EFFECTS ON SOYBEANS AND NEMATODE POPULATIONS OF THREE SOIL FUMIGANTS APPLIED AT SEVERAL RATES AT TIME OF PLANTING [EFECTOS DE TRES FUMIGANTES INYECTADOS DURANTE LA SIEMBRA SOBRE SOYA Y POBLACIONES DE NEMATODOS]

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ABSTRACT

Various rates of ethylene dibromide, DD, and 1,3-D injected at planting to a depth of 20 cm with two chisels per row set 25 cm apart increased soybean yields and reduced population levels of *Meloidogyne incognita* and *Helicotylenchus* sp. in a Fuquay loamy sand. Liters per ha of active ingredient that increased yields significantly were: ethylene dibromide, 4.67, 9.34, 18.68, 37.36, and 56.04; DD, 18.68, 37.36, and 74.72; 1,3-D 18.68 and 37.36. The average yield increase for these rates was 31%. Yield differences among pesticide rates were not significant. Yields were not increased significantly with DD at 7.01 l/ha, 1,3-D at 9.34 l/ha and phenamiphos at 2.8 kg a.i./ha. DD at 74.72 l/ha was phytotoxic.
Key Words: control, Glycine max, Nemacur, Soilbrom, Paratrichodorus christiei, 1,3-dichloropropene, methods of application.

INTRODUCTION

Nematode control on soybeans is becoming increasingly important in the Southeast. The advent of DBCP (1,2-dibromo-3-chloropropane) as an at-plant treatment provided the grower with an economical control that adapted well to soybean cultural practices. It has generally been more effective than the nonfumigant materials (4,5) and it is the only fumigant approved for at-plant use. However, the recent restrictions placed on the manufacture and use of DBCP have raised questions relative to its availability and recommended use on soybeans in the future. Hence, efforts are being made to find new materials or methods of using old materials that provide control equal to or superior to that obtained with DBCP.

DD (1,3-dichloropropene, 1,2-dichloropropane), 1,3-D (1,3-dichloropropene), and ethylene dibromide (1,2-dibromoethane) have long been recognized as excellent nematicides. However, they have been considered highly phytotoxic and unsafe to use as at-plant treatments on row crops (1). In the past, row treatments evaluation of DD, 1,3-D and EDB has been primarily with a single chisel under the row. We believe that phytotoxicity of these materials may be reduced and the effectiveness increased if reduced rates are injected with two chisels to the side of the row. Here we report results of evaluations of rates of these materials injected with two chisels per row 12.5 cm to either side of the row at time of planting.

Cooperative investigations of Agricultural Research, Science and Education Administration, U.S. Department of Agriculture, and the University of Georgia College of Agriculture Experiment Stations, Coastal Plains Station, Tifton, Georgia 31794. This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the USDA nor does it imply registration under FIFRA.

MATERIALS AND METHODS

The study was conducted at Tifton, Georgia on a Fuquay loamy sand (88% sand, 8% silt, and 4% clay) infested with *Meloidogyne incognita* (Kofoid and White) Chitwood, *Paratrichodorus christiei* (N.) Minor (Allen) Siddiqi and *Helicotylenchus* sp. The preceeding crops were soybean *(Glycine max* (L.) Merr.) followed by hairy vetch *(Vicia villosa* Roth). The experimental design was a randomized complete block replicated four times. Plots were 6.1 m long with four rows each spaced 0.9 m apart. The soil was turned 25 cm deep. Fertilizer was applied as indicated by soil tests.

Treatments shown in Tables 1 and 2 included five rates of ethylene dibromide, four rates of DD, three rates of 1,3-D and one rate of phenamiphos (ethyl 4-(methylthio)-*m*-tolyl isopropylphosphoramidate). Ethylene dibromide, DD and 1,3-D were injected 20 cm deep, 2 chisels per row spaced 25 cm apart. Phenamiphos, included as a standard, was applied in a 30-cm band over the row and rototilled 10-15 cm deep. Treatments were applied and seed of 'Ransom' soybean were planted 18 May 1978. Seeding rate was ca 10 viable seeds per 30 cm of row. Soil moisture was 7.3% and the soil temperature at the 10 cm depth was 21C minimum and 31C maximum at planting. Rainfall was very light the first 17 days after planting. The first rain (0.8 cm) occurred 9 days after planting and the second rain (3.3 cm) occurred 17 days after planting. Weeds were controlled with trifluralin (a, a, a-trifluoro-2, 6-dinitro-*N,N*-dipropyl-p-toluidine) at 0.56 kg a.i./ha applied before planting and cultivated as needed. Insecticides were applied when needed. The plots were irrigated with ca 3.8 cm of water 29 August, 11 September and 18 September. Stand counts were made 2 June on the two center rows of each plot.

The level of nematode infestation was determined 26 September. Soil samples were collected from the two center rows of each plot, and nematodes were extracted by the centrifuge-sugar-flotation method (3). Roots of 10 plants from the two outside rows of each plot were rated for severity of galling. Root-knot ratings were based on a 1-5 scale: 1 equals no galling, 2 equals 1-25%, 3 equals 26-50%, 4 equals 51-75%, and 5 equals 76-100% of root systems galled. Soybean yields, height and lodging data were obtained from the two center rows of each plot. Lodging was based on a 1-5 scale: 1 equals no lodging, 5 equals severe lodging. Data were subjected to analysis of variance and Duncan's multiple range test (6).

RESULTS AND DISCUSSION

All treatments except phenamiphos at 2.8 kg a.i./ha, 1,3-D at 9.34 l/ha and DD at 7.01 l/ha increased yields significantly relative to the control (Table 1). Ethylene dibromide was as effective at 4.67 l/ha as it was at the higher rates. DD at 18.68 l/ha and 1,3-D at 9.34 l/ha were also as effective as the higher rates of the corresponding material. Phenamiphos at 2.8 kg a.i./ha produced 282 kg/ha less than ethylene dibromide at 56.04 l/ha, but differences were not significant. Plots treated with DD at 7.01 l/ha yielded the least of the treated plots.

Stands were significantly reduced by DD at 74.72 l/ha. Plants that emerged in this treatment also grew slowly for the first few days. In spite of the phytotoxicity, this treatment produced one of the greatest yields. Differences in plant height were not significant. Lodging was not severe for any treatment (data not shown).

Root-knot indices were reduced significantly by all treatments except DD at 7.01 and 18.68 l/ha, ethylene dibromide at 4.67 l/ha and 1,3-D at 9.34 l/ha (Table 2). The numbers of *M. incognita* larvae were reduced significantly by all treatments except DD at 7.01 and 18.68 l/ha and 1,3-D at 9.34 l/ha. Yield was negatively correlated (P : 0.01)

Table 1. Effects on soybeans of four nematicides applied at time of planting, Tifton, Georgia 1978[1]. Means of four replicates.

Treatment, formulation and rate (l/ha)	Yield (kg/ha)	Stand (no. plants/m)	Height (cm)
Ethylene dibromide 90EC, 56.04	2473 a	27.9 ab	74.9 a
Ethylene dibromide 90 EC, 9.34	2466 a	29.8 a	71.1 a
Ethylene dibromide 90 EC, 18.68	2419 a	25.3 ab	72.4 a
Ethylene dibromide 90 EC, 37.36	2292 a	25.1 ab	70.6 a
Ethylene dibromide 90 EC, 4.67	2231 ab	30.1 a	68.1 a
DD 100L, 37.36	2406 a	28.1 ab	73.7 a
DD 100L, 74.72	2278 a	13.2 c	68.1 a
DD 100L, 18.68	2238 ab	28.9 ab	73.2 a
DD 100L, 7.01	1848 bc	27.2 ab	69.9 a
1,3-D 92L, 37.36	2359 a	24.0 b	73.2 a
1,3-D 92L, 18.68	2318 a	28.6 ab	68.6 a
1,3-D 92L, 9.34	2117 a-c	28.3 ab	70.6 a
Phenamiphos 15G, 2.8[2]	2191 a-c	26.0 ab	69.9 a
Control	1788 c	28.6 ab	69.3 a

[1]Data followed by the same letter in columns are not different (P equals 0.05) according to Duncan's multiple range test.
[2]kg a.i./ha.

with root-knot index (r : -0.57) and root-knot larvae (r : -0.62). The numbers of *Helicotylenchus* sp. were reduced significantly by all treatments except DD at 7.01 and 18.68 l/ha, 1,3-D at 9.34 and 18.68 l/ha and ethylene dibromide at 4.67 l/ha. The number of *P. christiei* present did not differ significantly.

These data suggest that the fumigants, except DD at 74.72 l/ha, applied to soybeans at time of planting caused no phytotoxicity. The highest rates used that did not result in phytotoxicity were: ethylene dibromide 56.04 l/ha, DD 37.36 l/ha, and 1,3-D 37.36 l/ha. However, it must be noted that conditions were ideal for the escape of these materials from the soil within a relatively short period of time. Under different soil and climatic conditions, phytotoxicity could possibly occur, especially at the high rates, reducing yields rather than increasing them. Soil conditions that may retard the release of these chemicals from the soil (thereby increasing phytotoxicity) are low temperature and high moisture, organic matter and clay content (2).

RESUMEN

Inyecciones en la siembra de varias concentraciones de bibromuro de etileno, DD, y 1,3-D a una profundidad de 20 cm con dos inyectores por surco separados 25 cm aumentaron los rendimientos de soya y redujeron los niveles de población de *Meloidogyne incognita* y *Helicotylenchus* sp. en una arena limosa Fuquay. Se obtuvieron aumentos significativos de rendimientos con las siguientes concentraciones (l/ha): bibromuro de etileno, 4.67, 9.34, 18.68, 37.36, y 56.04; DD, 18.68, 37.36, y 74.72; 1,3-D, 18.68 y 37.36. El promedio de aumento de rendimiento para estas dosis fue de 31%. Las diferencias en rendimiento entre los diferentes niveles de pesticida no fueron significativas. Los rendimientos no aumentaron significativamente con DD a

Table 2. Effects on nematode populations of four nematicides applied to soybeans at planting, Tifton, Georgia, 1978[1]. Means of four replicates.

Treatment, formulation and rate (l/ha)	Number of nematodes/150cc soil, September 26			
	Root-knot index	*Meloidogyne incognita*	*Helicotylenchus* sp.	*Paratrichodorus christiei*
Ethylene dibromide 90EC, 56.04	1.1 ef	0 c	2 c	40 a
Ethylene dibromide 90EC, 9.34	1.4 ef	98 c	6 c	114 a
Ethylene dibromide 90EC, 18.68	1.0 f	16 c	0 c	94 a
Ethylene dibromide 90EC, 37.36	1.0 f	2 c	12 c	50 a
Ethylene dibromide 90EC, 4.67	3.0 bc	384 bc	58 bc	108 a
DD 100L, 37.36	1.9 de	172 bc	14 c	76 a
DD 100L, 74.72	1.0 f	4 c	0 c	56 a
DD 100L, 18.68	3.2 a-c	652 a-c	30 bc	58 a
DD 100L, 7.01	4.0 a	804 ab	76 bc	70 a
1,3-D 92L, 37.36	1.9 de	58 c	8 c	54 a
1,3-D 92L, 18.68	2.4 cd	376 bc	46 bc	34 a
1,3-D 92L, 9.34	3.1 a-c	694 a-c	170 a	86 a
Phenamiphos 15G, 2.8[2]	1.8 d-f	120 bc	8 c	66 a
Control	3.5 ab	1102 a	108 ab	62 a

[1]Data followed by the same letter in columns are not different (P equals 0.05) according to Duncan's multiple-range test.
[2]kg a.i./ha.

7.01 l/ha, 1,3-D a 9.34 l/ha y con fenamifos a 2.8 kg i.a./ha; DD a 74.72 l/ha fue fitotóxico.

Claves: Combate de nematodos, Glycine max, Nemacur, Soilbrom, 1,3-dicloropropenos, Paratrichodorus christiei, métodos de empleo.

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