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HELICOVERPA ZEA (LEPIDOPTERA: NOCTUIDAE) DYNAMICS AND PARASITISM IN MARYLAND SOYBEANS

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ABSTRACT

Larval populations of the corn earworm, *Helicoverpa zea* (Boddie), were surveyed in soybeans from 1995 to 1997 to catalogue larval parasites and quantify rates of parasitism. In addition, the relationship between moth captures in black-light traps and larval densities in soybeans was examined. Parasitism was consistently high throughout the region averaging 80.3%, 82.3%, and 73.1% for all dates in 1995, 1996, and 1997, respectively, and appeared to suppress *H. zea* populations. The predominate parasite species was *Microplitis croceipes* (Cresson) with some parasitism by *Cotesia marginiventris* (Cresson), *Meterous autographae* Meusebeck, and *Winthemia rufopicta* (Bigot). The date of the peak weekly capture of moths explained 99.7% of subsequent larval densities in soybeans, while the average weekly moth catches did not. The earlier moth peak in 1995 corresponded with higher populations of larvae, while the later peaks in 1996 and 1997 were followed by very low, sub-economic larval populations. Departures from normal for precipitation and temperature during August explained 99.8% and 95.3%, respectively, of the variation in the date of peak moth capture.

Key Words: *Helicoverpa zea*, soybeans, parasitism, black-light traps, Lepidoptera

RESUMEN

Las poblaciones de las larvas del gusano del elote, *Helicoverpa zea* (Boddie), fueron muestreadas en soya desde 1995 hasta 1997 para catalogar los parasitos de larvas y cuantificar la tasa de parasitismo. Además, la relación entre las polillas capturadas en trampas de luz negra y la densidad de las larvas fueron examinadas. El parasitismo fue consistentemente alto atravéz de la región con un promedio de 80.3%, 82.3%, y 73.1% para las fechas en 1995, 1996, y 1997, respectivamente, y aparentemente con ello delimito las poblaciones de *H. zea*. La especie de parasito predominante fue *Microplitis croceipes* (Cresson) seguido con el parasitismo por parte de *Cotesia marginiventris* (Cresson), *Meterous autographae* Meusebeck, y *Winthemia rufopicta* (Bigot). La fecha correspondiente al número mas alto de polillas capturadas explica 99.7% de las densidades de larvas subsecuentes sobre la soya, mientras que el promedio semanal de las polillas capturadas no lo indica. El pico de la población mas temprana en 1995 correspondio con poblaciones mas altas de las larvas, mientras que los picos mas tardes de la población en 1996 y 1997 fue seguidos con poblaciones sub-económicas de larvas muy bajas. Las salidas normal de la precipitación y temperatura durante agosto explicaron 99.8% y 95.3%, respectivamente, de la variación en la fecha del pico de la población de polillas capturadas.

The corn earworm, *Helicoverpa zea* (Boddie), is a periodic pest of soybeans in Maryland on the Delmarva peninsula. Herbert et al. (1991) reported that a third of the acreage in Virginia was treated annually with insecticides to control *H. zea*. The dynamics of *H. zea* are somewhat different in Maryland because of a lack of a large overwintering population like parts of Virginia and North Carolina. Although a small population does often overwinter in the most southern region of the peninsula, most of the population migrates into the area from more southern states (R. A. B., unpublished data). Field corn on the Delmarva peninsula provides a harborage for these immigrants which, coupled with continued migration of adults from further south and lack of parasitism, can result in the maintenance of large populations of *H. zea* that pose a threat to soybeans later in the summer (Zehnder et al. 1990).

The movement of *H. zea* into soybeans is governed by an array of factors, the most important of which is the relative condition of the corn (Stinner et al. 1982). Although corn is preferred over soybeans by ovipositing *H. zea* adults, senescing corn becomes less attractive compared with soybeans (Fitt 1989). If the corn stays green for a longer period, this may allow adjacent soybeans more time to mature and close their canopies, thereby rendering them less susceptible to *H. zea* damage when moths finally shift their oviposition from mature corn. Corn earworm larvae were almost ten times more likely to exceed economic thresholds when soybean canopies were open as opposed to closed (Bradley et al. 1986). If soybeans are in a susceptible early reproductive stage like R2 (full bloom) when oviposition occurs, significant yield losses can result in a relatively short time (McWilliams 1983; Fehr & Caviness 1977; Kogan 1979).

A survey in Virginia, including the southern portion of the Delmarva peninsula, found significant parasitization of *H. zea* in soybeans (Zehnder et al. 1990). Our objective was to survey soybeans grown further north for parasite species attacking *H. zea* larvae in order to determine the rate of parasitism over time, along with other larval mortality factors like diseases. We sought to examine the relationship between moth captures in blacklight traps and larval populations in soybeans.

Materials and Methods

Soybean fields were sampled weekly over a three year period from 1995-1997 during the time when earworm adults typically shift ovipositing from corn to soybeans (Aug-Sep for the lower Eastern Shore of Maryland). Sampling was done with a standard insect sweep net to take 25 sweeps per sample with 10 samples per field. Each sample location was at least 50 paces from the previous one and areas were sampled only once. Care was taken to sample from the top of the soybean canopy down through the rest of the plants. Samplers walked along rows while sweeping alternately in both directions perpendicular to the row. The sizes of the fields ranged from 0.5 to 53 ha. This method is the recommended scouting protocol for soybeans in Delaware, Maryland, and Virginia with economic thresholds of three earworms per 25 sweeps in narrow row soybeans and five earworms in wide-row soybeans (Anonymous 1995a). The contents of the net were checked and earworms and other Lepidoptera were removed with a brush and placed immediately in 30-ml plastic cups containing standard insect diet (Southland Products, Inc., Lake Village, AR), one larva per cup. Larvae were held at 27°C and 15 h photophase until their parasitism status could be determined. The percentage of parasitism was calculated and corrected for larval mortality and the effect caused by the artificial removal of larvae from the potential population of hosts (Marston 1980). Any larvae that died without parasite emergence were dissected to check for immature parasites. Parasite identifications were conducted by the USDA-ARS Systematic Entomology Laboratory in Beltsville, MD. Voucher specimens of parasites were placed in the Maryland Department of Agriculture insect collection.

The number of adult moths captured in blacklight traps in 5-8 locations each year in the region was recorded and compared with larval captures. Blacklight traps were used because the state has operated a network of traps every year since 1973. These traps were placed in locations that were unique to each farm but consistent from year-to-year. Traps were 36.2 cm wide and 129.5 cm tall and used 15 watt blacklight bulbs powered by 115 V, 60 cycle AC current. Depending on the location, traps were suspended or placed on tripods that raised them 46-61 cm above the soil surface. Historic data from these traps allowed us to concentrate our sampling in areas that regularly experience high levels of *H. zea* adult captures. Temperature and precipitation data were collected from a network of weather stations in the region.

Multiple regression of the departures from normal in temperature and precipitation during the months of May through Sep., monthly averages of adult *H. zea* captures, and the Julian day for peak moth capture were used to construct a model with forward selection (SAS Institute 1990) to identify those variables which predicted the total number of larvae found in soybeans during a season. Monthly averages for adult captures were calculated by adding the average number of adults caught per night in a week, including any overlapping weeks between months, and dividing by the number of weeks. The peak moth date was the mid-week Julian day with the highest adult captures during the season. The averaging period to determine normals for temperature and precipitation was from 1961 to 1990 (Anonymous 1995b, 1996, 1997).

Results and Discussion

The number of *H. zea* larvae found in soybeans varied significantly among the sample years (Table 1). The average number of moths caught per month in black light traps had no predictive value for larval numbers in soybeans during the study period. However, there were consistent peaks in adult levels every year in late Aug. and early Sep. (Fig. 1). Our data agree with the findings of Herbert et al. (1991) regarding the influence of peak flights of moths and threats to the soybean acreage, namely, that earlier peaks increase risk. The weekly peak in 1995 was during the period Aug. 14-20, while in 1996 and 1997 both peaks occurred during Sep. 4-10 (Fig. 1). This average moth flight peak date explained 99.7% of the variation in larval captures in soybeans ($df = 1,1$; $F = 404.34$; $P = 0.03$).

The reasons for variability of the peaks in moth flights are unknown but probably are influenced directly by weather, and indirectly by the weather's effects on the corn crop. Direct effects might include prevailing winds and storm fronts

TABLE 1. INCIDENCE OF NON-PARASITISM MORTALITY FACTORS IN *H. zea* LARVAE COLLECTED FROM MARYLAND SOYBEANS, 1995-1997.

Collection dates	No. *H. zea*[1] collected	% *H. zea*[2] eclosed	% Dead from disease		% Unknown mortality
			N. rileyi	Virus	
15-Aug-1995	30	70.0	0.0	0.0	16.7
23-Aug-1995	162	50.0	0.0	0.0	12.3
30-Aug-1995	237	40.1	1.3	0.4	17.3
6-Sep-1995	154	32.5	0.0	0.0	13.6
12-Sep-1995	144	33.0	1.4	0.7	14.6
20-Sep-1995	65	7.7	4.6	0.0	12.3
All Dates 1995	762	32.9	1.0	0.3	15.2
13-Aug-1996	7	28.6	0.0	0.0	57.1
20-Aug-1996	9	33.3	0.0	0.0	33.3
4-Sep-1996	58	25.9	5.2	0.0	50.0
19-Sep-1996	61	1.6	34.4	9.8	31.1
All Dates 1996	135	15.6	17.8	4.4	40.7
27-Aug-1997	1	0.0	0.0	0.0	100.0
4-Sep-1997	4	0.0	0.0	0.0	25.0
9-Sep-1997	56	41.1	10.7	0.0	26.7
16-Sep-1997	73	35.6	9.6	0.0	23.3
25-Sep-1997	36	19.4	11.1	5.5	25.0
All Dates 1997	170	50.0	10.0	1.2	25.3

[1]All Dates row in this column refers to the sum total of *H. zea* larvae found that year.
[2]All Dates row in all remaining columns refers to the variable mean for that year.

which bring in migrants from the south or the temperature, which controls the rate of development of larvae in the corn. In our study, the average departures from normal precipitation and temperature in Aug. explained 99.8% and 95.3%, respectively, of the variation in the date of peak moth flights. Practical experience and other research has previously established a link between the weather, especially precipitation during the summer, and the condition of the corn which determines how long the crop is attractive to gravid females of *H. zea*. Hot, dry conditions likely increase the rate of larval development in corn, leading to an earlier moth peak while, at the same time, shortening the period when the corn remains attractive as an oviposition site. Usually, the aforementioned weather conditions will also retard the development of the soybean crop, slowing canopy closure and delaying maturities to stages more susceptible to damage from larval feeding. These conditions normally trigger alert warnings to growers from local organizations like the Cooperative Extension Service and state departments of agriculture.

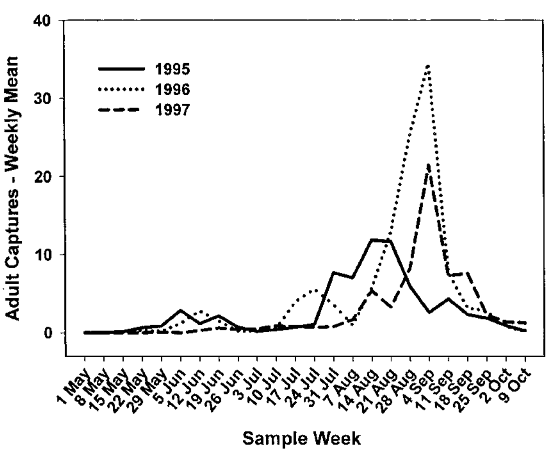

Fig. 1. Mean weekly capture of corn earworm moths from 1995-1997 in five to eight blacklight traps located in a three county area in the lower Eastern Shore region of Maryland.

In contrast, wetter, cooler conditions may act to maintain preferred oviposition sites for *H. zea* in the corn, by slowing development of the crop, thereby allowing the soybean crop to progress past the earlier, more vulnerable reproductive stages. Pressure in soybeans from *H. zea* larvae was highest in 1995 when the lower Eastern Shore areas experienced a severe drought (Fig. 2). In contrast, 1996 and 1997 experienced average to above average precipitation and *H. zea* populations were lower in soybeans (Fig. 2).

Over the period from 1995-1997, *Microplites croceipes* (Cresson) was the most frequently encountered parasite species attacking *H. zea* in soybeans (Fig. 3). Zehnder et al. (1990) and Her-

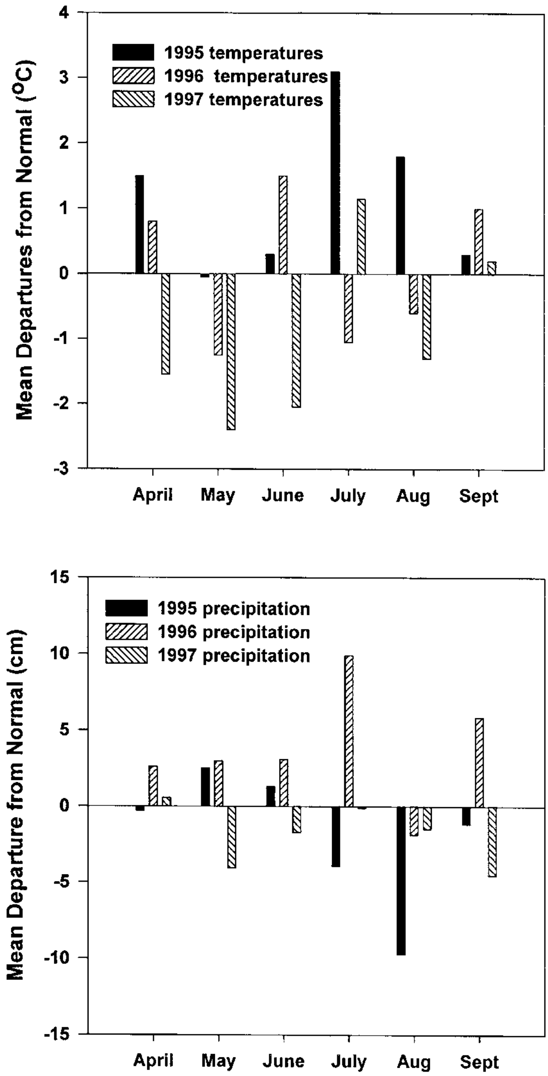

Fig. 2. Departures from mean temperature and precipitation during 1995-1997 from seven stations in the lower Eastern Shore region of Maryland.

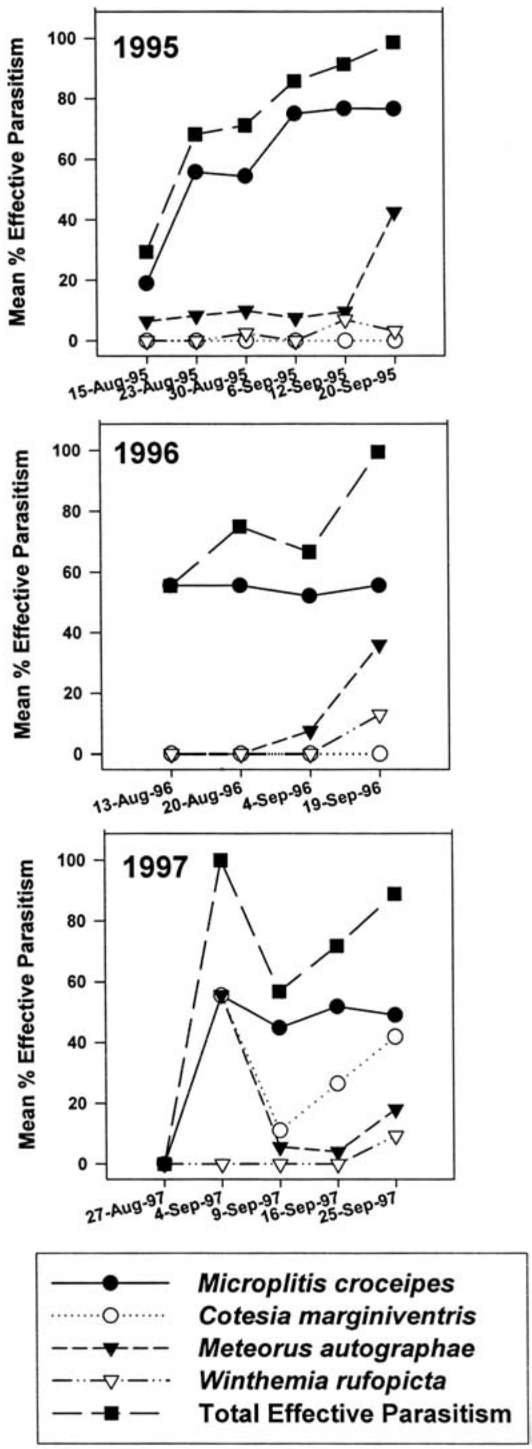

Fig. 3. Mean estimated effective parasitism of *H. zea* larvae collected from Maryland soybean fields from 1995-1997. Estimated effective parasitism (EEP) is calculated by first determining apparent parasitism (AP): AP = no. parasitized *H. zea*/no. parasitized *H. zea* + no. healthy *H. zea* (Marston 1980). EEP = AP + AP(1-AP) (Marston 1980).

bert et al. (1993) found similar results with this parasite. This native species is an important parasite of *H. zea* and other Heliothines (Stadelbacher et al. 1984; Bottrell et al. 1968; King et al. 1985). Other parasite species collected included *Cotesia marginiventris* (Cresson) (Hymenoptera: Braconidae), *Meteorus autographae* Muesbeck (Hymenoptera: Braconidae), and *Winthemia rufopicta* (Bigot) (Diptera: Tachinidae). In 1996, one *H. zea* larva was parasitized by *Glyptapanteles militaris* (Walsh) (Hymenoptera: Braconidae).

The weekly increase in parasitism was consistent across years with an average increase of 13.9%, 14.7%, and 22.2% each week during 1995, 1996, and 1997, respectively (Fig. 3). Only in 1995 were economic thresholds exceeded at some sites and growers prepared to apply insecticides. However, most of the cooperating farmers held off treating soybeans that year because the drought had degraded the value of their stands. These dry conditions resulted in few cases of disease among the collected larvae (Table 1). In contrast, the incidence of larvae with symptoms typical of infection by *Nomuraea rileye* (Farlow) and a virus increased in the next two years, which experienced wetter and cooler conditions than normal (Table 1).

Overall, this study demonstrated the utility of considering the departures from normal for precipitation, and perhaps temperature in Aug., in predicting risk to the soybean crop on the Delmarva peninsula from attack by *H. zea*. We do not suggest that this method take the place of cumulative experience or information from other sources, including sampling corn, nor does it provide an alternative for scouting soybeans and making control decisions. Rather, it supports existing conventional wisdom for managing this pest. However, further examination of the relationship between peak moth flights and weather conditions may provide growers with a quick and inexpensive method for predicting risk to their soybean crop and targeting their scouting efforts. Departure from normal data are readily available and can be quickly utilized to support decisions on the deployment of scouts.

This study also identified parasite species and quantified parasitism over the crucial period when soybeans are most vulnerable to *H. zea* attack. Although the ability of parasites to suppress *H. zea* populations in soybeans was not assessed, it is clear that a significant portion of the pest populations are consistently and heavily attacked by a suite of parasites, most notably *M. croceipes*. This species has been shown to be unaffected by differences in soybean cultivars such as leaf pubescence (Tillman & Lambert 1995). It also will search non-crop plants for hosts, such as *Geranium dissectum* L., a species with several close relatives that are common on the Delmarva peninsula (Kaas et al. 1993; Tatnall 1946). Hopper and King (1986) found that this parasite exhibited a linear functional response to host densities, a characteristic which should make it an important factor in suppressing *H. zea* populations, especially given the wide range of larval densities present in soybeans during this study. Judging by the rapid and regular disappearance of *H. zea* larvae from fields, parasites like *M. croceipes* may play a significant role in the population dynamics of this pest in Maryland soybeans.

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