AN ANALYSIS OF THE BEET ARMYWORM OUTBREAK ON COTTON IN THE LOWER RIO GRANDE VALLEY OF TEXAS DURING THE 1995 PRODUCTION SEASON

K. R. Summy, J. R. Raulston, D. Spurgeon and J. Vargas
USDA, ARS
Subtropical Agricultural Research Laboratory
Weslaco, TX

Abstract

A survey was performed in the cotton-production region of the Texas and Tamaulipas Lower Rio Grande Valley (LRGV) following a series of destructive insect outbreaks that extensively damaged the Texas LRGV cotton during 1995. Surveys in the Texas LRGV cotton acreage revealed heavy damage to plants, relatively high densities of beet armyworm, *Spodoptera exigua* (Hübner), and other lepidopterous and homopterous pests, and an apparent general scarcity of an index predator, the green lacewing *(Chrysoperla* spp). Similar surveys in the Tamaulipas LRGV revealed a low incidence of plant damage, low densities of lepidopterous and homopterous pests, and relatively high densities of green lacewings. These trends indicated a disruption of green lacewing populations and by extrapolation--probable disruption of other predator and parasitoid populations in the Texas LRGV cotton. A prominent difference between the study areas in the initiation of pesticide treatments to the 1995 cotton crop was the area-wide application of ULV malathion and pesticide applications for aphid control in the Texas LRGV. We hypothesize that the early-season pesticide use pattern is one of the most plausible explanations for the observed pest outbreaks in the Texas LRGV. Severe insect damage to Texas LRGV cotton resulted in a compensatory square production that facilitated an abnormally high incidence of boll weevil reproduction during July and August.

Introduction

A series of destructive insect outbreaks that occurred on cotton in the Texas Lower Rio Grande Valley (LRGV) during the 1995 production season contributed to one of the worst crop failures in the history of cotton production in this region. An initial and general outbreak of cotton aphid, *Aphis gossypii* Glover was followed by a severe outbreak of lepidopterous pests. This outbreak was dominated by the beet armyworm, *Spodoptera exigua* (Hübner), but also included large numbers of cabbage loopers, *Trichoplusia ni* (Hübner), and smaller numbers of bollworms, *Helicoverpa zea* (Boddie),and tobacco budworms, *Heliothis virescens* F. Late-season, sweetpotato whitefly, *(Bemesia tabaci* (Gennadius)), populations increased to levels comparable to those attained during a previous outbreak (1990) that caused severe damage to cotton and fall vegetable crops (pers. com. D. R. Riley). Damage caused by these outbreaks affected most of the 1995 cotton acreage in Cameron, Hidalgo, and Willacy Counties, and reduced the final harvest to ~54,000 bales (~13% of the projected harvest).

During the beet armyworm outbreak in the Texas LRGV, a preliminary survey in the Tamaulipas LRGV indicated the absence of similar insect problems in that area. We investigated these differences by initiating an intensive survey that encompassed the principal cotton-producing areas of the Texas and Tamaulipas LRGV. Our objectives were to quantify differences in the incidence of plant damage, and densities of pest species and natural enemy associates occurring on cotton, and to identify factors contributing to the pest outbreaks in the Texas LRGV.

Materials and Methods

The survey was conducted in two phases. The initial survey was conducted between June 28 and July 14, 1995, and included 20 cotton fields in the Texas LRGV (Cameron, Hidalgo and Willacy Counties), and 12 fields located in the Tamaulipas LRGV. The Texas LRGV fields were located within a 25 x 80 mi area extending from Mission in Hidalgo County, east to Port Mansfield in Willacy County, and south to Los Fresnos in Cameron County (Fig. 1). Fields in the Tamaulipas LRGV were located within 25 mi of the Rio Grande River in an area extending from Rio Bravo east to Empalme (about 20 mi.) and south to Valle Hermoso. The survey fields were distributed throughout most of the respective cotton producing areas and thereby yielded samples representative of the cotton production region.

The survey areas are situated on the Rio Grande River flood plain and share common climates, soils, and biota (Correll and Johnston 1970, Lonard *et al*. 1991). About 60% of the acreage in the Texas LRGV are irrigated; the Texas survey incorporated both dryland and irrigated fields. Fields in the Tamaulipas LRGV were located within the major irrigation district of northeast Tamaulipas. Eleven of these fields had received at least one irrigation as evidenced by furrow rounding from running water and the presence of used irrigation ditches; one field was dryland and had received no irrigation. However all irrigation activities were officially terminated by the Mexican government in late April. Cotton production practices are similar in the survey areas, with some producers maintaining farming operations in both areas. The agriculture systems of both areas share many crops (cotton, corn, sorghum), however the Texas LRGV produces a variety of fall, winter and spring vegetables, (concentrated primarily in Hidalgo and extreme southern Starr County), citrus and sugarcane. Mexican vegetable production is restricted to fall and spring crops of

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okra and squash. Uncultivated hosts of the beet armyworm including wild sunflower, *Helianthus* spp., and the highly preferred host pigweed, *Ameranthus* spp., (Wene and Sheets 1965) are abundant in both areas.

Five whole-plant samples were randomly selected from each of five randomly-selected sites in each survey field. The numbers and locations of fruiting branches, fruiting structures present on each branch, (squares, blooms, immature bolls, open bolls), and fruiting structures damaged by either boll weevil or lepidopterous larvae were diagrammatically compiled for each sample. The position of fruiting branches were stratified into upper, middle and lower thirds of the plant. Foliar damage was quantified by classifying leaves as undamaged or damaged (> than 10% of leaf surface lost) by lepidopterous larvae. All insects were collected and identified *in situ* after being dislodged from excised plants onto a 0.5 x 1.0-m plastic tray. Aphids and whiteflies were counted on 10-cm^2 leaf disks from each of 40 randomly selected leaves in each field. When adequate square numbers were available, separate random samples of 100 squares were collected from both the soil surface and from plants in each Texas LRGV field to determine square injury by lepidopterous larvae and boll weevil.

An index of beneficial arthropod populations was obtained by examining the plants for egg stalks deposited by the green lacewing *(Chrysoperla* spp),which is an important predator of aphids and lepidopterous eggs and small larvae (Eveleens *et al*. 1973, Ridgeway *et al*. 1977, Ruberson *et al*. 1994). Egg stalks produced by green lacewings are relatively persistent and provide evidence of past occurrence of this important predator. Rarity or absence of egg stalks provided evidence that substantial numbers of this predator had not been, and were not currently, occupying a particular field. Current densities of *Chrysoperla* spp. larvae were estimated by dislodging the insects from plants along 1.0 m of row (two per each of five sampling sites per field) over the sampling tray.

Ten 1-m^2 samples in each field (two at each of the five randomly-selected sample points) were used to estimate densities of lepidopterous pupae and pupal exuviae occurring in the topsoil. All pupae and pupal exuviae were collected from the upper ~8 cm of soil, placed into labelled vials and transported to the laboratory for identification. Conformation of spiracles and cremasters were used to differentiate species.

Between July 26 and August 3, 1995, a second survey that emphasized estimation of boll weevil larval population densities, and reproductive activity, was conducted in all sampled fields that had not been destroyed or harvested. For larval density estimates, all fruiting forms, including those that had abscised, were collected from 10 random 1-m^2 samples/field. Weevil immatures were detected by fruit dissections. When adequate numbers of squares on plants were available, an additional 100- square sample was collected for estimation of boll weevil reproductive activity.

Statistical comparisons between the study areas were made using Student's t-test with the exception of frequency of occurrence of green lacewing egg stalks and larvae, which were examined using the χ^2 statistic. Comparisons between irrigation practice and among communities within the Texas LRGV survey area were made using ANOVA and means were separated using LSD.

Results

During the initial survey, beet armyworm larval populations in Texas LRGV cotton were declining. Norman and Sparks (1995a) had previously reported larval population levels of 5 to 60/row ft. Nevertheless, population levels we observed were significantly greater than those occurring in Tamaulipas LRGV cotton ($t = 3.833$, $df = 19$, $P < 0.01$) (Table 1). Populations of the bollworm/budworm complex also occurred at significantly higher levels in Texas LRGV than in Tamaulipas LRGV cotton ($t = 2.825$, $df = 19$, $P <.01$), however, no significant difference in numbers of cabbage looper larvae was observed between the two areas ($t = 2.048$, $df = 19.1$, $P = 0.055$),(Table 1). Two homopterous pests that were significantly more abundant in the Texas LRGV were the cotton aphid ($t = 2.277$, $df = 15$, $P = 0.038$) and the sweetpotato whitefly ($t = 3.403$, $df = 15.1$, $P < 0.01$) (Table 2).

Beet armyworm pupae or pupal exuviae were detected in all of the Texas LRGV cotton fields sampled, but in only two fields in the Tamaulipas LRGV. Densities in Texas LRGV cotton were ~100x those in Tamaulipas LRGV cotton ($t = 4.30$, $df = 29$, $P < 0.01$) (Table 3). Pupae and pupal exuviae of the bollworm/budworm complex were also more abundant in the Texas LRGV than in the Tamaulipas LRGV ($t = 2.76$, $df = 29$, $P = 0.01$) (Table 3).

In addition, estimates from these data indicate ~4.3 billion beet armyworm moths were produced in the 360,000 acres of Texas LRGV cotton prior to mid-July. Considering the magnitude of this production, and the propensity of noctuid moths, including the beet armyworm, for long-distance migration (Mikkola and Salmensuu 1965, French 1969, Aarvik 1981, Wolf *et al*. 1990, Raulston *et al*. 1995), the enormous numbers of beet armyworms emerging from cotton in the Texas LRGV also posed a potential threat to most of the other cotton production regions of the state.

Green lacewing egg stalks were detected in 55 and 100% of Texas and Tamaulipas LRGV fields, respectively ($\chi^2 = 35.1$, $df = 1$, $P < 0.01$), and occurred on a larger percentage of plants sampled in Tamaulipas than in Texas LRGV ($t = 6.111$, $df = 29.9$, $p < 0.01$) (Table 4). Further, egg stalk numbers were significantly higher in Tamaulipas LRGV than in Texas LRGV cotton ($t = 3.585$, $df = 12.0$, $P < 0.01$).

Although not statistically significant, green lacewing larvae tended to be detected in a higher percentage of fields in Tamaulipas LRGV than in Texas LRGV (83.3 and 50.0%, respectively) (χ^2 = 3.6, df = 1, P = 0.059), and their numbers tended to be greater in Tamaulipas LRGV cotton than in Texas LRGV cotton (t = 1.522, df = 11.3, P = 0..156) (Table 5). Larval populations in Tamaulipas may have been low because of extremely low prey populations.

Late-instar and adult cotton aphids, and parasitism by the wasp parasite, *Lysiphlebus testaceipes* (Cresson), were observed in both survey areas, but numbers of these stadia and the parasites were too low for statistical comparisons (Texas, 0.3 ± 0.1/10-cm² leaf disk; Tamaulipas, total of 2 late-instar nymphs in all samples). Both of the late-instar nymphs collected from Tamaulipas LRGV were parasitized by *L. testaceipes* , but parasitism was detected in only 1.1% of the late-instar and adult aphids sampled from Texas LRGV cotton.

Several other beneficial arthropod species including spiders, and predaceous hemipterans and coleopterans were detected in both the Texas and Tamauli-pas LRGV cotton. However, most occurred at levels too low to permit valid statistical comparisons. The low incidence of predators in the Tamaulipas LRGV is at least partially explained by the stage of crop maturity and the low densities of available prey species. This explanation is not applicable to the low populations of natural enemies in the Texas LRGV cotton because prey were readily available and the cotton crop was phenologically still relatively immature.

Foliar damage by lepidopterous larvae in the Texas LRGV cotton was significantly greater than in the Tamaulipas LRGV (71.4% and 7.6%, respectively) (t = 20.668, df = 28.2, P < 0.01) (Table 6). This damage was attributed primarily to beet armyworm because it is normally a foliar feeder (Eveleens *et al*. 1973) and was the most abundant species present. In addition to differences in foliar damage, damage to bolls from lepidopterous feeding was significantly greater in Texas LRGV cotton than in Tamaulipas (t = 7.017, df = 18, P < 0.01) (Table 7). Absence of differences in percentages of square damage (t = 0.196, df = 4.2, P=0.854) (Table 7) were misleading because of the extremely low square populations in Tamaulipas.

Random square samples could be collected from plants in only 19 fields, and from the ground in only 18 fields in Texas LRGV. Square densities in the other Texas LRGV and in Tamaulipas LRGV fields were too limited to yield adequate square collections. A substantial proportion of squares on the plants were infested with boll weevil immatures (n = 1900, $\bar{x}$ = 27.7 ± 7.4%, range = 0 - 91%). A similar proportion of ground-collected squares were infested (n = 1800, $\bar{x}$ = 30.7 ± 7.8%, range = 5 - 96%). These samples also indicated a high level of damage to squares by lepidopterous larvae, ranging from 0 - 91% (n = 1900, $\bar{x}$ = 23.3 ± 4.3%).

Tamaulipas LRGV cotton was characterized by a mature fruit load consisting of 1% squares, 67% green bolls, and 32% open bolls. In comparison, the fruit load on Texas LRGV cotton consisted of 75% squares and blooms, and 25% green bolls. Significantly higher numbers of squares (t = 6.785, df = 9.3, P < 0.01) were observed in Texas LRGV cotton while significantly high-er numbers of green bolls (t = 8.623, df = 30, P < 0.01) and open bolls (t = 6.8, df = 30, P < 0.01) were observed in Tamaulipas LRGV cotton (Table 8). Crop maturity in the Tamaulipas LRGV was at a usual stage for early July. Based on populations of blooms and bolls at the time of this survey, yield potentials of 0.55 - 0.70 and 1.9 - 2.4 bales were estimated for Texas and Tamaulipas LRGV cotton, respectively. These estimates were obtained using the methods of Norman and Sparks (1995b). The differences in pest and fruit populations and fruit damage levels between the survey areas indicate that infestations of lepidopterous larvae, rather than normal physiological shed, plant age, or environmental factors, were primarily responsible for the altered fruiting patterns observed in the Texas LRGV cotton.

In the second survey square samples were collected from plants in only 7 fields in Texas LRGV. Square damage by lepidopterous larvae ranged from 0 - 71% (n = 700, $\bar{x}$ = 28.8 ± 8.6%). These data show that extensive damage by lepidopterous larvae in Texas LRGV cotton continued at least until early August. Boll weevil infested squares (n = 700, $\bar{x}$ = 36.4 ± 10.1%, range = 11 - 90%) indicated that weevil reproduction also continued at high levels after the initial survey.

Fruit collections from one-m² samples in the second survey revealed significantly higher boll weevil densities in the Texas LRGV than in the Tamaulipas LRGV (t = 2.326; df = 13.1; P = 0.0357) (Table 9). The mean boll weevil population density was about 21 times greater in Texas than in Tamaulipas.

Because the Texas LRGV survey included both irrigated and dryland production fields, the data were examined for effects of irrigation on numbers of fruit/plant, leaf damage levels, and population levels of pest species and green lacewing egg stalks. A corresponding analysis was not performed using data for the Tamaulipas LRGV because only one dryland field was examined in that area. The presence of irrigation ditches and evidence of furrow smoothing by running water indicated that all other study fields in Tamaulipas had received at least one irrigation. In the Texas LRGV analysis, the percent of leaves damaged by lepidopterous larvae was significantly greater in irrigated than in dryland cotton (F = 4.66; df = 1, 17; P = 0.0455) (Table 10). All other comparisons, including numbers of squares, bolls, beet armyworm larvae and pupae, aphids, whiteflies, green lacewing egg stalks, and damage to squares and bolls, indicated no differences between irrigated and dryland fields. Although not statistically significant, whiteflies tended to be more numerous in irrigated cotton (Table 10). Despite the significantly higher incidence of leaf damage from lepidopterous larvae, our collective data indicate that irrigated fields were no more attractive to these pests than were dryland fields. These data indicate the impact of the beet armyworm on fruit populations were similar in irritated and dryland cotton.

A final analysis was performed on the Texas LRGV data to compare numbers of fruit, beet armyworm larvae and pupae, aphids, whiteflies, and green lacewing egg stalks, and levels of damage to leaves, squares, and bolls, on a community basis. The numbers of squares ($F = 6.73$; $df = 7, 12$; $P < 0.01$), aphids ($F = 47.54$; $df = 7, 8$; $P < 0.01$), whiteflies ($F = 5.76$; $df = 7, 8$; $P = 0.0124$), and green lacewing eggs ($F = 45.05$; $df = 7, 12$; $P < 0.01$) differed significantly among communities, but no consistent pattern in these differences was detected (Tables 11 and 12). No other differences among communities were detected. These data indicate relative uniformity in beet armyworm population levels and damage throughout the Texas LRGV, and an absence of association of these parameters with irrigation practices.

Discussion

Our data document marked differences in cotton plant damage, fruit load, and population levels of pest insects and green lacewing egg stalks, between the Texas and Tamaulipas LRGV. They further indicate the absence of influences of irrigation practice or survey field location (community) within the Texas LRGV on beet armyworm populations and their associated damage. Both the Texas and the Tamaulipas LRGV are located on the flood plain of the Rio Grande River. They share a common climate and represent a single biocenose. Similar cotton farming practices are utilized in both areas. Further, beet armyworms were detected, in cotton in both areas. Therefore, the outbreak of beet armyworms that occurred only in the Texas LRGV cotton does not appear to be a result of agronomic, weather, or ecological differences.

Early-season (mid-April to late-May) pesticide use patterns differed markedly between study areas. Pesticide applications to Tamaulipas LRGV cotton were limited to an average of 0.95 applications of acephate or dimethoate for fleahoppers and 0.5 applications of azinphosmethyl, malathion (EC), or methyl parathion for boll weevils. Only field margins were treated for boll weevils (J. Vargas Camplis, unpublished data). In contrast, Texas LRGV cotton received an average of 1.7 applications of ULV malathion for boll weevil control (Boll Weevil Eradication Program, whole-field treatments), 1 application for fleahoppers (primarily dicrotophos or acephate), and 1.5 applications for aphids (dicrotophos, acephate, or Provado) (J. W. Norman, pers. com.). In all, Tamaulipas LRGV cotton received an average of <1.5 pesticide applications during the early season while Texas LRGV cotton received about 4.2 applications. The prominent differences between the study areas in the initiation of pesticide treatments to the 1995 cotton crop was the area-wide application of ULV malathion and pesticide applications for aphid control in the Texas LRGV.

Application of insecticides to agroecosystems have repeatedly been impli-cated in the subsequent destabilization of pest and beneficial insect complexes (Reynolds *et al*. 1975). In U.S. cotton production systems, disruption of natural enemy complexes through the use of early-season pesticides (arsenicals, chlorinated hydrocarbons, organophosphates, and pyrethroids) have commonly resulted in outbreaks of secondary pests including aphids, *Heliothis/Helicoverpa* spp., spider mites (Lincoln and Graves 1978), whiteflies (Henneberry and Toscano 1993), and beet armyworms (Stoltz and Stern 1978, Lambert 1991, Moore 1991, Smith 1989, Smith 1994, Ruberson et al. 1994). In fact, release of secondary pests including beet armyworms (Eveleens *et al.* 1973), through adverse effects of pesticides on beneficial arthropod populations, has been accomplished in experiments and the mechanisms of such releases are well known. Further, Ruberson *et al*. (1994), reported 96% and 56% reductions in predators associated with beet armyworm egg masses and larvae, respectively, in cotton plots treated with pesticide compared to untreated plots. Based on our data and supporting reports from the literature, we hypothesize that the early-season pesticide use pattern is one of the most plausible explanations for the observed pest outbreaks in the Texas LRGV.

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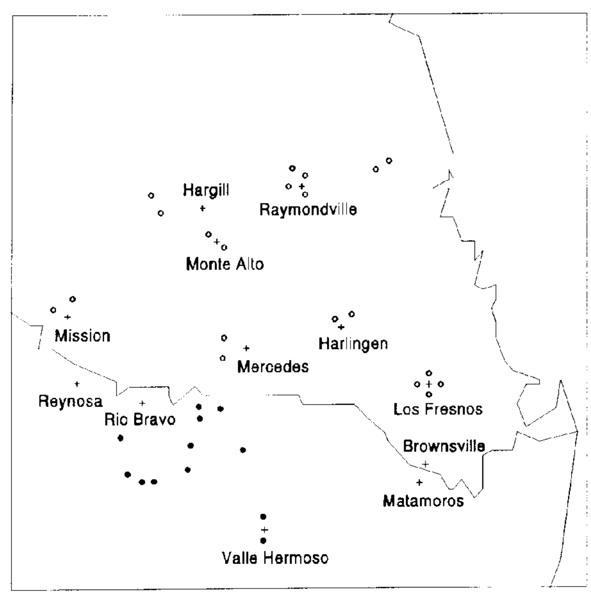

Figure 1. Locations of survey fields in the Texas (○) and Tamaulipas (●) LRGV.

Table 1. Incidence of selected lepidopterous pests on cotton foliage in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	No. Larvae/Plant[a] ($\bar{x}$ ± SE)	Range
	Beet Armyworm	
Texas	0.526 ± 0.136 a	0.0 - 2.1
Tamaulipas	0.003 ± 0.003 b	0.0 - 0.04
	Cabbage Looper	
Texas	0.488 ± 0.230 a	0.0 - 4.0
Tamaulipas	0.017 ± 0.009 a	0.0 - 0.1
	Bollworm/Budworm Complex	
Texas	0.100 ± 0.035 a	0.0 - 0.6
Tamaulipas	0.000 ± 0.000 b	-

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 2. Incidence of selected homopterous pests on cotton foliage in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	No./10-cm² Sample[a] ($\bar{x}$ ± SE)	Range
	Cotton Aphid	
Texas	1.471 ± 0.625 a	0.0 - 8.1
Tamaulipas	0.047 ± 0.018 b	0.0 - 0.2
	Sweetpotato Whitefly	
Texas	10.809 ± 3.000 a	0.3 - 40.1
Tamaulipas	0.558 ± 0.149 b	0.0 - 1.6

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 3. Density of lepidopterous pupae and pupal skins in soil samples from cotton fields in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	Pupae/m² [a] ($\bar{x}$ ± SE)	Range
	Beet Armyworm	
Texas	3.079 ± 0.560 a	0.1 - 9.5
Tamaulipas	0.025 ± 0.013 b	0.0 - 0.1
	Bollworm/Budworm Complex	
Texas	0.174 ± 0.047 a	0.0 - 0.8
Tamaulipas	0.008 ± 0.008 b	0.0 - 0.1

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 4. Incidence and relative abundance of chrysopid egg stalks on cotton foliage in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	% Plants[a] Infested ($\bar{x}$ ± SE)	No. Stalks/Plant[a] Mean (± SE)	Range
Texas	24.4 ± 7.5 a	0.9 ± 0.3 a	0.0 - 4.6
Tamaulipas	88.1 ± 6.0 b	6.6 ± 1.6 b	0.4 - 16.7

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 5. Incidence of chrysopid larvae in foliage of cotton plants in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	No./Row m[a] ($\bar{x}$ ± SE)	Range
Texas	0.125 ± 0.039 a	0 - 0.5
Tamaulipas	0.625 ± 0.326 a	0 - 4.1

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 6. Incidence of lepidopterous feeding damage to cotton foliage in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	% Leaves Damaged[a] ($\bar{x}$ ± SE)	Range
Texas	71.4 ± 2.7 a	47.2 - 92.0
Tamaulipas	0.6 ± 0.3 b	1.5 - 18.7

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 7. Incidence of lepidopterous feeding injury to cotton fruiting structures in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	No./Plant[a] ($\bar{x}$ ± SE)	% Damaged[a] ($\bar{x}$ ± SE)
	Squares	
Texas	4.2 ± 0.6 a	22.8 ± 3.3 a
Tamaulipas	0.1 ± 0.1 b	26.7 ± 19.4 a
	Bolls	
Texas	1.4 ± 0.2 a	47.1 ± 6.6 a
Tamaulipas	5.0 ± 0.4 b	0.6 ± 0.3 b

[a]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 8. Within-plant distribution of fruiting forms on cotton plants in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, July, 1995

Stratum	No. Fruiting Forms/Plant ($\bar{x}$ ± SE) Squares	Blooms	Green Bolls	Open Bolls
		Texas		
Upper	2.6 ± 0.3	0.2 ± 0.04	0.3 ± 0.1	0.0 ± 0.0
Middle	1.2 ± 0.2	0.2 ± 0.03	0.7 ± 0.1	0.0 ± 0.0
Lower	0.4 ± 0.1	0.0 ± 0.0	0.5 ± 0.1	0.0 ± 0.0
		Tamaulipas		
Upper	0.1 ± 0.0	0.0 ± 0.0	2.0 ± 0.2	0.2 ± 0.1
Middle	0.0 ± 0.0	0.0 ± 0.0	1.8 ± 0.2	0.8 ± 0.2
Lower	0.0 ± 0.0	0.0 ± 0.0	1.2 ± 0.2	1.4 ± 0.2

Table 9. Densities of immature boll weevils in cotton fields located in the Lower Rio Grande Valley of Texas and adjacent Tamaulipas, Mexico, 1995

Region	Fields[a] Sampled	Boll Weevils/m² [bc] ($\bar{x}$ ± SE)
Texas	14	3.8 ± 1.5 a
Tamaulipas	9	0.2 ± 0.1 b

[a]Samples collected during 26 July - 3 August. Original fields not included in survey had either been shredded or plowed.
[b]Includes all forms (live and dead) in squares and bolls.
[c]Means followed by the same letter are not significantly different at α=0.05 (Student's *t*).

Table 10. Incidence of fruit, plant damage, and pests in dryland and irrigated cotton in the Texas Lower Rio Grande Valley, 1995

	Mean/Sample[a] squares	bolls	beet armyworm larvae	beet armyworm pupae	aphids	whiteflies	green lacewing egg stalks
Dryland	5.9a	0.9a	0.4a	2.2a	0.9a	3.9a	1.4a
Irrigated	3.5a	1.7a	0.6a	3.3a	1.7a	14.0a	0.7a

	Mean Percent Damage leaves	squares	bolls
Dryland	62.8b	13.8a	39.9a
Irrigated	76.9a	26.0a	49.8a

[a]Means followed by the same letter are not significantly different at α=0.05 (LSD).

Table 11. Incidence cotton pests and green lacewing egg stalks in various communities in the Texas Lower Rio Grande Valley, 1995

Community	Mean/Sample[a]				
	beet armyworm larvae	beet armyworm pupae	aphids	whitefly	green lacewing egg stalks
Mission	0.3a	1.7a	0.03c	34.9a	0.6c
Hargil	0.6a	1.0a	0.5bc	4.3bc	0.6c
Monte Alto	0.02a	3.2a	1.8b	9.0bc	0.0c
Mercedes	1.0a	4.0a	0.6bc	6.2bc	0.6c
Harlingen	0.4a	0.3a	0.1c	20.2ab	3.3b
Los Fresnos	0.9a	5.0a	7.6a	0.3c	0.0c
Raymondville	0.1a	4.5a	0.8c	7.7bc	0.02c
Port Mansfield	0.9a	0.4a	0.1c	3.3bc	4.1a

[a]Means followed by the same letter are not significantly different at α=0.05 (LSD).

Table 12. Incidence of fruit and plant damage in various communities in the Texas Lower Rio Grande Valley, 1995

Community	Mean/Sample		Mean Percent Damage		
	squares	bolls	leaves	squares	bolls
Mission	0.8b	0.8a	91.7a	21.5a	64.1a
Hargill	9.5a	1.9a	59.7a	8.4a	14.5a
Monte Alto	7.4a	1.6a	55.4a	9.8a	23.0a
Mercedes	2.9b	1.8a	75.7a	30.2a	42.2a
Harlingen	3.1b	0.9a	79.8a	23.8a	54.2a
Los Fresnos	4.1b	1.4a	78.6a	34.2a	64.1a
Raymondville	3.1b	2.1a	67.0a	26.6a	39.2a
Port Mansfield	3.9b	0.4a	73.9a	14.9a	62.7a

[a]Means followed by the same letter are not significantly different at α=0.05 (LSD).