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Cotton Insect Pest Management Reports for the Texas High Plains

2009 Report

Dr. David Kerns
Extension Entomologist – Cotton

Bo Kesey
Extension Program Specialist – Cotton Entomology

Texas AgriLife Extension Service
Texas AgriLife Research and Extension Center
Lubbock Texas

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Table of Contents

Evaluation of Insecticides for Control of Western Flower Thrips in Cotton, 2009

Cooperators: Brian and Rex Reinert, Cotton Growers / Texas AgriLife Extension Service

David Kerns, Emilio Nino and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Castro County, Extension Program Specialist-Cotton

Castro County

Summary:

Treaments in this test included Temik at 3.5 lbs, Avicta Complete Cotton seed treatment, Dimthoate, Orthene, Carbine, ProNatural Sulfur and several rates of a new muscle poison insecticide, HGW86. Between Temik and Avicta, Temik provided longer residual control, lasting about 25 days, while Avicta lasted about 18 days. Both should have received foliar applications after their residual control had declined but did not; Avicta may have benefited from two foliar applications. Of the foliar sprays, Orthene was the superior product, providing 5-6 days control. Dimethoate performed slightly less, not offering 3-5 days of control. HGW86 at the higher rates and Carbine offered some WFTs suppression, while Sulfur offered very little control.

Objective:

The objective of this study was to determine the efficacy of several foliar insecticides (including an OMRI approved organic treatment), a seed treatment and in-furrow application of Temik and to determine their residual activity.

Materials and Methods:

This test was conducted in a commercial cotton field near Dimmitt, TX. FiberMax 9180BG2F was planted on 15 May on 40-inch rows, and irrigated using pivot sprinkler irrigation. The test was a RCB design with four replications. Plots were 2-rows wide × 60 ft in length. Foliar sprays were applied on a 50% band with a CO_2 pressurized hand-boom sprayer calibrated to deliver 10 gpa through Teejet XR8003VS extended range flat spray tip nozzles (2 per row) at 30 psi. The in-furrow insecticide was applied at planting with the seed using a granular-insecticide metering box at a depth of 1.5 inches. Insecticides were applied on 27 May, and 3 and 12 Jun. Insecticide application type and rates are presented in Table 1.

Adult and immature WFTs were sampled by visually inspecting 10 whole plants per plot. Samples were taken on 2, 9, 16 and 23 Jun. Plant damage was visually assessed on 11 and 17 Jun using a 1-5 damage rating scale where 1 = no damage and 5 = extensive damage. Plant height and leaf area was estimated on 17 Jun by collecting 5 plants per plot. Height was determined by measuring the distance from the cotyledons to the terminal. Leaf area was estimated using a leaf area indexer. Data were analyzed with ANOVA, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

Shortly after crop emergence on 27 May, 12 days after planting (DAP) and prior to any foliar applications, immature WTFs were very low but the presence of adults indicated initial colonization. At this time Temik and Avicta had the lowest number of WFTs, significantly lower than any other treatment (Table 2).

Although no foliar treatments had been applied, some slight differences in WFTs population was noted among treatments. At 2 days following the first foliar application (DAA1), all of the insecticide treatments had fewer immature and total WFT than the untreated. For adult WFTs, Sulfur did not differ from the untreated, and Temik had the fewest but did not differ from Avicta or any foliar treatment except Sulfur and HGW alone at 13.57 fl-oz. Temik also had the fewest immature WFTs, significantly fewer than Carbine and the Sulfur. None of the foliar treatments differed from one another for immature WFTs. By 21 DAP and 7 DAPP1, the WFTs population had increased to 7.63 per plant in the untreated, not differing from Sulfur. ProNatural Sulfur offered little or no protection from WFTs in this test, and may have made plants more attractive to WFTs relative to the untreated. At this time Avicta was averaging 1.93 immatures per plant, and although it did not differ from Temik which was averaging 0.08 immatures per plant, appeared to have lost residual efficacy. Temik had the fewest total WFTs, but did not differ from Orthene, or HGW86 at 20.67 or 27.14 fl-oz. At the 5 Jun evaluation, the overall WFTs population had declined dramatically due to recent precipitation, but by 11 Jun, the population had rebounded.

On 11 Jun (31 DAP; 8 DAA2), there were no differences among treatments for immature WFT (Table 3). At this time, Avicta had the greatest number of adult WFTs but did not differ from any of the HGW86 treatments, Dimethoate, Avicta or Temik. It appeared that Temik had lost its residual activity somewhere between 4 and 10 Jun (22-30 DAP). The reason Avicta contained more WFTs than the untreated and the Sulfur treatment is probably due to extensive damage in these two treatments resulting in plants that are unattractive to WFTs for further colonization. This is evident when comparing damage ratings; the untreated HGW at 10.18 fl-oz Carbine and Sulfur were all heavily damaged on 11 Jun. Temik had the least damage followed closely by Orthene and Avicta. On 15 Jun (35 DAP; 3 DAA3), immature WFTs were relatively low across all treatments but Sulfur had the greatest number but did not differ from Avicta (Table 4).

Despite heavy damage, Sulfur also had the most adult and total WFTs, but did not differ from Temik or Avicta. Since the Temik and Avicta treated cotton was protected from early WFTs colonization and had only light damage, it is conceivable that since the insecticide's residual control had diminished, that these plants might be more attractive to immigrating WFTs than plants with more damage. However, the Sulfur-treated plants were also highly damaged yet WFTs continued to be attracted to these plants. This may be due to the light yellow color of the spray or other factors. On 17 Jun (37 DAP; 5 DAA3) none of the treatments other than Orthene appeared to be offering acceptable control. Damage ratings on 17 Jun indicated that the untreated, HGW86 at 10.18 fl-oz, Carbine and Sulfur all suffered heavy damage. HGW86 at 13.57 (alone or with Dyne-Amic) and 20.67 fl-oz, and Dimethoate suffered moderate damage, while Temik, Orthene and to a slightly lesser extent, Avicta suffered the least damage. The untreated plots had the shortest plants although not significantly shorter than any of HGW86 treatments, Temik of Avicta. The untreated also suffered the most damage based on leaf area, but did not differ from Sulfur or HGW86 used alone at 13.57 fl-oz. Temik-treated plants had significantly greater leaf area than all the other treatments except Orthene; and Orthene had more leaf area than the remaining treatments except Dimethoate. Temik provided longer residual control than Avicta, but both should have received foliar applications after their residual control had declined; Avicta may have benefited from two foliar applications. Of the foliar sprays, Orthene was the superior product. Dimethoate performed slightly less, not offering as long of residual control as Orthene. HGW86 at the higher rates and Carbine offered some WFTs suppression, while Sulfur offered very little control. All insecticide handling properties were good and no phytotoxicity was detected.

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Table 1.

Treatment/formulation	Rate amt product/acre	Application type
Untreated	--	--
HGW86 10 OD (100GL) + Dyne-Amic	10.18 fl-oz + 0.5 pt	foliar
HGW86 10 OD (100GL) + Dyne-Amic	13.57 fl-oz + 0.5 pt	foliar
HGW86 10 OD (100GL) + Dyne-Amic	20.67 fl-oz + 0.5 pt	foliar
HGW86 10 OD (100GL) + Dyne-Amic	27.14 fl-oz + 0.5 pt	foliar
HGW86 10 OD (100GL)	13.57 fl-oz	foliar
Orthene 97	3.0 oz	
Carbine 50WG	2.3 oz	foliar
ProNatural Micronized Sulfur	4.2 lbs	foliar
Dimethoate 4E	0.5 pt	foliar
Temik 15G	3.5 lbs	in-furrow at planting
Avicta Complete Cotton	--[a]	seed at planting

[a]Avicta Complete Cotton is a mixture of Avicta 500FS at 0.15 mg(AI)/seed, Cruiser 5FS at 0.34 mg(AI)/seed, and Dynasty CST 125FS at 0.03 mg(AI)/seed.

Table 2.

Treatment/formulation	Rate amt product/acre[a]	WFT per plant: 27 May – cotyledon (12 DAP; pre-foliar) immatures	adults	total	29 May – cotyledon (14 DAP; 2 DAA1) immatures	adults	total	3 Jun – 1 true leaf (21 DAP; 7 DAA1) immatures	adults	total
Untreated	--	0.00 a	2.90 abc	2.90 ab	1.65 a	1.88 a	3.53 a	6.78 ab	0.85 a	7.63 ab
HGW86 + Dyne-Amic	10.18 fl-oz	0.00 a	3.05 ab	3.05 a	0.25 bcd	0.18 c	0.43 cde	5.43 ab	0.85 a	6.28 bc
HGW86 + Dyne-Amic	13.57 fl-oz	0.03 a	2.05 cd	2.08 bc	0.25 bcd	0.23 bc	0.48 cde	4.35 bc	0.78 a	5.13 cd
HGW86 + Dyne-Amic	20.67 fl-oz	0.00 a	2.35 abcd	2.35 abc	0.25 bcd	0.15 c	0.40 cde	1.53 bc	0.75 a	2.28 fgh
HGW86 + Dyne-Amic	27.14 fl-oz	0.00 a	1.69 d	1.68 c	0.28 bcd	0.17 c	0.40cde	1.77 ab	0.81 a	2.62 efgh
HGW86	13.57 fl-oz	0.05 a	1.65 d	1.70 c	0.35 bcd	0.65 b	1.00 cd	5.45 bc	0.68 a	6.13 bc
Orthene 97	3.0 oz	0.00 a	3.25 a	3.25 a	0.42 bcd	0.00 c	0.43 cde	0.44 abc	0.54 a	1.02 gh
Carbine 50WG	2.3 oz	0.03 a	2.28 bcd	2.30 abc	0.70 b	0.45 bc	1.15 c	4.28 bc	0.55 a	4.83 cde
ProNatural Sulfur	4.2 lbs	0.75 a	1.90 d	1.98 c	0.60 bc	1.55 a	2.15 b	8.65 a	0.78 a	9.43 a
Dimethoate 4E	0.5 pt	0.00 a	2.00 c	2.00 c	0.33 bcd	0.05 c	0.38 de	2.95 c	1.03 a	3.98 def
Temik 15G	3.5 lbs	0.00 a	0.00 c	0.00 d	0.03 d	0.03 c	0.05 e	0.08 bc	0.48 a	0.55 h
Avicta	--	0.03 a	0.33 c	0.35 d	0.13 cd	0.15 c	0.28 de	1.93 ab	0.98 a	2.90 efg

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).
[a]See Table 1 for full listing of treatment components and rates.

Table 3.

Treatment/formulation	Rate amt product/acre[a]	WFT per plant: 5 Jun – 2 true leaves (23 DAP; 2 DAA2) immatures	adults	total	11 Jun – 3 true leaves (31 DAP; 8 DAA2) immatures	adults	total	11 Jun Damage rating (1-5 scale)
Untreated	--	0.30 ab	0.25 abc	0.55 b	0.90 a	2.35 cde	3.25 bcd	5.00 a
HGW86 + Dyne-Amic	10.18 fl-oz	0.30 ab	0.20 abc	0.50 bc	0.88 a	3.50 abcd	4.38 abc	4.03 c
HGW86 + Dyne-Amic	13.57 fl-oz	0.15 bc	0.20 bc	0.33 bc	1.05 a	3.28 abcde	4.33 abc	3.50 d
HGW86 + Dyne-Amic	20.67 fl-oz	0.20 bc	0.18 abc	0.40 bc	0.88 a	3.73 abc	4.60 abc	3.25 e
HGW86 + Dyne-Amic	27.14 fl-oz	0.30 ab	0.20 c	0.38 bc	0.63 a	2.85 bcde	3.48 abcd	2.75 g
HGW86	13.57 fl-oz	0.25 bc	0.08 abc	0.45 bc	0.48 a	4.48 a	4.95 a	3.50 d
Orthene 97	3.0 oz	0.28 abc	0.20 c	0.35 bc	0.58 a	2.60 bcde	3.18 cd	2.25 h
Carbine 50WG	2.3 oz	0.13 bc	0.08 c	0.20 c	0.98 a	2.20 de	3.18 cd	4.00 c
ProNatural Sulfur	4.2 lbs	0.53 a	0.38 a	0.90 a	0.55 a	2.03 e	2.58 d	4.50 b
Dimethoate 4E	0.5 pt	0.03 c	0.20 abc	0.23 bc	1.08 a	3.73 abc	4.80 ab	3.00 f
Temik 15G	3.5 lbs	0.20 bc	0.33 ab	0.53 bc	0.53 a	3.63 abcd	4.15 abc	2.00 i
Avicta	--	0.38 ab	0.13 c	0.50 bc	1.05 a	3.98 ab	5.03 a	2.75 g

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).
[a]See Table 1 for full listing of treatment components and rates.

Table 4.

Treatment/formulation	Rate amt product/acre[a]	WFT per plant: 15 Jun – 4 true leaves (35 DAP; 3 DAA3) immatures	adults	total	WFT per plant: 17 Jun – 5 true leaves (37 DAP; 5 DAA3) immatures	adults	total	17 Jun: Damage rating (1-5 scale)	Plant height (cm)	Leaf area (cm^2)
Untreated	--	0.63 bc	2.65 bc	3.28 bc	3.85 ab	1.53 bc	5.38 cd	5.00 a	3.73 c	16.02 g
HGW86 + Dyne-Amic	10.18 fl-oz	0.55 c	3.08 b	3.63 b	2.05 cde	1.98 ab	4.03 cde	4.03 c	4.58 abc	21.19 ef
HGW86 + Dyne-Amic	13.57 fl-oz	0.38 cd	2.78 bc	3.15 bc	0.35 cde	1.13 cd	3.48 ef	3.50 d	4.68 abc	22.85 def
HGW86 + Dyne-Amic	20.67 fl-oz	0.38 cd	2.25 bcd	2.63 bc	1.18 cd	0.95 cd	2.13 fg	3.25 e	5.00 ab	22.62 def
HGW86 + Dyne-Amic	27.14 fl-oz	0.50 c	2.58 bc	3.08 bc	0.88 def	1.23 bcd	2.10 fg	2.75 g	4.47 abc	26.53 cde
HGW86	13.57 fl-oz	0.33 cd	2.30 bcd	2.63 bc	1.98 cde	1.40 d	3.38 ef	3.50 d	4.23 bc	20.88 eg
Orthene 97	3.0 oz	0.10 d	1.03 d	1.13 d	0.28 f	0.43 d	0.70 g	2.25 h	5.20 ab	35.79 ab
Carbine 50WG	2.3 oz	0.30 cd	1.68 cd	1.98 cd	1.33 def	0.90 cd	2.23 efg	4.00 c	5.45 a	27.42 cd
ProNatural Sulfur	4.2 lbs	1.18 a	5.85 a	7.03 a	4.93 a	2.75 a	7.68 a	4.50 b	4.77 ab	20.50 fg
Dimethoate 4E	0.5 pt	0.33 cd	2.70 bc	3.03 bc	2.13 cde	1.58 bc	3.70 def	3.00 f	5.43 a	31.63 bc
Temik 15G	3.5 lbs	0.40 cd	5.28 a	5.68 a	3.10 bc	2.45 a	5.55 bc	2.00 i	4.63 abc	37.09 a
Avicta	--	0.95 ab	5.70 a	6.65 a	4.75 a	2.58	7.33 ab	2.75 g	4.55 abc	29.42 c

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).
[a]See Table 1 for full listing of treatment components and rates.

AgriLIFE EXTENSION
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Evaluation of Preventive Insecticides for Control of Western Flower Thrips in Cotton, 2009

Cooperators: Rusty Whitt, Cotton Grower, Texas AgriLife Extension Service

David Kerns, Monti Vandiver, and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Bailey/Parmer Counties, and Extension Program Specialist-Cotton

Bailey County

Summary:

Most of the products evaluated in this test are new and at this time referred to as numbers rather than product names. Shortly after crop emergence on 1 Jun, 17 days after planting (DAP) western flower thrips (WTFs) were moderate in this test (averaging 2.53 per plant in the untreated), and exceeded the Texas action threshold of 1 thrips per plant on cotyledon stage cotton. At this time, all of the treatments contained fewer immature, adult and total WFTs than the untreated but did not differ among each other.
Following this evaluation, the WFTs population declined substantially and no differences were detected among treatments on 8 or 15 Jun. No differences were detected among treatments in plant stand, but there were differences in vigor, lint and seed yield, and percent turn out. The Temik-treated plots consistently had the most vigorous plants; significantly higher than any other treatment. Cruiser + XDE-175 at 0.15mg(AI) had the second highest vigor rating, but did not statistically differ from any treatment containing Cruiser, except Cruiser alone. All of the treatments exhibited higher vigor ratings than the untreated. Cruiser + XDE-175 at 0.13mg(AI) had the highest lint yield but did not differ from any other treatments containing Cruiser except Avicta CC, and Cruiser + SYN545377 at 0.20mg(AI). Treatments that did not differ from the untreated included Avicta CC, Cruiser + EXE211, STP15273 + STP17217 and Temik. It was surprising the Temik had the highest vigor rating yet produced intermediate yields relative to the other treatments. Cruiser + XDE-175 at 0.13mg(AI) also had had the highest seed yield but did not differ from any other treatments containing Cruiser except Avicta CC. The untreated produced the lowest seed yield, and did not differ from Avitca CC, Cruiser + EXE211, STP15273 + STP17217 or Temik. Cruiser + XDE-175 at 0.13mg(AI) also had had the highest turn out, but was statistically only higher than Temik. Treatments that had turn outs significantly greater than the untreated included Cruiser alone, Avicta CC, Cruiser + XDE-175 at 0.13mg(AI) and both Cruiser + SYN545377 treatments.

Objective:

To evaluate new seed treatments for efficacy towards thrips relative to Crusier, Avicta Complete Cotton and Temik.

Materials and Methods:

This test was conducted in a commercial cotton field near Muleshoe, TX. DeltaPine 0924B2R was planted on 15 May on 30-inch rows, and irrigated using pivot sprinkler irrigation. The test was a RCB design with four replications. Plots were 4-rows wide × 60 ft in length. The in-furrow insecticide was applied at planting with the seed using a granular-insecticide metering box at a depth of 1.5 inches. The remaining insecticides were applied as seed treatments. Insecticide application type and rates are presented in Table 1.

Adult and immature Western Flower Thrips (WFT) were sampled by visually inspecting 10 whole plants per plot. Samples were taken on 1, 8 and 15 Jun. Crop stand counts were taken on 5 Jun by counting the number of plants per 1/1000th acre in each plot. Vigor ratings were taken on 22 Jun by subjectively assigning a 1-100 value to each plot with 1 = dead plants and 100 = most vigorous plants within the replicate. All plots were hand harvested on 5 Nov using a HB stripper. An area of 1/1000th acre was harvest from the center two rows of each plot. Harvested samples were ginned at the Texas AgriLife Ginning Facility in Lubbock. Data were analyzed with GLM, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

Shortly after crop emergence on 1 Jun, 17 days after planting (DAP) WTFs were moderate in this test (averaging 2.53 per plant in the untreated), and exceeded the Texas action threshold of 1 thrips per plant on cotyledon stage cotton. At this time, all of the treatments contained fewer immature, adult and total WFTs than the untreated but did not differ among each other (Table 2).

Following this evaluation the WFTs population declined substantially and no differences were detected among treatments on 8 or 15 Jun. No differences were detected among treatments in plant stand, but there were differences in vigor, lint and seed yield, and percent turn out (Table 3). The Temik-treated plots consistently had the most vigorous plants and rated 100; significantly higher than any other treatment. Cruiser + XDE-175 at 0.15mg(AI) had the second highest vigor rating, but did not statistically differ from any treatment containing Cruiser, except Cruiser alone. All of the treatments exhibited higher vigor ratings than the untreated. Cruiser + XDE-175 at 0.13mg(AI) had the highest lint yield but did not differ from any other treatments containing Cruiser except Avicta CC, and Cruiser + SYN545377 at 0.20mg(AI). Treatments that did not differ from the untreated included Avicta CC, Cruiser + EXE211, STP15273 + STP17217 and Temik. It was surprising the Temik had the highest vigor rating yet produced intermediate yields relative to the other treatments. Cruiser + XDE-175 at 0.13mg(AI) also had had the highest seed yield but did not differ from any other treatments containing Cruiser except Avicta CC. The untreated produced the lowest seed yield, and did not differ from Avitca CC, Cruiser + EXE211, STP15273 + STP17217 or Temik. Cruiser + XDE-175 at 0.13mg(AI) also had had the highest turn out, but was statistically only higher than Temik. Treatments that had turn outs significantly greater than the untreated included Cruiser alone, Avicta CC, Cruiser + XDE-175 at 0.13mg(AI) and both Cruiser + SYN545377 treatments. No phytotoxicity was detected in this study.

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Table 1.

	Treatment/formulation[a]	Rate mg(AI)/seed	Application type
1.	Untreated	--	--
2.	Cruiser 5FS	0.34	seed
3.	Avicta Complete Cotton[b]	--[b]	seed
4.	Cruiser 5FS + EXC211 480EC	0.34 + 0.10	seed
5.	Cruiser 5FS + XDE-175	0.34 + 0.13	seed
6.	Cruiser 5FS + XDE-175	0.34 + 0.15	seed
7.	STP15273 + STP17217	0.375 + 0.375	seed
8.	Cruiser 5FS + SYN545377	0.34 + 0.20	seed
9.	Cruiser 5FS + SYN545377	0.34 + 0.40	seed
10.	Temik 15G	5.0 lbs-product/acre	in-furrow

[a]The following known fungicides were included: all treatments included Apron XL 3LS at 12g(AI)/kg-seed, Maxim 4FS at 2.5g/kg-seed and Systhane 40WP at 21g(AI)/kg-seed; all treatments but no. 7 included Dyanasty CST 125FS at 0.03mg(AI)/seed; treatment no. 7 included Trilex Flowable 220FS at 10g(AI)/kg-seed, Baytan 30 at 5g(AI)/kg-seed and Allegiance LS at 15g(AI)/kg-seed.
[b]Avicta Complete Cotton is a mixture of Avicta 500FS at 0.15 mg(AI)/seed, Cruiser 5FS at 0.34 mg(AI)/seed, and Dynasty CST 125FS at 0.03 mg(AI)/seed.

Table 2.

Treatment/formulation[a]	Rate mg(AI)/seed	WFT per plant: 1 Jun – cotyledon (17 DAP) immatures	adults	total	8 Jun – 2 true leaves (24 DAP) immatures	adults	total	15 Jun – 4 true leaves (31 DAP) immatures	adults	total
Untreated	--	1.35 a	1.18 a	2.53 a	0.25 a	0.13 a	0.38 a	0.08 a	0.58 a	0.65 a
Cruiser 5FS	0.34	0.13 b	0.33 b	0.45 b	0.13 a	0.33 a	0.45 a	0.25 a	0.75 a	1.00 a
Avicta Complete Cotton	--[a]	0.10 b	0.18 b	0.28 b	0.23 a	0.48 a	0.70 a	0.08 a	1.03 a	1.10 a
Cruiser 5FS + EXC211 480EC	0.34 + 0.10	0.10 b	0.35 b	0.45 b	0.08 a	0.23 a	0.30 a	0.13 a	0.93 a	1.05 a
Cruiser 5FS + XDE-175	0.34 + 0.13	0.08 b	0.40 b	0.48 b	0.13 a	0.35 a	0.48 a	0.05 a	0.98 a	1.03 a
Cruiser 5FS + XDE-175	0.34 + 0.15	0.05 b	0.25 b	0.30 b	0.23 a	0.40 a	0.63 a	0.05 a	0.58 a	0.63 a
STP15273 + STP17217	0.375 + 0.375	0.05 b	0.30 b	0.35 b	0.13 a	0.28 a	0.40 a	0.05 a	0.65 a	0.70 a
Cruiser 5FS + SYN545377	0.34 + 0.20	0.00 b	0.10 b	0.10 b	0.10 a	0.25 a	0.35 a	0.13 a	0.70 a	0.83 a
Cruiser 5FS + SYN545377	0.34 + 0.40	0.00 b	0.15 b	0.15 b	0.23 a	0.35 a	0.58 a	0.03 a	0.65 a	0.68 a
Temik 15G	5.0 lbs-product/acre	0.03 b	0.18 b	0.20 b	0.18 a	0.18 a	0.35 a	0.03 a	0.83 a	0.85 a

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).
[a]See Table 1 for full listing of treatment components and rates.

Table 3.

Treatment/formulation[a]	Rate mg(AI)/seed	5 Jun stand (plant/acre)	22 Jun vigor rating (1-100 scale)	5 Nov yield (lbs-lint/acre)	5 Nov seed (lbs/acre)	5 Nov % turn out
Untreated	--	58906 a	60.00 f	1228.39 d	1912.95 d	22.00 c
Cruiser 5FS	0.34	61625 a	75.00 de	1636.72 ab	2607.06 ab	25.00 ab
Avicta Complete Cotton	--[a]	58725 a	83.75 bc	1413.58 bcd	2263.84 bcd	25.00 ab
Cruiser 5FS + EXC211 480EC	0.34 + 0.10	57638 a	81.25 bcd	1319.35 cd	2068.40 cd	23.50 abc
Cruiser 5FS + XDE-175	0.34 + 0.13	62531 a	81.25 bcd	1648.31 a	2663.98 a	25.50 a
Cruiser 5FS + XDE-175	0.34 + 0.15	61988 a	87.50 b	1458.80 abc	2298.91 abcd	23.75 abc
STP15273 + STP17217	0.375 + 0.375	61806 a	73.75 e	1323.07 cd	2083.98 cd	23.67 abc
Cruiser 5FS + SYN545377	0.34 + 0.20	59994 a	78.75 cde	1484.22 abc	2354.92 abc	24.33 ab
Cruiser 5FS + SYN545377	0.34 + 0.40	60719 a	83.75 bc	1500.62 abc	2398.19 abc	25.33 a
Temik 15G	5.0 lbs-product/acre	60538 a	100.00 a	1416.05 bcd	2221.15 bcd	23.25 bc

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).

[a]See Table 1 for full listing of treatment components and rates.

AgriLIFE EXTENSION
Texas A&M System

Developing an Action Threshold for Thrips in the Texas High Plains-2009

Cooperators: Tyler Black, Tim Black, Chuck Rowland, Bruce Turnipseed, Justin Crownover - Cotton Growers / Stephen Cox – Private Consultant / Texas AgriLife Extension Service

David Kerns, Megha Parajulee, Ed Bynum, Monti Vandiver, Manda Cattaneo, Kerry Siders and Dustin Patman
Extension Entomologist-Cotton, Research Entomologist-Cotton, Extension Entomologist, EA-IPM Bailey/Parmer Counties, EA-IPM Gaines County, EA-IPM Hockley/Cochran Counties, EA-IPM Crosby County

South Plains & High Plains

Summary:

In the Texas High Plains and most of the cotton growing areas of the United States thrips are a dominating pest during the pre-squaring stage of cotton. The most dominate thrips species affecting irrigated cotton fields on the Texas High Plains is the western flower thrips, *Frankliniella occidentalis* (Pergande). This was the third year conducting this study. The purpose of this study was to determine at what population density western flower thrips should be subjected to control tactics to prevent yield reduction and significant delayed maturity, to compare two action thresholds for thrips, and to determine whether there is a relationship thrips induced yield reduction and temperature. This study was conducted in irrigated cotton across the Texas High Plains. Based on limited data; it appears that when the daily maximum temperature is at or below 83° F for a 4-5 day period, the current action threshold of 1 thrips/true leaf appears to be too high and that a better threshold should probably be about 0.5 thrips/true leaf. When the daily maximum temperature is > 83° F, the current action threshold of 1 thrips/leaf appears to be acceptable or possibly too high when temperatures exceed 90° F.

Objective:

To determine at what population density western flower thrips should be subjected to control tactics to prevent yield reduction and significant delayed maturity, to compare two action thresholds for thrips, and to determine whether there is a relationship thrips induced yield reduction and temperature.

Materials and Methods:

This study was conducted in irrigated cotton in Bailey County in 2007, in Bailey, Crosby, Gaines, Hale, Hockley and Lubbock counties in 2008, and in Gaines, Lubbock and Hale counties in 2009. In 2007-08, plots at all locations were 2-rows wide × 100-ft long, while in 2009 all plots were 4-rows wide × 100-ft. Plots were arranged in a RCB design with 4 replicates. The foliar treatment regimes are outlined in (Table 1). These treatments were simply a means of manipulating the thrips populations at different times in an attempt to focus on when thrips feeding is most damaging.

All foliar sprays consisted of Orthene 97 (acephate) applied at 3 oz-product/acre with a CO_2 pressurized hand boom calibrated to deliver 10 gallons/acre. Thrips were counted weekly by counting the number of larvae and adult thrips from 10 plants per plot. Whole plants were removed and inspected in the field. Each plot was harvested in entirety in 2007, using a stripper with a burr extractor, and a 1/1000th acre portion was harvested from each plot using an HB hand stripper from tests in 2008-09. Data were analyzed using linear regression models and PROC MIXED with means separated using an F protected LSD ($P \leq 0.05$) (SAS Institute 2003).

Results and Discussion:

In 2007, we only had one test site. At this location the thrips numbers were relatively low throughout the test period (Figure 1A). The thrips did not exceed the action threshold in the untreated plots until week 3. All of the treatment regimes that were sprayed during week 1 yielded significantly more lint than the untreated (Figure 1B), although the thrips populations were below 0.5 thrips/plant during this period (Figure 1A). Although both of the threshold treatment regimes were sprayed at the same time, and did not differ from each other, the threshold regime that did not depend on the occurrence of thrips larvae yielded significantly more than the untreated. The treatment regime sprayed on weeks 2 and 3 failed to produce significantly more lint than the untreated.

There was a significant correlation between yield and thrips density at week 2 or 1 true leaf stage (Figure 2A) and week 3 or 2 true leaf stage (Figure 2B). Week 3 exhibited the closest correlation with an R^2=0.97 probably because it represents cumulative damage over the entire time period. On both graphs yield reduction appeared to level off at approximately 1 thrips per plant. At the 1 true leaf stage, the decline in yield appeared to lessen at approximately 0.5 thrips/plant (Figure 2A) while at the 2 true leaf stage yield reduction appeared to lessen at about 1 thrips per plant (Figure 2B). Regardless of growth stage, 0.5 thrips/true leaf appears to be the most suitable threshold in this test, which is 50% of the current recommended threshold.

For the 2008 tests, the data for thrips densities and yields were pooled across locations for presentation. Additionally, yields were normalized across locations to account for variation due to other factors. Overall thrips densities were higher in 2008 than in 2007, particularly during the first 2 weeks of development (Figure 3A). There were significant differences in the thrips populations among treatments during weeks 2 and 3. Invariably, plots receiving an insecticide application the previous week tended to have lower thrips numbers than those that were not treated. Despite higher thrips numbers, unlike 2007 there were no significant differences in yield across tests when pooled, or by test that could be attributed to thrips damage despite obvious injury due to thrips at several locations (Figure 3B). Similarly, regression analyses of the 2008 data could not detect any significant relationships between thrips density and yield.

The lack of impact of thrips on yield in 2008, despite higher thrips densities during the first few weeks of plant development (critical time period based on 2007), appears to be related to temperature and subsequent rapidity of plant growth (Table 2). Although sites such as Hale County in 2008 had temperatures similar to those experienced at week 1 in Bailey County in 2007, cool temperatures were short lived and subsequent temperatures were much warmer.

In 2009, thrips density at our test sites were lower than desired with the highest numbers being encountered at the Hale County site where thrips density approached 1.5, 1.75 and 0.4 thrips/plant during weeks 1, 2, and 3 respectively (Figure 4A). Additionally temperatures at Hale County were initially cool with lows and highs of 56 and 74 °F, but warmed considerably within a few days (Table 2). Although yield differences could not be detected among the various treatments, significant correlations for thrips density and yield were observed. The best correlation occurred at week 2 (Figure 4B). Based on this correlation, the highest yields were observed when thrips averaged approximately 1.5/plant. At week 2 the cotton was at the 2 true leaf stage and the recommended threshold at this time is 2 thrips/plant. Thus it appears that the recommended thrips threshold may be slightly too high under these circumstances.

When looking at thrips densities pooled across locations in 2009, the overall thrips density was lower than in 2008 (Figure 5A). These values were especially suppressed by data from the Gaines County site which had very low thrips numbers. Similar to 2008, we could not detect any differences in yield within sites or across sites, however, unlike 2008 significant correlations between pooled thrips density and pooled normalized yields were observed. When thrips density for week 3 and yield for 2009 are regressed, a highly significant correlation is observed (Figure 5B). This suggests that thrips populations at any one period in time during 2009 were too low to impact yield, but since week 3 represents an accumulation of damage over a 3 week period, a trend towards yield loss did occur. In this model, yield declines until thrips reach 0.5 to 1.0 thrips/plant. Due to the cumulative damage effect, it is difficult to identify a specific action threshold based on this data, but it appears that thrips populations should be maintained at least below 1 thrips/plant.

Acknowledgments:

Appreciation is expressed to Cotton Incorporated, Texas State Support, and Plains Cotton Growers, Inc. for financial support of this project.

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Table 1. Foliar treatment regime timings.			
	2007	2008	2009
1) Untreated check	X	X	X
2) Automatic treatment on week 1	X	X	X
3) Automatic treatment on weeks 1 and 2 (only week 2 in 2008)	X		X
4) Automatic treatment on weeks 1, 2 and 3	X	X	X
5) Automatic treatment on week 2		X	X
5) Automatic treatment on weeks 2 and 3	X	X	X
6) Treatment based on the Texas AgriLife Extension Threshold[a]	X	X	X
7) Treatment based on the above threshold with 30% larvae	X	X	
[a]One thrips per plant from plant emergence through the first true leaf stage, and one thrips per true leaf thereafter until the cotton has 4 to 5 true leaves			

Table 2. Test sites plant growth and climatic conditions.				
	Week 1	**Week 2**	**Week 3**	**Week 4**
	Growth stage	**Growth stage**	**Growth stage**	**Growth stage**
County	**Avg Temp ^oF (min-max)**	**Avg Temp ^oF (min-max)**	**Avg Temp ^oF (min-max)**	**Avg Temp ^oF (min-max)**
2007				
Bailey	Cotyledon	1 true leaf	2 true leaves	4 true leaves
	52-79	54-82	57-82	56-86
2008				
Bailey	Cotyledon	2 true leaves	4 true leaves	6 true leaves
	68-100	61-93	62-97	62-90
Crosby	Cotyledon	2 true leaves	5 true leaves	--
	68-102	66-95	67-98	--
Gaines	Cotyledon	1 true leaf	2 true leaves	5 true leaves
	59-95	63-91	68-102	65-95
Hale	Cotyledon	1 true leaf	3 true leaves	5 true leaves
	56-74	58-93	57-93	60-94
Hockley	Cotyledon	2 true leaves	4 true leaves	6 true leaves
	67-103	64-95	67-100	63-90
Lubbock	Cotyledon	2 true leaves	4 true leaves	5 true leaves
	61-91	68-96	65-95	70-99
2009				
Gaines	Cotyledon	2 true leaves	4 true leaves	6 true leaves
	56-81	59-87	65-93	--
Hale	Cotyledon	2 true leaves	4 true leaves	5 true leaves
	56-74	58-88	61-93	--
Lubbock	Cotyledon	2 true leaves	4 true leaves	5 true leaves
	58-82	58-82	58-88	64-92

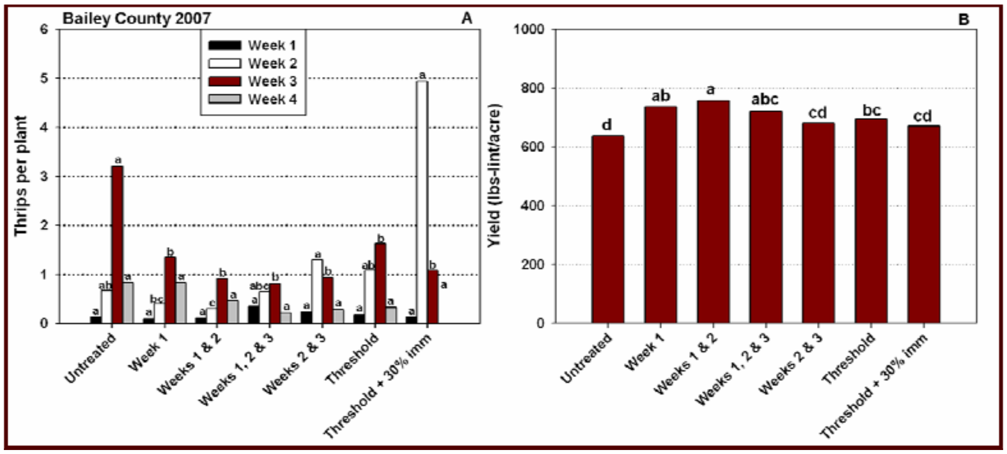

Figure 1. (A) Number of thrips per plant at various treatment regimes. (B) Yield of cotton exposed to various treatment regimes for thrips. Same colored bars capped with the same letter are not significantly different based on LSMEANS and a *F* protected (LSD, *P* < 0.05).

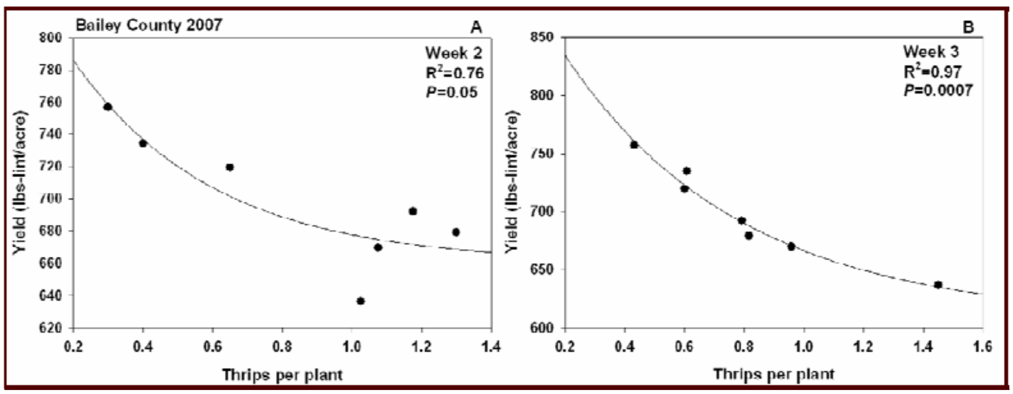

Figure 2. Linear relationship between thrips per plant and yield

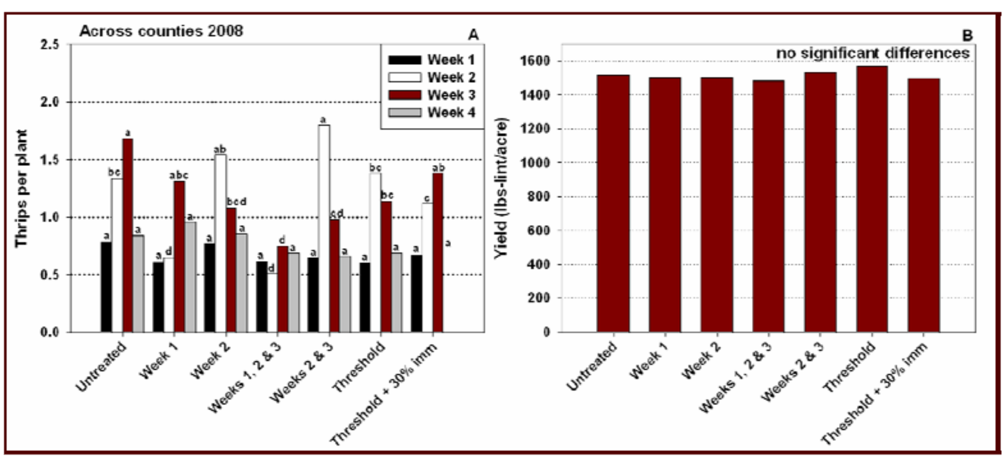

Figure 3. (A) Number of thrips per plant at various treatment regimes. (B) Yield of cotton exposed to various treatment regimes for thrips. Same colored bars capped with the same letter are not significantly different based on LSMEANS and a *F* protected (LSD, *P* < 0.05).

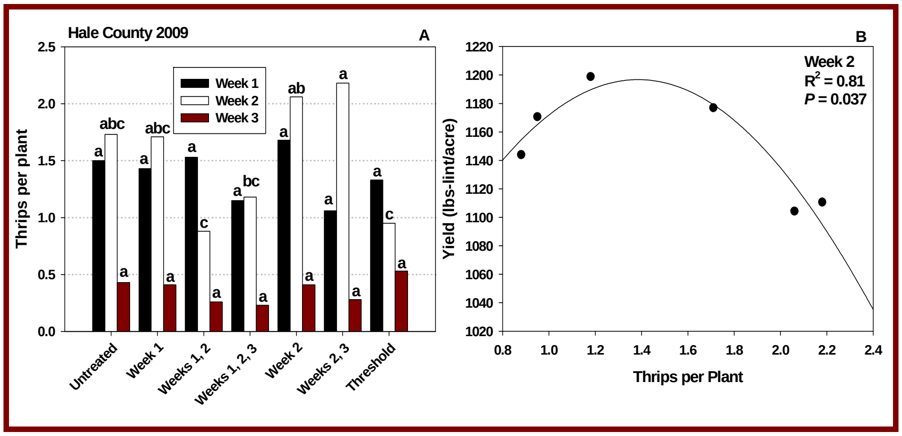

Figure 4. (A) Number of thrips per plant at various treatment regimes; same colored bars capped with the same letter are not significantly different based on LSMEANS and a *F* protected (LSD, *P* < 0.05). (B) Linear relationship between thrips per plant and yield.

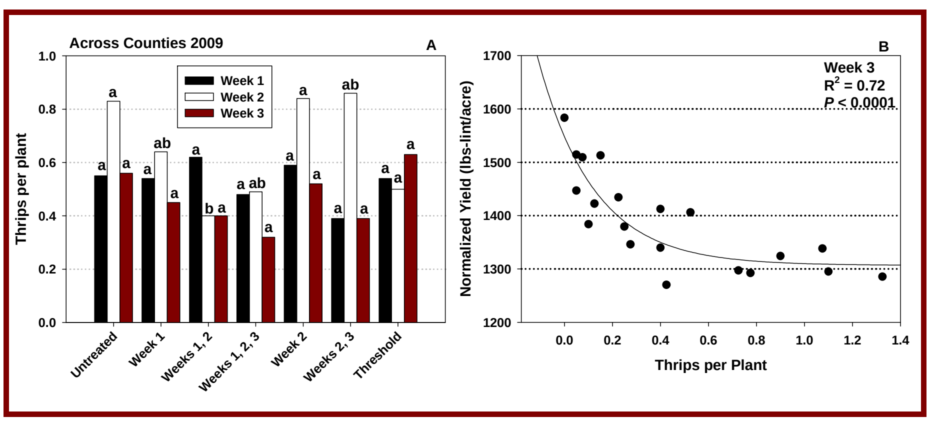

Figure 5. (A) Number of thrips per plant at various treatment regimes; same colored bars capped with the same letter are not significantly different based on LSMEANS and a *F* protected (LSD, *P* < 0.05). (B) Linear relationship between thrips per plant and yield.

Development of a Binomial Sampling Plan to Estimate Thrips Populations in Cotton to Aid in IPM Decision Making

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South Plains, High Plains and Permian Basin

Summary:

Thrips are problematic throughout much of the U.S. cotton belt and can negatively impact early-season cotton if curative action is not taken. In this study we compare two different methods (visual and cup) for sampling thrips on seedling cotton, and using these sampling methods we began the process of developing a binomial sampling plan. This study was conducted in a variety of locations across the Texas High Plains and far west Texas in commercial cotton fields. The sample data collected from both methods of sampling were used to determine how many cotton leaves were infested to mean thrips density relationship needed to develop the binomial sample plan using the following formula ($P(I)=1-e^{-m[LN(amb-1)/(amb-1-1)]}$). Taylor's power law effectively modeled the thrips sample data from both sample methods. Taylor's coefficients suggest that thrips nymphs tend to be more clumped than adult thrips, but neither appear to be highly clumped. This may be an artifact of small sample unit size. The relationship between the P(I) cotton leaves and thrips mean density was also modeled well by using the method of Wilson and Room (1983). The relationship was similar for both sample methods and thrips age classes, thus both sample methods should perform equally well. However, additional data is needed to determine the relative cost reliability of each sample method and develop sample plans. This will be completed in 2010.

Objective:

To determine how many cotton leaves were infested to mean thrips density relationship needed to develop the binomial sample plan using the following formula ($P(I)=1-e^{-m[LN(amb-1)/(amb-1-1)]}$) and determine which of the two sampling methods (visual or cup) was more effective.

Materials and Methods:

This study took place in a number of commercial cotton fields located across far west Texas and the Texas High Plains. Western flower thrips were sampled in each cotton field in an area at least 60 rows x 200 ft that was left untreated by foliar and/or preventative treatments for thrips.

Thrips at each location were counted from individual plants on a weekly basis from crop emergence to the 5 true leaf stage. Fifty sampling bouts per field were conducted for each sampling method. Each sampling bout consisted of three plants from the same location within the field.

The two sampling methods evaluated were conducted using two destructive sample methods (Figure 1); a visual and a 16oz plastic cup sampling method. Individual plants were removed from the soil by gently grasping the cotton stem at the soil line and pulling straight up. Then the cotton plant was either subjected to visual or the cup sample method. Visual inspection was accomplished using a sharpened pencil to pry apart folded or creased leaf tissue to expose hidden thrips then adults and nymphs were counted and recorded. The cup method was employed by inserting the cotton plant into the cup and shaken vigorously for several seconds to dislodge any thrips on the plant into the cup. Adult and nymph thrips dislodged into the cup were counted and recorded, then discarded.

Sample data from both methods was used to determine the proportion cotton leaves infested to mean thrips density relationship (Wilson and Room 1983) needed for development of the binomial sampling plan. With enough data, a binomial sequential sampling plan will be developed following procedures developed by Wilson and Room (1983a,b). The relationship of the mean and proportion of thrips infested cotton leaves will be determined by:

$$P(I)=1-e^{-m[LN(amb-1)/(amb-1-1)]}$$

where P(I)=the proportion of thrips infested leaves, a and b are parameters from Taylor's power law (1961), and m=the mean density at which a management decision is needed.

The variance component k of the negative binomial distribution will be determined:

$$k = m/(am^{(b-1)}-1)$$

where a and b are parameters from Taylor's power law (1961) and m is the threshold.

The threshold used in this study is 1 thrips per true leaf and is a nominal threshold as an economic threshold has yet to be established for western flower thrips in cotton.

Results and Discussion:

Taylor's power law effectively modeled the mean/variance relationship for total thrips for both sample methods, thrips age classes and pooled across age classes (Table 1). Interestingly, Taylor's a-coefficient was less than 1 regardless of age class or sample method. Wilson (1994) regards Taylor's values that are less than 1, as artifacts of curve fitting or random sample variability, which is likely the reason here. Regressing the observed P(I) cotton leaves on the estimated P(I) cotton leaves illustrate how well the method of Wilson and Room (1983a,b) modeled the relationship between mean adult and nymph thrips density and proportion thrips infested cotton leaves (Figure 1 A & B). This was true for both sampling methods, although the cup sample method appeared to provide a better fit than the visual sample method as evidenced by the greater variability explained by the model for the cup sample method relative to the visual sample method. This may have occurred because of the potential for greater sampler error associated with the visual method.

The effect of age class on thrips aggregation was evident for both sample methods. Immature thrips tend to hide in the terminals of the cotton plant and are less mobile than winged adults, thus it was not unexpected to find that nymphs, regardless of sample method, exhibited a more aggregated distribution than adults (Figure 2 A & B). Wilson and Room (1983a) reported similar findings for *Heliothis* spp. age classes. The estimated P(I) for the nominal ET of 1 thrips per leaf derived using the binomial model of Wilson and Room (1983a, b) for the cup and visual sample methods was 0.77 and 0.74 respectively. These values were determined from the pooled thrips data, although using adult thrips would provide similar results.

These preliminary results indicated that further analysis is needed to determine if pooling across thrips age classes should be used to determine the upper decision line for the SPRTs developed.

Acknowledgments:

Appreciation is expressed to Cotton Incorporated CORE Projects and in part by Plains Cotton Growers, Inc.

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Table 1. a and b of Taylor's power law and coefficient of determination.			
Thrips age classes and Pooled age classes	a	b	R^2
Cup Sample Method			
Adult	0.6035	1.366	0.958
Nymph	0.7349	1.290	0.928
Pooled	0.6231	1.379	0.937
Visual Sample Method			
Adult	0.6873	1.397	0.963
Nymph	0.9436	1.3840	0.912
Pooled	0.7711	1.490	0.950

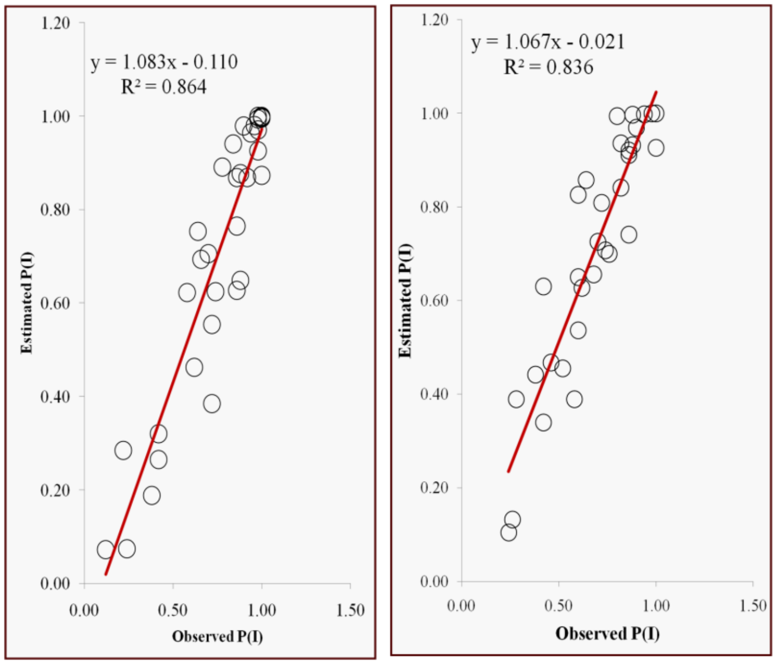

Figure 1. A) Cup sample method total thrips: relationship between observed and estimated P(I) cotton leaves; B) Visual sample method total thrips: relationship between observed and estimated P(I) cotton leaves.

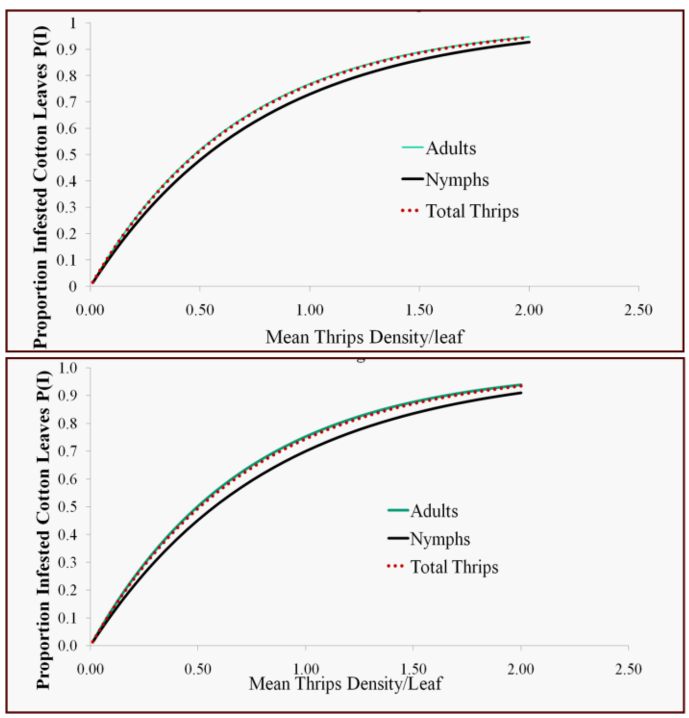

Figure 2. A) Cup sample and B) Visual sample methods: proportion of infested cotton leaves as a function of density for different thrips age classes and pooled across age classes.

AgriLIFE EXTENSION
Texas A&M System

Impact and Benefit of Foliar Insecticides Applied Over Preventative Insecticides for Thrips Control – Dimmitt,TX 2009

Cooperators: Richard Boozer, Cotton Grower / Texas AgriLife Extension Service

David Kerns, Emilio Nino and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Castor/Lamb Counties and Extension Program Specialist-Cotton

Castro County

Summary:

Thrips are a significant economic pest of cotton during the pre-squaring stage of growth and development in most of the cotton growing areas of the United States. On the Texas High Plains it is not uncommon for Orthene to be included in early-season Roundup application for thrips control regardless if a preventative seed treatment or Temik had been used. However, the benefit of these applications is not known and in some parts of the cotton belt, may actually be detrimental because of secondary pest outbreaks. In this test the thrips populations was 78% western flower thrips and 22% onion thrips. Temik provided 30 to 35 days of control and did not appear to benefit from foliar applications of Orthene at the 1-2 true leaves (TL), 3-4 TL or 1-2 and 3-4 TL stages. Aeris appeared to last 18 to 21 days, and benefited from Orthene applications at the 3-4 TL. It does appear that Orthene applications, with or without Roundup, have some benefit when applied over preventative treatments; but only once the efficacy of those preventative treatments have diminished and thrips are present. Preventative and foliar applied Orthene did prevent damage and prevented delayed maturity based on mike. Thus, close scouting for thrips, even though the cotton has been treated preventatively, is recommended to determine if a foliar application is advisable. Automatic foliar applications following preventative treatments is not recommended and represents an unnecessary expense and may flare secondary pests.

Objectives:

The objective of this study was to determine if foliar applications of Orthene following preventative applications of Temik and Aeris resulted in better thrips control, less damage, and increased yield.

Materials and Methods:

This study represents 1 of 20 similar research sites located throughout the U.S. Cotton Belt including Texas, Louisiana, Arkansas, Missouri, Tennessee, Mississippi, Georgia, South Carolina, North Carolina and Virginia. This test was conducted in irrigated cotton near Dimmitt, TX in 2009. The cotton, FiberMax 9058F, was planted on 11 May on 40-inch rows. The test was irrigated as needed using furrow-run irrigation.

The experimental design was a 3 x 4 factorial with 4 replicates. Plots were 4 rows wide × 100 ft in length. The main factors were the preventative treatments which included: 1) Untreated, 2) Aeris and 3) Temik at 5 lbs-product/acre. Aeris is a seed treatment, while Temik was applied in-furrow at planting at approximately 1.5-inches in depth. The Temik applicator boxes were calibrated prior to planting.

The secondary factors were applications of foliarly applied Orthene 97 at 3.0 oz-product/acre at: 1) Untreated, 2) 1-2 true leaves (TL) stage, 3) 3-4 TL stage and 4) 1-2 and 3-4 TL stages. All foliar sprays consisted of Orthene 97 applied at 3 oz-product/acre with a CO_2 pressurized hand boom calibrated to deliver 10 gallons/acre on a 50% band.

Beginning at the 1 TL stage, 5 plants per plot were collected into 1-pt jars containing 50% isopropyl alcohol. These jars were sealed and transported to the laboratory where the solution was filtered using 4-inch filter paper in a Buchner funnel fastened onto a 1-liter Erlenmeyer flask attached to a vacuum pump. Each plant was carefully rinsed onto the filter paper with 50% isopropyl alcohol. After filtration, adult and immature thrips were counted with a stereomicroscope. Adult thrips from all plots that did not receive an application of Orthene were collected for species identification by Dr. Jack Reed, Mississippi State University. In addition to collecting plants, damage was assessed by subjectively rating each plot on a 1 to 5 scale where 1 = no damage, and 5 = damaged equivalent to the untreated plot (did not receive a preventative or foliar application) in each replicate. Plant height was also assessed in each plot by measuring 5 plants from the soil surface to the terminal tip. Evaluations were made on 1, 8 and 17 June.

A 1/1000th acre portion was harvested from each plot using an HB hand stripper on 6 November. The entire samples were ginned at the Texas AgriLife Research and Extension Center at Lubbock to determine yield and gin turnouts. Lint samples were submitted to the Fiber and Biopolymer Research Institute at Texas Tech University for HVI analysis, and USDA Commodity Credit Corporation (CCC) Loan values were determined for each plot.

Data were analyzed using PROC GLM with means separated using an F protected LSD ($P \leq 0.05$).

Results and Discussion:

The thrips collected in the study were identified as 78% western flower thrips, *Frankliniella occidentalis*, and 30% onion thrips, *Thrips tabaci*. The presences of significant onion thrips may be due to past production of onion in the area. Thrips collected during the 1 June evaluation were lost due to a processing error, but thrips were recovered from the 8 and 17 June collections (Table 1). At no time did we detect a significant interaction between preventative treatments and the foliar timings for thrips counts. Thus, based on thrips numbers, it initially appears that the foliar Orthene applications did not play a beneficial role over the Aeris or Temik alone. However, when looking just at the foliar treatments, at no time did we detect any significant impact of

Orthene on the thrips populations relative to the untreated. This suggests that either Orthene did not work, or that it had lost activity by the time we made our evaluations and thrips had already re-infested the plots. The latter is the most likely explanation since stat were collected at 7 or 9 days after treatment.. Therefore, in this case we do not think that the thrips evaluations were necessarily a good indicator of the benefit, or lack thereof, of the foliar applications.

Although we could not detect any activity from the foliar applications, there were significant impacts on the thrips population by the preventative treatments. On 8 June, Temik had significantly fewer adult, immature and total thrips than the untreated, whereas Aeris never differed from the untreated. Additionally, Aeris did not differ from Temik in immature thrips. This evaluation was taken 28 days after planting (DAP), which is typically 7 to 12 days beyond the point where Aeris loses its activity.

On 17 June, the thrips population was more than 3× greater than it was on 8 June, but the results were very similar to 8 June. None of the treatments differed for immature thrips, which suggests that colonization was taking place across all preventative treatments. However, Temik contained fewer adults and total thrips than the untreated, but did not differ from Aeris. Aeris did not differ from the untreated. The reason Temik did not differ from Aeris suggests that it was losing its efficacy, as is evident by the number of thrips collected from the Temik plots. At 37 DAP, Temik at 5 lbs/acre has typically lost most of its activity. However, since Temik differed from the untreated, it was evident that, although not as effective as desired, Temik was still providing some control.

On 1 June, prior to any foliar treatments, Temik and Aeris had significantly less damage than the untreated, and Temik had less damage than Aeris (Table 2). This is probably just a few days after Aeris was losing efficacy. There was no significant impact on height at this time. At 28 DAP, the same trend was detected, and both Aeris and Temik had taller plants than the untreated. Additionally, those plots that received Orthene tended to have less damage than those that had not (untreated and 3-4 TL timing). A significant interaction between damage in the preventative and foliar treatments was detected on 8 June. This interaction appears to be due to a reduction in damage in the untreated preventative plots where Orthene was applied, but no effect in the Aeris and Temik plots (Figure 1). Thus, at 28 DAP, and 7 days after the Orthene application, neither Aeris nor Temik benefited from the 1-2 TL timing foliar sprays.

On 17 June, damage among the preventative and foliar timings were similar to 8 June. By this time the untreated had significantly more damage than Temik or Aeris, and more than any of the foliar timings. Temik exhibited no damage, and was significantly lower than Aeris. Plots that received both the 1-2 TL and the 3-4 TL foliar applications had significantly less damage than those that one or the other. In addition to less damage, Temik and Aeris both had taller plants than the untreated. A significant interaction between preventative and foliar treatments was observed for damage on 17 June. Based on damage, Temik did not appear to benefit from the foliar applications, while the untreated saw slight benefit when applied at either 1-2 TL or 3-4 TL, and moderate benefit when applied at both timings (Figure 2). Aeris appeared to slightly benefit from applications targeting the 3-4 TL stage. These data suggest that Aeris benefited from Orthene applications at 28 DAP, but Temik did not.

The only yield difference detected was for Temik, which yielded more than either Aeris or the untreated (Table 3). Although we could not detect a difference among treatments in maturity based on NAWF, differences were evident based on micronaire. Both Aeris and Temik had significantly higher mikes than the untreated; suggesting that the untreated suffered delayed maturity. Among the foliar timings, plots receiving applications at both the 1-2 TL and 3-4 TL stages and the 3-4 TL stage, were the only ones with significantly higher mike than the untreated. Those receiving the 1-2 TL stage application did not differ from any of the other treatments, including the untreated. This suggests that the foliar treatments were beneficial in preventing damage and delayed maturity. No other significant differences were detected for any other lint quality parameters or loan values. However, a significant interaction was detected for % elongation between preventative and foliar treatments. This interaction appears to be related to benefit of the 3-4 TL and 1-2 & 3-4 TL applications to Temik relative to the untreated and Aeris.

Acknowledgments:

Appreciation is expressed to the National Cotton Council, Bayer CropScience, and the Plains Cotton Growers for partial funding of this project, and to the Texas Department of Agriculture - Food and Fiber Research for funding of HVI testing at the Texas Tech University - Fiber and Biopolymer Research Institute.

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Table 1. Mean number of thrips per 5 plants, Dimmitt, TX 2009[a]

Treatment[c]	8 Jun 2 true leaves (28 DAP & 7 DAAP 1)[b] adults	immatures	total	17 Jun 5 true leaves (37 DAP & 9 DAAP 2)[b] adults	immatures	total
			by preventative treatment			
Untreated	5.75 a	4.75 a	10.50 a	34.38 a	2.94 a	37.31 a
Aeris	5.88 a	2.75 ab	8.63 a	25.31 ab	1.44 a	26.75 ab
Temik 15G	2.00 b	0.50 b	2.50 b	16.38 b	1.06 a	17.44 b
	$P < 0.006$	$P < 0.003$	$P < 0.0003$	$P < 0.05$	NS	$P < 0.04$
			by foliar treatment timing			
Untreated	2.08 a	3.08 a	5.17 a	26.00 a	2.83 a	28.83 a
1-2 TL	4.83 a	1.25 a	6.08 a	27.92 a	1.67 a	29.58 a
3-4 TL	5.83 a	4.17 a	10.00 a	24.33 a	2.17 a	26.50 a
1-2 & 3-4 TL	5.42 a	2.17 a	7.58 a	23.17 a	0.58 a	23.75 a
	NS	NS	NS	NS	NS	NS
Preventative X Foliar interaction	NS	NS	NS	NS	NS	NS

Means in a column within a treatment type followed by the same letter are not significantly different based on an F protected LSD ($P \geq 0.05$).

[a]The 1 Jun sample was lost in a processing error.

[b]DAP = days after planting; DAAP = days after foliar application.

[c]Aeris was applied as a seed treatment; Temik was applied in-furrow at planting at 5 lbs-product per acre; foliar treatments consisted of Orthene 97 at 3 oz-product per acre.

Table 2. Damage ratings and mean plant height, Dimmitt, TX 2009[a]

Treatment	1 Jun 1 true leaf (21 DAP & pre-foliar) damage (1-5 scale)	1 Jun height (cm)	8 Jun 2 true leaves (28 DAP & 7 DAAP 1) damage (1-5 scale)	8 Jun height (cm)	17 Jun 5 true leaves (37 DAP & 9 DAAP 2) damage (1-5 scale)	17 Jun height (cm)
by preventative treatment						
Untreated	5.00 a	7.09 a	4.38 a	6.59 b	3.81 a	4.45 b
Aeris	1.94 b	5.86 a	2.00 b	7.43 a	2.50 b	4.92 a
Temik 15G	1.00 c	5.33 a	1.00 c	7.80 a	1.00 c	5.36 a
	$P < 0.0001$	NS	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	$P < 0.001$
by foliar treatment timing						
Untreated	2.67 a	5.90 a	2.67 a	7.11 a	3.00 a	4.87 a
1-2 TL	2.67 a	6.02 a	2.25 c	7.17 a	2.58 b	4.92 a
3-4 TL	2.58 a	6.13 a	2.58 ab	7.42 a	2.42 b	4.98 a
1-2 & 3-4 TL	2.67 a	6.33 a	2.33 bc	7.41 a	1.75 c	4.87 a
	NS	NS	$P < 0.009$	NS	$P < 0.0001$	NS
Preventative X Foliar interaction	NS	NS	$P < 0.002$	NS	$P < 0.0001$	NS

Means in a column within a treatment type followed by the same letter are not significantly different based on an F protected LSD ($P \geq 0.05$).

[a]Damage rating based on a 1-5 scale where 5 is equivalent to the preventative untreated/foliar untreated plot, and 1 = no damage.

[b]DAP = days after planting; DAAP = days after foliar application.

[c]Aeris was applied as a seed treatment; Temik was applied in-furrow at planting at 5 lbs-product per acre; foliar treatments consisted of Orthene 97 at 3 oz-product per acre.

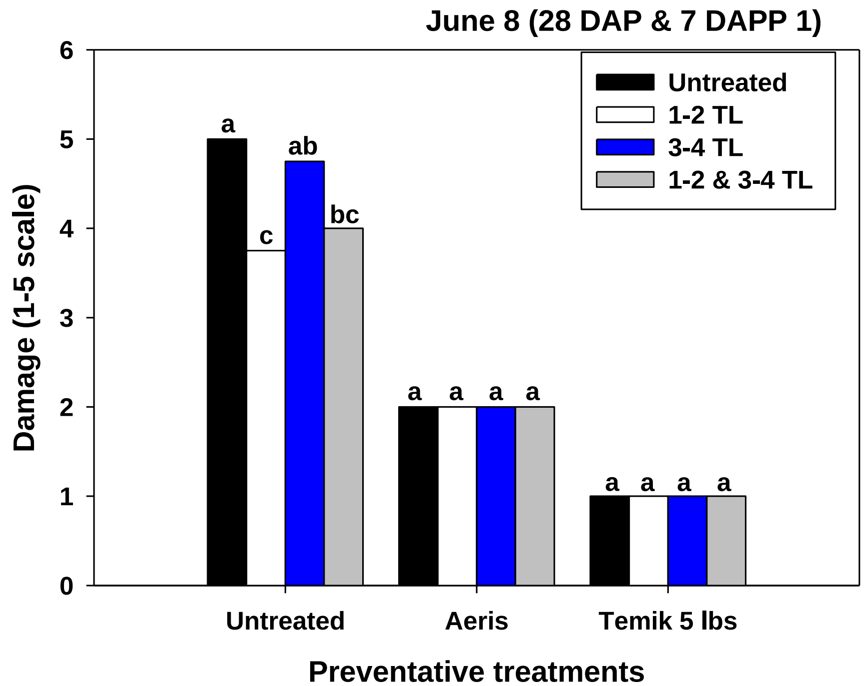

Figure 1. Mean damage ratings within preventative treatments on June 8. Bars within a preventative treatment capped by the same letter are not significantly different based on an F protected LSD (*P* ≥ 0.05).

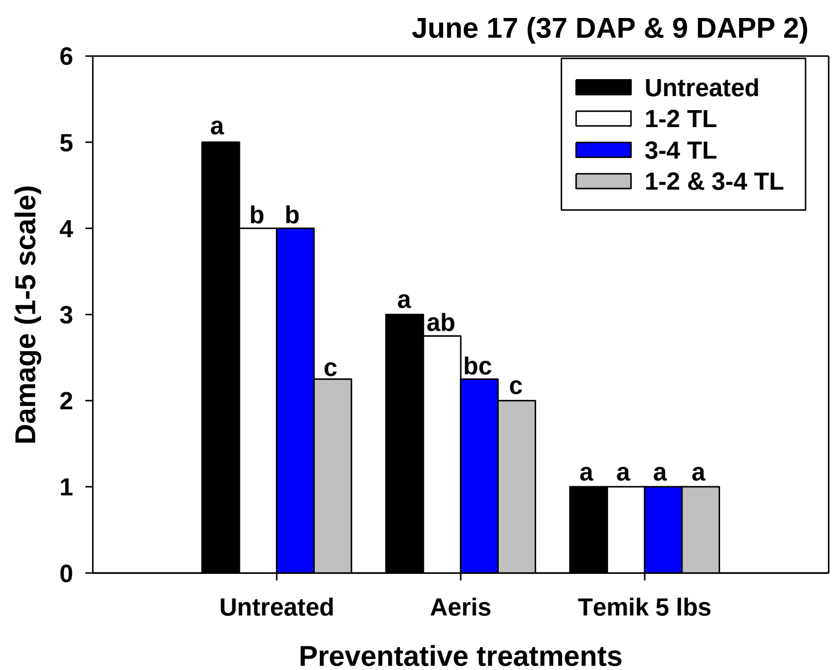

Figure 2. Mean damage ratings within preventative treatments on June 17. Bars within a preventative treatment capped by the same letter are not significantly different based on an F protected LSD (*P* ≥ 0.05).

Table 3. Maturity, yield and HIV lint analyses, Dimmitt, TX 2009.

Treatment[a]	Maturity[b]	Yield (lbs-lint/ac)	Micronaire	Staple length (32nds)	% length uniformity	Strength (g/tex)	% elongation	Rd (% reflec)	+b (yellow)	Leaf grade	Loan value ($/lb)
by preventative treatment											
Untreated	4.50 a	1057.17 b	3.64 b	1.09 a	79.59 a	29.32 a	6.68 a	80.22 a	7.33 a	2.94 a	0.54 a
Aeris	3.75 a	1080.10 b	3.86 a	1.09 a	79.97 a	29.35 a	6.52 a	79.86 a	7.22 a	3.44 a	0.54 a
Temik 15G	4.44 a	1177.83 a	3.78 a	1.09 a	79.87 a	28.28 a	6.82 a	79.77 a	7.12 a	3.33 a	0.54 a
	NS	$P < 0.009$	$P < 0.002$	NS	NS	NS	NS	NS	NS	NS	NS
by foliar treatment timing											
Untreated	5.08 a	1116.09 a	3.67 b	1.11 a	80.00 a	29.48 a	6.64 a	79.88 a	7.33 a	3.25 a	0.55 a
1-2 TL	4.00 a	1071.44 a	3.79 ab	1.08 a	79.64 a	29.00 a	6.73 a	80.03 a	7.04 a	3.25 a	0.54 a
3-4 TL	4.17 a	1124.47 a	3.67 b	1.08 a	79.85 a	27.99 a	6.57 a	80.14 a	7.34 a	3.36 a	0.53 a
1-2 & 3-4 TL	3.67 a	1108.17 a	3.90 a	1.09 a	79.75 a	29.43 a	6.72 a	79.79 a	7.19 a	3.08 a	0.54 a
	NS	NS	$P < 0.004$	NS	NS	NS	NS	NS	NS	NS	NS
Preventative X Foliar interaction	NS	NS	NS	NS	NS	NS	$P < 0.04$	NS	NS	NS	NS

Means in a column within a treatment type followed by the same letter are not significantly different based on an F protected LSD ($P \geq 0.05$).

[a]Aeris was applied as a seed treatment; Temik was applied in-furrow at planting at 5 lbs-product per acre; foliar treatments consisted of Orthene 97 at 3 oz-product per acre.

[b]Maturity is the number of days beyond the most immature plot based on NAWF on 20 August.

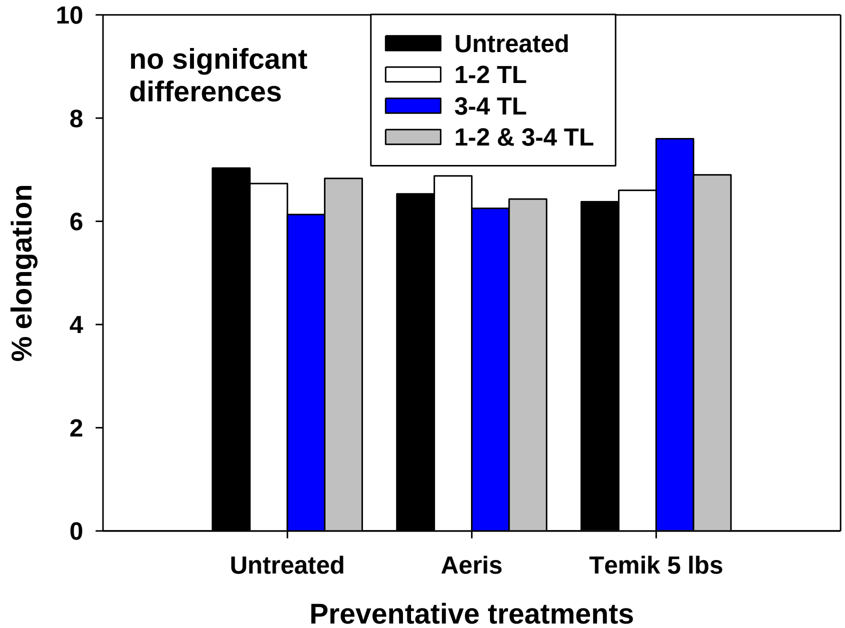

Figure 3. Mean % elongation from HIV analysis. No significant differences among foliar timings within preventative treatments or vice versa based on an F protected LSD ($P \geq 0.05$).

Impact and Benefit of Foliar Insecticides Applied Over Preventative Insecticides for Thrips Control – Sunray,TX 2009

Cooperators: Casey Kimbral, Cotton Grower / Texas AgriLife Extension Service

David Kerns, Ed Bynum, Marcel Fischbacher and Bo Kesey
Extension Entomologist-Cotton, Extension Entomologist, CEA-AG/NR, Moore County and Extension Program Specialist-Cotton

Moore County

Summary:

Thrips are a significant economic pest of cotton during the pre-squaring stage of growth and development in most of the cotton growing areas of the United States. On the Texas High Plains it is not uncommon for Orthene to be included in early-season Roundup application for thrips control regardless if a preventative seed treatment or Temik had been used. However, the benefit of these applications is not known and in some parts of the cotton belt, may actually be detrimental because of secondary pest outbreaks. In this test the thrips populations was 100% western flower thrips. At no time were there any differences among the treatments in thrips density. Additionally, at no time did we detect a significant interaction between preventative treatments and the foliar timings for thrips counts. Damage throughout the duration of this test was light; cotton that received no preventative or foliar insecticide protection suffered only light damage. The fact that some damage was evident suggests that higher numbers of thrips were likely present before the 9 June sample. Environmental conditions when this test occurred were very cool and this cotton was very slow to emerge and grow. At this time it was at the 1 true leaf (TL) stage. At 34 DAP on 9 June, the same damage trend was detected, and at that time, both Aeris and Temik had taller plants than the untreated. Additionally, those plots that received Orthene tended to have less damage than those that had not (untreated and 3-4 TL timing). A significant interaction between damage in the preventative and foliar treatments was detected on 9 June. This interaction appears to be due to a reduction in damage in the untreated preventative plots where Orthene was applied, but no effect in the Aeris and Temik plots. Thus, at 34 DAP, and 7 days after the Orthene application, neither Aeris nor Temik benefited from the 1-2 TL timing foliar sprays. However, the differences in damage was very minor. On 16 June, damage among the preventative and foliar timings were similar to previous ratings but Temik had less damage than Aeris. The untreated had significantly more damage than Temik or Aeris, and more than any of the foliar timings. Among the foliar

treatments, plots that received both the 1-2 TL and the 3-4 TL foliar applications had significantly less damage than those that one or the other, and those that received only the 1-2 TL timing had less damage than the 3-4 TL timing. This suggests that we probably had more thrips present in the lost 2 June sample than the others. A significant interaction between preventative and foliar treatments was observed for damage on 16 June. Based on damage, Temik did not appear to benefit from the foliar applications, while the untreated saw some light benefit when applied at either 1-2 TL or 3-4 TL, and slightly more benefit when applied at both timings. Aeris appeared to slightly benefit from foliar applications as well. These data suggest that Aeris benefited from Orthene applications at 34 DAP, but Temik did not. But again, damage was so light that this benefit did not result in yield of lint quality increases. Thus although we were able to observes slight difference in damage and plant height, overspraying preventative treatment in this test did not appear to be beneficial.

Objectives:

The objective of this study was to determine if foliar applications of Orthene following preventative applications of Temik and Aeris resulted in better thrips control, less damage, and increased yield.

Materials and Methods:

This study represents 1 of 20 similar research sites located throughout the U.S. Cotton Belt including Texas, Louisiana, Arkansas, Missouri, Tennessee, Mississippi, Georgia, South Carolina, North Carolina and Virginia. This test was conducted in irrigated cotton near Sunray, TX in 2009. The cotton, FiberMax 9058F, was planted on 6 May on 30-inch rows. The test was irrigated as needed using a pivot irrigation system.

The experimental design was a 3 x 4 factorial with 4 replicates. Plots were 4 rows wide × 100 ft in length. The main factors were the preventative treatments which included: 1) Untreated, 2) Aeris and 3) Temik at 5 lbs-product/acre. Aeris is a seed treatment, while Temik was applied in-furrow at planting at approximately 1.5-inches in depth. The Temik applicator boxes were calibrated prior to planting.

The secondary factors were applications of foliarly applied Orthene 97 at 3.0 oz-product/acre at: 1) Untreated, 2) 1-2 true leaves (TL) stage, 3) 3-4 TL stage and 4) 1-2 and 3-4 TL stages. All foliar sprays consisted of Orthene 97 applied at 3 oz-product/acre with a CO_2 pressurized hand boom calibrated to deliver 10 gallons/acre on a 50% band.

Beginning at the 1 TL stage, 5 plants per plot were collected into 1-pt jars containing 50% isopropyl alcohol. These jars were sealed and transported to the laboratory where the solution was filtered using 4-inch filter paper in a Buchner funnel fastened onto a 1-liter Erlenmeyer flask attached to a vacuum pump. Each plant was carefully rinsed onto the filter paper with 50% isopropyl alcohol. After filtration, adult and immature thrips were counted with a stereomicroscope. Adult thrips from all plots that did not receive an application of Orthene were collected for species identification by Dr. Jack Reed, Mississippi State University. In addition to collecting plants, damage was assessed by subjectively rating each plot on a 1 to 5 scale where 1 = no damage, and 5 = damaged equivalent to the untreated plot (did not receive a preventative or foliar application) in each replicate. Plant height was also assessed in each plot by measuring 5 plants from the soil surface to the terminal tip. Evaluations were made on 2, 9 and 16 June.

A 1/1000th acre portion was harvested from each plot using an HB hand stripper on 27

October. The entire samples were ginned at the Texas AgriLife Research and Extension Center at Lubbock to determine yield and gin turnouts. Lint samples were submitted to the Fiber and Biopolymer Research Institute at Texas Tech University for HVI analysis, and USDA Commodity Credit Corporation (CCC) Loan values were determined for each plot.

Data were analyzed using PROC GLM with means separated using an F protected LSD ($P \leq 0.05$).

Results and Discussion:

The thrips collected in the study were identified as 100% western flower thrips, *Frankliniella occidentalis*. Thrips collected during the 2 June evaluation were lost due to a processing error, but thrips were recovered from the 9 and 16 June collections (Table 1). However, thrips pressure was very low in this test during the two sample dates when were successfully recovered. At no time were there any differences among the treatments in thrips density. Additionally, at no time did we detect a significant interaction between preventative treatments and the foliar timings for thrips counts.

On 2 June, 27 days after planting (DAP) and prior to any foliar treatments, Temik and Aeris had significantly less damage than the untreated (Table 2). However, damage throughout the duration of this test was light; cotton that received no preventative or foliar insecticide protection suffered only light damage. The fact that some damage was evident suggests that higher numbers of thrips were likely present before the 9 June sample. Environmental conditions when this test occurred were very cool and this cotton was very slow to emerge and grow. At this time it was at the 1 true leaf (TL) stage. There was no significant impact on height at this time. At 34 DAP on 9 June, the same damage trend was detected, and at that time, both Aeris and Temik had taller plants than the untreated. Additionally, those plots that received Orthene tended to have less damage than those that had not (untreated and 3-4 TL timing). A significant interaction between damage in the preventative and foliar treatments was detected on 9 June. This interaction appears to be due to a reduction in damage in the untreated preventative plots where Orthene was applied, but no effect in the Aeris and Temik plots (Figure 1). Thus, at 34 DAP, and 7 days after the Orthene application, neither Aeris nor Temik benefited from the 1-2 TL timing foliar sprays. However, although the damage differences appear vast based on the graph, because the highest level of damage (5) was set to equal the untreated, and since the untreated had only light damage, the true differences in damage is very minor.

On 16 June, damage among the preventative and foliar timings were similar to previous ratings but Temik had less damage than Aeris. The untreated had significantly more damage than Temik or Aeris, and more than any of the foliar timings. Among the foliar treatments, plots that received both the 1-2 TL and the 3-4 TL foliar applications had significantly less damage than those that one or the other, and those that received only the 1-2 TL timing had less damage than the 3-4 TL timing. This suggests that we probably had more thrips present in the lost 2 June sample than the others. A significant interaction between preventative and foliar treatments was observed for damage on 16 June. Based on damage, Temik did not appear to benefit from the foliar applications, while the untreated saw some light benefit when applied at either 1-2 TL or 3-4 TL, and slightly more benefit when applied at both timings (Figure 2). Aeris appeared to slightly benefit from foliar applications as well. These data suggest that Aeris benefited from Orthene applications at 34 DAP, but Temik did not. But again, damage was so light that this benefit did not result in yield of lint quality increases (Table 3). However, this test suffered an early freeze which greatly impacted its yield, quality and loan value, and rendered the test suspect for drawing sound conclusions on impact on yield, lint quality and loan value.

Acknowledgments:

Appreciation is expressed to the National Cotton Council, Bayer CropScience, and the Plains Cotton Growers for partial funding of this project, and to the Texas Department of Agriculture - Food and Fiber Research for funding of HVI testing at the Texas Tech University - Fiber and Biopolymer Research Institute.

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Table 1. Mean number of thrips per 5 plants, Sunray, TX 2009[a]

Treatment[c]	9 Jun 3 true leaves (34 DAP & 7 DAAP 1)[b] adults	immatures	total	16 Jun 5 true leaves (41 DAP & 7 DAAP 2)[b] adults	immatures	total
			by preventative treatment			
Untreated	1.69 a	0.13 a	1.81 a	1.19 a	0.00 a	1.19 a
Aeris	1.06 a	0.13 a	1.19 a	0.81 a	0.06 a	0.88 a
Temik 15G	0.81 a	0.00 a	0.81 a	0.69 a	0.00 a	0.69 a
	NS	NS	NS	NS	NS	NS
			by foliar treatment timing			
Untreated	0.92 a	0.00 a	0.92 a	0.08 a	0.00 a	0.08 a
1-2 TL	1.42 a	0.00 a	1.42 a	1.25 a	0.00 a	1.25 a
3-4 TL	0.83 a	0.33 a	1.17 a	0.75 a	0.00 a	0.75 a
1-2 & 3-4 TL	1.58 a	0.00 a	1.58 a	1.50 a	0.08 a	1.58 a
	NS	NS	NS	NS	NS	NS
Preventative X Foliar interaction	NS	NS	NS	NS	NS	NS

Means in a column within a treatment type followed by the same letter are not significantly different based on an F protected LSD ($P \geq 0.05$).

[a]The 2 Jun sample was lost in a processing error.

[b]DAP = days after planting; DAAP = days after foliar application.

[c]Aeris was applied as a seed treatment; Temik was applied in-furrow at planting at 5 lbs-product per acre; foliar treatments consisted of Orthene 97 at 3 oz-product per acre.

Table 2. Damage ratings and mean plant height, Sunray, TX 2009[a]

Treatment	2 Jun 1 true leaf (27 DAP & pre-foliar) damage (1-5 scale)	height (cm)	9 Jun 3 true leaves (34 DAP & 7 DAAP 1) damage (1-5 scale)	height (cm)	16 Jun 5 true leaves (41 DAP & 7 DAAP 2) damage (1-5 scale)	height (cm)
by preventative treatment						
Untreated	5.00 a	4.44 a	3.38 a	6.83 b	2.63 a	7.89 a
Aeris	1.00 b	4.56 a	1.06 b	7.30 a	1.31 b	8.50 a
Temik 15G	1.00 b	4.69 a	1.00 b	7.44 a	1.00 c	13.58 a
	$P < 0.0001$	NS	$P < 0.0001$	$P < 0.0001$	$P < 0.0001$	NS
by foliar treatment timing						
Untreated	2.33 a	4.42 a	2.42 a	7.10 a	2.67 a	8.50 a
1-2 TL	2.33 a	4.67 a	1.17 b	7.38 a	1.33 c	14.73 a
3-4 TL	2.33 a	4.63 a	2.33 a	7.15 a	1.58 b	8.33 a
1-2 & 3-4 TL	2.33 a	4.54 a	1.33 b	7.13 a	1.00 d	8.40 a
	NS	NS	$P < 0.0001$	NS	$P < 0.0001$	NS
Preventative X Foliar interaction	NS	NS	$P < 0.0001$	NS	$P < 0.0001$	NS

Means in a column within a treatment type followed by the same letter are not significantly different based on an F protected LSD ($P \geq 0.05$).

[a]Damage rating based on a 1-5 scale where 5 is equivalent to the preventative untreated/foliar untreated plot, and 1 = no damage.

[b]DAP = days after planting; DAAP = days after foliar application.

[c]Aeris was applied as a seed treatment; Temik was applied in-furrow at planting at 5 lbs-product per acre; foliar treatments consisted of Orthene 97 at 3 oz-product per acre.

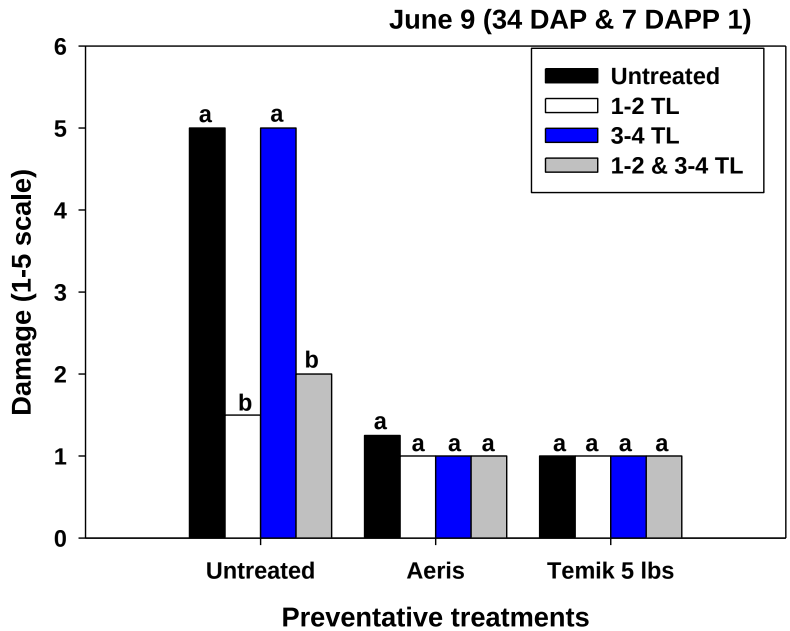

Figure 1. Mean damage ratings within preventative treatments on June 9. Bars within a preventative treatment capped by the same letter are not significantly different based on an F protected LSD (*P* ≥ 0.05).

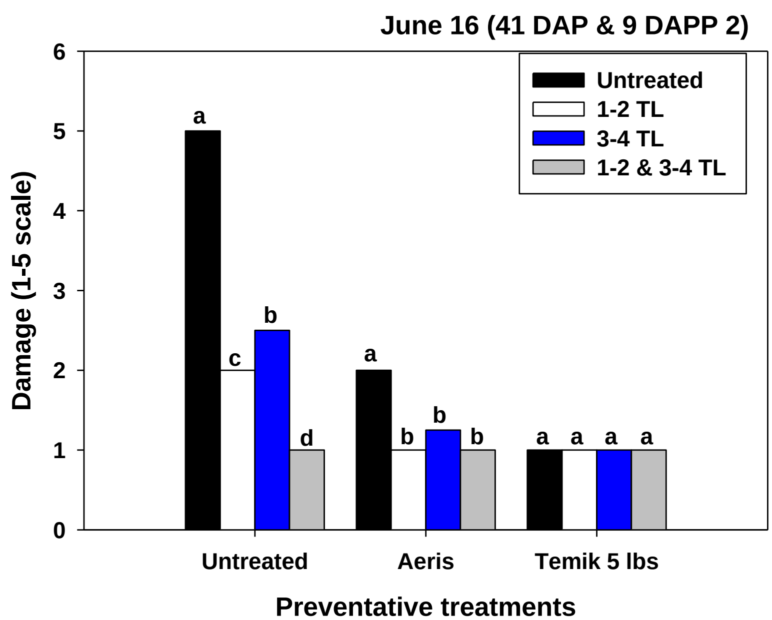

Figure 2. Mean damage ratings within preventative treatments on June 16. Bars within a preventative treatment capped by the same letter are not significantly different based on an F protected LSD (*P* ≥ 0.05).

Table 3. Maturity, yield and HIV lint analyses, Sunray, TX 2009.

Treatment[a]	Maturity[b]	Yield (lbs-lint/ac)	Micronaire	Staple length (32nds)	% length uniformity	Strength (g/tex)	% elongation	Rd (% reflec)	+b (yellow)	Leaf grade	Loan value ($/lb)
by preventative treatment											
Untreated	3.31 a	892.30 a	2.24 a	1.17 a	79.21 a	27.79 a	6.25 a	72.44 a	10.43 a	4.88 a	0.39 a
Aeris	3.56 a	868.88 a	2.23 a	1.15 a	78.78 a	27.03 a	6.18 a	72.16 a	10.77 a	4.31 a	0.40 a
Temik 15G	2.94 a	915.64 a	2.29 a	1.17 a	79.31 a	27.77 a	6.41 a	73.26 a	10.02 a	4.69 a	0.41 a
	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
by foliar treatment timing											
Untreated	3.17 a	848.06 a	2.27 a	1.16 a	78.88 a	27.77 a	6.33 a	72.46 a	10.43 a	4.50 a	0.40 a
1-2 TL	3.08 a	820.05 a	2.20 a	1.16 a	78.67 a	26.36 a	6.22 a	72.26 a	10.60 a	4.83 a	0.38 a
3-4 TL	3.67 a	1020.91 a	2.33 a	1.16 a	79.48 a	27.81 a	6.38 a	73.38 a	9.98 a	4.75 a	0.41 a
1-2 & 3-4 TL	3.17 a	880.06 a	2.23 a	1.17 a	79.37 a	28.18 a	6.18 a	72.38 a	10.62 a	4.42 a	0.41 a
	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Preventative X Foliar interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means in a column within a treatment type followed by the same letter are not significantly different based on an F protected LSD ($P \geq 0.05$).

[a]Aeris was applied as a seed treatment; Temik was applied in-furrow at planting at 5 lbs-product per acre; foliar treatments consisted of Orthene 97 at 3 oz-product per acre.

[b]Maturity is the number of days beyond the most immature plot based on NAWF on 20 August.

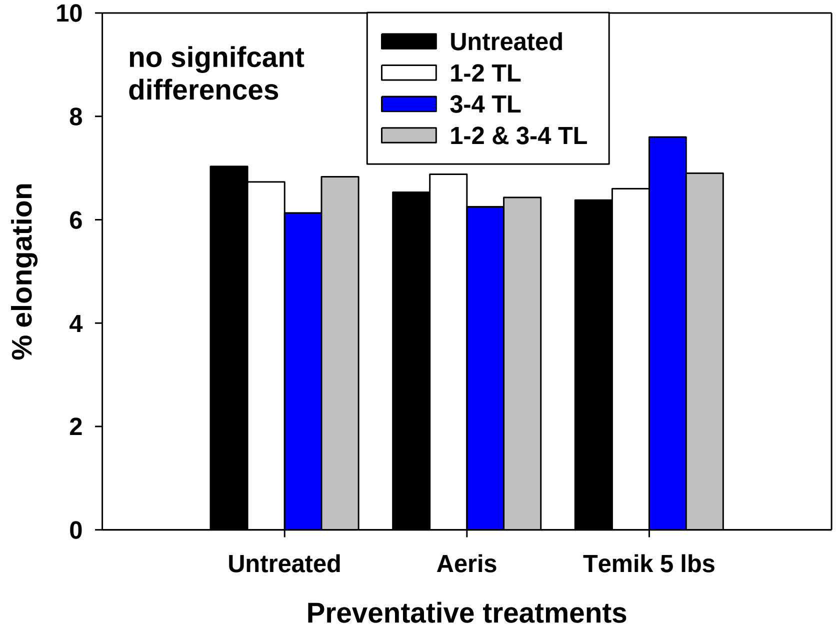

Figure 3. Mean % elongation from HIV analysis. No significant differences among foliar timings within preventative treatments or vice versa based on an F protected LSD ($P \geq 0.05$).

Efficacy of Insecticides Targeting Cotton Aphids and Impact on Key Aphid Predators, 2009

Cooperators: Texas AgriLife Research & Extension Center – Lubbock

David Kerns, Brant Baugh and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Lubbock County and Extension Program Specialist-Cotton

Lubbock County

Summary:

Cotton aphids, *Aphis gossypii* Glover are a common pest of cotton grown in the High Plains of Texas. The objectives of this two-year study included: 1) to determine the efficacy of commonly used aphicides at mitigating aphid populations in cotton, 2) to determine which aphicides have the least detrimental impact on key aphid predators, and 3) to collect data to support or refute the current aphid action threshold. The aphid population was higher and more persistent in 2009 than in 2008. Bidrin, Carbine and Intruder reduced the mean aphid population below threshold at 3 DAT in both years. In 2009, Centric did not reduce the mean aphid population below threshold until 14 DAT, suggesting that this product should be applied when aphids just reach the 50 per leaf threshold and the population is increasing as demonstrated in 2008. In 2008, Trimax Pro did not perform as well as the other insecticides as exhibited by the 182 percent increase in aphid numbers between the three and five day post-treatment counts. In 2009, the aphid population in the Trimax Pro treatment was well above threshold at 7 DAT. In 2008, Bidrin and Carbine did not significantly differ in percent reduction of lady beetle larvae compared to the untreated check, while Centric, Intruder and Trimax Pro had fewer lady beetle larvae than the untreated check. In 2009, Carbine was the only treatment that did not differ from the untreated check. The differences in results may be attributed to spray coverage as the plant canopy in 2008 was dense compared to 2009. The lady beetle population was above the suggested 0.2 per one foot of row density in both years, but we did not observe a rapid decrease in the aphid population in 2009. Although more data is needed, this test suggests that yield loss begins to occur when the aphids average 25 to 50 per leaf. Thus our current action threshold of 50 aphids per leaf appears to be fairly accurate.

Objective:

To determine the efficacy of commonly used aphicides at mitigating aphid populations in cotton, to determine which aphicides have the least detrimental impact on key aphid predators and to collect data to support or refute the current aphid action threshold.

Materials and Methods:

This test was conducted at the Texas AgriLife Research and Extension Center in Lubbock, Texas. Cotton 'DeltaPine 174 RF' was planted on 4 June 2008 and 9 June 2009 on 40-inch rows and irrigated using furrow run irrigation. Plots were 4-rows wide × 25-feet long. Plots were arranged in a randomized complete block design with 4 replicates. An aphid outbreak was induced by overspraying the entire test area with Karate 1EC (lambda cyhalothrin) at 4.0 fl-oz per acre on 18 July and 7 August in 2008, and on 23 and 29 July and 4 August 2009. The aphicide treatments and rates are outlined in Table 1. All treatments were applied with a CO2 pressurized hand boom calibrated to deliver 10 gallons/acre. The boom consisted of 2 hollow cone TX-6 nozzles per row spaced at 20 inches.
Treatments were applied on 21 and 28 August in 2008 and 2009, respectively, when the aphid population was approaching or had exceeded the action threshold of 50 aphids per leaf.

The aphid population was estimated by counting the number of aphids per leaf. Ten 3 to 4 node terminal and ten mid to lower canopy leaves were randomly sampled per plot.

Predators were estimated utilizing a 36-inch x 40-inch black drop cloth. Drop cloths were laid between the rows and approximately 1.5 ft-row of cotton were shaken onto the drop cloth from each row, and the type and number of predators were counted. Only lady beetle larvae data are presented. The % reduction in lady beetle larvae relative to the untreated was estimated using Henderson-Tilton's equation.

The plots were harvested on 19 November in 2008 using an HB hand stripper. A 1/1000th acre section was harvested from the middle two rows of each plot. Samples were ginned at Texas AgriLife Ginning Facility in Lubbock. In 2009 yield data was not taken due to herbicide damage compounded by an early freeze.

All count data were analyzed using PROC MIXED and the means were separated using an F protected LSD ($P \leq 0.05$) (SAS Institute 2003). The 2008 yields were correlated with aphid densities using a exponential decay linear regression model.

Results and Discussion:

<u>Aphids - 2008</u>
On 21 August, the aphid population was averaging across all plots, 46.66, 19.82 and 33.24 aphids per leaf on the mid to lower canopy leaves, 3 to 4th node leaves, and averaged across both leaf locations respectively (Figure 1A). There were no statistical differences among treatments at this time. Although the aphid population was not at the treatment threshold, since the population appeared to be rapidly increasing treatments were initiated on 23 August. On 26 August, 3 days after treatment (DAT), aphids in the untreated plots had increased to slightly over threshold (Figure 1B). All of the aphicides had fewer aphids than the untreated throughout the plant canopy. There were no

differences among the aphicides for aphids on the 3 to 4th node leaves, but Bidrin and Intruder had fewer aphids on the mid to lower canopy leaves than Carbine. Carbine was not expected to exhibit full activity at 3 DAT since this chemistry acts as an anti-feedent and requires time for the aphids to starve and/or desiccate. At 5 DAT, aphid numbers in the untreated were slightly lower than at the 3 DAT evaluation (Figure 1C). All of treatments had significantly fewer aphids than the untreated; however, Trimax Pro did not differ from the untreated in the number of aphids infesting the mid to lower canopy. Based on the mean number of aphids from both leaf locations, Trimax Pro did not perform as well as the other aphicides. Aphid numbers in the Trimax Pro plots on the mid to lower canopy leaves increased 181.62% from 3 DAT to 5 DAT. None of the other treatments exhibited an increase in aphid numbers. The increase in aphids in the Trimax Pro plots may have been due to its impact on lady beetles. By 10 DAT, the aphid population had declined considerably across the entire test, and none of the treatments were exceeding threshold (Figure 1D).

Aphids - 2009

In 2009, the aphid population was substantially greater than in 2008. On 28 August, the aphid population was averaging across all plots, 110.48, 166.07 and 138.28 aphids per leaf on the mid to lower canopy leaves, 3 to 4th node leaves, and averaged across both leaf locations respectively (Figure 2A). There were no statistical differences among treatments at this time. Bidrin, Intruder and Carbine reduced the aphid population below threshold at 3 DAT, and all of the treatments were significantly lower than the untreated (Figure 2B).

By 7 DAT, similarly to 2008, aphids in the Carbine continued to decrease while aphids in the Intruder-treated plots remained low and static (Figure 2C). Aphids in the Bidrin, Centric and Trimax Pro plots increased slightly from 3 to 7 DAT. Bidrin increased to near threshold while Centric and Trimax Pro remained well above threshold. At 14 DAT the aphid population had crashed across all treatments (Figure 2D).

Although we could not detect any differences among treatments in yield in 2008, we were able to demonstrate a significant relationship between aphid density at 5 DAT and yield (Figure 3). Although more data is needed to alleviate spuriousness, these data suggest yield loss began to occur when the aphids averaged 25 to 50 per leaf. Thus our current action threshold of 50 aphids per leaf appears to be fairly accurate.

Lady Beetles

Convergent lady beetle, *Hippodamia convergens* Guérin-Méneville was the most prevalent predator present in these tests both years. Before treatment, lady beetle larvae averaged 9.28 and 4.08 per 6 ft-row in 2008 and 2009 respectively. In 2008 at 3 DAT, lady beetle larvae did not suffer significant mortality in the Carbine or Bidrin treatments relative to the untreated plots, while all of the neonicotinoids (Centric, Intruder and Trimax Pro) contained fewer lady beetle larvae than the untreated (Figure 6). In 2009, perhaps because the lady beetle population was 50% lower than in 2008, differences were less clear and Carbine was the only treatment that did not differ from the untreated (Figure 6). The reason Bidrin caused significant mortality in 2009 but not in 2008 may be due to plant height and canopy density. The cotton in 2009 was smaller than in 2008 and inner canopy coverage may have been better in 2009.

The University of Arkansas suggests that at least 0.2 lady beetle larvae or 0.3 lady beetle adults per 1 ft-row may be sufficient to biologically manage an aphid infestation (Chappell et al. 2005). Lady beetle larvae averaged 2.58 and 1.04, while the adults averaged 0.28 and 0.25, in 2008 and 2009 respectively at 0 DAT. Although the numbers of adults were similar between years, there were fewer larvae in 2009; but still above the suggested 0.2 per 1 ft-row density. However, we did not observe the rapid decrease in the aphid population in 2009.

Acknowledgments:

This project was funded in part by Plains Cotton Growers, Inc.

Disclaimer Clause:

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Table 1. Aphicide treatments and rates.

Treatment	Active Ingredient	Rate (product/ac)
1) Untreated	--	--
2) Bidrin 8	Dicrotophos	8.0 fl-oz
3) Carbine 50WG	Flonicamid	1.5 oz
4) Centric 40WG	Thiamethoxam	2.0 oz
5) Intruder 70WSP	Acetamprid	0.6-0.75 oz*
6) Trimax Pro 4.44SC	Imidacloprid	1.8 fl-oz

All treatments included crop oil concentrates at 1.0% v/v.
* Rate for Intruder was 0.75 oz in 2008 and 0.6 oz in 2009.

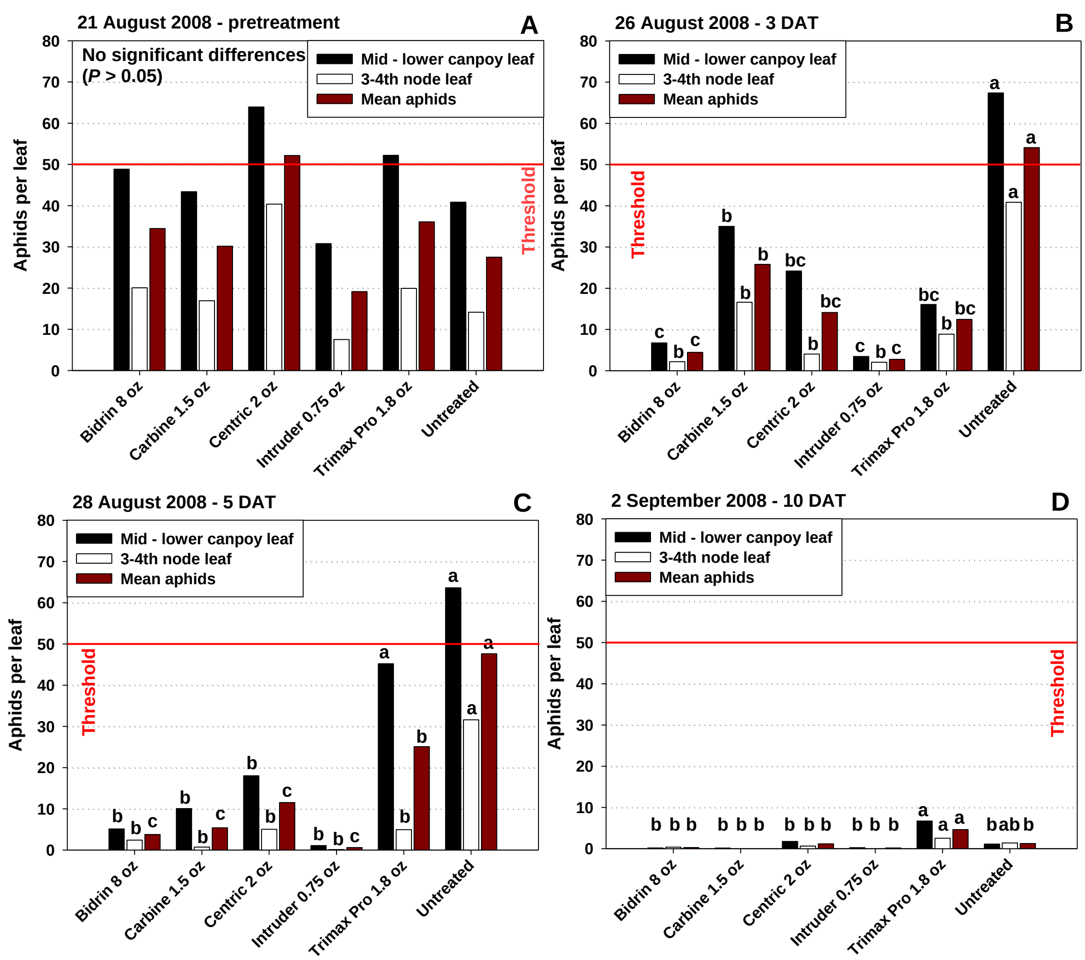

Figure 1. Number of cotton aphids per leaf in 2008 before application (A), 3 DAT (B), 5 DAT (C), and 10 DAT (D) during 2008. Same colored bars capped with the same letter are not

significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

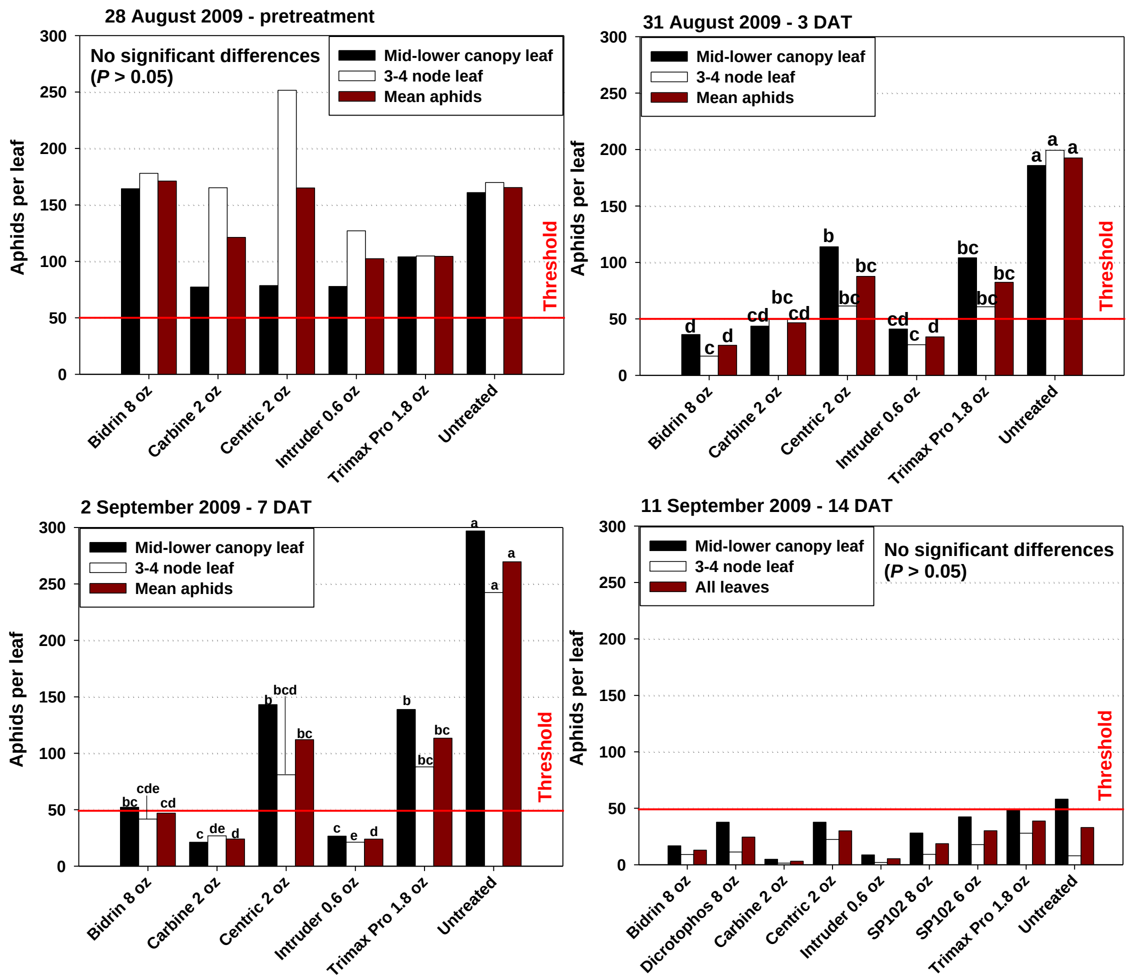

Figure 2. Number of cotton aphids per leaf in 2009 before application (A), at 3 DAT (B), 7 DAT (C) and 14 DAT (D); Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

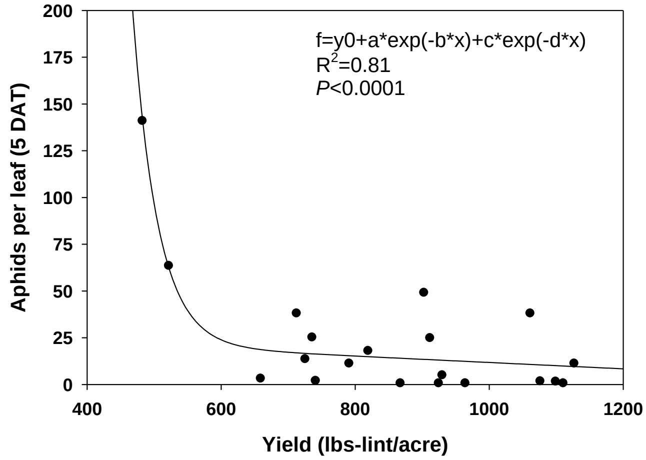

Figure 3. Linear relationship in 2008 of cotton aphid density at 5 DAT and yield.

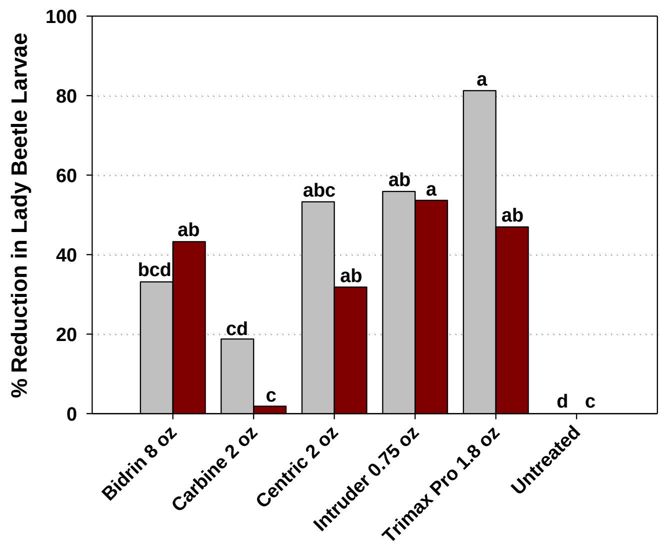

Figure 4. Percentage reduction in lady beetle larvae based on a Henderson-Tilton's equation. Same colored bars capped with the same letter are not significantly different based on an F protected Mixed Procedure (LSD, $P < 0.05$).

Evaluation of Insecticides against Cotton Aphids and Impact on Lady Beetle Larvae in Cotton, 2009

Cooperators: Texas AgriLife Research & Extension Center – Lubbock,TX

David Kerns, Brant Baugh, Dustin Patman and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Lubbock County, EA-IPM Crosby/Floyd County, and Extension Program Specialist-Cotton

Lubbock County

Summary:

At 3 days after treatment (DAT), all of the insecticides, Carbine, Centric, Bidrin, Intruder, Dicrotophos and two rates of SP 102000022560 (imidacloprid + spirotetramat pre-mix) had fewer aphids on upper and lower canopy leaves, and averaged across both leaf positions than the untreated, although Trimax Pro, Centric, and both rates of SP 102000022560 still exceeded the action threshold. By 7 DAT, the aphid population had continued to increase in the untreated plots but all insecticide treatments contained fewer aphids. However, Trimax Pro, Centric, both rates of SP 102000022560 and Dicrotophos were all exceeding the action threshold. By 14 DAT the aphid population had declined across all plots and no statistical differences were observed. Overall, the most efficacious treatments appeared to be Intruder and Carbine, followed by Bidrin and Dicrotophos. All of the insecticides except SP 102000022560 at 6 fl-oz had fewer LB adults than the untreated. Among the other insecticides, most appeared to be equally harsh but Trimax Pro had less impact than Carbine or Bidrin. The percentage reduction in LB larvae was variable but some statistical differences were evident. SP 102000022560 at 8 fl-oz appeared to be harshest towards LB larvae, but was not statistically different from Trimax Pro, Bidrin, Intruder of Dicrotophos. Insecticides that did not differ from the untreated included Carbine, Trimax Pro, Centric, Bidrin and SP 102000022560 at 6 fl-oz. Insecticides that did not differ from the untreated in the percentage reduction in MPBs included Carbine, Centric and SP 102000022560 at 6.0 fl-oz. Dicrotophos and Trimax Pro appeared to be the harshest towards MPBs but did not differ from Centric, Bidrin or Intruder.

Objective:

To determine the efficacy of several insecticides towards cotton aphids and lady beetle larvae.

Materials and Methods:

This test was conducted at the Texas AgriLife Research and Extension Center in Lubbock, TX. DeltaPine 174RF was planted on 9 Jun on 40-inch rows, and was irrigated using row irrigation. The test was a RCB design with four replications. Plots were 4-rows wide × 50 ft in length. Insecticides were applied with a CO_2 pressurized hand-boom sprayer calibrated to deliver 10 gpa through TX-6 hollow cone nozzles (2 per row) at 40 psi. The insecticides to be evaluated were applied to all four rows of each plot on 28 Aug.

Treatments were evaluated by counting the number of cotton aphids (CA) from 10, 3 to 4^{th} node leaves (top leaf sample) and 10 leaves from the lower 50% of the plant canopy (lower leaf sample) per plot on 28 and 31 Aug, and 4 and 11 Sep. Predators were estimated on 28 and 31 Aug utilizing a 36-inch x 40-inch black drop cloth. Drop cloths were laid between the rows and approximately 1.5 ft-row of cotton were shaken onto the drop cloth from each row, after which the type and number of predators were counted. Predators counted included lady beetles, minute pirate bugs, big-eyed bugs, damsel bugs, syrphid fly larvae, lacewing larvae and spiders; only lady beetle, minute pirate bug, spiders and total predators are presented. The percentage reduction in predators post treatment was calculated using Henderson-Tilton's formula. Data were analyzed with PROC MIXED, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

On 28 Aug, the CA population across all plots was averaging 114.47, 159.37 and 136.93 CAs per leaf on the mid to lower canopy leaves, 3-4^{th} node leaves, and averaged across both leaf locations respectively. There were no statistical differences among treatments at this time and all plots were well above the Texas threshold of 50 aphids per leaf (Table 1).

On 31 Aug, 3 days after treatment (DAT), all of the insecticides had fewer aphids at both leaf positions and averaged across both leaf positions than the untreated, although Trimax Pro, Centric, and both rates of SP 102000022560 (imidacloprid + spirotetramat pre-mix) exceeded the action threshold. Among the insecticides at the 3-4^{th} node leaf position, Intruder, Bidrin, and Dicrotophos had the fewest aphids, but did not differ from Carbine, Trimax Pro, Centric, or SP 102000022560 at 8 fl-oz. On the lower canopy leaves and averaged across both leaf positions, Bidrin had the fewest aphids but did not differ from Carbine, Intruder, Dicrotophos or SP 102000022560 at 8 fl-oz. By 7 DAT, the aphid population had continued to increase in the untreated plots but all insecticide treatments contained fewer aphids. However, Trimax Pro, Centric, both rates of SP 102000022560 and Dicrotophos were all exceeding the action threshold. Among the insecticides, Carbine, Bidrin, Intruder Dicrotophos and SP 102000022560 at 6 fl-oz were all statistically similar. By 14 DAT the aphid population had declined across all plots and no statistical differences were observed. Overall, the most efficacious treatments appeared to be Intruder and Carbine, followed by Bidrin and Dicrotophos.

All of the insecticides except SP 102000022560 at 6 fl-oz had fewer LB adults than the untreated (Table 3). Among the other insecticides, most appeared to be equally harsh but Trimax Pro had less impact than Carbine or Bidrin. The percentage reduction in LB larvae was variable but some statistical differences were evident. SP 102000022560 at 8 fl-oz appeared to be harshest towards LB larvae, but was not statistically different from Trimax Pro, Bidrin, Intruder of Dicrotophos. Insecticides that did not differ from the untreated included Carbine, Trimax Pro, Centric, Bidrin and SP 102000022560 at 6 fl-oz.

Insecticides that did not differ from the untreated in the percentage reduction in MPBs included Carbine, Centric and SP 102000022560 at 6.0 fl-oz. Dicrotophos and Trimax Pro appeared to be the harshest towards MPBs but did not differ from Centric, Bidrin or Intruder. Centric was the only product that appeared to negatively impact spiders. However, this data is suspect because of the low number of spiders. When pooling all predators, all of the insecticides reduced the predator population relative to the untreated. Among the insecticides, all appeared similar in harshness although Centric exhibited less impact than Dicrotophos and SP 102000022560 at 8 fl-oz. All of the insecticides evaluated exhibited good handing and mixing characteristics, and no phytotoxicity was observed.

Acknowledgments:

Appreciation is expressed to Plains Cotton Growers, Aceto Agricultural Chemicals Corp., Bayer CropScience, Dupont Crop Protection and FMC Corporation Agricultural for financial support of this project.

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Table 1.

Treatment/formulation	Rate amt product/acre	28 Aug (pre-treatment) CA per leaf 3-4th node leaf	28 Aug (pre-treatment) CA per leaf lower canopy leaf	28 Aug (pre-treatment) CA per leaf total	31 Aug (3 DAT) CA per leaf 3-4th node leaf	31 Aug (3 DAT) CA per leaf lower canopy leaf	31 Aug (3 DAT) CA per leaf total
Carbine 50WG + COC	1.5 oz + 1% v/v	165.20 a	77.25 a	121.23 a	49.60 bc	43.55 cd	46.58 cd
Trimax Pro 4.44SC + COC	1.8 oz + 1% v/v	104.80 a	104.05 a	104.43 a	60.75 bc	104.10 bc	82.43 bc
Centric 40WP + COC	2.0 oz + 1% v/v	251.55 a	78.55 a	165.05 a	61.45 bc	113.90 b	87.68 bc
Bidrin 8EC + COC	8 fl-oz + 1% v/v	177.95 a	164.35 a	171.15 a	17.00 c	36.15 d	26.58 d
Intruder 70WP + COC	0.6 oz + 1% v/v	127.05 a	77.80 a	102.43 a	27.10 c	41.00 cd	34.05 d
SP 102000022560 SC + UAN 28%	6.0 fl-oz + 2.5% v/v	130.45 a	92.90 a	111.68 a	93.05 b	103.00 bc	98.03 b
SP 102000022560 SC + UAN 28%	8.0 fl-oz + 2.5% v/v	142.90 a	126.55 a	134.73 a	46.85 bc	93.00 bcd	69.93 bcd
Dicortophos 8EC + COC	8 fl-oz + 1% v/v	164.60 a	147.90 a	156.25 a	8.80 c	83.05 bcd	45.93 cd
Untreated	--	169.85 a	160.90 a	165.38 a	199.30 a	185.85 a	192.58 a

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).

Table 2.

Treatment/formulation	Rate amt product/acre	4 Sep (7 DAT) CA per leaf 3-4th node leaf	4 Sep (7 DAT) CA per leaf lower canopy leaf	4 Sep (7 DAT) CA per leaf total	11 Sep (14 DAT) CA per leaf 3-4th node leaf	11 Sep (14 DAT) CA per leaf lower canopy leaf	11 Sep (14 DAT) CA per leaf total
Carbine 50WG + COC	1.5 oz + 1% v/v	26.85 de	21.20 c	24.03 d	1.45 a	4.85 a	3.15 a
Trimax Pro 4.44SC + COC	1.8 oz + 1% v/v	87.95 bc	138.85 b	113.40 bc	27.90 a	49.45 a	38.68 a
Centric 40WP + COC	2.0 oz + 1% v/v	81.00 bcd	143.10 b	112.05 bc	22.45 a	37.65 a	30.05 a
Bidrin 8EC + COC	8 fl-oz + 1% v/v	41.70 cde	52.15 bc	46.93 cd	9.05 a	16.75 a	12.90 a
Intruder 70WP + COC	0.6 oz + 1% v/v	20.20 e	26.65 c	23.93 d	2.05 a	8.70 a	5.38 a
SP 102000022560 SC + UAN 28%	6.0 fl-oz + 2.5% v/v	73.15 bcde	65.95 bc	69.55 bcd	17.80 a	42.40 a	30.10 a
SP 102000022560 SC + UAN 28%	8.0 fl-oz + 2.5% v/v	122.65 b	141.00 b	131.83 b	9.25 a	28.10 a	18.68 a
Dicortophos 8EC + COC	8 fl-oz + 1% v/v	54.00 cde	65.95 bc	59.98 cd	11.25 a	37.65 a	24.45 a
Untreated	--	242.40 a	296.90 a	269.65 a	7.90 a	58.05 a	32.98 a

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).

Table 3.

Treatment/formulation	Rate amt product/acre	Percent reduction on 31 Aug (3 DAT)				
		LB adults	LB larvae	MPB	SPI	Total predators
Carbine 50WG + COC	1.5 oz + 1% v/v	89.17 a	1.84 c	16.42 cd	25.00 b	53.39 ab
Trimax Pro 4.44SC + COC	1.8 oz + 1% v/v	50.00 bc	46.97 abc	66.67 ab	0.00 b	57.22 ab
Centric 40WP + COC	2.0 oz + 1% v/v	66.25 ab	31.82 bc	34.82 abcd	66.67 a	39.37 b
Bidrin 8EC + COC	8 fl-oz + 1% v/v	95.83 a	43.25 abc	49.41 abc	25.00 b	57.95 ab
Intruder 70WP + COC	0.6 oz + 1% v/v	85.83 ab	53.63 ab	52.73 abc	0.00 b	66.92 ab
SP 102000022560 SC + UAN 28%	6.0 fl-oz + 2.5% v/v	25.00 cd	37.28 bc	23.22 bcd	0.00 b	53.18 ab
SP 102000022560 SC + UAN 28%	8.0 fl-oz + 2.5% v/v	60.83 abc	86.07 a	14.88 cd	0.00 b	75.98 a
Dicortophos 8EC + COC	8 fl-oz + 1% v/v	83.13 ab	51.89 ab	67.96 a	0.00 b	77.69 a
Untreated	--	0.00 d	0.00 c	0.00 d	0.00 b	0.00 c

Values followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).
[a]Percentage reduction calculated using Henderson-Tilton's formula.

AgriLIFE EXTENSION
Texas A&M System

Efficacy of Carbine and Intruder towards Cotton Aphids in Cotton, 2009

Cooperators: Texas AgriLife Research & Extension Center – Lubbock,TX

David Kerns, Brant Baugh, Dustin Patman and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Lubbock County, EA-IPM Crosby/Floyd Counties, and Extension Program Specialist-Cotton

Lubbock County

Summary:

Carbine and Intruder have both been shown to be excellent aphicides, in multiple studies in the Texas High Plains. Under very high aphid pressure in 2009, various rates of each of these insecticides was evaluated. At 3 days after treatment (DAT), CAs in the untreated plots had increased and were averaging 425.18 CAs per leaf. Both insecticides at the various rates all had fewer CAs than the untreated throughout the at the 3-4th node leaf position, mid - lower canopy leaves and across both leaf positions, but none of the treatments had reduced the number of aphids below the action threshold of 50 CAs per leaf. At 3 DAT, although there were inconsistencies in rate response within insecticides, Intruder appeared to have more activity than Carbine. This was expected since Carbine tends to be slightly slower acting than Intruder. At 7 DAT, Carbine was exhibiting more activity and was performing equally to Intruder. CA numbers in the untreated had increased to 512.43 CAs per leaf across both leaf potions. At this time all of the treatments had statistically fewer CAs than the untreated. CA numbers had decreased sharply by 14 DAT, and all of the treatments, including the untreated, had dropped below the action threshold.

Objective:

To determine the efficacy of differing rates of Carbine and Intruder targeting cotton aphids.

Materials and Methods:

This test was conducted at the Texas AgriLife Research and Extension Center in Lubbock, TX. DeltaPine 174RF was planted on 9 Jun on 40-inch rows, and was irrigated using row irrigation. The test was a RCB design with four replications. Plots were 4-rows wide × 50 ft in length. Insecticides were applied with a CO_2 pressurized hand-boom sprayer calibrated to deliver 10 gpa through TX-6 hollow cone nozzles (2 per row) at 40 psi. The insecticides to be evaluated were applied to all four rows of each plot on 28 Aug. A crop oil concentrate was added to each treatment at 1% v/v. Treatments were evaluated by counting the number of cotton aphids (CA) from 10, 3 to 4^{th} node leaves (top leaf sample) and 10 leaves from the lower 50% of the plant canopy (lower leaf sample) per plot on 28 and 31 Aug, and 4 and 11 Sep. Data were analyzed with PROC MIXED, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

On 28 Aug, the CA population across all plots was averaging 93.22, 143.58 and 118.40 CAs per leaf on the mid to lower canopy leaves, 3 to 4th node leaves, and averaged across both leaf locations respectively. There were no statistical differences among treatments at this time (Table 1).

On 31 Aug, 3 days after treatment (DAT), CAs in the untreated plots had increased and were averaging 425.18 CAs per leaf. All of the insecticides had fewer CAs than the untreated throughout the at the 3-4^{th} node leaf position, mid - lower canopy leaves and across both leaf positions, but none of the treatments had reduced the number of aphids below the action threshold of 50 CAs per leaf.

At 3 DAT, although there were inconsistencies in rate response within insecticides, Intruder appeared to have more activity than Carbine. At 7 DAT, Carbine was exhibiting more activity and was performing equally to Intruder (Table 2). CA numbers in the untreated had increased to 512.43 CAs per leaf across both leaf potions. At this time all of the treatments had statistically fewer CAs than the untreated. CA numbers had decreased sharply by 14 DAT, and all of the treatments, including the untreated, had dropped below the action threshold. All of the products evaluated demonstrated good mixing and handling characteristics and no phytotoxicity was observed.

Acknowledgments:

Appreciation is expressed to Plains Cotton Growers and ISK Biosciences for financial support of this project.

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Table 1.

Treatment/ formulation	Rate amt product/acre	28 Aug Aug (pre-treatment) CA per leaf 3-4th node leaf	lower canopy leaf	total	31 Aug (3 DAT) CA per leaf 3-4th node leaf	lower canopy leaf	total
Untreated	--	162.20 a	96.75 a	129.48 a	265.35 a	585.00 a	425.18 a
Carbine 50WG	1.4 oz	124.05 a	65.15 a	94.60 a	117.80 b	147.25 bc	132.53 bc
Carbine 50WG	1.7 oz	180.60 a	106.00 a	143.30 a	90.80 bc	197.25 bc	144.03 bc
Carbine 50WG	2.0 oz	108.25 a	76.75 a	92.50 a	60.65 bc	188.25 bc	124.45 bc
Carbine 50WG	2.3 oz	159.10 a	143.95 a	151.53 a	98.95 bc	333.50 b	216.23 b
Intruder 70WP	0.6 oz	177.65 a	100.65 a	139.15 a	53.85 bc	123.75 c	88.80 c
Intruder 70WP	0.75 oz	156.85 a	89.20 a	123.03 a	45.75 c	116.75 c	81.25 c
Intruder 70WP	0.9 oz	115.00 a	104.35 a	109.68 a	44.70 c	185.25 bc	114.98 bc
Intruder 70WP	1.1 oz	108.50 a	56.15 a	82.33 a	83.80 bc	171.75 bc	127.78 bc

Values in a column followed by the same letter are not significantly different based on an F-protected LSD (*P* ≤ 0.05).

Table 2.

Treatment/ formulation	Rate amt product/acre	4 Sep (7 DAT) CA per leaf 3-4th node leaf	lower canopy leaf	total	11 Sep (14 DAT) CA per leaf 3-4th node leaf	lower canopy leaf	total
Untreated	--	319.75 a	385.35 a	512.43 a	9.30 a	17.50 a	18.05 a
Carbine 50WG	1.4 oz	49.95 b	17.45 c	58.68 b	0.90 b	0.5 b	1.15 c
Carbine 50WG	1.7 oz	54.20 b	18.35 c	63.38 b	1.00 b	0.85 b	1.43 c
Carbine 50WG	2.0 oz	21.90 b	17.90 c	30.85 b	1.15 b	1.60 b	1.95 c
Carbine 50WG	2.3 oz	16.20 b	12.45 c	22.43 b	0.90 b	1.35 b	1.58 c
Intruder 70WP	0.6 oz	47.60 b	91.40 b	93.30 b	1.40 b	1.45 b	2.13 c
Intruder 70WP	0.75 oz	62.35 b	23.75 c	74.23 b	1.00 b	2.25 b	2.13 c
Intruder 70WP	0.9 oz	34.75 b	25.55 c	47.53 b	6.05 a	7.25 b	9.68 b
Intruder 70WP	1.1 oz	17.35 b	12.65 c	23.68 b	2.25 b	1.00 b	2.75 c

Values in a column followed by the same letter are not significantly different based on an F-protected LSD (*P* ≤ 0.05).

Potential of Diamond Insecticide for Lygus Management in the Texas High Plains, 2009

Cooperators: Glenn Farms, Cotton Grower / Dana Palmer, Private Consultant / Texas AgriLife Extension Service

David Kerns, Dustin Patman, Brant Baugh, Kerry Siders, Bo Kesey
Extension Entomologist-Cotton, EA-IPM Crosby/Floyd Counties, EA-IPM Lubbock County, EA-IPM Hockley Counties and Extension Program Specialist-Cotton

Hockley County

Summary:

Pretreatment counts showed no significant differences among treatments in the Lygus populations. Post-treatment observations at 7 DAT showed a sharp decline in Lygus densities across all treated plots, while the densities increased in the untreated plots dropped to 4 per 6 ft-row. All treatments showed significant decreases in Lygus populations at 7 DAT. At 14 DAT, all of the treatments had fewer Lygus than the untreated, but Diamond + Acephate was the only treatment that had no Lygus. However, Diamond + Acephate did not significantly differ from Acephate alone, Diamond + Carbine, or Diamond at 9 or 12 fl-oz. Carbine and Diamond at 6 fl-oz appeared weak, but the rate of Carbine tested (1.7 oz) is considerably lower than the recommended rate for Lygus (2.3 oz). The low rate was tested to determine if there was an additive effect when combined with a low rate of Diamond (6 fl-oz). These data suggest that combining the two low rates of Diamond and Carbine may be a viable strategy for managing mixed populations of adult and immature Lygus. Based on external Lygus feeding stings, all of the treatments had fewer stings than the untreated 7 DAT. Treatments containing Acephate had the fewest stings but did not statistically differ from Diamond at 9 fl-oz, Carbine or Diamond + Carbine. Based on simple linear regression, when sampling dime sized bolls, one might expect to find about 17 damaged locules per 100 stings. When looking across several similar studies relationships between external damage and yield were evident. Although the R^2 was much lower than desired, it appears that notable yield reduction may occur when 100 bolls average 1 sting per boll. This suggests that a Lygus treatment action threshold may be developed utilizing external damage as the determining factor. Approximately 100 stings would equate to 16-17 damaged locules per 100 bolls.

Objective:

This test was designed to evaluate the efficacy of Diamond (novaluron) insecticide alone or mixed with adulticidal insecticides for managing late season infestations of Lygus, to quantify external and internal damage on bolls, and impact on yield.

Materials and Methods:

This study was conducted west of Wolfforth, TX, in Hockley Co. Cotton 'FiberMax 9063B2F' was planted on May 15, 2009, and irrigated using sub-surface drip irrigation. The test was a RCB design with 4 replicates. Plots were 4 rows × 60 ft in length. Treatments are listed in Table 1.

The Lygus populations were estimated by drop cloth method (3 ft x 2 ft) and expressed as mean density/6 ft-row (Figure 1). Bolls of approximately 10 to 20-mm diameter (~150 to 200 HU maturity) were collected at random from each plot for damage assessment. Lygus population counts were made at 0, 7, 14 and 21 DAT, and boll samples were collected at 0 and 7 DAT.

Pre-treatment observations on Lygus densities and boll samples were taken on August 20, 2009. Fifteen bolls were collected from each plot to assess external and internal damage. The samples were collected in Ziploc bags and stored in a refrigerator until damage observations were recorded. The insecticide application was made on August 20 using a four nozzle CO_2 pressurized hand boom sprayer with a discharge rate of 10 gallons/acre.

The external damage assessment was made by counting the number of feeding punctures using a 10× magnifying lens (Figure 2a). For internal damage, bolls were cut cross sectional with two cuts, one at about one third and next at two thirds from the tip (Figure 2b). The number of locules damaged were counted and recorded as internal damage.

The plots were harvested on November 10 using an HB hand stripper. A 1/1000th acre section was harvested from the middle two rows of each plot. Samples were ginned at Texas AgriLife Ginning Facility in Lubbock.

Data were analyzed using PROC MIXED and means separated using protected LSD ($P \leq 0.05$). The relationship between external and internal damage, and yield and external damage was made using linear regression analyses. Data from other Lygus tests were included in these analyses for a more robust data set.

Results and Discussion:

Pretreatment counts taken on August 21 (0 DAT) showed no significant differences among treatments in the Lygus populations (Figure 1a). At this time, Lygus were averaging 12.26 per 6 ft-row, well above the action threshold of 4 per 6 ft-row.

Post-treatment observations at 7 DAT showed a sharp decline in Lygus densities across all treated plots, while the densities in the untreated plots dropped to 4 per 6 ft-row (Figure 1b). The Lygus population continued to drop across all plots at 14 and 21 DAT indicating that the initial infestation was probably a solitary event originating from a nearby alfalfa field that had been recently cut (Figures 2a & b).

At 14 DAT, all of the treatments had fewer Lygus than the untreated, but Diamond + Acephate was the only treatment that had no Lygus. However, Diamond + Acephate did not significantly differ from Acephate alone, Diamond + Carbine, or Diamond at 9 or 12 fl-oz. Carbine and Diamond at 6 fl-oz appeared weak, but the rate of Carbine tested (1.7 oz) is considerably lower than the recommended rate for Lygus (2.3 oz). The low rate was tested to determine if there was an additive effect when combined with a low rate of Diamond (6 fl-oz). These data suggest that combining the two low rates of Diamond and Carbine may be a viable strategy for managing mixed populations of adult and immature Lygus.

Based on external Lygus feeding stings, all of the treatments had fewer stings than the untreated 7 DAT (Figure 3a). Treatments containing Acephate had the fewest stings but did not statistically differ from Diamond at 9 fl-oz, Carbine or Diamond + Carbine. The damage relationships among treatments were similar for internal injury or the number of damaged locules per 100 bolls (Figure 3b). As expected there is a very close relationship between external stings and internal damage. Based on simple linear regression, when sampling dime sized bolls, one might expect to find about 17 damaged locules per 100 stings (Figure 4).

Yield differences could not be detected in this test, possibly because of stand issues in some plots associated with hail events early in the season (Figure 5a). However, when looking across several similar studies relationships between external damage and yield were evident. Although the R^2 was much lower than desired, it appears that notable yield reduction may occur when 100 bolls average 1 sting per boll (Figure 5b). This suggests that a Lygus treatment action threshold may be developed utilizing external damage as the determining factor. Based on Figure 7, 100 stings would equate to 16-17 damaged locules per 100 bolls.

Acknowledgments:

Appreciation is expressed to Plains Cotton Growers for financial support of this project.

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Table 1. Insecticides evaluated rates, classification and MOA.

Insecticide	Active Ingredient	Rate applied (per acre)	Classification	Mode of Action
Diamond 0.83 EC		6 fl-oz		
Diamond 0.83 EC	Novaluron	9 fl-oz	Benzoylurea	Chitin biosynthesis inhibitor
Diamond 0.83 EC		12 fl-oz		
Carbine 50 WG	Flonicamid	1.7 oz	Flonicamid	Feeding blocker
Acephate 97	Acephate	0.75 lbs	Organophosphate	Acetylcholine esterase inhibitor
Diamond 0.83 EC + Carbine 50 WG	Novaluron + Flonicamid	6 fl-oz + 1.7 oz		
Diamond 0.83 EC + Acephate 97	Novaluron + Flonicamid	6 fl-oz + 0.75 lbs		

All treatments included Dyne-Amic non-ionic surfactant at 0.375% v/v

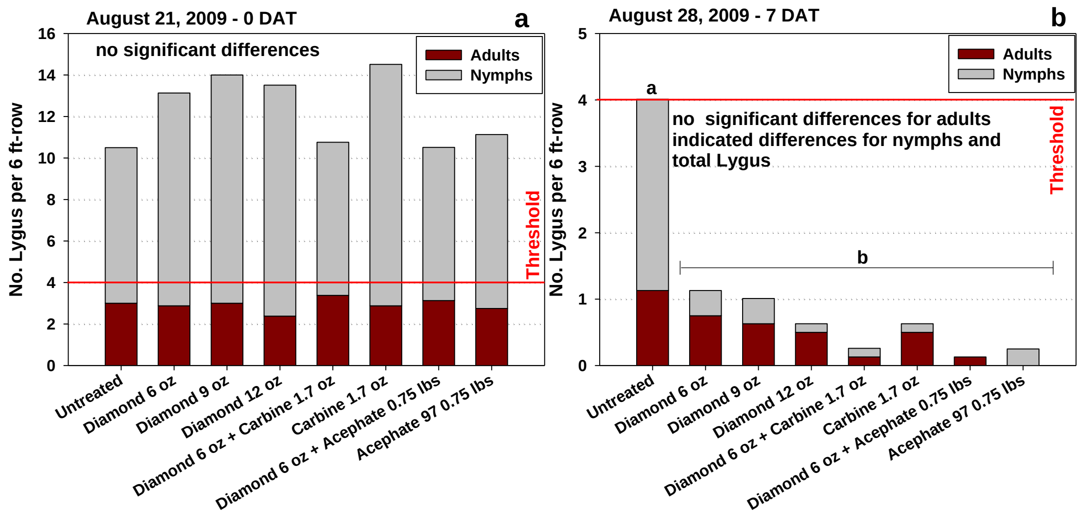

Figure 1. Lygus populations at 0 DAT (a) and 7 DAT (b). Bars capped by the same letter are not significantly different based on PROC MIXED and means separated using protected LSD (*P* ≤ 0.05).

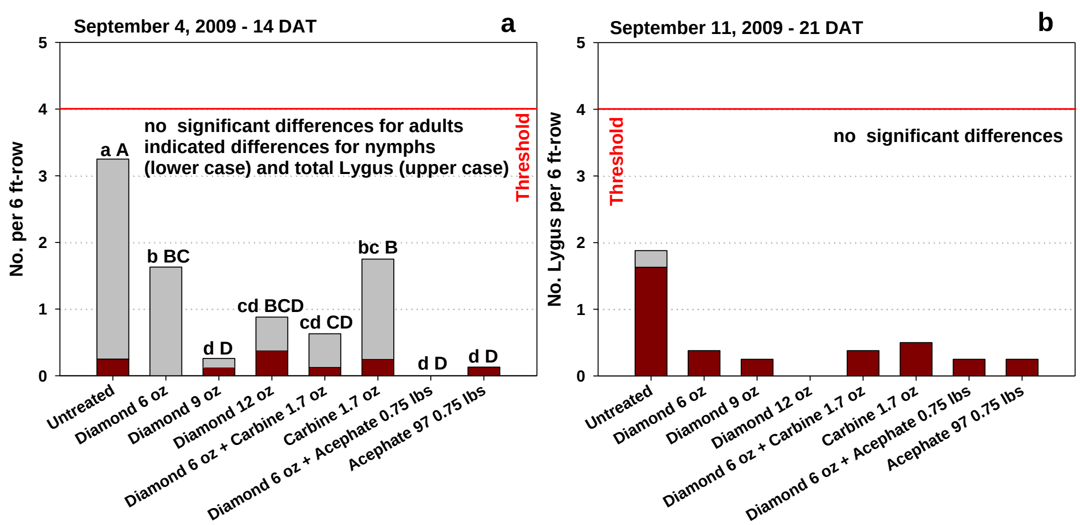

Figure 2. Lygus populations at 14 DAT (a) and 21 DAT (b). Bars capped by the same letter are not significantly different based on PROC MIXED and means separated using protected LSD (*P* ≤ 0.05).

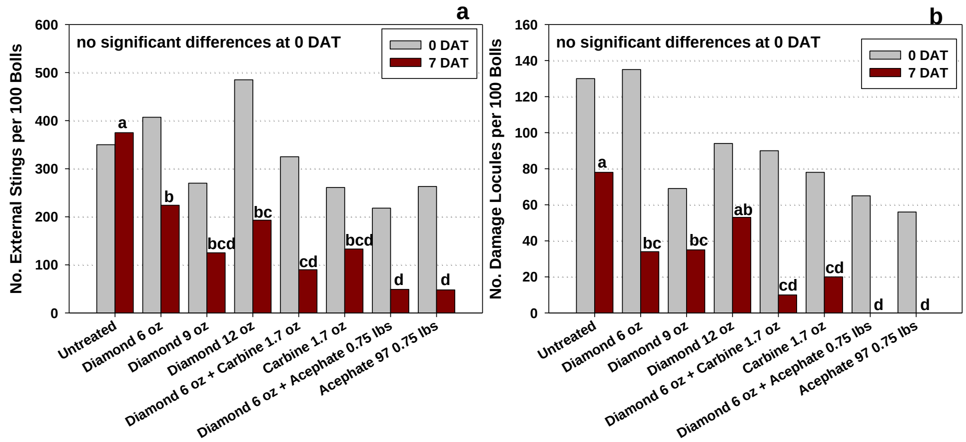

Figure 3. Impact of insecticides on preventing external Lygus stings (a) and internal damage (b) to bolls. Same colored bars capped by the same letter are not significantly different based on PROC MIXED and means separated using protected LSD ($P \leq 0.05$).

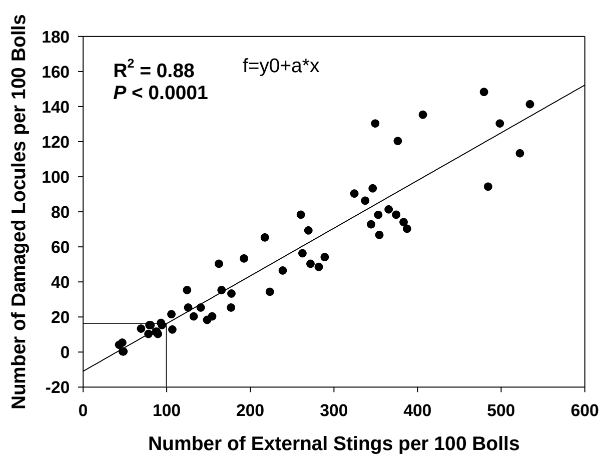

Figure 4. Relationship between the external and internal Lygus damage to dime sized (10-20 mm diameter) bolls.

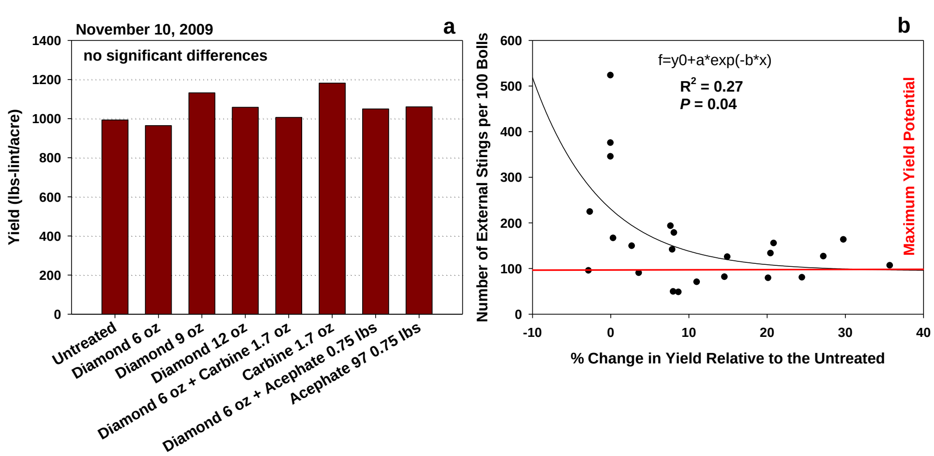

Figure 5. Yield (a) and the relationship between external damage and maximize yield through protection from Lygus (b).

Evaluation of Insecticides for Control of Western Tarnished Plant Bug in Cotton, 2009

Cooperators: Richard Boozer, Boozer Farms, Cotton Grower / Texas AgriLife Extension Service

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Extension Entomologist-Cotton, EA-IPM Bailey County, EA-IPM Lubbock County, EA-IPM Castro County, and Extension Program Specialist-Cotton

Castro County

Summary:

Lygus in this test began slightly above the recommended action threshold for treating, but declined as the test progressed. Thus product assessment was made under low Lygus populations and may have been different had the population been higher. The insecticides tested included Carbine, Hero, Vydate, Orthene, Brigadier (mix of imidacloprid and bifenthrin) and two rates of SP 102000022560 (mix of imidacloprid and spirotetramat). At 3 DAT, there were no significant differences among treatments for adults, and all of the insecticide treatments had fewer nymphs and total Lygus than the untreated. Similarly at 7 DAT, there were no significant differences among treatments for adult Lygus. All of the insecticides had fewer nymphs than the untreated, but SP 102000022560 at 8 fl-oz, Hero and Orthene had significantly fewer nymphs than SP 102000022560 at 6 fl-oz. Additionally, SP 102000022560 at 8 fl-oz and Hero had fewer total Lygus than SP 1020000250 at 6 fl-oz. Overall, at low and declining WTPB numbers, SP102000022560 did not perform well at the 6 fl-oz rate, while the high rate and the other insecticides demonstrated acceptable efficacy.

Objective:

The objective of this test was to evaluate various insecticides, some at below normal use rates, against Lygus in the Texas High Plains.

Materials and Methods:

This test was conducted in a commercial cotton field near Dimmitt, TX. FiberMax 9058F was planted on 11 May on 40-inch rows, and irrigated using furrow irrigation. The test was a RCB design with four replications. Plots were 4-rows wide × 60 ft in length. Insecticides were applied with a CO_2 pressurized hand-boom sprayer calibrated to deliver 10 gpa through TX-6 hollow cone nozzles (2 per row) at 40 psi. Insecticides were applied to the all four rows of each plot on 31 Aug.

Western tarnished plant bug (WTPB) populations were estimated on 31 Aug, and 3 and 7 Sep utilizing a 36-inch x 40-inch black drop cloth. Drop cloths were laid between the rows and approximately 1.5 row-ft of cotton were shaken onto the drop cloth from each row; four drop cloth samples were taken per plot. Data were analyzed with ANOVA, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

On 31 Aug (pretreatment count), the WTPB population was averaging 1.28, 2.93 and 4.21 adults, nymphs and total WTPB per 6 ft-row across all plots, and no statistical differences were detected among treatments for nymphs, adults or total WTPBs. The action threshold for WTPB in Texas in post bloom cotton is 4 per 6 ft-row. Thus, WTPBs in this test slightly exceeded the action threshold.

At 3 DAT, the WTPB population had declined across all plots and although there were no significant differences among treatments for adults, all of the insecticide treatments had fewer nymphs and total WTPBs than the untreated. Similarly at 7 DAT, there were no significant differences among treatments for adult WTPBs. Against WTPB nymphs, all of the insecticides had fewer nymphs than the untreated, but SP 102000022560 at 8 fl-oz, Hero and Orthene had significantly fewer nymphs than SP 102000022560 at 6 fl-oz. Additionally, SP 102000022560 at 8 fl-oz and Hero had fewer total WTPBs than SP 1020000250 at 6 fl-oz. Overall, at low and declining WTPB numbers, SP102000022560 did not perform well at the 6 fl-oz rate, while the high rate and the other insecticides demonstrated acceptable efficacy. Insecticide handling properties were good and no phytotoxicity was detected.

Acknowledgments:

Appreciation is expressed to Plains Cotton Growers, Bayer CropScience, Dupont Crop Protection and FMC Corporation Agricultural for financial support of this project.

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Treatment/ formulation	Rate amt product/acre	WTPB per 6 ft-row: 31 Aug (pre-treatment) nymphs	adults	total	3 Sep (3 DAT) nymphs	adults	total	7 Sep (7 DAT) nymphs	adults	total
Untreated	--	2.88 a	1.00 a	3.88 a	1.25 a	0.75 a	2.00 a	1.38 a	0.25 a	1.63 a
SP 102000022560 SC + UAN 28%	6.0 fl-oz + 2.5% v/v	3.63 a	1.00 a	4.63 a	0.63 b	0.13 a	0.75 b	0.50 b	0.13 a	0.63 b
SP 102000022560 SC + UAN 28%	8.0 fl-oz + 2.5% v/v	2.50 a	1.00 a	3.50 a	0.13 b	0.38 a	0.50 b	0.00 c	0.00 a	0.00 c
Hero 1.24EC + COC	7.23 fl-oz + 1% v/v	3.25 a	1.38 a	4.63 a	0.13 b	0.13 a	0.25 b	0.00 c	0.00 a	0.00 c
Brigadier 2SC + COC	6.4 fl-oz + 1% v/v	2.75 a	1.50 a	4.25 a	0.13 b	0.13 a	0.25 b	0.13 bc	0.00 a	0.13 bc
Vydate C-LV 3.77 + COC	12.7 fl-oz + 1% v/v	3.38 a	1.13 a	4.50 a	0.00 b	0.13 a	0.13 b	0.13 bc	0.00 a	0.13 bc
Orthene 97 + COC	0.5 lbs + 1% v/v	2.63 a	1.50 a	4.13 a	0.25 b	0.00 a	0.25 b	0.00 c	0.13 a	0.13 bc
Carbine 50WG + COC	2.3 oz + 1% v/v	2.38 a	1.75 a	4.13	0.25 b	0.25 a	0.50 b	0.13 bc	0.00 a	0.13 bc

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).

AgriLIFE EXTENSION
Texas A&M System

Evaluation of Imidacloprid/Spirotetramat Pre-Mix for Control of Western Tarnished Plant Bug in Cotton, 2009

Cooperators: Glenn Farms, Cotton Grower / Dana Palmer, Private Consultant / Texas AgriLife Extension Service

Kerry Siders, David Kerns
EA-IPM Hockley/Cochran Counties, Extension Entomologist-Cotton

Hockley County

Summary:

On 26 Aug (pretreatment count), the Lygus population was averaging 11.50 per 6 ft-row across all plots, and no statistical differences were detected among treatments for nymphs, adults or total Lygus. At 5 DAT all of the insecticide treatments had fewer adults and total Lygus than the untreated, while Baythroid was the only treatment to differ from the untreated for nymphs. Additionally, Baythroid contained significantly fewer total Lygus than either rate of SP 102000022560 (pre-mix of imidacloprid + spirotetramat). By 9 DAT the Lygus population had decreased across all plots and there were no significant differences among treatments for nymphs. However, the Baythroid-treated plots contained fewer adults and total Lygus than any other treatment. SP 102000022560 at 6 fl-oz did not differ from the untreated at 9 DAT, while the 8 fl-oz rate had significantly fewer adults than the untreated. Overall, Baythroid was the most efficacious treatment evaluated while SP 102000022560 provided marginal, short lived control.

Objective:

The objective of this test was to evaluate a new insecticide SP 102000022560 (pre-mix of imidacloprid + spirotetramat) for Lygus control relative to a standard.

Materials and Methods:

This test was conducted in a commercial cotton field near Wolfforth, TX. FiberMax 9063B2F was planted on 15 May on 40-inch rows, and irrigated using a drip irrigation system. The test was a RCB design with four replications. Plots were 4-rows wide × 60 ft in length. Insecticides were applied with a self propelled Lee Spider sprayer calibrated to deliver 19 gpa through 8002E nozzles (2 per row) at 30 psi. Insecticides were applied to the all four rows of each plot on 26 Aug. Western Tarnished Plant Bug (WTPB) populations were estimated on 26 and 31 Aug, and 4 Sep utilizing a 36-inch x 40-inch black drop cloth. Drop cloths were laid between the rows and approximately 1.5 row-ft of cotton were shaken onto the drop cloth from each row; four drop cloth samples were taken per plot. Data were analyzed with ANOVA, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

On 26 Aug (pretreatment count), the WTPB population was averaging 11.50 per 6 ft-row across all plots, and no statistical differences were detected among treatments for nymphs, adults or total WTPBs. At 5 DAT all of the insecticide treatments had fewer adults and total WTPBs than the untreated, while Baythroid was the only treatment to differ from the untreated for nymphs. Additionally, Baythroid contained significantly fewer total WTPB than either rate of SP 102000022560 (pre-mix of imidacloprid + spirotetramat). By 9 DAT the WTPB population had decreased across all plots and there were no significant differences among treatments for nymphs. However, the Baythroid-treated plots contained fewer adults and total WTPBs than any other treatment. SP 102000022560 at 6 fl-oz did not differ from the untreated at 9 DAT, while the 8 fl-oz rate had significantly fewer adults than the untreated. Overall, Baythroid was the most efficacious treatment evaluated while SP 102000022560 provided marginal, short lived control. Insecticide handling properties were good and no phytotoxicity was detected.

Acknowledgments:

Appreciation is expressed Bayer CropScience for financial support of this project.

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Treatment/ formulation	Rate amt product/acre	WTPB per 6 ft-row								
		26 Aug (pre-treatment)			31 Aug (5 DAT)			4 Sep (9 DAT)		
		nymphs	adults	total	nymphs	adults	total	nymphs	adults	total
Untreated	--	5.50 a	5.63 a	11.13 a	3.88 a	5.50 a	9.38 a	0.63 a	3.13 a	3.75 a
SP 102000022560 SC + UAN 28%	6.0 fl-oz + 2.5% v/v	6.00 a	6.13 a	11.38 a	2.63 a	2.13 b	4.75 b	0.63 a	3.00 ab	3.63 a
SP 102000022560 SC + UAN 28%	8.0 fl-oz + 2.5% v/v	5.25 a	5.75 a	11.75 a	2.50 ab	2.25 b	4.75 b	0.38 a	1.75 b	2.13 a
Baythroid XL	2.6 fl-oz	5.88 a	5.88 a	11.75 a	0.00 b	0.13 b	0.13 c	0.00 a	0.00 c	0.00 b

Values in a column followed by the same letter are not significantly different based on an F-protected LSD ($P \leq 0.05$).

Impact of Pre-Bloom Square Loss on Yield in Late Planted Cotton in the Texas High Plains

Cooperators: Texas AgriLife Extension Service

David Kerns, Tommy Doederlein, Brant Baugh, Dustin Patman and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Lynn/Dawson Counties, EA-IPM Lubbock County, EA-IPM Crosby/Floyd Counties and Extension Program Specialist-Cotton

Lubbock County

Summary:

It is not uncommon for the High Plains cotton crop to be late planted due to environmental conditions. There has been research demonstrating the extraordinary capability of cotton to compensate for pre-bloom square loss. However, when cotton is planted late in a shortened season, the ability of the cotton to compensate is questionable. There were four treatments which consisted in manual square removal on pre-bloom cotton. There were no significant differences in yield or five of six HVI lint quality factors. The impact of early-season square loss was evident in its impact on fruit location and on fiber maturity. There appeared to be a trend demonstrating that loan values suffer with increasing early-season square loss. There is evidence that cotton will compensate for early-season square loss. However, stress factors that lower the boll carrying capacity may give the illusion of compensation when in fact it may not have occurred. Capping boll carrying capacity was evident by the trend towards higher micronaire where natural square retention was lower; this suggest that bolls that may have produced immature fiber were shed and compensated bolls tended to be more immature.

Objective:

To determine the impact of pre-bloom square loss on the yield of late-planted cotton, the impact of pre-bloom square loss on lint quality of late-planted cotton and if compensation occurs, determine where compensation occurs on the plant.

Materials and Methods:

This test was conducted at Glover Farm of the Texas AgriLife Research and Extension Center in Lubbock, TX. Cotton, 'Phytogen 375 WRF' was planted on June 1, 2009 on 40-inch rows and was irrigated as needed using furrow run irrigation. Plots were 1-row wide × 14-feet long. The test was a randomized complete block design with 4 replicates. Plots were evenly thinned to 35 plants per plot (32,670 plants per acre) on July 12, 2009. All abnormally small or deformed plants were removed leaving a uniform plant population.

Treatments consisted of 0, 30, 50 and 100% manual square removal on pre-bloom cotton. On July 12, 2009, all of the squares in each plot were counted and numbered. The numbered squares from each plot were then randomized and based on the percentage to be removed; squares were randomly selected for removal. Square slated for removal were removed using fine forceps on July 13, 2009. At that time the plants were approximately 18 days into squaring and at approximately 13-14 nodes.

At harvest on October 30, 10 consecutive plants from each plot were plant mapped, and the entire plot was hand harvested. Samples were ginned at Texas AgriLife Ginning Facility in Lubbock. Lint samples were submitted to the International Textile Center at Texas Tech University for HVI analysis, and USDA Commodity Credit Corporation (CCC) Loan values were determined for each treatment by plot. All count data were analyzed using PROC GLM and the means were separated using an F protected LSD ($P \leq 0.05$). Relationships were determined by using linear regression models, and distribution data were analyzed with PROC FREQ and differences in distribution relative to the 0% square removal treatment was determined using Chi-square tests ($P \leq 0.05$).

Results and Discussion:

We could not detect any differences in yield (Figure 1A) or any lint qualitative factors (micronaire, staple length, uniformity, elongation and color) with the exception of lint strength (Figure 1B). The reason for the lack of differences in yield are not certain, but may include yield compensation, stress induced limited fruit carrying capacity or a combination of these factors. This test did suffer water stress the last week of June due to delayed irrigation. Regardless of the reason for a lack of yield differences among treatments, the impact of early-season square loss was evident in its impact on fruit location and on fiber maturity.

At harvest, plants that had no squares removed had significantly more 1st position bolls than plants where 100% of the squares were removed (Figure 2A). Similarly, the frequency of boll distribution (1st, 2nd and 3rd positions) was different between 0 and 100% square removal (Figure 2B). Neither 30 nor 50% square removal treatments differed from the 0% removal treatment.

There were also differences in boll distribution vertically within the plant canopy. When looking at the number of fruit at nodes 13 and lower, there were significantly more bolls where there were no squares removed relative to the other treatments (Figure 3A). Although the 30 and 50% square removal treatments did not differ from each other, both had significantly more bolls at nodes 13 or lower relative to the 100% removal treatment. There were no differences among treatments in the total number of bolls per plant, suggesting either compensation in the addition of upper canopy bolls in the 30, 50 and 100% square removal treatments, or all treatments reaching a stress induced boll carrying capacity. The 100% square removal treatment was the only treatment where the vertical distribution of bolls (nodes ≤ 13 vs. nodes ≥ 14) differed from the 0% square removal treatment (Figure 3B). These data suggest that boll distribution is affected somewhere between 50 and 100% square loss on cotton in the 18th day of squaring, and that the greatest difference occurs based on vertical distribution rather than horizontal (within a branch fruit position).

Because the frequency of bolls in the 100% square removal treatment were higher on the plant and further out on individual fruiting branches, we would expect this treatment to suffer boll maturity problems regardless of yield; yet we did not detect differences among treatments in micronaire. However some linear trends were observed. Micronaire appears to decline in relation to increased square removal, although more data points are required to strengthen the model (Figure 4A). In support of this data, fruit retention based on individual plots demonstrates that micronaire declines with higher fruit retention (Figure 4B). This data supports the premise that stress was limiting boll load and essentially equating yield and boll density across treatments. Plots that shed the most upper fruit (low quality), regardless of treatment, trended towards the highest micronaire.

Another measure of boll maturity is fiber strength. As previously noted, the 100% square removal treatment had weaker fiber than the other treatments (Figure 1B). There was a strong correlation between the % of squares removed and strength (Figure 5). Fiber strength declined as a higher percentage of squares were removed. This data suggest that some compensation was taking place and that the compensated bolls were immature and suffered in fiber strength.

A similar relationship was noted for loan value. Although the 100% square removal treatment was the only treatment that differed from the 0% square removal, having a lower loan value (Figure 6A). There appeared to be a trend demonstrating that loan values suffer with increasing early-season square loss, but more data points are needed to strengthen the model (Figure 6B).

Acknowledgments:

Appreciation is expressed to Plains Cotton Growers, Inc. for partial financial support of this study and to Dr. Randy Boman for growing the cotton and allowing us to utilize it.

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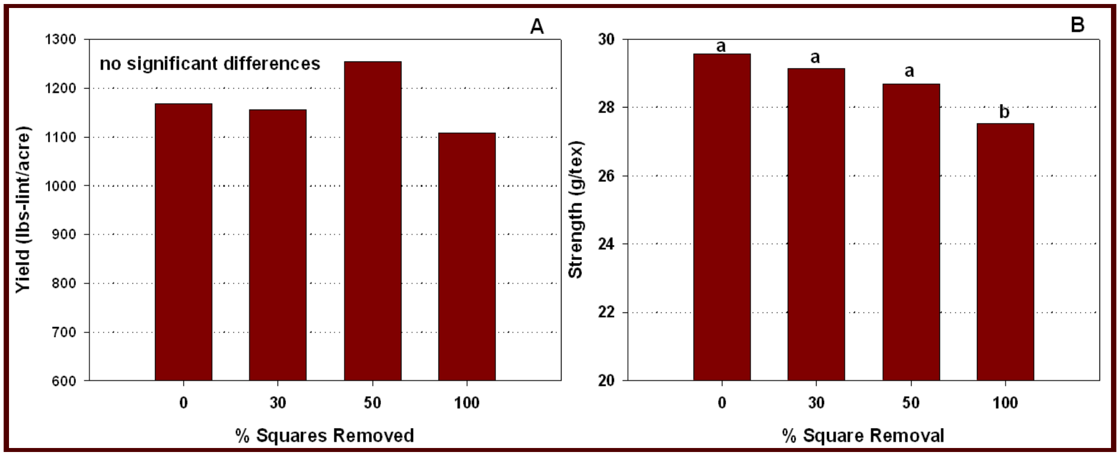

Figure 1. (A) Yield and (B) fiber strength of cotton subjected to 0, 30, 50 or 100% square removal at 13 node stage. Bars capped with the same letter are not significantly different based on GLM and a *F* protected (LSD, $P < 0.05$).

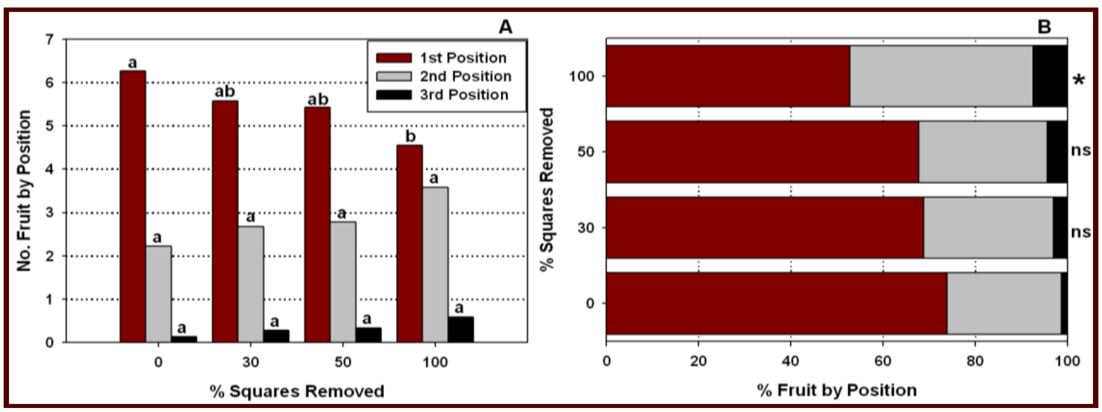

Figure 2. (A) Number of bolls per plant subjected to 0, 30, 50 or 100% square removal at 13 node stage. Same colored bars capped with the same letter are not significantly different based on GLM and a *F* protected (LSD, $P < 0.05$). (B) Distribution frequency of bolls, * denotes significant difference from the 0% square removal base on PROC FREQ and Chi-square tests ($P \leq 0.05$).

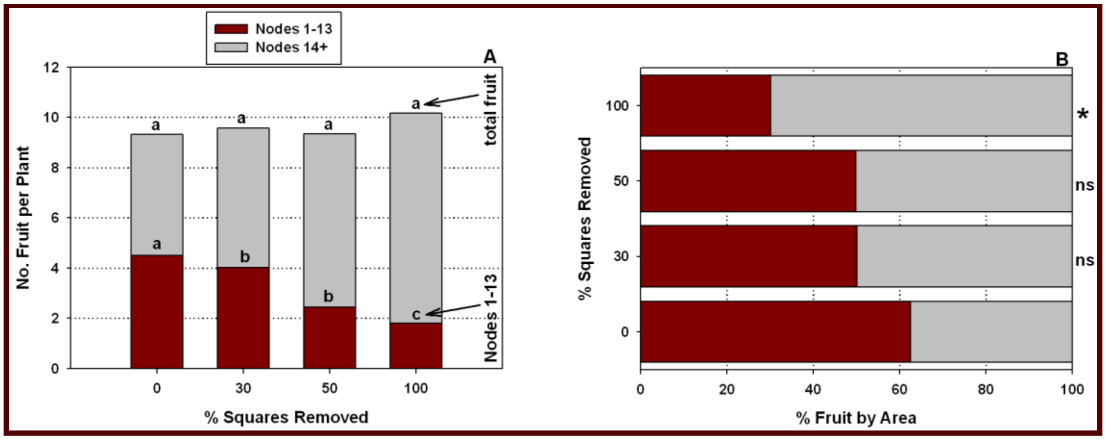

Figure 3. (A) Number of bolls per plant subjected to 0, 30, 50 or 100% square removal at 13 node stage. Same colored bars capped with the same letter are not significantly different based on GLM and a *F* protected (LSD, $P < 0.05$). (B) Distribution frequency of bolls, * denotes significant difference from the 0% square removal base on PROC FREQ and Chi-square tests ($P \leq 0.05$).

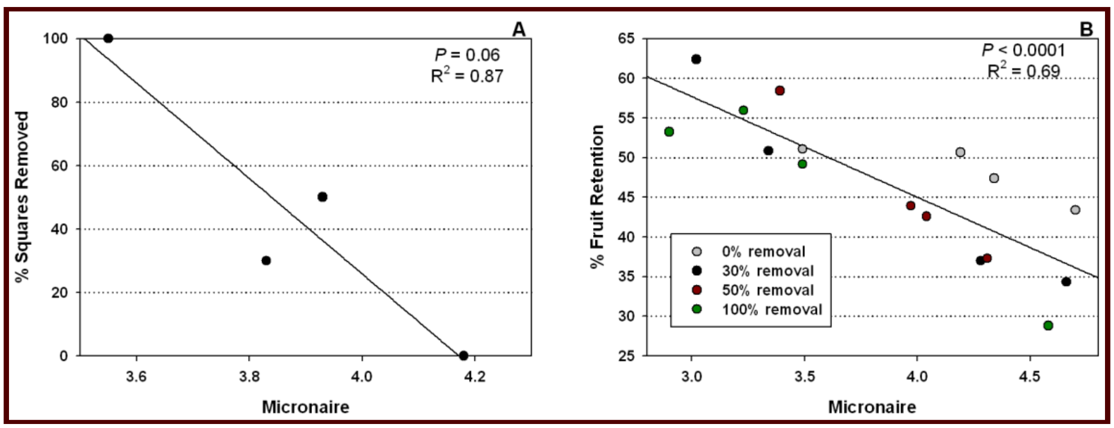

Figure 4. (A) Simple linear relationship between fiber micronaire and percentage of squares removed. (B) Simple linear relationship between fiber micronaire and percentage fruit retention.

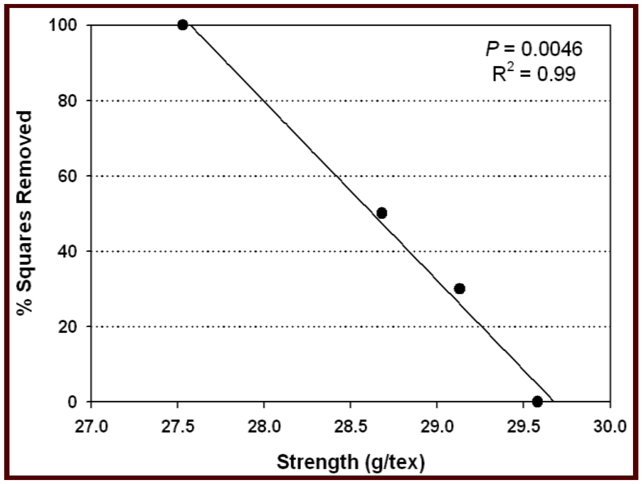

Figure 5. Simple linear relationship between fiber strength and percentage of squares removed.

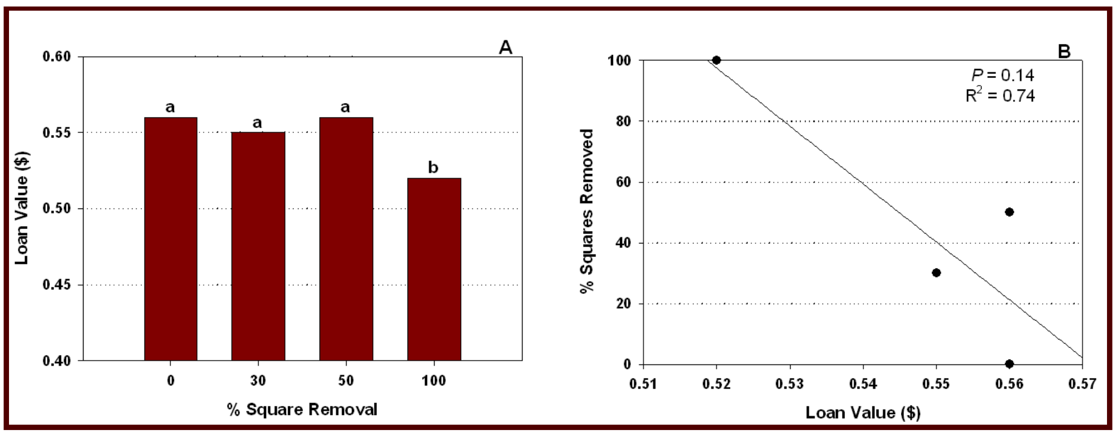

Figure 6. (A) Loan value of cotton subjected to 0, 30, 50 or 100% square removal at 13 node stage. Bars capped with the same letter are not significantly different based on GLM and a *F* protected (LSD, $P < 0.05$). (B) Simple linear relationship between loan value and percentage of squares removed.

Evaluation of Insecticides for Beet Armyworm Control in Cotton, 2009

Cooperators: Texas AgriLife Research & Extension Center – Lubbock

David Kerns, Brant Baugh, Dustin Patman and Bo Kesey
Extension Entomologist-Cotton, EA-IPM Lubbock County,
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Lubbock County

Summary:

Beet armyworm (BAW), *Spodoptera exigua*, is an occasional pest of cotton in Texas and is often flared by pyrethroid applications targeting Lygus or bollworms. Diamond (novaluron) is an insect growth regulator that interferes with chitin synthesis and has activity on various lepidopterous pests and Lygus. Although harsh against some insect predators, Diamond is reportedly relatively soft on most and may be a good choice for managing BAW in cotton when Lygus are also present. Belt (flubendiamide) is a new insecticide that acts as a muscle poison, and has been shown to have excellent BAW activity in a previous study. Other studies also suggest that it has good bollworm activity at higher rates. However, the higher rate is probably not necessary for effective beet armyworms control, so in this test a lower rate was evaluated. Intrepid was utilized as a standard in this test. The BAW populations was not especially high in this test and before treatment was averaging 2.50, 3.44, 2.81 and 8.75 small, medium, large and total BAW larvae per 6-ft-row. Although all of the products evaluated are relatively slow acting, there were some differences detected among treatments at 3 days after treatment (DAT). Among the insecticides, Diamond at 3 fl-oz had the fewest medium-sized BAWs, but did not differ from Diamond at 9 or 12 fl-oz, Diamond + Intrepid or Belt. Based on total larvae, Diamond at 12 fl-oz had the fewest BAWs, but did not differ from Diamond at 3 or 9 fl-oz, Diamond + Intrepid or Belt. Because all of the products tested are relatively slow acting, the 3 DAT results are questionable. At 7 DAT, all of the insecticides had fewer large-sized and total BAWs than the untreated, but did not differ among each other. Prior to spraying, there were no differences among treatments in the percentage of damaged squares. AT 7 DAT, neither Belt nor Diamond at 3 fl-oz differed from the untreated in damaged squares. None of the remaining treatments contained damaged squares but did not differ statistically from Belt. Because of the damage ratings, further evaluation of Belt at 2 fl-oz and Diamond at 3 fl-oz is needed to fully support recommendation at these rates.

Objective:

To determine the efficacy of various rates of Diamond and other insecticides towards beet armyworms.

Materials and Methods:

This test was conducted at the Texas AgriLife Research and Extension Center in Lubbock, TX. DeltaPine 174 RF was planted on 9 Jun on 40-inch rows, and was irrigated using row irrigation. The test was a RCB design with four replications. Plots were 4-rows wide × 50 ft in length. Insecticides were applied on 2 Sep with a CO_2 pressurized hand-boom sprayer calibrated to deliver 10 gpa through TX-6 hollow cone nozzles (2 per row) at 40 psi. All treatments included MSO at 1.88% v/v.

The beet armyworm (BAW) population was estimated on 1, 5 and 9 Sep utilizing a 36-inch x 40-inch black drop cloth. Drop cloths were laid between the rows and approximately 1.5 row-ft of cotton were shaken onto the drop cloth from each row, the number and size, small (< 0.25 inch), medium (0.25-0.625 inch) and large (> 0.625 inch), of BAW larvae were counted. On 2 and 9 Sep, 20 squares were collected from each plot and the number of damaged squares were counted. Damaged squares were those with full feeding penetration into the interior of the flower bud. All data were analyzed using PROC MIXED, and means were separated using an F-protected LSD ($P \leq 0.05$).

Results and Discussion:

Prior to insecticide application, the BAWs were averaging 2.50, 3.44, 2.81 and 8.75 small, medium, large and total BAW larvae per 6-ft-row. At this time there were no significant differences among treatments (Table 1).

At 3 DAT, all of the insecticide treatments except Intrepid contained fewer medium larvae than the untreated. Among the insecticides, Diamond at 3 fl-oz had the fewest medium-sized BAWs, but did not differ from Diamond at 9 or 12 fl-oz, Diamond + Intrepid or Belt. Based on total larvae, Diamond at 12 fl-oz had the fewest BAWs, but did not differ from Diamond at 3 or 9 fl-oz, Diamond + Intrepid or Belt. Because all of the products tested are relatively slow acting, the 3 DAT results are questionable.

At 7 DAT, all of the products evaluated had sufficient time to exhibit full activity. At this time the number of small and medium larvae had declined substantially, suggesting an aging and stagnant population. However, all of the insecticides had fewer large-sized and total BAWs than the untreated, but did not differ among each other. Prior to spraying, there were no differences among treatments in the percentage of damaged squares (Table 2). AT 7 DAT, neither Belt nor Diamond at 3 fl-oz differed from the untreated in damaged squares. None of the remaining treatments contained damaged squares but did not differ statistically from Belt. No phytotoxicity from any insecticide was observed in this test.

Acknowledgments:

Appreciation is expressed to Plains Cotton Growers, Makhteshim Agan of North America, Inc. and Bayer CropScience for financial support of this project.

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Table 1.

Treatment/ formulation[a]	Rate amt product/acre	Number of BAW per 12 ft-row											
		1 Sep (pre-treatment)				5 Sep (3 DAT)				9 Sep (7 DAT)			
		small	medium	large	total	small	medium	large	total	small	medium	large	total
Untreated	--	3.50 a	5.00 a	1.25 a	9.75 a	1.75 a	3.25 ab	1.75 a	6.75 a	0.00 a	1.00 a	3.00 a	4.00 a
Diamond 0.83EC	3 fl-oz	2.50 a	4.50 a	4.00 a	11.00 a	2.00 a	0.00 d	0.50 a	2.50 bc	0.00 a	0.50 a	0.25 b	0.75 b
Diamond 0.83EC	6 fl-oz	0.75 a	2.50 a	2.00 a	5.25 a	2.75 a	1.75 bc	0.50 a	5.00 ab	0.00 a	0.50 a	0.25 b	0.75 b
Diamond 0.83EC	9 fl-oz	2.50 a	5.00 a	1.25 a	8.75 a	1.25 a	0.50 cd	0.75 a	2.50 bc	0.00 a	0.00 a	0.00 b	0.00 b
Diamond 0.83EC	12 fl-oz	1.00 a	0.75 a	4.00 a	5.75 a	0.50 a	0.50 cd	0.50 a	1.50 c	0.00 a	0.00 a	0.50 b	0.50 b
Diamond 0.83EC + Intrepid 2F	3 fl-oz + 4 fl-oz	7.00 a	5.50 a	2.75 a	15.25 a	0.50 a	1.25 cd	0.25 a	2.00 bc	0.00 a	0.25 a	0.00 b	0.25 b
Intrepid 2F	6 fl-oz	0.75 a	2.75 a	4.50 a	8.00 a	1.25 a	4.25 a	1.50 a	7.00 a	0.25 a	0.25 a	0.25 b	0.75 b
Belt 480SC	2.0 fl-oz	2.00 a	1.50 a	2.75 a	6.25 a	0.75 a	1.50 cd	0.25 a	2.50 bc	0.00 a	0.50 a	0.25 b	0.75 b

Values in a column followed by the same letter are not different based a Proc Mixed analysis with an F protected LSD ($P \geq 0.05$).

Table 2.

Treatment/ formulation	Rate amt product/acre	% damaged squares	
		1 Sep (pre-treatment)	9 Sep (7 DAT)
Untreated	--	3.75 a	3.75 a
Diamond 0.83EC	3 fl-oz	7.50 a	3.75 a
Diamond 0.83EC	6 fl-oz	5.00 a	0.00 b
Diamond 0.83EC	9 fl-oz	2.50 a	0.00 b
Diamond 0.83EC	12 fl-oz	7.50 a	0.00 b
Diamond 0.83EC + Intrepid 2F	3 fl-oz + 4 fl-oz	2.50 a	0.00 b
Intrepid 2F	6 fl-oz	5.00 a	0.00 b
Belt 480SC	2.0 fl-oz	3.75 a	1.25 ab

Values in a column followed by the same letter are not different based a Proc Mixed analysis with an F protected LSD ($P \geq 0.05$).

AgriLIFE EXTENSION
Texas A&M System

Boll Damage Survey of Bt and Non-Bt Cotton Varieties in the South Plains Region of Texas 2007-09

Cooperators: Texas AgriLife Extension Service

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Extension Entomologist-Cotton, EA-IPM Bailey/Parmer Counties, EA-IPM Castro/Lamb Counties, EA-IPM Lynn/Dawson Counties, EA-IPM Gaines County, EA-IPM Hale/Swisher Counties, EA-IPM Hockley/Cochran Counties, EA-IPM Lubbock County, EA-IPM Terry/Yoakum Counties and EA-IPM Crosby/Floyd Counties

South Plains

Summary:

Late-season boll damage surveys were conducted in 2007, 2008 and 2009 to evaluate the amount of Lepidoptera induced damage in Bt cotton varieties relative to non-Bt cotton varieties. Additional, data was collected on the number of insecticide applications required for these varieties to manage lepiopterous pests, and the number of bolls damaged by sucking pests in 2009. Boll damage was light in 2007; however, more damaged bolls where found in the non-Bt fields (3.11%) than in the Bollgard (0.52%) and Bollgard II (0.25%) fields, but did not differ from the Widestrike fields (1.29%). Very few insecticide applications were made targeting bollworm in any of the 2007 survey fields and there were no significant differences among variety types. None of the Bt cotton fields were treated for bollworms, whereas 9% on the non-Bt field received a single insecticide application. Late season bollworm damage in 2008 was similar to 2007. All of the Bt cotton variety types had significantly fewer damaged bolls than the non-Bt varieties and none of the Bt varieties required insecticide applications for lepidopterous pests, but unlike 2007, more non-Bt cotton was treated for bollworm and/or beet armyworms in 2008 (41% of the fields received a single insecticide application). In 2009, none of the surveyed fields were treated for lepidopterous pests. Worm damaged bolls were 2.83, 0.13 and 0.40% in non-Bt, Bollgard II and Widestrike varieties respectively. There were no differences among the variety types in sucking bug damaged which averaged 1.96% across all varieties.

Objective:

The objective of this study was to compare the qualitative value of Bollgard II, Widestrike and Bollgard insect control traits in grower fields relative to each other and to non-Bt cotton varieties.

Materials and Methods:

In 2007, 2008 and 2009, boll damage surveys were conducted to quantify bollworm damage in late season Bt and non-Bt cotton varieties. Although the source of the damage is not certain, most of it is suspected to have come from cotton bollworms although beet armyworms were present in some fields in 2008, and fall armyworms were present in 2009. Two of the non-Bt were treated for a mixed population of bollworms and beet armyworms in Bailey County in 2008, and non-Bt field in Gaines County in 2009 contained about 20% fall armyworms and 80% bollworms. The survey was conducted late season because Bt levels in mature/senescent cotton tends to deteriorate relative to rapidly growing plants. Thus, late season would represent the time period when Bt levels would be less intensely expressed and damage would be more likely to occur.

Grower fields of non-Bt, Bollgard, Bollgard II and Widestrike cotton were sampled throughout the South Plains region of Texas (Table 1). Samples were taken after the last possible insecticide applications and before approximately 20% of the boll were open. Three distinct areas were sampled within each field, and 100 consecutive harvestable bolls were sampled from each location. Each field by variety type served as a replicate. Bolls were considered damaged if the carpal was breached through to the lint. The insecticide history in regard to insecticides targeting bollworms was recorded. In addition to bollworm damage, external Lygus and/or stinkbug damage to bolls was sampled for in most fields in 2009.

All data were analyzed using PROC MIXED and the means were separated using an F protected LSD ($P \leq 0.10$).

Results and Discussion:

In 2007, damage was very light across all of the field types. However, more damaged bolls where found in the non-Bt fields (3.11%) than in the Bollgard (0.52%) and Bollgard II (0.25%) fields, but did not differ from the Widestrike fields (1.29%) (Table 2). Damage in the Widestrike fields did not differ from the Bollgard and Bollgard II fields. The fact that Widestrike did not differ from the non-Bt fields does not appear to indicate a lack of efficacy, but probably indicates a lack of area wide bollworm pressure. Very few insecticide applications were made targeting bollworm in any of the 2007 survey fields and there were no significant differences among variety types. None of the Bt cotton fields were treated for bollworms, whereas 9% on the non-Bt field received a single insecticide application.

Late season bollworm damage in 2008 was similar to 2007. All of the Bt cotton variety types had significantly fewer damaged bolls than the non-Bt varieties (Table 3). There were no differences in boll damage among the Bt types. Similar to 2007, none of the Bt varieties required insecticide applications for bollworms, but unlike 2007, more non-Bt cotton was treated for bollworms and/or beet armyworms in 2008 (41% of the fields received a single insecticide application).

Bollworm populations were exceptionally light during 2009 with the exception of Gaines County. Both Bollgard II and Widestrike varieties suffered very low damage to boll feeding lepidopterous pest in 2009 and had significantly fewer damaged bolls than the non-Bt varieties (no Bollgard fields were sampled in 2009) (Table 4). There were no differences in damaged bolls between the Bt types, and there were no differences among any of the varietal types in sucking bug damage. None of the fields sampled in the 2009 survey were treated for lepipoterous pests. Much of the South Plains had significant acreage of late-planted grain sorghum and corn, and these crops tended to act as trap crops, essentially preferentially attracting bollworms and fall armyworms away for the cotton.

Based on these data, Bt cotton appears to continue to be highly effective in preventing boll damage by lepidopterous pests in the South Plains region of Texas.

Acknowledgments:

Appreciation is expressed to the Monsanto Company for financial support of this project and the Plains Cotton Growers, Inc. for financial support of this project.

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Table 1. Number of fields sampled by county and Bt trait in 2007-09.

County	Non-Bt	Bollgard	Bollgard II	Widestrike
Year 2007				
Bailey	0	3	1	0
Castro	4	0	3	0
Dawson	1	3	2	4
Floyd	3	0	4	0
Gaines	0	0	0	1
Hale	7	0	6	3
Hockley	3	2	2	2
Lubbock	1	5	2	1
Parmer	2	1	0	1
Terry	1	0	3	4
TOTAL	22	14	23	16
Year 2008				
Bailey	5	0	5	0
Castro	6	0	6	1
Dawson	0	0	0	2
Gaines	4	0	3	10
Hale	3	0	2	1
Hockley	5	5	5	3
Lubbock	6	0	5	0
TOTAL	29	5	26	17
Year 2009				
Bailey	1	0	1	0
Castro	1	0	2	1
Crosby	1	0	1	0
Dawson	0	0	1	1
Gaines	2	0	2	2
Hale	1	0	1	0
Hockley	1	0	1	0
Swisher	1	0	1	0
TOTAL	8	0	10	4

Table 2. Percentage of damaged bolls and insecticide applications for non-Bt and various Bt technology varieties grown in the South Plains of Texas, 2007.

Variety type	n[a]	% damaged bolls[b]	Mean no. sprays per site[c]
Non-Bt	22	3.11 a	0.09 a
Bollgard	14	0.52 b	0.00 a
Bollgard II	23	0.25 b	0.00 a
WideStrike	14	1.29 ab	0.00 a

Means in a column followed by the same letter are not significantly different based on an F protected Mixed Procedure LSD ($P \leq 0.10$).

[a]Number of fields sampled.

[b]Percentage of damaged bolls from three locations in each field, 100 bolls sampled per locations, 300 bolls per field.

[c]Mean number of insecticide applications targeting lepidopterous pests per site.

Table 3. Percentage of damaged bolls and insecticide applications for non-Bt and various Bt technology varieties grown in the South Plains of Texas, 2008.

Variety type	n[a]	% damaged bolls[b]	Mean no. sprays per site[c]
Non-Bt	29	3.16 a	0.41 a
Bollgard	5	0.53 b	0.00 b
Bollgard II	26	0.04 b	0.00 b
WideStrike	17	0.18 b	0.00 b

Means in a column followed by the same letter are not significantly different based on an F protected Mixed Procedure LSD ($P \leq 0.10$).

[a]Number of fields sampled.

[b]Percentage of damaged bolls from three locations in each field, 100 bolls sampled per locations, 300 bolls per field.

[c]Mean number of insecticide applications targeting lepidopterous pests per site.

Table 4. Percentage of damaged bolls and insecticide applications for non-Bt and various Bt technology varieties grown on the South Plains of Texas, 2009.

Variety type	n[a]	% worm damaged bolls[b]	% sucking bug damaged bolls[b]	Mean no. sprays per site[c]
Non-Bt	8	2.83 a	3.83 a	0.00 a
Bollgard II	10	0.13 b	2.06 a	0.00 a
WideStrike	4	0.40 b	0.00 a	0.00 a

Means in a column followed by the same letter are not significantly different based on an F protected Mixed Procedure LSD ($P \leq 0.05$).
[a]Number of fields sampled.
[b]Percentage of worm or sucking bug damaged bolls from three locations in each field, 100 bolls sampled per locations, 300 bolls per field.
[c]Mean number of insecticide applications targeting lepidopterous pests per site.

Evaluation of Seedling Transgenic Cotton Containing *Bacillus thuringiensis* Toxins to Saltmarsh Caterpillar, *Estigmene acrea* (Drury)

Cooperators: Texas AgriLife Research

David Kerns and Bo Kesey
Extension Entomologist-Cotton and Extension Program Specialist-Cotton

Lubbock County

Summary:

The saltmarsh caterpillar, *Estigmene acrea* (Drury), is an occasional pest of cotton, *Gossypium hirsutum* L., in the U.S. Although saltmarsh caterpillar is most often encountered late in the season, the most damaging populations are usually dispersing late instars infesting seedling cotton. Three cotton varieties, a non-Bt, a Bollgard 2 (Cry1Ac + Cry2Ab), and a Widestrike (Cry1Ac + Cry1F), were evaluated at the two true-leaf stage for resistance to feeding by neonate and late fourth-instar saltmarsh caterpillars. The Bollgard 2 and Widestrike varieties were very resistant to neonate saltmarsh caterpillars, killing 100% with no visible damage after 3 days of exposure. Mortality on the non-Bt variety was 0% and damage was evident. When exposed to fourth-instar larvae, the Widestrike and Bollgard 2 varieties killed 80 and 90%, respectively, after 7 days of exposure. Mortality by the non-Bt variety was 10%. Leaf consumption by fourth-instar saltmarsh caterpillars on the Bt varieties was negligible, while a mean of 19.7-cm^2 of the non-Bt variety was consumed per larva. Based on relative leaf area of cotton on the Texas High Plains and the estimate that cotyledon- to two true-leaf-stage cotton can withstand 75% damage without significantly impacting yield, treatment thresholds for late-instar saltmarsh caterpillars may approximate 0.5, 1.0, and 1.5 larva per plant on cotyledon, one true-leaf, and two true-leaf-stage cotton, respectively.

Objective:

In this study, we report the impact of early- and late-instar saltmarsh caterpillars on non-Bt, Bollgard 2, and Widestrike varieties of cotton. The primary purpose of this study was to determine if seedling Bt cotton can withstand migratory infestations of primarily late-instar saltmarsh caterpillars.

Materials and Methods:

Damage by saltmarsh caterpillar to seedling-stage cotton expressing Cry1Ac + Cry2Ab, Cry1Ac + Cry1F, and a non-Bt variety was evaluated in a greenhouse at the Texas A&M System, AgriLife Research and Extension Center, Lubbock, TX, in 2007. Saltmarsh caterpillar larvae were collected from various weedy habitats in Lubbock County, TX, and reared on Stonefly *Heliothis* Diet (Ward's Natural Science, Rochester, NY). F_2 generation larvae were used for this study.

Cotton seeds were planted in 115-mm square x 89-mm tall plastic pots containing standard potting soil. The cotton varieties evaluated were DP174RF (non-Bt), DP141B2RF (Cry1Ac + Cry2Ab, Bollgard 2) (Deltapine, Monsanto Company, St. Louis, MO), and PHY 375 WRF (Cry1Ac + Cry1F, Widestrike) (Phytogen, Dow AgroSciences LLC, Indianapolis, IN). Four cotton seeds were planted per pot, but were thinned after emergence to two plants per pot. Plants were maintained throughout the duration of the study at 25.5 ± 2°C and a photoperiod of 14:10 (L:D) hours in a greenhouse.

The experiment was a randomized complete design with 10 replications; each replication consisted of a single pot. Treatments included each of the aforementioned cotton varieties infested with two saltmarsh caterpillar larvae or left noninfested. One test consisted of neonate larvae, while another test consisted of fourth-instar larvae.

At the two true-leaf stage, just before infestation, plants in each pot were enclosed in a cage constructed from an 89-mm diameter x 133-mm tall Styrofoam cup with the bottom excised. Fitted plastic lids with 38-mm square openings covered with fine cloth mesh were used to enclose the top of each cup. The saltmarsh caterpillar neonates and fourth-instar larvae were allowed to feed for 3 and 7 days, respectively, after which mortality was evaluated. Larvae unable to move upon prodding with a sharpened pencil were considered dead. Missing larvae were considered to have died.

In addition to mortality, at 3 days post infestation with neonate larvae, leaf damage was rated using a 1 to 12 scale where 1 = no damage, 2 to 11 = approximate leaf area (mm^2) consumed or window paned, and 12 = 12 mm^2 leaf area or greater consumed or window paned. At 7 days post infestation with fourth-instar larvae, the cotton plants were removed from the pots and the leaf area was measured using a LI-3100 area meter (Li-Cor Biosciences, Lincoln, NE).

All data were analyzed using GLM (SAS Institute 2004). Means were separated using an *F*-protected LSD ($P \leq 0.05$).

Results and Discussion:

Neonate Larvae. Neonate saltmarsh caterpillar larvae were extremely sensitive to the cotton varieties containing either Bollgard 2 or Widestrike transgenic traits, each causing 100% mortality (Table 1). No neonate larvae feeding on the non-Bt variety DP 174RF died. Consequently, the non-Bt variety exhibited a mean damage rating of 9.4 ± 0.97, while those containing the Bt traits suffered no visible damage. These findings are consistent with that reported by Tindal et al. (2008) where survival of neonate saltmarsh caterpillar larvae feeding on a Bollgard 2 cotton variety was 0% at 2 days after infestation. Thus, it is evident that cotton varieties containing the Bollgard 2 and Widestrike Bt traits are safe from foliar feeding saltmarsh caterpillars originating from egg masses deposited directly.

Fourth-Instar Larvae. Significantly more fourth-instar saltmarsh caterpillar larvae feeding on varieties containing Bollgard 2 and Widestrike Bt traits died than did those feeding on the non-Bt variety, but mortality did not differ between the two Bt varieties (Table 2). Although the Bt varieties were exposed to large larvae, mortality after 7 days of non-preferential exposure resulted in 80 and 90% mortality on the Widestrike and Bollgard 2 varieties, respectively. Non-Bt plants allowed to grow in the absence of saltmarsh caterpillars had a mean leaf area of 75.6 cm^2, while those exposed to two, fourth-instar larvae had a significantly smaller mean leaf area of 36.3 cm^2, a 48% reduction. Neither the Bollgard 2 nor the Widestrike varieties suffered a significant reduction in leaf area relative to noninfested plants, indicating the surviving saltmarsh caterpillar larvae fed very little. Under field conditions, it is probable that dispersing larvae encountering Bollgard 2 or Widestrike cotton varieties would not feed substantially on those plants but continue to move until death, starvation-induced precocious pupation, production of supernumerary molts, or until a suitable host was encountered (Jones et al. 1980, Safranek and Williams 1984). Leaf area did not differ among the varieties when not infested, but both infested Bt varieties had more leaf area than the non-Bt variety.

Damage potential and impact on yield by defoliation of seedling cotton is variable and unclear. Destruction of 50% of one cotyledon on cotyledon-stage cotton resulted in a 4 to 6% increase in yield, while cotton with one cotyledon removed suffered no effect, and when 1.5 or both cotyledons were removed, yield was reduced 11 to 33 and 81 to 100%, respectively (Verhalen et al. 2008). Thus, yield loss was not significant until 75% of the leaf tissue was removed. Similarly, Lane (1959) found that a cotton seedling must suffer more than 75% leaf area reduction before yield was affected. Wanjura and Upchurch (1998) reported in a 2-year study that on cotton averaging 2.8 nodes, yield was reduced both years only when all the cotyledons and true leaves were removed, and during 1 year, yield was significantly less when the true leaves were removed. However, Wilson et al. (2003) reported that cotton defoliated as much as 87% at the node 2 and 4 stages suffered no reduction in boll dry weight, but crop maturity might be affected. Although conflicting information exists, it seems a reduction in leaf area of 75% or more may adversely affect yield.

Nondamaged cotton on the Texas High Plains will typically have an approximate leaf area of 20.0 ± 4.14, 33.8 ± 7.43, and 45.3 ± 8.27 cm^2 at the cotyledon, 1-true-leaf, and 2-true-leaf stages, respectively (Kerns, unpublished data) (Table 3). In our study, a single fourth-instar saltmarsh caterpillar larva consumed a mean of 19.7-cm^2 leaf tissue in a 7-day period, which ended near or at the onset of pupation. Thus, if seedling cotton can tolerate approximately 75% defoliation without significantly impacting yield, it is plausible that on healthy cotton with an adequate plant population, cotyledon-stage cotton fed on by late fourth-instar saltmarsh caterpillars can withstand about 0.5 larva per plant, 1 true-leaf cotton about 1 larva per plant, and 2 true-leaf stage cotton about 1.5 larvae per plant. However, these values need to be validated in the field.

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Table 1. Leaf-feeding Damage Ratings and Percentage Mortality of First-instar Saltmarsh Caterpillars Exposed to Non-Bt and Transgenic Bt Cotton Varieties

Variety	Bt trait	n	Percent mortality	Damage rating (1-12)
DP174RF	None	9	0 a	9.4 ± 0.97 a
DP141B2RF	Cry1Ac & Cry2Ab	10	100 b	1.0 b
PHY375WRF	Cry1Ac & Cry1F	10	100 b	1.0 b

Means followed by the same letter in a column are not significantly different (*F*- Protected LSD, $P \leq 0.05$).

Table 2. Leaf Feeding Damage and Percentage Mortality of Fourth-instar Saltmarsh Caterpillars Exposed to Non-Bt and Transgenic Bt Cotton Varieties

				Leaf area (cm^2)	
Variety	Bt trait	n	Percent mortality	Larvae absent	Larvae present
DP174RF	None	10	10.00 ± 10.00 a	75.60 Aa	36.29 Bb
DP141B2RF	Cry1Ac & Cry2Ab	10	90.00 ± 10.00 b	60.85 Aa	64.11 Aa
PHY375WRF	Cry1Ac & Cry1F	10	80.00 ± 13.33 b	79.63 Aa	73.85 Aa

Means followed by the same lower-case letter in a column and the same upper-case letter in a row are not significantly different (*F*- Protected LSD, $P \leq 0.05$).

Table 3. Calculated Leaf Area cm^2 (% Reduction) of Three Stages of Seedling Cotton Fed On by Fourth-instar Saltmarsh Caterpilar[a]

	Leaf area cm^2 (% reduction)		
Larvae/plant	Cotyledon	One true leaf	Two true leaf
0.0	20.03 (0.00)	33.76 (0.00)	45.30 (0.00)
0.5	10.20 (49.09)	23.93 (29.11)	35.47 (21.70)
1.0	0.37 (98.17)	14.10 (58.23)	25.64 (43.40)
1.5	0.00 (100)	2.07 (93.87)	15.81 (65.11)
2.0	0.00 (100)	0.00 (100)	5.98 (86.81)

[a]Consumption based on a mean of 19.66-cm^2 leaf area by a single fourth-instar larva over a 7-day period with temperature averaging 25.5 ± 2°C.