2004 BELTWIDE COTTON CONFERENCES, SAN ANTONIO, TX – JANUARY 5-9

RESPONSE OF SELECTED COTTON VARIETIES TO THE RENIFORM NEMATODE IN ALABAMA

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Abstract

The reniform nematode (*Rotylenchulus reniformis*) is currently a management obstacle to cotton production in many regions of the country. The identification of varieties that have defined levels of tolerance would be a cost effective management tool to cotton producers. Selected cotton varieties were evaluated in four tests at three different locations in producers fields naturally infested with the reniform nematode. Varieties were evaluated in a conventionally tilled, monocultured cotton field in Limestone Co., AL; a no-till, cotton field in Lawrence Co., AL; a no-till, annual corn cotton rotation field in Lawrence Co; and a conventionally tilled, monocultured cotton field in Escambia Co., AL. Evaluations were repeated over the 2002 and 2003 growing seasons. In all of the field trials, cotton variety parameters evaluated consisted of seed cotton yields and reniform nematode populations at planting, mid season, and harvest. Reniform nematode reproduction potential was determined in greenhouse trails, which indicated all of the commercial varieties tested are susceptible to the reniform nematode. Field trials indicated that varieties, with early season vigor, produced higher yields in the field trails naturally infested with the reniform nematode.

Introduction

The reniform nematode is currently a pest not only in Alabama, but a large portion of the cotton belt. The reniform nematode has been estimated to cause a 8% loss to the Alabama cotton crop. Currently there are no varieties with resistance to the reniform nematode. There are only a few management practices that can be implemented to overcome the effects of the reniform nematode, which include the use of nematicides such as Temik 15G, Vydate L, and Telone II. Crop rotations with non-host plants also have a positive effect on reducing reniform populations. Nematicides and rotations can reduce reniform populations and increase cotton yields, but they are not always environmentally sound or cost effective. Recently there have been efforts to breed for resistance to the reniform nematode in cotton, but a commercially resistant variety will take many years to develop and release.

Our objective was to evaluate commercially available varieties response to the reniform nematode and to identify and define levels of tolerance that may be available in current varieties. The identification of varieties that produce higher yields in the presence of the reniform nematode would be a valuable asset in assisting producers with their reniform management plan.

Materials and Methods

Field trials were conducted in 2002 and 2003 on the Newby, Clark, and Ward Farms in Limestone, Lawrence, and Escambia counties in AL, respectively. All field trials were in fields naturally infested with *R. reniformis*. Varieties were evaluated in a conventionally tilled, monocultured cotton field in Limestone Co. in north AL; a no-till, annual corn cotton rotation field in Lawrence Co. in north AL; a no-till cotton field in Lawrence Co. in north AL; and a conventionally tilled monocultured cotton field in Escambia Co. in south AL. Evaluations were repeated over the 2002 and 2003 growing seasons. All plots were maintained with standard production practices recommended by the Alabama Extension System and commonly used in the area. Population densities of reniform nematode in all field plots were determined at planting, peak bloom, and at harvest. Soil cores, 1-in diameter and 8-in deep were collected from the rows in each plot in a systematic sampling pattern. Nema-

todes were extracted using gravity screening and sucrose centrifugation technique. Seed cotton weights for each plot were recorded. Greenhouse trials were evaluated at the Plant Research Science Center on the campus of Auburn University to test for resistance among different varieties in a controlled environment. All field plot data and greenhouse data were statistically analyzed using ANOVA, and means were compared with Fisher's protected least significant difference test ($P \leq 0.05$).

Conventionally Tilled, Monocultured Cotton Test, Limestone Co., AL

Twelve transgenic cotton varieties were evaluated with and without nematicides. Nematicides consisted of Temik 15G (aldicarb) applied at 5.0lb/A in 2002, and Telone II (1, 3 dichloropropene) applied at 3 gal/A in 2003. Tests were planted with a MaxEmerge® plot planter April 18 and 22 in 2002 and 2003, respectively. Temik 15G at 5.0 lb/A was applied at planting in the seed furrow with chemical granular applicators attached to the planter in 2002. Di-Syston 15 G at 6.0 lb/A was used on the control plots to manage thrips. Telone II was injected into plots 12 inches deep with a ripper/bedder in 2003. Plots consisted of 2 rows, 25ft long, with 40 in. row spacing in both 2002 and 2003. The 2002 test was arranged as paired plots in a randomized complete block design with four replications. The 2003 test was arranged in a split plot in a randomized complete block design with four replications. The plots were harvested on September 30 and October 14 in 2002 and 2003, respectively.

No Till, Annual Corn Cotton Rotation Test, Lawrence Co., AL

Ten Cruiser treated transgenic cotton varieties were examined with and without Temik 15G plus Vydate in Lawrence Co. in 2002 and 2003. The tests were located in fields following a year of corn production. The tests were planted with a John Deere MaxEmerge® planter on April 22 and 19 in 2002 and 2003, respectively. Plots consisted of 1 row, 200 ft long, with a 30 in. row spacing and were arranged as a split plot with four replications. Temik 15G was applied at 7 lb/A at planting in the seed furrow with chemical granular applicators attached to the planter. Vydate L 16 oz/A was applied as a broadcast spray in June to each of the Temik plots. The Lawrence Co. tests were harvested November 11 and October 6 in 2002 and 2003, respectively.

No Till, Cotton Test, Lawrence Co., AL

Ten Cruiser treated transgenic cotton varieties were examined with and without Temik 15G plus Vydate in Lawrence Co. in 2003. The test was put in a field that was in cotton production the previous year. The test was planted April 19 in 2003. A John Deere MaxEmerge® planter was used to plant the test. Plots consisted of 1 row, 200 ft long, with a 30 in. row spacing and were arranged as a split plot with four replications. Temik 15G 7 lb/A was applied at planting in the seed furrow with chemical granular applicators attached to the planter. Vydate L 16 oz/A was applied as a broadcast spray in June to each of the Temik plots. The test was harvested on October 6.

Conventional Tilled, Monoculture Cotton Test, Escambia Co., AL

Thirty-two commercially available cotton varieties were examined with and without a nematicide in Escambia Co. in 2003. The test was planted April 30, 2003. Plots consisted of 1 row, 25 ft long, with a 38 in. row spacing and were arranged in a split plot in a randomized complete block design with six replications. Telone II was injected at 3 gal/A into plots 8 to 12 inches deep with a ripper/bedder. The plots were harvested on October 25, 2003.

Greenhouse Evaluation

Thirty-seven commercially available varieties were also examined in the greenhouse. Each variety was planted into a 500 cc polystyrene container inoculated with 2000 juvenile and vermiform adult reniform nematodes per 500cc of soil. Varieties were arranged in a randomized complete block design with 5 replications. At 60 days after planting, varieties were harvested. The roots were carefully removed from each pot. The reniform nematodes were then extracted from the soil using gravity screening and sucrose centrifugation technique. Reniform eggs were extracted with 10 % NaOCl solution. Reniform and eggs were enumerated using a stereomicroscope. Wet and dry shoot and root weights were recorded for each variety.

Results and Discussion

Conventionally Tilled, Monocultured Cotton Test, Limestone Co., AL

Reniform nematode reproductive factors (Rf) in 2002 varied from a high of 2.9 for FM 989 RR to a low of 0.7 for PM 1218 BR. Seed cotton yields ranged from 3193 to 2616 lbs/A for PM 1218 BR and DP 458 BR, respectively. The application of Temik 15G did not increase yields ($P \leq 0.05$) of any variety. Reniform nematode reproductive factors in 2003 varied from a high of 16.9 for DP 436 RR to a low of 2.0 for FM 989 BR. Seed cotton yields ranged from 4880 to 3739 lbs/A for ST 5599 BR and PM 1199 RR, respectively. The Telone treated plots ($P \leq 0.05$) out yielded the control plots in 2003.

No Till, Annual Corn Cotton Rotation Test, Lawrence Co., AL

Reniform populations were low following the corn rotation in 2002. However, the reniform reproductive factors increased dramatically and varied from a high of 66.1 for SG 501 BR to a low of 28.3 for ST 4793 RR. Seed cotton yields ranged from 2517 to 2321 lbs/A for SG 521 RR and DP 5415 RR, respectively. Reniform populations in 2003 were low following the corn rotation. However the reniform reproductive factors did not increase greatly and varied from a high of 1.58 for SG 215

BR to a low of 0.5 for PM 1218 BR and SG 521 RR. Seed cotton yields varied from 3301 to 2490 lbs/A for SG 501 BR and PM 1218 BR, respectively. The application of Temik 15G did not increase yields ($P \leq 0.05$) of any variety.

No-Till, Cotton Test, Lawrence Co., AL

Reniform reproductive factors in 2003 varied from a high of 3.9 for SG 215 BR to a low of 1.6 for DP 424 BIIR. Seed cotton yields in 2003 ranged from 3414 to 2460 lbs/A for DP 424 BIIR and DP 555 BR, respectively. The application of Temik increased yields ($P \leq 0.05$).

Conventional Tilled, Monoculture Cotton Test, Escambia Co., AL

Reniform reproductive factors in 2003 varied from a high of 1.7 for DP 33 B to a low of 0.2 for PM 1218 BR and SG 521 RR. Seed cotton yields ranged from 2606 to 847 lbs/A for FM 991 BR and DP 436 RR with Telone, respectively. All varieties produced higher yields ($P \leq 0.05$) in the Telone II treated plots compared to the control plots except for FM 991 BR. FM 991 BR variety produced 763 more lb/A seed cotton in the control plots as compared to the Telone ($P \leq 0.05$) plot. FM 991 RR and DP 555 BR produced 763 and 387 more lb/A seed cotton, respectively, in the control plots as compared to the Telone plots.

Greenhouse Evaluation

Reniform nematode numbers in the greenhouse in 2002 and 2003 increased in all of the pots, throughout the experiments. Reniform populations in 2002 ranged from a high of 79,135 in Phytogen GA 161 to a low of 26,691 in Sure Grow 747. Reniform egg counts varied from 37,719 to 10,892 in Phytogen GA 161 and Sure Grow 747, respectively. Reniform populations in 2003 ranged from a high of 141,316 in Deltapine 424 B2R to a low of 97,129 in Deltapine 449 BR. Reniform egg counts also varied from 221,931 to 167,890 in Deltapine 424 B2R and Deltapine 449 BR, respectively.

Greenhouse evaluations have demonstrated that all of the commercially available cotton varieties are susceptible to the reniform nematode. The north Alabama reniform field trials did not produce one variety that appeared tolerant in the presence of the reniform nematode. The cotton varieties which exhibited good early season vigor produced higher yields in these reniform nematode infested field trials. The south Alabama reniform field trial, located in Escambia Co. produced 3 varieties which may possess some tolerance to the reniform nematode. FM 991 BR, FM 991 RR, and DP 555 BR when untreated, out yielded the plots treated with Telone. The late maturity dates of these three varieties prohibit their successful application in north Alabama.

Table 1. Reniform nematode numbers, reproductive factors (Rf), and seed cotton yields from selected transgenic varieties in 2002 in a monocultured cotton field in Limestone Co., AL.

Treatment	Reniform at planting 150 cc soil	Reniform at harvest 150 cc soil	Rf	Seed cotton lbs/A
DP 5415 RR	5137 a	4893 b-d	1.0	2838 c-e
ST 4892 BR	3837 a	6354 a-c	1.7	2825 c-e
DP 451 BR	4094 a	5494 bc	1.3	3007 a-c
DP 436 RR	4712 a	5021 b-d	1.1	3038 a-c
DPL 458BR	3515 a	8063 a	2.3	2616 e
FM 989 RR	2395 a	6991 ab	2.9	3070 ab
PM 1218BR	4172 a	3090 d	0.7	3193 a
SG 215 BR	4635 a	5292 b-d	1.1	3185 a
PM 1199RR	3283 a	6672 a-c	2.0	2980 a-c
ST 4793 RR	4352 a	4674 cd	1.1	2850 b-d
DP 555 BR	4481 a	5253 b-c	1.2	2636 e-d
FM 989 BR	3747 a	6112 a-c	1.6	2853 b-d
LSD $\leq$ 0.05	2753	2231		231.67

Nematicide	Reniform at planting	Reniform at harvest	Rf	Seed cotton lbs/A
Temik	4030	5820 a	1.4	2938 a
No Temik	4030	5497 a	1.4	2911 a
LSD $\leq$ 0.05		910.8		94.5

Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 2. Reniform nematode numbers, reproductive factors (Rf) and seed yields from selected transgenic varieties in 2003 in a monocultured cotton field in Limestone Co., AL.

Varitey	Reniform at planting 150 cc soil	Reniform at harvest 150 cc soil	Rf	Seed cotton lbs/A
DP 5415 RR	57.94 bc	463.5 ab	8.0	4245.5 cd
ST 4892 BR	112.66 ab	598.8 ab	5.3	4034.7 de
DP 451 BR	80.47 a-c	293.0 b	3.6	4794.3 ab
DP 436 RR	25.75 c	434.8 ab	16.9	4444.8 a-d
DPL 444 BR	74.03 a-c	1100.9 a	14.9	4818.8 ab
DP 449 BR	96.56 a-c	347.8 b	3.6	4516.6 a-c
PM 1218 BR	80.47 a-c	833.9 ab	10.4	4247.1 cd
SG 215 BR	86.91 a-c	428.3 ab	4.9	4475.8 a-c
PM 1199 RR	64.38 a-c	361.6 b	5.6	3739.1 e
ST 4793 RR	38.63 bc	251.3 b	6.5	4423.5 b-d
ST 5599 BR	86.91 a-c	730.8 ab	8.4	4880.9 a
FM 989 BR	138.41 a	273.8 b	2.0	4547.7 a-c
LSD $\leq$ 0.05	77.926	675.35		439.14

Nematicide	Reniform at planting	Reniform at harvest	Rf	Seed cotton lbs/A
Telone	74.03 a	471.7 a	6.4	4595.58 a
No Telone	83.15 a	548.0 a	6.6	4265.89 b
LSD $\leq$ 0.05	31.813	275.71		179.28

Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 3. Reniform nematode numbers, reproductive factors (Rf) and seed yields from selected transgenic varieties in 2002 in a corn, cotton rotation in Lawrence Co., AL.

Treatment	Reniform at harvest 150 cc soil	Rf*	Seed cotton lbs/A
DP 5415 R	1326 ab	39.7	2321 b
ST 4793 R	946 b	28.3	2369 b
DP 436 R	1554 ab	46.5	2382 b
SG 521 R	1522 ab	45.6	2517 a
PM 1199 R	1738 ab	52.0	2422 ab
ST 4892 BR	1033 b	30.9	2387 b
SG 501 BR	2211 a	66.2	2356 b
SG 215 BR	1123 b	33.6	2329 b
PM 1218 BR	1535 ab	46.0	2391 b
DP 451 BR	1187 b	35.5	2365 b
LSD $\leq$ 0.05	941.6		105.3

Nematicide	Reniform at harvest 150 cc soil	Rf*	Seed cotton lbs/A
Temik	1290 a	39.0	2392 a
No Temik	1545 a	48.1	2376 a
LSD $\leq$ 0.05	421.1		47.1

*Average reniform population at planting was 33.4 per 150cc sub-sample of soil.

Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 4. Reniform nematode numbers, reproductive factors (Rf) and seed yields from selected transgenic varieties in 2003 in a corn, cotton rotation in Lawrence Co., AL.

Treatment	Reniform at harvest 150 cc soil	Rf*	Seed cotton lbs/A
DP 5415 R	32.1 a	0.83	2531 c
ST 4793 R	22.5 a	0.58	2917 b
DP 436 R	48.2 a	1.24	2690 bc
SG 521 R	19.3 a	0.50	3226 a
PM 1199 R	25.7 a	0.66	2650 bc
ST 4892 BR	28.9 a	0.74	3235 a
SG 501 BR	28.9 a	0.74	3301 a
SG 215 BR	61.1 a	1.58	2659 bc
PM 1218 BR	19.3 a	0.50	2490 c
DP 451 BR	28.9 a	0.74	2500 c
LSD ≤ 0.05	41.9		293.7

Nematicide	Reniform at harvest 150 cc soil	Rf*	Seed cotton lbs/A
Temik	33.4 a	1.29	2836 a
No Temik	29.6 a	0.57	2804 a
LSD ≤ 0.05	18.7		131.3

*Average reniform population at planting was 38.6 per 150cc sub-sample of soil.
Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 5. Reniform nematode numbers, reproductive factors (Rf) and seed yields from selected transgenic varieties in 2003 in a cotton field in Lawrence Co., AL.

Treatment	Reniform at peak bloom 150 cc soil	Rf*	Seed cotton lbs/A
ST 4892 BR	141.6 bc	2.1	2607 fg
FM 960 BR	136.9 bc	2.0	3040 bc
DP 555 BR	157.7 bc	2.3	2460 g
DP 468 BIIR	154.4 bc	2.3	2678 ef
DP 449 BR	193.1 ab	2.9	2894 cd
DP 424 BIIR	106.2 c	1.6	3414 a
PM 1218 BR	135.1 bc	2.0	2823 de
DPLX03L300BR	134.0 bc	2.0	3204 b
SG 215 BR	263.9 a	3.9	2689 ef
DP 444 BR	196.3 ab	2.9	2892 cd
LSD ≤ 0.05	84.2		171.5

Nematicide	Reniform at peak bloom 150 cc soil	Rf*	Seed cotton lbs/A
Temik	154.2 a	2.66	2915 a
No Temik	169.7 a	2.19	2826 b
LSD ≤ 0.05	37.6		76.6

*Average reniform population at planting was 67.5 per 150cc sub-sample of soil.
Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 6. Reniform nematode numbers, reproductive factors (Rf) and seed yields from selected commercial varieties in a monocultured cotton field in Escambia Co., AL in 2003.

	Reniform at harvest 150 cc soil		Rf*		Seed cotton lbs/A	
Treatment	**Telone**	**Check**	**Telone**	**Check**	**Telone**	**Check**
BCG 28 R	1468	1236	0.6	0.7	2044	1228
Deltapearl	1699	850	0.7	0.5	2160	1805
DP 436 RR	1236	875	0.5	0.5	2096	847
DP 444 BR	1545	1854	0.7	1.0	1983	1381
DP 448 B	695	4171	0.3	2.3	2035	1242
DP 449 BR	1545	1545	0.7	0.9	1938	1692
DP 451 BR	927	1545	0.4	0.9	1969	1180
DP 458 BR	1545	1313	0.7	0.7	1814	1351
DP 491	1545	1545	0.7	0.9	2190	929
DP 493	1004	2008	0.4	1.1	2363	1615
DP 5415	927	1931	0.4	1.1	2169	1381
DP 555 BR	1081	2086	0.5	1.2	1919	2306
DP 5690 RR	1545	2085	0.7	1.2	2093	1860
DP 33 B	1004	3090	0.4	1.7	2300	1589
FM 991 RR	1030	1545	0.4	0.9	1917	2516
FM 958 B	1313	2472	0.6	1.4	2242	1303
FM 960 BR	2240	2703	1.0	1.5	1988	1560
FM 966	1622	2240	0.7	1.2	1814	1280
FM 989	1545	1622	0.7	0.9	2113	1176
FM 989 BR	1467	2240	0.6	1.2	1861	1129
FM 991 BR	952	1004	0.4	0.6	1843	2606
PM 1218 BR	541	1390	0.2	0.8	2162	1380
PHY 410 RR	1236	1236	0.5	0.7	1672	888
PHY 510 RR	1313	1390	0.6	0.8	2222	1493
ST 4793 RR	1545	1313	0.7	0.7	2241	2231
ST 4892 BR	1467	1236	0.6	0.7	2042	1332
ST 5303 RR	772	1777	0.3	1.0	1890	1211
ST 5599 BR	798	1468	0.3	0.8	2159	1278
ST 5242 BR	1159	1004	0.5	0.6	2247	1202
SG 215 BR	1184	2008	0.5	1.1	2455	1839
SG 521 RR	412	1236	0.2	0.7	2296	1890
SG 747	695	2086	0.3	1.2	2249	1411
LSD $\leq$ 0.05	1901				666	

Nematicide	**Reniform at harvest 150 cc soil**	**Rf***	**Seed cotton lbs/A**
Telone	1220 a	0.5	2078 a
No Telone	1751 b	0.9	1504 b
LSD $\leq$ 0.05	298.6		89.7

*Average reniform population at planting was 2343 in the Telone treated plots and 1802 in the check plots, per 150cc sub-sample of soil.

Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 7. Greenhouse mean reniform and egg counts per 500cc of soil in 2002.

Variety	Mean Reniform	Eggs
Sure Grow 747	26691	10892
Deltapine 458 BG/RR	29885	15671
Stoneville 4793 RR	31358	14585
Deltapine 5690 RR	36481	16959
Deltapine 565	37030	14755
Deltapine 555 BG/RR	37169	16518
Deltapine 5415	38022	22959
Stoneville 271	38689	20075
Deltapearl	40244	12873
Sure Grow 501 BG/RR	41562	19620
Deltapine 655 BG/RR	41571	20574
Stoneville 5599 BG/RR	42510	29880
Stoneville 580	42757	26430
Paymaster 1218 BG/RR	46721	23702
Texas 28 R	48384	27460
Deltapine 33B	49311	20300
Phytogen 355	52204	29185
Deltapine 491	52880	20188
Fiber Max 989 BG/RR	53187	27760
Sure Grow 521 RR	54781	26311
Deltapine 436 RR	54841	23335
Stoneville 4892 BG/RR	55321	21388
Fiber Max 989	55416	25817
Paymaster 1199 RR	55814	20123
Sure Grow 215 BG/RR	55852	28660
Deltapine 35B	55955	29231
Deltapine 451 BG/RR	60294	29020
Fiber Max 966	61704	30751
Fiber Max 991 RR	66092	29106
Phytogen 78 ACALA	67063	26342
Phytogen HS-12	75437	30241
Phytogen GA 161	79135	37719
LSD P≤ 0.05	25463	13903

Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).

Table 8. Greenhouse mean reniform and egg counts per 500cc of soil in 2003.

Variety	Mean Reniform	Eggs
Fiber Max 960 BR	103120	216403
Deltapine 468 B2/R	98880	216918
Deltapine 424 B2/R	141316	221931
Deltapine 444 BR	97129	167890
Deltapine 449 BR	108871	183872
LSD P ≤ 0.05	35656	57700

Means within columns followed by different letters are significantly different according to Fisher's LSD ($P \leq 0.05$).