Efficacy of Metalaxyl in Controlling Phytophthora Root and Stalk Rot of Soybean Cultivars Differing in Field Tolerance

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ABSTRACT

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Chemical control of root and stalk rot of soybean caused by *Phytophthora megasperma* Drechs. f. sp. *glycinea* (Hildeb.) Kuan and Erwin was tested under field conditions with four soybean cultivars differing in field tolerance to the disease. The systemic fungicide metalaxyl was used as an in-furrow treatment at 0.25, 0.5, and 0.75 kg a.i./ha applied with the seed at planting. Metalaxyl did not affect emergence. Metalaxyl treatments reduced plant losses during the season in extremely susceptible and susceptible cultivars but not in moderately susceptible and tolerant soybean cultivars. Rates of metalaxyl up to 0.75 kg a.i./ha did not reduce percentage of plant loss in extremely susceptible cultivar plots of the level equivalent to plant loss in the tolerant cultivar plots. Yield was increased and plant loss decreased in the extremely susceptible OX20-8 by metalaxyl treatments ranging from 0.5 to 1.5 kg a.i./ha.

The development and introduction of soybean (*Glycine max* (L.) Merr.) cultivars that exhibit tolerance to root rot caused by *Phytophthora megasperma* Drechs. f. sp. *glycinea* (Hildeb.) Kuan and Erwin (6) (*Pmg*) has resulted in low plant losses in commercial fields in southwestern Ontario (2).

Tolerance to root and stalk rot caused by *Pmg* is defined as a relative characteristic determined by the degree of plant loss or reduction in growth or yield in the presence of *Pmg* races for which a soybean cultivar lacks specific genes for resistance. At present, the planting of tolerant cultivars, eg, Harcor (4), provides the most effective method of disease control in Ontario. However, additional methods of control should be investigated because the extent of plant loss or stunting of tolerant cultivars may be more severe on compacted or water-logged soils. In addition, cultivars susceptible to *Pmg* may have valuable agronomic characteristics such as seed quality, high yield, or resistance to other diseases, which could not be exploited with the present method of control.

Vaartaja et al (9) reported that in-furrow application of the systemic fungicide CGA-48988 (metalaxyl) at planting significantly decreased stand loss from *Pmg* root rot and increased yields of a susceptible soybean cultivar (Steele). Recently, Abney and Scott (1) reported the efficacy of metalaxyl in reducing *Pmg* root rot in Indiana. Papavizas et al (7) reported that metalaxyl reduced disease but did not increase plant stands or yields in Kansas.

Few studies have been made on plant losses in tolerant cultivars treated with metalaxyl. Stands and yields of tolerant cultivars were improved more than those of nontolerant cultivars by treatment with metalaxyl (8).

The purpose of this research was to establish minimum rates of metalaxyl required to reduce *Pmg* infection of susceptible and tolerant soybean cultivars under field conditions and to determine the yield response of an extremely susceptible cultivar to metalaxyl treatments.

MATERIALS AND METHODS

Four cultivars representing a range of field tolerance to root and stalk rot caused by *Pmg* were chosen from preliminary test results (3). The four cultivars react with specific resistance to hypocotyl inoculation using *Pmg* race 1, but they are susceptible to the races that are currently predominant in Ontario. OX20-8 (a Harrow line), Steele, Amsoy 71, and Harcor were rated as extremely susceptible, susceptible, moderately susceptible, and tolerant, respectively, in the field tests.

Experiments were conducted at Woodslee in southwestern Ontario in an area consisting of Brookston clay loam with a history of root rot. The area was fall-plowed in 1978 and fall-plowed and leveled in 1979; spring tillage consisted of disking prior to planting. Fertilizer (8-32-16) was applied at the rate of 560 kg/ha, and chloramben was applied as a preemergence herbicide at 4.5 kg a.i./ha.

Field plots were planted in 4-m rows at a planting rate of 100 seeds per row with a row width of 50 cm. Metalaxyl was applied as a 5% granular formulation in the furrow with the seed at planting. Experiments were planted 5 June 1978 and 23 May 1979. Percentage of plant loss was calculated from differences in plant stand between 5 July and 20 September in 1978 and between 27 June and 30 August in 1979. The plots were examined periodically to determine that plant losses were caused by root and stalk rot. *Pmg* was isolated from a random sample of dying plants with characteristic symptoms of the disease during both seasons.

In a four-replicate, split-plot experiment conducted in 1978 and 1979, four cultivars were planted in four-row, randomized main plots with metalaxyl applied at rates of 0.00, 0.25, 0.50, and 0.75 kg a.i./ha on single-row, randomized subplots of each cultivar.

The effect of metalaxyl treatments on yield of OX20-8 was evaluated in a nine-replicate, randomized block experiment conducted in 1979. Four-row plots were treated with metalaxyl at 0.0, 0.5, 1.0, or 1.5 kg a.i./ha applied in-furrow with the seed at planting. Dead plants were counted and removed from plot rows at 1- to 2-wk intervals from seedling emergence until 30 August. Yield was determined at maturity by harvesting 2.4 m from each of the two center rows of each plot.

Unless otherwise indicated, significant differences are based on a 5% level of probability.

RESULTS

Averaged over 2 yr, metalaxyl treatments did not significantly increase or decrease seedling emergence in any of the four cultivars compared with the untreated controls. Seedling emergence was significantly different between 1978 (85%) and 1979 (64%). In 1978, plant emergence proceeded normally; in 1979, however, emergence was delayed 1–2 wk by cool, wet weather following planting. There was a significant cultivar × year interaction for emergence, and cultivars did not differ when averaged over both years.

The efficacy of metalaxyl in reducing *Pmg* root and stalk rot varied with the susceptibility of each soybean cultivar (Table 1). Plant losses of OX20-8 were significantly higher in all treatments compared with losses of the other

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Table 1. Mean percentage of plants killed by *Phytophthora megasperma* f. sp. *glycinea* in four soybean cultivars treated with metalaxyl, 1978–1979

Cultivar	Tolerance rating	Metalaxyl (kg a.i./ha)[a]				
		0.00	0.25	0.50	0.75	Mean
OX20-8	Extremely susceptible	69[b]	51	58[c]	42	50.3
Steele	Susceptible	24[d]	17	15	12	14.7
Amsoy 71	Moderately susceptible	17	11	12	11	11.3
Harcor	Tolerant	5	6	3	3	4.0
$LSD_{0.05}$		17	18	16	22	

[a] Differences among rates tested by orthogonal comparisons. Except where indicated, comparisons were not significant.
[b] Differs significantly ($P = 0.01$) from 50.3.
[c] Differs significantly ($P = 0.05$) from 42.
[d] Differs significantly ($P = 0.05$) from 14.7.

Table 2. Effect of metalaxyl on percentage of plant loss and yield of OX20-8 soybeans, 1979

Metalaxyl (kg a.i./ha)	Plant loss (%)	Plant yield (kg/ha)
0.0	54	1,940
0.5	30	2,340
1.0	20	2,740
1.5	10	2,930
$LSD_{0.05}$	9.7	397
$LSD_{0.01}$	13.2	539

cultivars. Analysis of treatment effects by paired orthogonal comparisons showed that metalaxyl significantly reduced plant loss of the extremely susceptible OX20-8 ($P = 0.01$) and the susceptible Steele ($P = 0.05$) compared with untreated checks. Comparisons of treatments indicated that at 0.75 kg a.i./ha, metalaxyl significantly ($P = 0.05$) reduced plant loss of OX20-8 compared with a rate of 0.50 kg a.i./ha; the same comparison for Steele was not significant. Metalaxyl treatments did not reduce plant losses of the moderately susceptible Amsoy 71 and the tolerant Harcor. There was a trend toward a higher mean percentage of plants killed by *Pmg* in 1978 (28%) than in 1979 (16%), but there were no significant interactions among years, varieties, and treatments.

In the separate 1979 experiment with OX20-8, plant stand at emergence, which ranged from 74 to 75%, was not affected by metalaxyl treatments. Metalaxyl at 0.5 kg a.i./ha significantly reduced plant loss and increased yield (Table 2). Periodic assessment of plants killed by *Pmg* 4–13 wk from planting showed that plant loss was highest between 7 and 9 wk from planting. During this interval, metalaxyl treatments of 0.0, 0.5, 1.0, and 1.5 kg a.i./ha averaged 25, 9, 5, and 2% plant loss, respectively.

DISCUSSION

Metalaxyl applied with the seed at planting as an in-furrow treatment was effective in reducing plant loss caused by *Pmg* during the growing season. The efficacy of the treatment, however, varied with the amount of fungicide and the relative tolerance of the soybean cultivar to *Pmg* root rot. Metalaxyl treatments were effective in reducing plant losses of the extremely susceptible OX20-8 and susceptible Steele. However, rates of metalaxyl up to 0.75 kg a.i./ha did not reduce percentage of plant loss of OX20-8 to a level equivalent to the plant loss in Harcor plots. Similar results were obtained in evaluating the effects of the fungicide mancozeb on potato varieties susceptible and tolerant to *P. infestans* (Mont.) d By.; the percentage of blighted tubers was less in the tolerant variety than in the susceptible variety treated with additional fungicide (5).

Stands at emergence were not affected by metalaxyl treatments. Average stand counts of cultivars over the 2-yr period ranged from 64 to 82% emergence regardless of treatment or tolerance rating.

The application of metalaxyl in increased amounts did not significantly reduce the incidence of dead plants of the moderately susceptible cultivar Amsoy 71 and the tolerant cultivar Harcor during the growing season. The apparent lack of response may be attributed to low plant losses in check plots, experimental variation, or the low rates of fungicide.

Yield of the extremely susceptible OX20-8 increased with a metalaxyl treatment of 0.5 kg a.i./ha, and plant loss was reduced by 24% compared with the control plot. In addition, yield was increased and plant loss was reduced an additional 10% by a treatment of metalaxyl at 1.0 kg a.i./ha compared with treatment at the 0.5 kg a.i./ha. The results suggest that plant losses of 10–24% during the growing season reduce soybean yields. These results are in agreement with those of Vaartaja et al (9).

OX20-8 is extremely susceptible and has shown high plant losses in other tests (3) where conditions favored development of disease. In this study, each increment of metalaxyl significantly reduced plant loss. Increments of metalaxyl from 0.0 to 0.5 and from 0.5 to 1.0 kg a.i./ha significantly increased the yield of OX20-8, and there was an upward trend at 1.5 kg a.i./ha. We conclude that, under conditions favorable for the development of *Pmg* root rot, high rates of metalaxyl would have to be applied to extremely susceptible cultivars to provide control equivalent to that provided by tolerant cultivars.

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