INFLUENCE OF TIMING OF SPRAYS FOR COTTON APHID (HOMOPTERA: APHIDIDAE) ON COTTON YIELD

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Abstract

In 1996 and 1997 an attempt was made to determine the optimum time, if any, to treat cotton, *Gossypium hirsutum* L., for the cotton aphid, *Aphis gossypii* Glover, in Mississippi. Cotton (Sure-Grow 125 and NuCotn 33) at three different growth stages (pre-pinhead square or about 4th node, full-grown square or about 6th node, and first bloom) was treated twice at 7-day intervals with provado (0.053 l/ha) for aphids. The fourth treatment was an untreated control. All other insects were controlled in all plots. Results were somewhat inconsistent for the pinhead square and full-grown square treatments but showed that the bloom treatments produced significantly higher yields than the untreated check and the pre-pinhead square treatments but not the full-grown square treatments. All treatments made to NuCotn 33b yielded significantly higher than corresponding treatments made to Sure-Grow 125. Results were borderline as to economic feasibility of the treatments. Definite conclusions cannot be drawn as to the optimum time to spray for aphids without further experimentation.

Introduction

The cotton aphid, *Aphis gossypii* Glover, has been recognized as a pest of cotton, *Gossypium hirsutum* L., in the United States since 1854 (Slosser et al. 1989). This species seldom damaged cotton until the 1940's when calcium arsenate was introduced as a control measure for boll weevils, *Anthonomus grandis* Boheman, and aphids often developed thereafter as a late-season pest in cotton (Slosser et al. 1989). *A. gossypii* became a problem in western (Grafton-Cardwell 1991), southwestern (Slosser et al.1989), and southeastern (King et al. 1988) United States in the mid-1980's and progressed until it became the number one cotton pest of the U.S. Cotton Belt in 1991 (Hardee and Herzog 1992).

Control failures in Mississippi for all classes of insecticides applied for cotton aphid have increased since 1988 (Hardee and Herzog 1991, 1992). Some of the causal factors for this rise in pest status include the onset of resistance to several commonly used organophosphate insecticides (O'Brien et al. 1990, Grafton-Cardwell 1991, Kerns and Gaylor 1992). The extensive use of pyrethroids in the late 1970's and early 1980's for tobacco budworm, *Heliothis virescens* (F.), and bollworm, *Helicoverpa zea* (Boddie), control (King et al. 1988) greatly increased pyrethroid resistance in cotton aphid to these materials. Grower cultural practices such as automatic, over-the-top sprays with organophosphorous insecticides for early-season cotton insects (Hardee and O'Brien 1990) have increased the potential for resistance development and decreased effect of biological control.

The cotton aphid has been found in certain instances to increase production costs (Hardee and O'Brien 1990) and reduce yields (Andrews and Kitten 1989, Bagwell et al. 1991, Fuchs and Minzenmayer 1995, Harris et al. 1992, Isley 1946, Price et al. 1983). However, Parker and Huffman (1991), Harris et al. (1992), and Weathersbee et al. (1995) expressed difficulty in separating effect of aphids on yield from that of other insects. Questions also remain as to the economic justification for chemical control of this insect (Hardee and O'Brien 1990, Chen et al. 1991, Zhang and Chen 1991, Harris et al. 1992, Wilhoit et al. 1992, Deguine et al. 1994, Rosenheim 1995, and Rosenheim and Wilhoit 1993). In addition, it has been proposed (Ebert and Cartwright 1997) that response to the cotton aphid in the United States should be to promote (1) reduced dependence on pesticides, (2) increased reliance on beneficial organisms, and (3) increased government regulation of chemical use. We report herein results of a 2-year study designed to separate the effects of treating cotton for aphids at different phenological stages of growth during the season.

Materials and Methods

The test site for the 1996 and 1997 growing seasons was located ≈ 3 km east of the USDA-ARS, Jamie Whitten Delta States Research Center at Stoneville, MS. Field plots were arranged in a randomized complete block design with 4 replications (contiguous on two sides, separated by 7-m alleys on each end) of 2 cultivars and 4 treatment regimes. The cultivars were NuCotn 33B (Delta and Pine Land, Scott, MS) and Sure-Grow 125 (Sure-Grow, Leland, MS, soon to be Delta and Pine Land) and were seeded on 8 May 1996 and 13 May 1997 at a rate of 98,000 plants/ha with a John Deere 7100 Series planter fitted with split box applicators. All plots received aldicarb (Temik 15G, Rhone Poulenc Ag, Research Triangle Park, NC) and etridiazole (Terrachlor Super-X, Uniroyal, Memphis, TN) at 0.84 and 1.68 kg (AI)/ha, respectively, at planting each year. In addition, all plots received cyanazine (Bladex, DuPont, Wilmington, DE) and norflurazon (Zorial, Sandoz Agro Inc., Des Plaines, IL) at 0.5 liter/ha and 0.2 liter/ha, respectively, applied on a 0.5 m band at planting. Plots were 60 m long x 36 or 48 1-m rows wide and were treated with two applications of imidacloprid (Provado, Bayer, Kansas City, MO) at approximately weekly intervals at 0.053 l/ha beginning at pre-pinhead square stage (≈ 4th node), pinhead square (6th node), and first bloom; the 4th treatment was an untreated control (Table 1). All other

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insecticide applications made to all plots are noted in Tables 2 and 3.

Sampling for Aphids

At least once per week beginning approximately at the 4th-node stage and continuing through mid-August, the number of aphids per 2.6 cm^2 on ten plants in each plot were counted on (1) the 3rd leaf down from the terminal, and (2) a mid-plant leaf selected at random (Hardee and Ainsworth 1993).

Yield Evaluation

On 2 October 1996 and 17 October 1997, a 2-row John Deere plot picker (supplied by Delta Research and Extension Center, Stoneville, MS) was used to harvest 2 rows x 55 m in each plot for yields (seed cotton/acre).

Data Analysis

Analysis of variance (ANOVA) (SAS Institute 1985) was computed for both years for aphid numbers for each sampling date, as well as yields (kg seed cotton/ha). Means were compared by least significant differences (LSD) at the 0.05% probability level (Steel and Torrie 1980).

Results and Discussion

Results were varied but showed that the bloom treatments produced significantly higher yields (Table 3) than the untreated check and the pre-pinhead square treatments but not the full-grown square treatments. All treatments made to NuCotn 33b yielded significantly higher than corresponding treatments made to Sure-Grow 125. Results were borderline as to economic feasibility of the treatments since the largest yield increase was 102 lb lint/A in the 1997 bloom treatment in NuCotn 33b. Definite conclusions cannot be drawn as to the optimum time to spray for aphids without further experimentation. Aphid numbers were consistently higher in the top of the plant than in the middle throughout the season regardless of variety (Tables 5 and 6). In general, Provado provided consistently favorable control of aphids at all treatment stages. About 2 weeks after the second application beginning at 4th and 6th nodes, numbers of aphids were significantly lower in the untreated control than treatments started at the pre-pinhead square and full-grown square stages. This suggested that parasites and predators provided some reduction in aphid numbers in the untreated plots. Additional research is planned.

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Table 1. Plot treatments for cotton aphids, 1996-1997.

	Dates of Provado treatments by treatment:		
Year	Pre-pinhead square	Pinhead square	Bloom
1996	21, 28 June	28 June, 5 July	5, 11 July
1997	20, 26 June	26 June, 7 July[1]	11, 18 July

[1]Delayed second application due to low numbers of aphids.

Table 2. Insecticide treatments in aphid test, 1996.

	Insecticide Application			
Plot(s)	Date(s)	Chemical	Company	Rate (AI/ha)
All	6, 11 Jun	oxamyl (Vydate)	DuPont Wilmington,DE	0.28 kg
SG-125	24 Jul	spinosad (Tracer)	Dow Elanco, Cedar Rapids, IA	0.067kg
All	7 Aug	methyl parathion + thiodan	Cheminova, Wayne, NJ; FMC Philadelphia, PA	0.14 kg 0.42 kg
All	15, 19, 24, 29 Aug	oxamyl	DuPont	0.28kg[1]

[1]Application by air (28 l water/ha). All others with high-clearance sprayer (45 l water/ha).

Table 3. Insecticide treatments in aphid test, 1997.

	Insecticide Application			
Plot(s)	Date(s)	Chemical	Company	Rate (AI/ha)
All	23 Jun	oxamyl	DuPont	0.28 kg
All	24 Jun	methyl parathion	Cheminova	0.56 kg
SG-125	25 Jul	lamda cy-halothrin (Karate) + profenofos (Curacron)	Zeneca, Mountain View, CA; Novartis, Greensvoro, NC	0.045kg 0.24 kg
NuCotn 33	6 Aug	methyl parathion	Cheminova	0.56 kg
SG-125	6 Aug	profenofos + methyl parathion	Novartis Cheminova	1.12 kg 0.56 kg
All	16 Aug	oxamyl + thiodicarb (Larvin)	DuPont Rhone-Poulenc (RTP, NC)	0.28 kg 0.56 kg
All	20, 25, 29 Aug, 4 Sep	oxamyl	DuPont	0.28kg[1]

[1]Application by air (28 l water/ha). All others with high-clearance sprayer (45 l water/ha).

Table 4. Yields in aphids tests (1996-1997).

	Yield (lb lint/A)		
Treatment	NuCotn 33	Sure-Grow 125	$\bar{x}$
		1996	
Untreated	1090a	813a	952ab
PHS	998b	871b	934a
FGS	1106a	848ab	977ab
Bl	1130a	890b	1010b
$\bar{x}$	1081[1]	856	----
		1997	
Untreated	1188a	1152a	1170a
PHS	1196ab	1138a	1167a
FGS	1274bc	1170a	1222a
Bl	1290c	1160a	1225a
$\bar{x}$	1237[1]	1155	----

Means followed by the same letter in the same column are not significantly different (P = 0.05; least significant difference [Steel and Torrie 1980]).
[1]Yields significantly higher (P=0.05) for NuCotn 33b than Sure-Grow 125 for all treatments and both years.
[2] PHS = pinhead squar; FGS = full-grown square; and BL = bloom.

Table 5. Number of aphids/leaf in 1996.

		$\bar{x}$ No. aphids/leaf on variety					
		NuCotn 33		SG-125		$\bar{x}$	
Dat	Trt[1]	Top[2]	Mid[2]	Top	Mid	Top	Mi
6/24	Cont	4.0ab	2.5b	4.8ab	2.0b	4.4	2.2
	PHS	1.1a	0.7a	1.1a	0.5a	1.1	0.8
	FGS	4.0ab	1.6ab	6.2b	1.8ab	5.1	1.7
	Bl	5.1b	2.9b	2.0a	2.0b	3.8	2.4
6/26	Cont	13.3b	6.5b	7.3ab	7.3b	10.3	6.9
	PHS	4.3a	1.8a	5.1a	1.6a	4.7	1.7
	FGS	9.8b	5.5b	8.6ab	6.3b	9.1	5.9
	Bl	14.2b	5.9b	12.6b	4.8b	13.4	5.4
7/01	Cont	22.0b	19.2c	22.3b	14.7b	22.2	17.0
	PHS	4.0a	1.4a	4.6a	2.6a	4.2	2.0
	FGS	10.8a	6.3b	6.2a	3.6a	8.5	5.0
	Bl	27.4b	15.8c	20.3b	13.4b	20.4	14.6
7/03	Cont	33.1c	26.3b	26.0b	31.7b	29.6	29.0
	PHS	6.4a	3.7a	6.4a	3.5a	6.4	3.6
	FGS	12.8a	6.6a	8.8a	7.9a	10.8	7.2
	Bl	25.1b	17.5b	30.6b	26.1b	27.8	21.8
7/08	Cont	41.2c	40.5c	25.0d	30.0c	33.1	35.2
	PHS	17.9b	18.2b	19.5c	13.3b	18.7	15.8
	FGS	10.1a	5.9a	13.0b	5.1a	11.6	5.5
	Bl	7.8a	6.8a	6.5a	7.8a	7.2	7.3
7/10	Cont	14.6b	14.5b	13.0b	21.0c	13.8	17.8
	PHS	22.5c	16.4b	22.2c	16.0b	22.4	16.2
	FGS	8.8a	3.5a	7.4a	3.6a	8.0	3.6
	Bl	5.9a	3.2a	5.8a	5.2a	5.8	4.2
7/15[3]	Cont	2.3a	4.4b	2.4a	3.6a	2.4	4.0
	PHS	21.4c	16.9d	13.8b	15.5c	17.6	16.2
	FGS	12.2b	9.0c	12.4b	7.1b	12.3	8.0
	Bl	2.6a	1.4a	1.6a	2.8a	2.1	2.1
7/17	Cont	3.2a	3.8b	2.1a	1.9a	2.6	2.8
	PHS	13.1b	12.2d	4.6ab	7.1c	7.8	9.7
	FGS	10.9b	8.6c	5.8b	5.9bc	8.4	7.8
	Bl	1.0a	1.2a	2.4a	4.2b	1.7	2.7
$\bar{x}$	Cont	16.7	14.9	12.9	14.0	14.8	14.4
	PHS	11.3	9.0	9.7	10.0	10.5	9.5
	FGS	10.9	6.6	9.0	5.6	10.0	6.1
	Bl	4.3	3.2	4.1	5.0	4.2	4.1
G $\bar{x}$		10.8	8.4	8.9	8.6	9.9	8.5

[1]Control -- none; PHS -- Provado applications made June 21 and 28; FGS -- Provado applications made June 28 and July 5; Bl -- Provado applications made July 5 and 11.

[2]Top -- 2.6 cm^2 of leaf surface on the 3rd leaf from terminal; middle -- 2.6 cm^2 of leaf surface on a mid-plant leaf.

Means followed by the same letter in the same column are not significantly different (P = 0.05; least significant difference [Steel and Torrie 1980]).

Table 6. Number of aphids/leaf in 1997.

		$\bar{x}$ No. aphids/leaf on variety					
		NuCotn 33		SG-125		$\bar{x}$	
Dat	Trt[1]	Top[2]	Mid[2]	Top	Mid	Top	Mi
6/23	Cont	0.2a	0.3a	0.2a	0.2a	0.2	0.2
	PHS	0.1a	0.1a	0.1a	0.1a	0.1	0.1
	FGS	0.1a	0.2a	0.3a	0.3a	0.2	0.2
	Bl	0.1a	0.3a	0.3a	0.1a	0.2	0.2
6/25	Cont	0.4b	0.6a	0.4a	0.6a	0.4	0.6
	PHS	0.4a	0.3a	0.2a	0.2a	0.3	0.2
	FGS	0.2a	0.4a	0.2a	0.6a	0.2	0.5
	Bl	0.6a	1.0a	0.4a	0.5a	0.5	0.8
6/30	Cont	0.4ab	0.8b	0.7b	0.6b	0.6	0.6
	PHS	0.2a	0.1a	0.2ab	0.3ab	0.2	0.2
	FGS	0.2a	0.4a	0.1a	0.1a	0.2	0.2
	Bl	0.6b	1.0b	1.1bc	0.6b	0.8	0.8
7/02	Cont	2.1b	1.0b	2.3b	0.6b	2.2	0.8
	PHS	0.4a	0.4a	0.5a	0.7b	0.4	0.4
	FGS	0.6a	0.5a	0.5a	0.5b	0.6	0.3
	Bl	2.4b	1.3b	1.0b	0.2a	1.7	1.2
7/10[3]	Cont	32.1b	8.7b	16.2	6.6ab	24.1	7.6
	PHS	5.6a	1.5a	9.4b	2.2a	7.5	1.8
	FGS	5.2a	1.5a	1.4a	6.1a	3.3	3.8
	Bl	42.8c	19.9c	28.4d	9.9bc	35.6	14.9
7/14	Cont	17.4b	13.3c	30.3c14.	18.5c	23.8	15.9
	PHS	13.8b	9.9b	2b	8.3b	14.0	9.1
	FGS	12.4b	8.6b	5.0a	3.4a	8.7	6.0
	Bl	3.4a	2.5a	4.8a	2.3a	4.1	2.4
7/18	Cont	0.7a	1.2a	1.2a	1.0a	1.0	1.1
	PHS	4.8b	3.5b	8.8c	4.4b	6.8	4.0
	FGS	7.2c	4.8b	4.4b	4.2b	5.8	4.5
	Bl	3.1b	3.5b	1.2a	1.8a	2.1	2.7
7/21	Cont	0.3a	0.4a	0.8b	0.6a	0.6	0.5
	PHS	0.7ab	0.9a	1.4c	2.0b	1.0	1.4
	FGS	1.1b	1.9b	0.1a	1.5b	0.6	1.7
	Bl	0.9b	0.6a	0.8b	0.6a	0.8	0.6
7/23	Cont	0.2a	0.3a	0.2a	0.4ab	0.2	0.4
	PHS	0.4a	0.3a	0.2a	0.3a	0.3	0.3
	FGS	0.5a	0.4a	0.6b	0.8bc	0.6	0.6
	Bl	0.9b	0.8b	0.9b	0.9c	0.9	0.8
$\bar{x}$	Cont	6.0	3.0	5.8	2.6	5.9	2.8
	PHS	2.9	1.9	3.9	1.9	3.4	1.9
	FGS	3.1	2.0 3.4	1.4	1.9	2.4	2.0
	Bl	6.1		4.3	2.0	5.2	2.7
G $\bar{x}$		4.5	2.6	3.9	2.1	4.2	2.4

[1]Control -- none; PHS -- Provado applications made June 20 and 26; FGS -- Provado applications made June 26 and July 7; Bl -- Provado applications made July 11 and 18.

[2]Top -- 2.6 cm^2 of leaf surface on the 3rd leaf from terminal; middle -- 2.6 cm^2 of leaf surface on a mid-plant leaf.

[3]Entomomogenous fungus, *Neozygites fresenii* (Nowakowski) Batko first observed.

Means followed by the same letter in the same column are not significantly different (P = 0.05; least significant difference [Steel and Torrie 1980]).