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Response of *Rotylenchulus reniformis* to Nematicide Applications on Cotton[1]

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Abstract: Field experiments were conducted to evaluate the efficacy of five nematicides for the management of *Rotylenchulus reniformis* and for their effects on growth, development, and yield of cotton. Treatments included 1,3-dichloropropene (1,3-D), fenamiphos, phorate, terbufos, aldicarb, and 1,3-D + aldicarb. Average *R. reniformis* population densities across all treatments increased from 5,284 at 10 days after planting to a final density at harvest of 15,622 nematodes/500 cm^3 soil. The 1,3-D + aldicarb combination was the only treatment with an average *R. reniformis* population density significantly ($P \leq 0.05$) lower than that of the untreated control. Seedling stand at 28 days after planting was significantly less in aldicarb-treated plots than in control plots. Plant height was significantly greater in plots treated with nematicides than in the controls. Seed cotton yield was significantly greater from treated plots. Cotton plots treated with the 1,3-D + aldicarb combination produced the highest average yield of 4,139 kg/ha.

Key words: 1,3-dichloropropene (1,3-D), aldicarb, chemical control, cotton, fenamiphos, *Gossypium hirsutum,* nematicide, phorate, reniform nematode, *Rotylenchulus reniformis,* terbufos.

The reniform nematode, *Rotylenchulus reniformis* Linford & Oliveira, 1940, was first identified as a parasite of cotton (*Gossypium hirsutum* L.) in 1940 (2,9). Symptoms associated with this nematode include stunted plants, plants with prematurely decayed roots, and dead plants (1). The reniform nematode was first considered an economically important pest on cotton in 1954 when it was found associated with Fusarium wilt in a disease complex (7). Reductions in cotton yields of 40–60% have been attributed to *R. reniformis* (1).

The reniform nematode was first identified in Mississippi on centipede grass, *Eremochloa ophiuroides* (Munro) Hack., in 1968 and is now known to occur in 43 counties in the state (8). In 1980 the reniform nematode was found in association with cotton in Mississippi, but currently no research is available to quantify actual yield losses attributed to *R. reniformis* in the state. The objectives of this study were to determine the efficacy of selected fumigant and nonfumigant nematicides on *R. reniformis* population development on cotton and the effects of the nematicides on cotton growth and yield.

Materials and Methods

Two experiments were conducted in 1988 at the Oklahoma plantation in Holmes County, Mississippi. The test sites were in fields with a previous history of *R. reniformis* infestation and continuous cotton production.

The nematicide treatments and rates were 1,3-dichloropropene (1,3-D) (28 liters/ha and 47 liters/ha), aldicarb (1.18 kg a.i./ha), fenamiphos (2.02 kg a.i./ha), phorate (0.84 kg a.i./ha), terbufos (1.68 kg a.i./ha), and 1,3-D (28 liters/ha) + aldicarb (0.56 kg a.i./ha). The 1,3-D was applied with a modified John Deere ripper-hipper. A CO_2-charged system was used to propel the fumigant through flow regulators (Spraying Systems Co., Wheaton, IL) mounted on stainless steel delivery tubes attached to the trailing edge of forward swept chisels. The fumigant was injected 7 days preplant 40.6 cm deep with a single chisel per row. Rows were immediately

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[1] Published with the approval of the Director, Mississippi Agricultural and Forestry Experiment Station, as Journal Series Paper J-7488. All nematicides used in this study, except terbufos, are currently registered for use on cotton. Strict adherence to all label instructions were followed in the handling and application of these products. All quantities taken from the terbufos-treated plots were destroyed.

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hipped with disk-hillers angled to build a row of soil, 81 cm wide × 31 cm high, to seal and prevent rapid loss of the fumigant. All remaining rows were subsoiled 40.6 cm deep and hipped without applying the fumigant.

Nonfumigant nematicides were applied at planting on 29 April. Fenamiphos and terbufos were applied in a 20-cm band behind the planter presswheel and incorporated into the top 2.5 cm of soil with springtooth tines. Aldicarb and phorate were applied in a furrow approximately 7 mm to the side and 7 mm above the seed.

The experimental design was a randomized complete block with five replications. Plots consisted of four 12.7-m-long rows spaced 97 cm apart. Replications were separated by a 4.6-m border. Each row was planted with 160 seeds of the cotton cultivar Deltapine 20. This cultivar has been shown to be susceptible to *R. reniformis* in greenhouse and field studies (Batson and Lawrence, unpubl.). Seeds were commercially treated with captan and carboxin plus metalaxyl. Cotton seedling stand (number of plants/12.7 m of row) and plant height were recorded at 28 and 80 days after planting, respectively. Plots were irrigated as needed with a center pivot system.

Population densities of *R. reniformis* in soil (juveniles and vermiform adults) were determined 10 days after planting and at monthly intervals for the duration of the test. Ten soil cores, 2 cm d × 20 cm deep, were collected from the two center rows of each plot in a systematic sampling pattern. Cores collected from each plot were mixed thoroughly and a 500-cm^3 subsample was removed. Nematodes were extracted with a semi-automatic elutriator, and the fraction of soil collected on a 38-μm-pore sieve was further processed by centrifugal flotation (sucrose sp gr = 1.13) (4).

Whole plots were mechanically harvested on 6 October with a John Deere harvester. Yield was recorded as kilograms of seed cotton per hectare. Harvest data and *R. reniformis* population densities were subjected to analysis of variance and means were compared using Fisher's protected least significant difference test ($P \leq 0.05$).

Results and Discussion

Rotylenchulus reniformis population densities were similar at both locations. Average densities 10 days after planting were 5,501 and 5,066 juveniles and vermiform adults per 500 cm^3 soil at sites 1 and 2, respectively (Table 1).

At site 1, *R. reniformis* densities 10 days after planting were significantly lower ($P \leq 0.05$) in plots treated with 1,3-D at 47 liters/ha than in control plots (Table 1). This reduction was due to the death of some of the nematodes from exposure to the 1,3-D treatment 7 days before planting. *Rotylenchulus reniformis* densities were 38–81% less in the 1,3-D-treated plots than the untreated plots. This reduction in population supports previous research (5) on reductions of *R. reniformis* populations by fumigation.

At 42 days after planting, *R. reniformis* populations were significantly lower in plots treated with 1,3-D (47 liters/ha) and 1,3-D + aldicarb than in the untreated control. Significantly ($P \leq 0.05$) more *R. reniformis* were recovered in fenamiphos-treated plots than in control plots. At 69 days, *R. reniformis* densities had increased in all plots except those treated with fenamiphos. At 96 days after planting, nematode densities in plots treated with phorate and fenamiphos were higher ($P \leq 0.05$) than densities recorded from all other treatments and the untreated control. The lowest population densities were recovered from the 1,3-D (47 liters/ha) and the 1,3-D + aldicarb treatments. There were no significant differences in *R. reniformis* populations among treatments at 137 days after planting. At harvest, 166 days after planting, *R. reniformis* populations ranged from 8,213 to 22,435/500 cm^3 soil. Fewer ($P \leq 0.05$) *R. reniformis* were recovered in the plots treated with 1,3-D (47 liters/ha), 1,3-D + aldicarb, aldicarb, or terbufos, relative to the other nematicide treatments and the untreated control.

TABLE 1. Effects of nematicide treatments on the population development of *Rotylenchulus reniformis* from 10 to 166 days after planting at two sites in Holmes County, Mississippi, 1988.

Nematicide treatment	Rate	*R. reniformis* density per 500 cm³ soil												
		Site 1							Site 2					
		10	42	69	96	136	166	Mean†	10	42	69	96	136	166	Mean†
1,3-D	28 liters/ha	3,790	3,211	21,555	14,283	17,802	17,504	13,024	4,820	4,593	7,408	19,895	12,599	13,354	10,445
1,3-D	47 liters/ha	1,288	2,156	10,356	10,815	19,721	8,213	8,758	1,635	4,593	5,017	19,895	17,604	11,323	10,011
1,3-D + aldicarb	28 liters/ha 0.56 kg a.i./ha	3,753	2,661	4,113	10,678	13,825	9,923	7,492	2,961	3,508	7,433	16,687	6,343	6,417	7,225
Terbufos	1.68 kg a.i./ha	7,259	4,340	16,253	15,993	18,198	10,071	12,019	7,947	10,812	13,131	38,532	8,139	5,500	14,010
Phorate	0.84 kg a.i./ha	7,941	6,332	12,586	27,650	15,931	16,389	14,471	5,451	4,921	17,628	13,825	18,644	17,765	13,372
Aldicarb	1.18 kg a.i./ha	6,046	5,693	17,752	12,438	14,383	9,873	11,083	7,696	9,663	14,160	21,258	9,365	6,925	13,493
Fenamiphos	2.02 kg a.i./ha	7,284	11,907	10,084	26,139	24,169	13,199	15,464	5,561	5,522	16,600	44,969	18,025	4,002	15,780
Control		6,654	6,348	10,530	15,807	19,833	22,435	13,601	4,460	6,065	13,590	24,726	32,730	12,772	15,724
FLSD ($P \leq 0.05$)		4,531	3,228	12,434	9,902	10,532	9,316	4,628	4,152	4,844	10,003	22,534	17,746	9,532	7,306

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test.
† Mean *R. reniformis* density across all sample dates.

Population development trends for *R. reniformis* at site 2 were similar to those at site 1. In general, *R. reniformis* population densities during the growing season were lower in plots treated with 1,3-D + aldicarb, but these differences were not significant ($P \leq 0.05$). Final densities ranged from 4,002 to 17,765/500 cm³ soil (Table 1). The final nematode densities recovered from plots treated with terbufos and fenamiphos were lower than those recovered 10 days after planting.

Temporal development of *R. reniformis* over the 1988 growing season was similar at both locations. In general, *R. reniformis* population densities were relatively low at the 10-day and 42-day samples in most treated plots and the untreated control. The highest *R. reniformis* population densities were recovered 96 days after planting, when densities of 27,650 and 44,969/500 cm³ soil were recovered from phorate-treated plots at site 1 and fenamiphos-treated plots at site 2. These represent a 248% increase in *R. reniformis* density at site 1 and a 709% increase at site 2.

At harvest the final *R. reniformis* population densities recovered in most of the nematicide-treated plots were lower than the density in the untreated control. The 1,3-D + aldicarb treatment was the only treatment in which the *R. reniformis* densities averaged across sampling dates were significantly lower than the nematode populations recovered from the untreated control at both locations (Table 1).

The reduction in final *R. reniformis* population densities in several of the nematicide-treated plots is important in that the final population represents the number of nematodes that overwinter and may serve as initial inoculum for subsequent crops. Although the preadult stage is considered resistant to environmental conditions (3,10), populations decline during the winter. Therefore, fewer nematodes going into the winter may result in a lower initial population the following year.

At site 1, cotton stand counts 28 days after planting ranged from 53 to 77 plants/

TABLE 2. Effects of nematicide treatments on plant stand (28 days after planting), plant height (80 DAP), and seed yield (166 DAP) of Deltapine 20 cotton in soil naturally infested with *Rotylenchulus reniformis* in Holmes County, Mississippi, 1988.

Nematicide treatment	Rate	Seedling stand†		Plant height (cm)		Seed cotton yield (kg/ha)	
		Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
1,3-D	28 liters/ha	69.7	76.2	85.6	50.6	3,801	1,486
1,3-D	47 liters/ha	68.8	70.2	83.3	57.7	3,859	1,454
1,3-D + aldicarb	28 liters/ha + 0.56 kg a.i./ha	69.1	68.8	93.0	93.0	4,274	4,004
Terbufos	1.68 kg a.i./ha	68.9	72.0	80.5	83.6	3,839	3,713
Phorate	0.84 kg a.i./ha	77.0	78.2	81.3	83.8	3,757	3,578
Aldicarb	1.18 kg a.i./ha	53.3	69.7	78.7	83.3	3,566	3,660
Fenamiphos	2.02 kg a.i./ha	72.8	68.5	78.7	68.6	3,556	2,686
Control		76.5	70.6	65.0	51.3	2,610	1,323
FLSD ($P \leq 0.05$)		10.6	4.6	8.4	11.2	503	465

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test.
† Number of live cotton plants per row; all rows received 160 seed.

12.7-m row (Table 2), averaging 69/row. Significantly fewer plants were recorded in the plots treated with aldicarb. Plant stand at site 2 ranged from 68 to 78/row (Table 2) with an overall average of 71/row. Cotton plant populations were significantly greater in the plots treated with phorate and 1,3-D (28 liters/ha) than in the untreated control.

At site 1, 80 days after planting, cotton plants growing in treated plots were significantly taller than plants growing in the untreated control (Table 2). Plant height ranged from 65.0 cm in the control to 93.0 cm in plots treated with 1,3-D + aldicarb. Plants from the latter treatment were taller ($P \leq 0.05$) than plants grown in the other treatments, except where 1,3-D was applied at 47 liters/ha. At site 2, the height of cotton plants ranged from 50.6 cm to 93.0 cm (Table 2). As at site 1, plants grown in 1,3-D + aldicarb were significantly taller than plants in the untreated control.

Seed cotton yield in nematicide-treated plots was increased ($P \leq 0.05$) over the control at both sites (Table 2). At site 1, plots that received 1,3-D + aldicarb produced the highest yield of all treatments, 4,274 kg/ha compared with 2,611 kg/ha from the control plots. At site 2, yields were greater ($P \leq 0.05$) from the nonfumigant-treated plots than from plots treated with 1,3-D at 28 liters/ha and 47 liters/ha and the untreated control (Table 2). The highest yield of 4,004 kg seed cotton/ha was recovered from the 1,3-D + aldicarb combination, compared with 1,323 kg/ha from the untreated control. The reduced seed cotton yields in plots with 1,3-D applied at 28 liters/ha and 47 liters/ha may be attributed to an early season thrips (*Frankliniella fusca* Hinds) infestation at this location. The fumigant 1,3-D does not exhibit systemic insecticidal–nematicidal activity and therefore would not provide early-season insect control.

In conclusion, the nematicide treatments used in this study varied in their effectiveness in reducing nematode population densities. Although the final *R. reniformis* densities were lower in some nematicide treatments, only 1,3-D + aldicarb significantly reduced the nematode population density averaged across all sampling dates during the growing season at both sites. Cotton plants from plots treated with 1,3-D + aldicarb were taller and produced higher seed cotton yields than did plants from control plots. This contrasts with previous studies conducted in Mississippi in which nematicides did not significantly effect cotton yields from *R. reniformis*-infested plots (6). In our study, seed cotton yield was greater in plots that received nematicides than in the untreated control plots.

Options for control of *R. reniformis* on

cotton are limited. Currently there are no commercially available cultivars resistant to *R. reniformis.* Although a cotton producer should not rely on a single control method in a nematode management system, results from this test have shown that nematicides may reduce *R. reniformis* population densities and provide economic returns in the form of higher yield.

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