POPULATION TRENDS OF BEET ARMYWORM ON COTTON IN THE LOWER RIO GRANDE VALLEY DURING THE 1996 PRODUCTION SEASON

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Abstract

Population trends of beet armyworm, *Spodoptera exigua* (Hubner), and its natural enemy associates on south Texas cotton were monitored during the 1996 production season. Pheromone traps detected a continual presence of beet armyworm moths at each of two study locations throughout a 4-month study period. However, infestations of the pest in a series of cotton plantings remained at innocuous levels throughout the season and caused no appreciable damage to plants. The latter trend was attributed to an extremely high incidence of mortality among immature stages (>99%), much of which was caused by members of an indigenous natural enemy species complex. The principal natural enemy groups included a complex of spiders, predaceous bugs (e.g., *Orius* and *Geocoris* spp.), beetles (e.g., Hippodamia and Scymnus spp.) and green lacewings (*Chrysoperla* spp.). The significance of indigenous natural enemies in the beet armyworm life system of southern Texas is discussed.

Introduction

Beet armyworm, *Spodoptera exigua* (Hubner), has become an increasingly destructive pest of cotton in the southern United States during the past decade (Stewart et al. 1996). Between 1986 and 1995, serious outbreaks of beet armyworm were documented in Georgia, Florida, Alabama and Arizona (Moore 1991; Smith 1989, 1994; Ruberson et al. 1994; Sprenkel and Austin 1996). Two of the most destructive outbreaks on record occurred during 1995, when explosive increases of beet armyworm and a multitude of unrelated pest species essentially destroyed the cotton crops of the Lower Rio Grande Valley (LRGV) and Southern Rolling Plains (SRP) regions of Texas (Huffman 1996; Summy et al. 1996). According to the Texas Comptroller of Public Accounts, actual monetary losses incurred as a result of the LRGV and SRP crop failures approached $200 million (Sharp 1995).

Because of the magnitude of these losses, the ecology of beet armyworm has become a subject of considerable interest. In an attempt to gain a better understanding of the population ecology of beet armyworm in the subtropical LRGV region, we monitored infestations of the pest occurring within a series of treated and untreated cotton plots during the 1996 production season. In essence, the study was designed to allow a comparison of beet armyworm survivorship and population trends occurring in the presence and absence (or reduced levels) of indigenous natural enemies under similar weather conditions (see DeBach and Bartlett [1964] for a discussion of "chemical check" and other natural enemy exclusion).

Materials and Methods

Studies were conducted at two locations in Hidalgo County, Texas: 1) a series of eight 1.0-ha plots located on ARS facilities in Weslaco, and 2) a series of four 0.6-ha plots located at Rio Farms, Inc., in Monte Alto. Plots at Monte Alto were planted to DPL-50 cotton on 3 March, and were subjected to two irrigations (at the time of planting and on 10 May). Plots at at Weslaco were planted to the same cultivar on 14 March and were irrigated twice (on 15 March and 20 June). Two of the four plots at Monte Alto were treated on two occasions (30 April and 7 May) with ultralow-volume (ULV) malathion at a rate of 16 oz spray mixture/acre using a Microfit Herbi™ applicator (Micron Sprayers, Ltd, Bromyard, Herefordshire, UK) operated from the bed of a pickup truck. Thereafter, plots were treated with conventional (EC-57) malathion applied at a rate of 32 oz mixture/acre using a tractor-mounted rig at 5- to 7-day intervals during 17 May - 29 July (a total of 16 additional treatments). Four of the eight plots at Weslaco were subjected to an initial treatment of ULV malathion (16 oz mixture/acre) using the Herbi™ applicator (on 7 May). Thereafter, a similar rate of ULV malathion was applied using a conventional tractor-mounted rig at weekly intervals during 17 May through 25 July (a total of 11 additional treatments).

Insect infestations within each plot were monitored using a random sampling scheme designed pest and natural enemy densities, and the incidence of damage caused by the various pest species. On each sampling date, five randomly-selected plants were sampled from each of five randomly-selected points per plot (locations determined by random numbers table). Each whole-plant sample was examined for beet armyworm egg clusters and larvae, selected natural enemies, and evidence of damage caused by beet armyworm and other lepidopterous pests. At each of the five sample points, two 1.0 m^2 quadrats delineated on the soil surface were excavated to a depth of ~5 cm to quantify densities of pupae and pupal exuviae of beet armyworm and other lepidopterous insects in topsoil. In addition, two sweep-net samples (50 sweeps/sample) were collected within each plot on each sampling date to determine the presence of various natural enemy species. Flight activity of beet armyworm moths at each study location was monitored at weekly intervals using pheromone traps baited with Pherocon™ dispensers (Trece,

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Inc.) and the toxicant Vaportape II™ (Hercon Environmental Company, Emigsville, PA).

Cohorts of immature beet armyworms were established and monitored in each series of plots in an attempt to quantify survivorship occurring in the presence and absence of natural enemies. Clusters of ~100 eggs deposited on wax paper strips were attached to foliage of five randomly-selected plants within plots at each location at weekly intervals during 1-27 May. Within 48-72 hours following attachment, a census was conducted in situ (using a 10-x hand lens) to quantify hatch success (i.e., numbers of first-stage larvae occurring in the vicinity of the parent egg cluster). Following a period of ~4-5 weeks, a 6-row x 15 m (~60 m^2) quadrat delineated on the soil surface around each original attachment site was excavated to a depth of ~5 cm to measure numbers of pupae and pupal exuviae. Collectively, these data facilitated the construction of stage-specific life tables for immature beet armyworms occurring within untreated control plots (natural enemies unencumbered) and insecinsecticide-treated counterparts (natural enemies impeded or excluded). Means for the various treatments were compared using Student's-t test.

Results and Discussion

Pheromone traps situated in the vicinity of cotton plots at Monte Alto and Weslaco detected a continual presence of beet armyworm moths throughout the 4-month study period (Table 1). During the period extending from 22 April through 28 August, trap catches at Monte Alto ranged between 0.67-16.0 adults/trap/week, while those at Weslaco were substantially greater (1.5-522.0 adults/trap/week). Such differences notwithstanding, the continuous flight activity evident at both study sites was similar to trends observed in other locations (KRS, unpublished data) and suggested a general abundance of beet armyworm moths within the LRGV region during the 1996 cotton season.

Nevertheless, infestations of beet armyworm on cotton remained at innocuous levels throughout the season and caused no appreciable damage to plants (Table 2). At the Weslaco site, densities of beet armyworm larvae and pupae ranged between 0 - 0.078/m^2 within the series of untreated (control) plots, and increased to somewhat higher levels within plots subjected to routine insecticidal treatment (0 - 0.236/m^2). At Monte Alto, random samples failed to detect the presence of beet armyworm larvae on foliage or pupae and pupal exuviae in topsoil throughout the study period. However, the presence of infestations on cotton were confirmed by the collection of beet armyworm larvae in sweep samples, although numbers collected at Monte Alto (a total of one larva on one occasion) were substantially lower than those obtained from similar samples at Weslaco (a total of 13 larvae on 7 occasions).

The apparent stability of beet armyworm infestations at both locations appears to have been the result of an extremely high incidence of mortality among immature stages (Table 3). At Weslaco, mortality ranged between 98.85 - 99.65% within the series of treated plots ($\bar{x}$ = 98.575%), and was slightly higher in the untreated controls (99.85 - 99.95%; $\bar{x}$ = 99.825%) (t = 3.693; df=6; P=0.01). No such differences were evident at Monte Alto, where mortality was uniformly high in both series of plots ($\bar{x}$ = 99.90 and 99.95% within treated and untreated plots, respectively) (t = 0.655; df=6; P = 0.537). At both locations, mortality appears to have been concentrated among eggs (79.3-92.7% real) and larval stages (7.1-20.6% real); the majority (>99%) of insects developing to the pupal stage completed development and emerged successfully (Table 3).

Much of the mortality occurring among immature beet armyworms was attributed to members of a diverse natural enemy complex, which were generally abundant at both locations throughout the season (Table 4). The predominant predator groups included 1) a complex of spiders (Araneae), 2) predaceous bugs, including *Orius* spp. (Anthocoridae), *Geocoris* spp. (Lygaeidae), damsel bugs (Nabidae), and assassin bugs (Reduviidae), 3) beetles, including *Hippodamia* spp. and *Scymnus* spp. (Coccinellidae) and 4) green lacewings, including *Chrysoperla* spp. (Chrysopidae). No egg or larval parasites of beet armyworm were detected at either location, although such parasites are known to exist and were probably present in relatively low numbers. Several of the predator species known to attack beet armyworm were present at variable densities throughout the season (e.g., *Orius* spp. and *Geocoris* spp), while others did not become evident until the mid-season period or later (e.g., *Chrysoperla* spp.).

Increases in natural enemy densities at both locations were presumably geared to population trends of several unrelated pest species, the most abundant of which were cotton aphid, *Aphis gossypii* Glover, and silverleaf whitefly, *Bemesia argentifolii* Bellows & Perring. The contrast in pest population levels occurring within the treated and untreated plots provided considerable evidence of natural enemy efficacy, i.e., the early-season flushes of cotton aphid and late-season increases of silverleaf whitefly were considerably more pronounced within treated plots in which natural enemy activity had been suppressed to an extent (Figs. 1-4). Few, if any, of the generalist predators present in these infestations are known to feed selectively on beet armyworm. However, the sheer abundance of predators in these infestations virtually assured a relatively high incidence of mortality among immature beet armyworms, a trend that appears to have been primarily responsible for the generally low levels of the pest that were evident throughout the season (see Tables 2-4).

Although the “chemical check” experiments provided evidence of natural enemy efficacy against beet armyworm and other pests, the reader should note that our attempts to suppress natural enemy activity by routine application of broad-spectrum insecticides (EC-57 and ULV malathion) were only marginally effective. Although both chemicals are known to be highly toxic to the majority of natural enemies present in these infestations, the frequency of treatments (5- to 7-day intervals) was apparently insufficient to prevent a continual influx of natural enemies into the series of treated plots from surrounding areas (similar trends were reported by Sparks et al. 1997, these proceedings). As a result of such continuous immigration, natural enemy densities within treated plots were commonly equivalent to or greater than those occurring within untreated controls several days after treatment. Thus, the contrasts summarized in Figs. 1-4 and Tables 2-4 merely reflect the effects of a local (and relatively minor) disruption of natural enemy *activity*, and do not adequately portray the far more serious consequences of a general disruption of natural enemy *populations* over a large geographic area (see Summy et al. 1996).

Conclusions

Population trends of beet armyworm in our experimental plots were similar to those reported in other locations during 1996 (e.g., Sparks et al. 1997, these proceedings), and are probably typical of trends normally occurring on LRGV cotton. Despite the fact that beet armyworm moths were present at both locations throughout the season, infestations of the pest on cotton remained at innocuous levels and caused no appreciable damage to cotton plants. Natural enemies were generally abundant at both locations, and appear to have been primarily responsible for the high incidence of mortality that maintained infestations of beet armyworm and other pests at subeconomic levels throughout the season. Additional research on the ecology of beet armyworm and its natural enemy associates in the subtropical LRGV environment is needed to facilitate the more efficient use of natural enemies in areawide pest management and suppression efforts.

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Table 1. Summary of beet armyworm trap catches near Weslaco and Monte Alto, Texas, 1996.

	Moths/Trap/Week[a]	
Month	Weslaco	Monte Alto
April	-----	6.0 (2-9)
May	68.7 (48-101)	1.7 (1-3)
June	60.6 (12-102)	2.1 (1-3)
July	64.3 (2-144)	3.6 (4-6)
August	254.2 (74-522)	12.4 (6-16)

[a] Range indicated in parentheses.

Table 2. Densities of immature beet armyworms on cotton near Weslaco and Monte Alto, Texas, 1996.

	Immature forms/m^2 [a]			
	Weslcao		Monte Alto	
Month	Treated	Control	Treated	Control
May	0.052	0.0	0.0	0.0
June	0.174	0.0	0.0	0.0
July	0.0	0.0	0.0	0.0

[a] Aggregate of larval and pupal stages.

Table 3. Mortality of immature beet armyworms infesting treated and untreated cotton plots near Weslaco and Monte Alto, Texas, 1996.

	Real Mortality (%)[a]			
	Weslaco		Monte Alto	
Stage	Treated	Control	Treated	Control
Eggs	89.000	92.725	79.325	88.400
Larvae	9.575	7.100	20.575	11.550
Pupae	0.000	0.000	0.000	0.000
Total	98.575a	99.825b	99.990a	99.950a

[a] Means within rows followed by same letter not significantly different at 5% level (Student's-*t* test).

Table 4. Seasonal abundance of selected predator groups in treated and untreated cotton plots near Monte Alto, Texas, 1996.

	Predators/sample			
	Monte Alto		Weslaco	
Month	Treated	Control	Treated	Control
		Spiders		
April	1.75	0.50	-----	-----
May	0.25	0.67	0.50	0.83
June	1.08	1.58	0.83	1.25
July	4.50	4.25	1.54	8.08
		Orius spp.		
April	2.00	2.50	-----	-----
May	3.00	6.83	1.80	4.35
June	6.17	8.67	13.50	10.38
July	1.00	0.42	1.63	0.54
		Geocoris spp.		
April	0.75	1.00	-----	-----
May	0.00	0.92	0.10	1.15
June	1.17	2.25	2.88	6.83
July	1.00	8.75	5.25	6.08
		Hippodamia spp.		
April	2.50	1.25	-----	-----
May	10.17	2.42	0.68	1.73
June	1.25	2.33	1.83	7.00
July	0.42	0.25	0.71	1.63
		Chrysoperla spp.		
April	0.00	0.00	-----	-----
May	0.08	0.25	0.00	0.00
June	2.55	5.33	1.67	3.58
July	19.58	6.58	2.50	5.88

[a] Aggregate of adult and immature stages. Estimates based on two 50-sweep samples per plot on each sampling date.

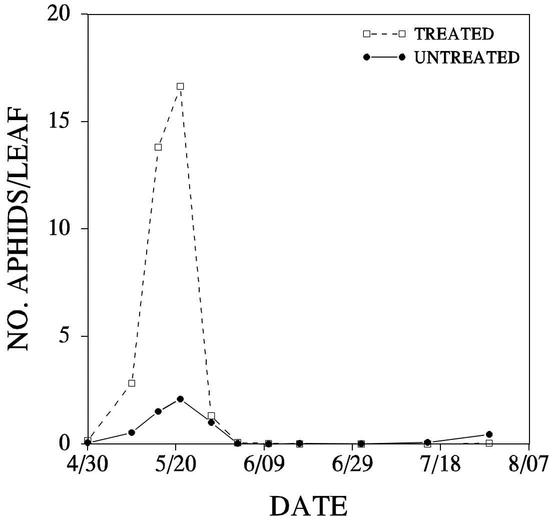

Fig. 1. Seasonal abundance of cotton aphid in treated and untreated cotton plots near Monte Alto, Texas, 1996.

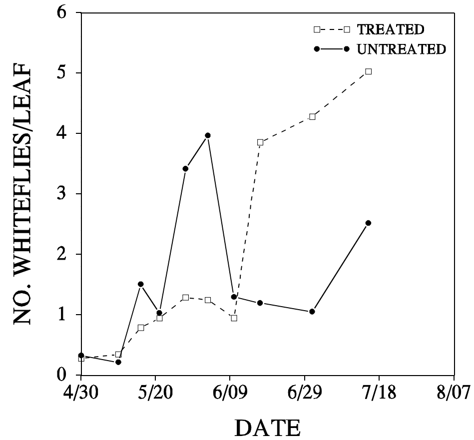

Fig. 3. Seasonal abundance of silverleaf whitefly in treated and untreated cotton plots near Monte Alto, Texas, 1996.

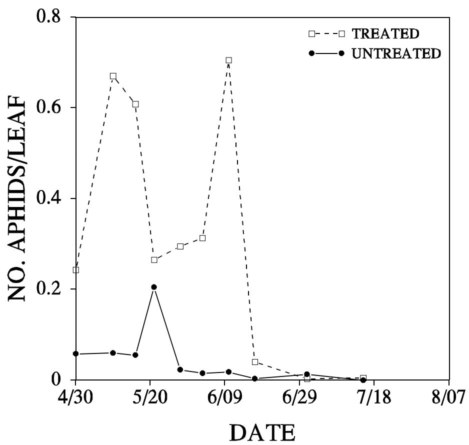

Fig. 2. Seasonal abundance of cotton aphid in treated and untreated cotton plots near Weslaco, Texas, 1996.

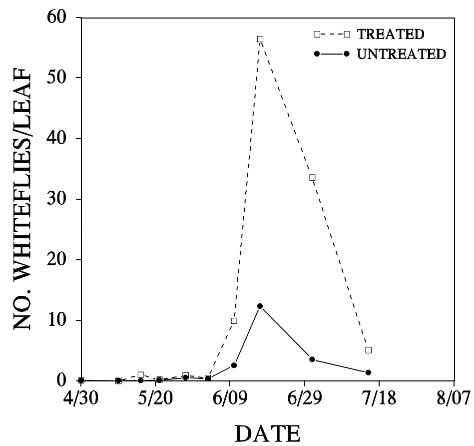

Fig. 4. Seasonal abundance of siverleaf whitefly in treated and untreated cotton plots near Weslaco, Texas, 1996.