Leaf Dry Matter Loss and Pod Dry Matter Increase of Wells Soybeans Infected with *Septoria glycines*

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ABSTRACT

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Wells soybeans (*Glycine max*) infected with *Septoria glycines* yielded less than uninfected benomyl-sprayed soybeans. Seed weight was reduced by *S. glycines* infection. The rate of leaf loss over time for *S. glycines*-infected plants was greater than for benomyl-sprayed plants during the pod-fill stage of development. The rate of dry matter accumulation in pods of *S. glycines*-infected plants was less than in benomyl-sprayed plants. There was no difference in pod numbers between *S. glycines*-infected and benomyl-sprayed plants.

The influence of Septoria brown spot, caused by *Septoria glycines* Hemmi, on soybean (*Glycine max* (L.) Merr.) yield has been documented in previous studies (5,8,9,13,14). The greatest effect of brown spot appears to be a reduction of seed size in infected plants compared with benomyl-sprayed plants (5). Pataky and Lim (8) reported no difference in number of pods per plant or seeds per pod between *S. glycines*-infected and uninfected plants. Their work suggests that the effect of *S. glycines* on soybean yield must take place during the latter part of the plant growth cycle when the plants are fully podded. This growth stage would correspond to R5 (beginning seed stage) by the soybean growth stage classification of Fehr et al (1). The purpose of the work reported in this paper was to determine the effect of *S. glycines* on the rate of leaf loss during the pod-fill growth stage (R5) of soybeans and the rate of pod-mass increase in soybeans.

MATERIALS AND METHODS

Wells soybeans were planted on Sidell silt loam at Urbana, IL, in rows 4.9 m long spaced 51 cm apart on 8 May 1980 and 28 May 1981. The planting rate was about 32 seeds (treated with *Rhizobium japonicum* (Kirchner) Buchanan) per meter of row. Rows were thinned after plant emergence each year to give 18 plants per meter. The plots were fumigated in 1980 to reduce the level of soilborne soybean pathogens (2) because the area had been in continuous soybeans for at least 16 yr. All plots (4.9 × 2.4 m) were fumigated with methyl bromide (Dow-Fume MC-2) at the rate of 726 g per plot on 18 April 1980. After fumigation, the plots were left for 2 wk and then aerated. The plots were not fumigated in 1981 but an attempt was made to remove all soybean stem residue from each plot in the fall of 1980.

The plots were arranged in a completely randomized design with four replicates of *S. glycines*-inoculated plots and four replicates of benomyl-sprayed plots. Benomyl (Benlate 50W) was applied to plants until runoff with a pressurized sprayer at weekly intervals starting at the late flower R2 (1) reproductive growth stage and continued to the late pod R6 growth stage at the rate of 35 g/100 L water. Plants were inoculated with *S. glycines* at early flower or the R1 growth stage on 9 July 1980 and 29 June 1981 by procedures reported earlier (4,5,9).

Leaf loss with time for both *S. glycines*-infected and uninfected benomyl-sprayed plants was determined at 2-day sampling intervals starting on 18 August in both seasons by collecting all yellow leaves and petioles on plants in a 3.5-m row. The 2-day sampling interval reduces sampling error (3). These leaves and petioles were oven-dried and weighed. Leaf loss with time was expressed as a percentage loss of the total leaf mass collected at maturity. A regression analysis of percentage leaf loss with time for *S. glycines*-infected and benomyl-sprayed plants was run for 1980 and 1981. A *t* test was used to determine if there was any difference in rate of leaf loss (10).

To determine the rate of pod dry matter accumulation on *S. glycines*-infected and benomyl-sprayed plants, four plants per plot were sampled in 1980 and five plants per plot in 1981 at a 7-day interval until the plants were mature. The pods were removed from the plants and counted, dried, and weighed. Pod mass was expressed as the average weight per pod for each sampling date. At each sampling date, the number of nodes with leaves showing *S. glycines* infection was determined. The first sample was taken at growth stage R5. A regression analysis of average pod weight with time was run for each treatment and differences between regression lines were tested with a *t* test (10). At each sampling date, the number of pods per plant for *S. glycines*-infected and benomyl-sprayed plants was compared and data were statistically analyzed.

At soybean maturity (25 October 1980 and 22 October 1981), two rows 3.1 m long were harvested from each plot for yield. Weight of 300 seeds was also determined.

RESULTS AND DISCUSSION

In both seasons, yields were reduced significantly ($P = 0.05$) by the brown spot pathogen (539 and 1,025 g seed per plot, respectively) compared with benomyl-sprayed plants (584 and 1,288 g seed per plot, respectively). There was also a statistically significant ($P = 0.05$) reduction in seed weight between *S. glycines*-infected (42.9 and 46.0 g/300 seeds, respectively) and benomyl-sprayed plants (50.8 and 51.6 g/300 seeds, respectively). These results agree with earlier work (5,9,13,14). The plot yield variation between 1980 and 1981 was probably due to the extremely dry growing conditions in 1980.

During a 2-yr period, *S. glycines*-infected plants lost leaf dry matter at a rate greater than benomyl-sprayed plants during the pod-fill period. In both years, the slopes (*b* values) of the regression lines for *S. glycines*-infected and benomyl-sprayed plants were significantly different ($P = 0.05$) (Table 1). At the start of collection of leaf loss data on 20 August in both years, seven nodes were defoliated on *S. glycines*-infected plants and six on benomyl-sprayed plants. The rate at which pod dry matter increased in *S. glycines*-infected plants in both seasons was lower than in benomyl-sprayed plants (Table 1). At first pod sampling on 18 August 1980, the number of pods per plant did not differ significantly ($P = 0.05$) for *S. glycines*-

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Table 1. Leaf dry matter loss and pod dry matter increase with time for Wells soybeans infected with *Septoria glycines* or sprayed with benomyl

	Regression coefficient (*b*)			
	Leaf dry matter		Pod dry matter	
Treatment	**1980**	**1981**	**1980**	**1981**
S. glycines-infected	3.959[a]	4.224[a]	0.0051[a]	0.0081[a]
Benomyl-sprayed	1.724	3.624	0.0085	0.0100

[a]Significantly different from benomyl-sprayed at $P \leqslant 0.05$.

infected and benomyl-sprayed plants (13 and 15, respectively). Neither did they differ significantly ($P = 0.05$) at soybean maturity (19 and 16 pods per plant, respectively). In 1981, *S. glycines*-infected plants averaged 40 pods per plant on 18 August and 36 pods per plant at maturity. Benomyl-sprayed plants averaged 43 pods per plant on 18 August and 33 pods per plant at maturity. The average pod mass for *S. glycines*-infected plants on the first sampling date (18 August) in 1980 and 1981 was 0.206 and 0.230 g per pod and for benomyl-sprayed plants, 0.230 and 0.283 g per pod. In both years, the 28 days between first sampling (18 August) and the last sampling (14 September) represents active dry matter accumulation in soybean pods.

I conclude from the data that the main influence of *S. glycines* on the rate of dry matter accumulation in pods is through a more rapid reduction in leaf dry matter (defoliation) over time but not through reduction in pod number. Most agronomic studies relating levels of defoliation to soybean yield and seed weight have dealt with defoliation at early stages of soybean development (7,11,12) and have not considered defoliation during the late pod-fill growth stage. Lockwood et al (6) studied the effect of artificial defoliation on soybean yield and seed weight. They reported that yield reduction was due to a reduced number of pods, smaller seeds, and a reduced number of seeds per pod. By their procedure, however, a large part of the leaf mass had been removed by the time the plants had reached the pod-fill growth stage (15 August in their early treatment schedule), which could account for the reduced pod numbers. Similarly, McAlister and Krober (7) reported a reduced number of pods per plant when soybeans were 40 and 80% defoliated at early bloom stage.

Additional work is needed to determine whether *S. glycines* influences the rate of photosynthesis during the pod-fill period or whether it influences conversion of photosynthetic reserves from leaves into developing seed, both of which would have a direct influence on the seed size.

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