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Evaluation of Chemicals and Variety Selection for Control of Nematodes in Cotton

Patrick M. Phipps,
Professor
Plant Pathology, Tidewater AREC
6321 Holland Rd.
Suffolk, VA 23437

Email: pmphipps@vt.edu
Phone: (757) 657-6450, Ext. 413

Darcy E. Partridge,
Postdoctoral Associate
Plant Pathology, Tidewater AREC
6321 Holland Rd.
Suffolk, VA 23437

Email: departri@vt.edu
Phone: (757) 657-6450, Ext. 423

Jon D. Eisenback,
Professor
Nematology, 103 Price Hall
Virginia Tech Campus
Blacksburg, VA 24061

Email: jon@vt.edu
Phone: (540) 231-4650

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Disease Incidence and Losses

Rhizoctonia and Pythium damping-off were the most common cause of seedling disease and reduced plant populations (Table 1). Although stand losses were as much as 30 percent, the impact on yield was minimal because of the crop's remarkable ability to compensate. One plant every 12 to 18 inches is generally enough to achieve a good yield, except in years with heavy crop stress caused by weather, insects, weeds, or diseases. Other factors that contributed to slow emergence and poor stands in 2006 were seed with low cool germ, periods with soil temperatures below 60°F or air temperatures below 40°F after planting, heavy rainfall, and/or planting seed too deep (0.75 in. or deeper). The optimum depth of planting is usually about 0.25 to 0.5

inches. Crop damage by southern root-knot nematode, *Meloidogyne incognita*, accounted for the heaviest loss of yield in fields planted continuously to cotton for five years or longer. No significant losses to reniform nematode, *Rotylenchulus reniformis*, were detected in 2006. Instances of yield losses to stubby root were found, but overall it was less destructive than southern root knot. Sting nematode continues to cause severe damage in cotton, but occurrences are usually spotty and confined to localized areas in sandy-textured soil. As in previous years, the Columbia lance nematode was not detected in 2006. Below-normal rainfall in July and August and below-average accumulations of degree days (DD_{60}) in May, June, September, and October were thought to account for cotton not achieving record yields in 2006.

Table 1. Estimated loss of yield to cotton diseases in 2006.

Disease	Causal agent(s)	Percent loss
Seedling disease	<i>Rhizoctonia solani</i> , <i>Pythium</i> spp.	0.75
Fusarium wilt	<i>Fusarium oxysporum</i> f. sp. <i>vasinfectum</i>	Trace
Verticillium wilt	<i>Verticillium dahliae</i>	0
Texas root rot	<i>Phymatotrichum omnivorum</i>	0
Ascochyta blight	<i>Ascochyta gossypii</i>	Trace
Bacterial blight	<i>Xanthomonas</i> spp.	0.1
Boll rots	<i>Diplodia</i> spp., <i>Fusarium</i> spp., <i>Xanthomonas</i> spp.	1.0
Leaf spots	---various---	0.1
Southern root-knot nematode	<i>Meloidogyne incognita</i>	2.0
Reniform nematode	<i>Rotylenchulus reniformis</i>	0.1
Other nematodes	<i>Trichodorus</i> spp., <i>Belonolaimus</i> spp., etc.	1.9
Total loss (%)		5.85*

*The loss estimate equals 4.63 million pounds in Virginia based on production of 74.568 million pounds of lint in 2006. At a value of \$0.417 per pound, the loss in revenues at the farm gate would be 1.93 million dollars in 2006.

Seasonal Degree Days, Rainfall, and Crop Growth in 2006

Rainfall in June, September, and October was 5.75, 4.64 and 4.62 inches above normal, and in May, July, and August was 0.96, 2.21, and 3.21 inches below normal, respectively (Table 2). Rainfall during the period from May to October totaled 36.4 inches, which was 8.7 inches above normal. Minimum air temperatures averaged near normal ($\pm 1^\circ\text{F}$) in June, July and September, 2°F above normal in October, 3°F above normal in August, and 2°F below normal in May. Maximum air temperatures were near normal ($\pm 1^\circ\text{F}$) in May, June, July, and October, 2°F below normal in September, and 4°F above normal in August according to records from a NOAA station (44-4044) at the Tidewater AREC in Suffolk. Cool temperatures in April and May slowed the speed of emergence in fields planted to cotton. Below normal rainfall in March (-3.16 inches), April (-1.44 inches) and May (-0.96 inch) allowed land preparation and planting to proceed in a timely manner across most of southeastern Virginia. Cotton showed good emergence and vigor after air temperatures reached into the 70s and 80s in May. Periods of drought stress in July and August caused wilting and stunting of crops, espe-

cially in fields with sandy textured soils and without irrigation. Above normal rainfall in September (+4.64 inches), October (+4.62 inches) and November (+2.96 inches) caused major delays in completing the harvest. Frost occurred in western portions of the Tidewater area on 14 October. Freeze occurred on 26 October when nighttime temperatures dropped into the upper 20°F range.

Cotton degree days (DD_{60}) from 1 May to 31 October totaled 2,053 or 120 below the 12-year average (Table 3). As the harvest season approached, many fields exhibited delayed maturity, but good yield potential. Months with below-average accumulations of degree days included May, June, September, and October.

The relationship of total rainfall and degree days to growth and yield of cotton in 2006 showed that the cotton crop received rainfall that was 5.9 inches above normal and 120 degree days below the 12-year average (Table 4, Fig. 1). While pinhead square was about a week late, the first flowers and first open bolls appeared within three days of the 12-year average. Dry weather stress in July and August were expected to reduce yield and suppress incidence of hardlock.

Table 2. Rainfall in the past five years compared to 74-year average (1933 to 2006).

Month	Rainfall (in.)*					
	2002	2003	2004	2005	2006	Normal
May	3.98	7.14	4.77	4.78	2.86	3.82
Jun	1.66	4.10	5.10	2.64	10.08	4.33
Jul	5.53	4.98	12.53	5.19	3.66	5.87
Aug	2.22	3.50	11.00	4.50	2.50	5.71
Sep	2.96	11.81	5.15	3.08	9.16	4.52
Oct	4.89	4.40	4.52	5.68	8.14	3.52
Total	21.24	35.93	43.07	25.87	36.40	27.77

*Based on daily records from NOAA weather station 44-4044 at the Tidewater AREC, Suffolk.

Table 3. Cotton degree day accumulations compared to the 12-year average (1995 to 2006).

Month	Cotton Degree Days (DD ₆₀)*					
	2002	2003	2004	2005	2006	Avg
May	271	216	395	169	221	256
Jun	513	421	426	433	386	427
Jul	615	543	523	587	541	531
Aug	564	536	427	557	542	496
Sep	373	334	320	393	259	324
Oct	162	116	100	158	104	139
Total	2498	2166	2191	2297	2053	2173

* Based on daily records posted on the Peanut/Cotton InfoNet (www.ipm.vt.edu/infonet/).

Table 4. Relationship of total rainfall and degree days to growth and yield of cotton over the past 12-yr period in the City of Suffolk.

Year	Rainfall ^z (in.)	Degree-days (DD ₆₀)	Pinhead square	1 st flower	1 st Open boll	Lint ^y (lb/A)
1995	23.83	2162	7 Jun	10 Jul	6 Sep	703
1996	35.43	2068	11 Jun	10 Jul	5 Sep	662
1997	20.09	1900	16 Jun	15 Jul	15 Sep	587
1998	24.94	2303	12 Jun	8 Jul	1 Sep	821
1999	49.71	2056	14 Jun	13 Jul	13 Sep	697
2000	27.27	2132	12 Jun	10 Jul	10 Sep	948
2001	22.72	2255	15 Jun	13 Jul	5 Sep	922
2002	21.24	2498	17 Jun	7 Jul	2 Sep	473
2003	35.93	2166	27 Jun	18 Jul	14 Sep	831
2004	43.07	2191	4 Jun	2 Jul	30 Aug	1159
2005	25.87	2297	27 Jun	13 Jul	6 Sep	1082
2006	36.40	2053	21 Jun	13 Jul	3 Sep	717 ^x
12-yr AVERAGE	30.54	2173	15 Jun	11 Jul	6 Sep	800

^zRainfall records for May through Oct at the Tidewater AREC in Suffolk, VA.

^yLint yields are for the City of Suffolk as reported by the Virginia Agricultural Statistics Service.

^xYield in 2006 is based on an estimate of statewide yield by the Virginia Agricultural Statistics Service.

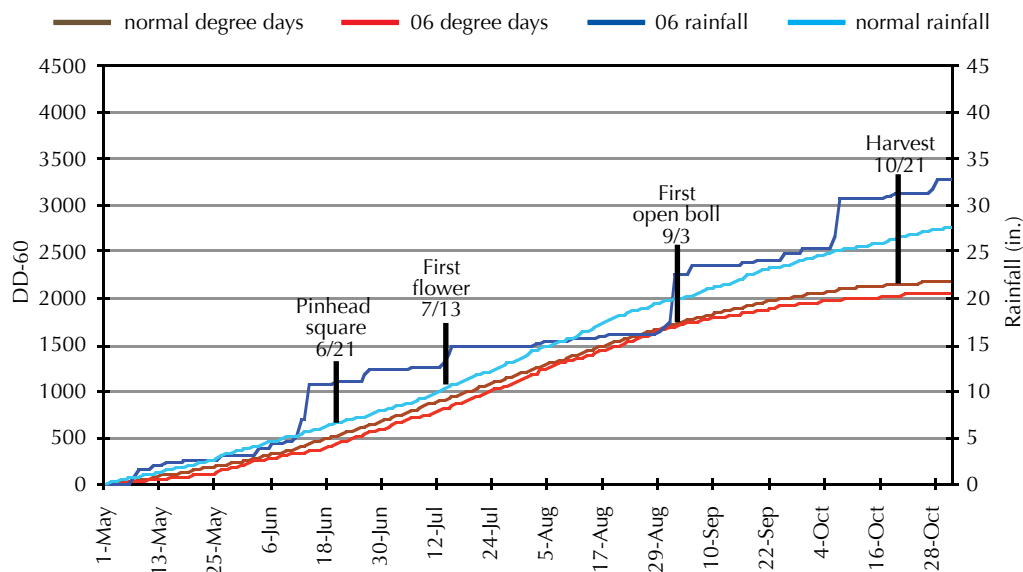


Figure 1. Degree days, rainfall, and crop development in 2006 at Suffolk.

Nematode Control Trials

The response of cotton to seed and in-furrow nematicide treatments in a field infested with stubby root nematode (R. L. Smith Farm, Branchville). Soil at the field site was loamy fine sand and was prepared for planting by ripping and bedding rows in stale beds of cotton from the previous two seasons. Plots were planted on 3 May. Treatments were main plots of four 30-foot long rows spaced 36 inches apart and subplots were two rows planted to ST 4575 BR (susceptible to southern root-knot) and ST 5599 BR (partially resistant to southern root-knot). A split-plot design was used with replications in four randomized complete blocks. Seed used in each treatment were from the same lot of each variety. Personnel with Syngenta Crop Protection applied Avicta Complete Pak. The base treatment of fungicide on ST 4575 BR was Baytan/Thiram/Allegiance and ST 5599 BR was treated with Apron XL/Maxim/NuFlow. The in-furrow treatment with KC791230 15G 5 pounds per acre was applied at planting. Treatments with Temik 15G were applied in-furrow at planting with and without a side-dress application on 10 July. A foliar spray of Orthene 97 at 8 ounces per acre was applied to all plots on 31 May for thrips control. Thereafter, standard practices were followed for cotton production in Virginia. Soil samples for determining nematode populations were collected on 7 September and a composite sample of replications was prepared for each treatment and variety. A soil elutriator and sugar flotation method were used to process samples. Yield was determined by

hand-harvesting 6-foot sections of rows or a total of 12 feet of row in each plot.

Stand counts averaged 1.82 and 1.76 plants per foot of row for ST 4575 BR and ST 5599 BR on 31 May, respectively (not shown). All treatments improved seedling vigor (Fig. 2) and suppressed thrips damage significantly. KC791230 and Temik in furrow significantly improved plant vigor ratings across both varieties, while all treatments improved vigor significantly above the untreated check (Table 5). All treatments had significantly reduced thrips injury in both varieties when evaluated on 9 June, and all treatments significantly increased numbers of flowers and plant height as of 21 July compared to the untreated check. ST 5599 BR had increased height over ST 4575 BR, while ST 4575 BR had significantly more flowers and open bolls on 15 September than ST 5599 BR. Nematode populations in soil ranged from 0 to 10 lesion, 20 to 100 stunt, and 50 to 270 stubby root nematodes per 500 cm³ soil on 7 September (not shown). Southern root-knot nematode was not detected. Numbers of open bolls on 15 September were significantly higher for ST 4575 BR than ST 5599 BR, but no significant differences were found in treatments. All treatments, except Temik 15G 5 pounds per acre in furrow, significantly increased lint yield above the untreated check. Temik 15G 5 pounds per acre in-furrow followed by a side-dress application resulted in lint yields that were significantly greater than other treatments.

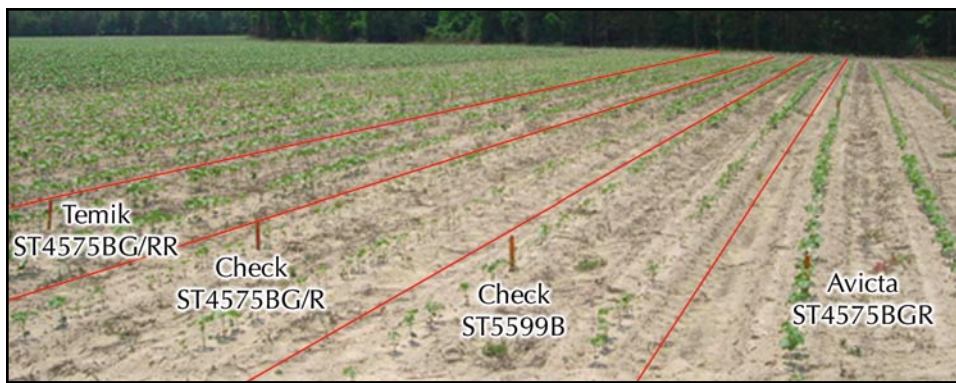


Figure 2. Visual differences in treatments with and without either Temik 15G or Avicta Complete Pak in 2006 at R.L. Smith Farm, Branchville.

Table 5. Response of cotton varieties to seed and in-furrow treatments for control of root-knot nematode in cotton, 2006 (R.L. Smith Farm, Branchville).

Variety, treatment and rate ^z	Plant vigor 9 Jun ^y	Thrips injury 9 Jun ^x	Flowers/12 ft of row 21 Jul ^w	Plant ht. (in.) 21 Jul ^v	Open bolls 15 Sep ^u	Lint yield (bales/A) ^t
ST 4575 BR						
Untreated Check	3.5 c ^s	6.0 a	13.5 b	21.4 c	6.1 c	0.94 c
Avicta Complete Pak (S)	9.0 b	1.0 b	20.8 a	26.2 b	7.6 ab	1.21 bc
Temik 15G 5 lb (F)	9.5 ab	1.0 b	18.8 ab	27.5 ab	8.5 a	1.14 bc
KC791230 5 lb (F)	10.0 a	1.0 b	23.0 a	28.0 a	8.4 a	1.36 ab
Temik 15G 5 lb (F) + 5 lb (B)	9.8 ab	1.0 b	22.0 a	26.9 ab	7.1 bc	1.56 a
LSD	0.8	0.01	6.3	1.6	1.3	0.30
ST 5599 BR						
Untreated Check	3.8 b	5.3 a	11.3	22.5 b	4.1	0.98
Avicta Complete Pak (S)	9.5 a	1.0 b	13.5	27.8 a	5.5	1.25
Temik 15G 5 lb (F)	10.0 a	1.0 b	18.0	27.5 a	5.4	1.19
KC791230 5 lb (F)	10.0 a	1.0 b	18.3	28.8 a	5.6	1.19
Temik 15G 5 lb (F) + 5 lb (B)	9.5 a	1.0 b	19.0	27.9 a	5.6	1.43
LSD	0.7	0.3	n.s.	1.6	n.s.	n.s.
Treatment mean						
Untreated Check	3.6 d	5.6	12.4 b	21.9 c	5.1	0.96 c
Avicta Complete Pak (S)	9.3 c	1.0	17.1 a	27.0 b	6.6	1.23 b
Temik 15G 5 lb (F)	9.8 ab	1.0	18.4 a	27.5 b	7.0	1.16 bc
KC791230 5 lb (F)	10.0 a	1.0	20.6 a	28.4 a	7.0	1.27 b
Temik 15G 5 lb (F) + 5 lb (B)	9.6 b	1.0	20.5 a	27.4 b	6.3	1.50 a
LSD	0.4	--	0.4	0.9	n.s.	0.22
Variety mean						
ST 4575 BR	8.4	2.0	19.6 a	26.0 b	7.5 a	1.24
ST 5599 BR	8.6	1.9	16.0 b	26.9 a	5.2 b	1.21
LSD	n.s.	--	2.7	0.5	0.5	n.s.
Split-plot analysis, P (F)						
Treatment	.0001	.0001	.0457	.0001	.0963	.0722
Variety	.0839	.0090	.0128	.0013	.0001	.6581
Treatment x variety	.1772	.0006	.5622	.4214	.2303	.8319

^zS=seed treatment, F=in seed furrow at planting, B=band application.

^yPlant vigor rating scale: 1=severely stunted, 10=healthy.

^xThrips injury scale: 0=no damage, 10=severe thrips damage.

^wData are number of flowers per two 6-ft sections of row.

^vData are measurements of six arbitrarily-selected plants per plot.

^uDetermined from counts of four plants per plot. ^tBales/A are weight of lint only. Lint was 41.4% of total weight and 480 lb/bale. Plots were harvested on 26 Sep.

^sMeans followed by the same letter(s) in a column and grouping are not significantly different according to Fisher's Protected LSD at $P \leq 0.05$ with the exception of bales/A which was evaluated at $P \leq 0.10$, "n.s."=not significant; "--" statistical analysis not valid because of significant interaction of treatment and variety.

Response of cotton to Avicta Complete Pak on seed and Temik 15G in-furrow in a field lacking nematode problems (Jason Holland Farm, Suffolk). Soil at the field site was Eunola loamy fine sand and was prepared for planting by ripping and bedding rows in stale beds of cotton from the previous season. Plots were planted on 16 May. Treatments were main plots of four 30-foot long rows spaced 36 inches apart and subplots were two rows planted to ST 4575 BG/RR (susceptible to southern root-knot) and ST 5599 BR (partially resistant to southern root-knot). A split-plot design was used with replications in four randomized complete blocks. Seed used in each treatment were from

the same lot of each variety. Personnel with Syngenta Crop Protection applied Avicta Complete Pak. The base treatment of fungicide on ST 4575 BR was Baytan/Thiram/Allegiance, and ST 5599 BR was treated with Apron XL/Maxim/NuFlow. Temik 15G was applied in-furrow at planting on 16 May. A foliar spray of Orthene 97 at 8 ounces per acre was applied to all plots on 30 May for thrips control. Thereafter, standard practices were followed. Soil samples for determining nematode populations were collected on 27 July, and a composite sample of replications was prepared for each treatment and variety. A soil elutriator and sugar flotation method were used to process samples. Plots were harvested

Table 6. Comparison of Avicta on seed to Temik 15G in-furrow in a cotton field without a nematode problem, 2006 (Jason Holland Farm, Suffolk).

Variety, treatment and rate ^z	Plant vigor 13 Jun ^y	Thrips injury 13 Jun ^x	Flower	Plant	Open bolls 4 Oct ^u	Lint yield (bales/A) ^t
			count/12 ft of row 20 Jul ^w	height (in.) 20 Jul ^v		
ST 4575 BR						
Untreated Check	7.8 b ^s	3.3 a	0.3	18.6	4.1	2.19
Avicta Complete Pak (S)	8.8 a	1.0 b	0.8	19.0	4.1	2.50
Temik 15G 5 lb (F)	8.8 a	1.0 b	1.3	19.7	4.4	2.22
LSD	0.01	0.5	n.s.	n.s.	n.s.	n.s.
ST 5599 BR						
Untreated Check	7.8 b	2.8 a	0.0	18.3	3.3	2.18
Avicta Complete Pak (S)	8.8 a	0.5 b	0.0	19.4	2.9	2.54
Temik 15G 5 lb (F)	8.8 a	1.0 b	0.3	19.4	3.5	2.34
LSD	0.8	0.9	n.s.	n.s.	n.s.	n.s.
Treatment mean						
Untreated Check	7.8 b	3.0 a	0.1	18.5 b	3.7	2.19 b
Avicta Complete Pak (S)	8.8 a	0.8 b	0.4	19.2 ab	3.7	2.52 a
Temik 15G 5 lb (F)	8.8 a	1.0 b	0.8	19.5 a	4.0	2.28 b
LSD	0.4	0.4	n.s.	0.8	n.s.	0.19
Variety mean						
ST 4575 BR	8.4	1.8 a	0.8 a	19.1	4.3 a	2.30
ST 5599 BR	8.4	1.4 b	0.1 b	19.0	3.2 b	2.35
LSD	n.s.	0.3	0.5	n.s.	0.5	n.s.
Split-plot analysis, <i>P</i> (F)						
Treatment	0.0014	.0001	.1053	.0431	.8384	.0645
Variety	1.0000	.0368	.0161	.7979	.0004	.5432
Treatment x variety	1.0000	.2740	.4208	.6080	.6086	.8539

^zS=seed treatment, F=in seed furrow at planting.

^yPlant vigor rating scale: 1=severely stunted, 10=healthy.

^xThrips injury scale: 0=no damage, 10=thrips damage on all plants.

^wData are number of flowers per two 6-ft sections of row.

^vData are measurements of six arbitrarily-selected plants per plot.

^uDetermined from counts of four plants per plot.

^tLint was 44.3% of seed cotton for ST 4575 BR and 44.5% for ST 5599 BR. One bale=480 lb. Plots were harvested on 1 Nov.

^sMeans followed by the same letter(s) in a column are not significantly different according to Fisher's Protected LSD at $P \leq 0.05$ with the exception of bales/A which were significantly different at $P=0.10$. "n.s."=not significant.

with a two-row spindle picker. Yield in bales per acre was determined by weight of seed cotton and the gin turnout for samples taken from replicated plots.

Stand counts averaged 2.03 and 1.95 plants per foot of row for ST 4575 BR and ST 5599 BR on 13 June, respectively (not shown), and the effect of treatment was not significant. Both Avicta Complete Pak and Temik 15G improved plant vigor and reduced thrips injury significantly compared to the untreated check (Table 6). Nematode populations in soil ranged from 15 to 30 stubby root and 360 to 633 spiral nematodes per 500 cm³ soil on 27 July (not shown). Southern root-knot nematode was not detected. Flower counts on 20 July and open bolls on 4 October were significantly greater in ST 4575 BR, but the effect of treatment was not significant in either variety. Both treatments showed increased plant height on 20 July, but only the response to Temik in furrow was significant. In analysis of data combined across varieties, plots treated with Avicta Complete Pak resulted in significantly higher yields than the untreated or Temik-treated plots ($P=0.10$).

The response of cotton to seed and in-furrow nematicide treatments (Tidewater AREC Farm, Suffolk).

Soil at the field site was Kenansville loamy fine sand. Land was prepared by ripping and strip-tilling rows in wheat stubble. Plots were planted on 25 April. Treatments were main plots of four 30-foot long rows spaced 36 inches apart and subplots were two rows planted to ST 4575 BR (susceptible to southern root-knot) and ST 5599 BR (partially resistant to southern root-knot). A split-plot design was used with replications in four randomized complete blocks. Seed used in each treatment were from the same lot of each variety. Personnel with Syngenta Crop Protection applied Avicta Complete Pak. The base treatment of fungicide on ST 4575 BR was Baytan/Thiram/Allegiance and ST 5599 BR was treated with Apron XL/Maxim/NuFlow. The in-furrow treatment with KC791230 5 pounds per acre was applied at planting. Treatments with Temik 15G were applied in-furrow at planting with and without an additional side-dress application on 10 July. Foliar sprays of Orthene 97 at 6 ounces per acre were applied to all plots

on 12 and 31 May for thrips control. Thereafter, standard practices were followed. Soil samples for determining nematode populations were collected on 26 July, and a composite sample of replications was prepared for each treatment and variety. A soil elutriator and sugar flotation method were used to process samples. All plots were harvested with a two-row spindle picker.

Stand counts averaged 1.82 and 1.68 plants per foot of row for ST 4575 BR and ST 5599 BR on 23 May, respectively (not shown). ST 4575 BR had significantly more plants than ST 5599 BR. ST 4575 BR had increased plant vigor on 10 June compared to ST 5599 BR. Since the treatment by variety interaction was not significant for any of the recorded factors, data analysis included the combined effects of treatments and varieties. All treatments increased plant vigor over the untreated check. The treatments of Temik and KC791230 applied in furrow at planting promoted the greatest increase in plant vigor in both varieties. No differences between varieties for thrips injury were observed on 10 June. Treatments with Temik and KC791230 reduced thrips injury compared to the untreated check across both varieties. Avicta Complete Pak reduced thrips injury significantly only on ST 4575 BR. The effect of treatments on plant height was not significant when combined across varieties, and small but significant differences were detected when data were compared within a variety. ST 4575 BR had significantly more flowers on 20 July and open bolls on 15 September compared to ST 5599 BR. Treatments with Temik and KC791230 in-furrow significantly increased flower and open boll counts over the untreated check. Temik applied in furrow followed by a side-dress application failed to increase flower counts, but did significantly increase open boll counts. Plant parasitic nematodes in soil on 26 July ranged from 78 to 128 stubby root, 165 to 303 ring, and 30 to 58 root-knot nematodes. Stubby root was the only nematode thought to be present at numbers that may have caused some root damage. Varieties were not significantly different in yield. Avicta Complete Pak on seed, KC791230 in furrow, and Temik in furrow followed by a side-dress application produced yields that were significantly greater than the untreated check.

Table 7. Response of cotton to seed and in-furrow treatments for control of stubby root nematode, 2006 (Tidewater AREC, Suffolk).

Variety, treatment and rate ^z	Plant vigor 10 Jun ^y	Thrips injury 10 Jun ^x	Flower count/12 ft of row 20 Jul ^w	Plant height (in.) 20 Jul ^v	Open bolls 15 Sep ^u	Lint yield (bales/A) ^t
ST 4575 BR						
Untreated Check	5.5 b ^s	1.5 a	12.5	16.7 b	2.3 b	1.56
Avicta Complete Pak (S)	6.8 a	0.3 b	15.3	17.8 ab	2.4 b	2.03
Temik 15G 5 lb (F)	7.3 a	0.0 b	26.0	18.8 a	3.4 a	1.79
KC791230 5 lb (F)	7.0 a	0.5 b	23.3	19.0 a	3.4 a	1.93
Temik 15G 5 lb (F) + 5 lb (B)	7.5 a	0.0 b	20.0	17.8 ab	3.1 ab	1.90
LSD	1.2	0.7	n.s.	1.5	1.0	n.s.
ST 5599 BR						
Untreated Check	4.5 b	1.8 a	4.8	15.8 b	1.5 b	1.56
Avicta Complete Pak (S)	6.0 ab	1.8 a	9.5	18.0 a	1.6 b	2.05
Temik 15G 5 lb (F)	6.3 a	0.3 b	17.3	17.4 ab	2.1 ab	1.70
KC791230 5 lb (F)	7.0 a	0.0 b	16.5	18.6 a	2.2 ab	1.95
Temik 15G 5 lb (F) + 5 lb (B)	7.3 a	0.0 b	14.8	18.6 a	2.4 a	2.00
LSD	1.6	1.5	n.s.	1.9	n.s.	n.s.
Treatment mean						
Untreated Check	5.0 d	1.6 a	8.6 c	16.3	1.9 b	1.56 c
Avicta Complete Pak (S)	6.4 c	1.0 ab	12.4 bc	17.9	2.0 b	2.04 a
Temik 15G 5 lb (F)	6.8 bc	0.1 bc	21.6 a	18.1	2.8 a	1.74 bc
KC791230 5 lb (F)	7.0 ab	0.3 bc	19.9 ab	18.8	2.8 a	1.94 ab
Temik 15G 5 lb (F) + 5 lb (B)	7.4 a	0.0 c	17.4 a-c	18.2	2.8 a	1.95 ab
LSD	0.5	0.9	8.8	n.s.	0.6	0.21
Variety mean						
ST 4575 BR	6.8 a	0.5	19.4 a	18.0	2.9 a	1.84
ST 5599 BR	6.2 b	0.8	12.6 b	17.7	2.0 b	1.86
LSD	0.3	n.s.	5.6	n.s.	0.4	n.s.
Split-plot analysis, P (F)						
Treatment	.0210	.0011	.0076	.1467	.0238	.0286
Variety	.0018	.2801	.0196	.3732	.0001	.8179
Treatment x variety	.2136	.2472	.9927	.2749	.7430	.9179

^zS=seed treatment, F=in seed furrow at planting, B=over-the-top, band application on 10 Jul.

^yPlant vigor rating scale: 1=severely stunted, 10=healthy.

^xThrips injury scale: 0=no damage, 10=thrips damage on all plants.

^wData are number of flowers per two 6-ft sections of row.

^vData are measurements of six arbitrarily-selected plants per plot.

^uDetermined from counts of four plants per plot.

^tWeight (lb/A) includes lint + seed; bales/A are weight of lint only. Lint was 41.9% for ST 4575 BR and 41.8% of total weight for ST 5599 BR. One bale was 480 lb. Plots were harvested on 21 Oct.

^sMeans followed by the same letter(s) in a column and group are not significantly different according to Fisher's Protected LSD ($P \leq 0.05$), "n.s."=not significant.

Evaluation of Syngenta seed treatments for control of southern root knot nematode (Rick Morgan Farm, Suffolk). Soil at the field site was Rumford loamy fine sand and was planted to cotton continuously since 2001. Land was prepared for planting by ripping and bedding rows in stale beds of cotton from the previous season. Personnel with Syngenta Crop Protection applied seed treatments. Seed of DP 444 BG/RR were planted on 10 May. Temik 15G 5 pounds per acre was applied to the seed furrow at planting. Treatments were replicated in four randomized complete blocks and plots were two 30-foot long rows spaced 38 inches apart. Dynasty + Cruiser was the reference standard seed treatment without nematicide. A foliar spray of Orthene 97 at 8 ounces per acre was applied to all plots on 31 May for thrips control; thereafter, standard practices were followed for cotton production in Virginia. Soil samples for determining nematode populations were collected on 7 September, and a composite sample of replications was prepared for each treatment. A soil elutriator and

sugar flotation method were used to process samples. All plots were harvested with a two-row spindle picker on 15 November.

Plant height on 24 July was reduced in plots treated with A14905E compared to treatments with A14905B and A14905H, but none of the treatments were significantly different from the standard treatment with Dynasty + Cruiser on seed or Dynasty + Temik 15G in furrow (Table 8). The effect of treatments on flowering and root galling was not significant. A14905E on seed had the highest number of open bolls on 19 September, while treatments of Dynasty + Cruiser, Dynasty + Cruiser + Avicta, and A14905B had significantly lower numbers of open bolls. The treatment of Dynasty + Cruiser + Avicta resulted in the highest lint yield, while A14905A, A14905B, A14905E, and Dynasty + Temik had significantly lower yields.

Table 8. Comparison of Syngenta seed treatments for control of southern root-knot nematode, 2006 (Rick Morgan Farm, Suffolk).

Treatment and rate (a.i.) ^z	Plant	Flower	Root-knot	Root gall	Open bolls	Lint yield
	height (in.)	count/12 ft	juveniles	index		
	24 Jul ^y	24 Jul ^x	/500 cm ³	(0-6)	19 Sep ^u	(bales/A) ^t
Dynasty 125FS 0.03 mg + Cruiser 5FS 0.34 mg/seed (S)	29.5 a-c ^s	23.5	8850	2.0	3.31 b-d	1.98 ab
Dynasty 125FS 0.03 mg + Cruiser 5FS 0.34 mg + Avicta 4.17FS 0.15 mg/seed (S)	29.5 a-c	29.0	6050	2.3	2.94 cd	2.13 a
A14905B 533.1FS 0.54 mg/seed (S)	30.2 a	24.5	5440	2.4	2.88 d	1.82 bc
A14905E 533.1FS 0.54 mg/seed (S)	28.6 c	21.0	5710	2.6	4.06 a	1.72 cd
A14905F 533.1FS 0.54 mg/seed (S)	29.3 a-c	21.5	7830	2.3	3.81 ab	1.89 a-c
A14905G 533.1FS 0.54 mg/seed (S)	29.0 bc	31.8	3230	2.4	3.63 a-c	1.94 a-c
A14905H 533.1FS 0.54 mg/seed (S)	30.1 ab	32.5	6540	1.5	3.75 ab	1.98 a-c
A14905A 537.6FS 0.54 mg/seed (S)	29.3 a-c	29.0	3910	2.0	3.50 a-d	1.79 b-d
Dynasty 125FS 0.03 mg/seed (S) + Temik 15G 0.75 lb/A (F)	29.1 a-c	19.8	5600	2.1	4.00 ab	1.55 d
Dynasty 125FS 0.03 mg + Cruiser 5FS 0.34 mg + Avicta 4.17FS 0.15 mg/seed (S) + Temik 15G (F) 0.75 lb/A (F)	29.3 a-c	28.3	5190	1.4	3.81 ab	1.93 a-c
LSD, $P \leq 0.05$	n.s.	n.s.	--	n.s.	0.69	0.26

^zS=seed treatment, F=in seed furrow at planting.

^yData are measurements of six arbitrarily-selected plants per plot.

^xData are number of flowers per two 6-ft sections of row.

^wCounts are from a composite of soil samples collected across four replications of each treatment on 7 Sep.

^vRoots of four plants per plot were dug and scored according to the percent of roots with galls: 0=none, 1=1-10%, 2=11-25%, 3=26-50%, 4=51-75%, 5=76-90%, 6=91-100%.

^uDetermined from counts of four plants per plot.

^tYield of lint was determined by ginning samples of seed cotton; lint was 42.8% of total weight and 480 lb/bale.

^sMeans followed by the same letter(s) in a column are not significantly different. "n.s."=not significant, "--"no data analysis because reps were combined into one sample.

Comparison of Bayer seed treatments for control of southern root-knot nematode (Rick Morgan Farm, Suffolk). Soil was prepared by ripping and bedding rows in stale beds of cotton from the previous season. The soil type was Rumford loamy fine sand that had been planted to cotton annually since 2001. Personnel with Bayer CropScience applied seed treatments on top of the seed vendor's base fungicide treatment. Included were ST 4575 BR (susceptible to southern root knot) and ST 5599 BR (partially resistant). Plots consisted of two 30-foot long rows spaced 38 inches apart. The treatment with Temik 15G 5 pounds per acre was applied to the seed furrow at planting on 10 May. Orthene 97 at 8 ounces per acre was applied to all plots on 31 May for thrips control. Thereafter, standard practices were followed. Soil samples for nematode populations were collected on 5 September, and a composite sample of replications was processed by a soil elutriator and sugar flotation method. All plots were harvested with a two-row picker on 15 November.

Stand counts were not significantly different and ranged from 1.89 to 2.1 plants/ft of row for ST 4575 BR and 1.75 to 1.90 plants/ft of row for ST 5599 BR on 7 June (data not shown). BCSTON + L1505A, which contained Avicta, increased early season growth in ST 4575 BR (Table 9) and ST 5599 BR (Table 10) significantly over that of other treatments according to height measurements on 24 July. Open bolls counted on 18 September were not significantly different across treatments in either variety. Counts of southern root knot nematode were above thresholds for causing crop damage in both varieties. Root galling was suppressed the greatest by Temik 15G on ST 4575 BR, but not significantly more than BCSTON + L1505A. Root galling was lower on ST 5599 BR, with some significant differences across treatments. The effect of treatments on open boll counts and yields were not significantly different in either variety.

Table 9. Comparison of Bayer seed treatments for control of southern root-knot nematode on ST 4575 BR, 2006 (Rick Morgan Farm, Suffolk).

Variety, treatment and rate ^z	Plant height ^y (in., 24 Jul)	Open bolls/ plant ^x (18 Sep) ³	Root-knot nematodes/ 500 cc soil ^w	Root galling ^v (5 Dec)	Yield ^u (bales/A)
Untreated Check	21.4 bc	0.6	2460	4.9 ab	1.81
Gauche Grande 0.375 mg a.i./seed (S)	21.3 c	0.9	3280	5.1 a	1.31
Gauche Grande 0.375 mg a.i. + Compound A (S)	22.7 bc	0.5	2170	4.6 ab	1.47
Gauche Grande 0.375 mg a.i. + EXP3 250 g a.i./100 kg seed (S)	23.0 bc	0.4	3900	4.6 ab	1.61
Gauche Grande 0.375 mg a.i. + EXP3 375 g a.i./100 kg seed (S)	23.0 bc	1.3	2980	4.9 ab	1.71
Gauche Grande 0.375 mg a.i. + EXP3 500 g a.i./100 kg seed (S)	23.2 b	0.4	3630	4.8 ab	1.74
BCSTON 02100602 0.34 mg a.i. + L1505A 0.15 mg a.i./seed (S)	25.8 a	0.4	2930	4.3 bc	1.64
Temik 15G 5 lb/A (F)	22.8 bc	0.9	2950	3.8 c	1.80
LSD	1.8	n.s.	--	0.6	n.s.

^zS=seed treatment, F=in furrow.

^yData are measurements of six plants per plot.

^xData are counts of four plants per plot.

^wSoil was sampled on 7 Sep. Data are counts in a composite sample of soil from four reps of each treatment combination.

^vRating scale: 0=none, 1=1-10%, 2=11-25%, 3=26-50%, 4=51-75%, 5=76-90%, 6=91-100% of root system with galls. Ratings are from four plants per plot.

^uBales/A are lint only. Lint was 42.8% of total weight. One bale equals 480 lb. Means followed by the same letter(s) in a column are not significantly different (LSD, P=0.05), "n.s." = not significant.

Table 10. Comparison of Bayer seed treatments for control of southern root-knot nematode on ST 5599 BR, 2006 (Rick Morgan Farm, Suffolk).

Variety, treatment and rate ^z	Plant height ^y (in., 24 Jul)	Open bolls/ plant ^x (18 Sep) ³	Root-knot nematodes/ 500 cc soil ^w	Root galling ^v (5 Dec)	Yield ^u (bales/A)
Untreated Check	24.4 bc	0.1	1540	1.9 d	1.88
Gaucht Grande 0.375 mg a.i./seed (S)	25.7 b	0.5	2620	3.0 ab	1.99
Gaucht Grande 0.375 mg a.i. + Compound A (S)	25.6 b	0.0	2730	2.4 b-d	1.95
Gaucht Grande 0.375 mg a.i. + EXP3 250 g a.i./100 kg seed (S)	25.6 b	0.2	2470	2.6 a-c	1.97
Gaucht Grande 0.375 mg a.i. + EXP3 375 g a.i./100 kg seed (S)	23.7 c	0.6	2120	3.2 a	1.71
Gaucht Grande 0.375 mg a.i. + EXP3 500 g a.i./100 kg seed (S)	24.9 bc	0.3	2670	2.7 a-c	2.07
BCSTON 02100602 0.34 mg a.i. + L1505A 0.15 mg a.i./seed (S)	27.7 a	0.7	900	2.1 cd	1.93
Temik 15G 5 lb/A (F)	24.1 c	0.4	3420	2.4 b-d	1.86
LSD	1.3	n.s.	--	0.7	n.s.

^zS=seed treatment, F=in furrow.

^yData are measurements of six plants per plot.

^xData are counts of four plants per plot.

^wSoil was sampled on 7 Sep. Data are counts in a composite sample of soil from four reps of each treatment combination.

^vRating scale: 0=none, 1=1-10%, 2=11-25%, 3=26-50%, 4=51-75%, 5=76-90%, 6=91-100% of root system with galls. Ratings are from four plants per plot.

^uBales/A are lint only. Lint was 43.3% of total weight. One bale equals 480 lb. Means followed by the same letter(s) in a column are not significantly different (LSD, P=0.05), "n.s." = not significant.

Response of cotton varieties to southern root-knot nematode and applications of seed and in-furrow treatments (Rick Morgan Farm, Suffolk). Soil at the field site was Rumford loamy fine sand and was prepared for planting by ripping and bedding rows in stale beds of cotton from the previous season. Seed of each variety were from the same seed lot and treated with the vendor's base fungicide treatment. Treatments were main plots of twelve 30-foot long rows spaced 38 inches apart and subplots were two rows of each variety. The seed treatment with Avicta Complete Pak was applied by personnel with Syngenta Crop Protection. The treatment with Temik 15G 5 pounds per acre was applied to the seed furrow at planting on 10 May. A foliar spray of Orthene 97 at 8 ounces per acre was applied to all plots on 31 May for thrips control. Thereafter, standard practices were followed. Soil samples for determining nematode populations were collected on 5 September, and a composite sample of replications was processed of each treatment/variety by a soil elutriator and the sugar flotation method. All plots were harvested with a two-row picker on 15 November.

Variety had a significant effect on stand, root galling, plant height, open bolls, and yield (Table 11). Root gall-

ing was the only factor to be affected significantly by treatment. Stand counts ranged from 1.40 to 1.91 plants per foot of row on 7 June (data not shown). ST 5599 BR and/or Temik 15G were the only factors to reduce root galling significantly as reported on 28 June. Ratings on 5 December indicated that Temik 15G and Avicta Complete Pak on seed reduced root galling significantly and that ST 5599 BR had significantly lower root galling than other varieties. Either Avicta Complete Pak on seed or Temik 15G in furrow tended to increase flower counts as of 15 July, but not significantly more than the untreated check. Counts of total bolls were not significant for treatment or variety. Populations of plant parasitic nematodes in composite samples of soil from plots of each variety and treatment showed 400 to 6,880 root-knot juveniles, 20 to 390 spiral nematodes, and 30 to 470 stubby root nematodes per 500 cm³ of soil. Yields were significantly different for variety, but not treatment in the combined analysis of yield data. However, there was a trend for increased yield by each variety when treated with either Avicta Complete Pak or Temik 15G. This increase ranged from 0.22 bales acre with Avicta Complete Pak to 0.37 bales acre with Temik 15G in furrow.

Table 11. The response of cotton varieties to seed and in-furrow treatments for control of southern root-knot nematode, 2006 (Rick Morgan Farm, Suffolk).

Variety, treatment and rate ^z	Plant height (in.)		Flower count/ 12 ft of row	Number of bolls 18 Sep ^w		Root-knot galling (0-6) ^v		Root-knot juveniles per 500 cm ³ soil ^u	Lint yield ^t				
	25 Jul ^y	25 Jul ^x		Total	Open	28 Jun	5 Dec	5 Sep	(bales/A)				
ST 4575 BR													
Untreated Check	21.1	b ^s	5.5	11.2	0.6	3.9	a	4.8	2760	1.46			
Avicta Complete Pak (S)	24.2	a	19.8	13.1	1.0	3.3	a	4.6	3480	1.64			
Temik 15G 5 lb/A (F)	25.9	a	25.0	11.6	0.9	2.1	b	4.5	1040	1.69			
<i>P</i> (F)	<.0001		.01255	.3064	.3530	.0001		.6543		.6400			
PHY 310 R													
Untreated Check	23.8	b	4.0	9.9	b	0.3	3.3	a	5.1	a	5010	1.15	
Avicta Complete Pak (S)	23.7	b	11.5	13.4	a	1.0	3.3	a	3.7	c	4440	1.50	
Temik 15G 5 lb/A (F)	27.5	a	9.8	9.6	b	0.9	2.6	b	4.4	b	3750	1.43	
<i>P</i> (F)	<.0001		.2705	.0465	.1440	.0615		<.0001			.5911		
DP 432 RR													
Untreated Check	24.0	b	10.0	12.0		1.1	3.6		4.6	a	2570	1.18	
Avicta Complete Pak (S)	24.7	ab	16.8	12.8		1.1	3.4		3.8	b	1420	1.27	
Temik 15G 5 lb/A (F)	25.2	a	20.0	11.3		1.9	2.9		3.6	b	400	1.42	
<i>P</i> (F)	.0580		.5267	.6567		.2571	.1667		.0213			.7380	
DP 445 BR													
Untreated Check	24.1		8.8	13.9		0.9	3.4	a	4.4		6880	1.35	
Avicta Complete Pak (S)	25.6		14.5	12.6		1.1	3.4	a	4.3		2200	1.58	
Temik 15G 5 lb/A (F)	25.8		14.0	13.1		0.9	2.4	b	3.8		1110	1.76	
<i>P</i> (F)	.2679		.3839	.7293		.7882	.0052		.1816			.4108	
DP 444 BG/RR													
Untreated Check	24.4	b	6.0	13.8		1.1	3.8	a	3.3	a	4570	1.10	
Avicta Complete Pak (S)	26.9	a	16.0	13.3		2.8	3.8	a	2.6	b	3430	1.31	
Temik 15G 5 lb/A (F)	28.5	a	15.0	12.7		1.3	2.2	b	2.4	b	1710	1.45	
<i>P</i> (F)	.0083		.0932	.6995		.0170	<.0001		.0283			.4621	
ST 5599 BR													
Untreated Chec	22.6	b	6.3	11.7		0.1	2.9	a	2.2		1150	1.54	b
Avicta Complete Pak (S)	27.0	a	15.0	14.4		0.3	2.9	a	1.8		3140	1.84	ab
Temik 15G 5 lb/A (F)	28.0	a	14.5	11.8		0.6	1.8	b	1.6		4570	2.05	a
<i>P</i> (F)	.0001		.3306	.2053		.1435	.0019		.0836			.0518	
Variety mean													
ST 4575 BR	23.7		16.8	11.9		0.8	3.1	a	4.6	a	2427	1.66	ab
PHY 310 R	25.0		8.4	11.0		0.7	3.0	a	4.4	ab	4440	1.36	cd
DP 432 RR	24.6		15.6	12.0		1.4	3.3	a	4.0	c	1463	1.29	d
DP 445 BR	25.2		12.4	13.2		1.0	3.1	a	4.2	bc	3397	1.56	bc
DP 444 BG/RR	26.8		12.3	13.2		1.7	3.3	a	2.8	d	3237	1.29	d
ST 5599 BR	25.9		11.9	12.6		0.3	2.5	b	1.9	e	2953	1.81	a
Treatment mean													
Untreated check	23.3		6.8	12.0		0.7	3.5	a	4.0	a	3823	1.30	
Avicta Complete Pak (S)	25.4		15.6	13.3		1.2	3.3	a	3.5	b	3010	1.52	
Temik 15G 5 lb/A (F)	26.8		16.4	11.7		1.1	2.3	b	3.4	b	2096	1.67	
Split-plot analysis, <i>P</i> (F)													
Treatment	.1289		.1902	.2838		.2715	.0085		<.0001		.2255	.4091	
Variety	.0001		.1272	.1494		.0001	.0051		.0300		.4600	.0001	
Treatment x variety	.0001		.8743	.6834		.0319	.2940		.1558		--	.9887	

^zS=seed treatment, F=in seed furrow at planting.

^yAverage of measurements for six plants per plot.

^xAverage number of flowers per two 6-ft sections of row.

^wDetermined from counts of four plants per plot.

^vRoots of four plants per plot were scored according to the percent of roots with galls: 0=none, 1=1-10%, 2=11-25%, 3=26-50%, 4=51-75%, 5=76-90%, 6=91-100%.

^uCounts are from a composite of soil samples collected across four replications of each treatment on 5 Sep. Square root transformation of population data was made in statistical analysis.

^tYield of lint was determined by ginning samples of seed cotton. One bale of lint equals 480 lb.

^sMeans followed by the same letter(s) in a column and group are not significantly according to Fisher's Protected LSD ($P \leq 0.05$), except the effects on plant height in DP 432 RR and root-knot galling on 28 Jun in PHY 310 R used an LSD $P=0.10$ for mean separations. Otherwise, plant height and boll counts were compared by Student-Newman-Keuls multiple range test ($P \leq 0.05$).

Evaluation of Chemicals and Variety Selection for Control of Nematodes in Cotton

Patrick M. Phipps, Darcy E. Partridge, and Jon D. Eisenback

Summary:

1. **2006 growing season:** Rainfall in June, September and October was 5.75, 4.64 and 4.62 inches above normal and May, July, and August was 0.96, 2.21, and 3.21 inches below normal, respectively. Total rainfall from May through October was 36.4 inches or 8.7 inches above normal. A total of 2053 DD₆₀ units were accumulated in the 2006 growing season or 120 units below the 12-year average from 1995 to 2006. Yields of cotton lint are estimated to average 717 pounds per acre or 1.5 bales per acre in 2006.
2. **Avicta Complete Pak compared to Temik 15G for thrips control:** Some trials showed increased damage by thrips in plots without Avicta Complete Pak on seed or Temik 15G in furrow. All trials were over sprayed about three to four weeks after planting with Orthene 97 8 ounces per acre upon emergence of the first true leaf to control thrips and increase the opportunity to measure the crops response to nematode control. It seems likely that this treatment also benefited performance of plots treated with Avicta Complete Pak on seed as well as Temik in-furrow.
3. **Avicta Complete Pak compared to Temik 15G for nematode control:** Trials having numbers and kinds of nematodes below threshold levels for crop damage showed yield increases to Avicta Complete Pak and Temik, which may be attributed to thrips control. Trials with southern root-knot nematode above thresholds for crop damage showed significant early season suppression of root galling by Temik in 5 of 6 varieties, whereas the effects of Avicta Complete Pak were not significant. Late season root galling was suppressed significantly by Temik and Avicta Complete Pak on 3 of 6 varieties.
4. **Avicta Complete Pak compared to Temik 15G for yield of cotton:** The yield of cotton treated with Avicta Complete Pak on seed or Temik in furrow was often similar and significantly higher than the check. ST 5599 BR showed significantly less root galling than other varieties, and produced significantly higher yield than all but one of six varieties. Overall, the performance of Temik 15G and Avicta Complete Pak was similar, and often significantly superior to the check in fields with stubby root and/or southern root-knot nematode.