INFLUENCE OF BOLL WEEVIL ERADICATION ON APHID POPULATIONS IN MISSISSIPPI COTTON

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Abstract

A survey was conducted to compare cotton aphid, *Aphis gossypii*, populations in that portion of Mississippi not involved in boll weevil eradication to populations in the Hill region, which had initiated eradication efforts in late summer of 1997 and was involved in the first full season of eradication in 1998. Aphid populations were distinctly higher inside the eradication area, peaking at levels approximately 5-fold higher than in the Delta and occurring approximately two weeks earlier. All nine survey fields in the Hill region exceeded average aphid populations of 100 per leaf or were treated with an aphicide before aphid populations reached this level. Only one of seven survey fields in the Delta region exceeded 100 aphids per leaf. This flaring of aphid populations in the eradication area is attributed to the destruction of beneficial insects as a result of applications of ULV malathion applied to control boll weevils. An epizootic of the fungal disease *Neozygites fresenii*, ultimately provided control of aphid populations in both regions, but development of this epizootic occurred approximately one week later in the Delta than in the Hill region. Yield losses to aphids flared as a result of eradication efforts are difficult to estimate, but were likely offset in whole or in part by reductions in losses to boll weevils.

Introduction

Cotton aphid, *Aphis gossypii* Glover, is an occasional pest of Mississippi cotton. Typically, low level populations begin to develop on seedling cotton and treatable populations, when they do occur, develop during late June and early July. Compared to pests such as tobacco budworm and boll weevil, the yield damaging potential of cotton aphids is somewhat limited. Reported yield losses range from 0 (Weathersbee, & Hardee, 1995) to 220 lbs of lint per acre (Layton, et. al., 1996). Factors thought to contribute to increased likelihood of aphid induced yield loss include: drought or other plant stresses, population level, and timing and duration of the infestation.

Cotton aphids are very difficult to control with currently labeled foliar insecticide treatments because of high levels of insecticide resistance. Labeled insecticides that have proven most effective during recent years include Bidrin (dicrotophos) and Provado (imidacloprid), but Furadan (carbofuran), which was available for use under Section 18 Emergency Exemption in 1998, provides more consistent control. However insecticides only provide short-term reductions in aphid populations and none of these materials are capable of providing effective season long control.

Fortunately, cotton aphid populations in Mississippi and other Mid-South states are subject to epizootics of a naturally occurring fungal disease, *Neozygites fresenii*, (Steinkraus, et. al., 1992) which consistiently appears during mid July, causes drastic declines in aphid populations, and continues to provide effective population suppression for the remainder of the season. Naturally occurring parasitoids, particularly the braconid wasp *Lysiphlebus testaceipes*, and predators, such as lady beetles, also play an important role in suppressing aphid populations and helping to maintain aphid numbers at sub-damaging levels until the *Neozygites* fungal disease appears. Disruption of these predators and parasitoids is considered to one of the primary reasons for yield threatening outbreaks of cotton aphids.

During the 1998 growing season approximately 365,000 acres of cotton in the Hill region of the state entered the first full season of boll weevil eradication, following initiation in August of 1997 with a series of applications of ULV malathion. Because of the intensive use of ULV malathion during the early years of a boll weevil eradication program, outbreaks of secondary pests often occur. The current survey was initiated to monitor the effects of ULV malathion treatments applied as part of the boll weevil eradication program on cotton aphid population development and prevalence of the *Neozygites* fungal disease. The primary objective of the survey was to utilize this unique, short lived opportunity to gain insight into the role of insecticide induced disruption of natural enemies in triggering aphid outbreaks.

Methods

A survey line consisting of 16 individual cotton fields located beside or near US Highway 82 was established during early June of 1998 (Figure 1). From one to three cotton fields were identified in each county along this transect line. Nine of these fields were located in the Boll Weevil Eradication Program Area. Of the fields located in the eradication area, seven were located in a Hill environment, but the two fields nearest the eradication program boundary line were located in a Delta environment.

Beginning the week of June 15, fields were visited weekly and sampled to determine population levels of cotton aphids. Fields were sampled by examining 20 randomly chosen leaves per field, counting the number of aphids per leaf, and determining the average number of aphids per leaf for each sample date. On sample dates when aphid populations in individual fields were sufficient, an

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additional sample of aphids was collected, preserved in ethanol, and mailed to the University of Arkansas. Fifty aphids from each of these samples were crushed and examined
microscopically for the presence of hyphae and spores of the entomopathogenic fungus, *Neozygites fresenii*. Results of these samples were recorded as percent infected aphids.

Results and Discussion

Seasonal trends of average aphid population levels in the Hills (Eradication Area) and Delta (Non-Eradication Area) are shown in Figure 2. Aphid populations peaked approximately two weeks earlier in the hills and reached a maximum level approximately five fold higher than that for Delta fields. More detailed information on aphid population levels in individual fields for the critical three week period of late June and early July are shown in Table 1. Note that during the week of July 1, seven of the nine fields in the Hills exceeded populations of 100 aphids per leaf. Of the two fields that did not exceed 100 aphids per leaf on this date, the Carroll 2 field had already been treated with the aphicide Furadan (carbofuran), and populations in the Lowndes 1 field exceeded 200 aphids per leaf during the subsequent week. Thus, all fields in the Hills either exceeded 100 aphids per leaf or received an application of aphicide by the week of July 8, while the highest aphid population reached in any Delta field by this point was 18.3 aphids per leaf.

Seasonal population curves for two individual fields from the Delta are shown in Figures 4 and 5. The Leflore 2 field shown in Figure 2 was the only Delta field in the survey that exceeded populations of 100 aphids per leaf, peaking at over 350 aphids per leaf during the week of July 22. Aphid populations in the other six delta fields remained exceptionally low throughout the season, following trends similar to that shown for the Sunflower 3 field in Figure 5. Figure 6 shows the seasonal population curve for the Lowndes 1 field, which was the only Hill field that had not exceeded 100 aphids per leaf or received an aphicide application by July 1. It is noteworthy that this field had received only 1 application of ULV Malathion by this date, while all other Hill fields except Lowndes 2 had received two or more treatments. The highest aphid populations in the survey, approximately 600 per leaf, were observed in the Oktibbeha 1 field, for which seasonal population trends are graphed in Figure 7. Note however, that aphid populations declined sharply in this field within one week of reaching this peak. This same precipitous drop in aphid populations is obvious in the Leflore 2 field (Figure 4) and in the graph of average seasonal aphid populations for both the Hills and Delta (Figure 2).

These sharp declines in aphid population are due to epizootics of the naturally occurring fungal disease, *Neozygites fresenii* (Steinkraus, et. al., 1991; 1992). This disease appears annually in Mississippi cotton aphid populations, normally between July 10 and July 25 (Layton, 1998). Once outbreaks of this disease begin, it usually provides effective natural control of cotton aphid populations for the remainder of the season. This is fortunate because cotton aphid exhibits high levels of resistance to most available aphicides (Hardee & Ainsworth, 1993) and aphid populations are capable of rebounding so rapidly following insecticide treatments that aphicides are not capable of providing effective long term control.

Average seasonal incidence of this disease is shown in Figure 3. Note that *Neozygites* incidence peaked approximately one week earlier in the Hills than in the Delta, suggesting that occurrence of this disease is at least partially dependent on aphid population levels. Figure 3 also shows a second, lower peak in occurrence of the *Neozygites* fungus during mid August. This is typical of the situation that occurs annually in Mississippi cotton as aphid populations peak in early to mid-July, crash due to the fungal epizootic, rebound somewhat during August, and are again suppressed by fungal disease epizootics.

This distinct difference in aphid population levels between the Hills and Delta is attributed to the effects of ULV malathion applications applied as part of the Boll Weevil Eradication Program. By July 1, survey fields in the Hill region had received an average of 2.2 applications of ULV malathion for control of overwintered boll weevils, and Hill fields received an average seasonal total of 13.4 ULV malathion treatments. Detailed data on parasitoid and predator populations were not collected during this preliminary study. However, destruction of parasitoids and predators by applications of ULV Malathion, is thought to be the primary reason for the flaring of aphid populations observed in the eradication program area. In particular, observations of mummified aphids parasitized by *Lysiphlebus testaceipes*, were notably uncommon in the Hills.

Detailed counts of bandedwinged whitefly populations were not made during this survey. However, it was apparent that whitefly populations also were flared inside the Boll Weevil Eradication Program Area. Increased aphid and whitefly populations also were observed during late August and September of 1997, due to the ULV malathion treatments applied as part of the initial fall diapause effort. Whitefly populations appeared earlier than normal in 1998, with significant numbers being observed during the latter portion of June and treatments being initiated on some fields during the latter half of July. During August whiteflies were one of the most common targets of grower applied insecticide treatments in the Hills, but treatable whitefly infestations were uncommon in the Delta. Thus two species of homopterous pests were clearly flared as a result of boll weevil eradication efforts and aphids and whiteflies were respectively ranked as the 2nd and 3rd most damaging insect pests of the Hill Region in 1998 (Williams, in Press). However much, if not all of the damage caused by homopterous pests was offset by the drastic reductions in yield losses to boll weevils experienced by Hill producers in 1998.

While these reports of increased aphid and whitefly populations during the early years of a boll weevil eradication program may be seen as a negative consequence eradication, the long term benefits of eradicating the boll weevil far outweigh the short term negatives. Regions where boll weevil has been eradicated not only enjoy reduced control costs and yield losses directly to boll weevils, but also experience fewer losses and expenses due to secondary pests, such as aphids and tobacco budworm. Results of this survey clearly show that aphid population outbreaks can be triggered by early season insecticide applications targeted toward other pests. As Boll Weevil Eradication progresses and the number and frequency of insecticide treatments declines, insecticide induced outbreaks should also decline.

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Table 1. Average number of aphids per leaf in individual fields during 3 consecutive weeks of sampling. Shaded cells indicate fields in which populations exceeded 100/leaf.

Hills (Eradication Area)			
	Avg. # aphids/leaf		
Field	24-Jun	1-Jul	8-Jul
Lowndes 1	0.6	17.5	220.9
Lowndes 2	0.9	134	245.6
Oktibbeha 1	1.7	131	607.7
Webster 1	0.2	124	224.5
Webster 2	0.7	210	370.6
Montgomery 1	0.2	232	**
Montgomery 2	4.4	147	**
Carroll 1	31.8	135	14.45
Carroll 2	3.2	5.8*	7.45
Avg. Hills	4.8	126.3	241.6

Delta (Non-Eradication Area)			
	Avg. # aphids/leaf		
Field	24-Jun	1-Jul	8-Jul
Leflore 1	0.9	2.2	0.6
Leflore 2	2.3	19.3	18.3
Sunflower 1	0	0	0.2
Sunflower 2	0.2	3.7	5.7
Sunflower 3	0.2	0	0.7
Washington 1	1.7	1.2	3.7
Washington 2	0.2	0.1	0.3
Avg. Delta	0.8	3.8	4.2

*This field treated with carbofuran (Furadan) on 6/30.
**No sample taken due to insecticide application.

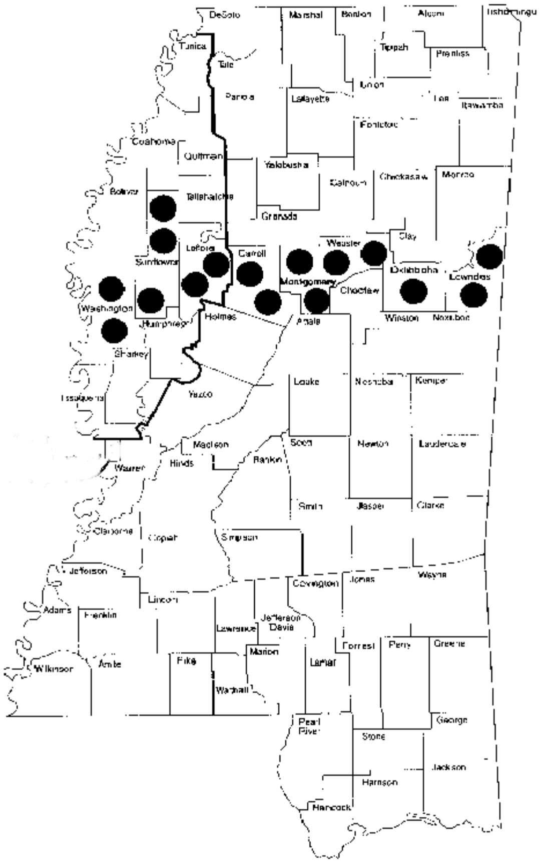

Figure 1. County distribution of survey fields located beside or near U.S. Hwy 82. Fields located east of the bold line were inside the Boll Weevil Eradication Program area.

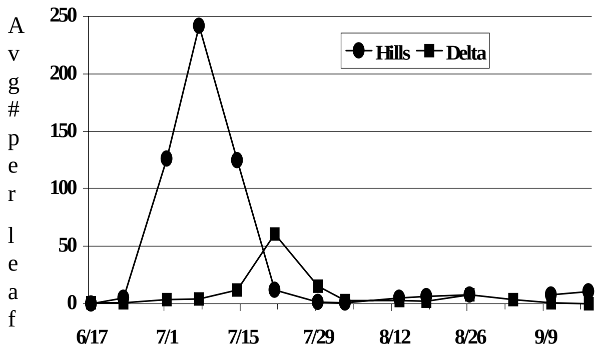

Figure 2. Average seasonal cotton aphid populations in Hills (Eradication Area, n=9) vs, Delta (Non-Eradication, n=7), 1998.

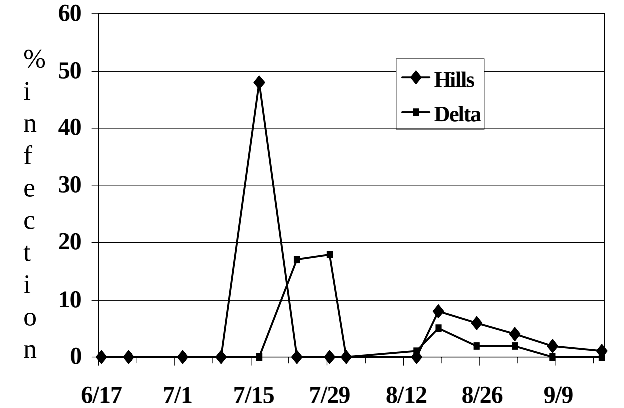

Figure 3. Average % infection with the fungal disease, *Neozygites fresnii*, in Hills (Eradication Area, n=9) vs Delta (Non-Eradication, n=7)

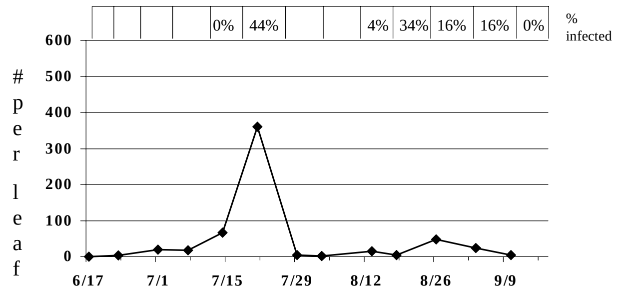

Figure 4. Seasonal cotton aphid populations, and % aphids sampled that were infected with the fungal diease, *Neozygites fresnii*, Leflore Co., Field 2, (Delta), 1998

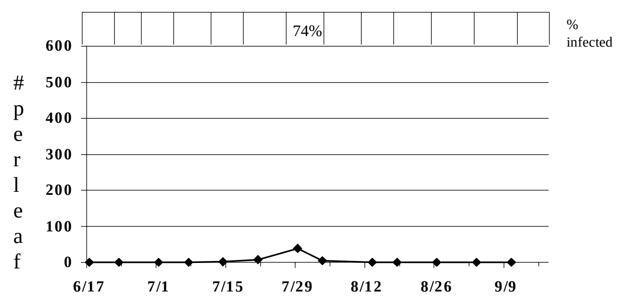

Figure 5. Seasonal cotton aphid populations, and % of aphids sampled that were infected with the fungal disease, *Neozygites fresnii*, Sunflower Co., Field 3 (Delta), 1998

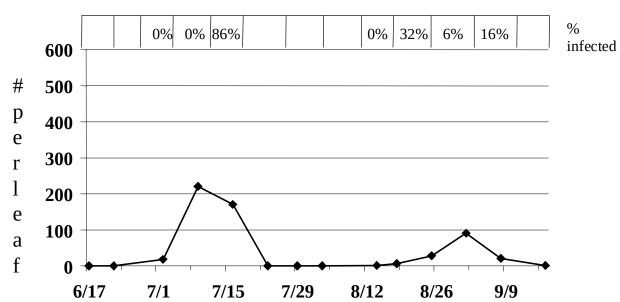

Figure 6. Seasonal cotton aphid populations, and % of aphids sampled that were infected with the fungal disease, *Neozygites fresnii*, Lowndes Col, Field 1 (Hills), 1998

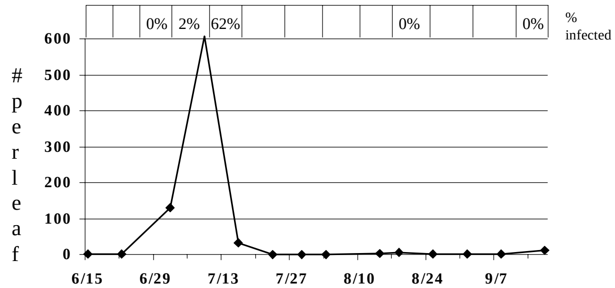

Figure 7. Seasonal cotton aphid populations, and % of aphids that were infected with the fungal disease, *Neozygites fresnii*, Oktibbeha Co., Field 1 (Hills), 1998