New Wheat Lines with Known Resistance Genes for Identification of Indian Wheat Stem Rust Races

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ABSTRACT

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Physiologic races of stem rust in India have been distinguished on a set of 12 Stakman differential cultivars; the resistance genes in these lines are few and mostly different from those available in the breeding material in India and are thus inadequate in identifying stem rust virulence genes. Wheats *Sr*9b-Mq, *Sr*10-Mq, *Sr*13-Mq, *Sr*22-Mq, combination III (*Sr*Tt1, *Sr*9e), Mentana (*Sr*8), Einkorn (*Sr*21), and TAF 2d (*Sr* Agi.) should be used to distinguish type races of stem rust, and Yalta (*Sr*11 and *Yt*1 & *Yt*2) and McMurachy (*Sr*6) should be used to differentiate biotypes from races. The lines carrying *Sr*26 (Eagle) and *Sr*27 (WRT 238-5) were completely resistant to Indian stem rust races and biotypes and are therefore suggested for detecting new virulence genes. The new differential series will be useful in detecting genetic variation in the pathogen corresponding to the resistance genes.

Physiologic races of stem rust (*Puccinia graminis* Pers f. sp. *tritici* Eriks & Henn.) in India are still classified on a set of 12 cultivars selected by Stakman and Levine (2). Because several genes for resistance in the currently cultivated Indian cultivars differ from those in the set of 12, virulence genes corresponding to the genes for resistance outside the Stakman differentials remain undetected. Work in Canada, the United States, and Australia has demonstrated that a standard race includes numerous components, differentiated by studying the reactions of wheats with genes for resistance different from those in the set of 12. Johnson et al (1) proposed the use of virulence formulas for race identification that has direct bearing on a breeding program. Recasting of a differential series with those carrying various resistance genes, mainly those available in the cultivars in India, is the first essential in a study of complete variation in virulence. We therefore devised a set of wheats that can distinguish the entire set of known Indian races and biotypes of stem rust.

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MATERIALS AND METHODS

Near isogenic lines for stem rust resistance genes and certain supplementary differentials in use in other parts of the world were tested with individual races and biotypes of stem rust. Standard procedures for the testing and classification of reactions were used (2). The inoculum of each race and biotype was obtained from a single-spore culture tested on the set of 12 wheats and supplementary local differentials in use for the differentiation of biotypes. All the tests were done at temperatures not exceeding 22 C.

RESULTS AND DISCUSSION

All known Indian races of stem rust could be distinguished on wheats carrying *Sr*9b, *Sr*10, *Sr*13, *Sr*22, combination III (*Sr*Tt1, *Sr*9e), Mentana (*Sr*8), Einkorn (*Sr*21), and TAF-2d (*Sr* Agi.) (Table 1). Einkorn is represented in the Stakman series of differentials. Khapli, carrying genes *Sr*7a, *Sr*13, *Sr*14, and probably others so far unidentified, is another differential in the Stakman series. *Sr*13-Mq, proposed as one of the new differentials, distinguishes a number of races that are avirulent on Khapli. Similar observations on Canadian and European virulences were made earlier by Watson (3). Mentana *Sr*9b-Mq and TAF-2 are used in Australia as supplementary differentials. Marquis, in the background of the first four listed wheats (Table 1), is resistant to race 14. Consequently, avirulence of race 14 on the resistance genes involved in these four lines should be viewed with caution.

Table 2 shows the identification of known biotypes of the type races on Yalta (*Sr*11, *Sr*Yt1, *Sr*Yt2) and McMurachy (*Sr*6). The biotypes are distinguished from their races on Charter and Yalta. Gabo and Yalta, both carrying *Sr*11, were extensively used in the Indian

Table 1. Reaction types given by classical Indian stem rust races on wheats with known stem rust resistance genes

Lines/cultivars with known genes	Races (as identified on the Stakman 12 differentials)													
	14	15	17	21	24	34	40	42	117	122	184	194	222	295
*Sr*9b-Mq	0;−2	3	X	3	3	4	3	0;−2	0;−2	4	4	3	0;	0;−2
*Sr*10-Mq	0;−1	0;−2	4	3	3	4	3	3	4	3−4	3	0;−1	0;	3
*Sr*13-Mq	0;−2	3	3	0;−2	4	3	3	3	4	4	0;	0;−2	3	4
*Sr*22-Mq	0;−2	3	3	3	0;−1	0;−1	3	0;	2−3	3	0;−2	0;−1	0;−1	3
Combination III (*Sr*Tt1, *Sr*9e)	0;	0;−2	0;−1	0;	0;	0;	3	0;	0;	0;	0;	0;	0;−1	0;
Mentana (*Sr*8)	4	3	3	0;−2+	4	3	3	4	4	0;−2+	3	4	4	3
Einkorn (*Sr*21)	4	4	4	0;−2	4	0;	0;−1	4	4	4	0;	0;−1	0;−2	4
TAF-2d (*Sr*Agi.)	0;	0;	0;	0;−1	0;−2	4	3	0;−1	3	0;−1	0;	0;−1	3	0;

Table 2. Identification of biotypes from their parent stem rust races on wheats carrying known genes

Races and biotypes distinguishable on local differentials	Cultivars	
	Yalta (*Sr*11, *Sr*Yt1, *Sr*Yt2)	McMurachy (*Sr*6)
21	0;−1	3
21A-1	4	4
40	0;−1	3
40A	4	4
42	0;−1	4
42B	3−4	0;−2
117	0;	3
117A	4	0;−2+
117A-1	0;	0;−1

breeding program, and the latter is a good differential. Both Yalta and McMurachy are used as supplementary differentials in Australia. The genes *Sr*11 and *Sr*6 are best recognized when present in varieties Yalta and McMurachy, respectively (R. A. McIntosh, *personal communication*).

Of the resistance genes considered for the classification of stem rust strains in India, genes *Sr*6, *Sr*8, *Sr*9b, *Sr*10, *Sr*11, *Sr*13, and *Sr*Tt1 are the ones in use in the classification of stem rust strains in North America. The use of resistance genes *Sr*6, *Sr*8, *Sr*9b, *Sr*11 for the identification of Indian rust strains has direct relevance to the agricultural situation in India since these genes have been identified in the currently grown cultivars analyzed for stem rust resistance (R. N. Sawhney, *unpublished data*).

In addition to the standard or local differentials, the use of wheats involving a combination of genes or single effective gene that protects seedlings against a wide spectrum of strains provides the opportunity of searching for strains that exist only in very low frequencies in the population but that nevertheless have important genes for virulence. The lines carrying *Sr*26 (Eagle) and *Sr*27 (WRT 238-5) are completely resistant to Indian stem rust races and biotypes. We therefore advocate use of these lines to trap the new field virulences. Use of both of these lines with resistance against a wide spectrum of strains in Australia was also recommended by Watson (3).

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