EFFECTS OF PLANTING DATE, IRRIGATION, AND INSECTICIDE TREATMENTS ON THE COTTON APHID IN COTTON

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Introduction

The cotton aphid is a consistent pest year-to-year in the Southeast and Midsouth of the US Cotton Belt. Cotton aphids typically attain very high populations during cotton's early blooming period, and can persist through much of the season. In Georgia, cotton aphid populations generally peak in early to mid-July, and are usually suppressed by a naturally-occurring fungal pathogen, *Neozygites fresenii* in mid- to late July. The true extent of damage inflicted by cotton aphids in Georgia is debatable, as several recent studies have failed to demonstrate any correlation between aphid populations and cotton yield or quality (Abney, Ruberson and Roberts, unpubl.). Nevertheless, there is the possibility that under certain conditions, such as drought or late planting, aphids may inflict economic injury on the cotton crop.

This study was designed to examine the effects of planting date, irrigation, and insecticidal treatment on aphid populations, and the resulting yield of the cotton crop.

Methods

Irrigation, Planting Date, and Insecticides Experiment. The experiment was laid out in a factorial design, with two adjacent blocks serving as the respective irrigated and dryland sections. Each of these two sections was, in turn, split in half, with one half being planted on 29 April 2003, and the other on 30 May 2003. In all trials, DPL 555 (BG/RR) cotton seed was used. Within each planting date/water regime treatment were five insecticide regimes (each replicated five times): (1) untreated control, (2) Assail® at 20 g AI/acre (5 July), (3) Centric® at 20 g AI/acre (5 July), (4) Trimax® applied twice (26 June and 5 July) at 1.5 ounces/acre, and (5) Trimax® applied three times (26 June, 5 July, and 11 July) at 1.5 ounces/acre. Each plot was 8 rows wide by 50 feet long, and plots were longitudinally separated by 10-foot long alleyways. All applications were made using a John Deere 6000 Hi-Cycle sprayer applying 6.8 gallons per acre with TX-6 hollow-cone nozzles, at 60 psi.

The irrigated and dryland treatments differed only in that the irrigated treatments were watered on 14 July (1"), 21 July (1.1"), 25 August (1.3"), and 16 September (1") (Table 1). The rainfall was sufficient and timely enough that little additional moisture was necessary.

Samples were taken on 27 June (essentially a pre-treatment count), 7 July, 15 July, and 5 August (only the late-planted cotton was sampled on this date) 2003. Each sample consisted of removing 1 upper leaf (third fully expanded leaf from the top) and 1 lower leaf from each of 10 randomly-selected cotton plants in the middle two rows of each

plot, placing the leaves in plastic bags, and counting the aphids on the leaves in the laboratory. Yield was taken by mechanically picking the middle 2 rows of each plot.

Statistical analyses. The experimental results (aphid numbers and yield) were analyzed using a three-way analysis of variance (given the factorial design), with the main effects being planting date, water regime, and insecticide. The design and analysis permitted an evaluation of interactions between effects.

Insecticide Tests. Two additional trials were conducted to separately examine the effects of various insecticides on cotton aphid populations. The first trial included 11 treatments (listed in Table 8), and the second trial included 10 treatments (listed in Table 9). Both trials were planted on 29 April 2003 (with DPL 555) in plots 8 rows (36" middles) wide and 50 feet long, and the plots were managed identically. Insecticides were applied on 2 July in Trial 1 and on 3 July in Trial 2. Application methodology was identical for both trials, using a John Deere 6000 high-clearance sprayer equipped with TX6 nozzles spaced 18 inches apart, and calibrated to deliver 6.8 GPA.

Number of nodes on plants were counted in Trial 2 on 2, 17, and 29 July to evaluate effects of aphids on plant growth. Similarly, the number of nodes above white flower (NAWF) were counted on 17 and 29 July in Trial 2 to evaluate plant maturity. Yield was taken by mechanically picking the middle 2 rows of each plot in both trials.

Statistical analyses. The experimental results (aphid numbers and yield) were analyzed using analysis of variance (ANOVA). Where significant differences were detected by ANOVA, means were separated using the Waller Duncan Bayesian *k* ratio.

Results and Discussion

Irrigation, Planting Date, and Insecticides Experiment: Aphid populations. Planting date had a significant effect on aphid populations on most sample dates (Tables 2 and 4, with marginal significance apparent in Table 3), with the greatest populations occurring in the early-planted plots (Figs. 1 and 2).

Water regime significantly affected aphid populations only on the first sample date (Table 2), with marginally significant effects on the third and fourth sample dates (Tables 4 and 5; see also Figs. 1 and 2). The basis for the differences on the first sample date is unclear, as both treatments received the same amount of rainfall prior to the first sample (the first irrigation application in which dryland plots were not watered did not occur until 14 July).

Insecticides exerted significant effects on aphid abundance on 7 and 15 July (Tables 3 and 4), but no differences in aphid population size attributable to insecticides occurred on 27 June or 5 August. However, insecticidal treatments interacted significantly with planting date and water regime on 15 July (Table 4), which is the first sample date after the third application of Trimax. No other significant interactions with insecticides were observed.

Aphid populations on 15 July are presented in Table 6. Assail® and Centric® generally performed better than Trimax in the early-planted cotton, but no differences were observed in the late-planted cotton, which had lower aphid populations from the beginning (Figs. 1 and 2). In all cases, the efficacy of the insecticides appears to have been subsumed by the fungal epizootic.

The interaction of insecticide treatment with planting date may be due to the more rapid decrease in aphid populations in the early-planted cotton relative to the late-planted cotton (Figs. 1 and 2). The interaction between insecticide treatments and water regime may be attributable to the somewhat more accelerated aphid decline in the dry block relative to the irrigated one (Figs. 1 and 2), but as noted earlier, there were little differences in moisture between the two blocks due to adequate rainfall. Thus, the water regime differences may represent block differences rather than water regime.

Irrigation, Planting Date, and Insecticides Experiment: Yield. Yields were unaffected by insecticide application (Table 7), but were significantly affected by water regime (or block). Planting date also significantly affected yields, and there was a strong interaction between planting date and water regime, probably due to variations in the rainfall during the season, and the timing of rainfall relative to the phenology of the cotton for the two planting dates. Yields (seed cotton) are presented in Table 8. For most treatments, there was a drop in yield from the early- to the late-planted cotton. This may be somewhat misleading, however, as intense stink bug pressure occurred late in the season, with the most serious problems occurring after the early-planted cotton was less susceptible to attack than the late-planted. No insecticides were used to control stink bugs, so damage was greater in the late-planted cotton.

Insecticide Tests: Aphid Populations. Significant differences in aphid numbers were first detected in both trials 10 days after treatment (Table 9 and 10). Centric (at all rates) and Centric® performed consistently well 10 DAT, but no effects were discernible 20 DAT due to an extensive of the aphid-pathogenic fungus. The high rate of F-1785 also performed comparable to Centric® and Assail® at 10 DAT (Table 9). Multiple applications of Trimax® failed to provide any added benefit over a single application (Table 9).

Insecticide Tests: Plant Growth and Yield. Number of nodes in Trial 2 were unaffected by treatment on any of the evaluation dates (2 July: df = 10,33, F = 0.95, P = 0. 4892; 17 July: df = 10,33, F = 0.89, P = 0.5336; 29 July: df = 10,33, F = 1.47, P = 0.2049). Nodes above white flower also did not differ among treatments on the sample dates (17 July: df = 10,33, F = 0.62, P = 0.7899; 29 July: df = 10,33, F = 0.89, P = 0.5529). Thus, at least during the sampling period, none of the treatments affected the rate of maturity or growth of the plant.

Conclusions

Insecticide treatments had limited impact on aphid populations in either of these studies, probably due to the intense activity of the fungal pathogen. However, aphid populations in the first experiment were ca. two-fold higher in the early-planted than in the late-

planted cotton, and aphid populations in the late-planted cotton never approached the levels that occurred in the early-planted plots. Similarly, during the aphid outbreak, aphid populations were consistently higher in the dryland block relative to the irrigated one. This would appear to have been a block rather than irrigation effect, however, based on the relative timing of irrigation applications. Insecticide use may, therefore, be of greater value in an early-planted crop where aphid populations may reach potentially damaging levels in advance of the fungal epizootic. Ultimately, all of the insecticide treatments provided similar levels of control, and none of these treatments translated into significant yield differences in any of the tests. Control efficacy against aphids was generally masked by the effectiveness of the fungal pathogen, but on the single date when differences could be detected, Centric® and Assail® generally performed better than Trimax® applied twice or three times.

Acknowledgments

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Table 1. Irrigation amounts in inches for aphid insecticidal efficacy trials. Tift Co., GA. 2003.

Date	Irrigated Efficacy Trials	Irrigated vs. Dryland Trials			
		Irrigated		Dryland	
		Early	Late	Early	Late
May 9	0.5	0.5	-	0.5[1]	-
June 27	-	-	0.5	-	0.5[1]
July 14	1.0	1.0	1.0	-	-
July 21	1.1	1.1	1.1	-	-
August 25	1.3	1.3	1.3	-	-
September 16	1.0	1.0	1.0	-	-

[1] 0.5 includes irrigation applied to dryland plots to prompt stand establishment.

Table 2. Effects of experimental regimes on total aphid populations on 27 June 2003.

Source	F value	P value
Planting date	13.51	0.0004
Insecticides	0.53	0.7105
Water regime	23.08	<0.0001
Planting date x Insecticides	0.97	0.4307
Insecticides x Water regime	0.42	0.7919
Planting date x Water regime	2.68	0.1055
Planting date x Water regime x Insecticides	0.51	0.7310

Table 3. Effects of experimental regimes on total aphid populations on 7 July 2003.

Source	F value	P value
Planting date	3.47	0.0661
Insecticides	11.43	<0.0001
Water regime	0.01	0.9175
Planting date x Insecticides	0.58	0.6803
Insecticides x Water regime	0.25	0.9086
Planting date x Water regime	8.47	0.0047
Planting date x Water regime x Insecticides	1.18	0.3243

Table 4. Effects of experimental regimes on total aphid populations on 15 July 2003.

Source	F value	P value
Planting date	29.74	<0.0001
Insecticides	7.52	<0.0001
Water regime	3.23	0.0761
Planting date x Insecticides	3.35	0.0138
Insecticides x Water regime	3.09	0.0203
Planting date x Water regime	0.01	0.9262
Planting date x Water regime x Insecticides	2.28	0.0683

Table 5. Effects of experimental regimes on total aphid populations on 5 August 2003 (note that the early-planted cotton was not sampled on this date, making planting date an irrelevant factor in this analysis).

Source	F value	P value
Planting date	NA	NA
Insecticides	0.53	0.7108
Water regime	3.85	0.0569
Planting date x Insecticides	NA	NA
Insecticides x Water regime	0.51	0.7303
Planting date x Water regime	NA	NA
Planting date x Water regime x Insecticides	NA	NA

Table 6. Aphid populations (nos. per two leaves) in relation planting date, water regime (dry or irrigated), and insecticide treatment on 15 July 2003, when significant insecticide effects were detected.

Insecticide	Planted 29 April		Planted 30 May	
	Dry	Irrigated	Dry	Irrigated
Untreated	2.98 ± 0.95 b	4.66 ± 3.58 ab	0.66 ± 0.43 a	2.24 ± 2.43 a
Assail 20 g AI/a	0.76 ± 0.40 b	0.90 ± 0.55 b	0.56 ± 0.54 a	4.60 ± 0.23 a
Centric 20 g AI/a	0.96 ± 0.29 b	2.00 ± 0.86 b	0.44 ± 0.38 a	1.26 ± 0.73 a
Trimax 1.5 oz/A 2x	6.90 ± 3.18 a	3.32 ± 2.40 ab	1.30 ± 0.89 a	1.84 ± 1.04 a
Trimax 1.5 oz/A 3x	2.90 ± 2.06 b	6.92 ± 4.89 a	0.80 ± 0.75 a	1.62 ± 2.54 a

Table 7. Effects of experimental regimes on seed cotton yield in the early- (29April 2003) and late-planted (30 May 2003) cotton.

Source	F value	P value
Planting date	10.67	0.0016
Insecticides	1.50	0.2099
Water regime	11.81	0.0009
Planting date x Insecticides	0.14	0.9689
Insecticides x Water regime	0.72	0.5794
Planting date x Water regime	7.60	0.0072
Planting date x Water regime x Insecticides	0.17	0.9547

Table 8. Seed cotton yields (pounds per acre) of insecticide treatments in relation to water regime (differences among insecticide treatments within water regimes are not statistically significant).

Insecticide treatment	Planting date	Water regime	
		Dry	Irrigated
Untreated	29April 2003	2702.4 ± 195.79	2202.8 ± 525.28
	30 May 2003	2040.9 ± 522.68	2285.1 ± 458.26
Assail 20 g AI/a	29April 2003	2713.7 ± 554.11	1989.9 ± 698.16
	30 May 2003	1989.9 ± 139.93	2026.8 ± 274.00
Centric 20 g AI/a	29April 2003	3085.6 ± 290.11	2239.7 ± 509.11
	30 May 2003	2466.7 ± 413.23	2009.7 ± 322.34
Trimax 1.5 oz/A 2x	29April 2003	2594.5 ± 783.15	2069.3 ± 496.09
	30 May 2003	2001.2 ± 647.14	1918.9 ± 200.57
Trimax 1.5 oz/A 3x	29April 2003	2480.9 ± 687.11	1970.0 ± 661.72
	30 May 2003	2058.0 ± 659.33	1975.7 ± 241.99

Table 9. Aphid numbers (per leaf) in relation to insecticide treatment for Trial 1. Means in columns followed by the same letter are not significantly different (Waller Duncan Bayesian *k* ratio, *k* = 100). Trimax (in the 3x treatment) also was applied 9 and 15 DAT.

Insecticide	Rate	No. aphids/leaf		
		2 DAT	10 DAT	20 DAT
Untreated	NA	22.8 ± 2.57	8.1 ± 7.14 ab	0.9 ± 1.07
F-1785	0.054 lbs AI/A	19.0 ± 7.72	3.3 ± 1.43 bcd	0.3 ± 0.23
F-1785	0.071 lbs AI/A	21.3 ± 19.06	1.59 ± 0.94 cd	0.2 ± 0.12
V10112	40 g AI/A	20.2 ± 14.77	6.2 ± 1.95 abc	1.0 ± 0.33
V10112	60 g AI/A	14.98 ± 5.68	8.4 ± 4.16 a	0.7 ± 0.33
V10112	80 g AI/A	11.0 ± 5.60	3.9 ± 2.53 abcd	0.5 ± 0.32
Trimax 1x	1.5 oz/A	18.5 ± 3.84	3.99 ± 2.89 abcd	1.0 ± 1.37
Centric	20 g AI/A	15.7 ± 9.61	1.7 ± 0.76 cd	0.2 ± 0.23
Assail	20 g AI/A	20.6 ± 4.57	1.0 ± 0.16 d	0.1 ± 0.06
Trimax 3x	1.5 oz/A	23.4 ± 5.79	3.4 ± 0.62 bcd	0.3 ± 0.28
	df	9,30	9,30	9,30
	F	0.68	3.04	1.41
	P	0.7166	0.0105	0.2290

Table 10. Aphid numbers (per leaf) in relation to insecticide treatment for Trial 2. Means in columns followed by the same letter are not significantly different (Waller Duncan Bayesian *k* ratio, *k* = 100).

Insecticide	Rate	No. aphids/leaf		
		2 DAT	10 DAT	20 DAT
Untreated	NA	7.3 ± 3.95	1.8 ± 0.37 b	0.7 ± 0.78 a
Centric	14.2 g AI/A	6.8 ± 3.88	0.1 ± 0.05 d	0.2 ± 0.14 b
Centric	17.0 g AI/A	4.6 ± 3.00	0.1 ± 0.10 d d	0.2 ± 0.19 b
Centric	21.g AI/A	7.1 ± 6.61	0.02 ± 0.02 d d	0.03 ± 0.02 b
Centric + Karate Z	14.2 g AI/A 11.3 g AI/A	4.3 ± 1.98	0.3 ± 0.10 d d	0.07 ± 0.09 b
Centric+ Karate Z	14.2 g AI/A 13.4 g AI/A	6.2 ± 2.26	0.4 ± 0.34 cd cd	0.4 ± 0.35 ab
Centric+ Karate Z	17.0 g AI/A 11.3 g AI/A	6.4 ± 3.63	0.5 ± 0.16 d	0.06 ± 0.05 b
Centric+ Karate Z	17.0 g AI/A 13.4 g AI/A	7.2 ± 5.08	0.6 ± 0.17 d	0.1 ± 0.13 b
Centric+ Steward	17.0 g AI/A 50.2 g AI/A	6.8 ± 2.92	0.3 ± 0.09 d	0.1 ± 0.12 b
Leverage	36 g AI/A	4.2 ± 2.26	1.2 ± 0.55 bc	0.4 ± 0.16 ab
Karate Z	13 g AI/A	8.3 ± 4.35	3.3 ± 1.81 a	0.5 ± 0.26 ab ✓
	df	10,33	10,33	10,33
	F	0.48	11.85	2.16
	P	0.8925	<0.0001	0.0473

Figure Captions

Fig. 1. Aphid abundance in relation to insecticide treatment and water regime in early-planted cotton (DPL 555, planted 29 April 2003) on sample dates.

Fig. 2. Aphid abundance in relation to insecticide treatment and water regime in late-planted cotton (DPL 555, planted 30 May 2003) on sample dates.

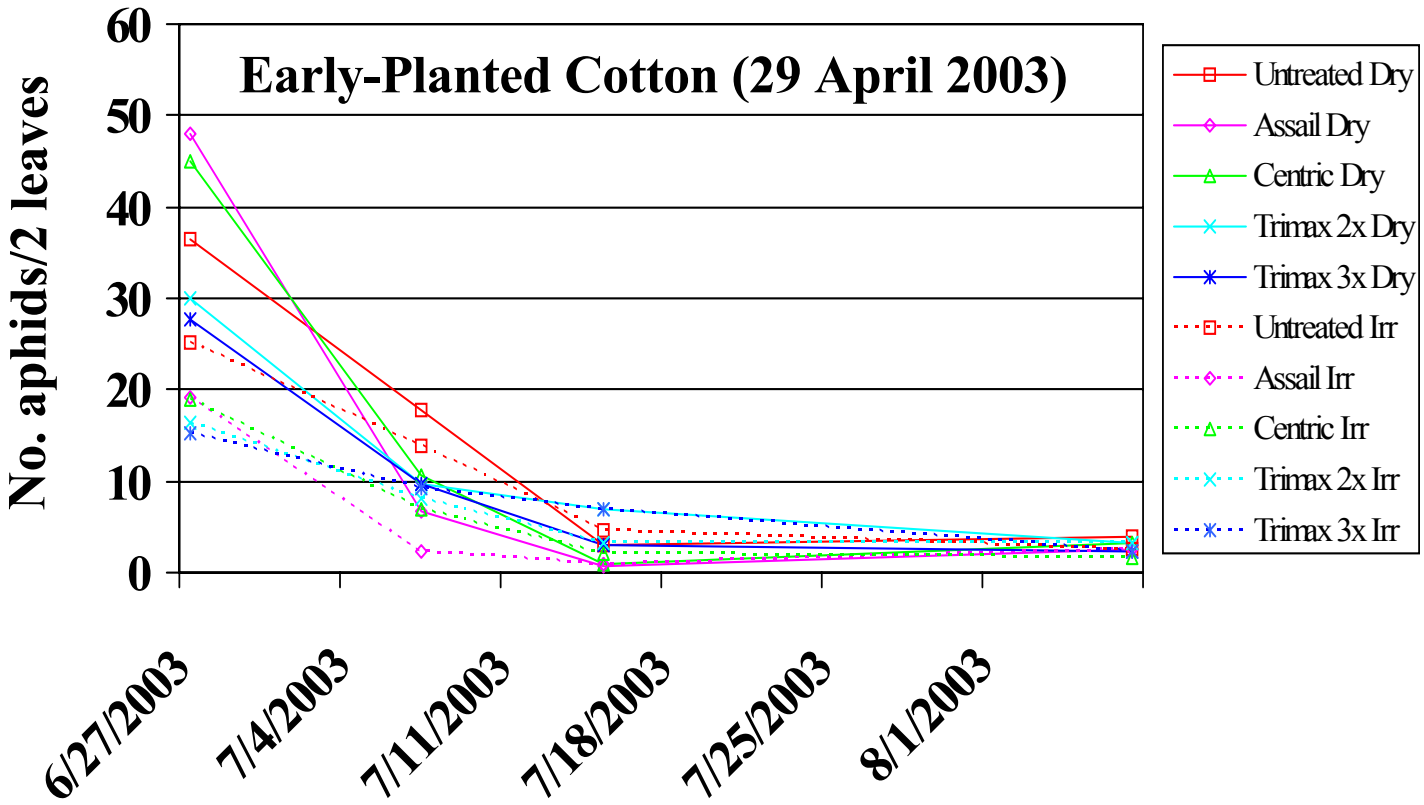
Early-Planted Cotton (29 April 2003)
No. aphids/2 leaves
60
50
40
30
20
10
0
6/27/2003
7/4/2003
7/11/2003
7/18/2003
7/25/2003
8/1/2003
Untreated Dry
Assail Dry
Centric Dry
Trimax 2x Dry
Trimax 3x Dry
Untreated Irr
Assail Irr
Centric Irr
Trimax 2x Irr
Trimax 3x Irr

Fig. 1

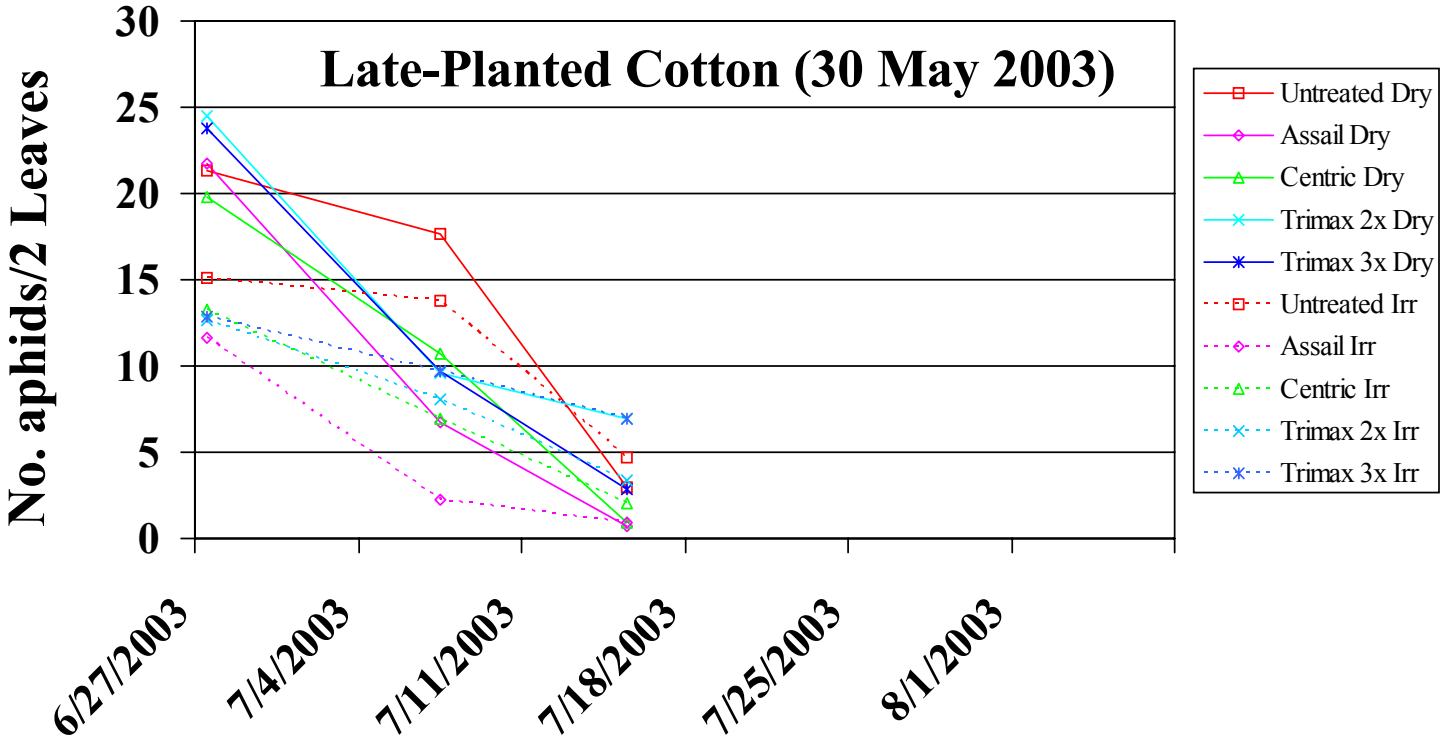
Late-Planted Cotton (30 May 2003)
No. aphids/2 Leaves
30
25
20
15
10
5
0
6/27/2003
7/4/2003
7/11/2003
7/18/2003
7/25/2003
8/1/2003
Untreated Dry
Assail Dry
Centric Dry
Trimax 2x Dry
Trimax 3x Dry
Untreated Irr
Assail Irr
Centric Irr
Trimax 2x Irr
Trimax 3x Irr

Fig. 2