THE EFFECTS OF INSECTICIDE, NITROGEN, AND PIX ON ARTHROPOD POPULATIONS IN COTTON IN 1998 AND 1999

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Abstract

A study was conducted in 1998 and 1999 to determine the effects of dual rates of insecticide, nitrogen, and Pix® on arthropod populations in cotton (*Gossypium hirsutum*). Sample data was recorded for ten arthropod populations. Populations sampled with a drop cloth included tarnished plant bugs (*Lygus lineolaris*), big-eyed bugs (*Geocoris* spp.), lady beetles (Coccinellidae), insidious flower bugs (*Orius insidiosus*), damsel bugs (*Nabis* spp.), lacewings (Chrysopidae), spiders (Araneae), beet armyworms (*Spodoptera exigua*), and tobacco budworms (*Heliothis virescens*) and cotton bollworms (*Helicoverpa zea*) (grouped as heliothines). Heliothine larvae and eggs were also counted during the visual samples. A significant positive effect of insecticide application on the number of eggs was found in 1998. Fewer larvae, big-eyed bugs, and total hemipteran predators were found in plots receiving supplemental insecticide applications. In 1999, more lady beetles were found in plots receiving a 100 lb/acre rate of nitrogen while an increase to 150 lb/acre showed no increase in lady beetle populations. Analysis indicated that there were more heliothine larvae (1998), total predators (1998), ants (1998), hemipteran predators (1998-99), and big-eyed bugs (1999) in plots receiving Pix applications.

Introduction

Insect damage to cotton crops is an obvious concern to growers. In order to effectively assess and possibly control this damage, the effects of numerous crop treatments on arthropod populations and plant development should be determined. Insecticidal control of insects is a common practice in today's cotton production systems. This method of insect control has proven to be effective yet costly, and often reduces the population of natural enemies as well as pests. While nitrogen applications may increase plant vigor and possibly production, it can also have indirect effects on arthropod populations. The use of Pix as a growth regulator is also common in cotton production. Pix may decrease the chances of late season exposure of cotton to escalated pest populations (McCarty 1994), however; it may have other, unknown effects on insect populations.

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The objectives of this study were: 1) determine the effects and interactions of various crop management factors on arthropod populations, 2) determine the effects of these treatments on cotton plant development, and, 3) relate insect data and plant development data, and their interactions with remote imagery. Objective one is the main topic of this paper.

Materials and Methods

This field study was conducted at Ramsey Bottom on the North Farm of the Mississippi Agriculture and Forestry Experiment Station, Mississippi State, MS, during 1998 and 1999. The cotton varieties used were Stoneville 474 (1998) and BXN 47 (1999). The seed were planted at normal plant densities (10 plants per m). The test was set up as a randomized complete block with a partial factorial arrangement of treatments (six treatments with four replications). The treatments consisted of various combinations and rates of insecticide (eradication sprays only versus eradication and supplemental sprays), nitrogen (50 and 100 lb/acre in 1998; 100 and 150 lb/acre in 1999) and Pix (none versus scheduled 8 oz. applications [formulated product]). Pix and supplemental insecticide applications began about first square and continued at about 7-d intervals until physiological cut-out. Each of the twenty-four test plots consisted of sixteen rows of cotton 15.24 m (50 ft) long. Since the test was conducted in an active area of the boll weevil eradication, all plots were exposed to multiple malathion sprays. Our intent with supplemental insecticide applications to some treatments, beyond those for weevil eradication, was to sterilize these treatments of insect pests. These sprays were much more frequent in 1998 than in 1999, which may account for reduced numbers of some pests and beneficial arthropods in 1998. The rates and dates of supplemental insecticide applications, not including ULV malathion, are shown in Table 1.

Insect data were collected by whole plant visual inspections and drop cloth samples. The visual samples were taken on eight plants from the center eight rows of each plot and were done twice a week. The drop cloth samples (2 m of row) were taken from the approximate center of each plot twice per week. The drop cloths used were constructed from duct canvas and dowels, and measured 1 x 1 m.

The arthropod populations counted in drop cloth samples included tarnished plant bugs (*Lygus lineolaris*), big-eyed bugs (*Geocoris* spp.), lady beetles (Coccinellidae), insidious flower bugs (*Orius insidiosus*), damsel bugs (*Nabis* spp.), lacewings (Chrysopidae), spiders (Araneae), beet armyworms (*Spodoptera exigua*), tobacco budworms (*Heliothis virescens*), and cotton bollworm (*Helicoverpa zea*). The tobacco budworm and the cotton bollworm populations were grouped as a single population (i.e., heliothines). Heliothine larvae and eggs were also counted during the visual samples. Data for all of these species are not shown because insufficient numbers were found to justify any conclusions. We grouped big-eyed bugs, damsel bugs, and insidious flower bugs as hemipteran predators.

We tested for significant effects of insecticide, nitrogen and Pix, as well as for insecticide by Pix and insecticide by nitrogen interactions on arthropod populations (Proc GLM, Fischer's LSD, P < .05; SAS Institute 1988). Because our design was an incomplete factorial, we could not test for nitrogen by Pix or three-way interactions.

Results and Discussion

For each year, seasonal population means for each treatment are presented in Table 2. Data analysis revealed a significant effect of insecticide on egg counts (1998), total hemipteran predators (1998), big-eyed bugs (1998), larval counts (1999), and spiders (1999) (Table 3, Fig. 1-4 and 9). In each case, the supplemental insecticide applications resulted in significantly lower population numbers with the exception of heliothine egg counts, which were elevated by supplemental applications. In 1999, analysis revealed a significant effect of nitrogen on lady beetles (Table 3, Figure 5). Lady beetle populations were higher in the plots receiving 100 pounds of nitrogen per acre versus those receiving 150 pounds of nitrogen per acre. Pix applications resulted in increased numbers of heliothine larvae (1998, Figure 6), total predators (1998), ants (1998), big-eyed bugs (1998), and hemipteran predators (1998 and 1999) (Figure 7). The apparently higher population numbers of these insects may be due to increased sampling efficiency in plots receiving Pix. Plants in these plots were conspicuously shorter than those not treated with Pix (data not shown). The drop cloth in particular may be more efficient in canopies where plants in adjacent rows do not overlap. Pix treated plots were also measurably "greener" then those not receiving Pix (data not shown) (Glover 1992). Greeness, plant height, or some other related attribute may effect plant attractiveness to arthropods.

A significant interaction was observed between insecticide and nitrogen for spiders in 1999 (Table 4). In treatments receiving a relatively high rate of nitrogen (150 lb), spider populations were larger in plots not treated supplementally with insecticide. However, at the low rate of nitrogen (100 lb), spider populations were higher when coupled with high rates of insecticide. Significant interactions were found between insecticide and Pix for egg counts (1998, Figure 8) and spiders (1999, Table 4). In 1998, intense insecticide application in the absence of Pix resulted in increased egg counts. However, relatively lower use of insecticide coupled with multiple Pix applications also resulted in increased egg counts. When Pix was applied, a high rate of insecticide resulted in increased population numbers of spiders, while in the absence of Pix a low rate of insecticide resulted in increased population numbers. The reasons for these interactions are unknown.

Summary

These results represent a portion of a larger research project initiated in 1998. Interestingly, repeated applications of Pix seemed to have more effect on arthropod populations than other management factors tested in this study, including insecticide applications. However, it must be noted that plots were repeatedly sprayed with malathion, and many insect populations were likely suppressed by these applications. This data along with cotton plant development data will be correlated with remotely sensed imagery to determine how various management factors could potentially influence the value of remote imagery as an insect management tool. Other components of this study include comparisons of efficiency between different sampling methods.

References

Glover, C.R., 1992. Pix and Prep Use in Cotton. New Mexico State University, United States Department of Agriculture Web Site, http://www.cahe.nmsu.edu/pubs/_a/a-213.htm

McCarty, J.C., Hedin, P.A., 1994. Effects of 1,1-dimethylpiperidenium chloride on the yields, agronomic traits, and allelochemicals of cotton (Gossypium hirsutum L.), a nine-year study. Journal of Agricultural Food Chemicals. V. 42, No. 10: 2302-2304.

Table 1. Applied insecticides, application dates, and application rates.[1]

1998[2]		
Insecticide	**Interval of Dates Used**	**Rates of Formulated Product**
Tracer 4F	10 June- 1 September	2.0 oz/acre
Baythroid 2EC	10 June- 4 Aug	4.0 oz/acre
Provado 4F	7 August- 1 September	4.0 oz/acre
Orthene 90S	15 August- 23 August	1 lb/acre

1999		
Insecticide	**Internal Dates Used**	**Rate**
Tracer 4F	5 July- 18 August	2.0 oz/acre
Baythroid 2EC	10 June- 4 Aug	4.0 oz/acre
Provado 1.6F	5 July- 18 August	4.0 oz/acre

[1] Multiple applications of ULV malathion were applied to all plots in both years as part of the Boll Weevil Eradication Program.

[2] Applications were made on about a 7-day basis. However, from July 16 through August 7 no applications were made due to adverse weather conditions.

Table 2. Seasonal treatment means and standard errors of heliothine eggs and larvae (terminal counts) and beneficial arthropod populations (drop cloth) (1998 and 1999).

Treatment[1]	HI HF HP		HI HF LP		HI LF LP	
Year 1998						
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
Eggs	21.97	±3.11	28.03	±3.88	20.45	±3.19
Larvae	20.07	±2.46	13.82	±2318	12.31	±1.76
Tot. Pred.[2]	4.07	±.73	2.51	±.51	3.17	±.64
Hemi. Pred[3]	0.34	±.09	0.13	±.04	0.11	±.44
Spiders	1.15	±.17	0.8	±.15	1.03	±.17
Ants	0.12	±.05	0.05	±.04	0.15	±.06
BEB[4]	0.3	±.07	0.09	±.04	0.05	±.03
Lady B.[5]	2.38	±.58	1.38	±.40	1.73	±.54
Year 1999						
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
Eggs	8.07	±1.61	9.635	±2.26	6.51	±1.55
Larvae	0.14	±0.81	0.14	±0.92	0.25	±0.85
Tot. Pred.[2]	2.81	±.45	2.52	±.49	2.31	±.38
Hemi. Pred[3]	0.29	±.08	0.08	±.04	0.22	±.09
Spiders	0.5	±.14	0.77	±.15	0.43	±.12
Ants	0.14	±.07	0.1	±.06	0.1	±.05
BEB[4]	0.2	±.08	0.04	±.07	0.14	±.07
Lady B.[5]	1.39	±.34	1.22	±.40	1.08	±.32

Treatment[1]	LI HF HP		LI HF LP		LI LF LP	
Year 1998						
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
Eggs	28.78	±4.78	17.8	±2.43	16.09	±2.74
Larvae	16.66	±2.10	12.87	±1.75	13.44	±1.83
Tot. Pred.[2]	4.09	±.78	3.05	±.52	3.0	±.53
Hemi. Pred[3]	0.46	±.11	0.32	±.08	0.25	±.06
Spiders	1.05	±.17	0.94	±.15	0.96	±.15
Ants	0.28	±.11	0.05	±.03	0.05	±.03
BEB[4]	0.34	±.08	0.3	±.08	0.21	±.05
Lady B.[5]	2.19	±.56	1.61	±.43	1.71	±.45
Year 1999						
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
Eggs	6.51	±1.50	5.72	±1.44	9.89	±2.61
Larvae	0.58	±1.11	0.33	±1.46	0.12	±1.34
Tot. Pred.[2]	3.35	±.52	3.6	±.49	2.5	±.37
Hemi. Pred[3]	0.39	±.11	0.22	±.06	0.22	±.06
Spiders	1.08	±.28	0.16	±.11	0.08	±.23
Ants	0.18	±.10	0.16	±.10	0.08	±.05
BEB[4]	0.31	±.10	0.16	±.06	0.08	±.04
Lady B.[5]	1.27	±.46	2.27	±.51	0.7	±.21

[1] HI plots received supplemental insecticide applications; LI plots received only malathion applications; HF plots received 100 lb/acre of nitrogen in 1998 and 150 lb/acre in 1999; LF plots received 50 lb/acre of nitrogen in 1998 and 100 lb/acre in 1999; HP plots received multiple applications of Pix; LP plots received no Pix applications

[2,3,4,5] Tot. Pred = total predators; Hemi. Pred= Hemipteran Predators; BEB= Big-Eyed Bugs Nymphs and Adults; Lady Beetles include larvae and adults.

Table 3. Significant main effects of insecticide, nitrogen, and Pix® on arthropod populations in 1998 and 1999.

Population	Treatment	Year	P > F
Heliothine Eggs	Insecticide	1998	0.02
Heliothine Larvae	Insecticide	1999	0.01
Spiders	Insecticide	1999	0.03
Lady Beetles[1]	Nitrogen	1999	0.02
Larvae	Pix	1998	0.02
Hemipteran Predators	Pix	1999	0.02
Big-eyed Bugs	Pix	1999	0.02

[1] Lady Beetle population includes larvae and adults.

Table 4. Significant interactions of insecticide and Pix and insecticide and nitrogen in 1998 and 1999.

Population	Interaction	Year	P > F
Heliothine Eggs	I*P	1998	0.02
Spiders	I*P	1999	0.01
Spiders	I*N	1999	0.02

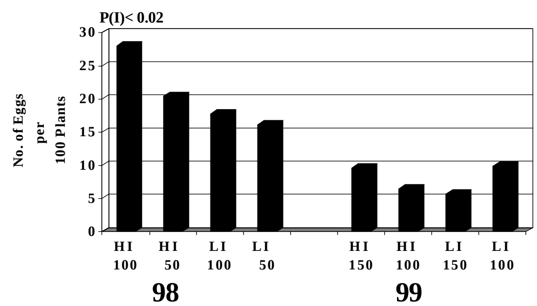

Figure 1. The effects of insecticide and nitrogen on Heliothine egg counts in 1998 and 1999. P(I) < 0.002 indicates a significant main effect of insecticide on egg counts in 1998. HI indicates plots received supplemental insecticide applications. LI indicates plots received only multiple malathion applications. 50, 100, and 150 are nitrogen rates expressed in lb/acre.

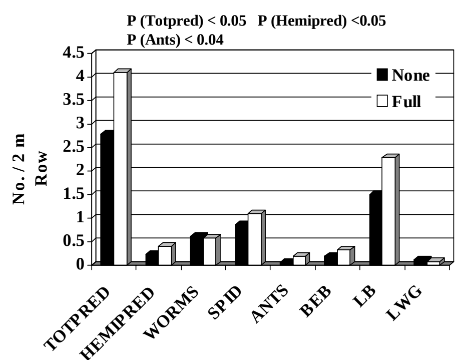

Figure 2. The effects of Pix on arthropod populations in drop cloth samples in 1998. None represents plots that received no Pix applications. Full represents plots that received multiple Pix applications. Significant main effects are indicated. Total predators (TOTPRED), hemipteran predators (HEMIPRED), spiders (SPID), big-eyed bugs (BEB), lady beetles (LB), lacewings (LWG).

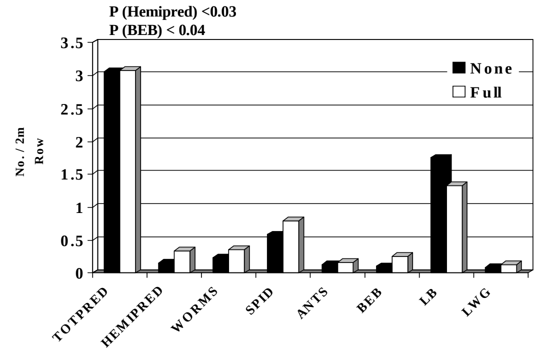

Figure 3. The effects of Pix on arthropod populations in drop cloth samples in 1999. None represents plots that received no Pix applications. Full represents plots that received multiple Pix applications. Significant main effects are indicated. Total predators (TOTPRED), hemipteran predators (HEMIPRED), spiders (SPID), big-eyed bugs (BEB), lady beetles (LB), lacewings (LWG).

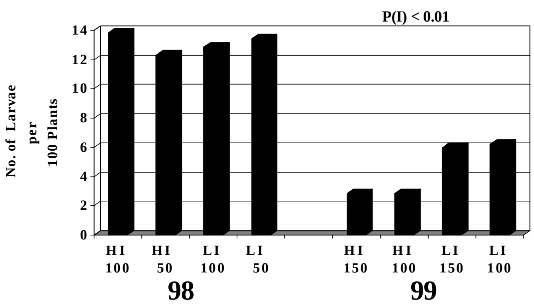

Figure 4. The effects of insecticide and nitrogen on Heliothine larval counts in 1998 and 1999. P(I) < 0.01 indicates a significant main effect of insecticide on larval counts in 1999. HI indicates plots received supplemental insecticide applications. LI indicates plots received only multiple malathion applications. 50, 100 and 150 are nitrogen rates expressed in lb/acre.

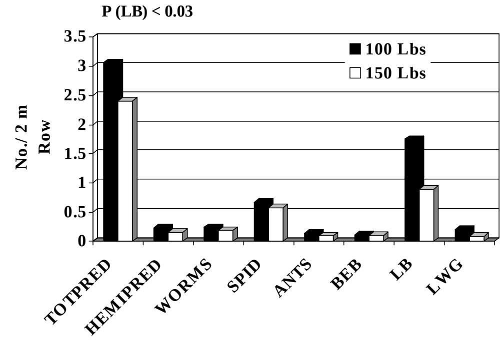

Figure 5. The effects of nitrogen on arthropod populations in drop cloth samples in 1999. 100 and 150 are nitrogen rates expressed on a per acre basis. Significant main effects are indicated. Total predators (TOTPRED), hemipteran predators (HEMIPRED), spiders (SPID), big-eyed bugs (BEB), lady beetles (LB), lacewings (LWG).

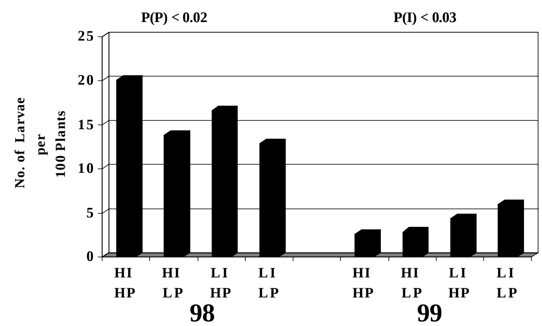

Figure 6. The effects of insecticide and Pix® on Heliothine larval counts in 1998 and 1999. P(P) < 0.02 indicates a significant main effect of Pix in 1998. P(I) < 0.03 indicates a significant main effect of insecticide on in 1999. HP plots received multiple applications of Pix. LP plots received no Pix applications.

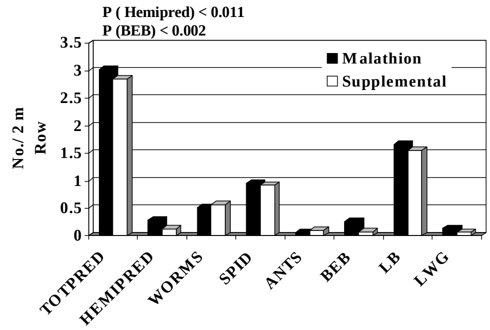

Figure 7. The effects of insecticide on arthropod populations in drop cloth samples in 1998. P(HEMIRED) < 0.01 indicates a significant main effect of insecticide on the hemipteran predator population. Significant main effects are indicated. Total predators (TOTPRED), hemipteran predators (HEMIPRED), spiders (SPID), big-eyed bugs (BEB), lady beetles (LB), lacewings (LWG).

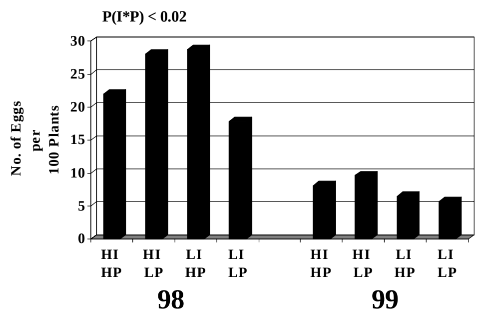

Figure 8. The effects of insecticide and Pix on Heliothine egg counts in 1998 and 1999. P(I*P) < 0.02 indicates a significant interaction of insecticide and Pix on Heliothine egg counts in 1998. HP plots received multiple applications of Pix. LP plots received no Pix applications.

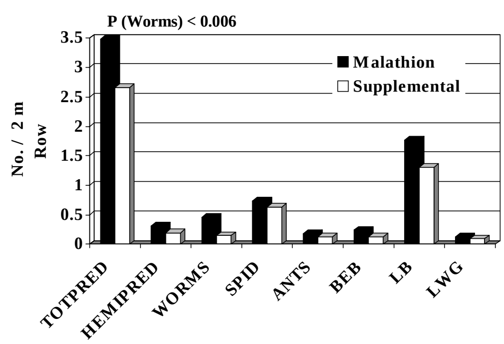

Figure 9. The effects of insecticide on arthropod populations in drop cloth samples in 1999. Significant main effects are indicated. Total predators (TOTPRED), hemipteran predators (HEMIPRED), spiders (SPID), big-eyed bugs (BEB), lady beetles (LB), lacewings (LWG).