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ROLE OF UNDERSOWN CATCH CROPS AND CROP ROTATION IN STATE OF HEALTH OF SPRING BARLEY

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Abstract. In the field experiment carried out in 2002-2004 the effect of undersown catch crops of Italian ryegrass and red clover and stands in crop rotations with 25, 50 and 75% of spring barley on its health was assessed. The composition of microorganisms colonizing the stem base in barley was also determined. It was indicated that catch crops did not have effect on differences in the degree of barley infestation by pathogens of net blotch, ear blight and fusarium foot rot. However, they caused increased incidence of powdery mildew and scald. Rust appeared only on barley grown without catch crops. An increased development of net blotch was observed on barley with catch crop, grown after spring wheat, and of scald – after potato. In pure stand the highest intensity of net blotch, powdery mildew, rust and leaf-strip disease was found in crop rotation with 75% of barley. This crop rotation was also favorable for development of the stem base diseases. No effect of the sowing method and stand in crop rotation on the number of microorganisms colonizing the stem base of spring barley was observed.

Key words: barley diseases, Italian ryegrass, net blotch, pathogens of the stem base, red clover, scald

INTRODUCTION

Catch crops constitute an indispensable element of crop rotations in organic agriculture and recommended in sustainable agriculture. Growing catch crops creates favorable conditions for reducing soil erosion, increasing the content of humus and biogenic components in soil and limiting their leaching (particularly nitrogen) into the profile and to ground waters, decreasing sterile evaporation of water, activation of soil microorganisms and processes occurring in soil; and has a positive effect on the state of canopy, manifesting itself in a lower weed infestation (numbers, biomass) and reduced invasiveness of pests and pathogens [Andrzejewska 1999, Wanic *et al*. 2004, Askegaard and Eriksen 2007, Jaskulska and Gałęzewski 2009]. It was also documented that catch

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crops can to some extent prevent negative consequences related to frequent return of cereals to the same field [Pešik and Kozak 1982, Andrzejewska 1999, Kuś and Jończyk 2000, Hiltbrunner *et al*. 2007].

In last 20 years a number of studies have been published documenting the above issues. Most of them refer to stubble catch crops; the literature on undersown catch crops is much more limited. Meanwhile undersown catch crops, through common growth with the field crop, and left on a field after its harvest and most often plowed in autumn for green manure, should to a greater extent shape soil and stand properties than stubble and winter catch crops.

That being so, a working hypothesis was formulated assuming that introducing undersown crops into the stand of barley may reduce development of diseases, particularly in crop rotations with a large proportion of this cereal. It was verified on the basis of an experiment aimed at estimating the effect of undersown catch crop of Italian ryegrass and red clover on the degree of spring barley infestation by pathogens in crop rotations with various percentage of this cereal.

MATERIAL AND METHODS

The basis for the study was a strict, static field experiment carried out from 1989 at the Production and Experimental Station in Bałcyny (53°35' N; 19°51' E) where the research complex of Olsztyn University is situated. The subject of this study was spring barley (cv. Rodion) grown in pure stand and with undersown catch crops of Italian ryegrass (cv. Gaza) and red clover (cv. Jubilatka), which was an element of crop rotations with 25, 50 and 75% proportion, with the following selection and sequence of plants:

I) barley grown in pure stand
crop rotations:
A: potato – spring barley – field pea – spring wheat (25% of barley – the control),
B: potato – spring barley – spring wheat – spring barley (50% of barley),
C: potato – spring barley – spring barley – spring barley (75% of barley)'

II) barley grown with undersown catch crops
crop rotations:
A: potato – spring barley with Italian ryegrass – field pea – spring wheat (25% of barley – the control),
B: potato – spring barley with red clover – spring wheat – spring barley with Italian ryegrass (50% of barley),
C: potato – spring barley with Italian ryegrass – spring barley with red clover – spring barley with Italian ryegrass (75% of barley).

Until 2000 the experiment was conducted as monofactorial (stand of barley in crop rotations were assessed), and from 2001 the second factor was introduced, which was undersown catch crops. It was carried out in the randomized split-plot design in 4 replications, with all the crop rotation plots at the same time. The experiment involved 96 plots (6 crop rotations x 4 crop rotation plots x 4 replications), with an area for harvest of 18 m^2.

The standard of spring barley sowing in both sowing method was 350 germinating grains per 1 m^2. In crop rotations with undersown crops together with cereal 24 $kg \cdot ha^{-1}$ of Italian ryegrass and 15 $kg \cdot ha^{-1}$ of red clover was sown. The biomass of undersown crops was plowed in autumn with fall plowing. Under potato (grown in the first plot of all the crop rotations) farmyard manure was used at a rate of 25 Mg·ha^{-1}, applied in autumn once in a four-year rotations. Rates of mineral fertilizers were not differentiated according to the sowing method of spring barley and stands, and they amounted to (kg·ha^{-1} of pure component): N – 60; P – 34.8 and K – 66.4. Tillage was standardized in all the plots and carried out with traditional methods. On treatments with spring barley chemical preparations against agrophages were not used.

The experiment was established in the typical gray-brown podsolic soil, formed from light loam. Its topsoil (0-20 cm) was characterized by slightly acid reaction (pH in 1 M KCl from 5.7 to 5.9), organic carbon content from 0.97 to 1.08%, moderate or high abundance in phosphorus (5.9-7.2 mg·100 g^{-1} soil) and magnesium (3.9-4.5) and high abundance in potassium (16.6-21.6 mg·100 g^{-1} soil) In respect of agricultural usefulness, the soil represents the quality class R IIIa, of the good wheat complex (2).

In the three years of the study (2002-2004) the growth of spring barley proceeded in varied rainfall and thermal conditions (Table 1).

Table 1. Rainfalls and air temperatures during spring barley growth
Tabela 1. Opady i temperatura powierza w okresie wegetacji jęczmienia jarego

10-day period Dekada	Rainfalls – Opady, mm				Temperature –Temperatura, °C			
	2002	2003	2004	mean średnia 1961-1995	2002	2003	2004	mean średnia 1961-1995
April – Kwiecień								
I	0.0	12.9	34.0		2.4	1.1	5.4	
II	5.6	6.6	3.5	x	9.8	6.6	8.3	x
III	4.4	4.1	14.0		9.8	10.1	6.7	
Sum or mean Suma lub średnia	10.0	23.6	51.5	35.4	7.3	5.9	6.8	7.0
May – Maj								
I	1.5	0.0	65.1		18.2	14.2	14.6	
II	17.0	36.9	15.0	x	13.7	7.0	13.3	x
III	71.6	41.7	7.0		16.4	15.6	9.8	
Sum or mean Suma lub średnia	90.1	78.6	87.1	57.6	16.1	12.3	12.5	12.5
June – Czerwiec								
I	10.2	0.6	21.4		15.3	18.4	15.9	
II	44.3	30.6	47.2	x	17.0	12.6	15.2	x
III	18.0	29.5	22.0		15.3	15.6	14.6	
Sum or mean Suma lub średnia	72.5	60.7	90.6	69.5	15.9	15.5	15.2	15.8
July – Lipiec								
I	1.5	66.5	19.3		18.8	16.5	15.9	
II	35.0	16.7	41.2	x	20.2	15.6	15.5	x
III	6.7	35.0	18.3		19.1	21.4	17.5	
Sum or mean Suma lub średnia	43.2	118.2	78.8	81.6	19.4	17.8	16.3	17.2

Their seasonal distribution did not exactly meet the needs of analyzed cereal. In the period April – July the total precipitation accounted in 2002 88.4% of the long-time standard for Bałcyny, and in 2003 and 2004 it exceeded the standard by 15.2 and 26.2% respectively. At the same time air temperatures in 2003 and 2004 stayed on the level of average values for long-time period, and in 2002 they were higher by 1.6°C. The most favorable conditions for barley cultivation occurred in 2004 (humid and moderately warm April, good moisture of the subsoil during its tillering (the first ten days of May), heavy rainfalls in June and moderately humid and warm July). In 2002 dry periods in April, the first three weeks of May and in the first ten days of July had a negative effect on the growth and development of barley. In the season 2003, in turn, low precipitation from 10th to 30th of April, dry June and rainy July did not create favorable conditions. Warm and humid June in 2002 and 2004 and heavy rainfalls in July 2003 (particularly in the first ten days) contributed to stronger plant infestation by fungal pathogens.

The assessment of spring barley state of health was made every year: after plant earing observations of pathological symptoms on leaves and ears were carried out, using the 5-degree scale of Hinfner and Papp [1964] and about two weeks before the harvest the occurrence of stem base diseases was estimated using the 5-degree scale of Ponchet modified by Mackiewicz and Dratch [1972]. The study involved 20 plants from each plot. The results were presented in the form of the infestation index. To determine the composition and structure of microorganisms colonizing the stem base, they were isolated on the glucose-potato growing medium, using the method by Raschid and Schlösser [1977].

The study presents the results in the form of averages from the 3 years of the study. They were statistically worked out with the variance analysis method, evaluating values of differences between treatments with Tukey's test at the significance level P = 0.05. Also the analysis of simple correlation between the degree of infestation by pathogens and grain yield was carried out. Calculations were made using the program Statistica.

RESULTS

In the present experiment in all the years of the study the occurrence of symptoms of net blotch of barley (*Helminthosporium teres*), rust of barley (*Puccinia hordei*), scald of cereals *(Rhynchosporium secalis*), ear blight and fusarium foot rot (*Fusarium* spp.), as well as eyespot (*Tapesia yallundae*), was observed on spring barley plants. Powdery mildew of cereals and grasses (*Blumeria graminis*) appeared on plants in the seasons 2002 and 2003, and leaf-strip disease (*Pyrenophora graminea*) and rhizoctonia disease (*Rhizoctonia* sp.) in 2004.

Observations of the health state of plants did not show a significant effect of spring barley sowing method on a degree of developing net blotch, ear blight and the stem base diseases on its plants (Table 2). Powdery mildew of cereals and grasses, scald of cereals, leaf-strip disease as well as rhizoctonia disease significantly stronger infested barley grown on the treatment with undersown crops. On average for crop rotation stands plant infection was, respectively, by 21,8%, 338%, 140,9% and 48,6% larger than that in pure stand. By contrast, the symptoms of rust of barley were found only in pure stand, whereas on the treatment with undersown crops the disease did not occur at all.

Table 2. Infestation index of spring barley plants, %
Tabela 2. Indeks porażenia roślin jęczmienia jarego, %

Disease, pathogen Choroba, patogen	Sowing system Sposób uprawy	Crop rotations with percentage of barley; forecrops – Płodozmiany z procentowym udziałem jęczmienia; przedplony							
		A – 25	B – 50		C – 75			mean średnia	$LSD_{0.05}$ $NIR_{0,05}$
		potato ziemniak	potato ziemniak	spring wheat pszenica jara	potato ziemniak	spring barley jęczmień jary	spring barley jęczmień jary		
Leaves – Liście									
Net blotch of barley Plamistość siatkowa jęczmienia *Helminthosporium teres*	pure – czysty with undersown crop – z wsiewką	12.53 21.10	16.18 17.48	20.13 26.68	31.45 19.23	26.90 19.80	25.33 17.28	22.09 20.26	I*** ni – ns II 4.30
Powdery mildew of cereals and grasses* Mączniak, prawdziwy zbóż i traw* *Blumeria graminis*	pure – czysty with undersown crop – z wsiewką	5.80 9.80	4.60 6.80	6.40 8.20	8.40 12.80	8.20 5.20	7.00 6.40	6.73 8.20	I 1.44 II 0.90
Rust of barley Rdza jęczmienia *Puccinia hordei*	pure – czysty with undersown crop – z wsiewką	1.33 –	2.47 –	0.93 –	0.80 –	2.00 –	1.07 –	1.43	– II 1.09
Scald of cererals Rynchosporioza zbóż *Rhynchosporium secalis*	pure – czysty with undersown crop – z wsiewką	0.63 4.75	1.38 2.75	– 3.75	1.63 2.25	– 0.25	– 2.00	0.61 2.63	I 1.73 II 1.13
Leaf-strip disease** Pasiastość liści** *Pyrenophora graminea*	pure – czysty with undersown crop – z wsiewką	2.00 9.50	2.25 4.50	2.00 9.50	3.25 9.00	4.50 5.75	4.75 7.00	3.13 7.54	I 3.34 II 1.75
Ears – Kłosy									
Ear blight Fuzarioza kłosów *Fusarium* spp.	pure – czysty with undersown crop – z wsiewką	2.50 3.75	1.50 2.50	2.30 2.25	3.90 5.25	5.75 4.15	3.90 6.35	3.31 4.04	I ni – ns II 1.89
Stem base – Podstawa źdźbła									
Fusarium spp.	pure – czysty with undersown crop – z wsiewką	20.12 15.89	23.88 21.94	29.75 30.06	27.19 29.00	31.19 28.38	31.06 33.00	27.20 26.38	I ni – ns II 5.10
Tapesia yallundae	pure – czysty with undersown crop – z wsiewką	4.42 3.77	6.56 7.81	10.19 4.13	8.88 12.13	11.56 8.06	8.56 10.69	8.36 7.77	I ni – ns II 3.99
Rhizoctonia sp.**	pure – czysty with undersown crop – z wsiewką	11.88 13.13	10.63 9.38	13.13 26.88	20.63 30.00	17.50 28.13	15.00 24.38	14.80 21.98	I 5.21 II 7.22

* 2002, 2003; ** 2004; *** I – sowing method – sposób siewu; II – interaction (sowing method x stands) – współdziałanie (sposób siewu x stanowiska)
ns – ni – non significant differences – różnice nieistotne

Intensity of barley infestation by the above mentioned pathogenic factors largely depended on its location in crop rotation. In pure stand significantly higher infestation of stems and leaves by the pathogen of net blotch was observed in the crop rotation with 50% of barley, in the stand after spring wheat and in all the plots of the four-field crop rotation with 75% of barley. In comparison with the control, the intensity of disease was, respectively, 1.6, 2.5, 2.1 and 2 times higher in comparison with the control treatment. On treatments with undersown crops, in turn, no significant effect of catch crops and barley density in crop rotation on the degree of infestation by this pathogen was found. Only a noticeable tendency to increasing incidence in the field after spring wheat was recorded. In pure stand, a barley percentage of 75% in crop rotation favored an increasing incidence of powdery mildew. A degree of infection of stems and leaves turned out to be significantly higher than that on the control: after potato by 44.8%, after a single succession of barley by 41.4% and two-time by 20.7%. Different situation was observed while growing barley with undersown crops. The disease developed much more heavily on barley in four-field crop rotation with 25% of barley and after potato in crop rotation with 75% of barley. Succession of barley in monoculture (one-time and two-time) significantly limited its occurrence (in comparison with the control treatment by 46.9 and 34.7%, respectively). Also plants grown on both plots of crop rotation B were characterized by a better health.

Symptoms of the occurrence of rust were observed only on plants of barley in pure stand. Significant escalation of the disease was observed only in the plot after potato in the crop rotation with a one-year break in barley growing (by 85.7%). Scald of cereals occurred only on plants of barley grown in pure stand after potato in all the crop rotations. Introducing undersown crops to cultivation resulted in a significant increase in plant infestation by this pathogen also after potato, but only in the crop rotation treated as the control. Tendency for its stronger development was also observed in cultivation after spring wheat. It was found that a single succession of the analyzed cereal in monoculture considerably decreased infestation; it was by more than 90% lower than in crop rotation A. For the pathogen *Pyrenophora graminea* – inducing leaf--strip disease (instead of its occurrence in one year only), in pure stand considerably more favorable conditions for development occurred in the least suitable stands for barley, that is with one and two-time sowing in the same plot (an increase in incidence by 125 and 137.5%). However, a significant decrease in incidence was observed in these stands on the treatment with undersown crops, as well as after potato (crop rotation B). In both sowing methods, on the plots of crop rotation C, barley ears turned out to be heavier infested by fusariosis, but only in the stands with a single succession of barley in pure stand and two-time with undersown crops, which was statistically documented.

Stem base diseases are dangerous pathologies of cereals. The sowing method did not significantly diversify the degree of stem infestation by *Fusarium* spp. and *Tapesia yallundae*. *Rhizictonia* sp., in turn, except for stands after potato in crop rotations A and B, significantly heavier infested barley grown together with undersown crops. Infestation index, on average for crop rotation stands, turned out to be almost 1,5 times higher than in pure stand.

Development of stem base diseases depended on previous crops and density of barley in the crop rotation. Both in pure stand and with undersown crops, one-year break in its growing in succession after spring wheat (crop rotation B) and after potato (C) and also a single – and two-time succession in monoculture resulted in an increase in stem infestation by fungi of the genus *Fusarium*. On average for the discussed stands, which were hardly different from one another, infestation turned out to be 1.6 times higher than that in the control crop rotation in pure stand and 1.9 times – with undersown crops. On the treatment with undersown crops, a significant increase in infestation occurred also in the plot after potato in crop rotation B. In the same stands, also more intensive infestation by *Tapesia yallundae* was observed (except for the plot after spring wheat on the treatment with undersown crops). The third fungus damaging the stem base which was recorded in the present study – *Rhizoctonia* sp. – significantly heavier infested barley grown in pure stand only in the plot after potato in crop rotation C, and with undersown crops after spring wheat (B) and in all the plots of four-field crop rotation C.

Stem base diseases were induced by 27 species of fungi and 2 asporogenous colonies (Table 3). Richer species composition occurred in pure stand of barley. No significant effect of the sowing method of barley and crop rotation stands on the general number of identified pathogens was observed. The presence of undersown crops, on average for crop rotation stands, limited the populations of: *Aureobasidium bolleyi*, *Drechslera bisepta*, *Drechslera sorokiniana* and *Fusarium eguiseti.* On plants of this treatment *Botrytis cinerea*, *Fusarium chlamydosporum, Mortierella izabelina*, *Mucor* sp. *oraz Periconia macrospinosa* did not occur at all. However, in comparision with pure stand, an increase in the number of *Aureobasidium pullulans*, *Fusarium nivale* oraz *Fusarium solani* was recorded here. In pure stand the occurrence of *Fusarium graminearum*, *Fusarium tricinctum*, *Mortierella alpina*, *Mortierella macrospinosa* and *Trichoderma hamatum* on the stem base was not recorded.

Spring barley infestation by *Helminthosporum teres* and its stem base by *Fusarium* spp. Showed a significant, negative relation with the grain yield of this cereal (*Helminthosporum teres*: $y = -0.13x + 6.37$, $r = -0.59$; *Fusarium* spp: $y = -0.07x + 7.54$, $r = -0.68$). Intensity of development of the other diseases was not significantly connected with the level of its yielding.

DISCUSSION

In the present study it was indicated that the degree of infestation of plants by pathogens of net blotch, septoria leaf and ear spot, ear blight, as well as *Fusarium* spp. and *Tapesia yallundae* – fungi developing on the stem base, did not depend on the sowing method of barley. By contrast, powdery mildew of cereals and grasses, scald of leaves, leaf-strip disease and rhizoctonia disease stronger infested barley grown together with undersown crops. Also the symptoms of rust of barley were recorded only on the treatment with undersown crops. Meanwhile, in the literature there are different opinions concerning the role of catch crops in affecting health of cereals. Jastrzębska [2009] indicated that the undersown catch crop of Persian clover did not have an effect on developing of the most of spring barley diseases. Only fungi of the genus *Fusarium*, attacking the stem base, found more favorable conditions for development on treatments with cereal growing in monoculture with an undersown crop. Also Deryło [1991], assessing the effect of stubble catch crop on the health of the analyzed cereal, recorded an increase in pathogenic symptoms caused by *Fusarium*, whereas he did not notice a relation between the sowing method and intensity of infestation by *Rhizoctonia secalis*, which is not proved by the results of the present study.

Table 3. Pathogens isolated from the stem base of spring barley
Tabela 3. Patogeny wyizolowane z podstawy źdźbła jęczmienia jarego

Major pathogens Ważniejsze patogeny	Crop rotations with percentage of barley; forecrops Płodozmiany z procentowym udziałem jęczmienia; przedplony						Mean średnia
	A – 25	B – 50		C – 75			
	potato ziemniak	spring wheat pszenica jara	spring barley jęczmień jary	potato ziemniak	spring barley jęczmień jary	spring barley jęczmień jary	
Pure stand – Siew czysty							
Aureobasidium bolleyi	6	7	7	7	10	9	7.7
Drehslera teres	2	7	3	1	2	5	3.3
Drehslera sorokiniana	3	1	–	5	7	–	2.7
Drehslera bisepta	3	–	–	2	4	6	2.5
Fusaruim equiseti	2	2	–	4	1	–	1.5
Fusarium solani	–	1	8	–	–	–	1.5
Aureobasidium pullulans	–	4	–	–	4	–	1.3
Mortierella izabelina	7	–	–	–	–	–	1.2
Fusarium avenaceum	1	1	1	–	–	2	0.8
Alternaria alternaria	–	–	2	2	–	–	0.7
Fusarium nivale	–	–	–	4	–	–	0.7
Rhizoctonia spp.	–	–	–	–	–	4	0.7
Others – Inne*	4	4	5	1	–	6	3.3
Total – Razem	28	27	26	26	28	32	27.9
Number of species Liczba gatunków	10	9	7	8	6	7	7.8
Growing with undersown crop – Uprawa z wsiewką							
Aureobasidium bolleyi	–	8	2	11	4	10	5.8
Drehslera teres	6	1	10	–	2	–	3.2
Aureobasidium pullulans	10	3	–	–	–	–	2.2
Drehslera sorokiniana	–	–	–	10	1	2	2.2
Fusarium oxysporum	–	2	2	-	7	–	1.8
Fusarium solani	–	3	–	3	4	1	1.8
Fusarium equiseti	2	2	–	–	–	3	1.2
Fusarium nivale	–	–	5	–	–	2	1.2
Fusarium culmorum	–	–	–	–	5	1	1.0
Fusarium tricinctum	2	–	3	–	–	–	0.8
Drehslera biseptata	–	–	–	–	1	3	0.7
Mortierella alpina	–	4	–	–	–	–	0.7
Truchoderma hamatum	–	–	4	–	–	–	0.7
Others – Inne*	6	3	–	4	4	7	4.0
Total – Razem	26	26	26	26	28	29	27.3
Number of species Liczba gatunków	7	8	5	4	9	10	7.2

$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:
total number of pathogens: sowing method – ogólnej liczebności patogenów: sposób siewu ns – ni
interaction – współdziałania: sowing method x stands – sposób siewu x stanowiska ns – ni

* pure stand – siew czysty: *Acremonium strictum*, *Botris cinerea*, *Fusarium cereals*, *Fusarium chlamydosporum*, *Fusarium culmorum*, *Fusarium oxysporum*, *Fusarium* spp., *Mortierella vinacea*, *Mucor* sp., *Periconia macrospinosa*, asporogenous colonies – kolonie nie zarodnikujące (2)

* growing with undersown crop – uprawa z wsiewką: *Alternaria alternaria*, *Fusarium avenaceum*, *Fusarium cereals*, *Fusarium graminearum*, *Fusarium* spp., *Mortierella macrospinosa*, *Rhizoctonia* spp., asporogenous colonies – kolonie nie zarodnikujące (2)

ns – ni – non significant differences – różnice nieistotne

Pawłowski and Woźniak [2000] in turn reported that introduction the undersown crop of Italian ryegrass into winter triticale grown in monoculture increased infestation of this cereal by rot pathogens, and the undersown crop of serradella reduced their activity. Andrzejewska [1999] in a review article quotes the opinion that in crop rotations with a high proportion of cereals grasses should not be grown as catch crops, since they constitute a link of the trophic chain of cereal plant pathogens. Different results were obtained by Klima [1983], who observed a reduction of take-all diseases of winter wheat by means of breaking the continuity of its cultivation in the same field by the stubble catch crop of winter rape.

Bailey *et al*. [2001], Lisova *et al*. [1996] and Prestes *et al*. [2002] claim that leaf and ear diseases occur more intensively after worse forecrops, which in the case of the most disease entities was confirmed by the present study. It indicated that a heavier infestation of stems and leaves by pathogens of net blotch, powdery mildew of cereals and grasses, rust of barley, leaf-strip disease and ear blight occurs as a result of growing barley in monoculture. Also the succession after spring wheat was favorable for more intensive infestation by pathogens of net blotch and after potato – by rust and scald. Panasiewicz *et al*. [2006] also proved that net blotch finds more favorable conditions for development in the crop rotation with 75% of barley, and Kurowski *et al*. [2007] reported that scald considerably more intensively infests barley sown in a good stand. However, in the earlier study, Kurowski *et al*. [1990] classified scald as crop rotation diseases of barley, with symptoms increasing in shortened crop rotations and in monocultures, which is confirmed by the study of Panasiewicz et al. [2006]. The role of crop rotation in intensity of the incidence of powdery mildew of cereals and grasses is disputable. Kurowski *et al*. [1990] claim that this pathogen more heavily infests cereals grown after good forecrops, which probably is connected with a better condition of plants. In another study, however, Kurowski *et al*. [2007] did not indicate the effect of stands on the degree of cereal infestation. Meanwhile in the presented study it was higher under conditions of barley growing in monoculture. Jastrzębska [2009] and Krupinsky *et al*. [2002], in turn, claim that pathogens spreading at considerable distances with wind (in our case *Puccinia hordei* and *Blumeria graminis*) do not show any connection with the succession of plants in crop rotation.

The study of Kurowski and Adamiak [2007] indicates that foot rot heavier damage barley grown in monoculture than in crop rotation, and eyespot of cereals and net blotch develop irrespective of the stand in crop rotation. The present study confirm this only in the case of foot rot. Also Kostrzewska [2009] in crop rotation with 75% of spring barley in the 3rd year of repeating its growing observed an increase in occurrence of symptoms of fusarium foot rot.

The species composition and structure of fungi identified on the stem base of barley hardly differed from those found by Mikołajska and Majchrzak [1995] and Wachowska [1998]. The most numerous pathogens were fungi of the genus *Fusarium*, which was also recorded in the studies of Deryło [1991] and Kurowski [2002]. Also: *Aureobasidium bolleyi, Aureobasidium pullulans* as well as *Drehslera teres* and *Drehslera sorokiniana*, were characterized by their considerable proportion, which was also confirmed in the own study by Kurowski [2002].

CONCLUSIONS

1. Undersown catch crops of Italian ryegrass and red clover did not have a significant effect of degree of spring barley infestation by pathogens of net blotch, ear blight, as well as fusarium foot rot and eyespot disease.
2. Powdery mildew of cereals and grasses, scald of cereals and leaf-strip disease developed heavier on plants of spring barley grown together with undersown crops, whereas rust of barley appeared only on plants of this cereal grown in pure stand.
3. Higher intensity of the incidence of powdery mildew of cereals and grasses and scald of cereals was observed on plants of spring barley with undersown crops, grown after potato, in relation to the symptoms on plants from the other stands.
4. Increasing infestation of plants by fungi of net blotch, powdery mildew of cereals and grasses, rust of barley and leaf-strip disease was observed in the crop rotation with 75% of barley grown in pure stand.
5. Pathogens of stem base developed more heavily on spring barley grown in the crop rotation with 75% of barley. In crop rotation with 50% of barley also the stand after spring wheat was favorable for an increase in infestation. Using undersown crops and diversification of the percentage of barley in crop rotation did not have an effect of the number of microorganisms colonizing the stem base.

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ROLA WSIEWEK MIĘDZYPLONOWYCH I PŁODOZMIANU W KSZTAŁTOWANIU STANU ZDROWOTNEGO JĘCZMIENIA JAREGO

Streszczenie. W doświadczeniu polowym realizowanym w latach 2002-2004 oceniano wpływ wsiewek międzyplonowych życicy wielokwiatowej i koniczyny czerwonej oraz stanowisk w płodozmianach z 25, 50 i 75% udziałem jęczmienia jarego na jego zdrowotność. Oznaczono również skład mikroorganizmów zasiedlających podstawę źdźbła jęczmienia. Wykazano, że wsiewki nie miały wpływu na zróżnicowanie stopnia porażenia jęczmienia przez patogeny plamistości siatkowej, fuzariozy kłosów oraz fuzaryjnej zgorzeli podstawy źdźbła. Powodowały jednak nasilone występowanie mączniaka prawdziwego oraz rynchosporiozy. Rdza pojawiła się tylko na jęczmieniu uprawianym bez wsiewek. Na jęczmieniu z wsiewkami, uprawianym po pszenicy jarej, obserwowano nasilony rozwój plamistości siatkowej, a po ziemniaku – rynchosporiozy. W uprawie czystej największe nasilenie plamistości siatkowej, mącznika prawdziwego, rdzy i pasiastości liści stwierdzono w płodozmianie z 75% udziałem jęczmienia. Płodozmian ten sprzyjał także rozwojowi chorób podstawy źdźbła. Nie stwierdzono wpływu sposobu siewu i stanowiska w płodozmianie na liczebność drobnoustrojów zasiedlających podstawę źdźbła jęczmienia jarego.

Słowa kluczowe: choroby jęczmienia, koniczyna czerwona, patogeny podstawy źdźbła, plamistość siatkowa, rynchosporioza, życica wielokwiatowa

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