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Rotylenchulus reniformis Management in Cotton with Crop Rotation[1]

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Abstract: One-year crop rotations with corn or highly resistant soybean were evaluated at four locations for their effect on *Rotylenchulus reniformis* population levels and yield of a subsequent cotton crop. Four nematicide (aldicarb) regimes were included at two of the locations, and rotation with reniform-susceptible soybean was included at the other two locations. One-year rotations to corn or resistant soybean resulted in lower *R. reniformis* population levels ($P \leq 0.05$) than those found in cotton at three test sites. However, the effect of rotation on nematode populations was undetectable by mid-season when cotton was grown the following year. Cotton yield following a one-year rotation to resistant soybean increased at all test locations compared to continuous cotton, and yield following corn increased at three locations. The optimum application rate for aldicarb in this study was 0.84 kg a.i./ha in furrow. Side-dress applications of aldicarb resulted in yield increases that were insufficient to cover the cost of application in 3 of the 4 years.

Key words: aldicarb, corn, cotton, crop loss, crop rotation, *Glycine max, Gossypium hirsutum,* reniform nematode, *Rotylenchulus reniformis,* soybean, *Zea mays.*

The reniform nematode, *Rotylenchulus reniformis* Linford and Oliveira 1940, is widely distributed in tropical and subtropical regions and is found throughout the southern United States (Heald and Robinson, 1990; Kinloch and Sprenkel, 1994; Starr, 1998). The nematode has a wide host range that includes cotton (*Gossypium hirsutum* L.) and a broad range of vegetable and field crops (Robinson et al., 1997; Thames and Heald, 1974). Highly infested fields within the United States are found in the cotton-growing areas of Alabama, Arkansas, Georgia, Louisiana, Missouri, Mississippi, and Texas (Baird et al., 1996; Koenning et al., 1999; Robinson et al., 1987; Starr et al., 1993; Wrather et al., 1992). The reniform nematode can cause yield losses of 30 to 40% in cotton (Gazaway et al., 1992).

Alternatives to nematicides include the use of host-plant resistance, crop rotation, cover cropping, and soil amendments (Gaur and Perry, 1991). The use of host-plant resistance in managing the reniform nematode has potential because sources of resistance genes have been identified (Cook et al., 1997; Jones et al., 1988; Yik and Birchfield, 1984), but incorporation of this resistance into commercial cultivars has proven difficult. No reniform-resistant cultivar of upland cotton is currently available.

An integrated approach to nematode management should include the use of all cultural and biological tools available to maintain populations below damaging levels. In such an integrated approach, the use of crop rotation with resistant host plants for reniform nematode management has received relatively little attention. Current crop rotations in Georgia rely primarily on rotation of cotton with corn (*Zea mays* L.) or peanut (*Arachis hypogaea* L.). Common rotations for cotton in North Carolina include corn and soybean (*Glycine max* L.). Corn grown following a susceptible sweet potato (*Ipomoea batatas* Poir.) crop reduced *R. reniformis* population levels as effectively as fallow soil (Braithwaite, 1974), though corn has been reported to allow limited reproduction (Heffes et al., 1992; Windham and Lawrence, 1992). The rotation of cotton with reniform nematode-resistant soybean cultivars also may reduce population densities of the nematode (Gilman et al., 1978). Soybean cultivars vary from highly resistant to *R. reniformis* to susceptible (Robbins et al., 1999; Robbins et al., 2001).

Management options for *R. reniformis* in cotton are limited to increased use of current rotation crops, new applications of under-utilized rotation crops, and nematicides. Cotton production relies heavily on nematicide application in many areas (Starr, 1998). The objective of this research was to evaluate and compare the effects of reniform-resistant soybean and corn on *R. reniformis* population densities and subsequent cotton yield in a crop-rotation sequence with cotton. Continuous cotton with various aldicarb regimes also was evaluated.

Materials and Methods

Georgia field tests: Crop-rotation sequences were evaluated in Jefferson County, Georgia, on the Smith Farm in 1998–1999 (a Dothan loamy sand; fine, loamy, kaolinitic, thermic Plinthic Kandiudults) and on the Harrison Farm in 2000–2001 (a Tifton loamy sand; fine, loamy, siliceous, thermic Plinthic Kandiudults). Both sites had been planted in cotton in the year prior to beginning this experiment, and both sites had natural

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infestations of *R. reniformis.* Each experiment had six replications in a randomized complete block design. All plots were 45.7 m long. Cotton plots were 3.9 m wide (four 97-cm-wide rows), but corn and soybean plots were 4.6 m wide (six 76-cm-wide rows). All plots were marked so that plots would be in the same place in both years of the rotation sequence.

In the first year of the rotation sequence, six reniform nematode management tactics were examined: (i) cotton with minimal nematode control (0.59 kg a.i./ha aldicarb in-furrow [Temik 15G, Aventis Crop Science, Research Triangle Park, NC), (ii) cotton with aldicarb in-furrow (0.84 kg a.i./ha), (iii) cotton with aldicarb in-furrow (0.84 kg a.i./ha) and a post-plant aldicarb side-dress application (0.84 kg a.i./ha), (iv) cotton with aldicarb in-furrow (1.18 kg a.i./ha), (v) corn as a rotation crop, and (vi) a soybean variety with a high level of resistance to reniform nematodes as a rotation crop. In the second year of the rotation sequence, all plots were planted with cotton. Plots that had been in cotton the first year received the same aldicarb treatment in the second year that they received in the first year. Plots that had been in corn or soybean the first year received 0.84 kg a.i./ha aldicarb when cotton was planted in the second year.

Side-dress applications of aldicarb were applied to specific cotton plots each year at approximately first bloom in a 30-cm band centered on the plant row and were incorporated to a depth of approximately 1 cm. Dates of application were 24 June 1998, 17 June 1999, 28 June 2000, and 2 July 2001.

In 1998, the first year of the rotation sequence on the Smith Farm, corn (Pioneer Brand 3245) was planted on 13 April and harvested on 18 August, cotton (Delta and Pine Land NuCotn 33B) was planted on 15 May and harvested on 19 October, and soybean (Hyperformer HY 798, maturity group VIII) was planted on 15 June and harvested on 30 October. In 1999, the second year of the rotation sequence, cotton (Delta and Pine Land DP 458 BG/RR) was planted on 18 May and harvested on 8 November. In 2000, the first year of the rotation sequence on the Harrison Farm, corn (Pioneer Brand 3245) was planted on 13 March and harvested on 10 August, cotton (Delta and Pine Land DP 655BRR) was planted on 18 May and harvested on 26 October, and soybean (Delta and Pine Land DP 7375 RR, maturity group VIII) was planted on 7 June and harvested on 31 October. In 2001, the second year of the rotation sequence, cotton (Stoneville 4892 BRR) was planted on 31 May and harvested on 12 November.

All plots received fertilizer, insecticide, and herbicide appropriate for the crop in that plot according to the University of Georgia Cooperative Extension Service recommendations. All cotton plots were managed identically except for nematicide applications, which varied by treatment. Irrigation was applied by center pivot as needed by the cotton plots regardless of need in soybean or corn plots.

Soil samples for nematode analysis were collected in each year of the study prior to planting cotton, in midseason, and at cotton harvest. Dates of soil sample collection were 14 May 1998, 13 August 1998, 19 October 1998, 17 May 1999, 20 July 1999, 8 November 1999, 16 May 2000, 6 July 2000, 26 October 2000, 31 May 2001, 3 July 2001, and 11 October 2001. Nematodes were extracted from 100 cm^3 soil by centrifugal flotation (Jenkins, 1964), and population counts were subjected to natural logarithm transformation prior to analysis of variance and means separation by Fisher's protected $LSD_{(0.05)}$.

The net return above variable costs (RAVC) from 1998 through 2001 for the six rotation-sequence and nematicide combinations (two cycles of each) was calculated as crop income minus variable costs. Variable costs included all cash operating expenses such as seed, fertilizer and lime, chemicals, scouting, irrigation, machinery, fuel, equipment repairs, labor, interest on expenses, marketing, ginning and warehousing (cotton), and drying (corn). Crop income was calculated as the average yield for each treatment multiplied by the average price received by Georgia farmers for the crop. Cotton-quality data were not available and not considered. Ginning and warehousing costs for cotton were the net cost minus cottonseed value based on 1.45 kg of seed per kg of lint and at the average price received by Georgia farmers for cottonseed. Among the continuous cotton treatments, the difference in variable cost was the difference in amount of aldicarb used, application cost if side-dressed, and net ginning and warehousing costs due to yield differences. All other inputs and production practices were the same. The 4-year weighted average price for cotton lint was $1.058/kg. The weighted average price for corn was $0.870/kg, and the weighted average price for soybean was $0.182/kg.

North Carolina field tests: Crop rotations were begun in Cumberland and Scotland Counties in 1992 in cotton fields with natural infestations of *R. reniformis.* The Cumberland County field had a Norfolk loamy sand (fine-loamy, kaolinitic, thermic Typic Kandiudults), and the Scotland County site had a Dunbar fine sandy loam (fine, kaolinitic, thermic Aeric Paleaquults). Each test site had eight replications of four treatments in a randomized complete block design. Plots were 7.7 m wide (eight 97-cm-wide rows) and 20 m long. Nematodes were extracted from 500 cm^3 of soil by elutriation and centrifugation (Byrd et al., 1976; Jenkins, 1964).

The first year of the rotation sequence included continuous cotton (Delta and Pine Land Acala 90), or a 1-year rotation to corn (Pioneer Brand 3245), reniform-resistant soybean (Centennial, maturity group VI), or reniform-susceptible soybean (Young, maturity group VI). All plots were planted in cotton (Delta and Pine Land Acala 90) in 1993. Aldicarb (0.40 kg a.i./ha) was applied to all cotton plots for insect control. Neither location was irrigated. All plots received fertilizer, insecticide, and herbicide appropriate for the crop in that plot according to North Carolina State University Cooperative Extension Service recommendations. All cotton plots were managed identically.

At the Scotland County site in 1992, corn was planted on 27 April, cotton on 7 May, and soybean on 19 May. Soil samples for nematode analysis were collected on 7 May, 30 July, and 23 November, and cotton was harvested on 23 November. At the Cumberland County site in 1992, corn was planted on 20 April, cotton on 6 May, and soybean on 19 May. Soil samples for nematode analysis were collected on 6 May, 30 July, and 4 November, and cotton was harvested on 4 November. At the Scotland County site in 1993, cotton was planted on 3 May and soil samples for nematode analysis were collected on 3 May, 11 August, and 13 October. Cotton was harvested on 13 October. At the Cumberland County site in 1993, cotton was planted on 13 May and soil samples for nematode analysis were collected on 13 May, 10 August, and 9 November. Cotton was harvested on 9 November. Nematode population counts were subjected to analysis of variance and means separation by Waller-Duncan k-ratio *t*-test (k-ratio = 100).

Results

Georgia field tests: In 1998, the first year of the rotation sequence on the Smith Farm, reniform nematode population levels were lower ($P \le 0.05$) by mid-August in plots where corn or resistant soybean were grown, and these differences persisted until cotton harvest (Table 1). The varying rates of aldicarb did not affect nematode population levels on any sampling date, but cotton yields were improved ($P \le 0.05$) in plots receiving 0.84 kg a.i./ha in-furrow. Additional improvement in yield ($P \le 0.05$) was made when aldicarb was applied as a post-plant side-dress treatment. Reniform population levels at planting in 1999, the second year of the rotation, generally were consistent with the end-of-season populations from the previous year, with nematode populations being lowest in plots that had previously been in corn or soybean (Table 1). By mid-season, nematode populations in plots previously in corn or resistant soybean had increased to levels similar to plots with continuous cotton receiving aldicarb at 0.84 kg a.i./ha. Rates of aldicarb had little effect on nematode population levels or cotton yield, though yield was lowest in plots receiving 0.59 kg a.i./ha or 1.18 kg a.i./ha. Yields were higher in plots following resistant soybean than in continuous cotton with aldicarb at 0.59 kg a.i./ha.

Nematode population levels on the Harrison Farm were not significantly affected by crop grown or rate of aldicarb applied (Table 2). Cotton yield was not affected by rate of aldicarb. Nematode population densities in 2001, the second year of the rotation, did not vary among treatments (Table 2). Cotton yield did vary among treatments, with cotton following corn or soybean having higher yield ($P \le 0.05$) than continuous cotton receiving aldicarb at 0.59 kg a.i./ha. Yields were not different among continuous cotton plots regardless of aldicarb rate.

The average annual RAVC from 1998 through 2001 for continuous cotton receiving aldicarb at 0.84 kg a.i./ha in-furrow was $177.25/ha. RAVC for continuous cotton receiving aldicarb at 0.84 kg a.i./ha in-furrow in furrow plus 0.84 kg a.i./ha side-dress was $173.00/ha. The RAVC for continuous cotton receiving aldicarb at

Table 1. *Rotylenchulus reniformis* population levels and crop yields during a 2-year crop-rotation sequence on the Smith Farm, Jefferson County, Georgia, in 1998 and 1999.

Year	Cropping sequence	Current crop	Aldicarb rate (kg a.i./ha) and timing	*Rotylenchulus reniformis* (No./100 cm³ soil)[1]			Yield[2] (kg/ha)
				14 May	14 Aug	19 Oct	
1998	cotton-cotton	cotton	0.59 in furrow	439 a	2,252 a	2,127 a	838 c
	cotton-cotton	cotton	0.84 in furrow	553 a	2,192 a	2,422 a	917 b
	cotton-cotton	cotton	0.84 in furrow and side-dressed[3]	501 a	1,726 a	1,283 ab	1,032 a
	cotton-cotton	cotton	1.18 in furrow	474 a	2,438 a	1,545 a	895 bc
	corn-cotton	corn	none	607 a	200 b	449 b	8,155
	soybean-cotton	soybean	none	481 a	141 b	96 c	2,352
				17 May	20 Jul	8 Nov	
1999	cotton-cotton	cotton	0.59 in furrow	386 bcd	1,598 ab	1,309 b	1,068 b
	cotton-cotton	cotton	0.84 in furrow	578 ab	1,206 b	2,013 ab	1,124 ab
	cotton-cotton	cotton	0.84 in furrow and side-dressed[3]	472 abc	2,115 ab	1,431 b	1,163 ab
	cotton-cotton	cotton	1.18 in furrow	789 a	2,568 a	2,369 a	1,065 b
	corn-cotton	cotton	0.84 in furrow	209 cd	1,512 ab	1,733 ab	1,137 ab
	soybean-cotton	cotton	0.84 in furrow	104 d	1,859 ab	1,246 b	1,195 a

[1] Nematode population means for the same year within a column followed by the same letter are not statistically different according to Fisher's Protected $LSD_{(0.05)}$. Nematode population data were subjected to a natural log transformation prior to statistical analysis, but numbers in the table are not transformed.

[2] Cotton yield is given as kg lint/ha and is calculated as 38% of seed cotton weight. Mean cotton yields within a year followed by the same letter are not statistically different according to Fisher's Protected $LSD_{(0.05)}$. Corn and soybean yields are given as kg/ha.

[3] Side-dress applications of aldicarb were made at approximately first bloom (17 June 1999 and 24 June 1998).

TABLE 2. *Rotylenchulus reniformis* population levels and crop yields during a 2-year crop rotation sequence on the Harrison Farm, Jefferson County, Georgia, in 2000 and 2001.

Year	Cropping sequence	Current crop	Aldicarb rate (kg a.i./ha) and timing	*Rotylenchulus reniformis* (No./100 cm³ soil)[1] 17 May	20 Jul	8 Nov	Yield[2] (kg/ha)
2000	cotton-cotton	cotton	0.59 in furrow	2,052 a	880 a	207 a	854 a
	cotton-cotton	cotton	0.84 in furrow	2,793 a	836 a	173 a	910 a
	cotton-cotton	cotton	0.84 in furrow and side-dressed[3]	3,995 a	853 a	203 a	886 a
	cotton-cotton	cotton	1.18 in furrow	4,295 a	581 a	230 a	864 a
	corn-cotton	corn	none	1,652 a	579 a	141 a	13,362
	soybean-cotton	soybean	none	3,453 a	681 a	138 a	1,344
				31 May	3 Jul	1 Oct	
2001	cotton-cotton	cotton	0.59 in furrow	635 a	472 a	714 a	1,112 c
	cotton-cotton	cotton	0.84 in furrow	882 a	633 a	635 a	1,250 abc
	cotton-cotton	cotton	0.84 in furrow and side-dressed[3]	641 a	529 a	566 a	1,267 abc
	cotton-cotton	cotton	1.18 in furrow	726 a	351 a	642 a	1,189 bc
	corn-cotton	cotton	0.84 in furrow	730 a	453 a	413 a	1,390 a
	soybean-cotton	cotton	0.84 in furrow	698 a	508 a	566 a	1,295 ab

[1] Nematode population means for the same year within a column followed by the same letter are not statistically different according to Fisher's Protected $LSD_{(0.05)}$. Nematode population data were subjected to a natural log transformation prior to statistical analysis, but numbers in the table are not transformed.
[2] Cotton yield is given as kg lint/ha and is calculated as 38% of seed cotton weight. Mean cotton yields within a year followed by the same letter are not statistically different according to Fisher's Protected $LSD_{(0.05)}$. Corn and soybean yields are given as kg/ha.
[3] Side-dress applications of aldicarb were made at approximately first bloom (28 June 2000 and 2 June 2001).

0.59 kg a.i./ha in-furrow and 1.18 kg a.i./ha in-furrow were \$114.31/ha and \$121.01/ha, respectively. RAVC was \$149.73/ha for cotton grown in rotation with corn, and \$26.95/ha for cotton grown in rotation with soybean.

North Carolina field tests: At the Cumberland County site, differences among rotations in *R. reniformis* population levels were not evident until cotton harvest. Plots planted to corn and resistant Centenial soybean had lower population densities than continuous cotton plots (Table 3). Plots with susceptible Young soybean had intermediate population densities of *R. reniformis* that were not different from other treatments ($P \leq 0.05$). Reniform population densities at planting in the second year were consistent with end-of-season populations from the previous year, with nematode populations being lower in plots that previously had been in corn or resistant soybean than in continuous cotton plots (Table 3). Cotton yield was higher ($P \leq 0.05$) in plots following resistant soybean.

At the Scotland County site, differences among rotations in reniform nematode population levels were evident by the end of July when corn and resistant Centennial soybean plots had lower ($P \leq 0.05$) nematode numbers than continuous cotton plots or susceptible Young soybean plots (Table 4). Plots with susceptible

TABLE 3. *Rotylenchulus reniformis* population levels and cotton yield during a 2-year crop rotation sequence in Cumberland County, North Carolina, in 1992 and 1993.

Year	Cropping sequence	Current crop	*Rotylenchulus reniformis* (No./100 cm³ soil)[1] 6 May	30 Jul	4 Nov	Yield[2] (kg/ha)
1992	cotton-cotton	cotton	23 a	134 a	241 a	
	corn-cotton	corn	95 a	86 a	58 b	
	Centenial soybean-cotton	soybean	15 a	52 a	54 b	
	Young soybean-cotton	soybean	103 a	154 a	71 ab	
			13 May	10 Aug	9 Nov	
1993	cotton-cotton	cotton	373 a	3,443 a	1,206 a	772 b
	corn-cotton	cotton	93 b	1,151 a	1,386 a	679 b
	Centenial soybean-cotton	cotton	68 b	1,076 a	1,278 a	979 a
	Young soybean-cotton	cotton	127 ab	1,281 a	1,971 a	751 b

[1] Nematode population means for the same year within a column followed by the same letter are not statistically different according to Waller-Duncan k-ratio *t*-test (k-ratio = 100). Nematode population data were subjected to a natural log transformation prior to statistical analysis, but numbers in the table are not transformed.
[2] Cotton yield is given as kg lint/ha and is calculated as 38% of seed cotton weight. Mean cotton yields within a year followed by the same letter are not statistically different according to Waller-Duncan k-ratio *t*-test (k-ratio = 100).

TABLE 4. *Rotylenchulus reniformis* population levels and cotton yield during a 2-year crop rotation sequence in Scotland County, North Carolina, in 1992 and 1993.

Year	Cropping sequence	Current crop	*Rotylenchulus reniformis* (No./100 cm³ soil)[1]			Yield[2] (kg/ha)
			7 May	30 Jul	23 Nov	
1992	cotton-cotton	cotton	1,025 a	861 a	1,524 a	
	corn-cotton	corn	1,772 a	177 c	352 bc	
	Centenial soybean-cotton	soybean	1,695 a	186 c	151 c	
	Young soybean-cotton	soybean	1,277 a	511 b	786 b	
			3 May	11 Aug	13 Oct	
1993	cotton-cotton	cotton	873 a	1,632 a	1,726 a	788 c
	corn-cotton	cotton	711 b	1,733 a	2,101 a	935 a
	Centenial soybean-cotton	cotton	261 c	1,410 a	1,882 a	883 ab
	Young soybean-cotton	cotton	311 c	1,774 a	1,889 a	836 bc

[1] Nematode population means for the same year within a column followed by the same letter are not statistically different according to Waller-Duncan k-ratio *t*-test (k-ratio = 100). Nematode population data were subjected to a natural log transformation prior to statistical analysis, but numbers in the table are not transformed.

[2] Cotton yield is given as kg lint/ha and is calculated as 38% of seed cotton weight. Mean cotton yields within a year followed by the same letter are not statistically different according to Waller-Duncan k-ratio *t*-test (k-ratio = 100).

Young soybean had lower population densities than continuous cotton plots ($P \leq 0.05$). Numbers of reniform nematodes at planting in the second year were highest ($P \leq 0.05$) in continuous cotton plots, lowest in plots following either resistant or susceptible soybean, and intermediate in plots following corn (Table 4). Cotton yield was greater ($P \leq 0.05$) in plots following corn or resistant soybean than in continuous cotton plots. Cotton lint yield in plots following susceptible soybean was intermediate between continuous cotton and corn or resistant soybean.

Discussion

Corn is a poor host for *R. reniformis,* and many hybrids support no reproduction (Windham and Lawrence, 1992), though the amount of reproduction on the hybrid used in this study is not known. Based on previous greenhouse studies, it appears that *R. reniformis* has greater levels of reproduction on resistant soybean cultivars than on any corn hybrid (Robbins et al., 1999; Robbins et al., 2000, 2001; Windham and Lawrence, 1992). Despite the likelihood of greater reproduction on resistant soybean than on corn, *R. reniformis* population densities following resistant soybean consistently were lower than densities following corn, though levels usually were statistically similar. This is consistent with the report that poor hosts can be as effective as non-hosts or fallow in reducing *R. reniformis* populations (Caswell et al., 1991).

Population levels in three of the four trials were significantly lower at the end of the growing season in corn or resistant soybean plots than in cotton plots receiving minimal aldicarb for insect control (0.59 kg a.i./ha in Georgia and 0.40 kg a.i./ha in North Carolina). These results are consistent with a previous report that 1 year of resistant soybean was effective in reducing reniform population levels and increasing the subsequent yield of cotton compared to continuous cotton grown without nematicide (Gilman et al., 1978). This study also is consistent with previous work documenting that nematode populations rebound quickly following a 1-year rotation, so any benefits will occur only in the first year following the rotation (Gilman et al., 1978).

Rotation with corn or resistant soybean generally was effective in suppressing the population density of *R. reniformis* and increasing cotton yield compared to low rates of aldicarb. The results were consistent when comparing locations in North Carolina and Georgia with a 6.5% to 25.0% yield increase, not including the corn rotation in Cumberland County, North Carolina, where yield was lower. Within a location in Georgia, these increases were slightly greater than or equal to the 5.2% to 12.4% yield improvement in continuous cotton treated with aldicarb at 0.84 kg a.i./ha. However, economic return for the 2-year rotation period was reduced with either rotation crop. The effect on cotton yield is consistent with previous work in which rotating cotton with resistant soybean provided an effect equal to growing continuous cotton treated with a nematicide (Gilman et al., 1978). Some of the benefits observed following corn or resistant soybean in Georgia may have been due to aldicarb, where cotton following the rotation crops received aldicarb at 0.84 kg a.i./ha, whereas cotton in the North Carolina trials included aldicarb at 0.4 kg a.i./ha. Previous work has demonstrated that nematicides may provide additional yield increases even following 2 years of an effective rotation crop (Rodríguez-Kábana and Touchton, 1984).

In all 4 years in the Georgia trials, cotton receiving aldicarb at 0.84 kg a.i./ha had numerically higher yields than cotton receiving aldicarb at 0.59 or 1.18 kg a.i./ha. Though not statistically different in any year, such consistency suggests that the optimum rate for aldicarb in furrow is less than 1.18 kg a.i./ha. Consistent with that conclusion, the greatest economic return in the portion of our study conducted in Georgia was achieved with continuous cotton receiving aldicarb at 0.84 kg a.i./ha. A study in Florida also indicated that 1.18 kg a.i./ha may be higher than necessary for maximum economic return in reniform-infested cotton fields (Zimet et al., 2002).

The side-dress application of aldicarb produced inconsistent results and did not increase economic return. Side-dress applications in this study were made 40, 30, 41, and 32 days after planting. Greater benefit may be derived from an application made just prior to hatching of the first generation of eggs produced on the cotton, which could be later than the applications in this study because levels of egg production will be affected by the amount of root growth and subsequent nematode penetration as well as soil temperature. Greater benefit also might be derived from making the application earlier to extend the period following planting, during which an effective concentration of aldicarb is present in the root zone. Irrigation following side-dress application might improve efficacy by moving the nematicide into the root-zone. The effects of application timing and irrigation or rainfall on the efficacy of side-dress applications of aldicarb have not been reported.

Corn and soybean appeared to be much less effective in suppressing *R. reniformis* levels on the Harrison Farm than at the other locations in this study. Though generally a poor host, corn sometimes fails to suppress *R. reniformis* levels (Srivastava and Sethi, 1986). Though weeds can support *R. reniformis* populations during rotations to a poor or non-host (Gaur and Haque, 1987), weeds were controlled well on the Harrison Farm. Population levels of *R. reniformis* in cotton are often greatest at depths between 40 and 120 cm, with relatively few nematodes in the top 15 cm (Robinson and Cook, 2001). If that were true on the Harrison Farm, then deeper samples might have documented a reduction in nematode populations when shallow samples did not. It is not known why the population levels measured on the Harrison Farm were highest prior to beginning the rotation in 2000 and lower during the next 2 years, even in continuous cotton plots.

In summary, a 1-year rotation to corn or resistant soybean can reduce *R. reniformis* population levels. However, nematode population densities rebound quickly when cotton is grown, so the rotation will provide a benefit for only one subsequent cotton crop. Cotton yield following a 1-year rotation likely will be increased, but the increase may be small compared to continuous cotton treated with a nematicide, and the total economic return for all years of the rotation cycle likely will be lower. Soybean, in particular, seems to be an economically unacceptable rotation crop in Georgia. Side-dress applications of aldicarb may provide yield increases too small to enhance economic return. In this study, the optimum application rate for aldicarb was 0.84 kg a.i./ha in furrow.

Rotylenchulus reniformis is an emerging nematode problem affecting cotton production in the southeastern United States. Rotation with non-host crops is an effective means of reducing nematode population levels, though additional control tactics may be beneficial. The economics of rotation with crops of lower value per hectare than cotton makes this practice of limited value to many cotton producers. Additional resources need to be devoted to development of integrated tactics for management of this nematode, such as development of host-plant resistance, new cropping systems, cover crops, and possibly chemical control.

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