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Soybean Response to a Planting-Time Application of Ethylene Dibromide in a Soil Infested with *Meloidogyne incognita, M. arenaria,* and *Heterodera glycines*

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Abstract: A field study was conducted to evaluate one susceptible and six nematode-resistant soybean cultivars for their effects on seed yield, nematode populations, and response to a fumigant nematicide, ethylene dibromide. The soil was a sandy loam, and the field was infested with a mixture of *Meloidogyne incognita, M. arenaria,* and *Heterodera glycines.* Soybean cultivars significantly affected yield and juvenile numbers of *Meloidogyne* spp. but did not affect the *H. glycines* juvenile population. Fumigation increased yield and numbers of *H. glycines* juveniles, whereas the numbers of *Meloidogyne* spp. juveniles were decreased. The interaction between cultivars and fumigation treatment was significant for yield but not for nematode numbers.

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

The soybean (*Glycine max* (L.) Merr.) is subject to attack by several species of plant-parasitic nematodes (3) including *Heterodera glycines* Ichinohe and species of the genus *Meloidogyne,* particularly *M. arenaria* (Neal) Chitwood and *M. incognita* (Kofoid and White) Chitwood. Approximately 15% of Alabama soybean yield is lost each year to nematode attack, about half to *H. glycines* and half to species of *Meloidogyne* (6). Genetic resistance to *H. glycines* is qualitative and available in many cultivars, and cultivars with resistance to *H. glycines* generally do not respond to nematicide treatment (1,4). Genetic resistance to *Meloidogyne* spp. is quantitative, and cultivars with resistance to *Meloidogyne* spp. often respond to fumigant nematicides, particularly in heavily infested soils (5,8). Our objective was to evaluate the performance of seven soybean cultivars with various combinations of resistance to *H. glycines* and *Meloidogyne* spp. in a field naturally infested with a mixture of *H. glycines* and *Meloidogyne* spp. with and without the application of the fumigant nematicide ethylene dibromide (EDB).

MATERIALS AND METHODS

The experiment was conducted during 1986 near Elberta, Alabama, in a Ruston fine sandy loam soil (60% sand, 22% silt, 18% clay, < 1% organic matter; pH 6.2) naturally infested with *H. glycines* (races 3, 4, and an undescribed race) and a mixture of *Meloidogyne* spp., composed of ca. 60% *M. arenaria* and 40% *M. incognita. Paratrichodorus minor* (Colbran) Siddiqi was also present in relatively low numbers. Fertility and pH were maintained at levels based on soil test recommendations, and weeds, insects, and foliar diseases were managed according to recommended practices (2).

Seven soybean cultivars were evaluated at two dosage levels of EDB, 0 and 0.68 ml/m of row per injector. The fumigant was applied at planting (27 May) with two injectors 13 cm to either side of the seed furrow to a depth of 20 cm. The injector slits were sealed with a floating board that followed immediately behind the injectors. Soil moisture at the time of application was ca. 60% field capacity; soil temperature was 27 C at 20 cm depth. The 14 treatments were arranged in a 2 × 7 factorial structured in a completely randomized design with eight replications. Cultivars, maturity groups, and their susceptibility to root-knot and cyst nematodes are listed in Table 1. Plots consisted of two rows, 7.5 m long, with 81 cm spacing between rows. The ends were trimmed at harvest to give a final row length of 6.0 m.

Samples for nematode analysis were collected 1 October by compositing 16–20 soil cores (each 2.5-cm-d × 20–25 cm deep)

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TABLE 1. Soybean cultivars and their reaction to *Meloidogyne arenaria*, *Meloidogyne incognita*, and *Heterodera glycines*, races 3 and 4.

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

R = resistant. S = susceptible.

per plot from the soybean rhizosphere. A 100-cm^3 subsample was used to determine total nematode numbers (7). Seed yield was obtained in late October by harvesting the entire end-trimmed plots with a small combine. All data were analyzed following standard procedures for analysis of variance (ANOVA), and differences between means were tested for significance using Fisher's least significance difference (P = 0.05).

Results and Discussion

Yields were high (av. = 3,484 kg/ha) in fumigated plots due to favorable rainfall (> 400 mm) during the growing season (Table 2). EDB increased yield 109% over nonfumigated plots. There was a significant fumigation treatment × cultivar interaction. Yield of 'Ransom' was increased 351%, whereas the yield of 'Kirby' was increased by only 36%. Cultivars significantly affected yield, ranging from 2,819 kg/ha for Kirby to 732 kg/ha for Ransom in nonfumigated plots.

Meloidogyne spp. juvenile numbers were significantly decreased by fumigation; there was a mean of 310 juveniles/100 cm^3 soil in nonfumigated plots compared with a mean of 158 juveniles/100 cm^3 soil in fumigated plots (Table 2). Cultivars also affected *Meloidogyne* spp. numbers, ranging from 198 juveniles/100 cm^3 soil for Ransom to 440 juveniles/100 cm^3 soil for 'Centennial'. There was no significant interaction between fumigation treatment and cultivars for *Meloidogyne* spp. juvenile numbers. It was not practical to determine relative proportions of *M. incognita* and *M. arenaria* in individual samples; however, there appeared to be little relationship between resistance to *M. incognita* and (or) *M. arenaria* and *Meloidogyne* spp. juvenile numbers in either fumigated or nonfumigated plots.

Heterodera glycines juvenile numbers were lower than *Meloidogyne* spp. numbers. Neither cultivar nor the cultivar × fumigation treatment interaction significantly affected *H. glycines* numbers. Factorial analysis revealed that fumigation resulted in an over-

TABLE 2. Effects of soybean cultivars and ethylene dibromide on yield and juvenile numbers of *Meloidogyne* spp. and *Heterodera glycines*, 1986.

	Seed yield (kg/ha)		Juveniles (no./100 cm^3 soil)			
			Meloidogyne spp.		*H. glycines*	
Cultivar	Control	Fumigated	Control	Fumigated	Control	Fumigated
Braxton	964	2,109	241	128	98	117
Centennial	1,428	4,334	440	185	41	110
Forrest	1,181	2,305	220	160	74	74
Gordon	2,203	3,950	380	163	76	97
Kirby	2,819	3,820	375	130	89	58
Leflore	2,348	4,566	314	205	38	119
Ransom	732	3,305	198	137	77	102
$\bar{x}$	1,668	3,484	310	158	70	97
LSD (P = 0.05)	769		117		66	

All data are means of eight replicates.
LSD values are for comparison of any treatment-cultivar combination pair.

all increase in numbers of *H. glycines* juveniles in soil.

On the basis of nematode numbers, genetic variation for reaction to *H. glycines* was lacking, and variation for response to *Meloidogyne* spp. did not relate to genetic resistance. For example, Ransom, which is susceptible to *Meloidogyne* spp., had lower juvenile numbers than 'Gordon' or Kirby, which are resistant to both *M. arenaria* and *M. incognita.* Apparently there are complete interactions for nematode resistance to *H. glycines* and *Meloidogyne* spp. in determining nematode numbers. Yield related well to root-knot nematode resistance.

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