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Response of Cotton to Infection by *Hoplolaimus columbus*[1]

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Abstract: Three field experiments were established in 1987 to determine the reaction of five cotton cultivars to infection by *Hoplolaimus columbus* and the efficacy of selected nematicides against this nematode. At two sites in Calhoun County, South Carolina, early season plant growth and subsequent yields were greater in plots treated with aldicarb, fenamiphos, and 1,3-dichloropropene. *Hoplolaimus columbus* suppressed yields approximately 10% at site 1 and 25% at site 2; however, greater yield suppression at site 2 may have been influenced by low levels of *Meloidogyne incognita.* At one site in Barnwell County, South Carolina, nematicide treatments did not increase plant growth or yield. At sites 1 and 2 where yield losses occurred, no differences in infection rate or yield among untreated cultivars were observed, nor was any nematicide more effective than another in preventing yield losses.
Key words: aldicarb, chemical control, Columbia lance nematode, cotton, fenamiphos, *Gossypium hirsutum, Hoplolaimus columbus, Meloidogyne incognita,* nematicide, 1,3-dichloropropene, root-knot nematode.

The Columbia lance nematode, *Hoplolaimus columbus* Sher, has been associated with yield losses in cotton (*Gossypium hirsutum* L.) in South Carolina (8,12–14). The nematode was also associated with the cotton stunt disease complex; however, failure of roots to penetrate hardpans was shown to be the primary cause of this malady (4). Nematicides reduced populations of *H. columbus* and, when combined with subsoiling, increased yields (5,6,10).

Limited information comparing resistance of cotton cultivars to *H. columbus* is available. McNair 511 may support fewer *H. columbus* than Stoneville 213 (4). Lockett had a Pf/Pi ratio of 7.4 compared with 2.0 for Deltapine 16. Deltapine 16, however, sustained a yield loss, whereas Lockett did not (14). Thus, nematode reproduction and yield may not be related. Our objectives were to compare host suitability and yield in cotton infected by *H. columbus* and to determine the efficacy of nematicides in preventing yield losses.

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MATERIALS AND METHODS

Two experiments were established on 23 April 1987 in Calhoun County, South Carolina, in a Magnolia sandy loam soil (74% sand, 19% silt, 7% clay, 1% organic matter; pH 6.3). Sites 1 and 2 had initial *H. columbus* population densities of 230 (range 57–575)/100 cm^3 soil and 238 (range 36–680)/100 cm^3 soil, respectively. A third experiment was established on 6 May 1987 in Barnwell County, South Carolina, in a Varina loamy sand (86% sand, 7% silt, 7% clay, 1% organic matter; pH 6.2) infested with 83 (range 6–260) *H. columbus*/100 cm^3 soil. The fields were cropped to cotton and soybean the previous 5 years, and yield losses caused by *H. columbus* had been observed. Trace levels of *Meloidogyne incognita* (Kofoid & White) Chitwood were detected in soil samples taken at planting in site 2 in Calhoun County.

Site 1 in Calhoun County contained six replications of cotton cultivars Coker 315, Deltapine 50, Deltapine 90, PD 1, and PD 3 in a split-plot within a randomized complete block design with nematicide as mainplots and cultivars as subplots to compare yield losses sustained by the cultivars. The nematicide treatment was 1,3-dichloropropene (1,3-D) plus aldicarb.

At site 2 in Calhoun County nematicides tested on Coker 315 were aldicarb, fenamiphos, and 1,3-D plus aldicarb. Treatments were arranged in a randomized complete block design and were replicated five times.

At Barnwell County (site 3) nematicides tested on Coker 315 were aldicarb, fenamiphos, and 1,3-D plus aldicarb. Treatments were arranged in a randomized complete block design and replicated six times.

Nonfumigant nematicides were applied at planting in-furrow with an electric powered Gandy applicator (Gandy Company, Owatonna, MN). 1,3-D was applied 25 cm deep with a single chisel per row using a gravity flow applicator with the chisel slit sealed by the press wheel. Rates and times of application are listed in Tables 1–3. All plots, each consisting of four 11-m-long rows on 96-cm centers, were subsoiled 30 cm deep at planting. Seeding rate was 20 seed/m of row.

Population densities of *H. columbus* per plot were determined at planting and at midseason. Soil samples consisted of a composite of 12 cores (2.5-cm-d and 20-cm deep) from the rhizosphere of the center two rows. Nematodes were extracted from 100 cm^3 soil using centrifugal-flotation (11). Six weeks after planting 10 root systems were excavated at random from the first and fourth rows of each plot and *H. columbus* was extracted from ca. 15 g fresh weight of roots using a modified mist apparatus (2). Roots were oven dried at 60 C for 72 hours after removal from the mist chamber. Recovery of nematodes from roots was expressed as nematodes per gram dry weight of root. Before nematode extraction percentages of plants with root pruning or excessive branching induced by *H. columbus* and galling (1 = no galling, 10 = 100% galled) by *M. incognita* (2) were recorded.

All plots were maintained using agronomic practices standard in the area (9). Plots in Calhoun County were irrigated as needed using a center pivot system. One meter of cotton was removed from the end of each row and the remaining plants in the center two rows were mechanically harvested. Lint yield was calculated as 33% of the combined seed–lint yield.

TABLE 1. Cotton lint yield and mean number of *Hoplolaimus columbus* per gram of root and percentage of plants with damaged roots 42 days after planting as affected by cultivars planted in untreated or nematicide treated soil at site 1, Calhoun County, South Carolina, 1987.

Cultivar	Yield kg/ha	*H. columbus*/ g root	Damaged roots (%)
	Untreated		
Deltapine 90	1,187 a	288 a	40 a
Coker 315	1,116 ab	599 a	30 a
Deltapine 50	1,081 ab	323 a	36 a
PD 1	1,010 b	417 a	36 a
PD 3	1,105 ab	183 a	44 a
$\bar{x}$†	1,100	362	37
	Treated‡		
Deltapine 90	1,309 a	24 a	20 a
Coker 315	1,220 a	29 a	14 a
Deltapine 50	1,204 ab	2 a	24 a
PD 1	1,136 b	7 a	16 a
PD 3	1,118 b	43 a	20 a
$\bar{x}$†	1,197	21	19

Data are means of six replications. Means followed by the same letter within a column, within a treatment regime, are not different ($P = 0.05$) according to LSD.

† Untreated vs. treated means over all cultivars are different ($P = 0.05$) according to a split-plot analysis with nematicide treatments as main plots.

‡ 1,3-D injected 25 cm deep at planting at 340 g a.i./100 m (34 kg a.i./ha broadcast) plus aldicarb in-furrow at 5.0 g a.i./100 m (0.5 kg a.i./ha broadcast). Rates were calculated based on a 96-cm row spacing.

Data from site 1 was subjected to analysis of variance for a split-plot design to compare the main effects of nematicide, cultivar, and their interaction. Comparisons of cultivars within nematicide treatments were according to LSD. Data from the two nematicide tests (sites 2 and 3) were subjected to analysis of variance. When a significant ($P = 0.05$) treatment effect was detected, means were separated using Duncan's new multiple-range test.

RESULTS AND DISCUSSION

Nematicide treatment increased yields of all cultivars ($P = 0.05$) (Table 1). Comparison of yields of treated vs. untreated individual cultivars at site 1 showed that all except PD 3 sustained ca. a 10% yield loss due to *H. columbus* (Table 1). Comparison of untreated vs. treated Coker 315

TABLE 2. Cotton lint yield, mean number of *Hoplolaimus columbus* per gram root and percentage of plants damaged 42 days after planting, galling by *Meloidogyne incognita,* and plant fresh weight of Coker 315 cotton as affected by nematicide treatments at site 2 in Calhoun County, South Carolina, 1987.

Treatments and g a.i./100 m (broadcast rate)	Yield (kg/ha)	*H. columbus*/ g root	Damaged roots (%)†	Gall rating‡	Fresh weight (g)	
					Shoot	Root
1,3-D 340 + aldicarb 5.0 (34 kg/ha + 0.5 kg/ha)	1,212 a	7 b	32 ab	0.4 c	57 a	5.0 a
Aldicarb 8.4 (0.84 kg/ha)	1,081 a	37 b	8 b	0.5 c	44 b	5.1 a
Fenamiphos 8.4 (0.84 kg/ha)	1,063 a	65 b	44 a	1.2 ab	38 b	3.8 b
Aldicarb 5.0 (0.5 kg/ha)	1,060 a	41 b	16 ab	1.0 b	41 b	4.3 ab
Untreated	884 b	2,267 a	44 a	1.7 a	9 c	1.1 c

Data are means of five replications. Means followed by the same letter within a column are not different according to Duncan's new multiple-range test ($P = 0.05$).
† Rates were calculated based on a 96-cm row spacing.
‡ Rating scale of 0 (no galls) to 10 (100% of surface area galled).

showed it sustained ca. a 25% yield loss at site 2; however, these higher yield losses may have been due to the additional presence of low levels of *M. incognita* (Table 2). Damage from *H. columbus* was manifested early in the growing season at site 2 as evidenced by the lower shoot and root weights of untreated vs. treated plants 6 weeks after planting (Table 2). Nematicide treatment reduced ($P = 0.05$) root damage due to *H. columbus* at site 1 (Table 1) but not site 2 (Table 2). This indicated that the subsequent yield losses observed in both tests were due to more than just physical damage to the root system.

TABLE 3. Cotton lint yield and mean number of *Hoplolaimus columbus* per gram dry weight root 42 days after planting as affected by nematicide treatments at site 3 in Barnwell County, South Carolina, 1987.

Treatments and g a.i./100 m (broadcast)†	Time of application	Yield (kg/ha)	*H. columbus*/ g root
Untreated		1,072 a	16 a
Aldicarb 5.0 (0.5 kg/ha)	At plant	1,037 a	26 a
1,3-D 340 + aldicarb 5.0 (34 + 0.5 kg/ha)	At plant At plant	1,020 a	3 a
Fenamiphos 8.0 (0.84 kg/ha)	At plant	1,007 a	21 a
1,3-D 340 + aldicarb 5.0 (34 + 0.5 kg/ha)	Preplant At plant	1,002 a	7 a

Data are means of six replications. Means followed by the same letter within a column are not different according to Duncan's new multiple-range test ($P = 0.05$).
† Rates were calculated based on a 96-cm row spacing.

The failure to detect differences in recovery of *H. columbus* among untreated cultivars 6 weeks after planting (Table 1) suggests that none of the cultivars were resistant to the nematode. The lower yield of untreated PD 1 relative to Deltapine 90 (Table 1) indicates that some cotton cultivars may exhibit tolerance to *H. columbus* similar to that reported for soybean (7,15).

All nematicides at site 2 reduced recovery of *H. columbus* from roots 6 weeks after planting, thereby increasing early season root and shoot weight and eventual seed yields; however, there were no differences in yield among the nematicides ($P = 0.05$) (Table 2). Although initial nematode population densities at site 3 were near the threshold of 100 *H. columbus*/100 cm^3 soil reported for the soil type (1), recovery of *H. columbus* 6 weeks after planting did not resemble levels recorded at sites 1 and 2 (Table 3). Nematode and nematicide activity may have been greater at sites 1 and 2 than at site 3 because of higher soil moisture content in irrigated soil, greater initial population densities of *H. columbus,* or the presence of low levels of *M. incognita* at site 2.

Galling observed at site 2 was on roots more than 20 cm deep and none was detected 6 weeks after planting. *Meloidogyne incognita* activity in the upper 20 cm of soil may have been affected by *H. columbus* activity (3,12).

Our results indicate that yield losses on cotton caused by *H. columbus* vary greatly. A more thorough understanding of the effects of edaphic, environmental, and genetic factors on the relationship between *H. columbus* and yield losses on cotton are needed to devise and implement appropriate management schemes.

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