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Resistance of spring barley cultivars to the new disease *Ramularia* leaf spot, caused by *Ramularia collo-cygni*

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Abstract. In 2004 and 2005, the occurrence of *Ramularia* leaf spot was monitored at breeding nurseries of spring barley. Higher *Ramularia* severity developed in the dryer and sunnier year of 2005. Generally, resistance of cultivars to *Ramularia* leaf spot was similar between years. Half of the tested cultivars were more damaged by *Ramularia* in the second year. Average disease severity increased from 7.0% in 2004 to 13.4% in 2005. The correlation analysis showed no relationship between *Ramularia* and other diseases severities. The effect of *Ramularia* AUDPC on the yield in 2005 showed weak negative correlation (r = -0.37*). It can be explained by higher Ramularia and lower severities of other diseases. Among the tested cultivars there were identified genotypes with a high complex resistance to all foliar diseases. Such cultivars were *Jersey*, *Philadelphia* and *Wikingett*.

Key words: *Ramularia*, spring barley, resistance of cultivars

INTRODUCTION

In the early nineties new necrotic leaf blotches were observed on the barley plants in several European countries. Some scientists support the thesis that abiotic stresses like high solar radiation or sudden bursts of sunshine in a wet summer cause these leaf spots, which are thought to be colonized subsequently by *Ramularia collo-cygni* as a saprophyte. A second group of scientists is convinced that this fungus causes the spottings (Greif, 2002). Ramularia leaf spot was identified in Lithuania in 2004 (Liatukas & Leistrumaitė, 2005).

Ramularia leaf spot disease is the dominant post-maturity disease of barley. As a late appearing disease, it deteriorates grain quality and reduces a thousand grain weight. It is also important, in a negative sense, that all barley varieties are more or less susceptible and that the disease is difficult to recognise because it is easily mistaken for other leaf spot diseases. While effects on yield have been studied and yield losses between 16 and 26% found, the influence on suitability for brewing has not yet been studied (Harvey, 2002).

Ramularia leaf spot disease of barley is probably one of the plant-pathogen interaction examples of when improvidence and narrow specialization of scientists and breeders did not allow them to anticipate the emergence of the new disease. A new challenge for breeders and plant pathologists is to anticipate the emergence of new harmful plant pathogens or at least to forecast the widening of existing geographical areas due to climate changes.

The main objective of this research was to evaluate resistance of spring barley cultivars included in the National List of Plant Varieties to the new disease *Ramularia* leaf spot.

MATERIALS AND METHODS

The experiment was set up in the non-replicated trials at the Lithuanian Institute of Agriculture during 2004–2005 in the breeding nurseries with natural infection. All investigated spring barley cultivars are included in the National List of Plant Varieties. The plots were 15 m^2, soil type loam, clay content 24–27%, pH 6.0–7.0; the percentage of organic matter 2.5–2.7; P_2O_5 190–250; K_2O 200–260 mg kg^{-1}soil. $N_{90}P_{60}$ K_{60} was applied annually.

The diseases were assessed once in 2004 when the plants were at early–medium milk development stage (BBCH 73-75). In the following year the diseases were assessed five times: from booting (BBCH 43-47) to milk development (BBCH 73-77). The severities of diseases were measured in percent, using the scale: 0.0, 0.1, 1, 5, 10, 20, 40, 60, 80 and 100%. *R. collo-cygni* was identified in the following way: leaves of barley with typical (dark brown necroses, 1–3 mm-long, 0.5–1.0 mm wide, clearly contained by leaf veins and surrounded with chlorosis). *Ramularia* spots were collected in breeding nurseries, placed in Petri dishes upper side down on moist filter paper, kept at natural room lighting at 18-20^{o}C for two days. Spots were scrutinised with 32-to-56-fold magnifications. Final identification was done with 600-to-800-fold magnifications (Sutton & Waller, 1988).

The area under the disease progress curve (AUDPC) was calculated as the total area under the graph of disease severity against time, from the first scoring to the last (Shaner & Finney, 1977). The severity and AUDPC of *Ramularia* leaf spot was correlated to the severity and AUDPC of the other diseases, yield, and Pearson's correlation coefficients were evaluated for significance.

RESULTS AND DISCUSSION

The evaluation of the spring barley cultivars in the trials over two years shows an increased severity of *Ramularia* leaf spot in the second year (Table 1). It has been observed that cultivars differ considerably in susceptibility and that some cultivars are more affected than others. Generally, resistance of cultivars to *Ramularia* between years was similar. The cultivars were divided into three groups according to the variations in cultivar resistance. About a quarter of cultivars were less damaged with *Ramularia* in the second year. All these genotypes were among the most resistant : in both years the severity of *Ramularia* mostly ranged from 1 to 5%. The second group included the cultivars with stable resistance, which also accounted for one quarter. Half of the tested cultivars were more damaged by *Ramularia* in the second year. Average disease severity increased from 7.0% in 2004 to 13.4% in 2005. Analysis of meteorological data shows that the second year was dryer. Such weather conditions were more adverse to the development of other disease complex than to *Ramularia*.

Table 1. Resistance of spring barley varieties to *Ramularia* leaf spot and complex of other leaf diseases, 2004-2005.

		Ramularia			Other leaf diseases*			Grain yield	
	Variety	2004	2005		2004	2005		2004	2005
		Maximum disease severity, %		AUDPC **	Maximum disease severity, %		AUDPC	t ha^{-1}	
1	*Arve*	0	10	46	90.1	40.3	798	2.7	2.9
2	*Henni*	1	1	7	15	5.1	91	4.7	4.8
3	*Landora*	1	20	128	50.1	41	449	5.3	4.3
4	*Omaha*	1	0.1	2	16	10.1	138	5.2	4.8
5	*Pongo*	1	1	13	21	41	483	5.4	4.4
6	*Potter*	1	10	127	15.1	15	189	5.5	4.6
7	*Sebastian*	1	5	39	15	10.2	114	5.7	4.4
8	*Tocada*	1	10	86.5	30	10.1	154	5.8	5.1
9	*Aidas*	5	5	47	60	20.2	424	4.1	4.4
10	*Alsa*	5	1	19	15.1	10.1	262	4.8	4.0
11	*Annabell*	5	5	67	12	26	436	5.8	4.9
12	*Aura*	5	10	190	26	40.1	734	5.2	4.2
13	*Jersey*	5	0.1	2	2.1	2.1	20	6.1	4.9
14	*Orthega*	5	5	67	15.1	6.1	140	5.2	5.0
15	*Pasadena*	5	10	127	26	10.3	204	5.3	4.9
16	*Philadelphia*	5	10	87	3	5.2	32	6.1	4.9
17	*Scarlett*	5	0.1	1	22	5.3	58	5.5	4.3
18	*Tolar*	5	20	172	16	10.2	169	5.7	4.7
19	*Wikingett*	5	1	8	2	1	7	6.0	4.9
20	*Auksiniai 3*	10	10	155	70	40.1	832	3.9	4.0
21	*Breamer*	10	10	105	2.1	1.1	12	5.8	4.1
22	*Cellar*	10	20	201	1	6	50	4.5	4.2
23	*Hanka*	10	5	61	30	21	156	4.7	4.2
24	*Justina*	10	40	290	2.1	5.1	67	5.8	5.2
25	*Luokė*	10	40	767	70.1	40.1	831	4.5	3.6
26	*Antto*	20	40	477	11	1.1	9.2	5.4	4.0
27	*Barke*	20	20	381	1.2	6.1	37	5.8	4.3
28	*Prestige*	20	40	262	1.2	6	66	5.8	4.2
29	*Ūla*	20	40	555	65	40.1	832	4.5	3.9
	Average	7.0	13.4	155	24.3	16.4	269	5.2	4.4

*-powdery mildew, leaf spot diseases (net blotch, spot blotch, rinchosporium), physiologic necrosis; **-area under diseases progress curve.

The second summer was warmer and had more days with sunshine. These reasons could explain higher *Ramularia* severity. R. collo-cygni produces toxin rubelin D, which fortifies the light dependent fatty acid peroxidation and in consequence damage of plant cells (Heiser et al., 2003). The late appearance of the disease may suggest a relatively high temperature requirement and be one of the reasons for higher

Ramularia severity (Cromey et al., 2002). The effect of solar irradiation can markedly contribute to withering of the infected leaves. Due to this, in sunnier summers *Ramularia* severity can be higher. *Ramularia* severity could be higher because of slower development of other diseases.

Table 2. The correlation of *Ramularia* leaf spot severity on spring barley with the other leaf diseases and yield.

Traits	2	3	4	5	6	7	8
1. *Ramularia* 2004	0.72**	0.70**	-0.10	-0.12	-0.04	0.06	-0.27
2. *Ramularia* 2005	1.0	0.86**	0.13	0.12	0.17	-0.01	-0.27
3. *Ramularia* 2005, *AUDPC*	---	1.0	0.26	0.25*	0.34*	-0.10	-0.37*
4. Other diseases 2004	---	---	1.0	0.79**	0.86**	-0.81**	-0.63**
5. Other diseases 2005	---	---	---	1.0	0.94**	-0.57*	-0.53*
6. Other diseases 2005, *AUDPC*	---	---	---	---	1.0	-0.66*	-0.58*
7. Grain yield 2004	---	---	---	---	---	1.0	0.71**
8. Grain yield 2005	---	---	---	---	---	---	1.0

*-significant at $P < 0.05$, ** $P < 0.01$ probability level

The correlation analysis showed no relationship between *Ramularia* and other diseases severities (Table 2). Only the relationship between *Ramularia AUDPC* and other diseases *AUDPC* was positive and weak (r = 0.34*). The relationships of *Ramularia* and other diseases between years were positive and strong (r = 0.70–0.79**). Very weak negative correlation was identified between *Ramularia* severity and yield. The main reason might be the higher severity of other diseases in the year 2004. The influence of ramularia *AUDPC* on yield in 2005 showed weak negative correlation (r = -0.37*). It can be explained by higher *Ramularia* and lower severities of other diseases. The data from the two experimental years indicate that *Ramularia* exerted a weak effect on the yield due to its late appearance and weak competition with other diseases.

CONCLUSIONS

There is strong evidence for the vital role of varietal resistance in achieving efficient control of *Ramularia* leaf spot. It has been observed that cultivars differ considerably in susceptibility and that some cultivars are constantly more affected than others. Higher *Ramularia* severity developed in the dryer and sunnier year of 2005. It could be the consequence of the influence of higher solar radiation on the activity of ramularia toxin and weaker competition with other diseases. Among the tested cultivars there were identified genotypes with a high complex resistance to all foliar diseases. Such cultivars were *Jersey*, *Philadelphia and Wikingett*.

REFERENCES

Cromey, M. G., Harvey, I. C., Sheridan, J. E. & et al. 2002. Occurrence, importance and control of *Ramularia collo-cygni* in New Zealand. In *Meeting the challenges of barley blights. Proceedings of the II International Workshop on Barley Leaf Blights.* Aleppo, Syria. April 7-11, pp. 337–342.

Greif, P. 2002. Importance of leaf spot *Ramularia c.c* for barley growers and breeders. In *Meeting the challenges of barley blights. Proceedings of the II International Workshop on Barley Leaf Blights.* Aleppo, Syria. April 7-11, pp. 331–336.

Harvey, I. C. 2002. Epidemiology and control of leaf and awn spot of barley caused by *Ramularia collo-cygni. New Zealand Plant Protection* **55**, 331–335.

Heiser, I., Sachs, E. & Liebermann, B. 2003. Photodynamic oxygen activation by rubellin D, a phytotoxin produced by Ramularia collo-cygni (Sutton et Waller). *Physiol. and Molec. Plant Path.* **62**, 29–36.

Liatukas, Ž. & Leistrumaitė, A. 2005. Ramularia (Ramularia collo-cygni Sutton et Waller) a new leaf spot disease of spring barley in Lithuania. *Agriculture. Scientific Articles* **90**, 61–74.

Shaner, G & Finney, R. E. 1977. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in Knox wheat. *Phytopath*. **67,** 1051–1056.

Sutton, B. & Waller, J. M. 1988. Taxonomy of *Ophiocladium hordei,* causing leaf lesions on Triticale and other Gramineae. *Trans. Br. Mycol. Soc*. **90**, 55–61.