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EFFECT OF NITROGEN FERTILIZATION AND FUNGICIDE PROTECTION ON WINTER TRITICALE WHOLESOMENESS

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Abstract. Until recently, triticale was considered to be a species of low disease susceptibility. Research results indicate, however, that it is more and more frequently infected by stem-base, leaf, and spike diseases, and the loses caused by disease occurrence may reach 1/3 of yield. The aim of the study was the determination of leaf and spike disease occurrence in winter triticale protected with fungicides, in the conditions of diversified nitrogen fertilization doses. Study material was winter triticale plants cultivar Gniewko, obtained from a three-year-long (2009-2011) filed experiment at the Production and Experimental Station in Bałcyny near Ostróda. First factor was nitrogen fertilization: 30, 60, 90, 120, and 150 kg·ha^{-1}. Second factor was the level of protection against fungal diseases: seed dressing, seed dressing and one on-leaf treatment, and seed dressing and two on-leaf treatments. Weather conditions in the study years significantly differentiated the intensity of disease symptoms. Nitrogen fertilization significantly affected winter triticale wholesomeness and caused a decrease in flag leaf infection by *Rhynchosporium secalis* only in the second research year. However, in the case of chaff septoriosis, an increase in infection was noted under the effect of increasing nitrogen doses. The applied fungicides effectively inhibited the development of flag and sub-flag leaves (leaf septoriosis, brown rust, powdery mildew) and spikes (chaff septoriosis and powdery mildew). Significant inhibition in fungal disease intensity was noted only after the application of two on-leaf treatments.

Key words: brown rust, chemical protection, fungal diseases, fungicides, leaf septoriosis, tan leaf spot

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INTRODUCTION

Triticale results from the efforts to obtain a species that combines good quality of wheat grain yield with abiotic and biotic stress tolerance and is suitable for cultivation in unfavourable conditions [Estrada-Campuzano *et al.* 2008, Villegas 2010, Estrada--Campuzano *et al.* 2012]. In fact, winter triticale demonstrates higher tolerance to poor soil conditions, has higher yield potential, and is characterized by high fodder value of grain [Smagacz and Dworakowski 2004, Stankiewicz 2005]. Proportion of cereals in the sowing structure is too high. This results in them having to be cultivated after one another. This kind of cultivation may lead to an increase in disease occurrence, in spite of the fact that triticale is characterized by high resistance to diseases [Parylak and Wojtala 2008, Małecka *et al.* 2010]. However, the results of research by many authors demonstrate that triticale is susceptible to root and stem-base infections [Parylak and Kita 2000, Adamiak *et al.* 2003, Filoda 2009, Janušauskaitė and Ciuberkis 2010, Parylak *et al.* 2010]. It also demonstrates susceptibility to leaf and chaff septoriosis, powdery mildew, brown rust, and spike fusarium wilt [Brzozowski *et al.* 2000, Zamorski and Nowicki 2000, Zamorski *et al.* 2001, Wakuliński *et al.* 2005, Weber and Hryńczuk 2005, Adamiak *et al.* 2008, Filoda 2009, Panasiewicz *et al.* 2012]. Estimated data indicates that yield loss caused by disease occurrence may reach 10%–30%. Effort is made to limit infections with different treatments, for example chemical protection with fungicide and agrotechnical treatments, as well as by choosing cultivars resistant to infections [Adamiak *et al.* 2008, Lemańczyk 2011].

The greatest effect on the formation of cereal yield, except soil and weather factors, is exerted by, decreasingly: fertilization, cultivar, crop rotation and plant protection, sowing, harvest, and soil cultivation [Giunta and Motzo 2004, Starczewski and Czarnocki 2004]. Nitrogen fertilization also affects plant wholesomeness. Not only the nitrogen dose, but also its application method limits or stimulates pathogen development [Brzozowski *et al.* 2000].

Resistance to disease is one of the basic factors that condition the upkeep of high grain productivity. Skilful use of genetic resistance makes it possible to significantly lower disease intensity [Czajowski *et al.* 2013]. Nevertheless, fungicides are significant in effective plant disease control and limit the losses in grain yield [Bertelsen *et al.* 2001].

Seed dressing is the first action towards the improvement of plant wholesomeness. It affects the initial plant development, which is subsequently responsible for plant shape, which makes it possible to affect the yield in further development [Dawson and Bateman 2000, Schoeny *et al.* 2001, Sawińska *et al.* 2006]. Dressing should be general preventive treatment in plant protection, as a necessary element of production technology.

Yearly overpowering of triticale by disease, in addition to heavy losses in grain yield, also causes a decrease in its quality. Therefore, research on the control of major pathogens at their diversified intensity and current analysis of the obtained economic effects becomes necessary [Kaniuczak 2011].

The aim of the study was the determination of leaf and spike disease occurrence of winter triticale protected with fungicides, in the conditions of diversified nitrogen fertilization doses. The study hypothesis assumed that the increase in the number of plant protection treatments would contribute to limiting plant infections.

MATERIAL AND METHODS

The basis of the work was made of the results gathered in a strict field experiment carried out at the Production and Experimental station in Bałcyny (53°35' N; 19°51' E). The experiment was set up as random sub-blocks (split-plot), in four repetitions. First factor was nitrogen fertilization (applied in the form of nitrate 17% and ammonium 17%) (kg·ha^{-1}): A 30, B 60, C 90 (60 + 30), D 120 (90 + 30), and E 150 (90 + 60). Nitrogen doses of 30 and 60 kg·ha^{-1} were applied in the early spring (after the onset of growth BBCH 27). Higher doses (90, 120, and 150 kg·ha^{-1}) were applied at two times: growth renewal (BBCH 27) and fourth internode stage (BBCH 38). Phosphorus and potassium fertilization was applied in total pre-sowing in the amounts of 30 kg P·ha^{-1} and 75 kg K·ha^{-1}. Second factor was the level of plant protection against fungal diseases: a – seed dressing (in the experiment set as the control group), b – seed dressing + one on-leaf treatment, c – seed dressing + two protective treatments. Sowing material was treated with Baytan Universal 094 FS (active substance triadimenol + imazalil + fuberidazole) at the dose of 400 ml per 100 kg grain. On-leaf treatment included spraying with Input 460 EC in the amount of 1 dm^3·ha^{-1} (spiroxamine + prothioconazole) at the first node stage (BBCH 31). Second fungicide application took place at the earing stage (BBCH 58), where Prosaro 250 EC was applied at the dose of 6 1 dm^3·ha^{-1} (tebuconazole + protioconazole). Weed control consisted of one spraying in the autumn with herbicide mixture (Boxer 800 EC 2 dm^3·ha^{-1}, active substance prosulfocarb, Glean 75 WG 5 g·ha^{-1}, active substance chlorsulfuron, and Legato 500 SC 0.5 dm^3·ha^{-1}, active substance diflufenican). Plot area for harvest reached 15 m^2. Triticale forecrop in the three-year-long study period was winter rapeseed.

At the milk-dough stage of triticale, per 25 randomly chosen plants from the plot, infection of flag and sub-flag leaves, as well as spikes, was evaluated macroscopically. Evaluation of the intensity of the diseases that developed on the plants was done according to a 9-degree scale, in which 9 stood for total resistance (no changes in all the organs), and 1 stood for plants totally susceptible (infection over 50% of the assimilation area) [Ralski and Muszyńska 1970] at the BBCH 65 stage (full flowering).

Results were processed with the analysis of variance using the Statistica®10 program, and the significance was verified with the Tukey's test at $p = 0.05$.

Research years were characterized by high changeability in the weather conditions, in particular in precipitation distribution during growth (Table 1). This directly affected the growth and development of winter triticale. In the analyzed study years, in the initial period of autumn growth, precipitation shortages occurred at higher temperatures from the ones noted in the many-years' period. In the growth seasons of 2009 and 2010, April was very dry but warm, whereas May was very humid. Higher than average temperatures occurred in July, which is desirable because grain and straw dries properly. Triticale harvest in 2011 was particularly strenuous. In July of that year, higher precipitation was noted, by 211%, in relation to the many-years' period.

Table 1. Meteorological data by the Weather Station in Bałcyny
Tabela 1. Dane pogodowe ze Stacji Meteorologicznej w Bałcynach

Growth period Okres wegetacji	Month – Miesiąc										
	September wrzesień	October październik	November listopad	December grudzień	January styczeń	February luty	March marzec	April kwiecień	May maj	June czerwiec	July lipiec
Mean air temperature – Średnia temperatura, °C											
2008/2009	11.9	8.6	4.0	-0.2	-3.7	-1.5	1.9	9.7	12.2	14.7	18.9
2009/2010	14.7	5.9	5.0	-1.7	-8.9	-2.9	2.1	7.9	12.0	15.7	20.8
2010/2011	12.2	5.4	4.4	-6.9	-1.6	-6.1	2.0	9.7	13.6	17.5	18.0
Mean – Średnia	12.9	6.6	4.5	-2.9	-4.7	-3.5	2.0	9.1	12.6	16.0	19.2
Many-years' mean (1961-2000) Średnia wieloletnia	12.6	8.1	2.8	-1.3	-3.5	-2.6	1.2	6.6	12.4	15.7	16.5
Precipitation sum – Suma opadów, mm											
2008/2009	17.0	104.6	40.5	29.4	16.2	14.7	68.0	3.7	89.6	133.1	82.2
2009/2010	15.6	58.5	40.8	29.6	13.3	14.2	23.8	9.4	105.5	73.7	87.8
2010/2011	45.0	11.2	110.4	39.2	29.6	20.5	8.6	33.7	41.5	56.2	171.9
Mean – Średnia	25.9	58.1	50.3	32.7	19.7	16.5	33.5	15.6	78.9	87.7	114.0
Many-years' mean (1961-2000) Średnia wieloletnia	57.1	54.0	51.4	40.4	26.3	19.6	27.4	35.2	56.7	68.3	81.3

RESULTS AND DISCUSSION

Evaluation of fungus infection carried out at winter triticale milk ripeness demonstrated the annual occurrence on flag and sub-flag leaves of: leaf septoriosis (*Septoria tritici*), tan leaf spot (*Pyrenophora tritici repentis*), brown rust (*Puccinia recondita*), and cereal rhynchosporium secalis (*Rhynchosporium secalis*). On the spikes of winter triticale, chaff septoriosis (*Septoria nodorum*) and fusarium wilt (*Fusarium* spp.) occurred. On the other hand, powdery mildew of cereals and grass (*Blumeria graminis*) (both on leaves and spikes) occurred only in 2010. Wakuliński *et al.* [2005] and Weber and Hryńczuk [2005] also observed an increase in the intensity of leaf disease occurrence in that species. The most favourable weather conditions for fungal disease development occurred in 2010, in which the highest degree of pathogen occurrence on winter triticale plants was noted (Tables 2-4).

Results of the present research indicate a significant variability in the occurrence and intensity of leaf and spike diseases of winter triticale depending on the weather course in the study years. According to Szwejkowski and Kurowski [2003], intensity of the particular diseases depends first of all on the weather course. Also Pecio and Danyte [2008], while studying the wholesomeness of spring cereals, confirmed that weather conditions during growth significantly differentiate plant infection by leaf and spike pathogens. Nieróbca [2011] and Panasiewicz *et al.* [2012] also observed differences in the occurrence and intensity of disease on winter triticale plantations in the study years. The authors found that this results, first of all, from changeable weather conditions, but also from environmental and agrotechnical conditions.

Nitrogen fertilization did not differentiate significantly the infection of winter triticale plants in the analyzed study years. Similarly, Woźniak [2002] classified nitrogen fertilization as one of less important factors that cause plant infection. However, in the study by Kurowski *et al.* [2004], winter triticale plants were the least infected in all the study years on the plots with no nitrogen fertilization, and the plots fertilized with nitrogen in three doses, only in-soil, were infected the most. Also Kurowski *et al.* [2010] and Panasiewicz *et al.* [2012], on the basis of the results of the conducted research, found a significant effect of nitrogen on plant wholesomeness.

The applied anti-fungus plant protection had an unambiguously positive effect on the lowering of plant infection with fungus. Single on-leaf treatment did not affect significantly the limitation of disease occurrence. Significant limitation of leaf septoriosis, brown rust, and powdery mildew was observed on sub-flag and flag leaves and chaff septoriosis and powdery mildew on spikes after the application of second on-leaf treatment. The results of the present study confirm the reports by other authors on the highest effectiveness of double spraying with various chemicals at the BBCH 31 and BBCH 58-59 stages [Jaczewska-Kalicka 2005, Sawińska and Małecka 2007, Sawińska and Zawada 2009]. Authors of many scientific works name the following as classical elements of successful combat with winter cereal diseases: seed dressing, fungicide application at the early developmental stage in the spring, and lowland meadow spraying at the earing stage [Czajka *et al.* 2000, Kurowski and Adamiak 2001]. Lowering the occurrence of disease symptoms as a result of fungicide protection was also found by other authors [Wróbel and Jabłoński 2004, Kurowski *et al.* 2010, Panasiewicz *et al.* 2012].

Table 2. Intensity of winter triticale sub-flag leaf diseases
Tabela 2. Nasilenie występowania chorób liści podflagowych przenżyta ozimego

Treatment Zabieg	Study year – Rok badań																			
	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia
	leaf septoriosis septorioza liści				tan leaf spots brunatna plamistość liści				brown rust rdza brunatna				*Rhynchosporium secalis* rynchosporioza				powdery mildew mączniak prawdziwy			
N dose – dawka N, $kg \cdot ha^{-1}$																				
30	7.6	7.5	8.7	7.9	8.3	7.7	7.8	7.9	8.8	8.2	8.9	8.6	8.7	9.0	8.3	8.7	9.0	6.4	9.0	8.1
60	7.6	7.2	8.7	7.8	8.2	7.5	8.0	7.9	8.7	8.1	8.9	8.6	8.7	8.7	8.8	8.8	9.0	6.7	9.0	8.2
90 (60 + 30)	7.4	7.5	8.5	7.8	8.2	7.7	8.0	8.0	8.8	8.5	8.8	8.7	8.7	8.8	8.6	8.7	9.0	6.8	9.0	8.3
120 (90 + 30)	7.8	6.8	8.9	7.8	8.4	7.8	8.3	8.1	8.7	8.3	8.9	8.6	8.8	8.9	8.8	8.9	9.0	6.5	9.0	8.2
150 (90 + 60)	7.6	7.1	9.0	7.9	8.3	8.0	8.2	8.2	8.8	8.0	8.8	8.5	8.7	8.9	8.3	8.7	9.0	6.7	9.0	8.2
Mean – Średnia	7.6	7.2	8.8	–	8.3	7.7	8.1	–	8.8	8.2	8.9	–	8.7	8.9	8.6	–	9.0	6.6	9.0	–
Protection method – Metoda ochrony																				
1*	7.6	6.9	8.8	7.8	8.3	7.7	8.0	8.0	8.9	7.5	8.9	8.4	8.7	8.9	8.6	8.7	9.0	5.8	9.0	7.9
2*	7.5	7.1	8.7	7.7	8.1	7.6	8.0	7.9	8.7	8.2	8.9	8.6	8.7	8.8	8.6	8.7	9.0	6.9	9.0	8.3
3*	7.6	7.7	8.9	8.1	8.4	7.9	8.2	8.2	8.8	9.0	8.9	8.9	8.8	9.0	8.7	8.8	9.0	7.2	9.0	8.4
$HSD_{0.05}$ – $NIR_{0,05}$ for – dla:																				
years – lat (Y)				0.22				0.25				0.17				0.12				0.14
nitrogen – azotu (N)	ns – ni	ns – ni	ns – ni	n.s.	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni
protection methods metod ochrony (P)	ns – ni	0.50	ns – ni	0.18	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.44	ns – ni	0.17	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	1.97	ns – ni	0.14
interaction – interakcji:																				
Y × N	ns – ni	ns – ni	ns – ni	0.50	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni
Y × P	ns – ni	ns – ni	ns – ni	0.35	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.29	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.25
other interactions – pozostałe interakcje					ns – ni															

1* – only seed dressing – tylko zaprawa nasienna, 2* – seed dressing and one foliar spraying – zaprawa nasienna i jeden zabieg nalistny, 3* – seed dressing and two foliar sprayings – zaprawa nasienna i dwa zabiegi nalistne
ns – ni – non significant differences – różnice nieistotne

Table 3. Intensity of winter triticale flag leaf diseases
Tabela 3. Nasilenie występowania chorób liści flagowych przenżyta ozimego

Treatment Zabieg	Study year – Rok badań																			
	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia
	leaf septoriosis septorioza liści				tan leaf spots brunatna plamistość liści				brown rust rdza brunatna				*Rhynchosporium secalis* rynchosporioza				powdery mildew mączniak prawdziwy			
N dose – dawka N, $kg \cdot ha^{-1}$																				
30	7.6	8.1	8.7	8.1	8.3	7.7	7.8	7.9	8.3	7.7	7.8	7.9	8.3	7.7	7.8	7.9	9.0	8.0	9.0	8.7
60	7.6	7.9	8.7	8.1	8.2	7.9	8.0	8.0	8.2	7.9	8.0	8.0	8.2	7.9	8.0	8.0	9.0	7.7	9.0	8.6
90 (60 + 30)	7.4	8.4	8.5	8.1	8.2	7.9	8.0	8.0	8.2	7.9	8.0	8.0	8.2	7.9	8.0	8.0	9.0	8.0	9.0	8.7
120 (90 + 30)	7.8	7.9	8.9	8.2	8.4	8.0	8.3	8.2	8.4	8.0	8.3	8.2	8.4	8.0	8.3	8.2	9.0	7.7	9.0	8.6
150 (90 + 60)	7.6	7.9	9.0	8.2	8.3	7.9	8.2	8.1	8.3	7.9	8.2	8.1	8.3	7.9	8.2	8.1	9.0	7.5	9.0	8.5
Mean – Średnia	7.6	8.0	8.8	–	8.3	7.9	8.1	–	8.3	7.9	8.1	–	8.3	7.9	8.1	–	9.0	7.8	9.0	–
Protection method – Metoda ochrony																				
1*	7.6	7.8	8.8	8.0	8.3	7.8	8.0	8.0	8.9	7.3	8.9	8.4	8.7	8.8	8.6	8.7	9.0	7.4	9.0	8.5
2*	7.5	7.8	8.7	8.0	8.1	7.8	8.0	7.9	8.7	7.7	8.9	8.4	8.7	8.9	8.6	8.7	9.0	7.8	9.0	8.6
3*	7.6	8.5	8.9	8.3	8.4	8.1	8.2	8.2	8.8	8.8	8.9	8.8	8.8	8.9	8.7	8.8	9.0	8.2	9.0	8.7
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:																				
years – lat (Y)				0.22				0.23				0.14				0.16				0.13
nitrogen – azotu (N)	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.24	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni
protection methods metod ochrony (P)	ns – ni	0.50	ns – ni	0.20	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.34	ns – ni	0.15	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.41	ns – ni	0.14
interaction – interakcji:																				
Y × P	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.25	ns – ni	0.18	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.23
other interactions – pozostałe interakcje					ns – ni															

1* – only seed dressing – tylko zaprawa nasienna, 2* – seed dressing and one foliar spraying – zaprawa nasienna i jeden zabieg nalistny, 3* – seed dressing and two foliar sprayings – zaprawa nasienna i dwa zabiegi nalistne
ns – ni – non significant differences – różnice nieistotne

Table 4. Intensity of winter triticale spike diseases
Tabela 4. Nasilenie występowania chorób kłosa przenżyta ozimego

Treatment Zabieg	Study year – Rok badań											
	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia	2009	2010	2011	mean średnia
	spike septoriosis septorioza kłosa				fusarium wilt fusarium				powdery mildew mączniak prawdziwy			
N dose – dawka N, kg·ha^{-1}												
30	7.7	7.8	8.1	7.9	8.1	8.3	7.8	8.1	9.0	8.6	9.0	8.9
60	7.9	7.6	8.2	7.9	8.2	8.3	7.9	8.1	9.0	8.2	9.0	8.7
90 (60 + 30)	7.6	7.9	7.8	7.8	8.5	8.5	8.1	8.3	9.0	8.4	9.0	8.8
120 (90 + 30)	7.8	7.4	8.3	7.8	8.4	8.5	8.1	8.3	9.0	8.2	9.0	8.7
150 (90 + 60)	7.8	7.3	8.2	7.8	8.1	8.4	8.3	8.3	9.0	8.0	9.0	8.7
Mean – Średnia	7.8	7.6	8.1	–	8.2	8.4	8.0	–	9.0	8.3	9.0	–
Protection method – Metoda ochrony												
1*	7.9	7.2	8.0	7.7	8.3	8.2	8.0	8.2	9.0	7.9	9.0	8.6
2*	7.8	7.5	8.0	7.7	8.3	8.5	7.9	8.3	9.0	8.1	9.0	8.7
3*	7.7	8.2	8.4	8.1	8.2	8.6	8.2	8.3	9.0	8.8	9.0	8.9
$LSD_{0.05}$ – $NIR_{0,05}$ for – dla:												
years – lat (Y)				0.23				0.25				0.13
nitrogen – azotu (N)	ns – ni	0.40	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni
protection methods metod ochrony (P)	ns – ni	0.31	ns – ni	0.23	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.41	ns – ni	0.13
Y × P	ns – ni	ns – ni	ns – ni	0.40	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	ns – ni	0.23
other interactions – pozostałe interakcje					ns – ni							

1* – only seed dressing, 2* – seed dressing and one foliar spraying, 3* – seed dressing and two foliar sprayings
ns – ni – non significant differences – różnice nieistotne

According to Adamiak *et al.* [2003], the greatest damage in triticale lowland meadow is caused by the generator of chaff septoriosis (its symptoms also occur on leaves) and cereal and stem-base rhynchosporium secalis. Also Solomon *et al.* [2006] classify *Septoria tritici* as one of the more dangerous cereal pathogens, and Oettler and Shmid [2000] found only partial genetic resistance of triticale to the above pathogen. According to Wróbel and Jabłoński (2004), septoriosis occurs on triticale annually but with different intensity. Results of the present research confirm the above opinion. The pathogen occurred in all the study years. To the lowest extent, the leaves of winter triticale became infected in 2011. That year had lower precipitation than the many-years' average. Brown rust to the highest extent infected the leaves in the second study year. Double on-leaf fungicide treatment significantly limited the occurrence of this disease. Panasiewicz *et al.* [2010] demonstrated an increased intensity of brown rust under the effect of nitrogen fertilization. The results of the present study do not confirm the above research. In all the study years, also symptoms of *Rhynchosporium secalis* were observed on the leaves of winter triticale, with significantly higher degree of infection in the year 2011. The studied experimental factors did not differentiate significantly the degree of *Rhynchosporium secalis* occurrence. Powdery mildew is classified as one of the most important triticale leaf diseases in Poland [Czembor *et al.* 2013]. According to Wakuliński [2005], a breakdown in triticale resistance to this pathogen occurred. Study results by Cichy and Olejniczak [2010] confirm the above thesis, as they demonstrate an increasing threat on the part of this pathogen in recent years. Czembor *et al.* [2013] underscore that the triticale cultivars grown in Poland are susceptible or very susceptible to the population of powdery mildew. On the other hand, Wakuliński *et al.* [2007], Cichy and Olejniczak [2010], and Bobrecka-Jamro *et al.* [2010] noted in their research only a small percentage of triticale strain with a high level of powdery mildew infection. In the present research, the occurrence of powdery mildew was found only in 2010, both on leaves and spikes of winter triticale.

According to Kurowski [2002], fungicide protection preserves triticale from *Fusarium* spp. infection. However, in the present research, infection of winter triticale spikes with *Fusarium* ssp. was found. However, Champeil *et al.* [2004] pointed out an increased infection risk by *Fusarium* ssp. and the threat of mycotoxin production. Three-year-long study period was characterized by low intensity of the disease, although it was significantly diversified by the weather conditions. The lowest infection was noted in the second study year. Fungicide protection variants did not differentiate significantly the intensity of fusarium wilt occurrence. The lowest effectiveness was demonstrated by the application of only seed dressing and the lowest percent of infected spike area was noted after the application of two on-leaf fungicide treatments. Also research by Nieróbca [2011] concerning winter triticale wholesomeness depending on the intensity of production technology confirm lower protection effectiveness on the plots with a lower number of treatments and disease occurrence depending on the weather course.

CONCLUSIONS

1. Diversified weather conditions in the study years to a significant degree determined the occurrence and intensity of disease symptoms caused by fungal pathogens on winter triticale.
2. Significant diversification of flag leaf infections by *Rhynchosporium secalis* and of spikes by *Phaeosphaeria nodorum* under the effect of nitrogen fertilization was noted in the second study year.
3. Only in one of the study years, an increase in the intensity of plant protection to two on-leaf treatments caused a significant limitation in the intensity of fungal diseases both on sub-flag and flag leaves (*Phaeosphaeria nodorum*, *Puccinia recondita*, and *Blumeria graminis*), as well as the spikes (*Phaeosphaeria nodorum* and *Blumeria graminis*).

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WPŁYW NAWOŻENIA AZOTEM I OCHRONY FUNGICYDOWEJ NA ZDROWOTNOŚĆ PSZENŻYTA OZIMEGO

Streszczenie. Pszenżyto do niedawna było uważane za gatunek mało podatny na choroby. Wyniki badań wskazują jednak, że jest coraz częściej porażane przez choroby podstawy źdźbła, liści i kłosów, a straty spowodowane występowaniem chorób mogą sięgać 1/3 volumenu plonu. Celem badań było określenie występowania chorób liści i kłosów pszenżyta ozimego chronionego fungicydami, w warunkach zróżnicowanej dawki nawożenia azotem. Materiałem badawczym były rośliny pszenżyta ozimego odmiany Gniewko, pozyskane z trzyletniego (2009-2011) doświadczenia polowego zlokalizowanego w Zakładzie Produkcyjno-Doświadczalnym w Bałcynach k. Ostródy. Czynnikiem pierwszego rzędu było nawożenie azotem ($kg \cdot ha^{-1}$): 30, 60, 90, 120, 150. Czynnik drugiego rzędu stanowił poziom ochrony przed chorobami grzybowymi: zaprawa nasienna, zaprawa nasienna i jeden zabieg nalistny oraz zaprawa nasienna i dwa zabiegi nalistne. Warunki pogodowe w latach badań w istotny sposób różnicowały nasilenie objawów chorób. Nawożenie azotem tylko w drugim roku badań istotnie oddziaływało na zdrowotność roślin pszenżyta ozimego, powodując obniżenie porażenia liści flagowych przez rynchosporiozę liści. Natomiast w przypadku septoriozy plew odnotowano wzrost porażenia pod wpływem rosnących dawek azotu. Użyte fungicydy skutecznie hamowały rozwój patogenów liści flagowych i podflagowych (septorioza liści, rdza brunatna, mączniak prawdziwy) oraz kłosów (septorioza plew i mączniak prawdziwy). Istotne ograniczanie nasilenia chorób grzybowych odnotowano dopiero po zastosowaniu dwóch zabiegów nalistnych.

Słowa kluczowe: brunatna plamistość liści, chemiczna ochrona, choroby grzybowe, fungicydy, rdza brunatna, septorioza liści

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