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Soybean Response to Ethylene Dibromide in a Soil Infested with *Meloidogyne arenaria* and *Heterodera glycines*[1]

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Abstract: One susceptible and six nematode-resistant soybean cultivars were evaluated in the field for their effects on seed yield, nematode populations, and response to the fumigant nematicide, ethylene dibromide. The soil was a loamy sand infested with *Meloidogyne arenaria* and *Heterodera glycines.* Cultivars significantly affected yield and numbers of *H. glycines* but did not affect *M. arenaria* numbers. Fumigation increased yield and reduced *M. arenaria* numbers but did not affect numbers of *H. glycines.* The interaction between cultivars and fumigation was significant for yield but not for nematode numbers.

Key words: *Glycine max, Heterodera glycines,* host-plant resistance, *Meloidogyne arenaria,* root-knot nematode, soybean, soybean cyst nematode.

Soybean (*Glycine max* (L.) Merr.) is susceptible to several species of plant-parasitic nematodes (3). About 15% of the Alabama soybean crop is lost each year to nematode attack, about 50% each to *Heterodera glycines* (Ichinohe) and *Meloidogyne arenaria* (Neal) Chitwood and *M. incognita* (Kofoid and White) Chitwood (6). Genetic resistance to *H. glycines* is qualitative, and soybean cultivars with resistance to this nematode generally do not respond with increases in yield to nematicide treatment (1,4). Genetic resistance to *Meloidogyne* spp. is quantitative, and yields of soybean cultivars with resistance to *Meloidogyne incognita* have been enhanced by treatment with fumigant nematicides, particularly in heavily infested soils where susceptible cultivars produce very low yields (5,10).

Previous studies evaluated the performance of nematode-resistant soybean cultivars in fields where a single nematode species predominated (1,4,5,8). Few studies (10) have evaluated nematode-resistant cultivars, especially those with resistance to multiple nematode species, for their usefulness in controlling nematodes where two pathogenic nematode species occurred concomitantly. Our objective was to evaluate the performance of seven soybean cultivars with various combinations of resistance to *H. glycines* and *M. arenaria* in a field infested with *H. glycines* and *M. arenaria* with and without the application of ethylene dibromide (EDB).

MATERIALS AND METHODS

The experiment was conducted in 1986 near Elberta, Alabama, in a Norfolk fine sandy loam soil naturally infested with *H. glycines* (races 3, 4, and an unidentified race) and *M. arenaria* (race 2). *Paratrichodorus christiei* Allen Sidiqi were also present in low numbers. The soil had a pH of 6.2 with < 1.0% organic matter (w/w). Soil fertility was maintained at recommended levels according to soil test recommendations. Weeds were controlled by a preemerge application of 2 kg/ha metolachlor (2-chloro-*N*-[2-ethyl-6-methylphenyl]-*N*-[2-methoxy-1-methylethyl]acetamide) and 0.85 kg/ha paraquat (1,1′-dimethyl-4,4′-bipyridinium ion), and cultivated twice. Foliar-feeding insects were controlled by two applications of 0.56 kg/ha methyl parathion (*O,O*-dimethyl-*O*-*p*-nitrophenyl phosphorothioate), according to recommended practices for the test area (2).

Seven cultivars were selected based on known reactions to *M. arenaria* and *H. glycines* (Table 1) and were evaluated at two nematicide levels, 0 and 1.36 ml EDB/m

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row (105 liter/ha, overall). EDB was applied at planting with two injectors 13 cm to either side of the seed furrow to a depth of 13 cm. The injector slits were sealed with a floating board immediately behind the injectors. The 14 treatments were arranged in a 2 × 7 factorial in a randomized complete block design with eight replications. Plots consisted of two 7.5-m-long rows 81 cm apart. They were trimmed at harvest to a length of 6.0 m. Planting date was 2 June.

Nematode populations at planting were determined by randomly collecting ten 500-cm^3 samples from the field using a 2.5-cm-d sampling tube and analyzing the samples separately. Average numbers of *M. arenaria* juveniles in the field at planting were estimated at 70 juveniles/100 cm^3 soil; populations of *H. glycines* juveniles were 10/100 cm^3 soil. Soil samples for nematode analysis were also collected 24 September, 5 weeks before harvest to coincide with the period of maximal population development of *Meloidogyne* spp. in soybean (8). Samples consisted of a composite of 16–20 soil cores (2.5 cm d) taken from each plot from the root zone to a depth of 20–25 cm. Nematodes were extracted from a 100-cm^3 subsample (7). Seed yield was obtained by harvesting each individual plot with a small plot combine. All data were analyzed using analysis of variance, and means were separated using Fisher's least significant difference ($P = 0.05$). All differences reported were significant at the 5% probability level.

Results and Discussion

Plots fumigated with EDB yielded an average of 77% more than nonfumigated plots (Table 2). Yield among nonfumigated cultivars was also significant, ranging from 960 kg/ha for 'Braxton' to 1,875 kg/ha for 'Leflore'. With the exception of 'Forrest', cultivars that were resistant to *H. glycines* race 3 tended to yield significantly better than the susceptible cultivars 'Ransom' and Braxton. The interaction between fumigation treatment and cultivars was significant, but the magnitude of the interaction effect mean square was small compared to the main effect mean square. Cultivars that showed the largest yield response to fumigation were Ransom (135% yield increase) and Braxton (119% yield increase), and those with lowest response were Leflore (46% yield increase) and Forrest (42% yield increase).

TABLE 1. Host response of soybean cultivars to *Meloidogyne arenaria* and *Heterodera glycines*, races 3 and 4.

Cultivar	*M. arenaria*	*H. glycines* Race 3	*H. glycines* Race 4
Braxton	R†	S	S
Centennial	S	R	S
Forrest	S	R	S
Gordon	R	R	S
Kirby	R	R	S
Leflore	S	R	R
Ransom	S	S	S

† R = resistant. S = susceptible.

EDB reduced *M. arenaria* juvenile numbers with an overall mean of 410 juveniles/100 cm^3 soil in nonfumigated plots and 179 juveniles/100 cm^3 soil in fumigated plots (Table 2). Cultivars had no significant effect on *M. arenaria* juvenile numbers in fumigated or nonfumigated plots. The interaction between nematicide treatment and cultivars was not significant. There was no apparent relationship between levels of resistance to *M. arenaria* among cultivars, as indicated in Table 1, and their ability to support populations of *M. arenaria* in the field.

Fumigation had no effect on late-season numbers of *H. glycines* juveniles, and there was no significant interaction between fumigation treatment and cultivars for *H. glycines* juvenile numbers. Differences among cultivars, however, were significant for numbers of *H. glycines*. Leflore (resistant to races 3 and 4 of *H. glycines*) had 62 juveniles/100 cm^3 soil, whereas Braxton (susceptible to *H. glycines*) had 148 juveniles/100 cm^3 soil, averaged across nematicide treatments. Because of the nature of sampling there was no clear-cut relationship between resistance to *H. glycines* and *H. glycines* numbers. For example Gordon (resis-

TABLE 2. Effects of fumigation with EDB and soybean cultivars on yield and juvenile numbers of *Meloidogyne arenaria* and *Heterodera glycines*, 1986.

	Seed yield (kg/ha)		Juveniles/100 cm³ soil			
			M. arenaria		*H. glycines*	
Cultivar	Control	Fumigated	Control	Fumigated	Control	Fumigated
Braxton	960	2,103	459	127	151	144
Centennial	1,372	2,607	418	175	78	86
Forrest	1,189	1,692	296	188	113	109
Gordon	1,463	2,561	389	139	125	164
Kirby	1,692	2,789	337	265	85	142
Leflore	1,875	2,744	476	176	49	75
Ransom	1,052	2,469	495	185	101	107
$\bar{x}$	1,372	2,424	410	179	100	118
LSD ($P = 0.05$)†	370		202		63	

† LSD values are for comparison of any treatment–cultivar combination pair.

tant to *H. glycines* race 3) did not differ from Braxton for *H. glycines* juvenile numbers (145/100 cm³ for Gordon vs. 148/100 cm³ for Braxton), averaged across nematicide treatments.

In conclusion, cultivars significantly affected *H. glycines* but not *M. arenaria* numbers when populations were determined just before harvest. Fumigation affected *M. arenaria* but not *H. glycines* numbers. Resistance to *H. glycines* was the most important factor in determining a cultivar's performance in nonfumigated plots. *M. arenaria* resistance was not as important a factor, in determining either yield or final nematode populations, even though *M. arenaria* numbers were high just before harvest. Thus, use of resistant cultivars to reduce populations of *M. arenaria* appears to be of little value. Genetic variation in populations of *M. arenaria* has been observed (9); therefore it is possible that different results could be obtained by subjecting this same set of cultivars to a different *M. arenaria* population.

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