SEASONAL CAPTURES OF BOLLWORM AND TOBACCO BUDWORM (LEPIDOPTERA: NOCTUIDAE) MALES IN PHEROMONE-BAITED TRAPS IN LOUISIANA

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ABSTRACT

Pheromone traps baited with synthetic sex lures of the bollworm, *Heliothis zea* (Boddie), and the tobacco budworm, *Heliothis virescens* (F.), were monitored over an eight-year period (1980-1987) in Louisiana. The total number of *Heliothis* spp. males captured in traps was observed to be highest during August and September. Seasonal totals indicated that the number of bollworms exceeded the number of tobacco budworms collected during each year of the study. Pheromone trap captures of tobacco budworms demonstrated a bimodal pattern of occurrence with peaks during June and September. The number of tobacco budworm males collected for August and September represented a greater percentage of the total *Heliothis* spp. population than was observed earlier in the season. These data also indicate that the seasonal abundance of the tobacco budworm has increased during the period 1984-1987 which emphasizes the importance of early harvest in cotton production by decreasing the damage potential of both *Heliothis* spp. during September.

Key Words: *Heliothis virescens*, *Heliothis zea*, Pheromone, Cotton, Louisiana.

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INTRODUCTION

The bollworm, *Heliothis (Helicoverpa) zea* (Boddie), and the tobacco budworm, *Heliothis (Heliothis) virescens* (F.), commonly infest cotton, *Gossypium hirsutum* L., at similar times and are often referred to as the bollworm-tobacco budworm complex. However, due to the innate ability of the tobacco budworm to quickly develop resistance to available insecticides (Sparks 1981), there is a need to distinguish between these pests when considering insecticidal control. Since the number of generations and relative abundance of each species can be quite variable (Lincoln et al. 1967; Bacheler 1985), and strongly contribute to pesticide use strategies, there is often a need to determine which species is present in the

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greatest numbers. A number of environmental (weather, moonlight intensity and phase, pesticide use) and biological (moth activity, host suitability and availability, predator and parasite density) factors are capable of influencing the population dynamics of these two species, thus making such studies difficult at best (Hartstack et al. 1973; Hartstack et al. 1979b; Pfrimmer et al. 1981).

Many of the earlier studies concerning seasonal occurrence and relative abundance of tobacco budworms and bollworms during the crop-producing season were conducted by collecting large samples of larvae from available hosts (Brazzel et al. 1953; Graves et al. 1965; Lincoln et al. 1967; Graves and Clower 1975; Clower 1980; Pfrimmer et al. 1981), which is a labor intensive and time consuming process. Studies based on adult sampling, prior to the identification of the pheromone components for *H. zea* and *H. virescens*, relied mainly on light traps (Merkl and Pfrimmer 1955; Hartstack et al. 1973; Lopez et al. 1979) or traps baited with virgin females (Stadelbacher et al. 1972; Hendricks et al. 1973). With the discovery and chemical synthesis of the female sex pheromone of the bollworm and the tobacco budworm (Roelofs et al. 1974; Tumlinson et al. 1975; Klun et al. 1980a, 1980b) and concurrent development of a relatively inexpensive and transportable trap (Hartstack et al. 1979a), researchers have been able to conduct studies over much larger areas while increasing the efficiency of the sampling technique (Hartstack et al. 1979b; Goodenough et al. 1987).

During the last 30 years, at least one distinct change in seasonal abundance of *Heliothis* spp. on cotton has occurred. Prior to the early 1970's, larval collections of *Heliothis* spp. from cotton primarily consisted of bollworms (Brazzel et al. 1953; Graves et al. 1965; Lincoln et al. 1967; Lincoln 1972). However, in the early 1970's, the tobacco budworm became the most abundant species on cotton, particularly late in the season (Clower 1980; Pfrimmer et al. 1981). Dynamic changes have occurred in cropping patterns, insecticide use patterns and pest management strategies during 1980-1987 that may have influenced the seasonal abundance of *Heliothis* spp. attacking cotton. The purpose of the present study was to examine the seasonal occurrence and relative abundance of the tobacco budworm and bollworm in Louisiana based on captures of males using synthetic pheromone baited traps.

MATERIALS AND METHODS

Trap Design and Placement

During 1980 and 1981, the Pherocon 1C sticky trap (Zoecon Corporation, Palo Alto, CA 94303) was used at three locations (Tensas, Bossier, and Franklin Parishes, Louisiana) for monitoring *Heliothis* spp. Beginning in 1982, in conjunction with the USDA-ARS multi-state trapping network (Goodenough et al. 1987), wire cone traps (TP 75-50) constructed according to the specifications of Hartstack et al. (1979a) were used for capturing adults. Both trap assemblies were mounted such that the bottom of the traps were set approximately 1-1.5 m above the soil surface. Separate traps for each species were placed at least 60 m apart at each trap site to reduce the interaction of active spaces. Each trap site was chosen based on trap accessibility and available hosts (especially cotton). Although the acreage of suitable hosts varied among trap sites, a cotton and soybean, *Glycine max* (L. Merr.) agroecosystem intermixed with grain sorghum, *Sorghum bicolor* L., and corn, *Zea mays* (L.), was most common at all locations. From 1984-1987, trap sites were included in Calcasieu, Iberville, Rapides, Avoyelles, Caddo, Natchitoches, East Baton Rouge, Morehouse and Ouachita Parishes in addition to those sites monitored in 1980-1981. However, numbers of traps monitored in specific years were based on potential cooperators and available supplies.

Synthetic Pheromone Lures

Traps were baited with the specific lure for each insect (Tumlinson et al. 1975; Hartstack et al. 1980; Klun et al. 1980a, 1980b). Bollworm and tobacco budworm sex pheromone bait formulations were obtained from Hercon Division, Herculite Products, Inc. (New York, NY). The bollworm lure (zealure) consisted of 1.25 mg A. I. of (Z)-11-hexadecenal, (Z)-9-hexadecenal, (Z)-7-hexadecenal and (n)-hexadecanal in a 2:3:87:8 ratio and was formulated in a strip of laminated plastic (22 × 13 cm). Until 1985, the lure for the tobacco budworm (virelure) was obtained from the same commercial source as zealure and consisted of 20 mg A. I. of (Z)-11-hexadecenal and (Z)-9-tetradecenal in a 94:6 ratio, respectively. In the spring of 1985 and thereafter, the tobacco budworm lure, consisting of the same components, was formulated in liquid polyvinyl chloride, allowed to dry and cut into thin blocks (Hendricks et al. 1987). Lures for each species were wrapped separately in aluminum foil, sealed in a plastic bag and stored in a freezer until needed. The lures were placed in the center of the trap at the bottom of the large cone and attached to the cross brace by a 10.16-cm piece of wire (0.12 cm diameter). Each trap was baited twice monthly, since no reduction in bait efficiency occurs in this time period (Hendricks et al. 1977).

Trap Monitoring

Traps were serviced at least once per week and in some cases daily. This schedule provided adequate data to track population changes and reduced the chances of misidentification due to insect decomposition from weather exposure. Numbers of males for each species per site was recorded to provide monthly totals. These data were sorted by year and mean monthly values for each species were derived per trap.

RESULTS AND DISCUSSION

Mean numbers of *Heliothis* spp. males captured in pheromone traps baited with the synthetic sex lures per month and per season are presented for 1980-1987 (Table 1). The wire cone traps effectively captured large numbers of tobacco budworm and bollworm males during the study. The bollworm was the dominant species collected during all months except May, 1982; September, 1980 and 1986 and June and September, 1987. The wire cone traps used from 1982-1987 captured 9 to 86-fold more males than the Pherocon 1C cardboard sticky traps used in 1980-1981. Numbers of *Heliothis* spp. captured per trap ranged from a mean of 2 males in May 1980 to a high of 3,967 in September, 1986. The largest seasonal *Heliothis* spp. captures per year occurred during 1984 (14,873) and 1986 (11,412). The tobacco budworm represented only 5% of the total *Heliothis* captured in 1984 but increased to 36% and 47% in 1986 and 1987, respectively. Also, the mean seasonal numbers of *Heliothis* males captured in 1984, 1985 and 1986 (14,873, 9,234 and 11,412, respectively) were about 1.6 to 3-fold greater than those recorded in previous years (1982-1983), when the same traps were used. However, in 1987 only

Table 1. Mean number of male *Heliothis* spp. adults captured in synthetic pheromone traps and percent tobacco budworm.

Year	No. Traps Per species*	April	May	June	July	August	September	Season
1980	6	—	2†(50)‡	54 (7)	26 (34)	25 (26)	66 (51)	173 (31)
1981	4	—	17 (28)	82 (41)	34 (14)	120 (30)	148 (36)	401 (33)
1982	12	579 (10)	192 (56)	1326 (41)	1484 (12)	1485 (15)	—	5066 (21)
1983	19	149 (2)	558 (15)	252 (22)	917 (15)	1221 (25)	2720 (27)	5817 (23)
1984	23	460 (2)	725 (8)	2584 (10)	3902 (4)	3753 (5)	3449 (4)	14873 (5)
1985	25	182 (6)	500 (10)	668 (31)	2636 (9)	3057 (14)	2191 (31)	9234 (17)
1986	17	248 (11)	191 (27)	701 (23)	2445 (15)	3860 (36)	3967 (54)	11412 (36)
1987§	27	112 (8)	215 (29)	763 (67)	653 (37)	1353 (45)	663 (55)	3759 (47)

* Hercon pherocon traps were used during 1980 and 1981; TP 75-50 cone traps were used during other years.

† Mean number of *Heliothis* spp. moths per month per trap site; 1 trap per species per site.

‡ Percent tobacco budworm from total *Heliothis* spp. captured.

§ Data were recorded only through September 15 during 1987.

3,759 adults were captured, the fewest since the TP 75-50 trap was used. These data suggest that the increased incidence of insecticide (pyrethroid) control failures during 1985 and 1986 (Plapp and Campanhola 1986; Luttrell and Roush 1987; Leonard et al. 1987) may be at least partially explained by a higher density of *Heliothis* spp. present in the field.

Based on mean monthly captures of each species over the eight-year study, tobacco budworm populations most often peaked in June and again in September (Table 1, Fig. 1). Historically, the majority of *Heliothis* spp. from larval collections on cotton during June have also been identified as tobacco budworms (Table 2). Also, Bacheler (1985) indicated that the tobacco budworm was observed as the predominant species during the first generation on cotton for Louisiana and Mississippi. Pheromone trap captures of *Heliothis* spp. during our study generally indicated that greater numbers of tobacco budworm males were collected during June than in July. Although the number of bollworms captured in traps consistently exceeded the numbers of tobacco budworms collected, the data in this study follow similar trends for population peaks when compared with the historic data of *Heliothis* spp. larval collections (Table 2). This trend is not surprising considering the close proximity of the trap sites to cotton fields and the limited host range of the tobacco budworm during this time of year. We do not expect that these traps would have collected similar numbers of tobacco budworms had the traps sites been selected at random. Although cotton was not the only host present, it did represent the largest acreage in the vicinity of the trap sites.

Generally, the absolute number of tobacco budworms captured in traps increased gradually during the course of the season. Graves and Clower (1975) and Pfrimmer et al. (1981) using egg and larval collections also observed an increase in the number of tobacco budworms; but not bollworms on cotton during August and September. Since 1968, other researchers (Table 2) have indicated similar results. Bacheler (1985) also indicated that heavier populations of tobacco budworm occurred later in the season in the mid-South. Since at least two and sometimes three generations of *Heliothis* would have been exposed to insecticide applications on cotton (Bacheler 1985), the increase in the density of tobacco budworm is not surprising, considering the tobacco budworm's greater tolerance to most insecticides (Sparks 1981).

During July, the number of bollworms captured greatly exceeded the number of tobacco budworms collected (Fig. 1). The historic data summarized in Table 2, based on larval collections from cotton are not consistent with these results. However, since the adult traps are not host specific to cotton, the influence of alternate hosts is capable of greatly affecting trap catch of both species (Hartstack et al. 1979b). Bollworm male captures increased sharply to 2 to 3-fold higher during July, August and September than observed for any previous month's capture. The increase of bollworm males during this time may indicate movement from outside Louisiana by long-range migration and/or the influence of host plants other than cotton during May and June. Evidence for long-range migration by *Heliothis* spp. has been reported (Sparks 1972; Hendrix et al. 1985; Goodenough et al. 1987), but the movement of large populations into an area and the immediate potential effects on a host are not well defined at this time. In Louisiana, corn and grain sorghum are grown in appreciable acreages (Fielder et al. 1986) and would provide early season hosts during May and June and allow bollworm populations to increase without the widespread influence of insecticidal control. Therefore,

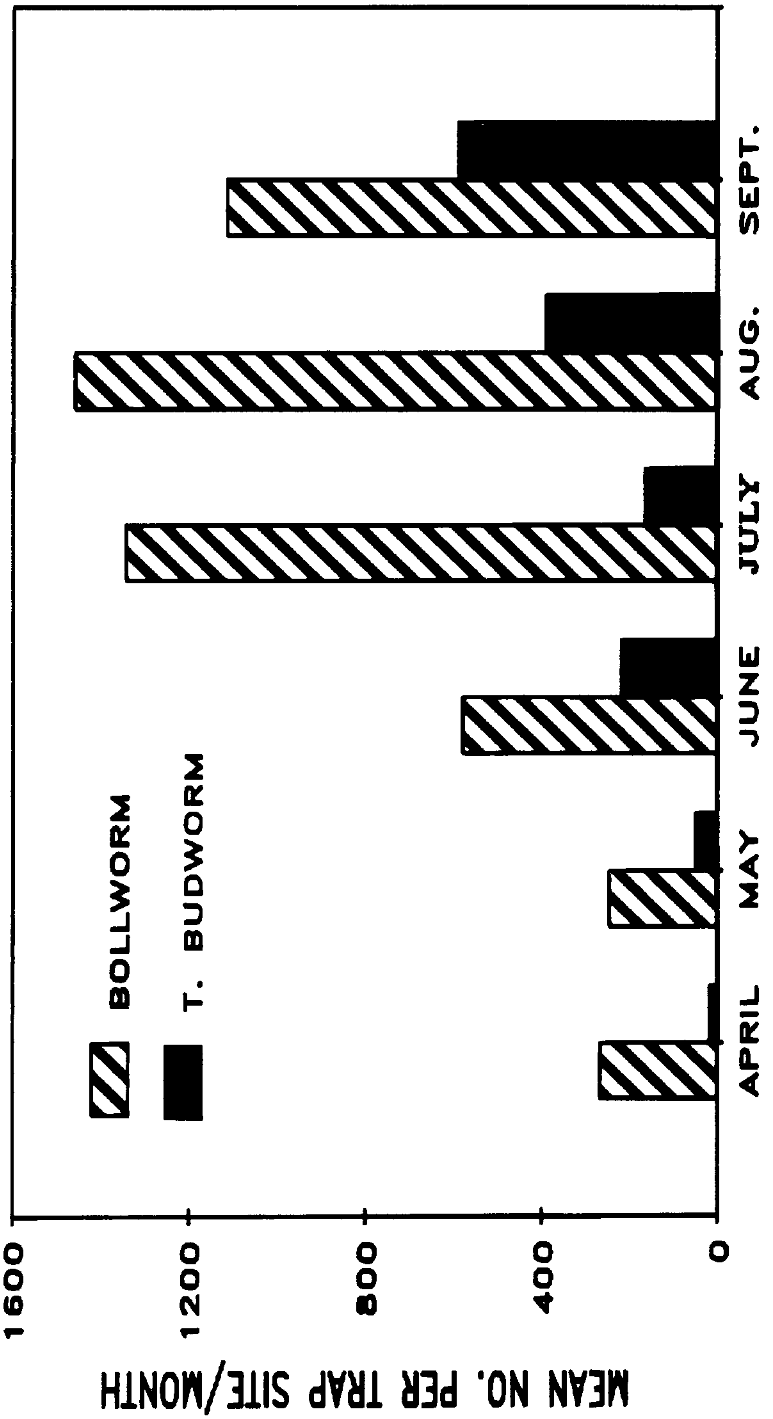

Fig. 1. Mean number of bollworm and tobacco budworm males captured per month in pheromone-baited traps in Louisiana, 1980-1987.

Table 2. Seasonal occurrence of *Heliothis* spp. based on larval collections from cotton.

Year(s)	Location	Percent Larvae Identified as Tobacco Budworm					Sample*	Reference
		June	July	August	September	Season	Size	
1949	Arkansas	—	—	10	0	—	59	Brazzel et al. 1953
1949	Louisiana	—	—	—	20	—	296	Brazzel et al. 1953
1952	Arkansas	47	47	15	15	31.0	414	Brazzel et al. 1953
1952	Louisiana	91	91	5	5	48.0	1992	Brazzel et al. 1953
1962	Georgia	65	65	11	—	46.8	4694	Snow 1964
1963	Texas	76	29	71	—	58.6	16860	Henry and Adkisson 1965
1963 - 64	Louisiana	—	9	2	6	5.6	4274	Graves et al. 1965
1963 - 64	Arkansas	21	4	6	6	9.1	5484	Lincoln et al. 1967
1963 - 68	Mississippi	49	17	20	12	24.3	1716	Pfrimmer et al. 1981
1968 - 69	Arkansas	—	—	—	35	—	—†	Lincoln 1972
1969 - 74	Mississippi	37	52	62	89	59.9	3802	Pfrimmer et al. 1981
1972 - 75	Louisiana	—	25	51	85	53.6	—†	Graves and Clower 1975
1975 - 78	Mississippi	71	58	89	95	78.5	5810	Pfrimmer et al. 1981
1976 - 78	Louisiana	—	—	>50	>50	—	—†	Clower 1980
1979	Mississippi	64	13	29	43	37.3	1963	Pfrimmer et al. 1981
1980 - 85	Mississippi	74	28	53	66	55.0	9594	Pfrimmer 1986

* Total number of larvae collected during the study.
† Number of larvae not available.

untreated alternate hosts susceptible to bollworm infestations would provide at least one source of refugia for a population increase capable of influencing male bollworm captures adjacent to cotton in July.

Generally, the peak month of bollworm capture was August followed by a slight decline during September (Fig. 1). Several factors may have contributed to this decrease in bollworm capture during September, but the most important reason is the increased competition by virgin females with the pheromone baited traps. Several studies (Hendricks et al. 1973; Hartstack et al. 1979b; Hartstack and Witz 1981) have reported reductions in trapping efficiency during periods when adults are present in high density. Since adult densities are greater at this time of the year (Hendricks et al. 1973; Hartstack and Witz 1981), such an influence is highly probable. Also, much of the cotton acreage in close proximity to the trap sites had started to senesce by this time (September), and cotton plants had apparently become unattractive to the females for oviposition. Therefore, bollworm moths may have begun to move from cotton in search of more attractive hosts. Since the host range of the bollworm is somewhat larger than the tobacco budworm, differences in host preference and timing of host susceptibility may affect trap catch during this time.

Pheromone traps are capable of capturing large numbers of *Heliothis* spp. males and estimating the relative abundance during the season. Data collected over long periods of time may help lead to the discovery of other factors responsible for *Heliothis* spp. population dynamics. The data collected during this study indicate that the tobacco budworm continues to occur in greater numbers during the latter part of the cotton-producing season (August and September). Also, the seasonal relative abundance of the tobacco budworm appears to have increased since 1984. Therefore, the recent emphasis in cotton production on early harvest may not only enhance the opportunity to harvest with less adverse weather but may also aid in managing the tobacco budworm and bollworm.

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