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INFLUENCE OF LEAF DISEASES ON GRAIN YIELD AND YIELD COMPONENTS IN WINTER WHEAT

Antanas Ronis, Roma Semaškienė, Zenonas Dabkevičius, Žilvinas Liatukas*

Lithuanian Institute of Agriculture
Department of Plant Pathology and Protection
Instituto al. 1, Akademija, Kedainiai distr., LT-58344, Lithuania

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Abstract: Leaf diseases' influence the relationship between the yield and yield components of winter wheat (*Triticum aestivum* L.). Field experiments were conducted during 2003–2006 on a light loamy gleyic cambisoil in the central part of Lithuania to determine how leaf disease severity level affects grain yield and yield components. The area under disease progress curves (AUDPC), grain yield and yield components were analysed using the analysis of variance and correlations. Infected wheat straw was applied to initiate epidemics in all treatments. Three winter wheat cultivars: Hereward, Aron and Tauras differing in the level of resistance to leaf diseases were used in the experiments. In total, six treatments were established: (i) untreated control, (ii) powdery mildew control (pmc) + leaf diseases severity level 0%, (iii) pmc + leaf diseases severity level 1.0–5.0%, (iv) pmc + leaf diseases severity level 5.1–10.0%, (v) pmc + leaf diseases severity level 10.1–25.0%, (vi) pmc + leaf diseases severity level > 25.1%. Wheat in all treatments, except for the untreated control, was protected by morpholine and triazole fungicides. Yield and yield components were affected by leaf diseases in all the treated cultivars during all experimental years. Significant ($p \leq 0.01$) medium and strong correlation coefficients were found between AUDPC and yield in all the treated cultivars under high pressure of leaf diseases in 2004.

Key words: fungicide treatment, disease severity levels, tan spot, Septoria leaf blotch, AUDPC

INTRODUCTION

Until 2000, the dominant production system for winter wheat in Lithuania involved conventional tillage and crop rotation. Since then farmers have been gradually shifting from conventional tillage system to minimum tillage. However, there is no official statistics about the acreage of wheat sown under minimal tillage. Increased demand for wheat grain resulted in a shorter crop rotation with other crops or wheat monoculture for two years (Seibutis 2005). Half of the total wheat acreage (approx. 300 000 ha) is sown after cereals – barley, rye, triticale, and wheat. Winter wheat crop sowing after triticale, which results in the occurrence of wheat leaf spot diseases, particularly tan spot, is becoming a substantial problem (Gaurilčikienė 2001).

Leaf diseases as by Septoria leaf and glume blotch (casual agents *Mycosphaerella graminicola*, anamorph *Septoria tritici* and *Phaeosphaeria nodorum*, anamorph *Stagonospora nodorum* and tan spot (casual agent *Pyrenophora tritici-repentis*, anamorph *Drechslera tritici-repentis*) have become a serious problem because it is difficult to control and its influence on wheat is significant under min-tillage system (Bhathal *et al.* 2003).

Septoria leaf and glume blotch in wheat is a serious problem in humid regions and especially when it is followed by cereals (Hardwick *et al.* 2001). Geographical latitude, sufficient amount of rain, frequency of cereals in crop rotation, fertilization with nitrogen, min-tillage and susceptible cultivars favour severe leaf blotch epidemic (Leath *et al.* 1993). Currently, yield losses attributed to Septoria leaf blotch disease have been reduced due to the presence of the new genotypes less susceptible to the disease (Ruzgas and Liatukas 2006; Singh *et al.* 2006).

Tan spot is another important leaf spot disease. Severely developed disease desiccates wheat leaves and reduces grain yield (Hosford *et al.* 1987). Tan spot is a major problem throughout the world where winter and spring wheats are grown (Bhathal *et al.* 2003; Priekule and Bankina 2004). In Denmark, grain losses attributed to this disease varied between 0.8–4.4 t/ha. The yield loss mainly depends on the level of primary inoculum source, disease severity and on control method selected (Jørgensen and Olsen 2007). Tan spot pathogen survives on infested stubble and under moist conditions produces pseudothecia. Ascospores produced in pseudothecia initiate the disease on wheat leaves after rain or abundant dew. The fungus produces windborne asexual conidia on dead leaf tissue, which spread to new crop foliage. Conidia can disperse the pathogen to neighbouring wheat fields (Wolf *et al.* 1998).

Tan spot in comparison with Septoria leaf blotch is a relatively new disease in Europe. Therefore, new cultivars with partial resistance to tan spot have been intro-

*Corresponding address:
antanasr@lzi.lt

duced in the market only recently (Ruzgas and Liatukas 2006; Singh *et al.* 2006).

The objectives of this study were to determine the role of straw as additional inoculum source, which affects winter wheat cultivars' susceptibility to leaf spot diseases, yield and yield components in central Lithuania.

MATERIALS AND METHODS

Field experiments were conducted during the growing seasons 2003–2006 at the Lithuanian Institute of Agriculture. The soil of the experimental site was light loamy gleyic cambisoil, containing 2.3–2.4% of humus, available phosphorus (P_2O_5) ranging from 122 to 180 mg/kg, available potassium (K_2O) from 130 to 144 mg/kg and pH between 7.0 and 7.2. The preceding crop was winter rape in all the years except for 2004 when winter wheat was sown after peas. The trials were established using three winter wheat *cvs*. Aron, Tauras, and Hereward.

Field plots were sown at a rate of 4.5 million viable seeds per ha on the depth of about 4 cm, with row spacing of 12.5 cm. The crops were planted in the first half of September in all experimental years. Fertilizer rates in pure elements (NPK) were: 0–90–140, 0–60–120, 20–80–140, 0–90–160 in 2002, 2003, 2004 and 2005, respectively. In April of each year, 90 kg/ha of nitrogen as ammonium nitrate was applied to promote wheat vegetation. At the beginning of May during 2003–2006 winter wheat crop was additionally fertilized with nitrogen (50 kg/ha). Two-three weeks later in 2003–2005, the crop was again supplied with nitrogen at the dose of 30 kg/ha.

Growth regulators, herbicides and insecticides were used to prevent wheat lodging, weed and insect damage.

A range of disease severity level was generated by covering post-emergence wheat plots with straw infected by a pathogens complex of leaf spot diseases (appox. 400 g/m^2) and by fungicide treatments. The plots (3 m^2) were arranged using a randomized complete-block design with six replications. To have a better access to the plots for assessing diseases and fungicide application, plots were spaced 0.4 m apart.

The experimental design included below:

1. Untreated control;
2. Powdery mildew control (PmC)[1] + leaf spot diseases' severity 0%;
3. PmC + leaf spot diseases' severity 1–5%;
4. PmC + leaf spot diseases' severity 5.1–10 %;
5. PmC + leaf spot diseases' severity 10.1–25%;
6. PmC + leaf spot diseases' severity > 25.1%;

[1] for the control of powdery mildew a morpholine fungicide was used (trade name Corbel, a.s. fenpropimorph 750 g/l, at the dose 0.75 l/ha);

[2] for the control of leaf spot diseases triazole fungicide was used (trade name Tilt, a.s. propiconazole 250 g/l, at the dose 0.5 l/ ha);

All chemicals were applied at a spray volume of 400 l aqueous suspension per ha using a precision hand-held sprayer Hardi with a constant boom pressure of 2.5 bars. Experimental plots were routinely monitored for powdery mildew, and fungicide was used as needed. Fungicide treatments with triazole were started immediately after visual detection of the first symptoms of leaf spot diseases. Fungicides were applied routinely every two weeks until the end of the growing season. A similar strategy was used in the third to sixth treatments where fungicide was applied shortly after target disease severity had been reached and routinely sprayed once a fortnight. Fungicides do not give complete control of fungi, as a result, they continue to grow slowly and do harm to leaves. That was the main reason why we chose intervals in the third – sixth treatments. At each evaluation date growth stage was recorded using a BBCH scale (Lancashire *et al.* 1991). Three fully expanded top leaves were scored for per cent of leaf area covered by chlorosis and necrosis. The diseased area was visually assessed on 10 randomly selected main tillers per plot. The area under disease progress curves (AUDPC) was calculated using the per cent estimates ratings in each cultivar (Campbell and Madden 1990).

At ripening stage tillers per square meter were counted. Later, samples of 25 ears per plot were randomly collected. Each sample was threshed using ear thresher and the grains were counted by grain counter CONDATOR (Pfeuffer, Germany) and weighed. The results were divided by 25 to get grain number per ear and grain weight per ear.

Each plot was harvested with a small plot harvester Hege 125C. Grain yield was weighed and grain moisture recorded using grain moisture-meter (Dickey-John Corporation, USA) and adjusted to 14%. Thousand grain weight (TGW) was determined.

Analysis of variance (ANOVA) was used to determine differences between treatments. The data were acceptable within normal limits with homogeneous treatment variances. Means for the yield were separated using Fisher's test and least significant differences (LSD) at the 1 and 5% level of probability were determined.

Correlation analysis was used to examine the relationship between tested factors. Analysis was conducted for all treatments within each year. Significance was estimated for the 0.01 and 0.05 probability levels.

RESULTS

Results from our experiments suggest that severity of leaf spot diseases depends mainly on weather conditions and resistance level of studied varieties. The influence of meteorological conditions on leaf spot disease development was earlier described (Ronis and Semaškienė 2006). Wheat cv. Hereward was more susceptible to leaf spot diseases than cvs. Aron and Tauras. The AUDPC values clearly indicated that under favourable weather conditions disease severity on leaves was above 25% in 2003 and 2004 (Table 1). Lower crop yield was obtained under unfavourable weather conditions for winter wheat. The weather conditions during the 2004 growing season were conducive to the early occurrence and fast spread of leaf spot diseases in winter wheat, whereas during the 2006 growing season high temperatures and especially lack of rainfall resulted in low grain yield. The amount of rainfall in June and July of 2006 accounted for 11.1 and 55.3% of

Table 1. AUDPC values and influence of powdery mildew and leaf spot diseases on yield and thousand grain weight (TGW) in three winter wheat cultivars during 2003–2006

Treatment	Year	Cultivar								
		Aron			Tauras			Hereward		
		AUDPC	Yield	TGW	AUDPC	Yield	TGW	AUDPC	Yield	TGW
Untreated control	2003	460	7.56	43.5	636	8.13	41.7	766	5.10	42.8
	2004	577	4.40	38.2	564	5.18	41.0	1129	3.53	36.8
	2005	338	8.49	46.4	151	8.5	45.3	265	8.19	43.1
	2006	134	4.14	40.1	90	4.81	44.9	106	5.34	39.4
Pmc[1] + leaf spot diseases' severity level 0%	2003	163**	8.10	44.5	267**	9.25**	45.4**	390**	5.41	46.0*
	2004	374**	5.05	40.8*	276**	7.42**	44.8**	481**	5.26**	40.6**
	2005	27**	8.76	48.1*	64**	8.89	46.2	101**	8.77	45.0*
	2006	59**	5.06*	41.2	33**	5.52	44.9	58**	5.83	40.1
Pmc + leaf spot diseases' severity level 1.0–5.0%	2003	339**	7.66	45.3	487**	8.32	46.2**	518**	5.98	43.3
	2004	380**	4.87	40.8**	329**	5.89	44.4**	457**	5.32**	40.8**
	2005	137**	8.27	47.2	117**	8.77	45.0	137**	8.99	44.4
	2006	74**	4.19	40.0	48**	5.21	45.0	75**	5.61	39.7
Pmc + leaf spot diseases' severity level 5.1–10.0%	2003	382**	7.98	44.4	487**	8.6	43.9*	614**	5.09	43.5
	2004	541	4.63	40.4*	450**	6.06	42.6	757**	4.77**	40.2**
	2005	–[2]	–	–	–	–	–	151**	8.46	44.0
	2006	–	–	–	94	5.11	45.4	102	5.14	39.4
Pmc + leaf spot diseases' severity level 10.1–25.0%	2003	392	8.10	44.1	576	8.46	44.4*	652	4.93	43.0
	2004	613	4.55	39.1	484**	5.78	42.1	638**	4.67**	39.9**
	2005	–	–	–	–	–	–	–	–	–
	2006	–	–	–	–	–	–	–	–	–
Pmc + leaf spot diseases' severity level > 25.1%	2003	–	–	–	–	–	–	630**	6.01	43.7
	2004	–	–	–	557	5.81	42.8	818**	4.31	37.7
	2005	–	–	–	–	–	–	–	–	–
	2006	–	–	–	–	–	–	–	–	–
LSD (0.05)	2003	69.9	0.54	2.34	101.4	0.57	2.07	121.8	1.05	2.84
	2004	64.7	0.79	1.90	78.4	1.29	1.90	99.7	0.84	1.70
	2005	17.6	0.75	1.37	13.1	0.88	1.36	26.7	0.81	1.85
	2006	11.1	0.75	1.21	8.0	0.79	1.10	11.9	0.73	1.40
LSD (0.01)	2003	93.5	0.73	3.13	135.7	0.76	2.77	163.0	1.43	3.80
	2004	87.3	1.08	2.57	104.9	1.75	2.54	133.4	1.13	2,28
	2005	23.8	1.01	1.83	17.7	1.18	1.82	35.8	1.09	2.47
	2006	14.9	1.01	1.63	10.8	1.06	1.48	16.0	0.98	1.88

[1]powdery mildew control
[2]leaf spotting diseases did not reach targeted severity

the mean values, respectively (data not shown). The yield component–thousand grain weight was suppressed in the same manner as grain yield.

Significant yield increases were obtained in all studied cultivars during the experimental years where the plants were protected against leaf spot diseases by triazole fungicide. Under leaf spot disease severity of 1.0–5.0% significant yield increase was obtained for cv. Hereward in all years, except for 2003, whereas significant yield increases for cvs. Aron and Tauras were obtained only in 2004. During the same year, significant yield increase for cv. Hereward was obtained for leaf disease severity 5.1–10.0 and 10.1–25.0%. Leaf spot disease severity higher than 5.0% significantly reduced grain yield in cvs. Aron and Tauras during all experimental years.

AUDPC values of leaf spot disease severity from 1.0–5.0% were significantly lower in comparison with the untreated control, but significant increase in grain yield was observed only for the cv. Hereward in 2004. Significant TGW increase was recorded for the cv. Tauras in 2003 and for all cultivars grown in the following season. Susceptible winter wheat cv. Hereward produced significantly higher grain yield as long as disease severity did not exceed 25% limit. At the end of anthesis (BBCH 69) disease severity was about 25% and at medium milk growth stage (BBCH 75) more than 65%.

Analysis of variance indicated that genotype, additional inoculum, and fungicide treatment had great effects on disease occurrence, grain yield and yield components. According to our results straw as additional inoculum source increased disease severity on wheat leaves. The most susceptible wheat cultivar appeared to be Hereward, followed by Aron and Tauras. Winter wheat cv. Tauras has been developed at the Lithuanian Institute of Agriculture; therefore the cultivar is better adapted to the local conditions (Anonymous 2001).

In 2003, AUDPC of cv. Aron medium correlated with yield (r = –0.51*) and did not correlate with other yield components (Table 2). In the next growing season, AUDPC strongly correlated with yield (r = –0.80**), grain weight/ear (r = –0.85**), TGW (r = –0.80**), poorly – with tillers/m^2 (r = –0.45*) and did not correlate with ear length (r = 0.01). Strong and medium correlation of AUDPC with tillers/m^2 and TGW was observed in 2005, whereas yield, ear length, grains/ear and grain weight/ear did not correlate.

In 2003, AUDPC of cv. Tauras poorly correlated with yield (r = –0.45*), medium correlated with TGW (r = –0.59**) and did not correlate with other yield components (Table 3). Strong correlation among AUDPC x grain weight/ear and AUDPC x TGW was observed in 2004, the correlation coefficients were r = –0.76** for both components. Medium correlations among AUDPC x yield and AUDPC x tillers/m^2 were observed (r = –0.59** and –0.54**). In 2005, AUDPC poorly correlated with TGW (r = –0.48*), medium – with yield (r = –0.59**) and strongly with tillers/m^2 (r = –0.75**). Correlation between AUDPC and tillers/m^2 was poor (r = –0.42*), whereas no correlation was observed among AUDPC x yield and the rest of the yield components in 2006.

In 2003, AUDPC of *cv.* Hereward poorly correlated with yield (r = –0.44*) and ear length (r = –0.37*), but did not correlate with other yield components (Table 4). In the next growing season, AUDPC correlation with ear length was poor (r = –0.39*). Correlation coefficients among AUDPC, tillers/m^2 and grains/ear were medium (r = –0.56** and 0.65**), and strong correlation was observed among AUDPC x yield, AUDPC x grain weight/ear and AUDPC x TGW there coefficients were –0.74**, –0.78** and 0.63**, respectively. In 2005, AUDPC medium correlated with tillers/m^2 and TGW (r = –0.63** and –0.51**). During the last experimental year AUDPC correlated poorly with yield and yield components or correlation did not occur.

Table 2. Correlation coefficients among AUDPC, yield and yield components of winter wheat cv. Aron grown in the central Lithuania during 2003–2006

Trait	Year	Yield t/ha	AUDPC	Tillers/m^2	Ear length	Grains/ear	Grain weight/ear
AUDPC	2003	–0.51**					
	2004	–0.80**					
	2005	–0.22					
	2006	–0.33					
Tillers/m^2	2003	nd	nd				
	2004	0.50**	–0.45*				
	2005	0.11	–0.71**				
	2006	0.25	–0.24				
Ear length	2003	–0.09	0.01	nd			
	2004	0.18	–0.18	0.42*			
	2005	0.14	0.04	0.02			
	2006	0.22	–0.16	0.20			
Grains/ear	2003	–0.33	0.04	nd	–0.09		
	2004	0.41*	–0.46*	0.05	0.10		
	2005	–0.03	0.08	–0.02	0.35		
	2006	0.42*	–0.40*	–0.16	0.32		
Grain weight/ear	2003	–0.38*	0.05	nd	–0.16	0.82**	
	2004	0.72**	–0.85**	0.44*	0.23	0.50**	
	2005	0.18	–0.16	0.15	0.24	0.72**	
	2006	0.54**	–0.49**	–0.04	0.31	0.95**	
TGW	2003	–0.16	–0.05	nd	–0.10	0.07	0.59**
	2004	0.74**	–0.80**	0.40*	0.13	0.42*	0.90**
	2005	0.48**	–0.60**	0.42*	–0.12	0.02	0.45*
	2006	0.46*	–0.37*	0.30	0.03	0.08	0.38*

*, ** – see Table 1
nd – no data (productive tillering was not assessed in 2003 season)

Table 3. Correlation coefficients among AUDPC, yield and yield components of winter wheat cv. Tauras grown in the central Lithuania during 2003–2006

Trait	Year	Yield t/ha	AUDPC	Tillers/m²	Ear length	Grains/ear	Grain weight/ear
AUDPC	2003	–0.45*					
	2004	–0.59**					
	2005	–0.59**					
	2006	–0.12					
Tillers/m²	2003	nd	nd				
	2004	0.40*	–0.54**				
	2005	0.44*	–0.75**				
	2006	–0.13	–0.42*				
Ear length	2003	–0.05	0.31	nd			
	2004	0.02	–0.08	–0.24			
	2005	–0.11	0.11	–0.20			
	2006	0.05	0.10	–0.17			
Grains/ear	2003	–0.45*	0.03	nd	0.21		
	2004	0.12	–0.27	0.05	0.33*		
	2005	–0.05	–0.18	0.22	0.43*		
	2006	–0.05	0.16	–0.23	0.43**		
Grain weight/ear	2003	–0.42*	–0.06	nd	0.16	0.75**	
	2004	0.48**	–0.76**	0.31	0.21	0.69**	
	2005	–0.11	–0.21	0.26	0.37	0.94**	
	2006	0.16	0.24	–0.24	0.36*	0.89**	
TGW	2003	0.49**	–0.59**	nd	0.05	–0.02	0.13
	2004	0.67**	–0.76**	0.47**	–0.01	0.04	0.58**
	2005	0.25	–0.48*	0.36	–0.26	–0.09	–0.01
	2006	0.46**	0.22	–0.11	–0.01	0.10	0.54**

*, ** – see Table 1; nd – no data (productive tillering was not assessed in 2003 season)

Table 4. Correlation coefficients among AUDPC, yield and yield components of winter wheat cv. Hereward grown in the central Lithuania during 2003–2006

Trait	Year	Yield t/ha	AUDPC	Tillers/m²	Ear length	Grains/ear	Grain weight/ear
AUDPC	2003	–0.44*					
	2004	–0.74**					
	2005	–0.28					
	2006	–0.34*					
Tillers/m²	2003	nd	nd				
	2004	0.63**	–0.65**				
	2005	0.19	–0.63**				
	2006	0.34*	–0.24				
Ear length	2003	0.21	–0.37*	nd			
	2004	0.11	–0.39*	0.19			
	2005	–0.17	–0.15	0.22			
	2006	–0.02	0.17	–0.42*			
Grains/ear	2003	0.14	–0.22	nd	0.63**		
	2004	0.49**	–0.56**	0.31*	0.08		
	2005	0.08	–0.15	0.09	0.38*		
	2006	0.01	0.34*	–0.25	0.48**		
Grain weight/ear	2003	0.21	–0.24	nd	0.62**	0.91**	
	2004	0.71**	–0.78**	0.63**	0.18	0.64**	
	2005	0.34*	–0.39*	0.29	0.08	0.74**	
	2006	0.30	0.10	–0.22	0.34*	0.81**	
TGW	2003	0.09	0.03	nd	–0.20	–0.43*	–0.01
	2004	0.83**	–0.84**	0.63**	0.24	0.48**	0.83**
	2005	0.62**	–0.51**	0.33*	–0.08	0.07	0.39*
	2006	0.49**	–0.23	–0.07	–0.02	0.15	0.70**

*, ** – see Table 1; nd – no data (productive tillering was not assessed in 2003 season)

DISSCUSION

In the second treatment, triazole fungicide Tilt did not give 100 percent protection against leaf spot diseases. Generally, fungicide was effective for the most part of wheat vegetation. The increase of leaf spot diseases was observed approximately 2–3 weeks before the end of wheat vegetation and disease severity varied from 0.5 to 4% in treated cultivars.

Yield and yield components were affected by leaf spot diseases in all treated cultivars during all experimental years. Significant reduction was more obvious in more conducive to disease years (2003 and 2004). Under dry weather conditions the influence of leaf spot diseases on yield and yield components was lower but on the other hand, grain yield was lower because of rainfall shortage and high temperature. In controlled environment Gibson and Paulsen (1999) found out that temperature increase by 1°C above 15°C decreased the yield by 3 to 5%. In the field, the influence of temperature on wheat yield could be much higher (Zhong-Hu and Rajaram 1994).

Yield components such as grains/ear, grain weight/ear, TGW and their relation with yield and disease were described previously by several researchers (Nelson *et al*. 1976; Kelley 2001). We also found that not only yield components mentioned above but also tillers/m^2 are important, especially in the case of susceptible wheat cv. Hereward. We found that leaf spot diseases under conducive weather conditions can significantly reduce the number of productive tillers. This finding agrees with the results of Simón *et al*. (2002). The researcher concluded that high severity of *Septoria tritici* could reduce the number of ears/m^2. In the following year the disease did not reduce the number of ears because of scarce rain after inoculation caused a delay in the progress of epidemic (Simón *et al*. 2002). According to our results the number of tillers was reduced by leaf spot diseases in treated cultivars in 2004. We also found that yield losses due to the reduction of productive tillers can be compensated by the increase in grain weight per ear and TGW. To minimize yield or productive tiller losses due to diseases in min-tillage system researchers recommend to increase seeding rate (Carr *et al*. 2003). Other authors determined that weeds might reduce number of tillers in cereals. Reduction of grain weight in spring barley was attributed to disease/weed stress during spikelet formation (Burleigh *et al*. 1988).

In 2004, leaf spot diseases reduced grain yield primarily by reducing tillers/m^2, grains/ear, grain weight/ear and TGW in cvs. Aron and Hereward. But grains/ear did not influence the yield in cv. Tauras ($r = 0.12$). According to Burleigh *et al*. (1988) results, *Pyrenophora teres* reduced grain yield by reducing ear number and kernel weight in spring barley.

Medium and strong positive correlations were found between grain weight/ear and grains/ear ($r = 0.50^{**}$–0.95^{**}). Strong correlation between the same yield components was found in spring wheat by Bleidere (2003).

Ear length did not correlate with AUDPC and yield in all cultivars during experimental years. Ear length correlated poorly or did not correlate with yield and yield components in more resistant to leaf spot diseases cvs. Aron and Tauras. These results agree with the results obtained by Bleidere (2003) who tested 20 spring wheat cultivars and concluded that all traits, except for the spike length, significantly correlated with grain yield.

In winter wheat monoculture fungal leaf diseases become a major problem. Under minimum tillage when straw residues are left on the soil surface, the pathogens can infect plants in the autumn or early in the spring. In the situations with min-tillage and when wheat is sown after wheat, tan spot becomes the dominant leaf disease already after one season, out-competing Septoria leaf blotch (Jørgensen 2006). In our trials, severity of tan spot was about seven to eight times higher that that of Septoria leaf blotch. Other authors have reported that the levels of primary inoculum have been correlated with tan spot epidemics development in the field (Zhang and Pfender 1993).

To prevent problems caused by diseases, highly resistant cultivars in combination with/or adequate fungicide treatments are needed.

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POLISH SUMMARY

WPŁYW CHORÓB LIŚCI NA PLON ZIARNA I SKŁADNIKI PLONU W PSZENICY OZIMEJ

Choroby występujące na liściach wpływają na wzajemne stosunki pomiędzy plonem i składnikami plonu pszenicy ozimej (*Triticum aestivum* L.). W latach 2003–2006 przeprowadzono doświadczenia polowe na słabogliniastej glebie (gleyic cambisol) w centralnej części Litwy, w celu określenia wpływu chorób liści na plon i jego części składowe. Powierzchnia pod krzywą postępu choroby (AUDPC), plon ziarna i składniki plonu były analizowane przy wykorzystaniu analizy wariancji oraz korelacji. W celu zapoczątkowania epidemii we wszystkich kombinacjach doświadczalnych wykorzystano zakażoną słomę pszenicy. Użyto trzy odmiany pszenicy ozimej: Hereward, Aron i Taurus, różniące się poziomem odporności na choroby liści. Doświadczenie obejmowało trzy kombinacje doświadczalne: (I) nie traktowana kontrola, (II) zwalczanie mącznika prawdziwego + rośliny zdrowe oraz (III) – zwalczanie mączniak prawdziwego + nasilenie chorób liści na poziomie 1,0–5,0%, (IV) – zwalczanie mącznika + nasilenie chorób liści na poziomie 5,1–10,0%, (V) – zwalczanie mącznika + nasilenie chorób liści na poziomie 10,1–25,0%, (VI) – zwalczanie mącznika + nasilenie chorób liści na poziomie > 25,1%. We wszystkich kombinacjach z wyjątkiem kontrolnej, pszenica była chroniona fungicydami z grupy morfolin i triazoli. Choroby liści wpłynęły we wszystkich latach badań na plon i składniki plonu traktowanych fungicydami odmian. Istotne ($p \leq 0{,}01$), średnie i wysokie korelacje stwierdzono pomiędzy AUDPC i plonem wszystkich traktowanych odmian będących pod wpływem wysokiej presji infekcyjnej chorób liści w 2004 roku.