COMPARISON OF INSECTICIDES & TIMING OF TREATMENTS FOR OPTIMUM IMPACT ON COTTON FLEAHOPPER

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Abstract

Two tests were conducted to determine the effects of insecticide treatments on cotton growth, yield, and economic return. **Test 1** was conducted to compare the effects of insecticides on cotton fleahopper numbers and subsequent impact on plant fruiting, yield and economic return. All insecticide treatments significantly reduced fleahopper numbers compared with those in nontreated cotton on all post-treatment inspections except for counts made 8 days after treatment 3 (8 DAT-3) in Intruder 70WP (0.6 oz/acre) and Orthene 97 Pel. treatments. Centric was the only treatment that maintained fleahopper numbers below the threshold level of 15/100 plant terminals on all inspection dates. Significantly greater numbers of squares, retained fruit, and greater retention of fruit on the first 10 fruiting branches were found on insecticide treated cotton as measured during the 4th week of bloom. Lint yield was significantly improved by all but one insecticide treatment, and dollar returns above the nontreated cotton ranged from $7.69 to $40.60 per acre. In **Test 2,** fleahopper numbers were above the established treatment threshold beginning in the first week of squaring, but the cotton vegetative internodes were short due to cold weather suggesting that fleahopper treatment would not be economical and treatment should be delayed a week. Therefore, a field experiment was conducted to evaluate the consequences of the suggested delayed treatment**.** Treatments were initiated beginning late in the 1st week of squaring followed by initiation of additional plot treatments on about a weekly basis thereafter. One set of plots was treated only during the 2nd and 4th weeks. All insecticide treated cotton was treated during the 4th week. Fleahoppers were reduced to very low numbers following initiation of treatments for the insect. Cotton growth, fruit retention and location, plant height, lint yield, and dollar returns were all affected by the treatments. Plants in the insecticide treated cotton had significantly more squares and bolls when plant mapped during the 4th week of bloom and produced significantly more cotton lint than the nontreated cotton. Plant mapping data at harvest revealed effects on internode length, number of main stem nodes, boll load location, and percentage boll retention at different locations on the plants. Insecticide treated plants averaged 11.6 inches shorter than nontreated based on final field measurement. The lowest yield and dollar return among the insecticide treatments was the cotton treated 4 times beginning late in the 1st week of squaring. This treatment produced a $43.16 per acre dollar return, whereas, the 3 remaining insecticide treatments averaged $86.90 per acre return over the nontreated cotton.

Materials and Methods

Both studies were conducted at the Texas Agricultural Experiment Station Meaney Annex at Corpus Christi. Cotton was planted at 4 seed/foot on 38-inch spaced rows with a 4-row John Deere 6100 buster type planter. Fertilizer applied was 125-22-0 + 6.7 lb zinc. Weed control included the use of Trilin 4 (1.0 qt/acre) in late October 2006. After planting Cotoran 4L (1.0 qt/acre) + Dual II Magnum 7.64 lb (1.0 pt/acre) was applied. The plant growth regulator Pix (old product) was applied on June 28 (16 oz/acre), July 12 (8 oz/acre) and on July 26 (24 oz/acre) due to excessive rainfall. Other than insecticide for fleahopper control, insecticide applied as an overspray to the entire test was Bidrin 8E (8.0 oz/acre) on July 12 and August 6 for control of stink bugs.

Plots were 8 rows wide by 40 ft long and treatments were replicated 4 times in a randomized complete block design. The insecticide treatments were applied to the center 4 rows in each plot so that an 8-row buffer of nontreated cotton was maintained between each insecticide treatment. Insecticide was applied with a self-propelled Spider Trac ground sprayer traveling at 4 mph through 4X hollow cone nozzles (2/row) at 40 psi in a total volume of 5.7 gpa.

Seed cotton from both studies was weighed, and a sample from each plot was ginned on a 10-saw Eagle laboratory machine to determine lint percentages. Lint samples were sent to the International Textile Center at Lubbock, Texas for fiber analysis. The software program Agriculture Research Manager (ARM revision 6.1.13) was used to conduct analysis of variance, and means were separated by LSD when P=0.05 or less.

Test 1: Comparison of insecticides

Stoneville 4554 B2RF variety cotton was planted on April 3, 2007. Three treatments were made for fleahopper control on May 16, 22, and June 4. The 1st treatment was made late in the 2nd week of squaring. The adjuvant Induce at 0.25% v/v was added to the spray mix.

Treatments were assessed by (1) counting the number of fleahoppers on 20 plants in the center 2 rows of each plot on May 13 [pretreatment], May 19 [3 DAT-1 = days after treatment-1], May 22 [6 DAT-1], May 24 [2 DAT-2], May 31 [9 DAT-2], June 3 [12 DAT-2], June 8 [4 DAT-3], and June12 [8 DAT-3], (2) conducting plant mapping on June 24 using P-Map during the 4th week of bloom, and (3) harvesting the center 2 rows of each plot with a 2-row model 9900 John Deere spindle picker on September 13.

Test 2: Timing of treatment

FiberMax 835LLB2 and FM 832LL variety cotton was planted on March 27, 2007. Insecticide was applied to two rows of each variety (data were combined for the 2 varieties). Centric 40WG (2.0 oz/acre) was applied on dates to achieve various timed plot treatments corresponding to squaring weeks. One set of plots was treated beginning May 10 (late in the 1st week of squaring), followed by another set of plots on May 16 (late 2nd week of squaring), and another set of plots on May 22 (late 3rd week of squaring). All insecticide plots were also treated May 31 (late 4th week of squaring – early bloom). This scheme resulted in sets of plots receiving 2, 3, or 4 treatments depending upon the week treatments were initiated. Another treatment regime consisted of treatments during the 2nd and 4th weeks.

Treatments were assessed by (1) counting the number of fleahoppers on 10 plants each in the center 2 rows [20 plants/plot] on May 10 [pretreatment), May 13 [3 DAT-WK1], May 19 [3 DAT-WK2], May 22 [6 DAT-WK2], May 24 [2 DAT-WK3], May 31 [9 DAT-WK3], June 3 [3 DAT-WK4], June 8 [8 DAT-WK4], and June12 [12 DAT-WK4]; (2) conducting plant mapping on June 21 using P-Map during the 4th week of bloom and again just before harvest on September 4, and (3) harvesting separately the center 2 rows of each plot with a 1-row International spindle picker on September 9.

Results and Discussion

Test 1: Comparison of Insecticides

Pretreatment counts across all plots revealed an average of 32.5 fleahoppers per 100 plant terminals (Fig. 1). Centric was the only treatment that subsequently maintained fleahopper densities below the treatment threshold (15/100 plant terminals) on all post-treatment inspection dates. However, the other insecticide treatments did have significantly lower fleahopper densities than the nontreated cotton.

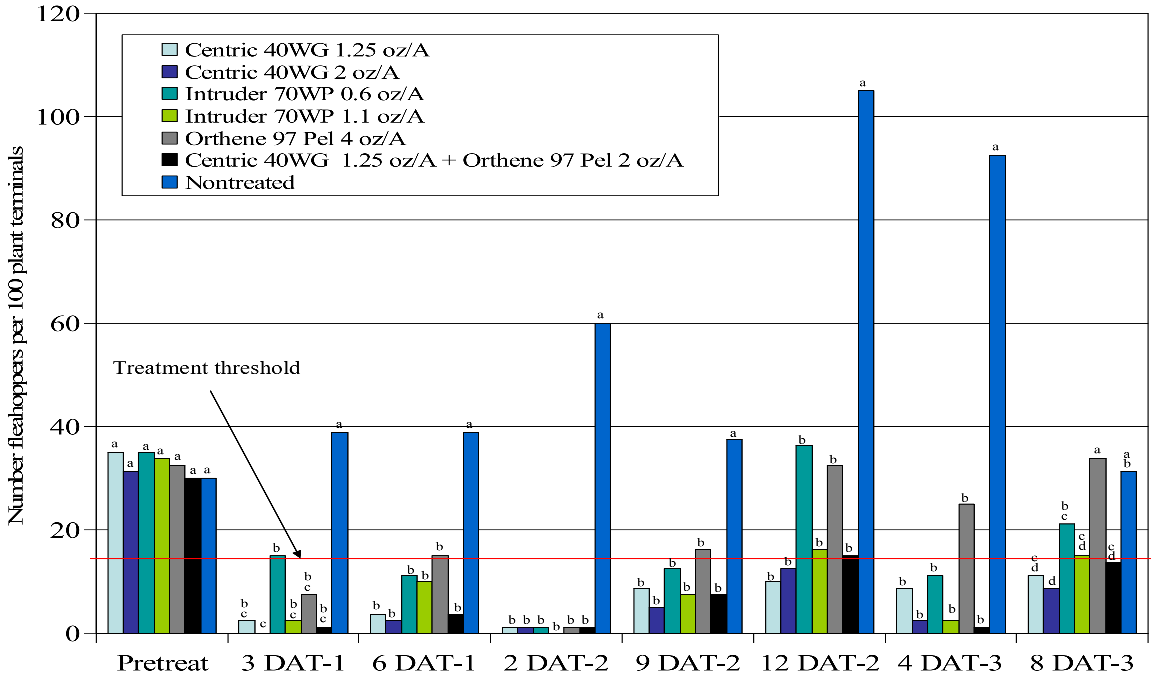

Fig. 1. Effect of various rates of insecticides on fleahopper numbers. DAT = days after treatment.

Plant mapping in the 4th week of bloom revealed significantly greater numbers of squares and retained fruit in insecticide treated cotton compared to nontreated cotton (Table 1). The percentage fruit retention in fruiting branch groups 1-5 and 6-10 was significantly lower in nontreated cotton, but when all fruiting branch groups were combined, there were no statistical differences although fruit retention was numerically greater in all insecticide treated plots compared with nontreated (the P-value of 0.0547 was only slightly higher than that accepted for statistical difference). Furthermore, the percentage fruit retention on positions 1, 2, 3, and 4 was, with one exception, significantly higher in insecticide treated cotton (Table 2).

Lint production was significantly greater for all insecticide treatments compared with the nontreated cotton except for the Orthene treatment, but even the Orthene treated cotton produced substantially more lint (48 lb/acre) than the nontreated cotton (Table 2). Dollar returns above the nontreated based strictly on the numerical lint yield differences ranged from $7.69/acre for the Orthene treatment to a high of $42.54/acre for the Intruder (0.6 oz/acre) treatment. Cotton value was based on lint and seed production, and costs included insecticide, application, and processing charges for the extra production above the nontreated cotton (see footnote at the bottom of Table 2).

It was evident in this study that treatment for cotton fleahopper under the conditions encountered resulted in increased economic value. The average increase in the study for all insecticides, rates, and combinations was 120.2 lb lint/acre and 187.5 lb seed/acre.

Table 1. Effect of fleahopper insecticide treatments on cotton plant fruiting characteristics, Texas Agricultural Experiment Station, Nueces County, TX, 2007.[2/]

Treatment[1/]	Rate oz/acre	Number/plant: Squares	Number/plant: Bolls	Number/plant: Abscised fruit	% Fruit retention by branches: 1 - 5	% Fruit retention by branches: 6 - 10	% Fruit retention by branches: all
Centric 40WG	1.25	18.9[a]	3.3[a]	3.9[b]	74.9[a]	94.6[a]	84.5[a]
Centric 40WG	2.00	20.6[a]	4.1[a]	4.5[b]	74.1[a]	94.4[a]	86.1[a]
Intruder 70WP	0.60	19.7[a]	2.7[a]	5.2[b]	68.1[a]	92.7[a]	81.2[a]
Intruder 70WP	1.10	19.2[a]	3.6[a]	5.6[b]	65.8[a]	93.8[a]	80.6[a]
Orthene 97 Pel	4.00	19.8[a]	3.3[a]	5.4[b]	68.9[a]	91.9[a]	77.8[a]
Centric 40WG + Orthene 97 Pel	1.25 + 2.00	19.9[a]	3.4[a]	5.9[b]	66.7[a]	91.7[a]	78.1[a]
Nontreated		13.5[b]	2.5[a]	12.4[a]	40.1[b]	66.4[b]	57.2[a]
LSD (P = 0.05)		2.79	1.32	2.88	13.66	8.54	NS
P > F		.0008	.2582	.0002	.0009	.0001	.0547

Means in a column followed by the same letter are not significantly different by ANOVA.

1/ Treatments were applied on 5/16, 5/22, and 6/4.

2/ Plant map during 4th week of bloom.

Table 2. Effect of fleahopper insecticide treatments on cotton fruit retention by position off main plant stem, lint production, and dollar return, Texas Agricultural Experiment Station, Nueces County, TX, 2007.

Treatment[1/]	Rate oz/acre	% Fruit retention by position[2/]: 1	2	3	4	Yield lb lint/acre	$ Return over nontreated[3/]
Centric 40WG	1.25	88.4[a]	79.4[a]	85.7[a]	93.8[a]	1270[ab]	34.33
Centric 40WG	2.00	88.9[a]	77.0[a]	87.2[a]	88.9[a]	1258[ab]	18.91
Intruder 70WP	0.60	83.3[a]	71.0[a]	90.4[a]	90.2[a]	1283[ab]	42.54
Intruder 70WP	1.10	86.5[a]	69.9[a]	79.9[a]	86.2[a]	1256[ab]	18.63
Orthene 97 Pel	4.00	87.6[a]	70.9[a]	81.9[a]	79.0[a]	1185[bc]	7.69
Centric 40WG + Orthene 97 Pel	1.25 + 2.00	82.0[ab]	69.7[a]	87.8[a]	92.9[a]	1291[a]	40.60
Nontreated		75.7[b]	39.7[b]	37.4[b]	55.4[b]	1137[c]	
LSD (P = 0.05)		7.51	14.35	13.54	19.44	98.4	
P > F		.0188	.0004	.0001	.0079	.0333	

Means in a column followed by the same letter are not significantly different by ANOVA.

1/ Treatments were applied on 5/16, 5/22, and 6/4.

2/ Plant map during 4th week of bloom.

3/ Cotton value based on $0.55/lb for lint and $0.065/lb for seed using a factor of 1.56 times lint weight. Costs include Centric 40WG ($4.50/oz), Intruder 70WP ($8.00/oz), Orthene 97 Pel ($8.00/lb), and application ($2.50/acre). Harvesting/hauling/ginning cost for the extra lint above nontreated cotton was set at $0.21/lb lint.

Test 2: Timing of Treatment

Pretreatment fleahopper counts averaged 31.0 per 100 plant terminals (Fig. 2); insecticide treatments were initiated the following day. Fleahoppers were subsequently maintained at very low numbers following the dates of initial treatment. One treatment (treated in weeks 2 and 4) was not treated in week 3 because there were not enough fleahoppers to warrant the application for this IPM designated set of plots. Fleahopper densities were double or more the 15/100 plants treatment threshold (generally recognized as an economically damaging population) in the nontreated cotton throughout the study. This threshold appears to be appropriate under favorable growing conditions.

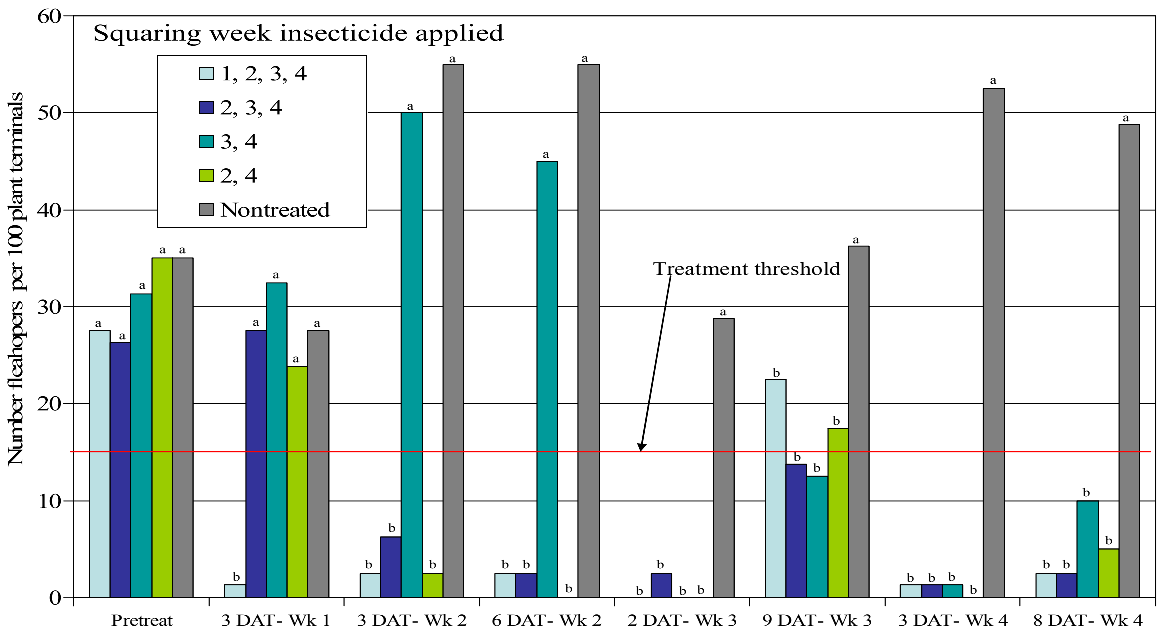

Fig. 2. Effect of insecticide timing on fleahopper numbers. DAT = days after treatment.

Plant mapping (P-Map procedure) was performed during the 4th week of bloom (June 21) just before an extended rainy period. Fruit retention within branch groups 6-10 and 11-15 was not significantly different among insecticide treatments, but was statistically greater than in nontreated cotton (Fig. 3). However, in branch group 1-5, % fruit retention was lower when treatments began on the 3rd week compared to the other insecticide treatment regimes, although all treatments had higher retention than the nontreated control. Numerically, in the insecticide treated cotton plots, percentage fruit retention for all branch groups combined was lowest when treatments were not initiated until the 3rd week of squaring, due mainly to the lower fruit retention for this treatment in branch group 1-5. Plant height was reduced in plots receiving the earliest treatment (Table 3). Nodes above white bloom were also reduced as a result of insecticide treatment, reflecting the result of earlier fruit set.

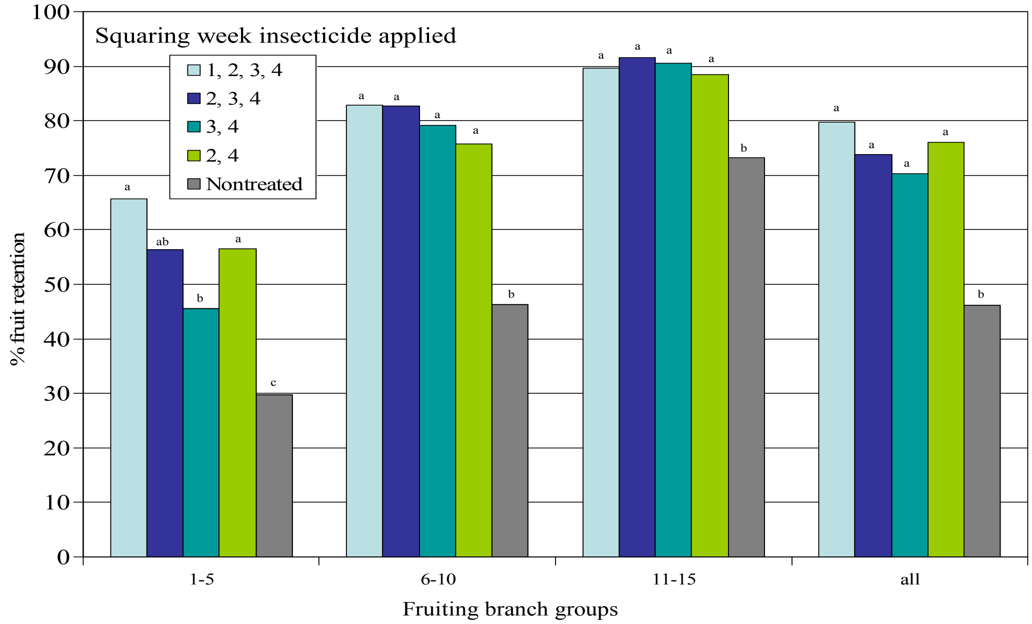

Fig. 3 Effect of fleahopper insecticide treatment timing on cotton fruit retention, from plant mapping during 4th week of bloom (June 21).

Plant measurements were again conducted using the P-Map procedure just before harvest on September 4 (Table 3 & Fig. 4). Plant height measurements indicated much taller plants in the nontreated cotton with no statistical differences for the insecticide treated cotton. Even with 48 oz of Pix applied, nontreated cotton plants averaged 8.2 inches taller as measured by P-Map on September 4 and 11.6 inches taller (data not shown) as measured a few days later in the field at harvest compared to insecticide treated plants. Average internode lengths were significantly longer in nontreated cotton and numerically shortest where 4 insecticide treatments were applied beginning in week 1. Numerically, and in 2 cases statistically, more main stem nodes per plant were found in the nontreated cotton. Numerically, the greatest number of fruiting nodes per plant was found in the nontreated cotton. The percentage boll retention was greater (often statistically greater) on the first 10 fruiting branches in all the insecticide treated cotton (Fig. 4). A numerical increase in boll retention was observed in nontreated cotton on fruiting branches 11-15, and significantly higher boll retention was found in nontreated cotton on branches 16-25. Therefore, when all bolls on plants were summed there were no differences in the boll count (Table 3), but heavier bolls and possible improvement of harvest efficiency based on boll location was evident in the lint production data (Fig. 5).

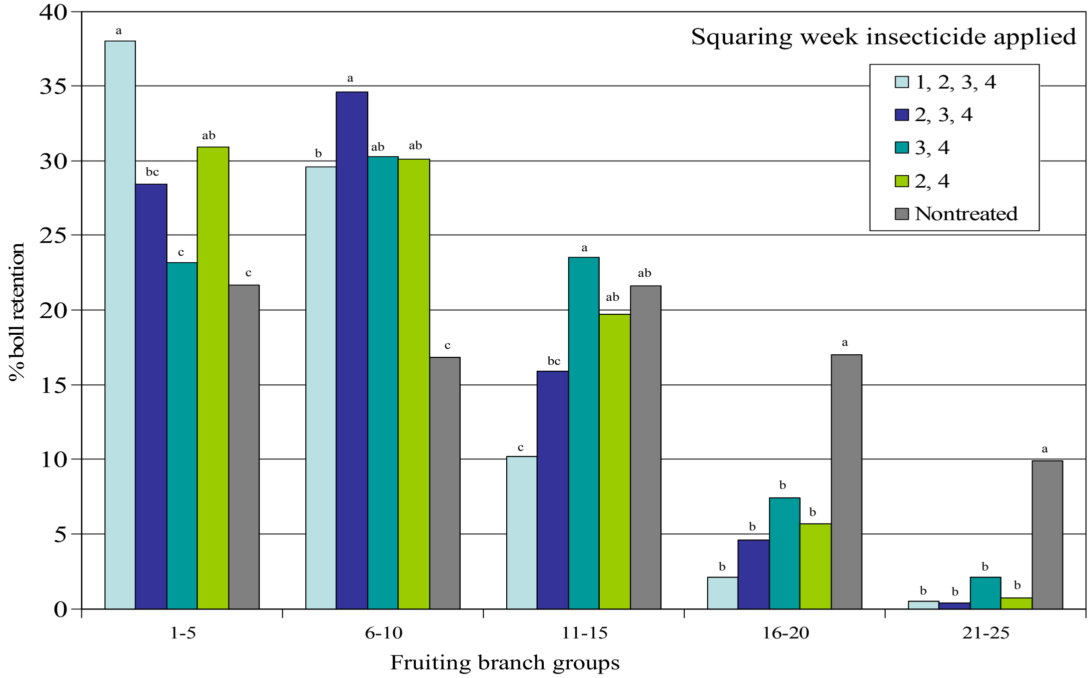

Fig. 4. Effect of fleahopper insecticide treatment timing on cotton boll retention by fruiting branch groups, from plant mapping just before harvest (September 4).

Table 3. Effect of fleahopper insecticide treatment timing on cotton plant growth characteristics, Texas Agricultural Experiment Station, Nueces County, TX, 2007.

	P-Map on June 21[2/]			P-Map on September 4[3/]			
Treatments by squaring week[1/]	Internode length (in.)	Plant height (in.)	NAWB[4/]	Internode length (in.)	Plant height (in.)	No. main stem nodes	Bolls/ Plant
1, 2, 3, 4	1.6[a]	34.4[b]	6.4[b]	1.41[c]	42.0[b]	29.7[ab]	10.9[a]
2, 3, 4	1.7[a]	37.0[ab]	6.1[b]	1.48[bc]	44.1[b]	29.9[ab]	10.9[a]
3, 4	1.7[a]	38.5[a]	6.5[b]	1.52[b]	44.8[b]	29.5[b]	10.9[a]
2, 4	1.7[a]	37.1[a]	7.0[b]	1.47[bc]	42.5[b]	29.0[b]	11.1[a]
Nontreated	1.7[a]	38.2[a]	8.3[a]	1.68[a]	51.6[a]	30.8[a]	11.0[a]
LSD (P = 0.05)	NS	2.7	0.97	.069	3.06	1.09	NS
P > F	.3138	.0477	.0034	.0001	.0001	.0474	.9963

Means in a column followed by the same letter are not significantly different by ANOVA.
[1/] Week 1 was in the first week of squaring. Centric 40WG was applied at 2 oz/acre during the weeks indicated.
[2/] Plant map during 4th week of bloom (June 21).
[3/] Plant map just before harvest.
[4/] NAWB = nodes above white bloom

Significantly less cotton was harvested in the nontreated plots, and numerically, where treatments were initiated during the 1st squaring week, yields were lower than the other treatments (Fig. 5). This 4-treatment regime resulted in $43.16 per acre return over the nontreated cotton, whereas, the remaining treatments averaged $86.90 per acre return. Although differences were not significant, numerical differences in dollar returns demonstrated that insecticide treatment did not need to be initiated until the 2nd week of squaring and even waiting until the 3rd week, under conditions experienced in this one season, would have been acceptable.

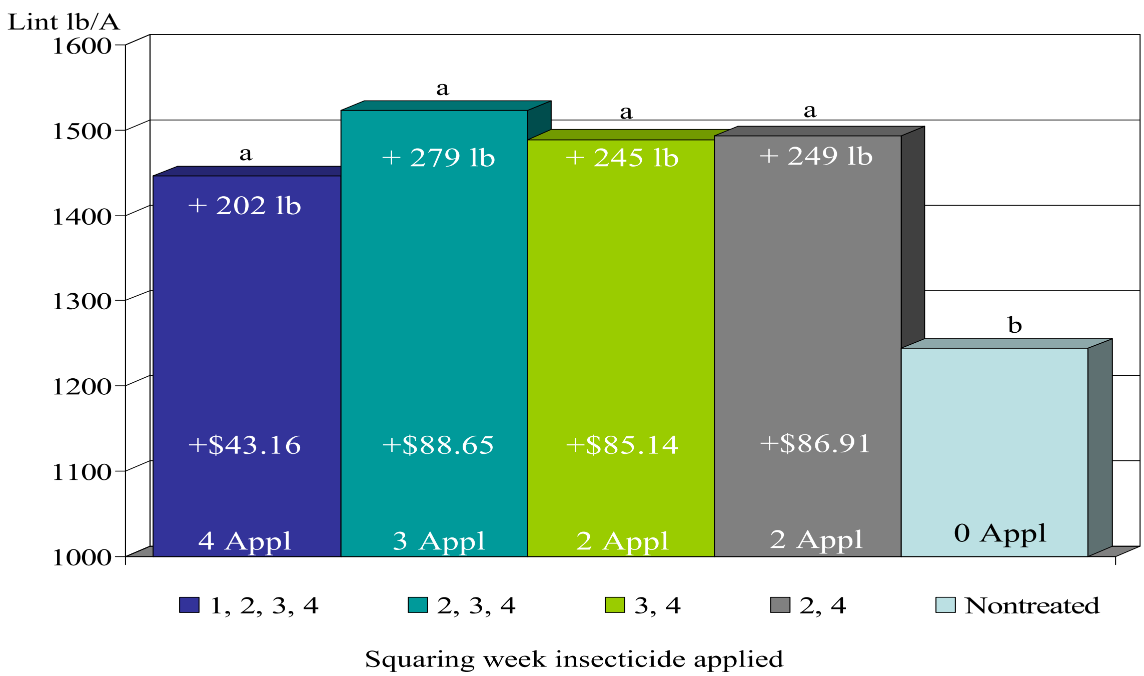

Fig. 5. Effect of fleahopper insecticide treatment timing on cotton yield and dollar return. Cotton value based on 0.55/lb and \$0.065/lb for seed using a factor of 1.56 times lint weight. Costs include Centric 40WG (\$4.50/oz), application (\$2.50/acre) and harvesting/hauling/ginning cost for extra lint above nontreated cotton (\$0.21/lb lint). LSD ($P = 0.05$).

Data for all treatments were combined to examine relationships between fleahopper nymph densities and different crop variables on 5 dates (May 24 to June 12), when fleahopper densities were highest and varied the most between treatments. Fleahopper densities on all 5 dates were significantly and negatively correlated with yield ($r^2 \approx 0.36$ each date) as well as with most crop data. As an example, on June 12, fleahopper densities were negatively correlated with squares per plant (r^2=0.58), green bolls per plant (r^2=0.34), green bolls on branches 1-5 and 6-10 (r^2=0.28 for each), and at positions 1, 2, and 3 (all $r^2 \approx 0.31$), as well as % fruit retention per plant (r^2=0.72), % fruit retention on branches 1-5 (r^2=0.51), 6-10 (r^2=0.85), and 11-15 (r^2=0.51), and at positions 1, 3 (r^2=0.56 for each), and 2 (r^2 = 0.77). Also, fleahopper densities were positively correlated with fruit abscised (r^2=0.5) and plant height at harvest (r^2=0.76). Examining the relationship between cotton yield and plant variables, we found that yield was positively correlated with squares per plant (r^2=0.31), as well as % fruit retention per plant (r^2 = 0.34), % fruit retention on branches 6-10 and 11-15, and positions 1, 2, and 3 ($r^2 \approx 0.25$ for each). Also, yield was negatively correlated with plant height at harvest (r^2=0.23). Multiple regressions were also examined to determine which set of variables best predicted yield, but due to autocorrelation among most plant variables and among insect densities on each date, no set of variables was better than any single variable for predicting yield.

Conclusions

(1) Compared to nontreated cotton, lint yield was significantly greater where insecticide was applied for cotton fleahopper using Centric 40WG (1.5 and 2.0 oz/acre), Intruder 70WP (0.6 and 1.1 oz/acre), and Centric 40WG + Orthene 97 (2.0 oz/acre), and it was numerically better in Orthene 97 (4.0 oz/acre) treated cotton.

(2) No advantage in lint production was gained by using higher rates of Centric or Intruder, although higher numbers of fleahoppers remained where the low rate of Intruder was applied.

(3) No advantage was obtained by initiating treatments for high numbers of cotton fleahopper late in the 1st full week of squaring or by applying more than two treatments under the growing conditions encountered.

(4) Relatively high dollar returns were obtained in both field experiments by control of cotton fleahopper. The insect is considered a "key pest" of Texas Gulf Coast cotton.

Acknowledgements

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