined based on the sampling sites marked out by a 1m x 0.25 m frame, in four randomly selected places in each plot. The obtained results were statistically processed using the variance analysis method and least significant differences were calculated using Tukey's confidence half-intervals with a 5% risk of error.

Table 1

Chemical composition of foliar fertilizers (%)

Foliar fertilizer	N	P	K	Mg	S	B	Cu	Fe	Mn	Mo	Zn
Insol 3	11.5	–	–	2.84	–	0.28	0.56	1.20	1.68	0.01	1.12
FoliCare 18:18:18	18.0	18.1	18.0	1.5	7.2	0.02	0.10	0.20	0.10	0.01	0.02

RESULTS AND DISCUSSION

One of the methods of weed infestation reduction in crop plants is the selection of varieties showing greater competitiveness against weeds. The importance of oat varieties in weed management is not well-recognised. Assessing the susceptibility of husked oat varieties to weed pressure, Adamiak and Adamiak (2004) showed that the variety Boryna competed better with weeds at the early growth stages (tillering), whereas the variety Kwant demonstrated greater competitiveness when the crop was at full growth (flowering). In the present experiment, irrespective of the weed control level, the husked variety Krezus was more competitive against weeds, which was probably attributable to plant height and high panicle density per unit area. Number of dicotyledonous weeds and of monocotyledonous weeds, total weeds, and air-dry weight of above-ground parts of weeds in the crop of this variety were all significantly lower compared to the naked variety Cacko (Table 2).

A total of 44 weed species were identified in the oat crop – 39 from the group of dicotyledonous weeds and 5 monocotyledonous species. Only single specimens occurred in the case of most of the taxa (Table 3). The floristic composition primarily comprised the following taxa: *Chenopodium album, Galinsoga parviflora, Matricaria maritima ssp. inodora, Polygonum aviculare,* and *Stellaria media* from the group of dicotyledonous weeds, while *Echinochloa crus-galli, Setaria pumila, Apera spica-venti,* and *Elymus repens* from monocotyledonous species. The abovementioned species were classified as dominant weeds, since they accounted respectively for 84.0% and 87.9% of the total number of weeds in the crops of the varieties Cacko and Krezus.

The weed community in the crop of the naked variety Cacko numbered 38 species, whereas the weed flora of the husked variety Krezus comprised a total of 35 species (Table 3). As many as 24 species from the group of dicotyledonous weeds and all monocotyledonous weeds (5 species) were common to the crops of both varieties. In addition, 9 taxa appeared in the naked oat crop, among others *Veronica agrestis*, *Stachys palustris*, *Sonchus arvensis,* and *Cirsium arvense.* At the same time, species such as: *Veronica persica*, *Centaurea cyanus*, *Convolvulus arvensis*, *Anthemis arvense*, *Anchusa arvensis,* and *Triforium pratense* were sporadically noted in the plots with husked oats. Analysing the species composition of the weeds colonising the oat crops, it can be concluded that, in the light of literature data, it was typical of this cereal grain (D e r y ł o et al. 2003; V a n h a l a and P i e t o l a, 2003; S a d o w s k i and R y c h c i k, 2008).

The numbers of weeds in the oat crop was dependent on the weed control level. Harrowing twice during the plant growth period reduced the number of dicotyledonous weeds, monocotyledonous weeds, and total weeds by 6%, 41% and 25%, respectively, compared to the control object (Table 4). The results of the studies of S a d o w s k i and R y c h c i k (2008) prove the beneficial effect of mechanical plant protection on weed infestation of oat crops. These authors found a 75% reduction in the number of weeds at the milk maturity stage in the plot which had been harrowed twice, compared to the spring evaluation. But weed biomass, expressed as air-dry weight of weeds, gives fuller information on the competitiveness of oats against weeds. In the present experiment, this parameter of weed infestation evaluation did not change under the influence of mechanical weed control (Table 4).

The number of weed species in the oat crop in which mechanical weed control was used was similar to the control object (Table 5). In the treatment with harrowing twice, the presence of 28 dicotyledonous and 5 monocotyledonous species was found, whereas in the control plots 31 dicotyledonous and 5 monocotyledonous species occurred. Mechanical control of dicotyledonous weeds in the oat crop completely eliminated 4 species (*Stachys palustris*, *Mentha arvense*, *Anthemis arvensis,* and *Papaver rhoeas)* and reduced the population of 11 taxa, compared to the control object. At the same time, 14 species increased their proportion in the weed community. In the group of monocotyledonous weeds, the same species were predominant in both treatment combinations, but in the object with mechanical protection *Echinochloa crus-galli* and *Setaria pumila* occurred with twice lower intensity.

In line with expectations and the results of studies of other authors, the weed-killing effect of the applied herbicide was higher than that of mechanical weed control (H y v ö n e n and S a l o n e n, 2002; D e r y ł o et al., 2003; S a d o w s k i and R y c h c i k, 2008). The number of dicotyledonous weeds declined between 56.3% and 70.2%, while air-dry weight of weeds between 18.1% and 24.1%, compared to the object in which weeds were controlled by using harrowing (Table 4). At the same time, the number of monocotyledonous weeds in the herbicide-treated plots was higher on average by 61.8% up to 133.8% than under conditions of mechanical weed control. This probably resulted from the fact that florasulam and 2,4-D EHE are substances which have an effect only on dicotyledonous weeds. While reducing their numbers, good conditions for the development of monocotyledonous taxa were created. When D e r y ł o et al. (2006) introduced more intensive weed control by applying a herbicide, among others, they obtained a reduction in the number of weeds per 1 m^2 by 31.7% and of their air-dry weight by 15.5% compared to mechanical crop protection. In other studies (D e r y ł o et al. 2003), chemical protection of oat crops against weeds significantly decreased their numbers by 72% and biomass by 76% compared to mechanical protection. Moreover, the number of species was reduced by 6 as well as most dominant species were reduced. In the present experiment, the application of the herbicide Mustang 306 SE decreased the number of species by 7 in relation to the control object (Table 5). Among others, *Conyza canadensis*, *Geranium pusillum*, *Stachys palustris,* and *Gypsophila muralis* were eliminated from the crop, but single individuals of *Veronica persica*, *Cirsium arvense*, *Lamium amplexicaule,* and *Trifolium pratense* appeared. At the same time, there was a distinct decrease in the numbers of almost all the dicotyledonous species. Among the monocotyledonous species, *Echinochloa crus-galli* significantly increased its proportion in the community, while the remaining taxa were generally reduced compared to the control object.

In the plots which were foliar fertilized with Insol 3 and Insol 3, together with the formulation Foli-Care 18:18:18, the number of dicotyledonous species was 25 and 22, respectively, whereas from the monocotyledonous group there were 5 species in each of them. Foliar feeding of plants generally intensified the occurrence of individual taxa compared to the object in which the herbicide Mustang 306 SE was used without the foliar fertilizers. This applied in particular to the dominant species such as *Echinochloa crus-galli* or *Chenopodium album*. Additionally, new species appeared in the foliar-fertilized plots, among others *Geranium pusillum* and *Veronica agrestis*. However, their proportion in the weed community was low and did not generally exceed 0.4%.

Table 2

Number and air-dry weight of weeds per 1 m^2 in the oat crop depending on variety, mean for 2007-2009

Trait	Variety		$LSD_{0.05}$
	Cacko	Krezus	
Number of dicotyledonous weeds	40.7	17.7	10.06
Number of monocotyledonous weeds	79.7	41.2	18.27
Total number of weeds	120.4	58.9	20.59
Air-dry weight of weeds in $g \times m^{-2}$	89.5	56.1	12.81

Table 3

Species composition and number of weeds per 1 m^2 in the oat crop depending on variety, mean for 2007-2009

	Weed species	Variety	
		Cacko	Krezus
	Dicotyledonous		
1	*Chenopodium album* L.	6.7	3.6
2	*Galinsoga parviflora* Cav.	6.2	1.0
3	*Matricaria maritima subsp. inodora* (L.)	4.4	2.7
4	*Polygonum aviculare* L.	3.1	1.5
5	*Stellaria media* (L.) Vill.	3.0	2.0
6	*Viola arvensis* Murray	2.5	0.3
7	*Amaranthus retroflexus* L.	2.4	0.2
8	*Plantago major* L.	1.8	0.6
9	*Spergula arvensis* L.	1.1	0.5
10	*Gnaphalium uliginosum* L.	1.1	0.1
11	*Fallopia convolvulus* L.	1.0	0.9
12	*Veronica arvensis* L.	1.0	0.4
13	*Capsella bursa-pastoris* L.	0.9	0.3
14	*Vicia hirsuta* L.	0.8	0.3
15	*Geranium pusillum* L.	0.7	0.4
16	*Anagallis arvensis* L.	0.6	0.1
17	*Galium aparine* L.	0.6	0.8
18	*Gypsophila muralis* L.	0.5	0.2
19	*Conyza canadensis* L.	0.4	0.5
20	*Raphanus raphanistrum* L.	0.4	0.1
21	*Myosotis arvensis* L.	0.3	0.5
22	*Vicia tetrasperma* L.	0.2	0.1
23	*Veronica agrestis* L.	0.2	-
24	*Stachys palustris* L.	0.2	-
25	*Sonchus arvensis* L.	0.1	-
26	*Cirsium arvense* L.	0.1	-
27	*Chamomilla suaveolens* L.	0.1	0.0
28	*Polygonum lapathifolium* L. subsp. *lapathifolium*	0.1	0.0
29	*Mentha arvensis* L.	0.1	-
30	*Papaver rhoeas* L.	0.1	-
31	*Cerastium arvense* L.	0.0	-
32	*Lamium amplexicaule* L.	0.0	-
33	*Oxalis fontana* Bunge	0.0	-
34	*Veronica persica* Poir.	-	0.2
35	*Centaurea cyanus* L.	-	0.1
36	*Convolvulus arvensis* L.	-	0.1
37	*Anthemis arvensis* L.	-	0.1
38	*Anchusa arvensis* L.	-	0.1
39	*Trifolium pratense* L.	-	0.0
	Total dicotyledonous weeds	40.7	17.7
	Number of dicotyledonous species	33	30
	Monocotyledonous		
40	*Echinochloa crus-galli* L.	42.6	12.4
41	*Setaria pumila* (Poir.) Roem. & Schult	17.7	10.8
42	*Apera spica-venti* L.	11.5	8.3
43	*Elymus repens* L.	5.9	9.5
44	*Poa annua* L.	2.0	0.2
	Total monocotyledonous weeds	79.7	41.2
	Number of monocotyledonous species	5	5
	Total number of weeds	120.4	58.9

0.0 – Species occurring in less than 0.1 per m^2

Table 4

Number and air-dry weight of weeds per 1 m^2 in the oat crop depending on weed control treatment, mean for 2007-2009

Trait	Weed control treatment					$LSD_{0.05}$
	A*	B	C	D	E	
Number of dicotyledonous weeds	49.7	46.7	13.9	15.8	20.4	22.38
Number of monocotyledonous weeds	61.0	36.1	58.4	84.4	62.0	40.64
Total number of weeds	110.7	82.8	72.3	100.2	82.4	ns**
Air-dry weight of weeds in g × m^{-2}	81.7	84.4	64.5	69.1	64.1	ns

ns** – difference not significant
A* – control treatment
B – harrowing twice
C – Mustang 306 SE
D – Mustang 306 SE + Insol 3
E – Mustang 306 SE + Insol 3 + FoliCare 18:18:18

Table 5

Species composition and number of weeds per 1 m^2 in the oat crop depending on weed control treatment, mean for 2007-2009

No.	Weed species	Weed control treatment				
		A*	B	C	D	E
	Dicotyledonous					
1	*Chenopodium album* L.	12.5	9.4	0.1	1.6	2.2
2	*Stellaria media* (L.) Vill.	5.2	6.1	0.4	0.6	0.3
3	*Galinsoga parviflora* Cav.	4.5	5.8	1.6	1.0	5.1
4	*Matricaria maritima subsp. inodora* (L.)	3.8	4.8	2.5	3.4	3.4
5	*Plantago major* L.	3.2	2.0	0.2	0.2	0.3
6	*Amaranthus retroflexus* L.	3.2	1.0	0.1	-	2.1
7	*Polygonum aviculare* L.	2.7	3.1	3.2	1.5	1.0
8	*Viola arvensis* Murray	2.4	1.4	0.7	1.6	0.9
9	*Fallopia convolvulus* L.	1.9	1.2	0.4	0.6	0.5
10	*Spergula arvensis* L.	1.3	0.5	0.7	0.7	0.8
11	*Conyza canadensis* L.	1.2	1.0	-	0.2	-
12	*Geranium pusillum* L.	1.2	0.9	-	0.4	0.2
13	*Capsella bursa-pastoris* L.	1.1	0.6	0.8	0.4	0.2
14	*Vicia hirsuta* L.	1.0	1.0	0.4	-	0.2
15	*Galium aparine* L.	1.0	1.8	0.3	0.2	0.3
16	*Myosotis arvensis* L.	0.6	0.7	0.1	0.5	-
17	*Stachys palustris* L.	0.4	-	-	-	-
18	*Gypsophila muralis* L.	0.3	1.3	-	-	-
19	*Anagallis arvensis* L.	0.3	0.4	0.4	0.4	0.2
20	*Gnaphalium uliginosum* L.	0.2	1.6	0.2	0.3	0.7
21	*Veronica arvensis* L.	0.2	0.6	1.0	0.8	0.9
22	*Raphanus raphanistrum* L.	0.2	0.4	0.1	0.2	0.3
23	*Mentha arvensis* L.	0.2	-	-	-	-
24	*Convolvulus arvensis* L.	0.2	0.1	-	-	-
25	*Polygonum lapathifolium* L. subsp. *lapathifolium*	0.2	0.1	0.1	-	-
26	*Anthemis arvensis* L.	0.2	-	-	-	-
27	*Chamomilla suaveolens* Pursh	0.1	0.2	-	-	-
28	*Sonchus arvensis* L.	0.1	0.2	-	-	0.1
29	*Vicia tetrasperma* L.	0.1	0.2	0.1	0.2	0.2
30	*Centaurea cyanus* L.	0.1	0.1	-	0.1	-
31	*Papaver rhoeas* L.	0.1	-	-	0.1	-
32	*Veronica persica* Poir.	-	0.2	0.1	0.1	-
33	*Cirsium arvense* L.	-	-	0.2	-	0.2
34	*Lamium amplexicaule* L.	-	-	0.1	-	-
35	*Trifolium pratense* L.	-	-	0.1	-	-
36	*Veronica agrestis* L.	-	-	-	0.4	0.2
37	*Anchusa arvensis* L.	-	-	-	0.2	-
38	*Oxalis fontana* Bunge	-	-	-	0.1	-
39	*Cerastium arvense* L.	-	-	-	-	0.1
	Total dicotyledonous weeds	49.7	46.7	13.9	15.8	20.4
	Number of dicotyledonous species	31	28	24	25	22
	Monocotyledonous					
40	*Echinochloa crus-galli* L.	21.4	11.9	29.7	41.0	33.5
41	*Setaria pumila* (Poir.) Roem. & Schult	20.5	9.5	12.5	17.5	11.2
42	*Elymus repens* L.	9.8	7.6	8.8	6.0	6.4
43	*Apera spica-venti* L.	8.6	6.2	6.8	18.7	9.0
44	*Poa annua* L.	0.7	0.9	0.6	1.2	1.9
	Total monocotyledonous weeds	61.0	36.1	58.4	84.4	62.0
	Number of monocotyledonous species	5	5	5	5	5
	Total number of weeds	110.7	82.8	72.3	100.2	82.4

A* – Explanations as in Table 4

CONCLUSIONS

1. The husked variety Krezus proved to be more competitive against weeds. Number of dicotyledonous weeds and of monocotyledonous weeds, total weeds, and air-dry weight of above-ground parts of weeds in the crop of this variety were all significantly lower compared to the naked variety Cacko.
2. In the crops of the oat varieties in question, *Chenopodium album, Galinsoga parviflora, Matricaria maritima ssp. inodora, Polygonum aviculare,* and *Stellaria media* were the dominant species from the group of dicotyledonous species, while *Echinochloa crus-galli, Setaria pumila, Apera spica-venti*, and *Elymus repens* among the monocotyledonous species.
3. In-crop harrowing, though it significantly reduced the number of monocotyledonous weeds, proved to be less effective in the reduction of air-dry weight of above-ground parts of weeds compared to chemical weed management.
4. More intensive weed control, in which the herbicide Mustang 306 SE was applied, reduced the number of dicotyledonous weeds (in particular the dominant species) and air-dry weight of weeds relative to the control object without herbicide protection. At the same time, the number of weed species decreased in the herbicide-treated plots (between 6 and 9), while the taxa such as, among others, *Gypsophila muralis*, *Convolvulus arvensis,* or *Chamomilla suaveolens* were eliminated.
5. Foliar feeding of plants with the foliar fertilizers Insol 3 and FoliCare 18:18:18 generally intensified the occurrence of individual weed taxa compared to the object in which the herbicide Mustang 306 SE was applied without the foliar fertilizers. Weed species such as, among others, *Polygonum aviculare*, *Capsella bursa-pastoris*, *Vicia hirsuta*, *Anagallis arvensis*, *Veronica arvensis* were an exception.

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Wpływ poziomu agrotechniki na zachwaszczenie zasiewów nagoziarnistej i oplewionej odmiany owsa (*Avena sativa* L.)

Streszczenie

Doświadczenie polowe przeprowadzono w latach 2007–2009 w Gospodarstwie Doświadczalnym Bezek koło Chełma. Celem badań było porównanie zachwaszczenia łanów oplewionej (Krezus) i nagoziarnistej (Cacko) odmiany owsa uprawianych w zróżnicowanych warunkach agrotechnicznych. Uwzględniono następujące poziomy agrotechniki: a – obiekt kontrolny; b – dwukrotne bronowanie; c – herbicyd Mustang 306 SE; d – Mustang 306 SE + nawóz dolistny

Insol 3; e – Mustang 306 SE + nawozy dolistne Insol 3 i FoliCare 18:18:18.

Bardziej konkurencyjna wobec chwastów była oplewiona odmiana Krezus. Zarówno liczba chwastów dwuliściennych, jednoliściennych i ogółem, jak i powietrznie sucha masa części nadziemnych chwastów w łanie tej odmiany były istotnie mniejsze w porównaniu z chwastami w łanie nagoziarnistej odmiany Cacko. Chwastami dominującymi w łanach porównywanych odmian owsa były *Chenopodium album, Galinsoga parviflora, Matricaria maritima ssp. inodora, Polygonum aviculare* i *Stellaria media* z grupy chwastów dwuliściennych, natomiast z jednoliściennych *Echinochloa crus-galli, Setaria pumila, Apera spica-venti i Elymus repens.* Wyższy poziom agrotechniki uwzględniający zastosowanie herbicydu Mustang 306 SE obniżył liczbę chwastów dwuliściennych i powietrznie suchą masę chwastów w odniesieniu do obiektu z mechanicznym pielęgnowaniem roślin.

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