Identification of New Sources of Resistance to Tan Spot of Wheat

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Abstract:

Tan spot, caused by *Pyrenophora tritici-repentis*, is a major foliar disease of wheat in western Canada. Isolates of *P. tritici-repentis* are presently classified into 11 races based on their virulence on a set of wheat differential cultivars. In western Canada only 5 of these races have been identified. More than 1000 accessions of wheat including synthetics and wild relatives were evaluated for resistance against all the virulent races of *P. tritici-repentis* that are prevalent in western Canada. Disease screening was done under controlled environmental conditions at the seedling stage. High level resistance to *P. tritici-repentis* was observed in some accessions of *Triticum monococum, T. turgidum*, *T. dicoccum*, *T. dicoccoides*, *T. timopheevii*, and *T. aestivum* including synthetic wheat. These accessions also showed good resistance to the leaf spot disease stagnospora nodorum blotch. They will be studied further to determine the genetic basis of resistance and to transfer their resistance to adapted wheat and durum cultivars.

Introduction

Intensified wheat production, changes in cultural practices including shifts from conventional tillage and stubble burning to reduced tillage practices, shorter crop rotations and growing of cultivars resistant to the rusts but susceptible to leaf spots has resulted in development of leaf spots of wheat worldwide in epidemic proportions (De Wolf et al. 1998). Leaf spots of wheat consists of a group of diseases: tan spot caused by *Pyrenophora tritici-repentis*, spot blotch caused by *Bipolaris sorokinina,* septoria tritici blotch caused by *Mycosphaerella graminicola* and stagonospora nodorum blotch caused by *Stagonospora nodorum*.

A complex of these diseases occurs in nature hence managing leaf spots is difficult. Although a number of management practices are useful in controlling leaf spots. These include the use of nonhost plants in the crop rotations, destruction and avoidance of infested straw, stubble and volunteer plants by either burning or burying. However, stubble burning and tillage increase the risk of soil erosion and can contribute to pollution of the environment. The application of fungicides is also effective in controlling leaf spot, but when grain prices are low their use is not cost-effective. Therefore, resistant cultivars are the most effective and economical means of controlling leaf spot (De Wolf et al. 1998).
The Saskatchewan Disease Surveys in recent years show that tan spot is the predominant foliar disease of wheat in Saskatchewan (Fernandez et. al. 1999). Four virulent races: 1,

2, 3, and 5 of *P. tritici-repentis* have been found to occur in western Canada (Lamari et. al.1998). Although resistance effective against each race has been identified but the narrow genetic basis of resistance necessitates the need to identify novel resistance genes. This research addresses to identify new sources of resistance, effective against all races of *P. tritici-repentis*.

Materials and Methods:

Wheat Germplasm:
A diverse range of wheat genotypes were tested in greenhouse tests for disease reaction to different races of *P. tritici-repentis*. The collection obtained from USDA world wheat collection consisted of 500 genotypes coming from eight tetraploid species and one diploid wheat species. The hexaploid wheat collection of 500 genotypes consisted of a collection of synthetic wheats coming from CIMMYT, Mexico and wheat genotypes collected from a variety of sources.

Disease Screening Procedures:
Initially all 1000 genotypes were tested with race 1 isolate Ptr 200 and genotypes showing resistant reaction were then tested with a mixture of isolates of races 1, 2, 3 and 5 to confirm their disease reaction. Subsequently 40 genotypes showing consistent disease reaction were tested in replicated tests with individual isolates Ptr 200 (race 1), Ptr 92-164 (race 2), Ptr 94-8-2 (race 3) and Ptr DW-13 (race 5).

Inoculum was produced using a modification of the method of Lamari and Bernier (1989). Mycelial plugs of 0.5-cm diameter from stock cultures were transferred to 10 cm petri plates containing V8P agar (150 ml V8-juice, 10 g PDA, 10 g agar, 3 g $CaCO_3$ and 850 ml distilled water). These cultures were incubated in the dark at 20-22^{o}C for six days. The plates were then flooded with sterile distilled water and the mycelium flattened with the base of a sterile test tube. To induce conidiophore production the plates were incubated under continuous light at room temperature for two days followed by one day in the dark in an incubator at 15-16^{o}C to induce conidia production. The plates were flooded with distilled water and the conidia were suspended in the distilled water by gently brushing the mycelium with a camel-hair brush to dislodge the conidia from the conidiophores. Spore concentration was measured with a haemocytometer and adjusted to 3000 conidia per milliliter by addition of distilled water.

Using a hand sprayer, plants at the two-leaf stage were sprayed until runoff with the conidial suspension of the appropriate isolate. Following inoculation, the seedlings were incubated for 24 h in continuous leaf wetness in a mist chamber located in a growth room at 22/17^{o}C (day/night) with a 16 h photoperiod and then returned to benches in the same growth room. Eight days after spore-inoculation, the seedlings were rated for disease reaction based on the 1-5 lesion type rating scale developed by Lamari and Bernier (1989).

Results:

Resistance to *P. tritici-repentis* races 1, 2, 3, and 5 has been identified in all ploidy levels of wheat. Results of evaluation of disease reaction of 40 genotypes screened against *P. tritici-repentis* races 1, 2, 3 and 5 are given in table 1. These resistant sources were effective against stagonospora nodorum blotch also (data not presented). More than 90% susceptible genotypes showed necrotic symptoms hence additional efforts should be made to breed for resistance to necrosis component of tan spot. Although majority of genotypes showed resistance to chlorosis but equal proportion of accessions showed susceptibility to chlorosis induced by race 3 or 5. Hence, wheat breeding programs when screening for tan spot resistance should include all the virulent races of *P. tritici-repentis*.

Majority of *T. monococum* and *T. timopheevii* accessions tested showed resistance to both necrosis and chlorosis component of tan spot. Cultivated durum genotypes show poor resistance to tan spot however, the potential to transfer resistance from related species such at *T. timopheevii*, *T. dicoccum* and *T. dicoccoides* exits. Most cultivated common wheat genotypes show susceptibility to tan spot. However, among hexaploid wheat tested high level of resistance in CIMMYT synthetic wheat lines, some introductions and spelt wheat was observed. The synthetic wheat lines besides showing resistance to leaf spots are good sources for fusarium head blight resistance (data not presented). Resistance was observed in all ploidy level of wheat for both necrosis and chlorosis component of tan spot indicating the resistant sources may carry different resistance genes.

To determine the genetic basis of resistance to tan spot and to introgress the novel resistance genes into durum and common wheat varieties, crosses have been initiated among the newly identified resistant sources and adapted wheat and durum cultivars. Presently segregating generations are being tested.

Literature Cited:

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Table 1. Evaluation of disease reaction of 40 genotypes screened against *P. tritici-repentis* races 1, 2, 3 and 5 under growth chamber conditions.

	ENTRY	Race 1	Race 2	Race 3	Race 5
1	Synthetic Hex. Elite # 1	1.24	1.24	1.39	2.61
2	Synthetic Hex. Elite # 9	1.17	1.21	1.18	3.22
3	Synthetic Hex. Elite # 25	1.02	1.22	1.39	3.07
4	Synthetic Hex. Elite # 67	1.28	1.11	1.31	1.17
5	Synthetic Hex. Elite # 85	1.29	1.42	1.28	1.24
6	Synthetic Hex. Elite # 89	1.18	1.13	1.22	1.06
7	Septoria Synthetic # 57	1.24	1.17	1.24	1.12
8	Septoria A Gen Syn. # 106	1.29	1.18	1.31	1.06
9	ALTAR*S/*Ae. squa.*//YACO	1.81	1.29	1.94	1.22
10	92MREHTR 28B	1.36	1.30	1.38	1.18
11	CIMMYT LINES # 18	1.44	1.24	1.19	1.06
12	INTROS # 7	1.35	1.35	1.31	1.17
13	2000 Spelt # 20	1.31	1.11	1.17	1.25
14	Katepwa	4.52	4.50	1.95	3.99
15	Glenlea	4.40	4.13	1.95	1.59
16	Erik	1.53	1.39	1.35	1.28
17	Crocus	4.39	3.67	1.94	1.41
18	AC Splendor	4.31	2.94	2.29	2.39
19	CDC Teal	2.94	3.44	2.17	1.89
20	Kenyon	4.61	4.24	2.41	3.73
21	6B-365	4.29	1.78	4.41	2.01
22	6B-662	1.89	1.47	1.47	3.70
23	ND495	4.41	3.28	1.83	2.06
24	Janz	3.88	3.13	2.44	2.11
25	Domain	4.00	3.54	1.83	4.17
26	Conway	4.19	3.92	2.33	4.00
27	98W1147	3.73	3.78	1.39	1.22
28	Alsan	3.13	3.28	1.78	1.56
29	Coulter	4.28	3.88	4.06	4.11
30	AC Avonlea	3.35	3.67	4.06	2.24
31	4B-242	1.46	1.35	1.56	1.50
32	4B-160	4.58	1.68	4.06	2.30
33	*T. timopheevii* # 199	1.27	1.13	1.17	1.25
34	*T. dicoccoides* # 206	1.35	1.14	1.19	1.13
35	*T. timopheevii* # 227	1.25	1.17	1.23	1.06
36	*T. dicoccoides* # 235	1.22	1.12	1.18	1.30
37	*T. turgidum* # 283	1.38	1.17	1.44	1.50
38	*T. dicoccum* # 420	1.22	1.06	1.39	1.12
39	*T. monococum* # 429	1.22	1.14	1.50	1.13
40	*T. monococum* # 433	1.12	1.00	1.35	1.22
	$LSD_{0.05}$	0.72	0.32	0.20	0.30