CULTURAL PRACTICES AFFECTING THE ABUNDANCE OF COTTON APHIDS AND BEET ARMYWORMS IN DRYLAND COTTON

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Abstract

A study was conducted at the Texas Agricultural Experiment Station farm at Munday, Texas during the 1998 cotton growing season to quantify the effect of planting date and planting pattern on beet armyworm, *Spodoptera exigua* (Hübner), and cotton aphid, *Aphis gossypii* Glover, abundance. The 1998 growing season was the first full year of boll weevil eradication in the central Rolling Plains. 'Sphinx' cotton was planted on April 29, May 19, and June 9, representing early, normal, and late planting dates in the Texas Rolling Plains. Within each planting date, planting pattern treatments included 1) solid-row stand, 2) two rows planted, one row skipped (*Skip 2x1*), and 3) two rows planted, two rows skipped (*Skip 2x2*). Abundance of beet armyworm was monitored weekly by visually inspecting all the plants in 13 row-ft per plot, whereas cotton aphid abundance was estimated by inspecting 10 leaves from the top half and 10 leaves from the lower half of plants from each plot. Percentage square damage by beet armyworm was also quantified. Analysis of variance showed that average beet armyworm abundance varied significantly with planting date and planting pattern. Late planted cotton was significantly most susceptible to beet armyworm infestation, followed by early planted and normal planted cotton. *Solid-row* pattern attracted fewest numbers of beet armyworms, followed by *Skip 2x1* and *Skip 2x2*, with a strong positive relationship between the number of rows skipped and beet armyworm abundance. Cotton aphid abundance was not significantly affected by planting dates; however, average abundance was lower in normal planted cotton compared with early and late planted cotton. Planting pattern had a significant effect on aphid abundance, with a strong positive relationship between the number of rows skipped and cotton aphid abundance. Because normal planted cotton was least attractive to beet armyworms and cotton aphids during boll weevil eradication, the current recommended uniform planting date of mid-May for boll weevil management may continue to be the best planting date for insect pest management in the Rolling Plains during eradication.

Introduction

The boll weevil eradication (BWE) program is known to have a direct impact on the incidence and population dynamics of many cotton insects. Use of pesticides, primarily malathion, over a wide geographical region eliminates natural enemy complexes, causing secondary pest outbreaks in absence of natural enemies. Boll weevil eradication programs in Alabama, Mississippi, and many other southeastern states have contributed to aphid explosions and resistance, outbreaks of sporadic pests such as beet armyworms, and the emergence of new pests such as the sweetpotato whitefly in those regions. In light of developing pest management strategies during and after boll weevil eradication in the Texas Rolling Plains, there is a need to investigate the consequences of the weevil eradication program on the incidence and severity of secondary pests. The potential secondary pest outbreaks during boll weevil eradication in the central Rolling Plains include beet armyworms and cotton aphids.

Historically, the beet armyworm has been considered an occasional, late season pest in cotton associated with hot and dry conditions. However, most of the outbreaks during the past few years have occurred in areas actively attempting to eradicate the boll weevil, particularly with the use of ULV malathion (Smith 1989, Stewart et al. 1996). Beet armyworm is now considered a secondary pest rather than a mere occasional pest. It has been documented in southeastern states that the elimination of natural enemies from the system is the primary reason for beet armyworm outbreaks (Ruberson et al. 1994), indicating that boll weevil eradication in Texas may have a direct influence on beet armyworm outbreaks.

Cotton aphids became a serious problem in the southeastern U.S. following the heavy use of calcium arsenate for control of boll weevil. Cotton aphids have been a yearly secondary pest in cotton in the Rolling Plains of Texas for the past 20 years, with moderate to high densities during 1990, 1991, 1993, and 1995 (Slosser et al. 1997, Slosser et al. 1998). Naturally occurring biological control agents have contributed to the maintenance of aphid populations to a secondary pest status in the Rolling Plains region, and projects are underway to investigate the methods to enhance the efficacy of natural enemies of cotton aphids through modifications in cultural practices (Parajulee et al. 1997). However, there is no information on aphid population response to the elimination of natural enemies resulting from weevil eradication efforts.

The objective of our study was to quantify the population abundance patterns of beet armyworms and cotton aphids as impacted by the boll weevil eradication program launched in the fall of 1996 and 1997 in the central Rolling Plains. Specific objectives were to examine the effect of planting date and planting pattern on population abundance of beet armyworms and cotton aphids during boll weevil eradication.

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Materials and Methods

The study was conducted at the Texas Agricultural Experiment Station farm at Munday, Texas during the 1998 cotton growing season. The cotton variety 'Sphinx' was planted in 40" rows, with the plot size consisting of 20 rows wide by 75 ft. long. The test consisted of two treatments (planting date and planting pattern) with three levels each, and the entire test was replicated three times, with a total of 27 experimental plots. The three planting dates included uniform planting date (UPD) of May 19 and three weeks before (April 29) and three weeks after (June 9) the UPD, representing normal, early, and late planting dates for the Rolling Plains region. The three planting patterns included 1) solid-row stand of 4.2 plants/ft (55,000 plants/acre), 2) two rows planted, one row skipped (36,660 plants/acre), hereafter referred to as *Skip 2x1*, and 3) two rows planted, two rows skipped (27,500 plants/acre), hereafter referred to as *Skip 2x2*. The entire test was deployed in a split-plot design, with the planting date as a whole plot and planting pattern treatments as subplots. Crop and land management followed a standard practice recommended for dryland cotton production for the region. All plots were fertilized @ 30-0-0-12 (N-P-K-S) lbs/acre on July 1. Soil moisture was monitored in all treatment plots, once per month, using a combination of gravimetric and neutron scattering techniques. Boll Weevil Eradication Foundation (BWEF) personnel coordinated the malathion applications in fields that reached or exceeded the predetermined threshold of two weevils per trap; one grandlure-baited pheromone trap was placed every 5 acres throughout the eradication zone. Our experimental plots received ULV malathion applications @ 12 oz. AI/acre on June 19, August 26, September 3, September 24, and October 1.

Abundance patterns of beet armyworms and cotton aphids were monitored weekly starting one week after the test plots received first application of ULV malathion as part of boll weevil eradication. Beet armyworm egg mass and larval abundance were monitored by visually inspecting all the plants in 13 row-ft per plot (randomly throwing a 6.5-ft stick at two points within the middle 6-8 rows of a plot), and counting and recording the number of egg masses and larvae present. Beet armywom abundance was monitored from June 29 to August 18 for a total of 8 sample weeks. Cotton aphid abundance was estimated by inspecting 10 leaves from the top half and 10 leaves from the lower half of plants from each plot. Aphid abundance was monitored only in the normal planted cotton until average aphid abundance exceeded 1 aphid/leaf (June 29 to August 18); all plots were sampled on August 24, August 31, and September 9. Cotton was harvested when >97% of the bolls were open; early and normal planted cotton were harvested on October 7 and the late planted cotton was harvested on October 27. Seed cotton was hand-picked from 6.5 row-ft in four locations within the middle four rows of cotton. A laboratory gin was used to separate seed and lint. Insect abundance data were subjected to a repeated measures analysis of variance, with planting date, planting pattern, and their interaction as sources of varibility and sample week as repeated measures (Abacus Concept 1989). Lint yield data were subjected to a two-way analysis of variance, with planting date, planting pattern, and their interaction as sources of variability.

Results and Discussion

Beet Armyworm Abundance

Beet armyworm activity was observed in our experimental plots in late May, but the damage by beet armyworms was not apparent until late June. Analysis of variance showed that average beet armyworm larval abundance varied significantly with planting date (F = 8.94; df = 2, 18; P < 0.01) and planting pattern (F = 5.34; df = 2, 18; P = 0.01), but there was no significant interaction between planting date and planting pattern (F = 0.05; df = 4, 18; P > 0.99). Among three planting dates, late planted cotton was significantly most susceptible to beet armyworm infestation (Table 1). Cotton planted in mid-May (normal planting) had a lower beet armyworm abundance compared with early planted cotton, but this difference was not significant. Beet armyworm abundance did not reach economic threshold (ET) of 20 larvae/13 row-ft in normal planted cotton on any sample date during the entire 8-wk sampling period. On the other hand, beet armyworm larval abundance surpassed the ET in both early and late planted cotton on August 11; the abundance remained above ET (32.6 larvae/13 row-ft) in late planted cotton for two consecutive weeks. Percentage square damage by beet armyworms was lowest in early planted cotton (4%), followed by normal (8%) and late planted cotton (16%). Layton (1994) also indicated a higher beet armyworm infestation and economic damage in delayed planting in Mississippi.

Planting pattern had a significant impact on beet armyworm larval abundance in cotton. *Solid-row* planting attracted fewest numbers of beet armyworms, followed by *Skip 2x1* and *Skip 2x2* (Table 1). Overall, abundance of beet armyworms increased linearly with increased number of skipped rows (r = 0.99, n = 3). Although not scientifically evaluated to date, there have been a number of anecdotal reports in the literature suggesting a significant effect of skip-row planting on beet armyworm abundance. Leveson (1992) reported that the first beet armyworm outbreak of the season in Eufaula, Alabama usually occurrs in skips and turn rows, and the population spreads throughout the farm. Layton (1994) indicated that the fields with skippy or open canopies, or skip-row planting pattern were more vulnerable to beet armyworm infestation during the 1993 beet armyworm outbreak in Mississippi Delta.

Historically, our experimental farm did not have beet armyworm problems. However, we experienced a severe beet armyworm infestation this year (first year of area-wide boll weevil eradication), primarily on irrigated cotton, and it was also a problem throughout the central Rolling Plains. Therefore, the severity of beet armyworms in this region during this growing season can be attributed to boll weevil eradication that may have affected the resident natural enemy populations. It has also been documented in other cotton growing states that the elimination of natural enemies from the system is the primary reason for beet armyworm outbreaks (Ruberson et al. 1994). Other factors that might have contributed to the severity of beet armyworms in 1998 growing season include a hot, dry weather, high overwintering population build-up during the past few years, immigration aided by wind patterns, and moths' preference to oviposit in sprayed cotton.

Cotton Aphid Abundance

Aphid abundance was below economic threshold of 50 aphids per leaf throughout the season in our experimental plots. The low aphid abundance during this growing season can be attributed to extremely hot and dry weather. Abundance of cotton aphids varied significantly with planting pattern (F = 4.53; df = 2, 18; P = 0.02), but not with planting date (F = 1.03; df = 2, 18; P = 0.38); the interaction between planting date and planting pattern was also not significant (F = 0.47; df = 4, 18; P = 0.75). Although not statistically significant, average aphid abundance was lower in normal planted cotton compared with early and late planted cotton (Table 2). These results are in agreement with Slosser (1993) who reported a reduced susceptibility of late May planted cotton to cotton aphids in the northern Rolling Plains.

Planting pattern had a significant impact on cotton aphid abundance. *Solid-row* planting pattern was associated with the lowest aphid abundance, followed by *Skip 2x1* and *Skip 2x2* (Table 2). Overall, abundance of cotton aphids increased linearly with increased number of skipped rows (r = 0.98, n = 3). This is the first scientific report demonstrating the effect of skip-row planting on cotton aphid abundance.

Lint Yield

Average lint yield varied with planting date and planting patterns (Table 3). Normal planted cotton yielded slightly more cotton lint than late planted cotton, whereas the early planted cotton produced the lowest yield among three planting dates. Overall, *Skip 2x1* produced higher lint yield than solid-row or *Skip 2x2* treatments. However, there was a significant interaction between planting date and planting pattern (Table 4). Solid-row and *Skip 2x1* treatments resulted in similar yields in early and late planted cotton, whereas solid-row planting produced significantly lower yield than *Skip 2x1* in normal planted cotton. On the other hand, *Skip 2x2* produced a slightly higher yield than solid-row in normal planted cotton, while it produced a significantly lower yield than solid-row in late planted cotton. The study showed that the *Skip 2x2* pattern not only increased susceptibility of cotton to beet armyworms and aphids, but it also did not outyield *Skip 2x1* pattern in any of the three planting dates evaluated.

Soil Moisture Conservation

Skip 2x1 maintained slightly higher moisture in the soil column than solid-row or *Skip 2x2* throughout the 4-month survey period (Table 5). The rainfall during the growing season was lowest in 1998 compared with the previous 17 years; a record low rainfall limited the quantification of effect of skip-row patterns on soil moisture retention and conservation.

References

Abacus Concept. 1989. SuperANOVA, accessible general linear modeling. Abacus Concepts, Berkeley, CA.

Layton, M. B. 1994. The 1993 beet armyworm outbreak in Mississippi and future management guidelines, pp. 854-856. *In*: Proceedings, Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Leveson, H. 1992. A sampling method to determine treatment levels for beet armyworm, p. 863. *In*: Proceedings, Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Parajulee, M. N., R. Montandon, and J. E. Slosser. 1997. Relay intercropping to enhance abundance of insect predators of cotton aphid (*Aphis gossypii* Glover) in Texas cotton. International Journal of Pest Management 43: 227-232.

Ruberson, J. R., G. A. Herzog, W. R. Lambert, and W. J. Lewis. 1994. Management of the beet armyworm: integration of the control approaches, pp. 857-859. *In*: Proceedings, Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Slosser, J. E. 1993. Influence of planting date and insecticide treatment on insect pest abundance and damage in dryland cotton. Journal of Economic Entomology 86: 1213-1222.

Slosser, J. E., R. Montandon, W. E. Pinchak, and D. R. Rummel. 1997. Cotton aphid response to nitrogen fertility in dryland cotton. Southwestern Entomologist 22: 1-10.

Slosser, J. E., W. E. Pinchak, and D. R. Rummel. 1998. Biotic and abiotic regulation of *Aphis gossypii* Glover in west Texas dryland cotton. Southwestern Entomologist 23: 31-65.

Smith, R. H. 1989. Experiences with beet armyworm control in cotton in 1988, pp. 273-275. *In*: Proceedings, Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Stewart, S. D., M. B. Layton, and M. R. Williams. 1996. Occurrence and control of beet armyworm outbreaks in the cotton belt, pp. 846-848. *In*: Proceedings, Beltwide Cotton Conferences. National Cotton Council, Memphis, TN.

Table 1. Average (±SE) number of beet armyworms per 13 row-ft in dryland cotton, as affected by planting date and planting pattern, Munday, Texas, 1998.

Planting Date	No. BAW per 13 row-ft	Planting Pattern	No. BAW per 13 row-ft
Early (April 29)	6.60 (4.51)b	Solid-row	3.21(1.10)b
Normal (May 19)	3.11 (0.71)b	Skippy 2x1	6.17 (1.77)ab
Late (June 9)	10.18 (2.27)a	Skippy 2x2	10.51 (4.65)a

Means followed by same letter within a column are not significantly different (P>0.05).

Table 2. Average (±SE) number of cotton aphids per leaf in dryland cotton, as affected by planting date and planting pattern, Munday, Texas, 1998.

Planting Date	No. aphids/leaf	Planting Pattern	No. aphids/leaf
Early (April 29)	3.76 (0.60)a	Solid-row	1.82 (0.31)b
Normal (May 19)	2.35 (0.41)a	Skippy 2x1	2.72 (0.53)ab
Late (June 9)	3.13 (0.59)a	Skippy 2x2	4.71 (0.61)a

Means followed by same letter within a column are not significantly different (P>0.05).

Table 3. Average (±SE) lint yield (lbs/acre) in dryland cotton, as affected by planting date and planting pattern, Munday, Texas, 1998.

Planting Date	Yield (lbs/acre)	Planting Pattern	Yield (lbs/acre)
Early (April 29)	349.6 (19.5)b	Solid-row	380.7 (16.0)ab
Normal (May 19)	391.9 (16.3)a	Skippy 2x1	395.8 (21.2)a
Late (June 9)	387.5 (16.8)ab	Skippy 2x2	352.4 (15.4)b

Means followed by same letter within a column are not significantly different (P>0.05).

Table 4. Average (±SE) lint yield (lbs/acre) in dryland cotton, as affected by interaction of planting date and planting pattern, Munday, Texas, 1998.

Planting Date	Solid-row	Skip 2x1	Skip 2x2
Early (April 29)	374.0 (34.7)a	350.4 (44.7)a	324.4 (27.3)a
Normal (May 19)	349.7 (17.8)b	435.2 (14.9)a	390.7 (28.9)ab
Late (June 9)	418.5 (17.9)a	401.7 (37.0)ab	342.2 (8.5)b

Means followed by same letter within a row are not significantly different (P>0.05).

Table 5. Amount of soil moisture (inch per 5-ft column) in dryland cotton, as affected by planting pattern, Munday, Texas, 1998.

Sample Date	Solid-row	Skip 2x1	Skip 2x2
June 23	12.90 (0.24)a	13.07 (0.22)a	13.13 (0.27)a
July 21	11.21 (0.40)a	11.33 (0.28)a	11.27 (0.36)a
August 19	8.89 (0.36)a	9.41 (0.26)a	9.27 (0.25)a
September 14	8.23 (0.44)a	8.48 (0.30)a	8.08 (0.30)a
Average	10.31 (0.36)a	10.57 (0.33)a	10.44 (0.36)a

Means followed by same letter within a row are not significantly different (P>0.05).