EVALUATION OF THRIPS DAMAGE ON MATURITY AND YIELD OF VIRGINIA COTTON

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Abstract

Visual plant damage ratings, PMAP plant mapping techniques and yield measurements were used to evaluate the impact of selected insecticide treatment options on thrips damage to cotton seedlings, plant growth and yield. All experiments were conducted at Virginia Tech's Tidewater Agricultural Research and Extension Center in Suffolk, VA. Treatments included: selected in-furrow applied or seed treated insecticides, both with and without an additional foliar insecticide band at true leaf stage; foliar applied insecticides, alone; and Command herbicide safening insecticides. Insecticides included selected organophosphates and carbamates, and imidacloprid and spinosad. Thrips populations were considered high during the first few weeks after plants emerged and damage to seedlings reached extreme levels in untreated controls. This combined with the additional stresses caused by unusually cool early season weather and later-season dry weather resulted in retarded plant growth. All treatments reduced thrips damage, and in most cases, the reduction was significant. PMAP data indicated that all treatments allowed plants to mature faster than plants in untreated control plots. Treated plants were taller and had more squares, green and open bolls on most evaluation dates. Most importantly, all treatments resulted in significantly higher lint yields compared with untreated controls. The yield increase over that produced by the untreated controls, averaged over all experiment treatments, was 380 lb lint/acre. Specific treatments and comparisons are discussed.

Introduction

Early season thrips feeding on seedlings is known to reduce cotton yield under certain conditions (Roberts et al. 1990). Field trials in Virginia in 1995 showed that seedling damage by thrips reduced yields by an average of 177-198 lb lint/acre (Herbert 1995). In 1996, a field experiment in Virginia evaluating the impact of thrips damage combined with wind and sand burn showed that yield in sand-burned and late-planted cotton averaged 506 and 466 lb lint/acre, respectively, but the average yield was almost 1600 lb lint/acre in an adjacent experiment in the same field with early planted cotton that did not sustain sand damage (Herbert 1997). The combination of stresses by thrips and sand burn reduce cotton seedling stand, slowed maturity and caused yield reductions of almost 1000 lb lint/acre. Research on the effects of thrips damage, combined with climatic stress, was continued in a series of field experiments in 1997.

Materials and Methods

Four field experiments were established at Virginia Tech's Tidewater Agricultural Research and Extension Center farm, Suffolk, VA. Delta and Pine Land 51 cotton was planted into a Kenansville soil (well drained, loamy sand) on May 1-8, 1997. Ground preparation included moldboard plowing, disking, land conditioning and forming 24-inch wide and 4-inch high seed beds on 36-inch row centers with a peanut row bedder. In-furrow insecticides were applied at planting time, either as seed treatments (commercially treated or as planter box treatments), or as granules or liquids placed into the seed furrow. All insecticide treated seed was provided by Gustafson, Inc., Dallas, TX. Gustafson, Inc. also provided insecticide-untreated seed from the same seed lot for use in all remaining test treatments. In-furrow granules were applied using tractor-mounted inverted jars calibrated to deliver exact amounts of product through lid holes via gravity. In-furrow liquids were applied with a tractor-mounted CO_2 pressurized sprayer calibrated to deliver five gallons total volume per acre at 24 psi through one SS8001E flat fan nozzle mounted just above the planter disks and turned parallel to the row direction to deliver the spray fan into the seed furrow. Foliar insecticide bands were applied in a 12 to 14-inch band over the row with a CO_2 pressurized backpack sprayer calibrated to deliver 17.0 gallons per acre at 22 psi through one 8004E flat fan nozzle per row. A randomized complete block experimental design was used with four replicates. Individual plots were four rows by 40 feet long. Only the center two rows of each plot received insecticide treatments.

Thrips plant damage ratings were taken based on visual inspection of the two center rows of each plot using a 0 - 5 scale, where 0 = no damage, 1 = 10% damaged leaves, 2 = 25% leaves damaged but no bud damage, 3 = 75% leaves and 0 - 25% buds damaged, 4 = 90% leaves and greater than 25% buds damaged, and 5 = dead plants. PMAP procedures (Landivar 1993) were used several times in the season, beginning at appearance of first squares, to document plant height, number of vegetative, reproductive, and total nodes, and number, position and retention rate of squares and bolls. PMAP data were recorded on six randomly selected plants per plot, a total of 24 plants per treatment. After defoliation near the end of the season, number of open bolls was recorded on six plants per plot. Yield was determined by harvesting bolls from the center two rows of each plot (80 row feet) using a commercial John Deere 2-row cotton combine. Gross yields were reduced by 63% to account for seed and trash weight.

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PMAP data were summarized using programmed procedures that generate means for all plant responses measured and 'average' stylized plant maps depicting node and fruit set structure for each treatment. Note: the version of PMAP used (5.0) does not include statistical procedures. All other data were subjected to standard ANOVA and mean separation procedures.

Results and Discussion

Thrips Injury

Thrips populations were high in the first few weeks after plant emergence and damage to cotton seedlings reached extreme levels (up to 4.1 on the 0 - 5 scale) in untreated controls. Damage peaked on either June 16 or 23 depending on the specific experiment. On those dates, plants in all treatments of all experiments had significantly less thrips damage compared with untreated controls. On June 16, in the in-furrow with and without an additional foliar treatment experiment, the foliar treatment significantly improved the level of thrips control for all in-furrow treatments (Table 1). With the additional foliar treatment, there was no significant difference among in-furrow treatments. Foliar treatments, alone, provided essentially equal levels of control compared with in-furrow and in-furrow plus foliar treatments (Table 4). All Command herbicide safening insecticide treatments provided significant control (Table 7), as did all spinosad (Tracer 4SC) treatments (Table 8).

PMAP Data

Only part of the PMAP data will be presented and discussed. Full reports are available upon request. In the in-furrow with and without an additional foliar treatment experiment, by July 21, in all treatments plants were taller and numbers of reproductive nodes and squares were greater (Table 2). In most cases, the additional foliar treatment resulted in more squares compared with the in-furrow treatment alone. This trend continued through July 28, with all treatments resulting in more squares and green bolls by July 28, and more open bolls on September 22 compared with the untreated control (Table 3). With foliar treatments, alone, all resulted in taller plants with more reproductive nodes and squares by July 14 (Table 5), more squares and green bolls by August 11, and more open bolls on September 22 compared with the untreated control (Table 6). Foliar treatments, only, also faired well compared with in-furrow treatments (Tables 5 & 6). With Command herbicide insecticides, all resulted in significantly more open bolls by September 22 (Table 7).

Lint Yield

All insecticide treatments, in all experiments, resulted in significantly more cotton lint yields compared with untreated controls. This has not always been the case in past field experiments in Virginia. In the in-furrow with and without an additional foliar treatment experiment, there were few significant differences in yields among treatments (Table 3), although both Temik 15G and Payload applied in-furrow, with the additional foliar band of Orthene 75S, yielded significantly more than the Gaucho 480 seed treatment alone. The additional Orthene 75S foliar band resulted in a numerical increase in yield in four of the five in-furrow treatments evaluated, and therefore seemed to 'equalize' differences among those treatments. In the foliar treatment, alone, experiment, the were some differences in yields among treatments, but all treatments significantly increased yields compared with the untreated control (Table 6). In the Command herbicide safening experiment, all treatments significantly improved yields, with the treatments including Di-Syston 8E having the highest yields (Table 7). In the Tracer 4SC experiment, all treatments resulted in significant yield increases, and most were not significantly different from yields obtained with more traditional treatments (Table 8).

Brief Summary of Findings

The most important finding of these experiments was that all insecticide treatments applied for control of cotton thrips resulted in improved plant growth, as measured in plant height and development and number of reproductive structures, and produced significantly higher lint yields compared with untreated controls. Increases in lint yields ranged from 228 to 644 lb/acre, with an overall average increase (averaged over all treatments, all experiments) of 380 lb/acre. These data demonstrate the importance of managing thrips damage to cotton seedlings in Virginia. Yield reductions in untreated plants are not always this severe. Conditions in 1997 exposed cotton to multiple stress factors which combined to slow plant growth and compromise yield potential. Thrips populations were considered high during the first few weeks after plants emerged and damage to seedlings reached extreme levels in untreated controls. This combined with the additional stresses caused by unusually cool early season weather and later-season dry weather resulted in retarded plant growth, and ultimately, reduced yields. We cannot predict, or in most cases affect, climatic stresses. We can, and recommend that our producers, minimize the stress caused by thrips feeding.

Additional important findings were that a single additional foliar applied treatment at the first true leaf seedling stage appeared to 'boost' or 'equalize' the activity of standard in-furrow treatments. This could be important information for producers when planning thrips management programs and in their selection of products. Also, results with Command herbicide safening insecticides, imidacloprid (Gaucho 480) and spinosad (Tracer 4SC) demonstrated the potential for expanding the selection of thrips management alternatives.

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Table 1. Effects of in-furrow insecticides, with and without an additional foliar band, on thrips damage to cotton seedlings. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Thrips damage rating[1]						
Material & rate/A	May 28	Jun 2	Jun 9	Jun 16	Jun 23	Jun 30	Jul 8
Temik 15G 5 lb (IF)	2.1 bc[2]	1.0 c-e	1.4 de	2.0 c	1.3 c	1.3 d	0.4 bc
Temik 15G 5 lb (IF) + Orthene 75S 3 oz (FB)	1.8 cd	0.6 e	0.6 g	1.0 d	0.5 d	0.5 f	0.1 c
Gaucho 480 8 oz/cwt (ST)	1.8 cd	1.1 b-e	1.9 bc	2.4 bc	2.3 b	1.9 b	0.8 b
Gaucho 480 8 oz/cwt (ST) + Orthene 75S 3 oz (FB)	2.0 bc	0.8 de	0.9 fg	1.3 d	0.5 d	0.5 f	0.4 bc
Thimet 20G 3.75 lb (IF)	2.1 bc	1.5 bc	2.0 b	2.8 b	2.1 b	1.8 bc	0.8 b
Thimet 20G 3.75 lb (IF) + Orthene 75S 3 oz (FB)	2.4 ab	1.3 b-d	1.0 e-g	1.4 d	0.5 d	0.5 f	0.4 bc
Di-Syston 15G 7 lb (IF)	2.4 ab	1.6 b	1.5 cd	2.4 bc	1.5 c	1.0 e	0.5 bc
Di-Syston 15G 7 lb (IF) + Orthene 75S 3 oz (FB)	2.1 bc	1.1 b-e	1.3 d-f	1.4 d	0.5 d	0.5 f	0.3 c
Payload 15G 5 lb (IF)	1.8 cd	1.3 b-d	1.1 d-f	2.3 c	1.4 c	1.6 c	0.4 bc
Payload 15G 5 lb (IF) + Orthene 75S 3 oz (FB)	1.5 d	0.9 de	1.0 e-g	1.4 d	0.5 d	0.5 f	0.3 c
Untreated	2.8 a	2.8 a	3.4 a	3.9 a	3.6 a	3.8 a	2.9 a
LSD (P=0.05)	0.5	0.6	0.4	0.5	0.3	0.2	0.4

[1]Thrips damage rated on a 0-5 scale, 0 = no thrips damage, 5 = dead plants.
[2]Means within a column followed by the same letter are not significantly different (LSD, P=0.05).

Table 2. Effects of in-furrow insecticides, with and without an additional foliar band, on growth of cotton. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Jul 21		
Material & rate/A	Height (in.)	# Reproductive nodes/plant	# Squares/plant
Temik 15G 5 lb (IF)	17.9[1]	8.4	18.9
Temik 15G 5 lb (IF) + Orthene 75S 3 oz (FB)	17.0	8.0	17.4
Gaucho 480 8 oz/cwt (ST)	15.6	7.9	17.0
Gaucho 480 8 oz/cwt (ST) + Orthene 75S 3 oz (FB)	17.9	8.3	19.0
Thimet 20G 3.75 lb (IF)	16.2	7.5	16.1
Thimet 20G 3.75 lb (IF) + Orthene 75S 3 oz (FB)	17.5	8.6	19.1
Di-Syston 15G 7 lb (IF)	17.7	8.5	19.3
Di-Syston 15G 7 lb (IF) + Orthene 75S 3 oz (FB)	17.1	8.5	19.8
Payload 15G 5 lb (IF)	18.0	8.3	19.4
Payload 15G 5 lb (IF) + Orthene 75S 3 oz (FB)	18.3	8.4	19.6
Untreated	12.8	6.9	14.6

[1]The PMAP program used generates means only, N=24, 6 plants/plot x 4 reps.

Table 3. Effects of in-furrow insecticides, with and without an additional foliar band, on growth and yield of cotton. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Jul 28		Sep 22	
Material & rate/A	# Squares /plant	# Green bolls/plant	# Open bolls /80 row ft	Lint lb/acre
Temik 15G 5 lb (IF)	21.5[1]	2.5[1]	93.0 ab[2]	1064 ab[2,3]
Temik 15G 5 lb (IF) + Orthene 75S 3 oz (FB)	21.0	2.7	111.83 a	1112 a
Gaucho 480 8 oz/cwt (ST)	21.6	1.8	100.5 a	888 b
Gaucho 480 8 oz/cwt (ST) + Orthene 75S 3 oz (FB)	22.6	2.3	115.3 a	1045 ab
Thimet 20G 3.75 lb (IF)	20.5	1.6	78.5 ab	959 ab
Thimet 20G 3.75 lb (IF) + Orthene 75S 3 oz (FB)	24.1	2.0	55.0 bc	975 ab
Di-Syston 15G 7 lb (IF)	23.8	2.3	106.3 a	1038 ab
Di-Syston 15G 7 lb (IF) + Orthene 75S 3 oz (FB)	23.6	2.4	112.3 a	932 ab
Payload 15G 5 lb (IF)	22.0	2.2	101.5 a	997 ab
Payload 15G 5 lb (IF) + Orthene 75S 3 oz (FB)	24.1	2.0	119.0 a	1113 a
Untreated	20.0	1.1	24.0 c	469 c

[1]The PMAP program used generates means only, N=24, 6 plants/plot x 4 reps.
[2]Means within a column followed by the same letter(s) are not significantly different (P=0.05) according to Duncan's new multiple range test.
[3]Cotton was harvested on Oct 23. Gross yields were reduced by 63% to account for seed and trash.

Table 4. Effects of in-furrow and applied insecticides on thrips damage to cotton seedlings. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Thrips damage rating[1]				
\Material & rate/A	Jun 9	Jun 16	Jun 23	Jun 30	Jul 7
Orthene 75S 1 lb (IF)	1.1 bc[2]	2.4 b	1.4 b	1.9 b	1.3 b
Orthene 75S 1 lb (IF) + Orthene 75S 4 oz (FB, @ 1st true leaf)	1.1 bc	1.6 d	0.5 c	0.8 c	0.9 bc
Orthene 75S 1 lb (IF) + Orthene 75S 4 oz (FB, @ 4 weeks)	1.1 bc	2.0 b-d	0.8 c	0.5 c	0.6 bc
Orthene 75S 6 oz (FB, @ 1st true leaf) + Orthene 75S 4 oz (FB, @ 4 weeks)	1.1 bc	1.8 cd	0.5 c	0.5 c	0.8 bc
Orthene 75S 4 oz (FB, @ 1st true leaf) + Orthene 75S 4 oz (FB, @ 4 weeks)	1.4 b	2.3 b	0.6 c	0.5 c	0.8 bc
Temik 15G 5 lb (IF)	1.0 c	2.1 bc	0.6 c	0.6 c	0.5 c
Untreated	2.1 a	3.6 a	4.1 a	3.8 a	3.0 a
LSD (P=0.05)	0.3	0.4	0.3	0.4	0.7

[1]Thrips damage rated on a 0-5 scale, 0 = no thrips damage, 5 = dead plants.
[2]Means within a column followed by the same letter are not significantly different (LSD, P=0.05).

Table 5. Effects of in-furrow and foliar applied insecticides on growth of cotton. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Jul 14		
Material & rate/A	Height (in.)	# Reproductive nodes/plant	# Squares/plant
Orthene 75S 1 lb (IF)	8.6[1]	5.9	7.2
Orthene 75S 1 lb (IF) + Orthene 75S 4 oz (FB, 1st true leaf)	8.9	5.5	6.1
Orthene 75S 1 lb (IF) + Orthene 75S 4 oz (FB, 4 weeks)	8.6	5.2	6.0
Orthene 75S 6 oz (FB, 1st true leaf) + Orthene 75S 4 oz (FB, 4 weeks)	8.4	5.1	6.3
Orthene 75S 4 oz (FB, 1st true leaf) + Orthene 75S 4 oz (FB, 4 weeks)	8.8	5.9	7.0
Temik 15G 5 lb (IF)	11.3	6.5	9.2
Untreated	5.9	4.4	4.5

[1]The PMAP program used generates means only, N=24, 6 plants/plot x 4 reps.

Table 6. Effects of in-furrow and applied insecticides on growth and yield of cotton. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Aug 11		Sep 22	
Material & rate/A	# Squares /plant	# Green bolls/plant	# Open bolls /80 row ft	Lint lb/acre
Orthene 75S 1 lb (IF)	16.4[1]	5.4[1]	24.7 ab[2]	450 ab[2,3]
Orthene 75S 1 lb (IF) + Orthene 75S 4 oz (FB, 1st true leaf)	16.7	6.8	20.0 ab	603 a
Orthene 75S 1 lb (IF) + Orthene 75S 4 oz (FB, 4 weeks)	17.3	5.7	11.7 b	445 ab
Orthene 75S 6 oz (FB, 1st true leaf) + Orthene 75S 4 oz (FB, 4 weeks)	15.6	5.2	17.0 ab	347 b
Orthene 75S 4 oz (FB, 1st true leaf) + Orthene 75S 4 oz (FB, 4 weeks)	16.0	6.8	21.7 ab	570 a
Temik 15G 5 lb (IF)	13.9	8.7	37.7 a	643 a
Untreated	17.1	4.8	2.3 b	119 c

[1]The PMAP program used generates means only, N=24, 6 plants/plot x 4 reps.
[2]Means within a column followed by the same letter(s) are not significantly different (P=0.05) according to Duncan's new multiple range test.
[3]Cotton was harvested on Oct 30. Gross yields were reduced by 63% to account for seed and trash.

Table 7. Thrips damage and yield of cotton treated with Command safening insecticides. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Thrips damage[1]			
Material & rate/A	Jun 16	Jun 23	# Open bolls /80 row ft	Lint lb/acre
TSX Di-Syston EC 64 fl oz (IF) + Command 3ME 21 fl oz (PRE)	1.9 de[2]	1.4 b	21.3 a	471 b[3]
TSX Di-Syston Granular 12 lb (IF) + Command 3ME 21 fl oz (PRE)	1.6 e	1.0 b	22.5 a	445 b
TSX Di-Syston 8E 12 fl oz (IF) + Command 3ME 21 fl oz (PRE)	2.6 c	0.9 b	18.3 ab	568 a
Untreated + Command 3ME 21 fl oz (PRE)	3.1 b	3.6 a	1.8 c	203 c
Di-Syston 8E 12 fl oz (IF) + Cotoran 4L 28 fl oz (PRE)	2.3 cd	1.1 b	13.8 ab	529 ab
Untreated + Cotoran 4L 28 fl oz (PRE)	3.6 a	3.8 a	9.0 bc	144 c
LSD (P=0.05)	0.4	0.5	9.6	87

[1]Thrips damage rated on a 0-5 scale, 0 = no thrips damage, 5 = dead plants.
[2]Means within a column followed by the same letter are not significantly different (LSD, P=0.05).
[3]Cotton was harvested on Oct 29. Gross yields were reduced by 63% to account for seed and trash.

Table 8. Thrips damage and yield. Thrips damage and yield of cotton treated with Tracer 4SC for thrips control. Tidewater Agricultural Research and Extension Center. Suffolk, Virginia, 1997.

	Thrips damage rating[1]					Lint
Material & rate/A	Jun 9	Jun 16	Jun 23	Jun 30	Jul 8	lb/acre[2]
Tracer 4SC 0.7 oz[3]	2.1 b[4]	2.9 bc	0.6 bc	1.0 b	0.4 b	961 ab[5]
Tracer 4SC 1.44 oz	2.1 b	3.0 b	1.0 b	1.0 b	0.6 b	845 b
Tracer 4SC 2.14 oz	2.0 b	2.5 c	0.6 bc	0.5 c	0.6 b	1001 ab
Tracer 4SC 2.85 oz	1.1 c	3.0 b	0.6 bc	0.5 c	0.8 b	882 ab
Orthene 75S 4 oz	1.5 bc	1.8 d	0.5 c	0.5 c	0.8 b	1101 a
Untreated	3.1 a	3.8 a	3.0 a	3.5 a	2.9 a	610 c
LSD (P=0.05)	0.7	0.4	0.4	0.009	0.7	---

[1]Thrips damage rated on a 0-5 scale, 0 = no thrips damage, 5 = dead plants.
[2]Cotton was harvested on Oct 23. Gross yields were reduced by 63% to account for seed and trash.
[3]All treatments applied twice: at first true leaf (May 29) and at 4 weeks (Jun 10).
[4]Means within a column followed by the same letter(s) are not significantly different (LSD, P=0.05).
[5]Means within a column followed by the same letter(s) are not significantly different (P=0.05) according to Duncan's new multiple range test.