Response of Winter Wheat Cultivars to Artificial Infection with *Pyrenophora tritici-repentis* in Field and Greenhouse Conditions

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Abstract

The response of 22 winter wheat cultivars to artificial infection with *Pyrenophora tritici-repentis* has been studied in the field conditions for three years and in the greenhouse conditions as well. The set of cultivars included the cultivars registered in the Czech Republic and Swiss cultivar Arina known for satisfactory resistance to different foliar and head blights. High level of field resistance to *Pyrenophora tritici-repentis* was detected in cultivars Arina, Vlasta, Rialto, Athlet, Trane, Siria, Vega, Alana, Samara. Not all cultivars showed similar reaction in field and greenhouse tests. Correlation between results of the field and the greenhouse tests was significant for 18 of 22 cultivars. Arina, Vlasta and Vega showed acceptable field resistance and high resistance in the greenhouse tests to *Pyrenophora tritici-repentis* too. The greenhouse experiments helped to differentiate between examined isolates collected from the territory of the Czech Republic. Cultivar reaction to isolates No. 98001, 98007, 98010, 00071 correlated significantly with the field results.

Keywords: *Pyrenophora tritici-repentis*; tan spot; winter wheat; resistance

INTRODUCTION

Pyrenophora tritici-repentis (Died.) Drechs. (anam. *Drechslera tritici-repentis* (Died.) Shoem.) is the causal agent of leaf spot disease of wheat known as "tan spot" or "yellow spot". This disease was found in all the major wheat growing areas of the world and it can cause yield losses from 3% to 50% (HOSFORD 1982). The incidence of tan spot has increased in the last years because of changes in cultural practices (DE WOLF *et al*. 1998). *Pyrenophora tritici-repentis* (PTR) appears mostly in a complex with other leaf spot pathogens of wheat such as *Phaeosphaeria nodorum*, *Mycosphaerella graminicola* etc. PTR was one of the most important wheat leaf spot pathogens in the Czech Republic in the years 2000–2001 and it was recorded in almost all observed districts. Tan spot has become a new problem in many European countries like in Poland (ZAMORSKI & SCHOLLENBERGER 1994), in Hungary (BAKONYI *et al*. 1998), in Russia (MIKHAILOVA & PRIGOROVSKAYA 2000), in Denmark (JENSEN *et al*. 2001), in France (DEVAL *et al*. 2000) in the last few years too.

The development of resistant cultivars to PTR is thought to be the best way to reduce yield losses caused by tan spot (DE WOLF *et al*. 1998). Resistance has been identified in several ploidy levels of wheat and sources of resistance are present in many areas of the world (LAMARI *et al*. 1992; REES & PLATZ 1992; LUZ 1995; RIEDE *et al*. 1996). Unfortunately, only a few of the currently grown cultivars showed a high level of resistance, while a somewhat larger number possess a moderate level of resistance (DE WOLF *et al*. 1998).

The aim of our study was to evaluate the response of selected winter wheat cultivars to artificial infection with leaf spot pathogen *Pyrenophora tritici-repentis* in the field and greenhouse conditions and to select the most resistant cultivars for use in breeding.

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MATERIALS AND METHODS

The reaction of 22 winter wheat cultivars to artificial infection with *Pyrenophora tritici-repentis* was tested in our field experiments for 3 years (1999–2001). Cultivar set included 21 cultivars registered in the Czech Republic and in the Swiss variety Arina, that was found in the examined conditions resistant to brown leaf spots caused by *Septoria tritici* (Šíp *et al*. 2001). Each cultivar was sown on three plots that were 2 m long with six rows spaced 20 cm. Mist irrigation of plots was used in decisive phases to promote infection spread. Two infected plots were separated from control variant by 1.2 m wide strip (1 × 2 m).

An inoculum was prepared from a mixture of Czech isolates of *P. tritici-repentis* cultivated on sterile oat grains in a flask at room temperature (Raymond *et al*. 1985). The inoculum, infected oat grains, was applied on experimental field plots with winter wheat cultivars repeatedly. The first application was performed in November–December, the second application in March–April (1–1.2 kg/ar dry material or double amount of fresh material). The first symptoms of tan spot were detected at the end of April. A periodic disease evaluation of randomly selected 8 plants (first 4 leaves) of each cultivar was pursued once a week since May or June. The disease was evaluated 5 times in 1999, 8 times in 2000 and 7 times in 2001. The first evaluation was done when the flag leaf occurred. Diseased leaf area, total leaf area and stage of crop development were observed. For the assessment of diseased leaf area the percentage scale was used. AUDPC (area under the disease progress curve) values characterized the disease development for each cultivar (Shaner & Finney 1977).

Figure 1. Rating scale used for evaluation of greenhouse reaction to tan spot (1 = resistant, 5 = susceptible)

The reaction of the same winter wheat cultivars to *Pyrenophora tritici-repentis* was also tested in the greenhouse conditions. The conidial suspensions of five different local monosporic isolates of *P. tritici-repentis* (98001, 98007, 98010, 98017, 00071) were separately used for inoculation of seedlings at the two-leaf stage (Ali & Francl 2001). Reaction of the cultivars was rated 8–10 days after inoculation, using the 1 to 5 rating scale (1 = resistant, 5 = susceptible) developed by Lamari and Bernier (1989) (Figure 1).

Statistical program UNISTAT 5.1 was used for analysis of results (Analysis of Variance, Pearson's correlation coefficient).

RESULTS AND DISCUSSION

The significant differences in the reaction of the tested winter wheat cultivars to inoculation with *Pyrenophora tritici-repentis* were proved in the field and greenhouse conditions. The lowest AUDPC values (in the field trial) were recorded in the cultivars Arina, Vlasta, Rialto, Athlet, Trane, Siria, Vega, Alana, Samara and the highest AUDPC values in cultivars Boka, Mona, Samanta, Bruta, Ina. The statistically significant correlation between AUDPC values for three years was proved (Table 1). The infection spread from the bottom leaves, where the highest infection was observed, to flag leaves. The infection of flag leaves started in flowering time.

Table 1. Interannual correlation coefficients between AUDPC values (n = 22) – all correlations were statistically significant at P = 0.05

	AUDPC 99	AUDPC 00	AUDPC 01
AUDPC 99	****	0.45	0.48
AUDPC 00	0.45	****	0.68
AUDPC 01	0.48	0.68	****

Table 2. The response of 22 tested winter wheat cultivars to tan spot in the field and greenhouse conditions

Cultivar	Field[+] AUDPC	Greenhouse[++]						Level of resistance[+++]	
		98001	98007	98010	98017	00071	average	field	greenhouse
Arina	228.22	2.25	2.00	2.00	2.00	1.50	1.95	R	R
Vlasta	310.97	2.17	2.25	1.75	1.42	2.33	1.98	R	R
Rialto*	331.67	3.50	2.83	2.10	3.25	3.00	2.94	R	MS
Athlet	346.37	1.63	2.25	2.00	3.33	2.00	2.24	R	MR
Trane	365.93	2.20	2.50	1.75	2.58	2.00	2.21	R	MR
Siria	374.28	2.38	2.33	2.00	3.42	2.00	2.43	R	MR
Vega	383.29	1.67	1.80	1.33	2.40	1.80	1.80	R	R
Alana	393.29	2.75	2.33	2.00	1.90	2.83	2.36	R	MR
Samara*	416.32	3.67	2.67	2.50	3.83	3.08	3.15	R	MS
Alka	461.33	2.75	2.33	1.83	2.58	2.08	2.32	MR	MR
Ebi	462.87	2.33	2.92	2.08	2.80	2.50	2.53	MR	MR
Estica	463.68	3.33	2.92	2.50	2.75	2.67	2.83	MR	MS
Versailles	483.71	3.17	2.92	2.33	3.75	3.08	3.05	MR	MS
Astella*	538.58	1.50	2.00	1.00	2.42	2.00	1.78	MS	R
Šárka*	555.40	2.00	2.50	1.13	3.00	1.50	2.03	MS	R
Saskia	576.94	2.60	2.92	2.50	2.00	2.00	2.40	MS	MR
Brea	587.10	2.83	2.58	2.20	1.90	2.50	2.40	MS	MR
Ina	622.85	3.60	3.17	1.75	3.17	2.50	2.84	S	MS
Bruta	637.56	2.83	2.00	3.00	3.83	2.67	2.87	S	MS
Samanta	660.10	3.40	3.33	2.92	2.10	3.17	2.98	S	MS
Mona	704.84	3.10	2.92	1.60	2.75	2.50	2.57	S	MR
Boka	710.13	3.33	2.92	2.33	3.33	2.50	2.88	S	MS

*cultivars with different reaction in the field and in the greenhouse tests

[+] AUDPC – average value for 3 years

[++] rating scale 1 (resistant) – 5 (susceptible); 98001, 98007, 98010, 98017, 00071 – PTR isolates; average – average score of 5 PTR isolates

[+++] R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible

Correlation between results of field and greenhouse tests was significant for 18 of 22 cultivars (Figure 2, Table 2). The cultivars Arina, Vlasta and Vega were resistant in the field conditions and in the greenhouse conditions too. The cultivars Rialto and Samara were resistant in the field tests but moderately susceptible in the greenhouse tests. On the other hand the cultivars Astella and Šárka were resistant in the greenhouse conditions and moderatelly susceptible in the field conditions. Levels of resistance in Table 2 were determined on the basis of multiple comparisons from ANOVA. Pearson's correlation coefficients between field and greenhouse results show Table 3. The correlation was found close between average AUDPC values from field and reaction in greenhouse (average of 5 PTR isolates). Cultivar reaction to isolates No. 98001, 98007, 98010, 00071 correlated significantly with the field results. The isolates No. 98001, 98017 were significantly more aggressive than isolates 98010 and 00071. Differences between isolates of *Pyrenophora tritici-repentis* have been reported in many studies (LUZ & HOSFORD 1980; SCHILDER & BERGSTROM 1990; KRUPINSKY 1992). Although the differences in infectivity of the five PTR monosporic isolates were recorded in our greenhouse trial, cultivars Astella, Vega, Arina and Vlasta were resistant to all isolates. The most sensitive to artificial infection with PTR in greenhouse were cultivars Samara, Versailles and Samanta.

EVANS *et al.* (1999) carried out similar study. Greenhouse and field reactions to tan spot of wheat lines

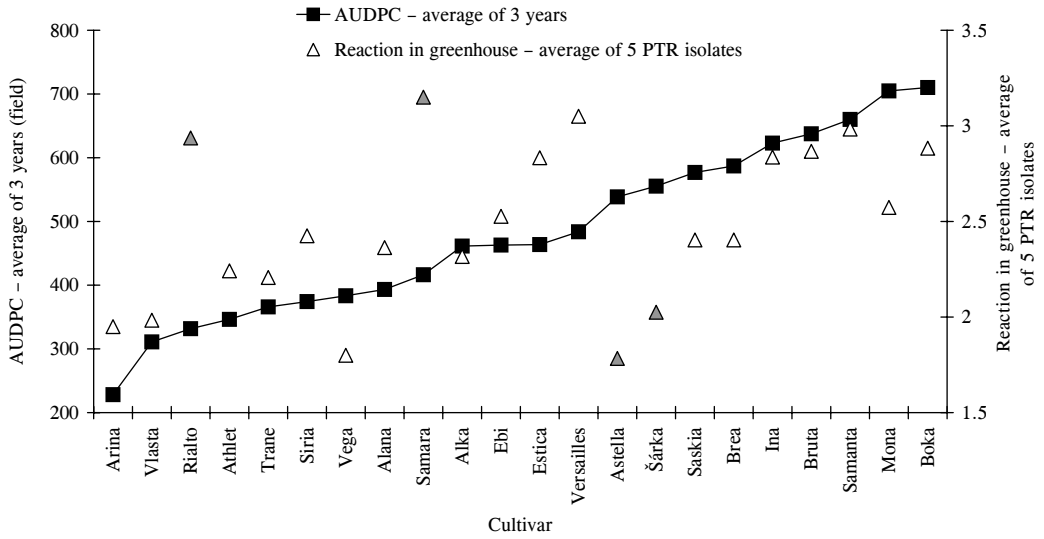

Figure 2. The response of 22 winter wheat cultivars to inoculation with *Pyrenophora tritici-repentis* (PTR) in the field and greenhouse conditions (marked triangles = reaction in greenhouse significantly different from field reaction)

Table 3. Pearson's correlation coefficients between average AUDPC values from field experiments and scores in greenhouse experiments for 5 PTR isolates (n = 18)

	Field^{+}	Greenhouse^{++}	98001	98007	98010	98017	00071
Field	****	0.73*	0.74*	0.64*	0.43*	0.29	0.57*
Greenhouse	0.73*	****	0.85*	0.73*	0.67*	0.56*	0.80*
98001	0.74*	0.85*	****	0.75*	0.46*	0.21	0.71*
98007	0.64*	0.73*	0.75*	****	0.33	0.09	0.61*
98010	0.43*	0.67*	0.46*	0.33	****	0.22	0.54*
98017	0.29	0.56*	0.21	0.09	0.22	****	0.18
00071	0.57*	0.80*	0.71*	0.61*	0.54*	0.18	****

*significant correlation (P = 0.05)

$^{+}$AUDPC – average value for 3 years

++average score of 5 PTR isolates No. 98001, 98007, 98010, 98017, 00071

were compared. Results from field and greenhouse experiments were significantly correlated. Greenhouse screening seems to be a useful technique to screen large number of wheat lines for reaction to tan spot, to identify potential sources of resistance in a wheat breeding program and helpful for the choice of suitable isolates for resistance tests.

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