Stem Rust Resistance Gene from Triumph 64 Identified in Four Other Winter Wheats

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ABSTRACT

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Five *Triticum aestivum* cultivars from the International Winter Wheat Performance Nurseries I through XII gave similar infection type patterns when tested with 28 isolates of wheat stem rust (*Puccinia graminis* f. sp. *tritici*). The crosses Triumph 64/Martonvasari 5, Parker/Martonvasari 5, and Triumph 64/Parker were made. Genetic analysis of three F_2 progenies tested to *P. graminis* isolate RTQ (72-00-53A) showed that a resistance gene tentatively designated SrTmp in Triumph 64 was also present in Martonvasari 5 and Parker. Similarity of infection types of Mironovskaya 808 and Fertodi 293 with the other three cultivars strongly suggests they also have SrTmp. Although SrTmp is widely distributed (United States, Russia, and Hungary), it occurs in very few cultivars. It provides an intermediate level of resistance to all races of *P. graminis* in North America except race 15-TNM and some isolates of race 56-MBC.

Additional key words: wheat stem rust resistance

The International Winter Wheat Performance Nurseries I (9) through XII were tested for the presence of genes for resistance to *Puccinia graminis* Pers. f. sp. *tritici* Erks. & E. Henn. using 28 isolates of the fungus, each with a different avirulence/virulence formula (3). Five of the 137 winter wheat (*Triticum aestivum* L.) cultivars had an identical infection type (IT) pattern. They had a low infection type (LIT) with the same 20 isolates and a high infection type (HIT) with the other eight isolates. The 20 avirulent isolates conditioned an LIT 2^+ to $2^=$. Seven isolates with an HIT were variants of race 15 (8): TMB, TDM, TLM, TMM, TMR, TNM-1, and TNM-2 (6); and one was race 56-MBC. The characteristic common to these two groups (LIT vs. HIT) of isolates is their avirulence or virulence to SrTmp (7), respectively.

This study was undertaken to verify if these cultivars had the same gene for resistance to *P. graminis*. If the same gene is present, the resistance base for a breeding program and subsequent selections cannot be broadened by using more than one of these cultivars. If different genes are present, however, the stem rust resistance base can be broadened by using the appropriate cultivars for parents.

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MATERIALS AND METHODS

Pedigrees of the five cultivars compared in this study are given in Table 1. Crosses were made among cultivars Triumph 64 (CI 13679), Parker (CI 13285), and Martonvasari 5, which on the basis of previous pathological tests appeared to have a gene in common for resistance to *P. graminis*. A maximum of 20 F_2 embryos per F_1 plant, and the five cultivars, were planted in vermiculite and fertilized with a water-soluble fertilizer (23-19-17, NPK) at a rate of 2.5 g per tray of 12 test materials when the seedlings were 5 and 8 days old. Seven days after seeding, seedlings were inoculated with a urediospore suspension of stem rust race 32, RTQ (72-00-53A), or race 15B-2, TNM (72-4-1A), in a light mineral oil. Inoculated plants were placed in a dew chamber at 18 C overnight. The next morning, the chamber was illuminated ($90-110\ \mu E \cdot sec^{-1} \cdot m^{-2}$) and the temperature allowed to rise gradually to 30 C over a 4-hr period, causing the dew to evaporate slowly. Plants were then placed in a greenhouse at 21 C. Using the rating scale described by Stakman et al (8), each plant was scored for IT 14 days after inoculation.

RESULTS AND DISCUSSION

Results of inoculating F_2 seedlings with stem rust race 32, RTQ (72-00-53A), and race 15B-2, TNM (72-4-1A), are given in Table 2. No segregation of LIT:HIT occurred among the F_2 plants from any of the crosses. All had LIT to race 32, RTQ, and HIT to race 15B-2, TNM. Six plants of 346 were more resistant with LIT of ;1^- to 1^- rather than 2 to $2^-2^=$. The IT of these plant could result from minor environmental variation or varying background genotype (2). In this study, the prevalent parental LITs were 2 to 2^-. Because no segregation occurred to either avirulent or virulent isolates, Triumph 64, Parker, and Martonvasari 5 appear to have a gene in common for resistance to *P. graminis*. The gene from Triumph 64 has been tentatively designated SrTmp.

Although Mironovskaya 808 and Fertodi 293 were not tested in crossing experiments, the similar IT of these two cultivars and the other three cultivars tested with the same isolates of *P. graminis* strongly suggests that they have the gene SrTmp. Mironovskaya 808 is a parent of Martonvasari 5 and probably the source of resistance in the latter cultivar. Infection type data showed that SrTmp was not in Bezostaya 1, another parent. Produttore, another parent of Martonvasari 5, has not been tested. Of the parents of Fertodi 293, Kawvale does not have SrTmp, and Bankuti has not been tested.

The gene SrTmp in Triumph 64 was

Table 1. Pedigree and origin of five winter wheat cultivars with the same infection type pattern resulting from the interaction with seven isolates of race 15, one of race 56, and 20 other races of *Puccinia graminis* f. sp. *tritici*

Cultivar	Pedigree	Origin
Triumph 64 CI 13679	Danne Beardless/Blackhull/3/Kanred/Blackhull//Florence/4/Kanred/Blackhull//Triumph	United States
Parker CI 13285	Quivira/3/Kanred/Hard Federation//Prelude/Kanred/4/Kawvale/Marquillo/Kawvale/Tenmarq	United States
Martonvasari 5	Mironovskaya 808/2*Bezostaya 1/3/Bezostaya 1/Produttore//Bezostaya 1	Hungary
Fertodi 293	Kawvale/Bankuti	Hungary
Mironovskaya 808	Autumnized selection from Artemovka spring wheat	USSR

Table 2. Number of F_1 plants produced from three wheat crosses and reaction of F_2 seedlings with *Puccinia graminis* race 32, RTQ (72-00-53A), and race 15B-2, TNM (72-4-1A)

Cross	No. of F_1 plants	No. of F_2 plants tested with race 32, RTQ, in each infection type			No. of F_1 plants	No. of F_2 plants tested with race 15B-2, TNM, in each infection type	
		$2^-,2^-2^=$	;$1,1^-$	3,4		$2^-,2^-2^=$	3,4
Triumph 64/Martonvasari 5	16	248	5	0	13	0	65
Parker/Martonvasari 5	4	43	1	0	0	-	-
Triumph 64/Parker	3	49	0	0	2	0	18

undoubtedly derived from Triumph because it is the only parental component of Triumph 64 that has a similar IT. The presence of SrTmp in either Triumph or Parker cannot be explained by the IT data of the individual parents listed for each cultivar. Such occurrences are not unusual in selections from breeding programs. The pedigree of Triumph is Blackhull/Kanred//Florence/3/Blackhull/Kanred. SrTmp may be present in other U.S. hard red winter wheat cultivars (D. V. McVey, *unpublished*). This resistance gene has now been identified in a small group of eastern European cultivars and another small group of American winter wheat cultivars presumably with eastern European ancestry.

These five cultivars do not provide diversity for resistance to *P. graminis*, a result previously suggested by the parental testing (3). Gene SrTmp has given an intermediate level of resistance against all races of *P. graminis* in North America to which it has been tested except isolates of race 15 and some isolates of standard race 56. In the United States, the presence of SrTmp in widely grown hard red winter wheats has provided important regional diversity of resistance between the hard red winter and the hard red spring wheat regions. The percentages of the total hard red winter wheat acreage occupied by various cultivars designated as Triumph (Triumph, Triumph 64, Improved Triumph, Newest Improved Triumph, and Rust Resistant Triumph) as reported in 5-yr interval surveys were 19.4% in 1959 (5), 25.4% in 1964 (5), 18.8% in 1969 (5), 12.4% in 1974 (4), and 8.9% in 1979 (1). This provided a screening effect on races of *P. graminis* carried northward by the wind into the hard red spring wheat region. Isolates of races 11, 32, 113, and 151, against which SrTmp is effective and would screen out, pose a greater threat to the hard red spring wheats than isolates of race 15 or 56, to which it is ineffective but to which the hard red spring wheats in turn are resistant.

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