

Effect of Red Leaf Blotch on Soybean Yields in Zambia

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ABSTRACT

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Red leaf blotch of soybean (*Glycine max*) caused by *Pyrenochaeta glycinis* (= *Dactuliophora glycinis*) has increased in disease incidence and severity as hectareage planted to soybeans has increased in Zambia. Field plots in Zambia consisting of six soybean cultivars were either unsprayed or sprayed with the fungicide triphenyltin acetate. Disease severity, vertical disease progress, defoliation, and the area under the disease progress curve (AUDPC) for unsprayed cultivars ranged from 14.0 to 24.1, 90 to 100, 2.4 to 6.2, and 653.9 to 1,322.5%, respectively. The cultivars Jupiter and Tunia had lower disease severity, vertical disease progress, and AUDPC values than Geduld, Magoye, Oribi, or Sable. Defoliation varied among cultivars. Disease severity was not significantly different between the early- to medium- and late-maturing cultivars when evaluated at corresponding growth stages. Yield differences and 300-seed weight between unsprayed and sprayed plots ranged from 6.5 to 37.1 and 15.9 to 25.8%, respectively. Yield losses were due to reduced seed size. Seed weight was negatively correlated with all disease parameters studied.

Red leaf blotch or *Pyrenochaeta* leaf blotch of soybean (*Glycine max* (L.) Merr.) is caused by *Pyrenochaeta glycinis* Stewart (= *Dactuliophora glycinis* Leakey) (4,10,20). *P. glycinis* was described in 1957 by Stewart (20) and the sclerotial state, *D. glycinis*, in 1964 by Leakey (10). The disease has been reported from Cameroon, Ethiopia, Malawi, Uganda, Zaire, Zambia, and Zimbabwe (8,11,13,16,18,19). The only report of *P. glycinis* on soybeans outside of Africa is from Bolivia (Commonwealth Mycological Institute Herbarium, Kew, England). The pathogen and disease have been reported on wild soybeans (*Neonotonia wightii* (Arnott) Lackey) in Ethiopia, Zambia, and Zimbabwe (4,9,13,20).

Soybean production in Zambia has increased from 540 to 15,000 t from 1974 to 1982 (2). The occurrence, incidence, and severity of the disease have increased concomitantly with increased soybean production (13). In Zambia, severe defoliation was caused by the disease in the 1974 through 1977 growing seasons (1,2,8,13). In 1977, a 50% reduction in soybean yields was reported (18). In Zimbabwe, red leaf blotch occurs throughout the soybean-growing area

each year. In 1982, yield losses ranged from 10 to 50% in Harare and Mashonaland provinces. Because a paucity of information exists about the damage potential of this disease, this study sought to determine the development of the disease on soybeans in the field in Zambia, yield losses, and differences in susceptibility between early- to medium- and late-maturing soybean cultivars. A portion of this study was published as an abstract (5).

MATERIALS AND METHODS

Field plots consisting of four-row plots 5 m long on 50-cm centers were planted

on 4 December at York Farms, Lusaka Province, and 15 December 1983 at the Mpongwe Development Project, Copperbelt Province. The fields had been planted to soybeans during the rainy season and irrigated wheat during the dry season for the previous 5 yr. The seeding rate was 40 seeds per meter of row. Four replicates of two treatments were arranged in a split-plot design. The treatments were unsprayed plots and plots sprayed weekly for 11 wk beginning about 3-4 wks after planting with triphenyltin acetate (Brestan 60WP) at 0.9 kg a.i./ha. The treatments were main plots, and six soybean cultivars were subplots. The fungicide was applied with a backpack sprayer.

The cultivars were either early- to medium-maturing (104-110 days) or late-maturing (114-121 days) types and either susceptible or resistant to *P. glycinis*. The early- to medium-maturing cultivars were Geduld (susceptible), Oribi (susceptible), Sable (resistant), and Tunia (resistant); the late-maturing ones were Jupiter (resistant) and Magoye (susceptible).

Disease severity, vertical disease progress, and defoliation were evaluated every 14 days beginning 3-4 wk after planting until the R8 growth stage (harvest maturity) (6). Disease severity

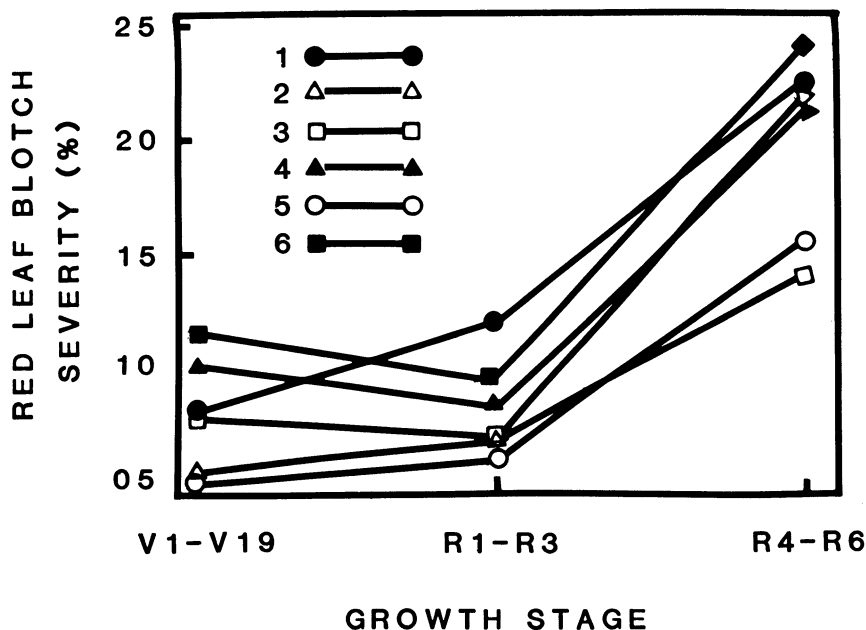


Fig. 1. Red leaf blotch severity (%) on six naturally infected soybean cultivars from unsprayed plot at three growth stages. Cultivars: 1 = Sable, 2 = Oribi, 3 = Tunia, 4 = Geduld, 5 = Jupiter, and 6 = Magoye.

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was measured as the percentage of the total leaf area showing symptoms according to the Horsfall-Barratt rating system (7). The lowest trifoliolate leaf of six to 10 plants per experimental unit was scored for symptoms at each rating date. Ratings were converted using the Elanco Conversion Tables (Elanco Products Co., Indianapolis, IN). The vertical disease progress of *P. glycines* was expressed as the percentage of the plant height in nodes to which red leaf blotch has spread based on the following formula (14): vertical progress = maximum height (nodes) at which symptoms appear / maximum height (nodes) of the plant \times 100. Defoliation was determined by counting the defoliated nodes at each disease rating (12). The area under the disease progress curve (AUDPC) was calculated using the formula by Shaner and Finney (17).

The two center rows of each plot were harvested at maturity. The moisture content of seeds from each plot was measured with a seed moisture meter (Steinlite Electron Moisture Tester, Seedburo Equipment Co., Chicago, IL). The 300-seed weight (g) and yields (t/ha) were adjusted to 13% moisture. Percent yield reduction was calculated using the following formula (15): yield reduction (%) = [(yield from sprayed plots less that from unsprayed plots) / (yield from sprayed plots)] \times 100. The percent seed weight reductions were calculated similarly. Yields of the unsprayed and sprayed plots were compared by an analysis of variance and least significant difference tests ($P = 0.05$). Correlation coefficients of disease severity, vertical disease progress, and AUDPC at the R5-R6 growth stages with yield (t/ha) and 300-seed weight (g) were recorded.

RESULTS

There was a significant treatment \times cultivar interaction for disease severity, vertical disease progress, defoliation, yield, and 300-seed weight at Mpongwe. Similar data were obtained from the York Farm field plot but, because of an epiphytotic of bacterial blight (*Pseudomonas syringae* pv. *glycinea* (Coerper) Young, Dye, and Wilkie), were not included herein (3).

The severity of red leaf blotch for unsprayed cultivars at the R4-R6 growth stages ranged from 14 to 24.1% (Fig. 1). Jupiter and Tunia had less disease than the other four cultivars. The vertical disease progress for unsprayed cultivars ranged from 90 to 100% at 91 days after planting (Fig. 2). The vertical disease progress for Jupiter was significantly lower than that for other cultivars.

No significant differences in defoliation were detected between cultivars for unsprayed and sprayed plots. Oribi and Sable had the lowest defoliation rate, with mean values of 2.4 and 2.8, respectively, at 91 days after planting

(Fig. 3). Jupiter had the highest rate of 6.1. The AUDPC values were significantly lower for Jupiter and Tunia, with the highest values calculated for Magoye and Sable (Table 1). Total yields of all

cultivars in unsprayed plots were lower than those of sprayed plots, with significant differences between unsprayed and sprayed plots of Geduld (21.9%), Magoye (37.1%), and Tunia (13.6%)

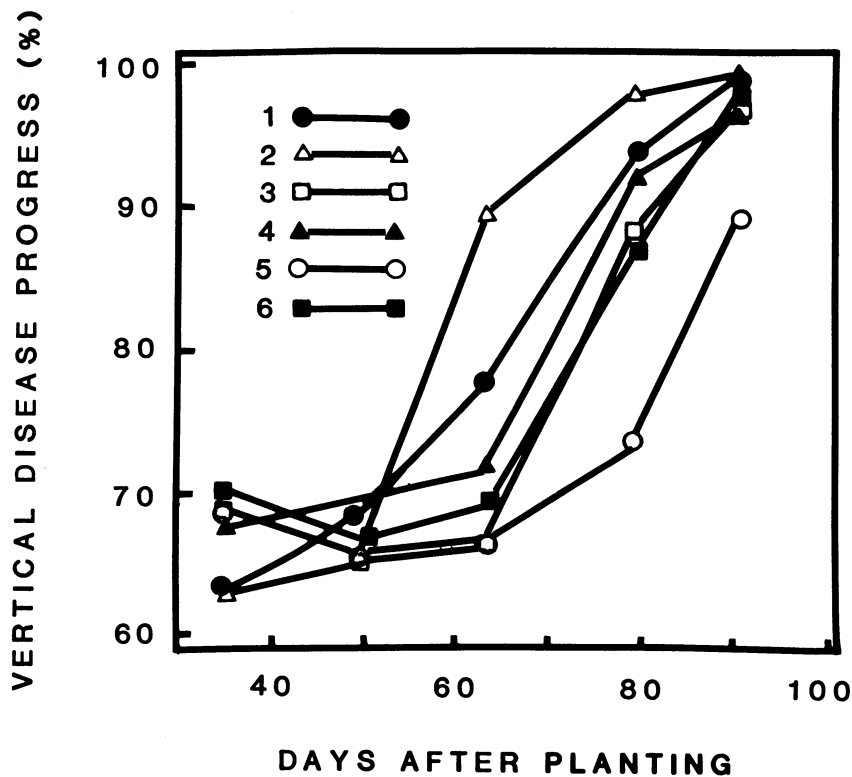


Fig. 2. Vertical disease progress (%) for red leaf blotch on six naturally infected soybean cultivars from unsprayed plot at various days after planting. Cultivars: 1 = Sable, 2 = Oribi, 3 = Tunia, 4 = Geduld, 5 = Jupiter, and 6 = Magoye.

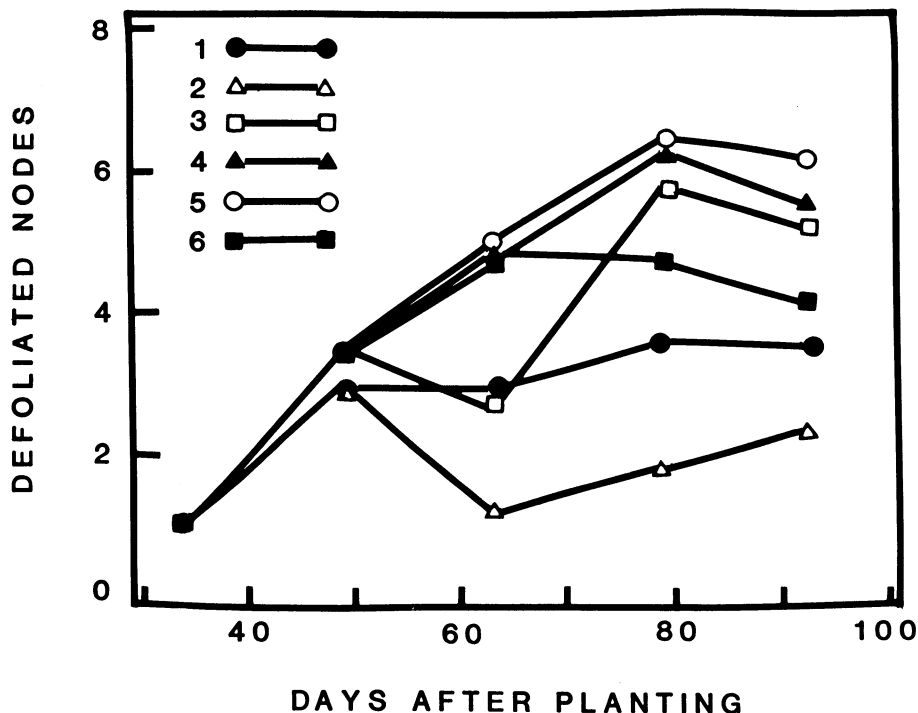


Fig. 3. Mean defoliated nodes for six soybean cultivars naturally infected with red leaf blotch from unsprayed plot at various days after planting. Cultivars: 1 = Sable, 2 = Oribi, 3 = Tunia, 4 = Geduld, 5 = Jupiter, and 6 = Magoye.

Table 1. Disease severity, area under the disease progress curve (AUDPC), yield, and 300-seed weight of six soybean cultivars infected with *Pyrenochaeta glycinis*

Cultivar	Maturity ^a	Treatment	Severity ^b	AUDPC ^c	Yield		Seed weight	
					t/ha	Loss (%) ^d	g	Loss (%) ^d
Sable	Early to medium	NI ^e	26.2		4.3		55.8	
		PT ^e	1.5	1,125.6	4.6	6.5	73.3	23.9
Oribi	Early to medium	NI	27.3		4.1		58.1	
		PT	1.9	962.8	4.6	10.8	75.3	22.8
Tunia	Early to medium	NI	16.4		3.8		58.0	
		PT	0.3	717.8	4.4	13.6	78.2	25.8
Geduld	Early to medium	NI	26.6		3.2		57.5	
		PT	1.0	949.9	4.1	21.9	68.4	15.9
Jupiter	Late	NI	21.1		1.9		49.5	
		PT	1.3	653.9	2.2	13.6	62.6	20.9
Magoye	Late	NI	30.5		2.2		38.1	
			1.1	1,322.5	3.5	37.1	47.7	20.1
FLSD ($P = 0.05$) ^f			7.4	185.2	0.6	13.6	2.9	4.8
C.V. (%) ^g			41.0	14.6	10.6	53.4	3.4	14.8

^a Early to medium (104–110 days) or late (114–121 days) depending on the number of days to reach 95% maturity.

^b Severity expressed as the percentage of the total leaf area diseased at growth states R5–R6.

^c Calculated by the formula of Shaner and Finney (17).

^d Percent yield and seed weight losses based on comparisons within replications to sprayed plots.

^e NI (natural infection) and PT (protected plots); PT with 11 weekly applications of triphenyltin acetate applied at 0.9 kg a.i./ha.

^f Fisher's least significant difference.

^g Coefficient of variation.

(Table 1). The percent yield loss was significantly lower between Magoye and the other cultivars.

Reductions in 300-seed weight were significantly lower for all cultivars in unsprayed plots than in sprayed plots (Table 1). Correlation coefficients for disease severity, vertical disease progress, and AUDPC at R5–R6 growth stages with yield were not significant, whereas those for 300-seed weight had significant correlations of -0.44 , -0.58 , and -0.48 , respectively.

DISCUSSION

Red leaf blotch reduced seed weight in unsprayed plots of all cultivars. This may be due to reduced photosynthesis and movement of metabolites to the developing seeds. The significant negative correlations between the various disease parameters and seed weight support this conclusion. This also suggests that reduction in yield caused by reduced seed weight could be affected by a reduced number of pods or seeds per pod. Yield losses resulting from reduced seed weight because of seed size reduction were reported for other soybean diseases including Septoria brown spot (14,15).

Defoliation of Jupiter and other cultivars probably was due to natural abscission rather than to the disease because there were no significant differences in defoliation between unsprayed and sprayed plots. Consequently, defoliation had little, if any, influence on seed weight in our experiment. Red leaf blotch causes moderate to severe defoliation in some cultivars during periods of rain or high humidity (8,20).

Late-maturing soybean cultivars were reported to be less severely affected by

red leaf blotch than early-maturing ones (1,13). We found that disease severity between early- to medium- and late-maturing cultivars was not significantly different when evaluated at corresponding growth stages. For example, Magoye and Jupiter, late-maturing cultivars, did not differ in disease severity or reduced seed weight when compared individually with the early- to medium-maturing cultivars.

Our data generally support the earlier field observations on resistant and susceptible cultivars. Jupiter and Tunia were significantly lower in disease severity and AUDPC than the other cultivars, whereas Sable was not.

The correlation coefficients were insignificant between red leaf blotch disease severity, vertical disease progress, and AUDPC with yield. This variation is possibly due to the planting site being a relatively new area under intensive crop production double-cropping soybeans with wheat. Land was cleared 5 yr ago, and the establishment of *Rhizobium* inoculum, increasing fertility, and soil pH was not uniform. For example, soil pH at this site ranged from 4.3 to 6.8.

Although other soybean diseases such as bacterial blight can be a problem, red leaf blotch presently is the major limiting disease to soybean production in Zambia. As new land is brought into cultivation, the occurrence, incidence, and severity of red leaf blotch continue to increase. Further research is needed to understand better how this disease affects yields through continued studies on severity, vertical progress, defoliation, and yield components. These studies will provide information necessary to develop control measures for the disease.

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