WEED INFESTATION OF CROPS OF WINTER SPELT WHEAT (Triticum aestivum ssp. spelta) CULTIVARS GROWN UNDER DIFFERENT CONDITIONS OF MINERAL FERTILIZATION AND CHEMICAL PLANT PROTECTION

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Abstract

A field experiment was carried out in the years 2008-2010 on rendzina soil. The aim of the study was to evaluate weed infestation of winter spelt cultivars ('Schwabenkorn' and 'Spelt I.N.Z.') grown under different conditions of mineral fertilization and chemical plant protection. In the experiment, two levels of mineral fertilization were compared (kg \times ha¹): I. N 60; P 26.2; K 83; and II. N 80; P 34.9; K 99.6. The chemical protection levels were as follows: A. Control treatment; B. Mustang 306 SE, Stabilan 750 SL; C. Mustang 306 SE, Attribut 70 WG, Stabilan 750 SL; D. Mustang 306 SE, Attribut 70 WG, Alert 375 SC, Stabilan 750 SL.

Apera spica-venti, Setaria pumila, and Galium aparine occurred in greatest numbers in the spelt wheat crop. The cultivar 'Schwabenkorn' was more competitive against weeds. The number of dicotyledonous and monocotyledonous weeds, their total number, and air-dry weight of weeds in the crop of this cultivar were significantly lower compared to cv. 'Spelt I.N.Z.'. Chemical protection of spelt wheat decreased weed dry weight compared to the control treatment without chemical protection. The application of higher rates of mineral fertilizers slightly increased the number of weeds but did not influence their dry weight and number of weed species.

Key words: spelt, weed communities, agnotechnical factors

INTRODUCTION

One of the main factors that reduce crop yields is the presence of weeds. Segetal weeds are characterized by high vigour, they grow faster than crop plants, produce more seeds, and adapt more easily to adverse habitat conditions. If they occur in large numbers, weeds gain a significant advantage over the crop plant,

it is therefore very important to select an appropriate and effective weed control method (Adamczewski and Praczyk, 1999). Many studies have been devoted to explain the relationship between the level of chemical crop protection and weed infestation of crop fields. These studies show that weed infestation increases with a decrease in the intensity of chemical plant protection, hence there arises a need to use more intensive crop protection treatments. Other weed control options are now gaining an ever greater importance, including the use of genetic properties of crop plant varieties, in particular their suppressive effect on weeds (Jedruszczak et al. 2004; Lemerle et al. 1996; Beres et al. 2010). The literature shows that individual crop plant varieties differ in their ability to compete with weeds (Lemerle et al. 1996; Feledyn-Szewczyk and Duer, 2005), which is primarily determined by the variation in traits such as emergence rate and biomass accumulation, plant height, tillering rate, or leaf area and leaf angle (Christensen, 1995; Sulewska, 2004; Feledyn-Szewczyk and Duer 2006). The above--mentioned characters determine the amount of photosynthetically active radiation penetrating through the crop canopy which directly affects weed growth. Many authors are of opinion that more intensive mineral fertilization is a factor that reduces weed infestation of crops (Blecharczyk et al. 2009; Kraska and Pałys, 2007). Higher NPK rates, through their beneficial effect on crop density, reduce the number and air-dry weight of weeds and differentiate their floristic composition. In turn, the studies of Gawrońska-- Kulesza et al. (2005) and Pałys et al. (2011)

found mineral fertilization to have a stimulating effect on weed infestation of winter wheat.

Due to the constantly growing interest in spelt wheat cultivation, it is advisable to seek varieties of this species that are less susceptible to weed pressure. German spelt cultivars can be mostly found in cultivation, hence the knowledge of their responses to different crop protection and fertilization options under the soil and climatic conditions of Poland may allow us to make recommendations for agricultural practice. The aim of the present study was to compare weed infestation of crops of two winter spelt wheat cultivars grown under different conditions of chemical plant protection and mineral fertilization.

MATERIALS AND METHODS

A field study was carried out in the period 2008-2010 in the Bezek Experimental Farm located near the city of Chełm (51°19'N 23°26'E). The experiment was established on mixed rendzina soil derived from chalk rock, with the granulometric composition of medium silty loam. The soil was characterized by alkaline pH (pH in 1 mol KCl -7.35), a high content of phosphorus (117.8 mg \times kg⁻¹ of soil) and potassium (242.4 mg × kg⁻¹ of soil) as well as a very low content of magnesium (19.0 mg \times kg⁻¹ of soil). Organic carbon content was 2.47%. Common wheat was the previous crop for spelt wheat. Tillage was performed in accordance with generally accepted agricultural practice recommendations for winter common wheat. Spelt ears were sown in mid-October at a rate of 350 kg per hectare. The experiment was set up in a randomized block design in triplicate, in 8 m² plots. The experimental design included 2 spelt wheat cultivars ('Schabenkorn' and 'Spelt I.N.Z.'), 2 levels of mineral fertilization, and 4 levels of plant protection.

Mineral fertilization was as follows (kg × ha⁻¹): I. N 60 (20+40); P 26.2; K 83; II. N 80 (20+40+20); P 34.9; K 99.6. Phosphorus and potassium fertilizers as well as 20 kg N × ha⁻¹ were applied before sowing spelt wheat. In the spring at the stem elongation stage (BBCH 32-34), an amount of 40 kg N × ha⁻¹ was applied in both fertilization treatments. In the treatment with the second level of fertilization, an amount of 20 kg N × ha⁻¹ was additionally incorporated into the soil at the heading stage (BBCH 52-55).

Plant protection levels included the following treatments: A. Control treatment (without chemical protection); B. Mustang 306 SE + Stabilan 750 SL; C. Mustang 306 SE + Attribut 70 WG + Stabilan 750 SL; D. Mustang 306 SE + Attribut 70 WG + Alert 375 SC + Stabilan 750 SL. The herbicides Mustang 306 SE (florasulam 6.25 g × 1^{-1} ; 2,4-D EHE 300 g × 1^{-1}) and Attribut 70 WG (propoxycarbazone 70%; methyl

ester of 2-benzoic acid sodium salt) were applied at the tillering stage (BBCH 23-25) at the rates of $0.41 \times \text{ha}^{-1}$ and $60 \text{ g} \times \text{ha}^{-1}$, respectively. The fungicide Alert 375 SC (flusilazole 125 g × l⁻¹; carbendazim 250 g × l⁻¹) at a rate of $1 \text{ l} \times \text{ha}^{-1}$ and the growth regulator Stabilan 750 SL (CCC 750 g × l⁻¹) at a rate of $2 \text{ l} \times \text{ha}^{-1}$ were applied at the stem elongation stage (BBCH 32-34).

Weed infestation was evaluated by the quantitative gravimetric method at the dough stage (85-87 BBCH) of spelt wheat. Weed species composition, number of weeds, and air-dry weight of the above-ground parts of weeds were determined based on sampling areas delineated by a 1 m \times 0.25 m frame in four randomly selected places in each plot. The obtained results were statistically analysed by analysis of variance and least significant differences were calculated using Tukey's confidence half-intervals with an error rate of 5%.

RESULTS

A total of 32 dicotyledonous weed species, 6 monocotyledonous taxa, and Equisetum arvense were found to occur in the spelt wheat crops (Tables 1-3). Irrespective of the experimental factors, dicotyledonous weeds accounted on average for 56%; among them, Galium aparine, Viola arvensis, and Matricaria maritima ssp. inodora were were represented in greatest numbers. The above-mentioned taxa accounted for, respectively, 17%, 10%, and 8% of the total number of weeds. Among the monocotyledonous species, Apera spica venti and Setaria pumila were predominant and they constituted 25% and 16%, respectively. In the studies of Kraska et al. (2009) and Palys et al. (2011) conducted on the same soil, G. aparine, V. arvensis, and A. spica-venti were also the species that were found in the crops in greatest numbers.

The weed communities in the crops of the wheat spelt cultivars compared were composed of distinctly different numbers of species (Table 1). Depending on the cultivar, the number of weed species ranged from 24 (cv. 'Schwabenkorn') to 37 (cv. 'Spelt I.N.Z.'), but this variation related primarily to dicotyledonous weeds (respectively, 18 and 30 species). The number of weeds accompanying the spelt wheat cultivars compared differed significantly. More than two times more dicotyledonous (Fig. 1) and monocotyledonous weeds (Fig. 2) were found in the crop of the cultivar 'Spelt I.N.Z.' compared to cv. 'Schwabenkorn'. The significant differences obtained were, respectively, 26.4 plants and 21.1 plants per 1 m². In the studies of Feledyn-Szewczyk and Duer (2005) as well as Feledyn-Szewczyk (2011), high weed competitiveness of the spelt cultivar 'Schwabenkorn', in relation to the winter wheat cultivars compared,

resulted from the specificity of its morphological traits. This cultivar was characterized by the highest height, tillering rate, leaf area and leaf area index (LAI). Pałys and Kuraszkiewicz (2003) also found varying effects of spelt wheat cultivars on weed infestation of crops. The cultivar 'Loge' was more competitive against weeds than cv. 'Bauländer Spelz'.

The cultivation of the spelt cultivars studied resulted in significant differences in the number of individual weed species. As many as sixteen species, including the dominant weeds, occurred with lower intensity in the 'Schwabenkorn' crop compared to the cultivar 'Spelt I.N.Z.', four taxa increased their numbers, whereas fifteen weed species did not appear at all. At the same time, only 2 taxa, i.e. Amaranthus retroflexus and Eupatorium cannabinum, from the 'Schwabenkorn' crop did not have their representatives in the weed community of the 'Spelt I.N.Z.' crop. The results of many studies on cereal cultivars have shown differences in their weed competitiveness (Lemerle et al. 1996, 2001; Korres and Froud-Williams, 2002; Pałys and Kuraszkiewicz, 2003; Feledyn-Szewczyk and Duer, 2005; Kraska, 2006; Parylak et al. 2006; Andruszczak et al. 2010b).

The levels of mineral fertilization (Table 2) had no effect on the number of weed species in the crops of the spelt wheat cultivars studied (on average, 25 dicotyledonous species and 6 monocotyledonous species in each crop) (Table 2). In the studies of Frant and Bujak (2006) as well as Pałys et al. (2011), the level of mineral fertilization in winter wheat crops did not affect the number of weed species. On the other hand, mineral fertilization differentiated the floristic composition of weed communities and numbers of individual taxa. The application of higher NPK rates, at the respective amounts of 80:34.9:99.6 kg × ha⁻¹, increased the total number of weeds by 11.5 plants × m⁻² on average, i.e. by 20.5% compared to the fertilization level of 60:26.2:83 kg × ha⁻¹. Eleven taxa determined the difference in weed infestation, in particular Setaria pumila and Melandrium album whose numbers were higher by 8.2 plants and 2.9 plants per 1 m², respectively, under the conditions of more intensive mineral fertilization. Twelve weed species occurred with similar or slightly lower intensity in the plots with the lower NPK rates, while eight species were completely eliminated. But they were replaced by other taxa, among others Echinochloa crus-galli, Galinsoga parviflora, Lamium amplexicaule, and Plantago major, which were not found in the plots with less intensive fertilization. On the other hand, in the studies of Frant and Bujak (2006) as well as Palys et al. (2011), the number of weeds in spring and winter wheat crops decreased as the level of mineral fertilization increased.

Weed infestation of the spelt wheat crop was significantly differentiated by the level of chemical crop protection. The application of the herbicide Mustang 306 SE (treatment B) significantly reduced the number of dicotyledonous weeds per unit area – by 37% (Fig. 1), while the number of species decreased by 4 compared to the control treatment without chemical protection (treatment A) (Table 3). This herbicide effectively eliminated 7 dicotyledonous species from the crop, whereas the numbers of 10 taxa decreased. Among them, Myosotis arvensis, Papaver rhoeas, and Galium aparine were the most sensitive. The above--mentioned species responded by reducing their numbers by 73%, 71%, and 45%, respectively, under the effect of this herbicide.

The introduction of a higher level of chemical crop protection by the application of an additional herbicide (treatment C) decreased the number of dicotyledonous weeds by 17.7% in relation to the control treatment, whereas the number of species was reduced to 21. Under the influence of the herbicides Mustang 306 SE and Attribut 70 WG, the majority of dicotyledonous species occurred with lower intensity than in the control plots and, moreover, 6 species were eliminated. At the same time, 4 taxa increased their proportion in the weed community, including Matricaria maritima subsp. inodora whose numbers increased more than twice.

The intensification of chemical plant protection, by applying two herbicides and a fungicide (treatment D), significantly reduced the number of dicotyledonous weeds per unit area by 34% compared to the control treatment (Fig. 1). This resulted mainly from the reduced occurrence of the following taxa: Galium aparine, Viola arvensis, Matricaria maritima subsp. inodora, Myosotis arvensis, and Papaver rhoeas. Additionally, 8 taxa were eliminated altogether. At the same time, five new species appeared, such as: Cirsium arvense, Galinsoga parviflora, Arnoseris minima, Daucus carota, and Lithospermum arvense. However, their percentage in weed infestation was low and usually did not exceed 1% (except for Cirsium arvense). Applying Mustang 306 SE and Attribut 70 WG in a winter wheat crop grown on the same soil, Kraska et al. (2009) obtained a reduction in the number of dicotyledonous weeds by 41% and in the number of monocotyledonous weeds by 30% relative to the control treatment without herbicides. At the same time, they obtained different results with respect to the number of species. In the herbicide-treated plots, they found the number of both dicotyledonous and monocotyledonous taxa to have increased in relation to the control treatment. This could have resulted from the fact that under the

conditions of herbicide application the numbers of dominant species (*G. aparine* and *A. spica-venti*) distinctly decreased, thereby enabling the emergence of new weed species from the soil seed bank.

The levels of chemical crop protection applied in the present experiment had varying effects on weed infestation by monocotyledonous species. Their total number in treatments B and C increased by 68% and 13%, respectively, relative to the control treatment without chemical protection (A), whereas in treatment D the value of this trait was found to have decreased by 5% (Fig. 2). In the treatment combination where the herbicide Mustang 306 SE was used (treatment B), Setaria pumila deserves special attention (Table 3), since it is distinguished by a nearly sixfold increase of its proportion in the weed community (from 3.3 plants to 19.4 plants). This was probably attributable to the lack of sensitivity of this species to the active substances of the herbicide, since florasulam and 2,4-D EHE control mainly dicotyledonous weeds. At the same time, by reducing the numbers of dicotyledonous weeds, favourable conditions for the growth of monocotyledonous taxa were created. Echinochloa crus-galli and Elymus repens also showed a lack of sensitivity to the chemical agents used in the experiment, which manifested itself in an increased proportion of these taxa in the weed community. On the other hand, Apera spica--venti was found in lower numbers in the control plots. Under the effect of Attribut 70 WG (treatments C and

D), the numbers of this species decreased from 14% to 47%. In the study of Kraska et al. (2009), depending on the applied rate of propoxycarbazone in the winter wheat crop, the numbers of *A. spica-venti* were reduced from 8% to 38%.

Weed biomass, expressed by air-dry weight of the above-ground parts of weeds, was significantly dependent on the cultivar and level of chemical crop protection, whereas varying mineral fertilization did not affect this trait (Table 4). In the study of Pałys et al. (2011), dry weight of weeds in a winter wheat crop increased as the level of mineral fertilization increased. Similar results were also obtained by Frant and Bujak (2006) in spring wheat crops. In the studies of Kraska et al. (2009) and Andruszczak et al. (2010a), foliar fertilization had no effect on weed infestation of cereal crops.

In the experiment in question, significantly higher weed biomass per 1 m² was found in the crop of the cultivar 'Spelt I.N.Z.' (on average by 64%), which can be evidence of its lower competitive ability against weeds compared to cv. 'Schwabenkorn' (Table 4). Irrespective of the cultivar and rates of mineral fertilizers, weed dry weight in all the treatments with chemical plant protection (B, C, and D) was significantly lower than in the control treatment without chemical protection, on average from 55% to 73%, but the differences between the chemically protected plots were not significant.

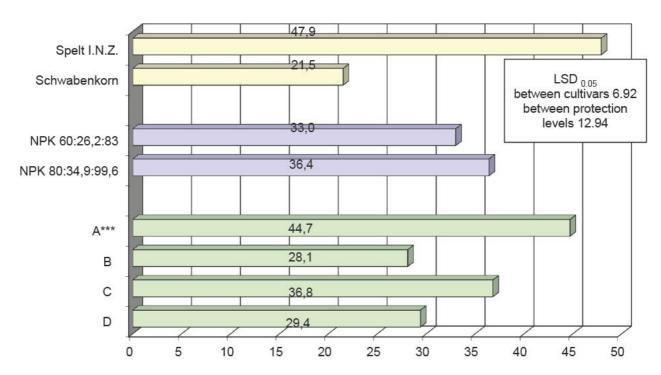


Fig. 1. Number of dicotyledonous weeds in the spelt wheat crop depending on experimental factors (plants \times m⁻²)

*** Explanations as in Table 3

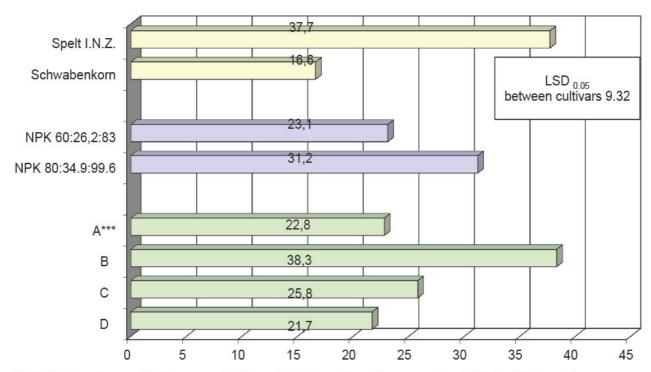


Fig. 2. Number of monocotyledonous weeds in the spelt wheat crop depending on experimental factors (plants × m⁻²) *** Explanations as in Table 3

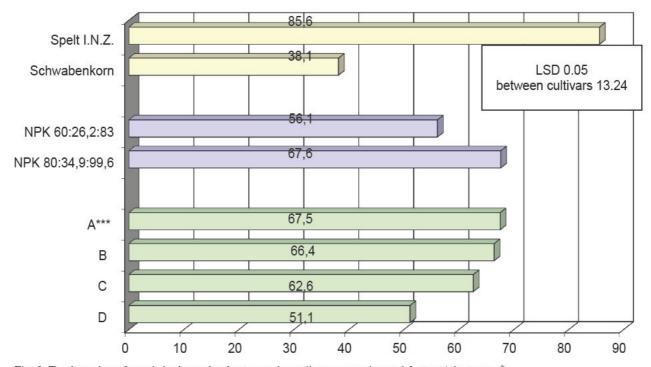


Fig. 3. Total number of weeds in the spelt wheat crop depending on experimental factors (plants \times m⁻²)

 $Table \ 1$ Number and species composition of weeds in the crops of the spelt wheat cultivars compared (plants × m-2)

Weed species	Cultivar			
weed species	Spelt I.N.Z	Schwabenkorn		
Dicotyledonous				
Galium aparine L.	13.9	7.5		
Viola arvensis Murray	8.1	3.8		
Matricaria maritima subsp. inodora (L.)	7.9	2.3		
Fallopia convolvulus L.	3.1	1.1		
Veronica agrestis L.	3.1	0.5		
Melandrium album (Mill.) Garcke	3.0	0.1		
Myosotis arvensis (L.) Hill	1.5	1.3		
Sonchus arvensis L.	1.2	0.2		
Papaver rhoeas L.	1.1	1.3		
Cirsium arvense (L.) Scop.	0.9	-		
Convolvulus arvensis L.	0.8	2.3		
Stellaria media (L.) Vill.	0.5	0.1		
Veronica persica Poir.	0.5	-		
Chenopodium album L.	0.3	0.1		
Polygonum aviculare L.	0.3	0.0		
Galeopsis tetrahit Mill.	0.3	-		
Galinsoga parviflora Cav.	0.2	0.4		
Solanum tuberosum L.	0.2	0.2		
Fraxinus excelsior L. (juv.)	0.2	-		
Lamium amplexicaule L.	0.2	-		
Plantago major L.	0.2	-		
Arctium tomentosum Mill.	0.1	-		
Arnoseris minima (L.) Schweigg. & Körte	0.1	-		
Artemisia vulgaris L.	0.1	-		
Conyza canadensis (L.) Cronquist	0.1	-		
Anagallis arvensis L.	0.0**	0.2		
Capsella bursa-pastoris (L.) Medik.	0.0	-		
Daucus carota L.	0.0	-		
Fumaria officinalis L.	0.0	-		
Lithospermum arvense L.	0.0	-		
Amaranthus retroflexus L.	-	0.1		
Eupatorium cannabinum L.	-	0.0		
Number of dicotyledonous weeds	30	18		
Monocotyledonous*				
Apera spica-venti (L.) P. Beauv.	22.0	8.5		
Setaria pumila (Poir.) Roem. & Schult.	12.0	7.4		
Echinochloa crus-galli (L.) P. Beauv.	1.6	0.1		
Equisetum arvense L.	1.4	0.2		
Elymus repens (L.) Gould	0.4	0.3		
Poa annua L.	0.2	-		
Avena fatua L.	0.1	0.1		
Number of monocotyledonous weeds	7	6		
Total number of species	37	25		

 $^{* \} Monocotyle do nous \ weeds \ together \ with \ \textit{Equisetum arvense}$

^{0.0**} Species occurring at less than 0.1 plants \times m⁻²

Table 2 Number and species composition of weeds in the spelt wheat crop depending on the level of mineral fertilization (plants×m⁻²)

Wood anaiga	Mineral fertilization level			
Weed species	NPK 60:26.2:83	NPK 80:34.9:99.		
Dicotyledonous				
Galium aparine L.	11.3	10.1		
Viola arvensis Murray	7.2	4.7		
Matricaria maritima subsp. inodora (L.)	4.9	5.4		
Convolvulus arvensis L.	1.8	1.3		
Myosotis arvensis (L.) Hill	1.3	1.5		
Fallopia convolvulus L.	1.1	3.1		
Papaver rhoeas L.	1.1	1.3		
Veronica agrestis L.	1.0	2.6		
Cirsium arvense (L.) Scop.	0.8	0.0		
Sonchus arvensis L.	0.4	1.0		
Stellaria media (L.) Vill.	0.4	0.2		
Veronica persica Poir.	0.3	0.3		
Galeopsis tetrahit Mill.	0.3	-		
Solanum tuberosum L.	0.3	-		
Polygonum aviculare L.	0.2	0.2		
Melandrium album (Mill.) Garcke	0.1	3.0		
Chenopodium album L.	0.1	0.2		
Fraxinus excelsior L. (juv.)	0.1	0.2		
Anagallis arvensis L.	0.1	0.1		
Amaranthus retroflexus L.	0.1	-		
Arnoseris minima (L.) Schweigg. & Körte	0.1	-		
Arctium tomentosum Mill.	0.0**	0.0		
Daucus carota L.	0.0	-		
Eupatorium cannabinum L.	0.0	-		
Fumaria officinalis L.	0.0	-		
Galinsoga parviflora Cav.	-	0.6		
Lamium amplexicaule L.	-	0.2		
Plantago major L.	-	0.2		
Artemisia vulgaris L.	-	0.1		
Conyza canadensis (L.) Cronquist	-	0.1		
Capsella bursa-pastoris (L.) Medik.	-	0.0		
Lithospermum arvense L.	-	0.0		
Number of dicotyledonous weeds	25	25		
Monocotyledonous*				
Apera spica-venti (L.) P. Beauv.	15.5	15.0		
Setaria pumila (Poir.) Roem. & Schult.	5.6	13.8		
Equisetum arvense L.	1.5	0.1		
Elymus repens (L.) Gould	0.2	0.5		
Poa annua L.	0.2	-		
Avena fatua L.	0.1	0.1		
Echinochloa crus-galli (L.) P. Beauv.	-	1.7		
9 1 7				
Number of monocotyledonous weeds	6	6		

^{*; 0.0**} Explanations as in Table 1

 $Table \ 3$ Number and species composition of weeds in the spelt wheat crop depending on the level of chemical protection (plants × m-2)

Weed species	Chemical protection level			
weed species	A***	В	С	D
Dicotyledonous				
Galium aparine L.	17.4	9.5	9.3	6.6
Viola arvensis Murray	7.1	6.3	5.3	5.1
Matricaria maritima subsp. inodora (L.)	4.4	3.1	9.9	3.2
Myosotis arvensis (L.) Hill	2.6	0.7	1.3	0.8
Papaver rhoeas L.	2.4	0.7	0.8	0.8
Fallopia convolvulus L.	2.2	1.8	2.9	1.5
Convolvulus arvensis L.	2.1	1.3	1.2	1.6
Veronica agrestis L.	1.7	1.7	1.0	2.8
Melandrium album (Mill.) Garcke	1.3	1.0	1.2	2.7
Stellaria media (L.) Vill.	0.9	0.1	0.2	-
Sonchus arvensis L.	0.4	0.4	0.9	1.0
Solanum tuberosum L.	0.4	-	0.2	-
Fraxinus excelsior L. (juv.)	0.2	0.3	0.1	-
Galeopsis tetrahit Mill.	0.2	0.2	0.0	0.2
Anagallis arvensis L.	0.2	0.2	-	0.1
Chenopodium album L.	0.2	0.1	0.2	0.2
Plantago major L.	0.2	-	0.1	0.1
Lamium amplexicaule L.	0.2	-	-	0.2
Conyza canadensis (L.) Cronquist	0.2	-	-	-
Polygonum aviculare L.	0.1	0.1	0.5	0.1
Artemisia vulgaris L.	0.1	0.1	-	-
Arctium tomentosum Mill.	0.1	-	0.1	-
Capsella bursa-pastoris (L.) Medik.	0.1	-	-	-
Eupatorium cannabinum L.	0.0**	-	-	-
Veronica persica Poir.	-	0.2	0.9	-
Galinsoga parviflora Cav.	-	0.2	0.6	0.4
Fumaria officinalis L.	-	0.1	-	-
Amaranthus retroflexus L.	-	-	0.1	-
Cirsium arvense (L.) Scop.	-	-	-	1.6
Arnoseris minima (L.) Schweigg. & Körte	-	-	-	0.2
Daucus carota L.	-	-	-	0.1
Lithospermum arvense L.	-	-	-	0.1
Number of dicotyledonous weeds	24	20	21	21
Monocotyledonous*				
Apera spica-venti (L.) P. Beauv.	18.4	17.1	15.8	9.8
Setaria pumila (Poir.) Roem. & Schult.	3.3	19.4	8.3	7.8
Equisetum arvense L.	0.7	0.3	-	2.2
Echinochloa crus-galli (L.) P. Beauv.	0.2	0.6	0.8	1.8
Elymus repens (L.) Gould	0.1	0.4	0.8	0.1
Avena fatua L.	0.1	0.2	0.1	-
Poa annua L.	-	0.3	-	-
Number of monocotyledonous weeds	6	7	5	5
Total number of species	30	27	26	26
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^{*;} 0.0** Explanations as in Table 1

^{***} A. Control treatment (without chemical protection); B. Mustang 306 SE + Stabilan 750 SL; C. Mustang 306 SE + Attribut 70 WG + Stabilan 750 SL; D. Mustang 306 SE + Attribut 70 WG + Alert 375 SC + Stabilan 750 SL

Chemical protection level		Spelt I.N.Z.			Schwabenkorn			Mean	
	Fertilization level								
	NPK 60:26.2:83	NPK 80:34.9:99.6	Mean	NPK 60:26.2:83	NPK 80:34.9:99.6	Mean	NPK 60:26.2:83	NPK 80:34.9:99.6	Mean
A***	44.9	35.1	40.0	22.9	26.9	24.9	33.9	31.0	32.4
В	14.1	17.4	15.7	17.1	10.1	13.6	15.6	13.7	14.7
C	14.0	20.1	17.1	6.0	9.0	7.5	10.0	14.6	12.3
D	9.6	13.9	11.7	4.4	6.6	5.5	7.0	10.2	8.6
Mean	20.6	21.6	21.1	12.6	13.1	12.9	16.6	17.4	-
LSD 0.05	between cu between pr	ltivars 5.81 otection levels	10.86						

Table 4 Air-dry weight of the above-ground parts of weeds in the crops of the spelt wheat cultivars compared (g × m⁻²)

CONCLUSIONS

- 1. The floristic composition and numbers of weeds colonising the spelt wheat crops depended primarily on the cultivar and level of chemical crop protection and to a smaller extent on mineral fertilization rates.
- 2. Irrespective of the experimental factors, Apera spica-venti (25%) and Setaria pumila (16%) had the highest percentages in the monocotyledonous class, while Galium aparine (17%) among the dicotyledonous weed species.
- 3. The number of both monocotyledonous and dicotyledonous weeds, total number of weeds and air-dry weight of the above-ground parts of weeds in the crop of the cultivar 'Schwabenkorn' were significantly lower compared to cv. 'Spelt I.N.Z.'.
- 4. The higher level of mineral fertilization slightly increased the number of weeds in the spelt crop, but it had no effect on weed dry weight and number of weed species.
- 5. Compared to the control treatment without chemical protection, air-dry weight of the above-ground parts of weeds decreased as the level of chemical plant protection increased. At the same time, the value of this trait in the chemically protected plots did not differ significantly.

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^{***} Explanations as in Table 3

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Zachwaszczenie łanu ozimych odmian pszenicy orkisz (*Triticum aestivum* ssp. *Spelta*) uprawianych w zróżnicowanych warunkach nawożenia mineralnego i ochrony chemicznej

Streszczenie

Doświadczenie polowe przeprowadzono w latach 2008-2010 na rędzinie mieszanej wytworzonej z opoki kredowej. Celem badań była ocena zachwaszczenia ozimych odmian pszenicy orkiszowej (Schwabenkorn i Spelt I.N.Z.) uprawianych w zróżnicowanych warunkach nawożenia mineralnego i ochrony chemicznej. Nawożenie mineralne przedstawiało się następująco (w kg czystego składnika na hektar): I. N 60; P 26,2; K 83 oraz II. N 80; P 34,9; K 99,6. Poziomy ochrony roślin obejmowały: A. Obiekt kontrolny; B. Mustang 306 SE, Stabilan 750 SL; C. Mustang 306 SE, Attribut 70 WG, Stabilan 750 SL; D. Mustang 306 SE, Attribut 70 WG, Alert 375 SC, Stabilan 750 SL.

Największy udział w zbiorowisku chwastów, niezależnie od czynników doświadczenia, miały Apera spica-venti i Setaria pumila z klasy jednoliściennych, z dwuliściennych zaś Galium aparine. Bardziej konkurencyjna wobec chwastów była odmiana Schwabenkorn. 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 odmianą Spelt I.N.Z. Zastosowane chemiczne zabiegi ochrony roślin zmniejszyły powietrznie suchą masę nadziemnych części chwastów w odniesieniu do obiektu kontrolnego bez ochrony. Wyższy poziom nawożenia mineralnego nieznacznie zwiększył liczbę chwastów w łanie orkiszu, nie miał jednak wpływu na ich powietrznie suchą masę oraz liczbę gatunków chwastów.