EFFECT OF LEPIDOPTERAN DAMAGE AND WEATHER TO COTTON IN TEN IRRIGATED FIELDS FOLLOWING MALATHION ULV APPLICATIONS: LOWER RIO GRANDE VALLEY, TEXAS-1995

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Abstract

In 1995, ten fields (25 to 40 a) of irrigated cotton on the same farm located north of Mercedes, Hidalgo County, Texas were sampled full season. Fields were adjoining or within 0.5 mi.. of each other and under the same production system. Yield potential was 1000 lbs. lint/acre. The lepidopteran pests attacking these fields included beet armyworm, cabbage looper, cotton bollworm and tobacco budworm. This was the only year that a spring boll weevil eradication program was conducted in the Lower Rio Grande Valley. Irrigated cotton comprised 225,000 acres of the total 360,000 acres planted in 1995. A fifty-two day drought was broken with 4.88 inches of rainfall on May 30 and 31. Temperatures were higher than normal during most of May, June and all of July.

These ten fields each received seven applications of malathion ulv as part of the Boll Weevil Eradication Program. These fields were also part of a malathion rate test of 16 oz. (5 fields) versus 12 oz. (5 fields) per acre. Weekly counts were made of healthy and insect damaged fruit in each field. Lepidopteran larval damage was excessive. It was responsible for a range of 0 to 49% of the estimated total yield loss by field. This variation of larval damage by field is as expected for insect pest population distributions. None of the fields, however, escaped high yield losses which are consistent and characteristic to climatic factors.

Introduction

Yields of the 1995 cotton crop in the Lower Rio Grande Valley (LRGV) of Texas averaged 80 lbs. lint/acre. This was an 85% reduction in the 10 year average yield of 580 lbs. (Huffman, 1996). No information has been shown for season-long fruiting and damage by lepidopteran pests in any irrigated field of cotton for 1995. Huffman (1996) reported that damage from lepidopteran pests included not only the usual cotton bollworm and tobacco budworm, but for the first time in high numbers the beet armyworm (BAW) and cabbage looper. Huffman (1996) and Norman (1995) stated that there were 4 generations of BAW, three of which had about a 21 day cycle. Near the end of the 1995 season (June 28 to July 4), high populations of only BAW larvae were found on the first of a two sample study in each of 20 dryland and irrigated cotton fields across the LRGV of Texas (Summy et al. 1996). Summy et al. (1996) found squares, flowers and green bolls but no open bolls in these fields on the Texas' side of the Rio Grande. A second sampling of 12 of these same cotton fields (July 11 to 28) showed no significant difference between fields in percent damaged and healthy squares and bolls (Summy et al. 1996). This second sampling by Summy et al. (1996) is what has been described as a late season postmortem. A late season postmortem of fruit loss, while valuable, cannot distinguish if missing fruit was lost by stress during the square or early boll stage or by insect feeding damage (Guthrie et al. 1994). This lack of precision with postmortems could be virtually eliminated with timely in season scouting efforts (Guthrie et al. 1994).

Reddy et al.. (1998) have shown the relation of high temperatures to cotton plant fruiting and boll retention. Fruit production efficiency, defined as dry weight of fruit per dry weight total mass produced increased as average daily temperatures increased to 85° F, then it declined rapidly as temperature increased above 85° F. Guinn (1982) showed that drought, cloudy days and excessive soil moisture cause square and boll shedding in cotton.

Jones et al. (1996) evaluated two rates of malathion ulv for boll weevil control in 10 (25 to 40 a) irrigated cotton fields on the same farm located north of Mercedes, Hidalgo County, Texas. During this study not only the efficacy of malathion for boll weevil control was monitored, but cotton plant fruiting populations and detailed insect damaged fruit counts were made weekly from first square to open boll in all fields. Weather data for the same period from the nearby Weslaco Research Station was monitored. These data are examined to better understand the cause of the 85% reduction in 1995 cotton yields for the LRGV of Texas. These data more than meet Guthrie et al. (1994) regiment, that a few timely in season plant monitoring efforts best determine causes of fruit loss and thus yield reduction.

Methods and Materials

Plot arrangement of these 10 irrigated cotton fields north of Mercedes in Hidalgo County, Texas were described in Jones, et al. (1996). Fields were in the same irrigated tract and separated by 30 feet to 0.5 mile. These fields were 25 to 40 acres in size and planted with a mid-season cultivar of cotton on March 5 to 15, 1995. The fields were irrigated before planting and then on May 1 to 7, June 2 to 6 and June 25 to 30. Row spacing was 39 in. across all fields. Five of these fields were treated with 12 oz./acre and five with 16 oz./acre of malathion ulv (95% Fyfanon ULV™, Cheminova, Denmark). There were 7 applications of malathion which were made on May 4, 11, 26; June 14 and July 6, 20, 28.

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Plants in 3 foot of row in each of four sample locations were counted on the first 2 sample dates, May 1 and 8. Plants/a in each field were projected from these samples. Counts of all fruiting forms including healthy and insect damaged were made weekly. This was done by whole plant examination of 10 to 14 plants selected at random per field. Plants were sampled in all parts of each field during the season, including the four corners and field centers. Field centers were sampled on half of the sample dates and corners on the other dates.

Green boll counts were divided into (1) small (red bloom to .5 in. diameter at center), (2) medium (.6 to 1 in. diameter) and (3) large (>1 in.). Open bolls including those beginning to open were counted and recorded. These counts by fields and dates varied as follows: 7 fields on May 1, four on May 30, six on June 12 and 10 on all other dates. The per plant counts of damaged and undamaged fruit were converted to per acre estimates based on plant counts/a. Field averages of fruit/a estimates were statistically compared for each date to derive a standard error of means. No counts of abscised fruit sites were made. Yields were estimated by the number of open bolls/a. A weight of 0.035 oz. lint/boll was used in this estimate of pounds lint/a because of small boll size.

Weather data was collected at the Texas Agricultural Experiment Station, 2415 East Highway 83, Weslaco, Texas. This data is recorded in their Meteorological Record for TAEX-District 12. The study area was approximately 10 miles northeast of the weather station.

Results and Discussion

The first application of malathion ulv was on May 4. On May 1 (Table 1) 96% of the fruit were at the pinhead and matchhead square size (<.25 in. diameter). Squares at the 1/3 grown (> 0.25 in.) or size for boll weevil oviposition success composed 4% of the fruit population. The other malathion applications were on May 11, 26; June 14; July 6, 20, and 28. Defoliant was applied on July 28. Lepidopteran pest control was conducted by the grower based on separate insect scouting information. Attempts to access this data and pesticide usage were unsuccessful. The grower did make several applications with methomyl and insect growth regulators as recommended by the Extension Service including two under emergency use permits. The low amount of medium boll (Table 2) and no large boll damage is probably the result of the grower applications.

The stress on fruiting in these irrigated fields is evident (Table 1). There were two peaks in white bloom numbers. These occurred on May 26 and June 26. Following both dates peaks in lepidopteran damage to both squares and small bolls occurred (Table 2). Damage was >20% on June 5 and >10% on July 3. Concurrent to the bloom peaks, there was a reduction in squares. One to two weeks after the bloom peaks there was a reduction in small boll numbers. These reductions in squares and small bolls are greater than that shown to be caused by insects (Table 1 & 2). Therefore, while insect damage is high it does not fully explain total fruit reduction observed. Tables 1and 2 explicitly show this.

The climatic conditions of May 25 through 29 were described as cloudy. This was followed on May 30 with 2.45 inches of rain and on May 31 with 2.43 inches. These were the first rains on the ten irrigated fields in 52 days. During the remainder of the crop season rains occurred on June 15 (0.23 inches), July 1 (0.22) and July 15 (0.03). With irrigation, lack of soil moisture was probably not a factor in the loss of fruit in these fields. However, Guinn (1982) states that periods of cloudy weather cause square and boll shedding. Further, Guinn (1982) states that cloudy weather accompanied by excessive rain in open blooms causes poor pollination and subsequent shedding. Also, heavy rain or irrigation may cause fruit shed by depriving the roots of available oxygen. All of these natural phenomena occurred before and after the first bloom peak of May.

From June 11 through 24 the average daily temperature had a mean of 80.4° F. This was followed for six days with an average daily temperature of 85.8° F. The average daily temperature for July was 87° F which was 2.6° above normal. The effect of high temperatures on fruiting and fruit retention is discussed by Reddy et al. (1998). Their data shows that the rate of fruit retention dropped dramatically at temperatures above 85° F. They also found that even if bolls escape average daily temperatures above 85° F during flowering, which causes boll abscission, exposure to such high temperatures later causes smaller boll size. Reduced yields indicate that this may have occurred. The season long peaks and valleys of the fruiting counts (Table 1) across the ten fields or just simply the two peaks in the white bloom counts indicate a crop under environmental stress (Baker et al. 1983).

Variations in damage occurred among fields and are presented in Table 2. One field had damage to squares on only one sample date and none to small bolls during the season. Total percent damaged squares caused by lepidopterans ranged from 0 to 51 among fields on a single sample date. This dramatic variation is typical of insect damage data from numerous community scouting and sampling test programs. Insects have always been found to group together for a variety of behavioral and ecological reasons. The presence of larvae feeding on the fruit was the basis for identifying species of Lepidoptera causing damage. However, larvae were not found on about 80% of the damaged fruit sampled. This is not unexpected since one larva can damage several fruiting forms while feeding. From these observations it was concluded that most of the square damage in May and June was caused by BAW. Square damage in July was caused mainly by bollworm/budworm.

Further variations in occurrence are shown in comparison with the field surveys by Norman (1995). He reported heavy populations of BAW larvae during the week of May 22 and again on the week of June 19. Square damage (2% to 9%) on the week of May 22 occurred in only 3 of the ten irrigated fields. All fields peaked on square damage on June 5 (Table 2). The next peak in square damage was on July 3. These variations indicate even with heavy populations of BAW larvae there were variations in occurrence and density among fields. These variations are typical of natural insect infestations with the lepidopteran adult or moth attracted to the cotton blooms as a nectar source. The peak bloom of these fields would be highly attractive to moths. With feeding and mating the moths lay their eggs causing larval development feeding damage to occur in the developing cotton fruit. The plants after peak bloom would have high numbers of young fruit available to support the next generation of these lepidopteran species. The data in Tables 1 & 2 shows this very well.

Huffman (1996) stated that there were 360,000 acres of 1995 cotton planted in the LRGV. All of this acreage was infested with the BAW. Two hundred fifty thousand acres were treated. An estimated 205,000 acres were eventually harvested. Extrapolating from the data presented by El-Lissy and Myers (1996) there were approximately 100,000 acres that were not treated during April and May with malathion ulv. This is based on the Boll Weevil Eradication Program's early season criteria of 2 applications if the boll weevil trap thresholds were reached. Summy et al. (1996) hypothesized that the total crop loss was caused by the BAW and that the BAW infestation was caused by pesticide use. This hypothesis is not supported by our data and that from the cited references.

In conclusion we agree with Huffman (1996) that weather conditions were optimal for BAW infestations including an early season drought. Also his further statement that the Boll Weevil Eradication Program did not cause the outbreaks but their insecticide applications may have exacerbated their severity because they killed beneficial insects. From our data we conclude that weather conditions caused >51% of the reduced yields and lepidopteran larval feeding damage caused as much as 49% of the reduced yields in these irrigated fields. The 49% yield reduction was calibrated from the highest insect damage levels that occurred in one field. This leaves a greater than 51% yield loss from weather factors if this had been calculated and averaged for all fields. Remember that 1 field had little to no insect damage. Insects were definitely not responsible for all the lost fruit and even some of the insect damaged fruit would have been shed because of physiological stress to the cotton plant. The interactions and complexities of nature are a wonder which we are striving to better understand for man's benefit.

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Table 1. Population means ± SE x 1000 of undamaged squares, white blooms, small bolls (red blooms to < 0.5 in. diameter), medium bolls, large bolls, and open bolls per acre. Mercedes, TX. 1995.

Date	Squares per acre	White blooms	Small bolls	Medium bolls	Large bolls	Open bolls
1-May	31.1 ± 2.9	0	0	0	0	0
8	53.8 ± 4.7	0	0	0	0	0
15	95.0 ± 10.8	0.4 ± 0.4	0.4 ± 0.4	0	0	0
22	171.7 ± 20.5	9.0 ± 1.9	15.1 ± 2.6	0.3 ± 0.3	0	0
26	159.7 ± 10.7	13.7 ± 3.7	26.5 ± 5.1	3.8 ± 2.3	0	0
30	212.4 ± 15.0	0	20.2 ± 2.8	5.6 ± 4.3	0	0
5-Jun	124.6 ± 11.9	5.3 ± 2.0	17.6 ± 3.5	10.5 ± 3.1	0	0
12	233.6 ± 11.4	0.8 ± 0.8	31.0 ± 12.0	22.3 ± 13.5	5.8 ± 2.2	0
19	192.9 ± 10.9	7.6 ± 2.8	46.6 ± 8.5	18.3 ± 5.3	9.4 ± 5.6	2.4 ± 1.3
26	202.3 ± 24.4	15.3 ± 2.9	60.1 ± 8.1	48.0 ± 9.4	29.3 ± 8.2	0.8 ± 0.5
3-Jul	176.9 ± 13.0	12.1 ± 3.8	42.7 ± 10.9	29.4 ± 6.0	37.7 ± 7.9	1.8 ± 1.0
10	88.8 ± 11.4	5.2 ± 1.4	27.9 ± 4.7	50.8 ± 9.9	45.5 ± 11.2	25.0 ± 5.5
17	80.9 ± 13.7	5.6 ± 1.6	46.8 ± 8.8	69.6 ± 6.7	34.3 ± 9.0	33.3 ± 10.0
24	14.4 ± 5.5	3.6 ± 2.2	8.6 ± 2.5	35.9 ± 7.5	24.1 ± 5.5	64.3 ± 11.3
31	6.4 ± 2.8	5.7 ± 2.5	1.2 ± 0.7	9.2 ± 2.8	18.9 ± 5.4	106.4 ± 8.7

Table 2. Population means ± SE x 1000 of damaged squares, small bolls, and medium bolls per acre. Mercedes, TX. 1995.

Date	Square damage	Small bolls	Medium bolls
1-May	0	0	0
8	0	0	0
15	0	0	0
22	2.0 ± 1.2	0	0
26	0.6 ± 0.6	0	0
30	3.2 ± 3.2	0	0
5-Jun	43.3 ± 9.4	4.9± 1.9	0.4 ± 0.4
12	0.8 ± 0.8	0	0
19	0	0	0.8 ± 0.6
26	3.7 ± 1.5	2.0 ± 1.4	0
3-Jul	35.2 ± 8.2	5.0 ± 2.3	1.8 ± 1.5
10	0.4 ± 0.4	0	0
17	0.3 ± 0.3	0.3 ± 0.3	0.3 ± 0.3
24	0.4 ± 0.4	0	0
31	0.3 ± 0.3	0	0.3 ± 0.3