Effect of Fungicides on Septoria Leaf and Glume Blotch, Fusarium Scab, Grain Yield, and Test Weight of Winter Wheat

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ABSTRACT

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During 1974 and 1975, winter wheat yields were reduced up to 15-20% by *Septoria tritici*, *S. nodorum*, and *Fusarium roseum* f. sp. *cerealis* 'Graminearum' as measured by yield response to fungicides. Wheat yields were 20% higher in 1974 in plots treated with mancozeb or mancozeb plus benomyl, and 15% higher when treated with benomyl alone. Yields were increased 15% in 1975 by mancozeb plus benomyl, and by 7-11% by benomyl or MBC (methyl 2-benzimidazole-carbamate). Mancozeb or mancozeb plus benomyl gave better control of *S. tritici* than did benomyl or MBC. Infection of heads by *S. nodorum* was reduced from 57% on nonsprayed plots to 8-22% by fungicide treatments. *Fusarium roseum* infection of grain was reduced from 24% in nonsprayed plots, to 12% in plots treated with mancozeb plus benomyl and to 4-8% in plots treated with MBC or benomyl. Test weights were increased 1.2-2.0% by fungicide treatment in 1974.

Yield losses in wheat (*Triticum aestivum* L.) to Septoria leaf blotch (caused by *Septoria tritici* Rob. ex Desm.), Septoria glume blotch [caused by *Septoria nodorum* (Berk.) Berk = *Leptosphaeria nodorum* Müller], and scab [caused by *Fusarium roseum* (Link) Snyd. and Hans. f. sp. *cerealis* (Cke.) Snyd. and Hans. 'Graminearum' = *Gibberella zeae* (Schw.) Petch] have been reported by many authors (1, 3, 4, 5, 6, 7, 10, 11, 12, 13). Boewe (3) reported that the Septoria disease in Illinois caused up to 55% yield loss and scab up to 11% yield loss. Because of the annual importance of these diseases in Illinois, and reports of control of Septoria leaf and glume blotch and Fusarium scab by foliar fungicide applications (1, 6, 7, 8, 11, 14), the value of foliar fungicide application was examined. Experiments in 1974 indicated that benomyl provided some control of scab and the Septoria diseases; therefore, the efficacy of benomyl in scab control was more thoroughly examined in 1975.

MATERIALS AND METHODS

Fungicide applications were made to uniform stands of winter wheat, cultivar Arthur 71, seeded at 70 kg/hectare (ha). The fungicides were applied with a CO_2 sprayer in 80 liters of water per hectare. Fungicide was applied in 1974 at 50% heading and again 10 days later. In 1975, the fungicides were applied at the milky dough stage and again 10 days later.

Mancozeb, (a coordination product of zinc and manganese ethylene bis-dithiocarbamate) was applied at 1.76 kg active ingredient (a.i.) per hectare alone or at 1.1 kg a.i./ha in combination with benomyl [methyl 1-(butylcarbamoyl-2-benzimidazole carbamate)]. Benomyl was applied at 0.55 kg a.i./ha alone or at 0.27 kg a.i./ha in combination with mancozeb. MBC (methyl benzimidazole carbamate) was applied at 0.55 and 1.1 kg/ha. Triton B-1956 was used as a spreader-sticker.

Plots were not replicated in 1974, but in 1975 a completely randomized block arrangement was used with four replications per treatment. In 1974, the harvested plot size was 84.6 m^2; in 1975, the harvested plot size was 30.8 m^2. Grain was harvested with a plot combine and yields were determined by actual grain weight. Test weights were determined using a Toledo field scale apparatus and Steinlite Electronic moisture tester.

Three 50-plant subsamples from each plot were rated for Septoria leaf blotch 15 days after the final fungicide application. The area of the flag leaf infected with *S. tritici* was visually rated on a 1-6 scale: 1 = no infection, 2 = 1-20% infection, 3 = 21-40% infection, 4 = 41-60 infection, 5 = 61-80% infection, and 6 = 81-100% of the flag leaf infected. Ratings for Septoria glume blotch were based on the percentage of heads with typical symptoms. Twenty-five randomly selected heads from each plot were used for glume blotch and head disease index (HDI) ratings. HDI data were obtained by scoring heads visually for discoloration on a 1-4 scale: 1 = 1% or less head area discolored, 2 = 10-50%, 3 = 51-90%, and 4 = greater than 90% head area discolored. The formula for HDI is:

$$\mathrm{HDI} = \Sigma\left(\frac{\text{No. heads in each class} \times \text{class number}}{\text{total no. of heads}}\right) \times 2.5$$

The percentage scab infection was determined by plating 1,000 kernels on pentachloronitrobenzene-peptone-salts agar medium (9) incubated under cool-white fluorescent lights at 21 C for 10-14 days.

RESULTS

Control of Septoria leaf blotch was best using benomyl plus mancozeb (Tables 1 and 2). Differences between fungicide-treated and untreated plots were obvious at the time leaf disease data were taken (Fig. 1). Plant senescence was delayed by 5-7 days in plots treated with mancozeb or benomyl plus mancozeb. Leaf samples taken at heading indicated that in both years *S. tritici* was the primary organism responsible for leaf death.

Plants sprayed with benomyl alone or in combination with mancozeb or with MBC had cleaner heads and a lower incidence of scab (Table 2). The reduction in scab was reflected in increased test weights (Table 1), and in reduced percentages of Fusarium-infected grain (Table 2). All fungicide treatments reduced scab infection, glume blotch infection, and HDI. *Cladosporium herbarum* (Pers.) Lk. and *S. nodorum* were primarily responsible for head discoloration.

In 1974, yields were increased by 20.6, 20.2, and 15.9% in plots treated with mancozeb, mancozeb plus benomyl, and benomyl, respectively (Table 1). In 1975, yields were increased 15, 11, and 7% by mancozeb plus benomyl, MBC (1.1 kg/ha) plus benomyl, and MBC (0.55 kg/ha), respectively (Table 2). No difference in test weight was observed between sprayed and nonsprayed plots in 1975.

TABLE 1. Effect of fungicides on yields of Arthur 71 wheat and on leaf blotch caused by *Septoria tritici* in 1974

Treatment			Grain	
Fungicide	Rate (kg/ha)	Leaf bloth (rating)[a]	Yield (kg/ha)	Test weight (% increase over check)
None (ck)	...	5.3	2,183	...
Mancozeb	1.76	3.4	2,746	1.7
Benomyl	0.55	4.3	2,593	2.0
Benomyl+ mancozeb	0.27 1.10	3.2	2,733	1.2

[a]Leaf blotch rating: 1 = no infection, 2 = 20%, 3 = 21-40%, 5 = 61-80%, and 6 = 81-100% flag leaf infection.

DISCUSSION

It is possible that factors other than control of Septoria leaf blotch, Septoria glume blotch, and Fusarium scab were involved in the yield increases observed with fungicide sprays in 1974 and 1975. However, similar yield increases and senescence delays have been observed by others (1, 6, 10, 11) following application of mancozeb. In 1976, a dry year with little development of Septoria leaf blotch or glume blotch, yields were not significantly different nor was senescence delayed in plots sprayed with either mancozeb or mancozeb plus benomyl, compared to unsprayed plots (B. J. Jacobsen, *unpublished*). Therefore, increases from sprays with benomyl or MBC are not likely to be due to kinetin effects of these materials or control of crown or root diseases. Since incomplete disease control was achieved through the use of fungicide sprays, it is likely that yield losses exceed the 15-20% shown in these studies.

Others (2, 8) have shown that yield increases following application of fungicides were due primarily to increased kernel weight. Since test weights were increased only 1.2-2.0% in 1974 and were unaffected in 1975, increases in harvested kernel numbers are more likely responsible for the yield increases recorded in these studies. More precise

Fig. 1. Delay in senescence in winter wheat owing to control of *Septoria tritici* by fungicide sprays. The strip between the white flags received fungicide treatments.

TABLE 2. Effect of fungicides on percentage seedborne scab (caused by *Fusarium roseum* f. sp. *cerealis* 'Graminearum'), Septoria glume blotch (caused by *Septoria nodorum*), and Septoria leaf blotch (caused by *Septoria tritici*), head discoloration index, and grain yield of Arthur 71 wheat in 1975

Treatment						
Fungicide	Rate (kg/ha)	Scab[u] (%)	Leaf blotch[v] rating	Glume blotch[w] (%)	HDI[x]	Grain yield (kg/ha)
Check	0	24.3[y]	5	57.3 a	46.6 a	2587.1 c
Benomyl	0.55	9.0 bc	4.2	20.0 bc	31.6 bc	2924.5 ab
Benomyl	0.55	4.0 d	4.2	22.7 bc	31.6 bc	2887.0 abc
MBC	0.55	6.0 d	4.0	8.3 bc	32.5 bc	2766.6 bc
MBC	1.10	8.0 bcd	4.1	24.0 b	28.3 bc	2879.1 ab
Benomyl + mancozeb	0.27 1.10	12.0 b	3.4 ns[z]	9.3 cd	37.5 b	3037.1 ab

[u]Average percentage infected grain of 1,000 kernels for each of four replicates.
[v]Leaf blotch rating: 1 = no infection, 2 = 20%, 3 = 21-40%, 4 = 41-60%, 5 = 61-80%, and 6 = 81-100% flag leaf infection.
[w]Average percentage of heads infected with *Septoria nodorum* of four replications of 50 heads each.
[x]Average head discoloration index: 1 = 19%, 2 = 10-50%, 3 = 51-90%, and 4 = 90% of head area discolored.
[y]Numbers in same column followed by the same letter are not significantly different, $P = 0.05$.
[z]None significant.

information on kernel weight could have been gathered by hand harvesting the grain since the combine blows out much of the light-weight grain with the chaff. The delay in senescence would logically provide a longer period for grain filling and thereby higher kernel weight. Alternatively, reduction in scab may have resulted in more kernels per head.

Control of scab and *S. nodorum* was obvious in both years. While seed samples were not saved for planting, increased seed quality should accrue since both fungi are seedborne and both reduce seed quality. Seedling blight due to *F. roseum* is a common problem in Illinois (3). If increases in seed quality are shown with seed from fungicide-sprayed fields, this practice could attain importance for wheat seed producers in Illinois and elsewhere.

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