Evaluation of Tolerance to Septoria Leaf Blotch in Spring Wheat

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ABSTRACT

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Differential loss in yield components of five spring wheat cultivars to Septoria leaf blotch epidemics as compared to fungicide-protected plants served as the basis for evaluation of tolerance. Yield and kernel weight furnish better estimates of tolerance to leaf blotch than grain number per head. In vulnerable wheat cultivars, lateral tillers sustained greater yield reductions than did the central tiller. Enhanced tillering possibly had a negative effect on yield in severe leaf blotch epidemics. The dwarf cultivar Bet-Dagan 131 exhibited yield and kernel weight reductions of about 40%, whereas the semi-dwarf cultivars manifested lower losses. The tolerant wheat cultivar Miriam, under leaf blotch severity equivalent to that of the other semi-dwarf cultivars, maintained a low level yield reduction similar to those attained by the moderately resistant cultivar Yafit. Under severe leaf blotch epidemics, vulnerable wheat cultivars with low 1,000-kernel weight are at a distinct disadvantage over agronomically similar cultivars with large grains.

Additional key words: Septoria tritici.

The Septoria leaf blotch disease of wheat caused by *Septoria tritici* Rob. ex Desm. often assumes epidemic proportions, and has caused serious yield reductions (6, 8, 12, 17). The rapid replacement of local wheat cultivars by high-yielding, short-strawed cultivars susceptible to Septoria leaf blotch, have increased the importance of this disease (12, 17).

Varietal resistance, chemical control, and suitable agronomic practices are the major control measures for Septoria leaf blotch (6, 11, 12, 17). Extensive breeding programs currently underway in many countries (12) are complicated by the presence of physiologic specialization of the pathogen (7).

In the management of host resistance genes to control small grain diseases, tolerance has been given high priority (9). The term is applied to plants that appear susceptible to a disease without sustaining severe losses in yield or quality (3, 4, 13). Attention is also drawn to establishment of disease equivalence, to the duration of pathogen interaction with the host, and to quantitative measures used to evaluate cultivar response (3, 9, 13, 14). The advantages of tolerance and proposed schemes for its employment were discussed by Caldwell et al. (3), Frey et al. (9), Schafer (13), and Simons (15, 16).

Tolerance of wheat cultivars to *Septoria nodorum* has been extensively investigated and reported (1, 2, 5), whereas information on tolerance of wheat cultivars to *S. tritici* is scarce (5, 8).

The purpose of this study was to investigate the effect of Septoria leaf blotch epidemics on components of yield of several spring wheat cultivars.

MATERIALS AND METHODS

Five high-yielding, short-strawed, autumn-sown spring wheat cultivars were studied including the semi-dwarf 'Lakhish' (height 110-120 cm) derived from the cross Yt/ /Nrn 10/B21-1C/3/FA, and the dwarf cultivar 'Bet-Dagan 131' (height 80-90 cm) of the same cross. These cultivars, together with the semi-dwarf cultivar 'Miriam', derived from the cross Ch53/2/Nrn 10/B26/3/Yq54/4/2 Merav, originated at the Volcani Center, Agriculture Research Organization, Israel. The semi-dwarf cultivars 'Mivhor 1177' (Penjamo Sib. × Gabo 55, cross 8156B) and 'Yafit' (2193/Ch53-An × Gb56 × An64) originated at the Hazera Seed Co., Israel. The experiment was conducted during the 1971-72 growing season and repeated in 1973-74 season, at the Lakhish Experiment Station, situated in the semi-arid Southern Coastal plains. The mean number of seedlings per square meter was about 200-250 for each of the wheat cultivars tested. Wheat plots of 75 m^2 were sown in eight replications of which four paired replications were protected with weekly sprays of tank-mix maneb (8). In the nonprotected wheat plots Septoria leaf blotch epidemics were established by spreading wheat straw infested with viable pycnidia of *S. tritici,* after seedling emergence. Short-duration sprinkler irrigation (20 m^3) was applied twice during the season to ensure build-up of the disease.

Disease development was recorded at the 10.5.4 wheat growing stage according to the Feekes' Scale (10), on 25

randomly selected wheat plants per plot, based on criteria established by Eyal and Ziv (8). Prior to harvest, these plants in all plots were removed for assessment of yield components.

Each wheat plant was subdivided into the following parts: (i) the central tiller, and (ii) the combined lateral tillers. For each, the number of kernels per head and 1,000-kernel weight were recorded and analyzed for fungicide-protected and nonprotected wheat plants.

RESULTS

Yield components of the five cultivars grown during the two seasons at the Lakhish Experiment Station are presented in Tables 1, 2 and 3. Analysis of variance was conducted on percentage loss of each cultivar converted to angles. The percentage differences between yield and number of kernels per head of central tiller and lateral tillers in fungicide-protected wheat plants are expressed as tillers ratio.

Responses of cultivars to the disease during the 1972-74 growing seasons were similar; however, more severe losses occurred in the second season (Table 1). The dwarf cultivar Bet-Dagan 131 and the semi-dwarf Mivhor 1177 manifested high losses in yield during the 1971-72 season, especially in single plant analysis. Lakhish expressed high losses in yield during the 1973-74 season. Miriam and Yafit manifested low yield losses. Yafit expressed a high tillers ratio which indicates a low yield of lateral tillers in contrast with yield of central tiller. Analysis of 1,000-kernel weight data showed similar cultivar response to that expressed by yield analysis (Table 2). Losses in kernel weight as high as 40% were recorded for lateral tillers of Bet-Dagan 131; Lakhish and Mivhor 1177 exhibited less

TABLE 1. Assessment of losses in yield caused by Septoria leaf blotch to five spring wheat cultivars grown at the Lakhish Experiment Station, Israel, during the 1971-72 and 1973-74 seasons

Season and cultivar	Yield		Yield/head central tiller		Yield/head lateral tiller		Mean yield/head		Tillers ratio[b]
	kg/dunam[a]	loss (%)	g[a]	loss (%)	g[a]	loss (%)	g[a]	loss (%)	(%)
1971-72:									
Bet-Dagan 131	440.2	32.6**[c]	1.7	16.3**	1.2	23.6**	1.3	20.9**	32.6
Lakhish	421.3	7.0	1.8	8.6	1.4	6.7	1.5	9.6*	23.7
Miriam	437.9	0.4	2.1	3.6	1.6	3.3	1.8	4.4	23.2
Mivhor 1177	410.6	6.5	2.2	21.3**	1.5	18.3**	1.7	19.7**	32.2
Yafit	381.2	6.6	1.7	3.6	1.1	2.5	1.2	3.9	38.1
1973-74:									
Bet-Dagan 131	445.3	34.7**	1.6	36.4**	1.1	48.4**	1.3	42.8**	29.9
Lakhish	503.1	12.2	1.6	24.1**	1.2	35.3**	1.4	29.4**	28.3
Miriam	462.1	14.4	1.8	1.7	1.2	+3.7	1.5	0.3	31.5
Mivhor 1177	476.7	21.0*	2.0	18.4**	1.3	24.9**	1.7	20.3**	34.1
Yafit	489.5	5.8	1.7	+0.4	1.1	+0.2	1.3	0.0	36.7

[a]Yield of fungicide protected wheat plots, % loss = (yield protected - yield of unprotected)/yield of protected plot; 1 dunam = 1/10 hectare.

[b]Expresses ratio in percent of treated central vs. treated lateral tillers.

[c]* Significant differences at $P = 0.05$. ** Significant differences at $P = 0.01$.

TABLE 2. Assessment of losses in 1,000-kernel weight caused by Septoria leaf blotch to five spring wheat cultivars grown at the Lakhish Experiment Station, Israel during the 1971-72 and 1973-74 seasons

Season and cultivar	1,000-kernel weight per plot		1,000-kernel weight central tiller		1,000-kernel weight lateral tiller		mean 1,000-kernel weight	
	g[a]	loss (%)	g[a]	loss (%)	g[a]	loss (%)	g[a]	loss (%)
1971-72:								
Bet-Dagan 131	35.5	16.8**[b]	39.2	8.1**	33.7	9.7**	35.6	9.2**
Lakhish	38.4	6.4**	42.8	7.5*	41.4	10.5**	41.8	9.8**
Miriam	40.9	7.9**	43.8	2.1	41.9	4.8	42.6	4.0
Mivhor 1177	32.7	5.1**	35.4	7.1**	32.1	7.8**	33.3	7.9**
Yafit	33.5	5.3**	33.4	3.0	33.3	3.4	33.4	2.0
1973-74:								
Bet-Dagan 131	39.0	24.2**	42.1	29.9**	40.6	39.9**	41.3	34.8**
Lakhish	43.6	12.3**	44.3	19.8**	44.2	25.5**	44.2	22.1**
Miriam	40.9	10.3**	42.3	10.0**	40.1	8.4**	41.3	8.0**
Mivhor 1177	35.4	19.2**	36.3	16.4**	34.5	24.4**	35.6	19.7**
Yafit	34.2	3.2*	33.9	1.2	34.8	1.5	34.3	1.4

[a]Data given for fungicide protected wheat plots.

[b]* Significant differences at $P = 0.05$. ** Significant differences at $P = 0.01$.

TABLE 3. Assessment of losses in number of kernels per head caused by Septoria leaf blotch of wheat to five spring wheat cultivars grown at the Lakhish Experiment Station, Israel, during the 1971-72 and 1973-74 seasons

Season and cultivar	Number kernels/head central tiller		Number kernels/head lateral tiller		Mean number kernels/head		Tillers ratio[b] (%)
	T[a]	loss (%)	T[a]	loss (%)	T[a]	loss (%)	
1971-72:							
Bet-Dagan 131	43.6	10.0*[c]	33.8	21.2**	36.4	17.1**	22.6
Lakhish	42.3	1.6	33.3	+3.6	35.5	+0.9	21.3
Miriam	49.8	6.1	41.1	7.9	43.5	8.6	17.6
Mivhor 1177	62.9	15.9**	46.4	11.3*	51.3	6.2	39.8
Yafit	50.9	3.9	32.5	6.2	37.7	6.2	39.8
1973-74:							
Bet-Dagan 131	39.3	9.7**	28.4	16.2**	32.6	13.4**	27.9
Lakhish	36.9	5.3*	26.6	13.8**	30.8	9.5**	27.9
Miriam	44.7	5.7**	34.3	11.3**	38.7	8.0**	27.9
Mivhor 1177	56.1	0.8	38.6	1.5	46.8	0.8	31.2
Yafit	50.1	+1.9	31.1	+1.4	39.2	+1.2	38.0

[a]Number of kernels per heads in fungicide treated wheat plots.
[b]Treated central vs. treated lateral tillers.
[c]* Significant differences at $P = 0.05$. ** Significant differences at $P = 0.01$.

TABLE 4. Septoria leaf blotch severities of unsprayed plots and Septoria Progress Coefficient (SPC) of five spring wheat cultivars grown in the Lakhish Experiment Station, Israel, during 1971-72 and 1973-74 seasons

Cultivar	1971-72 season		1973-74 season	
	Pycnidia coverage (%)[a]	SPC[b]	Pycnidia coverage (%)[a]	SPC[b]
Bet-Dagan 131	87.2	0.976	76.6	0.929
Lakhish	80.7	0.753	61.5	0.914
Miriam	77.8	0.716	64.0	0.855
Mivhor 1177	73.2	0.767	60.3	0.883
Yafit	43.7	0.671	14.6	0.739

[a]Mean pycnidia coverage of upper three leaves flag leaf, flag leaf minus one, and flag leaf minus two.
[b]SPC = Septoria Progress Coefficient; disease height divided by plant height.

severe losses. Miriam and Yafit manifested low kernel weight losses. Constant low kernel weight is expressed by the Mivhor 1177 and Yafit. These two cultivars have prolific ears with more than 50 grains per central tiller (Table 3). Losses in number of kernels per head of more than 10% are exhibited by the dwarf Bet-Dagan 131 (Table 3). Inconsistency in losses in number of kernels per ear is expressed by the other cultivars. Small differences in the mean kernel number per head were obtained in the cultivar Yafit, yet the lateral tillers were less prolific than the central tiller as expressed by tillers ratio.

Severe losses in yield, 1,000-kernel weight and to a lesser extent in number of grains per ear, corresponded with high percentage coverage by pycnidia of *S. tritici* of the upper three leaves (Table 4). The cultivar Yafit exhibited low pycnidia coverage, yet high Septoria Progress Coefficients (SPC) indicates that pycnidia reached upper plant parts.

The mean average number of tillers per plant for each of the cultivars tested was in the range of 3.5 - 4.0 tillers in 1971-72, and 2.3 - 2.8 tillers in the 1973-74 season. No significant differences were found in number of tillers from fungicide-protected wheat as compared to unprotected wheat plots.

DISCUSSION

The lack of resistance to Septoria leaf blotch in commercial wheat cultivars necessitates evaluation of other means of protection which will enable the wheat plant to express its yielding potential. Chemical control may serve as an economical interim means of reducing losses until effective germplasm can be introduced to vulnerable wheats (Eyal and Wahl, *unpublished).* Under optimal growing conditions (fertile soil, fertilizer, irrigation, etc.), vulnerable spring wheat cultivars with high-yielding potential (e.g. Mivhor 1177) may express their yielding capacity under fungicide protection, or in disease-free seasons (Table 1).

Evaluation of losses in yield components of commercial or advanced spring wheat cultivars serves as a promising selection procedure for detecting tolerance or moderate levels of resistance.

Analysis of yield, kernel weight and, to a lesser extent, number of kernels per head for randomly selected wheat plants revealed differential response in losses among the tested wheat cultivars, most of which showed equivalent disease severity. The cultivar Bet-Dagan 131 exhibited a high level of vulnerability, whereas Lakhish and Mivhor 1177 suffered losses of lower magnitude. Miriam, though manifesting equivalent pycnidia coverage, maintained low levels of yield reduction, thus it can be classified as tolerant to Septoria leaf blotch of wheat. Moderate resistance to Septoria leaf blotch, expressed in low pycnidial coverage as in the cultivar Yafit, resulted in nonsignificant yield and kernel weight losses.

Losses in yield components of lateral tillers due to Septoria leaf blotch are markedly greater than those suffered by the central tiller. Lateness in development, together with shorter stature of lateral tillers, may result in high disease severity and thus greater yield reductions.

In some environments, however, such as exist in Montana, late tillers are often less affected than primary tillers (A. L. Scharen, *personal communication*). Tillers ratio for yield and number of kernels per head of protected wheat plants was relatively constant for each cultivar, with the lowest ratio exhibited in Miriam and the highest ratio obtained in Yafit. High tillering capacity, or agronomic practices that stimulate tillering, may increase the effect of Septoria leaf blotch epidemics on yield losses of vulnerable cultivars.

Susceptible wheat cultivars characterized by grains with low kernel weight (Mivhor 1177), under severe leaf blotch epidemics may result in shriveled grains. Vulnerable cultivars with relatively larger kernels (Lakhish) suffering from similar loss percentages, resulted in smaller kernels still fit for milling.

An effort is being made to combine high-yielding potential of spring wheat cultivars while preserving characters exhibited by Miriam: tolerance to Septoria leaf blotch, high 1,000-kernel weight, low tillering capacity, and its wide adaptability under dryland conditions.

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