ACTA AGROBOTANICA
Vol. 64 (1): 79–90
2011

THE EFFECT OF SOIL EXTRACTS FROM A MONOCULTURE OF SPRING WHEAT *(Triticum aestivum L.)* GROWN UNDER DIFFERENT TILLAGE SYSTEMS ON THE GERMINATION OF ITS SEEDS

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Received: 16.05.2010

Abstract

The present experiment was carried out in the period 2006–2008. The aim of this study was to determine the effect of aqueous soil extracts from the soil of a spring wheat monoculture on seed germination energy and capacity, the length of the first leaf and of the longest radicle as well as the number of radicles. Moreover, the content of 0-dihydroxyphenols in the soil was compared in the last year of the study. The soil used to prepare the solutions came from a field experiment established on medium heavy mixed rendzina soil. Spring wheat, cv. Zebra, was grown using plough tillage and two conservation tillage methods in the presence of undersown crops (red clover, Westerwolds ryegrass) and stubble crops (lacy phacelia, white mustard).

Germination energy of the seeds watered with the soil extracts from the ploughed plots was significantly higher than this trait in the seeds watered with the extracts from the conservation tillage treatments with spring disking of the catch crops. Germination energy and capacity of spring wheat in the control treatment watered with distilled water were significantly higher compared to the other treatments under evaluation. Spring wheat watered with the aqueous extract prepared from the soil obtained from the plough tillage treatment produced a significantly longer first leaf compared to the treatments in which both conservation tillage methods had been used. The shortest leaf and the lowest number of radicles were produced by the seedlings watered with the soil extract from the treatment with the white clover stubble crop. Radicle length was not significantly differentiated by the soil extracts under consideration. The content of 0-dihydroxyphenols in the rendzina soil determined during the spring period was higher than that determined in the autumn. The content of 0-dihydroxyphenols in the soil was lower in the conservation tillage treatments with autumn incorporation of the catch crops than in the plots in which plough tillage and conservation tillage with spring disking of the catch crops had been used. The type of catch crop used did not have a significant effect on the soil content of these compounds. At the same time, it was found that the treatments in which the catch crops had been sown tended to have higher contents of these compounds compared to the plots without catch crops.

Key words: spring wheat, tillage systems, catch crops, allelopathy, monoculture, germination energy, germination capacity, 0- dihydroxyphenols

INTRODUCTION

The essential phenomena in which the role of allelopathy in the cultivation of plants is perceived are as follows: soil exhaustion, which is most frequently observed in monocultural cropping, mutual modification of plant growth among the plants in agrophytocenoses, crop self-regulation, and plant responses to the presence of the companion crop in mixed crops (Wójcik-Wojtkowiak, 1980, 1987; Ahmed and Wardle, 1994; Jaskulski, 1997). Soil exhaustion caused by the presence of allelopathic compounds may lead to disturbances in bio-chemical and physiological processes in plants. This results in the inhibition of developmental processes, in particular the growth process, which leads, as a consequence, to reduced plant productivity (Smyk, 1969/1970; Wójcik-Wojtkowiak, 1997). The cultivation of different types of cover crops and the use of their biomass for soil surface mulching are elements preventing soil sickness (Duer, 1997a; Parylak, 1996, 1997).

Cast et al. (1990) found that there were much fewer inhibitory compounds in the ploughed soil compared to direct sowing. This is associated with the specificity of such a cropping system that does not promote the dispersion of these compounds. Jaskulski et al. (1997) are of opinion that under direct sowing or minimum tillage conditions, but also under conditions that do not permit ploughed-in plants to be covered completely, a part of seeds planted during sowing in the immediate vicinity of the decomposing tissues of post-harvest crops or mulch plants can be exposed to the effect of allelopathic compounds.

Monocultural cropping reduces the diversity of microbes in the environment and leads to the accumulation of phenolic compounds in the soil and an increased content of phytotoxins causing self-toxicity and reduced yields (Wójcik-Wojtkowiak, 1987; Politycka 2005). Hruszka (1987a) proved that the concentration of phenols in the soil tilled layer in long-term monoculture stands is higher than in the soil cultivated under a crop rotation system. Among allelopathic compounds, the highest phytotoxic activity is attributed to phenols (Wójcik-Wojtkowiak, 1987; Inderjit, 1996). The soil content of toxic compounds exhibiting allelopathic properties is dependent to a large extent on weather conditions, plant developmental stage, soil type, and plant species mixed with the soil (Kimber, 1973; Jessop and Stewart, 1983; Oleszek and Jurzysta, 1987; Kobayashi, 2004; Stupnicka-Rodzynkiewicz et al. 2004a; Lipińska and Harkot, 2007).

The knowledge of allelopathic phenomena may be of essential practical importance from the point of view of interactions between crop plants and weeds as well as the weed control effect of crop plants (Stupnicka-Rodzynkiewicz, 1970; Ohno et al. 2000; Hochol et al. 2004; Stupnicka-Rodzynkiewicz et al. 2004ab). It also creates the possibility of using allelopathic compounds produced by plants to reduce the number of pests (Putnam and Duke, 1978).

The aim of the present study was to determine the effect of aqueous soil extracts from the soil of a spring wheat monoculture on seed germination energy and capacity, first leaf and radicle length as well as the number of radicles. The soil was cultivated using plough tillage and two conservation tillage methods in the presence of various catch crops. The aim of the study was also to evaluate the effect of the abovementioned tillage systems on the content of 0-dihydroxyphenols in the soil.

MATERIALS AND METHODS

Field experimental conditions

The study was conducted in the period 2006-2008, using an experiment set up in 2005 in the Bezek Experimental Farm (N: 51° 19', E: 23° 25') belonging to the Lublin University of Life Sciences. The experimental field was located on medium heavy mixed rendzina soil developed from chalk rock with the granulometric composition of medium silty loam. This soil had an alkaline pH (7.35), a high content of P and K as well as a very low content of magnesium; the organic carbon content was 2.47%.

The design of this static two-factor experiment, established using the split-plot method in four replications, included plough tillage (A) and conservation tillage (B and C) performed using two methods: with autumn (B) or spring (C) disking of the catch crops. There were also used four methods to regenerate the monoculture stand of spring wheat in the form of undersown crops (b – red clover; e – Westerwolds ryegrass) or stubble crops (c – lacy phacelia; d – white mustard). Plots without intercrops and stubble crops were the control treatment (a) in the present field experiment. The harvest plot area was 30 m^2. Winter wheat grown in this field for 3 years was the forecrop for spring wheat. In 2005 spring wheat and all the catch crops, both the intercrops and stubble crops, were sown and the tillage systems were used in accordance with the methodological assumptions, treating this year as the preliminary year.

Plough tillage, preparing the field for spring wheat, started with skimming and harrowing after the harvest of the forecrop. Ploughing was done to an average depth before winter. In the spring harrowing was performed, and before sowing cultivating and harrowing were done. Phosphorus fertilizers were applied in the spring at the rate of 30.5 kg×ha^{-1} P in the form of triple superphosphate, potassium fertilizers at the rate of 74.7 kg×ha^{-1} K in the form of 60% potassium salt, and 60 kg×ha^{-1} N in the form of ammonium nitrate. A second dose of nitrogen at the rate of 40 kg×ha^{-1} was introduced at the beginning of shooting (BBCH growth stages 30-33). Spring wheat, cv. Zebra (technological group – E), was sown at the rate of 5 million seeds per ha at a row spacing of 10 cm. Seeds were dressed with the seed dressing Panoctine 350 SL (350 g×l^{-1} guazatine in the form of acetate). Red clover (b), cv. Dajana – 20 kg×ha^{-1}, and Westerwolds ryegrass (e), cv. Mowester – 20 kg×ha^{-1}, were sown on the date of spring wheat sowing. Lacy phacelia (c), cv. Stala – 20 kg·ha^{-1}, and white mustard (d), cv. Borowska 20 kgxha^{-1}, were sown following the harvest of spring wheat and after performing post-harvest treatments in the second decade of August.

In the conservation tillage treatments (B and C), after the forecrop was harvested in the plots without red clover and Westerwolds ryegrass intercrops, grubbing to a depth of 18-20 cm and harrowing were done. Subsequently, lacy phacelia and white mustard were sown, in the same way as in the plough tillage treatment option. In one treatment, the cover crops were disked before winter (B), whereas in the other treatment they were left as mulch for winter and disking was done in the spring (C). In the treatments with autumn disking of the catch crops (B), spring tillage was the same as in the plough tillage treatment. In the plots with the other conservation tillage treatment (C), the field was harrowed after disking had been done; however, harrowing was repeated before sowing spring wheat.

The wheat crop protection programme included the following: Chwastox Extra 300 SL 3.5 $l \times ha^{-1}$ (300 $g \times l^{-1}$ MCPA) – (23-29 BBCH) and Alert 375 SC 1 $l \times ha^{-1}$ (125 $g \cdot l^{-1}$ flusilazole and 250 $g \times l^{-1}$ carbendazim) – (26-29 BBCH).

Laboratory experimental conditions

Aqueous extracts prepared from the soil collected from the spring wheat stand were used in the assays. The aqueous extracts were prepared from 30 g of soil per 100 ml of distilled water. The soil was collected using a soil sampling auger from the 0-20 cm layer in three randomly selected points of each plot in the spring before field work was started. The soil sampled in four replications was combined into a collective sample that was subsequently sieved through a 1 mm mesh sieve. The extracts were shaken in a laboratory shaker for 6 hours and then filtered through filter paper.

The experiment was carried out on 10 cm Petri dishes. 25 pieces of cereal seeds were sown into each of the dishes on the substrate composed of two layers of Whatman 1 filter paper. The filter paper was soaked with 20 ml of the respective extract, and then 10 ml of the extract was poured into each dish every day. Seeds watered with distilled water were the control treatment relative to the soil extracts. The experiment was carried out in two independent series with 5 replicates in each. The seeds germinated at a constant temperature of 21^{o}C obtained in a thermostatic cabinet with a photoperiod. The germination period was in conformance with the respective Polish Standard (PN-R-65950:1994) used for evaluation of seed germination capacity; this period was 8 days. Germination energy was evaluated after 4 days. The length of the first leaf and of the longest radicle and the number of radicles in the cereal seedlings were also determined in the cereal seedlings after 8 days.

In 2008 soil samples were collected during the spring period, before sowing spring wheat, and in late autumn in order to determine the content of 0-dihydroxyphenols (Figs 1-3). Total 0-dihydroxyphenols were determined, expressed in caffeic acid equivalents in accordance with the methodology given by Singleton and Rossi (1965). The assays were performed at the Central Testing Laboratory of the University of Life Sciences in Lublin.

The obtained results were statistically processed using the analysis of variance. The differences between the means were assessed using Tukey's test. The study results on germination energy and capacity were transformed with the function $\arcsin\sqrt{x}$.

RESULTS AND DISCUSSION

The spring wheat seeds watered with the soil extracts from the ploughed treatments had significantly higher germination energy than those from the plots in which conservation tillage had been used with spring disking of the catch crops (Table 1). Cast et al. (1990) draw attention to a lower content of inhibitory compounds in the ploughed soil compared to direct sowing. The present study found a significantly lower content of 0-dihydroxyphenols in the soil in the conservation tillage treatments with autumn disking of the catch crops compared to the ploughed plots (by 25.0%) and in the conservation tillage treatments with spring incorporation of the catch crops (by 31.5%). At the same time, a tendency towards a lower content of phenolics in the soil (by 8.7%) was found in the ploughed plots compared to the conservation tillage treatments with spring disking of the catch crops (Fig. 2). The presence of these compounds in the soil extracts obtained from the conservation tillage treatments with spring disking of the catch crops could have resulted in lower germination energy of the seeds compared to the treatments in which the seeds were watered with the soil extract from the ploughed plots. The seeds watered with the soil extracts from the conservation tillage treatments with autumn disking of the catch crops had slightly better germination energy compared to those watered with the soil extracts from the plots in which the conservation tillage treatments with spring disking of the catch crops had been used (Table 1). Seed germination energy was significantly higher in the control treatment, in which the seeds were watered with distilled water, than in the treatments watered with the soil extracts. At the same time, germination energy in the treatment watered with the soil extract from the spring wheat plot with the Westerwolds ryegrass intercrop was lower from 1.5% to 2.2% compared to the other treatments with the cover crops. However, statistical verification did not confirm the significance of these differences. Germination energy of the seeds watered with the soil extract from the spring wheat plot with the Westerwolds ryegrass intercrop in the conservation tillage treatments with autumn disking of the catch crops was significantly lower relative to the control treatment. The same correlation was found in relation to the extracts prepared from the soil sampled from the stand after the lacy phacelia stubble crop and the stand with the red clover intercrop in the conservation tillage treatment with spring disking of the catch crops (Table 1).

The tillage systems did not significantly differentiate the germination capacity of spring wheat. It was only found that the conservation tillage treatment with autumn disking of the catch crops tended to have germination capacity higher by 0.7% to 1.4% compared to the plough tillage treatment and the conservation tillage treatment with spring incorporation of the catch crops (Table 2). Such a pattern of results is reflected to some extent in the soil phenolic content. The germination capacity was lowest in the conservation tillage treatment with spring disking of the catch crops in which the dihydroxyphenolic content was highest (Fig. 2, Table 2).

All the soil extracts from the spring wheat stand had a negative effect on the germination capacity of spring wheat compared to the control treatment watered with distilled water. Jaskulski et al. (1997) also found that the biomass of fodder pea, yellow lupin, white mustard, and fodder sunflower, incorporated into the soil, significantly reduced the germination and size of spring barley seedlings. It should be noted, at the same time, that seed germination capacity was lower in the treatment watered with the soil extract from the monoculture stand without catch crops compared to the cover-cropped treatments. However, statistical verification did not confirm the significance of differences (Table 2). Likewise, Jessop and Stewart (1983) observed the greatest reduction in germination of wheat seeds under the influence of this plant's own residues, whereas a higher rate of germination was found in the presence of field pea and rape residues.

The germination capacity of the seeds watered with the soil extract from the spring wheat plot tilled using plough tillage after the lacy phacelia stubble crop was significantly lower compared to the conservation tillage treatment with autumn dusking of the catch crops and compared to the control treatment (Table 2). Parylak (1997) obtained opposite results when germinating winter triticale. In her experiment, seeds watered with the soil extracts germinated faster and in greater numbers than those watered with distilled water. She only found a slight inhibitory effect after using an extract from continuous monoculture. Variations in the results of studies on the effects of soil extracts on the germination of cereal seeds may result from different chemical properties of the tested extracts and high variability in the content of allelopathic substances in the soil extracts under investigation, which is noted by Duer (1988, 1997b).

Spring wheat watered with the aqueous extract prepared from the plough tillage treatments produced a significantly longer first leaf compared to both conservation tillage treatment methods (Table 3). The first leaf in the treatments watered with the soil extract from the plot with spring wheat grown after the white mustard cover crop was found to be significantly shorter compared to the treatments watered with the soil extracts from the plots after Westerwolds ryegrass and from the monoculture without catch crops (Table 3). The results of the bioassays conducted by Duer (1997b) show that water-soluble allelopathic organic compounds, washed out of the soil, caused not only the inhibition, but also the stimulation of the growth of wheat seedlings.

Radicle length in the spring wheat seedlings was not significantly differentiated by the aqueous soil extracts under evaluation. However, a tendency was observed that the soil extract prepared from the ploughed plots stimulated radicle growth compared to the conservation tillage treatments. At the same time, radicle length was lowest in the treatments watered with the soil extracts from the plot on which spring wheat was grown with the red clover intercrop and from the plot after the white mustard stubble crop (Table 4). The study of Hruszka (1987b) shows that soil extracts obtained from monocultures, compared to crop rotations, reduced the germination capacity of spring barley and winter rye and inhibited radicle growth. In turn, Duer (1997b) found the greatest inhibition in the growth of wheat roots when the plants were watered alternately with a soil extract and distilled water. Nevertheless, many authors stress that the growth of the first leaf and radicles can be differentiated by physical and chemical properties of soil extracts. But the effects of soil extracts on germination, leaf and root length of the test plants are a result of the interaction of many factors, and not only of allelopathic compounds present in the tested extracts (Cast et al. 1990; Blum et al. 1992; Duer, 1997b).

The seeds watered with the soil extracts from the ploughed plot and the conservation tillage treatment with autumn disking of the catch crops were found to have a significantly higher number of radicles compared to the conservation tillage treatments with spring disking of the catch crops (Table 5). All the extracts, except for the solution from the treatments with Westerwolds ryegrass, exhibited inhibitory effect on the number of radicles compared to the treatments watered with distilled water. In the cover-cropped treatments, spring wheat watered with the soil extracts from the spring wheat plot with the Westerwolds ryegrass intercrop produced the highest number of radicles, whereas this number was significantly lower in the case of the soil extracts from the plots of wheat grown after the lacy phacelia and white mustard stubble crops (Table 5). The number of radicles produced in the treatments watered with the soil extract from the ploughed plot without catch crops was significantly higher than in the conservation tillage treatments with spring disking of the catch crops. At the same time, the number of radicles in the germinating seeds watered with the soil extract from the conservation tillage treatments with spring disking of the red clover cover crop was significantly higher compared to the plough tillage treatment and the conservation tillage treatment with autumn disking of the catch crops. The situation was opposite in the treatments watered with the solution from the stand of wheat grown after the lacy phacelia stubble crop (Table 5).

The content of 0-dihydroxyphenols in the soil was significantly higher in the spring than in the autumn (Fig. 1). The presence of cover crops did not change significantly the content of phenolics in the soil (Fig. 3). It was only found that the cover-cropped treatments tended to have a higher content of these compounds compared to the control treatment without catch crops. At the same time, the highest dihydroxyphenolic content was found in the treatments with lacy phacelia, followed by the red clover plots in which the content was lower by 7.5%, then in the treatments with Westerwolds ryegrass (lower by 9.8%), in the plot with white mustard (by 13.9%), and in the treatments without catch crops (by 22.1%). Hochol et al. (2004), Stupnicka-Rodzynkiewicz et al. (2004a) and Stokłosa et al. (2008) found increased soil phenolic contents after the incorporation of white mustard, buckwheat, spring barley, oats, and rye biomass into the soil.

Table 1
The effect of soil extract type on germination energy (%) of spring wheat
(means for the period 2006 – 2008)

Catch crops	Tillage systems *A	B	C	Mean
	Actual data			
Control – distilled water	94.2	94.2	94.2	94.2
Treatment without catch crop	92.3	92.9	88.7	91.3
Trifolium pratense L.	93.8	90.5	88.7	91.0
Phacelia tanacetifolia Benth.	93.4	93.5	86.9	91.3
Sinapis alba L.	92.8	89.6	92.7	91.7
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	90.8	87.4	90.4	89.6
Mean	92.9	91.3	90.3	–
	Transformed data			
Control – distilled water	1.43	1.43	1.43	1.43
Treatment without catch crop	1.38	1.40	1.35	1.38
Trifolium pratense L.	1.40	1.38	1.34	1.37
Phacelia tanacetifolia Benth.	1.40	1.40	1.32	1.38
Sinapis alba L.	1.40	1.36	1.38	1.38
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	1.38	1.32	1.37	1.35
Mean	1.40	1.38	1.37	–
NIR 0,05 LSD 0.05	Tillage systems 0.024 Catch crops 0.041 Tillage systems x catch crops 0.086			

*A – Plough tillage
B – Conservation tillage with autumn disking of catch crops
C – Conservation tillage with spring disking of catch crops

Table 2
The effect of soil extract type on germination capacity (%) of spring wheat
(means for the period 2006 – 2008)

Catch crops	Tillage systems			Mean
	*A	B	C	
	Actual data			
Control – distilled water	97.3	97.3	97.3	97.3
Treatment without catch crop	95.3	94.2	92.8	94.1
Trifolium pratense L.	96.3	96.2	95.5	96.0
Phacelia tanacetifolia Benth.	93.0	97.3	94.3	94.9
Sinapis alba L.	97.2	95.8	94.7	95.9
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	94.2	96.8	95.0	95.3
Średnio Mean	95.5	96.3	94.9	–
Transformed data				
Control – distilled water	1.49	1.49	1.49	1.49
Treatment without catch crop	1.44	1.42	1.41	1.42
Trifolium pratense L.	1.46	1.45	1.46	1.45
Phacelia tanacetifolia Benth.	1.40	1.49	1.42	1.44
Sinapis alba L.	1.48	1.44	1.43	1.45
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	1.42	1.48	1.43	1.44
Mean	1.45	1.46	1.44	–
NIR 0,05 LSD 0.05	Catch crops 0.038 Tillage systems x catch crops 0.081			

*A – Plough tillage
B – Conservation tillage with autumn disking of catch crops
C – Conservation tillage with spring disking of catch crops

Table 3
The effect of soil extract type on first leaf length (cm) in spring wheat
(means for the period 2006 – 2008)

Catch crops	Tillage systems			Mean
	*A	B	C	
Control – distilled water	13.2	13.2	13.2	13.2
Treatment without catch crop	14.4	13.4	12.8	13.5
Trifolium pratense L.	13.6	12.5	12.5	12.8
Phacelia tanacetifolia Benth.	13.9	12.3	12.2	12.8
Sinapis alba L.	13.0	12.4	11.8	12.4
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	13.9	13.6	13.4	13.7
Mean	13.6	12.9	12.7	–
NIR 0,05 LSD 0.05	Tillage systems 0.61 Catch crops 1.05			

*A – Plough tillage
B – Conservation tillage with autumn disking of catch crops
C – Conservation tillage with spring disking of catch crops

Table 4
The effect of soil extract type on radicle length (cm) in spring wheat
(means for the period 2006 – 2008)

Catch crops	Tillage systems			Mean
	*A	B	C	
Control – distilled water	12.0	12.0	12.0	12.0
Treatment without catch crop	12.2	11.9	11.0	11.7
Trifolium pratense L.	11.3	10.8	10.3	10.8
Phacelia tanacetifolia Benth.	11.9	10.7	11.1	11.2
Sinapis alba L.	11.5	10.3	10.9	10.9
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	11.7	11.3	11.4	11.5
Mean	11.8	11.2	11.1	–
NIR 0,05 LSD 0.05	nie stwierdzono istotnych różnic no significant difference was found			

*A – Płużna uprawa roli Plough tillage
B – Conservation tillage with autumn disking of catch crops
C – Conservation tillage with spring disking of catch crops

Table 5
The effect of soil extract type on the number of radicles in spring wheat
(means for the period 2006 – 2008)

Catch crops	Tillage systems			Mean
	*A	B	C	
Control – distilled water	4.9	4.9	4.9	4.9
Treatment without catch crop	4.9	4.7	4.6	4.7
Trifolium pratense L.	4.6	4.6	4.9	4.7
Phacelia tanacetifolia Benth.	4.7	4.7	4.3	4.6
Sinapis alba L.	4.5	4.5	4.5	4.5
Lolium multiflorum Lam. *var. westerwoldicum* Wittm.	4.7	4.9	4.7	4.8
Średnio Mean	4.7	4.7	4.6	–
NIR 0,05 LSD 0.05	Tillage systems 0.07 Catch crops 0.12 Tillage systems x catch crops 0.25			

*A – Plough tillage
B – Conservation tillage with autumn disking of catch crops
C – Conservation tillage with spring disking of catch crops

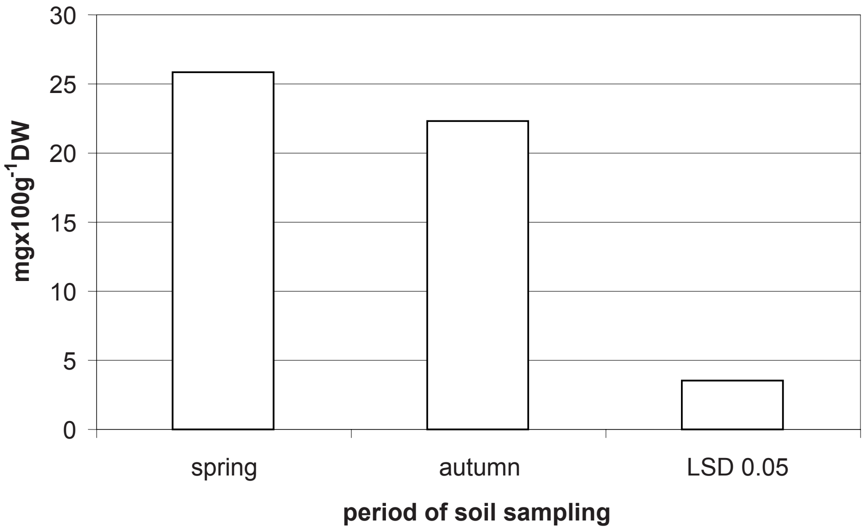

Fig. 1. The content of 0-dihydroxyphenols in soil (mgx100g^{-1} DW) depending on the period of soil sampling.

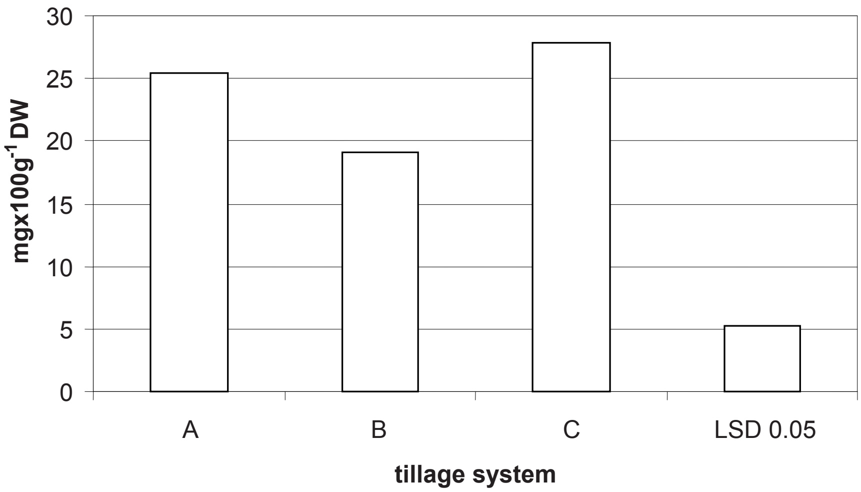

Fig. 2. The content of 0-dihydroxyphenols in soil (mgx100g^{-1} DW) depending on the tillage system: A – Plough tillage; B – Conservation tillage with autumn disking of catch crops; C – Conservation tillage with spring disking of catch crops.

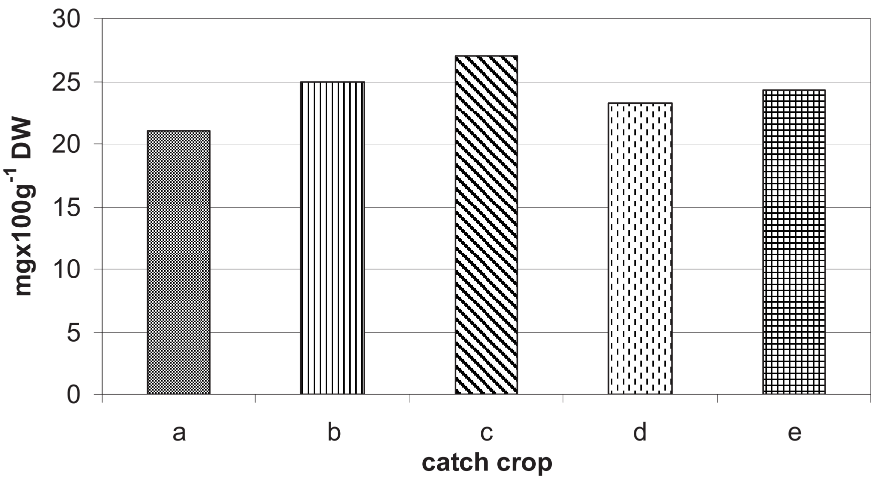

Fig. 3. The content of 0-dihydroxyphenols in soil (mgx100g^{-1} DW) depending on the catch crop: a. Control without catch crop; b. Trifolium pratense L. (undersown crop); c. Phacelia tanacetifolia Benth (stubble crop); d. Sinapis alba L. (stubble crop); e. Lolium multiflorum Lam. var. westerwoldicum Wittm. (undersown crop).

CONCLUSIONS

1. Germination energy of the spring wheat seeds watered with the soil extracts from the ploughed plots was significantly higher compared to the soil extracts from the conservation tillage treatments with spring disking of the catch crops.
2. The germination capacity of the seeds watered with the soil extracts was significantly lower compared to the germination capacity of the grains watered with distilled water.
3. First leaf length in spring wheat watered with the soil extracts from the plough tillage treatment was significantly higher compared to that in the seeds watered with the soil extract from the conservation tillage treatment. The seeds watered with the soil extracts from the treatments with white mustard produced a significantly shorter first leaf compared to the seedlings in the treatments with Westerwolds ryegrass and those watered with distilled water. But radicle length was not significantly differentiated by the soil extracts under evaluation.
4. The soil extracts from the conservation tillage treatments with spring disking of the catch crops showed inhibitory effect on the number of radicles in the germinating spring wheat seeds compared to the soil extracts from the plough tillage treatment and from the conservation tillage treatment with autumn incorporation of the catch crops. At the same time, the seeds in the treatments watered with distilled water produced a larger number of radicles than in the treatments watered with the soil extracts, except for the plots with Westerwolds ryegrass.
5. The content of 0-dihydroxyphenols in the soil was significantly higher in the spring than in the autumn. The application of conservation tillage with autumn disking of the catch crops reduced the soil content of 0-dihydroxyphenols compared to plough tillage and conservation tillage with spring incorporation of the cover crops. There was also found a tendency towards a higher concentration of 0-dihydroxyphenols in the soil in the treatments with catch crops compared to those without catch crops.

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Wpływ wyciągów glebowych spod monokultury pszenicy jarej (*Triticum aestivum L.*) z różnych systemów uprawy roli na kiełkowanie jej ziarniaków

Streszczenie

Doświadczenie przeprowadzono w latach 2006-2008. Celem badań było określenie wpływu wodnych wyciągów glebowych sporządzonych z gleby pobranej spod monokultury pszenicy jarej na energię i zdolność kiełkowania ziarniaków, długość pierwszego liścia i najdłuższego korzenia zarodkowego oraz liczbę korzeni zarodkowych. Jednocześnie w ostatnim roku badań porównano zawartość 0-dihydroksyfenoli w glebie. Gleba do sporządzenia roztworów pochodziła z doświadczenia polowego założonego na średnio ciężkiej rędzinie mieszanej. Pszenicę jarą odmiany Zebra uprawiano systemem płużnym oraz dwoma sposobami uprawy konserwującej w obecności wsiewek międzyplonowych (koniczyna czerwona, życica westerwoldzka) i międzyplonów ścierniskowych (facelia błękitna, gorczyca biała).

Energia kiełkowania ziarniaków podlewanych wyciągami glebowymi z obiektów uprawy płużnej była istotnie większa w porównaniu z ziarniakami podlewanymi wyciągiem z obiektów uprawy konserwującej z wiosennym talerzowaniem międzyplonów. Energia i zdolność kiełkowania pszenicy jarej w obiekcie kontrolnym podlewanym wodą destylowaną była istotnie większa w porównaniu z pozostałymi ocenianymi obiektami. Istotnie dłuższy pierwszy liść wytworzyła pszenica jara podlewana wodnym

wyciągiem sporządzonym z obiektów uprawy płużnej w porównaniu do obydwu sposobów uprawy konserwującej. Najkrótszy liść oraz najmniejszą liczbę korzeni zarodkowych wytworzyły siewki podlewane wyciągiem glebowym z obiektu z międzyplonem ścierniskowym gorczycy białej. Długość korzenia zarodkowego nie była istotnie różnicowana przez oceniane wyciągi glebowe. Zawartość 0-dihydroksyfenoli w glebie rędzinowej określona w terminie wiosennym była większa niż w terminie jesiennym. W obiektach uprawy konserwującej z jesienną inkorporacją międzyplonów zawartość 0-dihydroksyfenoli w glebie była mniejsza niż na poletkach uprawy płużnej i konserwującej z wiosennym talerzowaniem międzyplonów. Rodzaj zastosowanego międzyplonu nie miał istotnego wpływu na poziom zawartości tych związków w glebie. Jednocześnie stwierdzono tendencję większej ich zawartości w obiektach na których wysiewano międzyplony w porównaniu z poletkami bez międzyplonów.