A Procedure to Identify Resistance to Wheat Soilborne Mosaic in Wheat Seedlings

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ABSTRACT

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A procedure is described whereby wheat cultivars resistant to wheat soilborne mosaic (WSBM) can be identified in the seedling stage. Plants grown in flats were flooded three times upon emergence at 2-hr intervals at 15 C with distilled water that had roots of virus-infected plants submerged in it for 2 hr. After 6–8 wk of growth at 15 C, 74–98% of plants of susceptible genotypes showed symptoms. Conversely, of cultivars possessing high levels of WSBM resistance under field conditions, only 18% or fewer showed symptoms after 6–8 wk in the growth chamber.

Wheat soilborne mosaic (WSBM) is a serious disease of winter wheat (*Triticum aestivum* L.) in Kansas. The causal virus is thought to be transmitted by the soilborne fungus *Polymyxa graminis* Led. (3,6). Since the first epiphytotic in Kansas in 1952 (4), WSBM has spread throughout the eastern two-thirds of the state but rarely occurs in the western one-third. In Kansas, it has caused an estimated annual yield loss of 337×10^6 kg during each of the past 7 yr (8).

The most effective and only practical means of controlling WSBM is the use of resistant cultivars. From 1976 to 1983, the percentage of Kansas wheat acreage seeded with WSBM-resistant cultivars increased from less than 5% to about 50% (9). If this trend continues, most future cultivars developed for use in the eastern part of the state will possess a high level of resistance.

A high level of resistance to WSBM is inherited dominantly over susceptibility and controlled by a single locus (5); all sources of resistance currently used in Kansas breeding programs are thought to share the same factor (5). At present, selection of resistant genotypes is accomplished by planting accessions in naturally infested fields and classifying their reaction in the spring (5). Several sites in Kansas have been selected that consistently show high rates of infection. Even in these areas, however, symptom development is variable from year to year (5), and in 1983, WSBM symptoms were too indistinct to allow selection of resistant genotypes (W. W. Bockus, *unpublished*). Previous selection sites have even been abandoned because of erratic symptom development.

Purified WSBM virus can be transmitted mechanically to wheat leaves but the percentage of infected plants is often low (2). Higher infection levels are obtained when infected roots or debris from infested soil are soaked in water and young seedlings are exposed to this "inoculum" (1,2). Leaf symptoms on inoculated plants grown in the greenhouse or growth chamber are most distinct at 15 C but appear more rapidly at higher temperatures (2).

A technique for screening for WSBM resistance under controlled conditions would aid breeding programs by identifying susceptible lines in early-generation material, which could then be discarded to reduce population sizes. Several screening tests could be run each year and the technique would avoid variable weather conditions that could make WSBM symptoms less distinct than normal. The objective of this study was to develop such an inoculation procedure.

MATERIALS AND METHODS

Seed of 12 winter wheat cultivars was obtained from the Agronomy Department, Kansas State University, Manhattan 66506. Cutivars were selected based on their known field reaction to WSBM (Table 1) and represented the entire range from highly resistant to highly susceptible (9). All experiments were conducted in flats (10 × 40 × 65 cm) filled with a steamed mixture of silty clay loam soil, peat, and vermiculite (1:1:1). Cultivars were each planted in a single row in the flat with 25 seeds per row and covered with 2.5 cm additional soil. Cultivars were arranged in a randomized design and there were three replicate flats for each experiment. When seedlings began to emerge through the soil, flats were placed in a growth chamber (15 C, 1,000 ft-c) and flooded at three 2-hr intervals with inoculum. After inoculation, flats were kept at 15 C and watered and fertilized as needed.

The virus-vector culture was obtained from a naturally infested field near Manhattan, KS, in May 1982. Twenty-five plants (cultivar Sage) showing WSBM symptoms were dug, placed in plastic bags, transported back to the laboratory, and stored 1 wk at 4 C before use. Inoculum was prepared by washing most of the soil from the roots with tap water and soaking 300 g washed roots in a container with 4 L distilled water at 15 C. In this manner, source roots were used to provide three successive quantities of inoculum at 2-hr intervals. When the roots were removed, the inoculum water was divided equally among three flats and

Table 1. Percentage winter wheat seedlings showing wheat soilborne mosaic (WSBM) symptoms in the growth chamber 6 wk after inoculation

Cultivar	Field reaction to WSBM[y]	Percentage seedlings showing WSBM symptoms				
		Experiment number				
		1	2	3	4	Average
Arkan	1	...	...	...	8 a	...
Newton	1	0 a[z]	11 a	18 a	9 a	10
Plainsman V	1	...	...	...	17 ab	...
Homestead	2	40 b	47 b	50 b	18 ab	39
Buckskin	3	...	...	...	36 bc	...
Centurk	4	79 c	64 bc	52 b	50 c	61
Triumph 64	6	87 c	82 cd	55 bc	52 cd	69
Parker 76	7	97 c	88 d	81 d	88 e	89
TAM 105	7	98 c	85 cd	79 cd	86 e	87
Sage	8	96 c	74 cd	83 d	82 e	83
Sturdy	8	...	...	...	74 de	...
Vona	9	...	...	...	82 e	...

[y] Rating scale of 0–9: 0–3 = resistant, 4–6 = moderately resistant, and 7–9 = susceptible.
[z] Means of three replicates, with 15–25 plants per replicate. Values within a column followed by different letters are significantly different ($P = 0.05$) according to Duncan's multiple range test.

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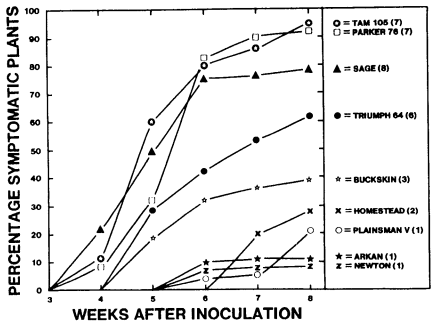

Fig. 1. Percentage of winter wheat seedlings showing wheat soilborne mosaic (WSBM) symptoms in the growth chamber at various times after inoculation. Number following cultivar name is the field reaction to WSBMV, where 0–3 = resistant, 4–6 = moderately resistant, and 7–9 = susceptible. Each point is the mean of three replicates, with 13–23 plants per replicate. $LSD_{0.05}$ = 36, 28, 21, 21, and 19 for weeks 4, 5, 6, 7, and 8, respectively.

poured over the soil surface. After establishing the virus/vector culture in the growth chamber, roots of symptomatic seedlings from one flat (rather than field-collected plants) were used to produce inoculum, although the procedure remained the same.

Inoculated seedlings were kept at 15 C for 6–8 wk, then rated for characteristic WSBM symptoms (7). Percentage infection was calculated by dividing the number of symptomatic seedlings by the number of seedlings examined. In one experiment, percentage infection was determined at weekly intervals for 8 wk after inoculation.

RESULTS AND DISCUSSION

High percentages (74–98) of symptomatic seedlings were obtained in susceptible genotypes by using the flood-inoculation technique (Table 1). Conversely, cultivars with field resistance to WSBM displayed 18% or fewer symptomatic plants.

When WSBM symptoms were rated weekly after inoculation, differences between cultivars were noted with regard to the date symptomatic seedlings first appeared (Fig. 1). Susceptible cultivars (Tam 105, Parker 76, and Sage) had a few plants showing symptoms 4 wk after inoculation, whereas cultivars with intermediate field reaction (Triumph 64 and Buckskin) did not have any symptomatic plants until the fifth week and resistant cultivars (Homestead, Plainsman V, Arkan, and Newton) did not begin to show symptoms until the sixth or seventh week. Cultivars tended to maintain their relative position from week to week; however, the best time to separate resistant, moderately resistant, and susceptible genotypes was the sixth to eighth week after inoculation.

Even in highly resistant cultivars (Arkan, Newton, and Plainsman V) significant percentages of symptomatic seedlings (8–20%) were noted. This may reflect the severity of the laboratory screening test or increased virus titer in resistant material under the growth-chamber environment, thus producing some symptomatic plants. The erratic reactions (ie, higher than expected incidence of symptoms) of Homestead and Buckskin in these tests parallel their unpredictable reaction in the field over several years of evaluation (C. L. Niblett, *unpublished*).

The correlation between field reaction and percentage of mosaic seedlings using data from all experiments was 0.89. Thus, the screening procedure described in this paper is a useful indicator of the field reaction of winter wheat cultivars to WSBM and should find application in wheat breeding programs where WSBM resistance has high priority.

LITERATURE CITED

1. Brakke, M. K., and Estes, A. P. 1967. Some factors affecting vector transmission of soil-borne wheat mosaic virus from root washings and soil debris. Phytopathology 57:905-910.
2. Brakke, M. K., Estes, A. P., and Schuster, M. L. 1965. Transmission of soil-borne wheat mosaic virus. Phytopathology 55:79-86.
3. Estes, A. P., and Brakke, M. K. 1966. Correlation of *Polymyxa graminis* with transmission of soil-borne wheat mosaic virus. Virology 28:772-774.
4. Fellows, H., Sill, W. H., Jr., and King, C. L. 1953. The 1952 epiphytotic of a soil-borne wheat mosaic in Kansas. Plant Dis. Rep. 37:287-289.
5. Modawi, R. S., Heyne, E. G., Brunetta, P., and Willis, W. G. 1982. Genetic studies of field reaction to wheat soilborne mosaic virus. Plant Dis. 66:1183-1184.
6. Rao, A. S., and Brakke, M. K. 1969. Relation of soilborne wheat mosaic virus and its fungal vector, *Polymyxa graminis*. Phytopathology 59:581-587.
7. Sill, W. H., Jr. 1958. A comparison of some characteristics of soil-borne wheat mosaic viruses in the Great Plains and elsewhere. Plant Dis. Rep. 42:912-924.
8. Sim, T., IV, and Willis, W. G. 1982. 1982 Kansas wheat disease losses. Kans. State Board Agric., Topeka. 4 pp.
9. Walter, T. L. 1982. 1982 Kansas performance tests with winter wheat varieties. Kans. Agric. Exp. Stn., Manhattan. 20 pp.