EVALUATION OF VARIETY TOLERANCE AND CHEMICAL MANAGEMENT OF SOUTHERN ROOT-KNOT NEMATODES

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Abstract

The southern root-knot nematode, *Meloidogyne incognita*, is an economically important parasite of cotton in Gaines County, Texas. The objectives of this research were to evaluate the performance of Stoneville (ST) 5458B2F and Fibermax (FM) 9063B2F planted in conjunction with Aeris, Avicta Complete Cotton, Temik 15G at 3.5 lbs/ac, Temik 15G at 5lbs/ac, or Temik 15G at 3.5lbs/ac plus a foliar application of Vydate C-LV at the third grown square. Adult and immature thrips whole plant counts, *M. incognita* gall counts, second-stage juvenile and eggs counts per 500 cm^3 soil, and plant height and number of node counts provided further information on the impact of root-knot nematodes. Plots were machine harvested and yield, gin turnout, fiber quality, and economics of treatments were determined. ST 5458B2F had significantly fewer galls per root and significantly fewer second-stage juveniles and egg counts per 500cm^3 soil than FM 9063B2F. Plants from plots treated with Temik 15G at 3.5 lbs and 5lbs had significantly fewer galls per root than plants from seed treated with Aeris, Avicta, and the untreated check. ST 5458B2F had significantly higher lint yield per acre than FM 9063B2RF which resulted in a significantly higher net value per acre. Net value of 5 lbs of Temik 15G was not significantly different from 3.5 lbs of Temik 15G, 3.5 lbs of Temik 15G with 17 oz of Vydate, and Aeris. Based on these results, planting tolerant varieties was the most economical and effective method in the management of root-knot nematodes.

Introduction

The southern root-knot nematode, *Meloidogyne incognita*, is an economically important parasite of cotton in Gaines County, Texas. Higher populations of this pest tend to occur in sandier fields that have had consecutive cotton crops and very little rotation to a non-host, such as peanuts (Kirkpatrick, 2001). Management decisions are dependent on the level of nematode infestation and the estimated nematode-induced yield loss (Kirkpatrick, 2001). Planting partially resistant varieties is one of the most effective tools in managing this pest (Zhou et al., 2003). Temik 15G applied in-furrow at planting followed by a foliar application of Vydate C-LV has increased cotton lint yields (Siders, 2008). Seed treatments are another option for the management of nematodes. Therefore, cotton production may be optimized by planting partially resistant cotton varieties in conjunction with the use of seed treatments or Temik 15G. The objectives of study were to evaluate the impact of two cotton varieties planted in conjunction with chemical treatments on southern root-knot nematode populations and the resulting effect on plant development, and to compare net returns between varieties, chemicals, and the interaction between varieties and chemicals.

Materials and Methods

The on-farm trial was conducted in Gaines County, TX in 2009 in a field with a 5 year crop history of cotton, peanuts, cotton, cotton, cotton. The field's soil was 93% sand, 3% silt, and 4% clay (sand soil type). The trial was planted on 7 May. Plots had 40-inch row spacing and were center-pivot irrigated. Plots were 8-rows wide and 400 ft in length. Experimental design was a randomized complete block design with 3 replications. See *Table 1* for a complete list of treatments. Production practices were uniform for all treatments. The number of adult and immature thrips was counted by visually inspecting 10 whole plants per plot on 20 May, 27 May, 3 June, and 10 June. The number of galls caused by *M. incognita* was counted by visually inspecting 10 plant roots per plot on 10 June. Soil samples were taken on 16 July to count *M. incognita* second-stage juveniles (J2) and eggs per 500cm^3 soil. Plant

height, number of nodes, and Nodes Above White Flower (NAWF) were counted on ten plants per plot on 14 August. The trial was harvested on 19 October. All plots were weighed separately using a Lee weigh wagon. Burr cotton grab samples were taken from each plot. All grab samples were weighed and then ginned using a sample gin with a lint cleaner, burr extractor and stick machine. Ginned lint was weighed and lint and seed turnouts were calculated. Lint and seed yields were determined by multiplying the respective turn out by field plot weights. Lint samples were collected for fiber quality analysis. Fiber analysis was conducted by the Texas Tech University Fiber & Biopolymer Research Institute and CCC lint loan values were determined for each plot. Lint value was calculated by multiplying lint loan value by lint yield. Total value was determined by adding lint and seed values. Net value was determined subtracting ginning cost, seed and technology cost, and treatment cost from total value. Statistical analysis of data was conducted using the GLM procedure in SAS 9.1 for Windows.

Table 1. Treatments

ST 5458B2RF[1] Untreated
ST 5458B2RF[1] & Aeris seed treatment (insecticide & nematicide)
ST 5458B2RF & Avicta Complete Cotton seed treatment (insecticide, nematicide, and fungicide)
ST 5458B2RF[1] & 3.5 lbs/acre of Temik 15G[2]
ST 5458B2RF[1] & 5 lbs/acre of Temik 15G[2]
ST 5458B2RF[1] & 3.5 lbs/acre of Temik 15G[2] & Vydate C-LV[3]
FM 9063B2RF[1] Untreated
FM 9063B2RF[1] & Aeris seed treatment (insecticide & nematicide)
FM 9063B2RF & Avicta Complete Cotton seed treatment (insecticide, nematicide, and fungicide)
FM 9063B2RF[1] & 3.5 lbs/acre of Temik 15G[2]
FM 9063B2RF[1] & 5 lbs/acre of Temik 15G[2]
FM 9063B2RF[1] & 3.5 lbs/acre of Temik 15G[2] & Vydate C-LV[3]

[1] Trilex Advance (fungicide) seed treatment was applied to all seed (with the exception of the Avicta seed treatment plots)
[2] Temik 15G was applied in-furrow at planting. Temik boxes were calibrated prior to planting the trial.
[3] Vydate C-LV was applied in a band at a rate of 17 oz per acre on 22 June

Results and Discussion

ST 5458B2F had significantly fewer galls per root than FM 9063B2F (*Table 2*). Temik 15G at 3.5 lbs and Temik 15G at 5 lbs had significantly fewer galls per root than Aeris, Avicta, and the untreated (*Table 3*). There was no significant interaction between variety and chemical, indicating that the response was consistent with both varieties. ST 5458B2F had significantly fewer egg per 500 cm^3 soil than FM 9063B2F (*Table 2*). There was no significant effect by chemical (*Table 3*) or by the interaction between variety and chemical.

Table 2. Average number of root galls caused by *Meloidogyne incognita* on 10 June and average number of *M. incognita* second-stage juveniles (J2) and eggs per 500 cm^3 soil on 16 July by variety

Variety	Average No. of Galls	Average No. of J2	Average No. of Eggs
FM 9063B2RF	30.5	639	5720
ST 5458B2RF	24.8	333	3298
Test average	26.2	486	4509
CV %	27.6	96.1	74.2
OSL	0.054	0.06	0.04

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Table 3. Average number of root galls caused by *Meloidogyne incognita* on 10 June and average number of *M. incognita* second-stage juveniles (J2) and eggs per 500 cm^3 soil on 16 July by chemical

Variety	Average No. of Galls	Average No. of J2	Average No. of Eggs
Untreated	35.6 ab	500	5460
Avicta	38.9 a	700	4760
Aeris	29.2 b	200	3120
3.5 lbs of Temik 15G	18.1 c	483	4253
3.5 lbs of Temik 15G plus 17 oz Vydate C-LV	-	667	4280
5 lbs of Temik 15G	15.6 c	367	5180
Test average	26.2	486	4509
CV %	27.6	96.1	74.2
OSL	<0.0001	0.46	0.86

Means within the same column with the same letter are not significantly different
CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Plant height did not significantly differ between FM 9063B2RF and ST 5458B2RF on 14 August (*Table 4*). However, FM 9063B2F had significantly more nodes per plant than ST 5458B2RF (*Table 4*). Plant height and number of nodes did not significantly differ between chemical treatments (*Table 5*). Nodes Above White Flower (NAWF) had a significant interaction between variety and chemical (P = 0.05). Due to the variety by chemical interaction, NAWF data is reported as interaction means (*Table 6*).

Table 4. Average plant height and number of nodes on 14 August by variety

Variety	Average Plant Height (inches)	Average No. of Nodes
FM 9063B2RF	18.1	16.7
ST 5458B2RF	18.6	15.5
Test average	18.4	16.1
CV %	5.9	3.6
OSL	0.21	<0.0001

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

ST 5458B2RF had significantly higher lint yield per acre and lint turnout than FM 9063B2F which resulted in a significantly higher net value per acre. However, FM 9063B2F had a significantly higher seed turnout per acre (*Table 7*).

Net value of 5 lbs of Temik 15G was not significantly different from 3.5 lbs of Temik 15G and Aeris (*Table 8*). However, 3.5 lbs of Temik did not significantly differ from the 3.5 lbs of Temik plus Vydate C-LV and Aeris did not significantly differ from 3.5 lbs of Temik plus Vydate C-LV, Avicta, and Untreated (*Table 8*).

The untreated plots had significantly more adult thrips on 20 May and immature thrips on 3 June than the other treatments (*Table 12*). Avicta seed treatment immature thrips did not significantly differ from the untreated plots on 3 June (*Table 12*). On 10 June the 5 lbs Temik 15G had significantly more adult thrips than the other treatments (*Table 12*). Thrips were not a limiting factor since treatments never reached the thrips threshold of 1 per true leaf.

Table 5. Average plant height and number of nodes on 14 August by chemical

Variety	Average Plant Height (inches)	Average No. of Nodes
Untreated	17.9	16.1
Avicta	17.7	16.0
Aeris	18.3	15.8
3.5 lbs of Temik 15G	19.6	16.7
3.5 lbs of Temik 15G plus 17 oz Vydate C-LV	18.3	15.9
5 lbs of Temik 15G	18.6	15.9
Test average	18.4	16.1
CV %	5.9	3.6
OSL	0.09	0.11

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Table 6. Average Nodes Above White Flower (NAWF) on 14 August for variety by chemical interaction means

Variety	Chemical	Average No. NAWF	
ST 5458B2F	Untreated	2.4	ab
ST 5458B2F	Aeris	2.8	a
ST 5458B2F	Avicta	1.9	c
ST 5458B2F	3.5 lbs of Temik 15G	2.5	ab
ST 5458B2F	3.5 lbs of Temik 15G plus 17 oz Vydate C-LV	2.5	ab
ST 5458B2F	5 lbs of Temik 15G	2.5	ab
FM 9063B2RF	Untreated	2.6	a
FM 9063B2RF	Aeris	2.2	bc
FM 9063B2RF	Avicta	2.4	ab
FM 9063B2RF	3.5 lbs of Temik 15G	2.6	a
FM 9063B2RF	3.5 lbs of Temik 15G plus 17 oz Vydate C-LV	2.2	bc
FM 9063B2RF	5 lbs of Temik 15G	2.6	a
Test average		2.4	
CV %		11.9	
OSL		0.0736	

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Table 7. Harvest results by variety

Variety	Lint turnout	Seed turnout	Bur cotton yield	Lint yield	Seed yield	Lint loan value	Lint value	Seed value	Total value	Ginning cost	Seed and Technology cost	Net Value
	---%---		---lb/acre---			$/lb	---$/acre---					
ST 54548B2F	36.2	48.0	3183	1152	1529	0.5647	650.32	152.87	803.20	95.49	67.57	620.57
FM 9063B2F	33.3	50.8	2341	778	1188	0.5688	442.45	117.66	560.12	70.23	67.57	402.75
Test average	34.7	49.4	2762	965	1359	0.5668	546.39	135.27	681.66	82.86	-	511.66
CV %	3.7	2.32	8.9	8.4	9.0	2.03	8.8	9.49	8.8	8.9	-	10.42
OSL	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.30	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Assumes:
$2.45/cwt ginning costs
$150/ton for seed
Value for lint based on CCC loan value from grab samples and FBRI HVI results
Net Value was determined by subtracting ginning cost, seed and technology cost and treatment cost ($19.57/acre, data not shown) from total value.

Table 8. Harvest results by chemical

Chemical	Lint turnout	Seed turnout	Bur cotton yield	Lint yield	Seed yield	Lint loan value	Lint value	Seed value	Total value	Ginning cost	Treatment cost	Net Value
	--------%--------		----------lb/acre----------			$/lb	----------$/acre----------					
5 lbs of Temik 15G	35.0	49.4	3023 a	1062 a	1490 a	0.5679	602.97 a	149.03 a	752.00 a	90.70 a	25.11	568.63 a
3.5 lbs of Temik 15G	35.2	50.0	2930 ab	1034 ab	1457 a	0.5636	583.48 ab	145.65 a	729.13 a	87.88 ab	20.16	553.52 ab
3.5 lbs of Temik 15G*	34.9	49.8	2720 bc	957 bc	1345 abc	0.5697	545.79 abc	134.47 abc	680.26 ab	81.60 bc	30.52	500.58 bc
Aeris	34.7	49.4	2822 abc	979 ab	1384 ab	0.5583	544.21 bc	138.40 ab	682.61 ab	84.66 abc	17.33	513.06 abc
Untreated	34.4	49.2	2551 c	880 c	1248 bc	0.5711	502.05 c	124.80 bc	626.84 c	76.53 c	8.61	474.14 c
Avicta	34.5	48.7	2527 c	878 c	1228 c	0.5700	499.83 c	119.28 c	619.11 b	75.80 c	15.70	460.04 c
Test average	34.7	49.4	2762	965	1359	0.5668	546.39	135.27	681.66	82.86	-	511.66
CV %	3.7	2.32	8.94	8.4	9.0	2.03	8.8	9.49	8.8	8.9	-	10.42
OSL	0.87	0.42	0.01	0.002	0.005	0.39	0.006	0.004	0.005	0.01	-	0.01

*Plus 17 oz Vydate C-LV
Application cost for Vydate was not included in Treatment cost because we assumed that the Vydate application was combined with a Roundup application
Means within the same column with the same letter are not significantly different
CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Assumes:
$2.45/cwt ginning costs
$150/ton for seed
Value for lint based on CCC loan value from grab samples and FBRI HVI results
Net Value was determined by subtracting ginning cost, seed and technology cost ($67.57/acre, data not shown) and treatment cost from total value.

Table 9. HVI fiber property results by variety

Chemical	Micronaire	Staple	Uniformity	Strength	Elongation	Leaf	Rd	+b
ST 5458B2F	4.7	36.0	80.5	30.0	8.0	2.1	80.3	8.1
FM 9063B2F	4.3	37.8	81.6	31.3	7.0	2.1	83.3	7.1
Test average	4.6	36.9	81.0	30.6	7.5	2.1	81.8	7.6
CV %	3.8	2.3	0.7	2.2	4.4	41.0	1.4	3.7
OSL	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	1.0	<0.0001	<0.0001

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Table 10. HVI fiber property results by chemical

Chemical	Micronaire	Staple	Uniformity	Strength	Elongation	Leaf	Rd	+b
5 lbs of Temik 15G	4.6	36.9	81.3	30.6	7.6 ab	2.0	81.4	7.6
3.5 lbs of Temik 15G	4.3	36.3	81.0	30.5	7.8 a	1.8	81.4	7.8
3.5 lbs of Temik 15G *	4.6	37.0	81.2	30.9	7.3 b	2.3	82.0	7.6
Aeris	4.6	36.8	80.7	30.4	7.6 ab	2.8	81.6	7.5
Untreated	4.6	37.0	80.8	31.0	7.2 b	2.0	82.3	7.7
Avicta	4.6	37.1	81.3	30.4	7.5 ab	1.7	82.2	7.5
Test average	4.6	36.9	81.0	30.6	7.5	2.1	81.8	7.6
CV %	3.8	2.3	0.7	2.2	4.4	41.0	1.4	3.7
OSL	0.06	0.61	0.29	0.61	0.05	0.26	0.63	0.49

*Plus 17 oz Vydate C-LV
Means within the same column with the same letter are not significantly different
CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Table 11. Average number of adult (A) and immature (I) thrips 20 May, 27 May, 3 June, and 10 June by variety

	Date							
	20 May		27 May		3 June		10 June	
Variety	A	I	A	I	A	I	A	I
FM 9063B2F	0.04	0.02	0.04	0.00	0.07	0.01	0.10	0.07
ST 5458B2F	0.05	0.01	0.06	0.01	0.07	0.08	0.06	0.11
Test average	0.04	0.01	0.05	0.00	0.07	0.04	0.08	0.09
CV %	172.6	374.3	146.3	600.0	117.4	146.1	95.2	124.9
OSL	0.67	0.35	0.52	0.33	0.84	0.006	0.14	0.32

CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Table 12. Average number of adult (A) and immature (I) thrips 20 May, 27 May, 3 June, and 10 June by chemical

	Date							
	20 May		27 May		3 June		10 June	
Variety	A	I	A	I	A	I	A	I
Untreated	0.15 a	0.05	0.05	0.00	0.05	0.12 a	0.07 b	0.07
Avicta	0.05 b	0.00	0.02	0.00	0.08	0.08 ab	0.02 b	0.12
Aeris	0.02 b	0.00	0.07	0.00	0.08	0.03 cb	0.07 b	0.07
3.5 lbs of Temik 15G	0.05 b	0.01	0.08	0.00	0.10	0.00 c	0.07 b	0.13
5 lbs of Temik 15G	0.00 b	0.00	0.03	0.00	0.07	0.00 c	0.18 a	0.03
Test average	0.04	0.01	0.05	0.00	0.07	0.04	0.08	0.09
CV %	172.6	374.3	146.3	600.0	117.4	146.1	95.2	124.9
OSL	0.02	0.53	0.70	0.44	0.74	0.03	0.03	0.56

Means within the same column with the same letter are not significantly different
CV – coefficient of variation
OSL – observed significance level, or probability of a greater F value

Summary

Meloidogyne incognita, is one factor that can significantly impact variety performance. FM 9063B2F had significantly more galls early-season and second-stage juveniles & eggs mid-season. This likely decreased crop potential and contributed to a lower yield at the end of the season. Therefore, based on this trial, planting tolerant varieties is the most economical and effective method in the management of nematodes. Chemical management also resulted in some increased control of nematodes. However, differences in chemical control were not as clearly defined as the variety effect. Temik 15G residual activity may have started to decrease around 10 June (approximately 34 days after planting) which would have been the optimal time for a Vydate C-LV application. Therefore, an earlier application of Vydate C-LV to the 3.5 lbs of Temik may have resulted in an increased yield over the 3.5lb of Temik alone. Previous studies have shown that accurate timing of Vydate C-LV application is vital for continued suppression of nematode populations. More research is needed in order to determine optimal variety and chemical management for nematodes across years.

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