INFLUENCE OF COTON VARIETIES ON ARTHROPOD FAUNA

P. B. Goodell[1], C. M. Garcia[1], K. D. Keillor[2], C. Haas[1], L. D. Godfrey[3] and D. Munk[4]
[1]Coop. Ext. Univ. Calif., Kearney Agricultural Center, Parlier, CA, [3]Department of Entomology, UC Davis, Davis, CA, [4]Fresno County

Abstract

Arthropods were sampled weekly in 1999 and 2000 from eleven replicated variety trials in the San Joaquin Valley (SJV). Ten sites contained both upland and Acala varieties while one plot contained Upland, Acala and Pima varieties. No significant differences were found in total arthropod population between varieties at most locations. Exceptions included three sites in which total lygus were greater on C-166, gossypol-free experimental Acala cotton and a single site where aphid were also greater on C-166. Natural enemies differed between varieties in more locations but their presence did not correspond to varieties and sites in which pests were significantly greater. Transgenic Bt and non-Bt cotton were compared for their influence on natural enemy insect populations during 1999 and 2000. Significantly greater total population of big-eye bug was found in 1999 on Bt cotton. In 2000, one trial had significantly greater or less green lacewing on Bt and non-Bt cotton.

Background

For over 50 years, San Joaquin Valley cotton production was based on a limited number of varieties of *Gossypium hirsutum*. Variety shifts occurred gradually as one valley wide standard dominance was that replaced by another. During the 1990's, variety selection changed dramatically, first with introduction of Pima cotton (*G. barbadense*) and then with change in the One-Quality Standard that allowed non-Acala quality cotton to be produced, including transgenic varieties. The number of variety selections available to growers grew from about a dozen to over 30 in a few years. Choice of variety was predicated on many factors, including experience with the variety, desire for shorter season cotton, or the management of risk.

Thirty years of IPM guidelines were developed on this narrow selection of cultivars based on Acala varieties. The shift to more varieties introduces new questions:

- ✓ Do newly introduced varieties have more or less affinity for key arthropod pests and natural enemies?
- ✓ Are the IPM guidelines relevant if affinity is different?
- ✓ Should new efforts be placed on developing trials to develop specific guidelines for new varieties?
- ✓ Does transgenic Bt cotton influence the population density of natural enemies?

These trials were designed to evaluate the influence of variety on arthropod fauna.

Methods and Materials

Variety Trials

During 1999 and 2000, trials were conducted utilizing existing uniform statewide Acala, Upland and Pima variety trials. The Statewide Cotton Specialist and Cotton Farm Advisors coordinated the trials that include Acala, Upland, and Pima varieties. The trials were placed in grower fields and on UC Research and Extension Centers and received standard production practices for the ranch. Each trial utilized a completely randomized block design and employing either three or four replications (Tables 1). Plot size was generally 8 to 16 rows wide with length depending on field size.

Only nine locations contained both Acala, Upland and Pima. These were chosen to ensure uniform arthropod presence. Four varieties each of Acala and Upland trials and two varieties of Pima (including Upland and Acala variety) were sampled in 1999 (Table 1). In 2000, only two locations had both Acala and Upland trials (Table 2).

Each location was sampled weekly for arthropods. The guard rows were sampled to avoid damage to harvest rows. Insects were collected with a standard 38-in sweep net using 50 sweeps across the top of the plants. The insects were transferred to a paper bag and placed in a freezer. Insects were identified and enumerated within five days of collections. Adults and nymphs of common insects were classified to adult or immature stage except for Western Tarnished Plant Bug (WTPB), *Lygus hesperus,* where adults were sexed and immatures identified to instar class and green lacewing where only adults were counted. Ten leaves located five nodes from the top of the plant were collected each week. The leaves were washed in 0.5 % bleach solution to remove mites and aphids. These were collected and counted under a microscope.

Data were entered weekly but for this paper, only the seasonal totals are presented. ANOVA and mean separation (Fishers Protected LSD) were used to analyzed the data set. Data for WTPB, cotton, aphid, spider mites, minute pirate bug, big-eye bug and green lacewing.

Bollgard Trials

In 1999 and 2000, trials were conducted at the Westside Research and Extension Center in Fresno County. These trials were established to evaluate Bollgard and Bollgard II cotton. These plots were four or eight rows wide, 30 feet long and used a Latin square design. Treatments in 1999 were DP50, DP50B (Bollgard), 15813 and 15985 (Bollgard II), replicated four times. Treatments in 2000 were NuCotton 33 B (Bollgard), Bollgard II, DP50B, and DP50. Two trials were conducted. Trial A was a randomized complete block with three replications of eight rows by 40-foot plots. Trial B was a 4x4 Latin square with four rows by 40 foot plots.

Arthropod samples were taken weekly as describe above. No leaf samples were collected. Seasonal totals for big-eye bug, minute pirate bug, and green lacewing were analyzed using ANOVA and Fisher's Protected LSD.

Results

Variety Trials

There were only few significant differences in total arthropod population in the 11 separate trials in 1999 and 2000 (Tables 3-6). WTPB populations were significantly different between varieties at only two locations in Acala during 1999 and at one in 2000. Only in 1999 in one trial were aphid populations were significantly different. Spider mite populations were significantly different at only one location each in 1999 and 2000.

Minute-pirate bug populations were significantly different between varieties at one location in 1999. Total big-eye bug populations for the season differed significantly between varieties in two locations in 1999 and a single location in 2000. Only one location had significantly different populations of green lacewing during 1999.

Bollgard Trials

There were no differences between cotton varieties in 1999 and 2000 in minute pirate bug densities. In 1999, DP50 had significantly fewer big-eye bugs than other varieties (Figure 1). In 2000, Trial A had significantly more green lacewing on DP50B and NuCotton 33B as compared to Bollgard II and DP50. There were no differences in the three beneficial insect totals in Trial B.

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Discussion

Based on these trials, there appears to be little difference between Acala, Upland and Pima varieties for arthropod affinity. The experimental Acala variety C-166 had significantly higher total populations of WTPB in three locations over two years. This experimental Acala variety is glandless and produces no gossypol, a natural plant defense compound. The rationale for developing such a plant is the expected increased value of the seed for human consumption.

The existing pest management guidelines are currently sufficient to sample and monitor the key pest and beneficial arthropods. However, these trials did not attempt to address the question of differential susceptibility to these pests.

The Bollgard trials provided mixed results. In one trial, Bollgard cottons had significantly greater populations of big-eye bugs than conventional cotton (Figure 1), while in another trial, Bollgard II and conventional cotton had fewer green lacewing than Bollgard (Figure 2). These results are consistent with those previously reported (Armstrong et al, 2000).

We believe that Bollgard cotton does not differ greatly in natural enemy composition or numbers. In the San Joaquin Valley, beet army armyworm is a sporadic pest. Bollgard can suppress beet armyworms and Bollgard II has been demonstrated to control beet armyworms (Goodell, unpublished data). Big-eye bugs and minute pirate bugs use beet armyworm as one source of prey (Flint and Dreistadt, 1998). However, these generalist predators use a wide range of insects as prey that Bollgard cotton is not expected to influence such as mites, lygus and aphid.

Green lacewing is generally in fields and increase occurs when a ready supply of aphids is available. It was not recorded whether these plots had differential populations of aphids in them. Concern that Bt toxicity to natural enemies, especially green lacewing, have been reported (Hilbeck et al, 1999; Hilbeck et al 1998a, Hilbeck et 1998b). However, these field tests did not support this concern.

References

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Table 1. Specific information on variety trials Acala, Upland and Pima cotton in 1999.

	Acala Variety Trials		
County	**Farm**	**Variety**	**Reps**
Fresno	Lauritzen	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, C-166	4
Madera	Triangle "T"	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, C-166	4
Kern	Shafter REC	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, C-166	4
Tulare	Moorehead	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, C-166	4
Fresno	WSFS REC	Maxxa, Phytogen 33, BXN 47, NuCotton 33B, C-166	4
	Upland Variety Trials		
County	**Farm**	**Variety**	**Reps**
Kern	Buttonwillow L & C	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, SG – 501	3
Madera	New Columbia	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, SG – 501	3
Merced	San Juan	Maxxa,Phytogen 33, BXN 47, NuCotton 33B, SG – 501	4
	Pima Variety Trials		
County	**Farm**	**Variety**	**Reps**
Fresno	J & J	S - 7, Phytogen 57, Maxxa, NuCotton 33B	4

Table 2. Specific information on variety trials Acala and Upland cotton in 2000.

	Acala Variety Trials		
County	**Farm**	**Variety**	**Reps**
Kern	Shafter REC	Maxxa, DP 6207, C166, BXN47, NuCotton 33 B	4
Fresno	West Side REC	Maxxa, DP 6207, C166, BXN47, NuCotton 33 B	4

Table 3. Significant differences (P<0.05) of pest populations in cotton variety trials during 1999.

Location	**WTPB (Lygus)**	**Aphid**	**Spider Mites**
Acala			
Shafter	NS	NS	NS
Moorehead	NS	NS	NS
West Side REC	0.0001	NS	NS
Triangle T	0.001	0.02	NS
Lauritzen	NS	NS	NS
Upland			
Buttonwillow	NS	NS	NS
San Juan	NS	NS	NS
New Columbia	NS	NS	NS
Pima			
J & J Farms	NS	NS	NS

Table 4. Significant differences (P<0.05) of pest populations in cotton variety trials during 2000.

Location	**WTPB (Lygus)**	**Aphid**	**Spider Mites**
Acala and Upland			
Shafter	NS	NS	NS
WSREC	0.0009	NS	NS

Table 5 Significant differences (P<0.05) of natural enemy insect populations in cotton variety trials during 1999.

Location	Minute Pirate	Big Eye Bug	Lacewing
Acala			
Shafter	NS	NS	NS
Moorehead	NS	NS	NS
West Side REC	NS	NS	0.005
Triangle T	0.02	0.03	NS
Lauritzen	NS	NS	NS
Upland			
Buttonwillow	NS	NS	NS
San Juan	NS	0.0001	NS
New Columbia	NS	NS	NS
Pima			
J & J Farms	0.03	NS	NS

Table 6. Significant differences (P<0.05) of natural enemy insect populations in cotton variety trials during 2000.

Location	Minute Pirate	Big Eye Bug	Lacewing
Acala and Upland			
Shafter	NS	NS	NS
WSREC	NS	0.01	NS

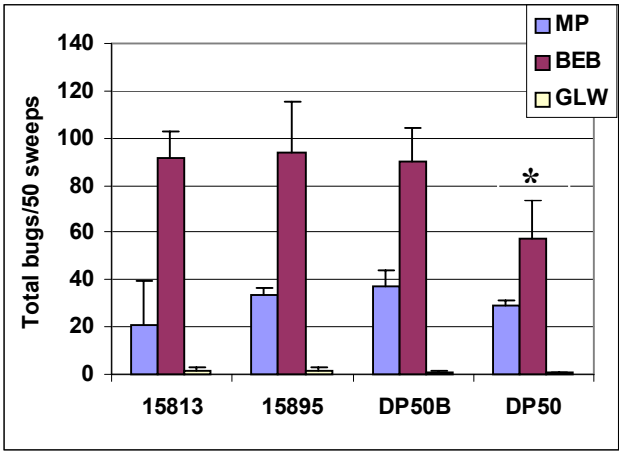

Figure 1. Total beneficial insects collected at WS REC, 1999. Asterisk represents significant differences (P <0.05) between treatments. MP is minute-pirate bug, BEB is Big-eye bug and GLW is green lacewing.

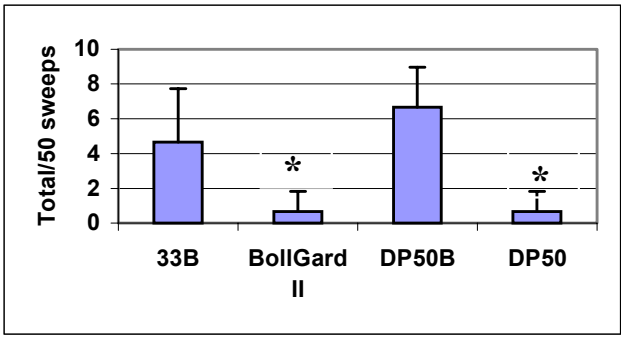

Figure 2. Total green lacewing collected from Trial A at WS-REC, 2000. Asterisk represents significant differences (P <0.05) between treatments.