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REDUCED PREDATION ON LEPIDOPTERAN EGGS DUE TO THE BOLL WEEVIL ERADICATION PROGRAM IN SOUTH TEXAS, 2005-2006

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Abstract

Predation on eggs of the lepidopteran pests *Helicoverpa zea* (Boddie) and *Spodoptera exigua* (Hübner) in cotton was monitored before and during the first two seasons of the Boll Weevil Eradication Program in south Texas (2005-2006). Mortality of eggs was reduced after malathion sprays for boll weevil relative to both pre-spray levels in cotton and in comparison to an adjacent unsprayed soybean field. The number of predation events observed was also reduced in comparison to pre-spray levels in cotton and post-spray levels in the soybean controls. Despite reduced mortality of lepidopteran pests, outbreaks were not observed in 2005 or 2006, probably due to reduced spray applications in comparison to the previous boll weevil eradication attempt in south Texas.

Introduction

Predators typically inflict significant mortality to lepidopteran pests in cotton (Nuessly and Sterling 1994, Ruberson et al. 1994, Stewart et al. 2001, Pfannenstiel 2004, 2005). In many circumstances predators provide excellent control unless disrupted by pesticides. However, there is significant evidence that initiation of the boll weevil eradication program at different locations in the southern USA has resulted in significant release of lepidopteran pests resulting in crop damage (Stewart et al. 1996, Summy et al. 1996). However, there have been no rigorous tests of the impact of the eradication program on predator complexes or the mortality they cause lepidopteran pests. Because of an ongoing long term project studying the predator complexes feeding on lepidopteran eggs in the Lower Rio Grande Valley (LRGV), the initiation of the Boll Weevil Eradication Program (BWEP) in 2005 allowed for an investigation of the impact of the program on predators and the change in their impact on eggs of two pest lepidopteran species, the bollworm, *Helicoverpa zea* (Boddie) and the beet armyworm, *Spodoptera exigua* (Hübner) (both Lepidoptera: Noctuidae).

During a previous attempt at instituting the BWEP in the LRGV, outbreaks of *S. exigua* led to significant crop damage (Stewart et al 1996, Summy et al. 1996) and the end of the BWEP program after one year. During the current permutation of the BWEP, two changes were instituted to try to reduce the likelihood of beet armyworm outbreaks. First year sprays for boll weevils did not begin until late summer to reduce overwintering weevils without causing serious impact on natural enemies of lepidopteran pests. During the second year, a pesticide free period during May was incorporated to allow natural enemy populations to build up, reducing the likelihood of outbreaks. From the third year on, sprays will be applied whenever trap catches exceed thresholds. It is hoped that boll weevil numbers will be reduced enough from previous year applications to prevent levels of spraying that would induce widespread outbreaks of lepidopteran pests while still reducing boll weevils.

The predator complex feeding on lepidopteran eggs in cotton has been extensively studied from 2001 to the present in the LRGV (Pfannenstiel 2004, 2005). Dominant predators of lepidopteran eggs in cotton include the cursorial spiders (dominated by the Anayphaenidae, Clubionidae and Miturgidae), the red imported fire ant [*Solenopsis invicta* (Buren)], the cotton fleahopper [*Pseudomatoscelis seriatus* (Reuter) (Hemiptera: Miridae)] and *Geocoris lividipennis* Stål (Hemiptera: Geocoridae). This study will evaluate the impact of BWEP sprays on predation of lepidopteran eggs in LRGV cotton. Here, I present data from the pre-program evaluation and the first two years of the BWEP.

Materials and Methods

Small cotton fields were planted using production practices typical of farmers in the lower Rio Grande Valley. Field size ranged from 2 to 5 acres during this study. Soybean fields were also planted and used as an unsprayed control for the impact of pesticides because it was not possible to have unsprayed cotton during the eradication program. Cotton (cv. Deltapine 54-14 RR in 2004, Deltapine 494 RR in 2005, and a combination of Deltapine 494 RR and 147 RR Flex in 2006) was always planted during the first week of March. Soybean (cv. Vernal) was planted during third week of March. Soybean was planted over drip irrigation while the cotton was drip irrigated in 2004 -2005 and flood irrigated in 2006.

Pesticide treatments were conducted by the BWEP. ULV malathion was used for all pesticide applications during the program and was applied either by air or by pickup truck using a mister. Pesticide applications were initiated in July 2005. Pesticides were to be applied to fields whenever trap catches were greater than 2 boll weevils per field per week, however actual application dates were inconsistently associated with trap catch during 2006.

Evaluation of predation was conducted using sentinel lepidopteran eggs and the observation techniques of Pfannenstiel & Yeargan (2002) as modified by Pfannenstiel (2004) and can be summarized as follows. Fields were divided into quadrants and 30 sampling stations selected in each quadrant. In each quadrant there were 10 stations per row with 5 m between stations and 7 rows between sample rows. The 10 sites per row were alternately assigned to either *H. zea* or *S. exigua* using different colored flags so that there were 15 sites for each egg type in each quadrant.

H. zea and *S. exigua* colonies were maintained in the laboratory by modified methods of Ignoffo (1965). Adults were placed in 3.8 l ice cream cartons lined with green florist paper for oviposition; a 10% sucrose solution was provided as a food source. Egg sheets were collected daily; paper on which eggs had been laid was cut into small (3 to 20 cm^2) sections containing either 10 *H. zea* eggs or one *S. exigua* egg mass each. Egg groups or masses were then placed in a refrigerator at 4°C to stop development until used or discarded after 4 d. Groups of 10 *H. zea* eggs (as opposed to 1 egg) were used to extend the amount of time that a predator feeds, thus increasing the probability of observing predation events. All eggs in each *S. exigua* egg mass (range 20 to ~160 eggs/mass) were counted and recorded before placement into the cotton field.

Eggs were transported to the field in an ice chest with ice and then attached to plants at 3 PM by stapling the eggs in the desired location. Afternoon was used for deployment of eggs for purely logistical purposes. *H. zea* eggs typically take 2.5 or more days to develop in the field in Texas and would be available to predators throughout this time (R. S. P. personal observation). Paper sections containing eggs were not used if any of the eggs were dislodged during transportation. Egg groups were attached to the top of a cotton leaf about 55 - 70% of plant height and this relative location was maintained as the cotton plants grew.

Egg groups were observed at three-hour intervals (6 PM, 9 PM, 12 Midnight, 3 AM, 6 AM, 9 AM, 12 Noon, and 3 PM CDT) for the following 24 h. This distribution of sampling times results in 4 day (9 AM, 12 Noon, 3 PM and 6 PM) and 4 night samples (9 PM, 12 Midnight, 3 AM, and 6 AM CDT). Sunrise occurred as the 6 AM sample was being finished and sunset occurred just before the 9 PM sample was initiated, allowing for equal numbers of day and night samples despite a photophase lasting about 14 h. *H. zea* and *S. exigua* eggs take about 3 d to develop; due to their prompt refrigeration, eggs used during this study did not approach hatching at any time. At each observation period, predators observed feeding on the eggs were identified or collected for subsequent identification. All observations of predation could be assigned to day (9 AM, 12 Noon, 3 PM and 6 PM) or night (9 PM, 12 Midnight, 3 AM, and 6 AM). Eggs of each species were replaced when all eggs on the sheet had been consumed allowing accurate estimation of egg mortality (24 h). This experiment was conducted on six dates in each of the years of the study. Sampling was initiated in late April or early May and continued at two to four week intervals through July or August. On some dates both crops could not be sampled because either the soybean was still too small in the spring or had senesced in the late summer

Results

Egg mortality of both *H. zea* and *S. exigua* was consistently high in cotton during the years (2002-2003) before the BWEP began and ranged from 25 to 90 %, respectively (Pfannenstiel 2004, 2005). Because levels of predation were similar between *H. zea* and *S. exigua* species, only the data for *H. zea* will be presented here. Predation in cotton was compared to that in soybean in 2004 and was generally similar between the two crops rising from between 30 and 40% (respectively) early in the season to near 60% towards the end (Fig. 1). Egg mortality in cotton was slightly lower in 2005 and ranged from 30 to 50 % before pesticide applications began (Fig. 2). The first estimation of mortality post-malathion application was reduced to less than 10% mortality per 24 h from 30% on the previous date (Fig. 2). Before this, the lowest 24 h mortality on any date from 2001 to 2004 was about 20%. The last sample date in 2005 was the only date in 6 years of observation with a mortality rate less than 10 % and only the 2nd time ever that there was 24 h mortality less than 22 %. The reduction in mortality in 2006 was less than observed 2005 due to application of malathion by edge sprays rather than full field aerial applications. In 2006, post-spray mortality/24 h ranged from 30-40% before malathion applications began and around 20% after (Fig. 3).

In 2004, as in the years before that (Pfannenstiel 2005), predation events were more frequently observed in cotton than in Soybean by a ratio ranging from 3 to 4:1. In 2005, this pattern was apparent until sprays began in August when there was a significant reduction in observation of predation in cotton compared to soybean (cotton:soybean) from about 3:1 pre-spray to 0:5 post-spray. Similarly, in 2006, there was a 2.5:1 ratio of observations until edge sprays of malathion were initiated, this pattern reversed and the ratio of observations in the two crops became about 1:3 × with many more observations in soybean. Egg mortality varied dramatically between cotton and soybean after sprays began in 2006 with mortality decreasing in cotton from about 40 to 20% while increasing nearly threefold from 28 to 80% in soybean (Fig. 3). The large increase in mortality in soybean was due primarily to higher observations of nocturnal feeding by cursorial spiders and a predatory cockroach that had previously not been observed in south Texas cotton

Discussion

Malathion applications, whether by air or edge application by flatbed mister resulted in reduction in lepidopteran egg mortality in cotton both when compared to previous dates and when compared to an adjacent untreated soybean field. During 2006, egg mortality in soybean increased significantly due to invasion by an exotic cockroach. It is likely that this cockroach would have colonized cotton as well resulting in higher than normal mortality there as well. The relatively high impact of edge treatments of malathion was surprising. Mortality was reduced even into the middle of the field (personal observation) suggesting that these predators move around frequently within cotton fields resulting in their contacting pesticide residues even though they may cover only a portion of the field.

In 2006, the exotic cockroach, *Blattella asahinai* Mizukubo (Orthoptera: Blattellidae), was discovered in the LRGV in soybean and cotton. In the absence of pesticide inputs, the Asian cockroach reached very high densities in soybean and was the predator most frequently observed feeding on lepidopteran eggs. It is likely that in the absence of malathion sprays the densities of this cockroach would have increased in cotton and caused significant mortality to lepidopteran eggs there. This cockroach appears to be very susceptible to pesticides.

In 2005 and 2006, sprays by the BWEP reduced mortality of lepidopteran eggs but thus far has not led to any outbreaks of lepidopteran pests. Unfortunately, trap catches of boll weevils hve also remained high. Beginning in 2007 sprays will be conducted throughout the year to increase the impact on the boll weevil. This program will continue to evaluate the impact of the BWEP on predators and their impact on eggs of lepidopteran pests.

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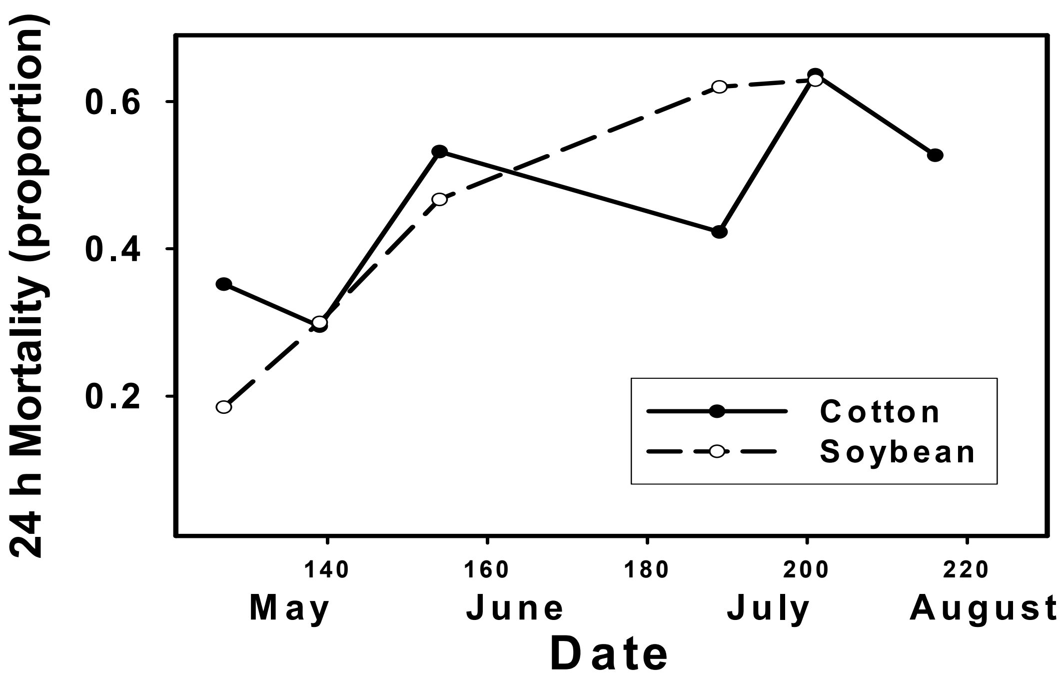

Figure 1. Mortality of *H. zea* eggs in cotton and soybean, 2004

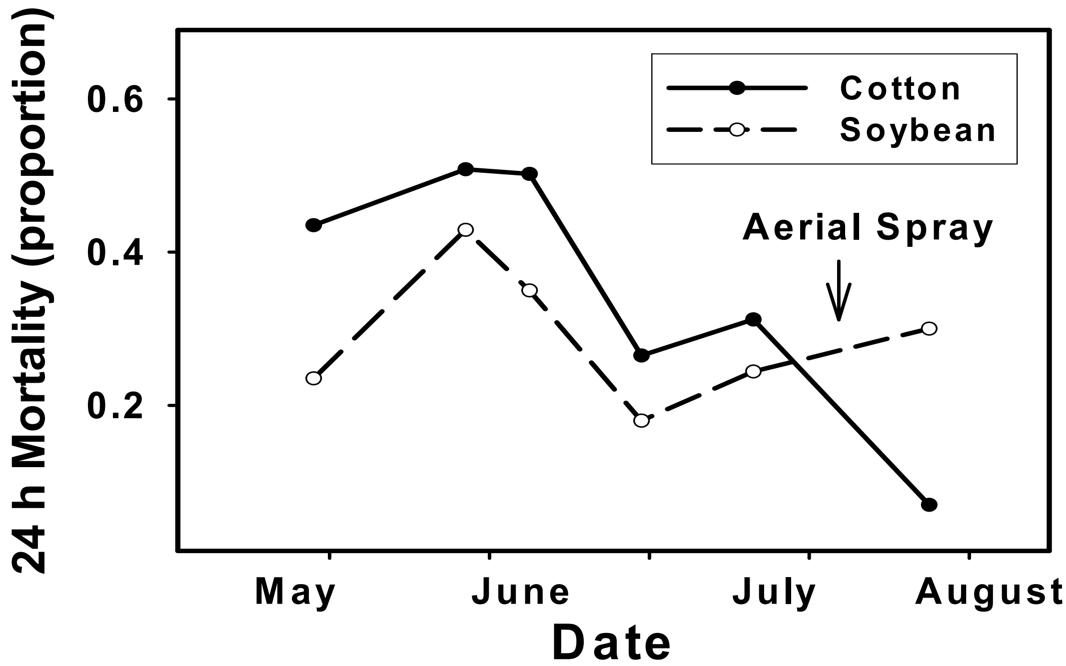

Figure 2. Mortality of *H. zea* eggs in cotton and soybean, 2005.

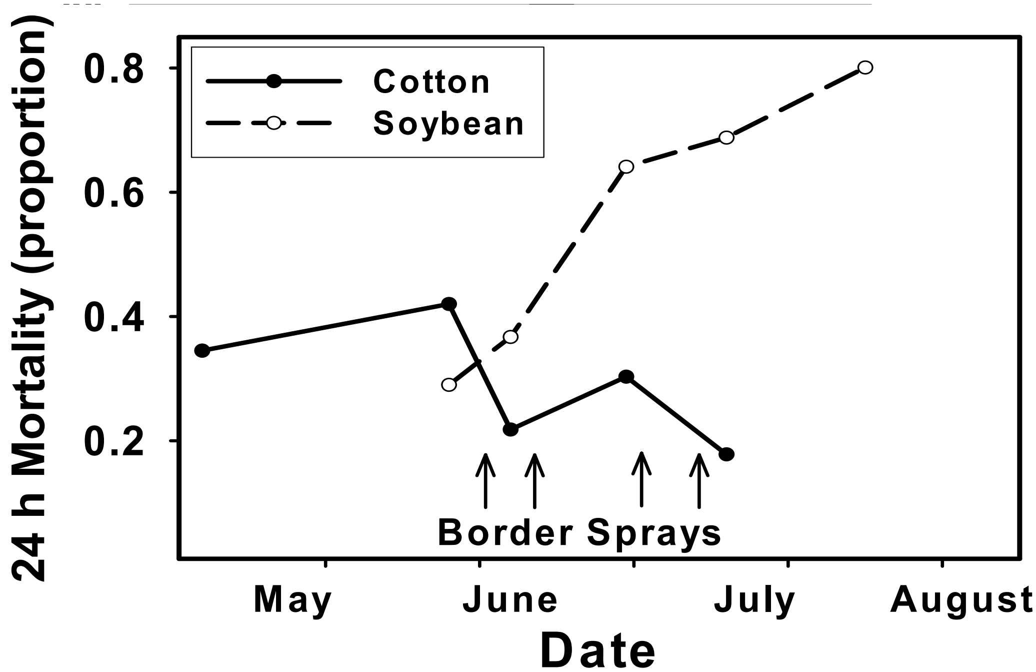

Figure 3. Mortality of *H. zea* eggs in cotton and soybean, 2006. All sprays were only of the field borders.