Yield Losses in Soybeans Induced by Powdery Mildew

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ABSTRACT

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Soybean yield losses caused by natural infection with *Microsphaera diffusa*, the powdery mildew fungus, were assessed by testing three susceptible and three resistant cultivars at three locations in Iowa for 3 yr. A spray containing benomyl was applied weekly to plant rows until runoff, from 1 July until near plant maturity. Nonsprayed rows served as controls. Seed yield losses ranged from 0 to 26%; mean seed yield loss for the 3 yr was 13%. Plants of resistant cultivars were not infected by *M. diffusa*, and seed yield was unaffected by benomyl treatment. Findings indicate that no disease other than powdery mildew reduced the yield in nonsprayed susceptible plants and that benomyl had no phytotoxic or stimulatory effects on resistant plants.

Powdery mildew of soybeans (*Glycine max* [L.] Merr.) caused by *Microsphaera diffusa* Cke. & Pk. has been reported recently in Minnesota (5), Illinois (8), and Iowa (2). The disease has occurred in the southern United States for many years. Lehman reported soybean powdery mildew in North Carolina in 1947 (7). He reported the disease was caused by *Microsphaera* sp., but Johnson and Jones (6) believed that *M. diffusa* was the causal organism, a conclusion confirmed by other researchers (2,5,8). The disease was rarely seen in Iowa before 1973 but has been observed each year since then. A survey in central Iowa in 1975 revealed that powdery mildew was present in 19% of 311 fields examined (4). In the fields in which the disease was found, the mean prevalence of plant infection was 79%. The popularity of mildew-susceptible cultivars such as Corsoy and Hark, which comprised more than 50% of the soybean acreage in northern Iowa in 1977, probably is a factor in the current prevalence of the disease (4).

In the early stages of powdery mildew disease, small, thin, light-gray, or white fungal colonies spread rapidly on the upper surface of leaves and the undersides sometimes turn pink to red. In later stages, infected areas enlarge and sometimes coalesce to cover the leaf surface (1). The fungus produces a superficial infection of leaf mesophyll cells, but the aerial mycelium on the leaf surface is particularly dense (3,8).

A preliminary study of soybean yield losses caused by powdery mildew made in central Iowa during 1975 (4) showed an average yield loss of 10% for three susceptible cultivars. The present study was designed to obtain more extensive data on the effect of *M. diffusa* on soybean seed yield losses.

MATERIALS AND METHODS

Tests were conducted from 1976 through 1978 in Iowa near Ames (central), Kanawha (north-central), and Nashua (northeast) on fertile, well-managed soils. Three susceptible (S) and three resistant (R) cultivars were tested. In maturity group II (early at Ames, medium at Kanawha and Nashua), two S cultivars (Corsoy and Harosoy 63) and two R cultivars (Beeson and Lindarin 63) were grown. In maturity group III (medium at Ames, late at Kanawha and Nashua), one S cultivar (Kanrich) and one R cultivar (Wayne) were grown. The susceptibility or resistance of these cultivars was determined in an earlier study (3). Plants were grown in rows 3 m long and 1 m wide. Each plot consisted of three rows; the center row was harvested for determination of seed yield.

At each location, plots of each cultivar were either untreated or sprayed until runoff with benomyl (methyl 1-[butylcarbamoyl]-2-benzimidazolecarbamate) at 1 g/L every week from 1 July until plant maturity. Each treatment was replicated six times in a complete randomized block. A 4-ha block of Corsoy (S) was sown adjacent to the test

Table 1. Seed yields from nonsprayed and benomyl-sprayed plots of soybean cultivars resistant and susceptible to *Microsphaera diffusa* at three locations in Iowa during 1976, 1977, and 1978

Cultivar and disease reaction[a]	Seed yield[b] Control (q/ha)	Benomyl (q/ha)	Control (q/ha)	Benomyl (q/ha)
		1976		
	Ames		Kanawha	
Corsoy (S)	29.7	33.5[c]	29.3	28.6
Beeson (R)	34.3	32.1	30.6	27.9
Harosoy 63 (S)	26.1	29.5[c]	25.1	24.8
Lindarin 63 (R)	25.4	24.7	26.5	23.7
Kanrich (S)	26.0	24.7	23.8	24.8
Wayne (R)	26.4	26.7	25.4	25.8
		1977		
	Nashua		Kanawha	
Corsoy (S)	25.5	32.3[d]	26.6	35.9[d]
Beeson (R)	34.4	33.2	30.7	32.5
Harosoy 63 (S)	24.9	31.3[c]	23.6	30.3[d]
Lindarin 63 (R)	32.4	32.9	28.8	30.3
Kanrich (S)	27.1	33.1[c]	25.3	30.2[c]
Wayne (R)	42.6	40.6	31.8	33.1
		1978		
	Nashua		Kanawha	
Corsoy (S)	26.9	31.9[d]	29.7	37.3[d]
Beeson (R)	37.3	37.8	34.8	34.4
Harosoy 63 (S)	27.3	31.2[d]	28.0	34.1[d]
Lindarin 63 (R)	31.1	32.0	31.6	33.5
Kanrich (S)	29.1	33.6[d]	28.6	31.9[c]
Wayne (R)	38.7	38.3	34.8	33.1

[a] S = susceptible, R = resistant.
[b] Each value is mean of six replicates.
[c] Significantly different from control value at 5% confidence level.
[d] Significantly different from control value at 1% confidence level.

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plot to provide a source of *M. diffusa* conidial inoculum. The disease in the experimental plots was the result of natural infection with *M. diffusa*.

RESULTS AND DISCUSSION

In 1976, powdery mildew was first observed on plants at Ames and Kanawha during the first week of August and on plants at Nashua 2 wk later. By the end of August, all plants of susceptible cultivars at Ames and nearly all of those at Kanawha were infected. The test at Nashua was abandoned because of insufficient natural infection.

At Ames, seed yield of two S cultivars, Corsoy and Harosoy 63, was 11% lower (significant at $P < 0.05$) in nonsprayed than in benomyl-sprayed plots (Table 1). No significant yield loss was detected in plots of Kanrich. At Kanawha, none of the three S cultivars tested had significantly higher seed yields in sprayed plots than in nonsprayed plots.

In 1977, powdery mildew was first observed on plants at Nashua and Kanawha during mid-July. The disease spread rapidly among susceptible plants in both tests, and by mid-August nearly all leaves of all susceptible plants were covered by the fungus. No powdery mildew developed at Ames because of a severe drought.

At Nashua, seed yield of the three S cultivars, Corsoy, Harosoy 63, and Kanrich, was significantly lower in nonsprayed than in benomyl-sprayed plots: 22, 20, and 18% lower, respectively (Table 1). At Kanawha, yield of the three S cultivars also was significantly lower in nonsprayed than in benomyl-sprayed plots: 26, 22, and 16% lower, respectively.

In 1978, powdery mildew was first observed on plants at Kanawha during the first week of July and on plants at Nashua in mid-July. The test at Ames was abandoned because of insufficient natural infection.

At Nashua, seed yield of the three S cultivars was significantly ($P < 0.01$) lower in nonsprayed than in benomyl-sprayed plots: 16% lower for Corsoy and 13% lower for both Harosoy 63 and Kanrich (Table 1). At Kanawha, yield of these cultivars was also significantly lower in nonsprayed than in benomyl-sprayed plots: 20, 18, and 10% lower, respectively.

During the 3 yr in which the tests were conducted, the seed yield loss in susceptible cultivars ranged from 0 to 26%, with a mean yield loss of 13%. Plants of the resistant cultivars were not infected by *M. diffusa,* and their seed yield was unaffected by treatment with benomyl. These results indicate that no disease except powdery mildew was reducing the yield in nonsprayed plots of susceptible plants and that benomyl was neither phytotoxic nor stimulatory to resistant plants.

Although seed yield losses were variable, the occurrence of losses as high as 26% suggests that powdery mildew is a major soybean disease in the Midwest. Resistance to *M. diffusa* in soybeans is conditioned by a single dominant gene (5), which can be used to control powdery mildew. Results suggest that the use of cultivars resistant to powdery mildew (3) by soybean producers would be beneficial in areas where powdery mildew occurs.

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