BOLLWORM AND BUDWORM MOTH ACTIVITY IN THE TEXAS ROLLING PLAINS

E. P. Boring, M. N. Parajulee and J. E. Slosser
Texas Agricultural Extension Service
Texas Agricultural Experiment Station
Vernon, TX

Abstract

Cotton bollworm and tobacco budworm male moth traps were monitored weekly for 15 years to investigate seasonal flight activity patterns. Bollworm male moth traps were monitored daily for 11 years to quantify the effect of lunar cycles on moth generation cycles. Seasonal trends for both species were similar, although bollworm moth numbers captured per trap week were about 13 times larger than those for budworm moths. Mean seasonal abundance curves for both species, with upper confidence limits, were constructed so years of unusual moth severity could be determined. Daily trap data showed that the moon phase influenced the capture of bollworm moths as indicated by a significant positive correlation between trap catch and percentage moon illumination. Maximum bollworm trap catch occurred 71% of the time during the full moon followed by 1st quarter (11%), last quarter (9%) and new moon (9%). When traps were serviced weekly, the relationship between trap catch and lunar cycles was not apparent.

Introduction and Objectives

Cotton is the primary warm season crop produced in the Texas Rolling Plains and it is the most abundant host of bollworms and budworms. Of the 450,000 cotton acres, 91% is rain-fed or dryland production and 9% is irrigated. Other major bollworm host crops include grain sorghum, peanuts, alfalfa and corn with about 60,000, 38,000, 25,000 and 1,000 acres planted respectively. Most of the peanut and alfalfa acreage is irrigated.

Damage caused by bollworm and budworm larvae are second to the boll weevil in causing the most damaging to cotton. Populations of these pests vary greatly from year to year. Although irrigated cotton is more heavily infested, especially in drier years, damaging populations occur in some dryland fields each year. As the cotton plant begins to square it becomes more attractive to bollworms and budworms and as it begins to bloom it becomes even more attractive. Cotton is most likely to be damaged by bollworms from the initiation of blooming until cut-out or from early July through mid-September. Tobacco budworm damage is most likely from mid-August through mid-September. Once square numbers drop below 65,000 per acre the likelihood of damaging bollworm and budworm population is greatly reduced.

Pheromone traps have been used to monitor the activity of male bollworm and tobacco budworm moths in determining seasonal dynamics, migration, spatial distribution and field population estimations. Our objectives were to investigate the long-term seasonal bollworm and budworm moth flight activity patterns and to quantify the effect of moon phase on cotton bollworm moth flight activity in the Texas Rolling Plains.

Materials and Methods

A 15-yr weekly survey (April through October) was conducted to monitor bollworm and tobacco budworm moth populations in Hardeman and Knox counties. An 11-yr daily survey (mid-April through late September) during the years 1983-88,1991-1992, and 1994-1996 was conducted in Haskell, Knox and Wilbarger counties. A 6-yr survey (January through December, 1991-1996) was conducted to delineate the beginning and end of both bollworm and budworm moth activity, and single tobacco budworm and bollworm pheromone traps in Wilbarger County were monitored daily from June 8 to September 2, 1988 and from April 1 to October 1,1998.

The Texas pheromone trap, cone-50-25 (Hartstack et al. 1979) was used to monitor both species. The trap was mounted on a metal rod with the bottom of the cone 3.2 feet above the soil surface. Daily traps were inspected each morning except on weekends and holidays for which the counts on the next working day were distributed equally among the missing days. Weekly traps were inspected approximately in the middle of each calendar week.

Data Analyses

Seasonal Activity Patterns. Average weekly abundances were used to construct seasonal abundance curves for each of the 15 years to examine variations among years. Using a 15yr average, a mean abundance curve was constructed with 95% upper confidence limits for both species.

Effect of Moon Phase on Seasonal Patterns. Daily survey data were compared with the weekly survey data to quantify the influence of sampling frequency between moon phase and moth activity patterns. The relationship between moon phase and trap catch was established with linear correlation for both daily and weekly data. Nightly percentage moon illumination was calculated for each of the 15 years, and the percentage illumination was converted into 1 of the 4 phases of the moon within a lunar calendar, with each phase consisting of 7 or 8 days. The new moon phase comprised about 16% moon illumination, followed by 1st quarter (16-86%), full moon (about 86%), and last quarter (16-86%). Also, the percentage of trap catches during each moon phase within a lunar calendar were compared using an

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1172-1175 (1999)
National Cotton Council, Memphis TN

ANOVA; the percentage of occurrences of the peak trap catch during each moon phase were also compared.

Results and Discussion

Seasonal Activity Patterns

Bollworm seasonal abundance curves showed that moth activity was low during April/May; increased through September, and then numbers declined to less than 2 moths/trap/wk by the end of October (Fig. 1). Average seasonal (29-wk survey per season) trap catches ranged from 113 moths/trap/wk in 1992 to 427 moths/trap/wk in 1984, with the 15-yr average of 231 (±43 SE) moths/trap/wk. Average weekly trap catch in any single week was recorded as high as 1,804 moths/trap on July 21, 1984. The mean population abundance curve, with 95% upper confidence limit (UCL) based on 15-yr averages, showed 2 population abundance peaks, with the first peak during mid-July to mid-August and the second peak during late September.

Tobacco budworm moths also exhibited a seasonal trend in abundance pattern similar to that of bollworms, except that the tobacco budworm abundance remained low through early August in most years (Fig. 2). However, the tobacco budworm abundances in 1982 and 1996 were higher than the 15-yr average throughout the cotton growing season. Average seasonal (29-wk survey per season) trap catches of tobacco budworm moths ranged from 7 moths/trap/wk in 1995 to 80 moths/trap/wk in 1982, with the 15-yr average of 18 (±5 SE) moths/trap/wk. The highest average catch for a single week was 267 budworm moths per trap on September 1, 1982. Mean population abundance curve of budworm moths showed a single peak during early September.

Because climatic factors and availability of suitable host plants affect the seasonal dynamics of bollworm/budworm complex (Slosser et al. 1987, Fitt 1989, Parajulee et al. 1998), seasonal abundance patterns (Figs. 1 and 2) showed a considerable year-to-year variation in terms of numbers and seasonal peaks for each species. The mean abundance curve constructed for each species based on a long-term survey enables us to identify years with high moth severity. For example, overlay graphs of 1984 bollworm moth abundance and 1982 tobacco budworm moth abundance with their respective mean abundance curves (Fig. 3 and 4) clearly indicate that those years were severe years with respect to moth abundance of each species.

The mean abundance curve is also useful in determining the within season abundance pattern with respect to the long-term seasonal pattern. For example, a significantly higher early spring (e.g., April) moth abundance above UCL would be suggestive of moth immigration to the region, as indicated by a sharp rise in bollworm abundance.

A 6-yr survey of the moth populations throughout the year showed that activity of bollworm and tobacco budworm moths in the field began in early April and early May, respectively, while the moth activity of both species ceased by early November (Fig. 5). Hence, our long term survey of moth populations from early April to late October (Figs. 1 and 2) should have contained the entire population in any given year.

Although weekly trap catch data do not replace field sampling for larval abundance in making management decisions, trap information can serve as a warning of possible larval infestations and aid in determining when to intensify field sampling. Determining the time of potential larval infestations in the field through adult monitoring reduces considerably the amount of effort required in continuous sampling of fields.

Effect of Moon Phase on Seasonal Patterns

Average number of bollworm moths trapped per day showed that patterns of moth catch were synchronized with lunar cycles, with peak trap catches occurring during full moon, in all years, except in 1984 and 1996. The 1984 and 1996 seasons were the 2 driest during our 15 yr study. Also, those 2 years were the most severe bollworm years during the past 15 yr in Knox county, with the largest sustained bollworm larval population in 1984 (Robinson et al. 1986) and the highest bollworm larval abundance in 1996. Severe drought in the area might have caused a greater moth influx from non-irrigated cotton (Fitt 1989) and other hosts to our study sites which contained irrigated cotton. Weather severity (hot and dry season) might have caused the asynchrony between moth generation cycles and the lunar cycles during those years.

Correlation analysis of moth counts and moon phase and the comparison of proportions of moths caught during different phases of the lunar cycle also suggested a significant relationship between the generation cycles of the moths and the lunar cycles, but the sampling frequency affected the perceived relationship. Correlation analyses showed a positive significant relationship between daily moth counts and percentage moon illumination (or moon phase) (r = 0.30, n = 936, P < 0.01), but there was no significant correlation between weekly moth counts and moon phase (r = 0.04, n = 330, P > 0.40). Analysis of variance of daily moth counts showed that moth abundance varied with calendar month, moon phase, and their interaction (month: df = 5, 1,348; F = 17.9; P < 0.001, phase: df = 3, 1,348; F = 17.0; P < 0.001, month x phase: df = 15, 1,348; F = 1.9; P = 0.02), whereas ANOVA of weekly moth counts showed no significant effect of moon phase or month x moon phase interaction (month: df = 4, 310; F = 27.7; P < 0.001, phase: df = 3, 310; F = 0.3; P = 0.85, month x phase: df = 12, 310; F = 0.6; P = 0.84). While moth abundance from daily survey during full moon was significantly higher than in other phases, the abundances during other phases were not significantly different from each other (Fig. 6). Similarly, the proportion of peaks occurring during full moon (71%) was significantly higher than that occurring during new moon (9%), first quarter (12%), and last quarter (9%) on daily count data, whereas the distribution of peaks of the weekly data was 26, 28, 30, and 15% on full moon, new moon, first quarter, and last quarter, respectively.

Daily bollworm moth activity from 1983 illustrates the relationship between moth activity peaks and lunar cycles (Fig. 7). Daily 1988 tobacco budworm moth activity indicates that for the budworm that a similar moth activity and lunar cycle relationship exists (Fig. 8).

Results of this study clearly showed that moon phase influenced the capture of bollworm males in pheromone traps, with the mean catch per day at full moon being significantly higher than at other phases. However, when the samples were taken weekly, this relationship was not apparent, indicating the importance of sampling frequency in discriminating the effect of moon phase on trap catch. Hoffmann et al. (1991) reported no relationship between moon phase and bollworm moth trap catch in California when the traps were monitored weekly, but they noted that if traps had been checked more frequently, the influence of moon phase on trap catch might have been more apparent.

The relationship between moth flight activity cycle and lunar cycle can be used in forecasting potential oviposition and larval activity during the cotton growing season. The expected time of peak moth activity (full moon ± 3 days) coupled with seasonal abundance trends provides information on timing and severity of infestations so that enhanced sampling can be planned accordingly. The relationship between daily trap catches and moon phase can also be coupled with crop stage and management to more efficiently manage bollworm infestations. Crop irrigation applied within 10 days of bollworm egg-laying enhances the attractiveness of plants to the moths and increases the amount of tender growth available for neonate larvae (Slosser 1980). Thus, the avoidance of irrigation during the waxing phase of lunar cycle would reduce the plant attractiveness to moths during predicted peak moth abundance (full moon ± 3 days); lowering the environmental support of egg-laying, egg hatch, and larval development of bollworms.

Acknowledgments

We thank Gary Puterka (USDA ARS, Kearneysville, WV), Rex Price, Bobby Idol, Matt Angerer (Texas Agricultural Experiment Station, Vernon, TX), and Billy Whitaker (Texas Agricultural Extension Service, Vernon, TX) for their assistance in monitoring traps.

References Cited

Fitt, G. P. 1989. The ecology of *Heliothis* species in relation to agroecosystems. Annu. Rev. Entomol. 34: 17-52.

Hartstack, A. W., Jr., J. A. Witz, and D. R. Buck. 1979. Moth traps for the tobacco budworm. J. Econ. Entomol. 72: 519-522.

Hoffmann, M. P., L. T. Wilson, and F. G. Zalom. 1991. Area-wide pheromone trapping of *Helicoverpa zea* and *Heliothis phloxiphaga* (Lepidoptera: Noctuidae) in the Sacramento and San Joaquin valleys of California. J. Econ. Entomol. 84: 902-911.

Parjulee, N. M., J. E. Slosser, E. P. Boring. 1998. Seasonal activity of *Helicoverpa zea* and Heliothis virescens (Lepidoptera: Noctuidae) detected by pheromone traps in the Rolling Plains of Texas. Environ. Entomol. 27: 1203-1219.

Robinson, J.R.C., J. E. Slosser, J. K. Walker, and J. R. Price. 1986. CDA/ULV-oil technology versus conventional spray technology for ground application of sprays for bollworm control in the Texas Rolling Plains. Southwest. Entomol. suppl. 11: 25-37.

Slosser, J. E. 1980. Irrigation timing for bollworm management in cotton. J. Econ. Entomol. 73: 346-349.

Slosser, J. E., J. A. Witz, G. J. Puterka, J. R. Price, and A. W. Hartstack. 1987. Seasonal changes in bollworm (Lepidoptera: Noctuidae) moth catches in pheromone traps in a large area. Environ. Entomol. 16: 1296-1301.

Texas Agricultural Statistics Service. 1996. Texas Agricultural Statistics. USDA, Nat. Agri. Stat. Ser., Austin, TX.

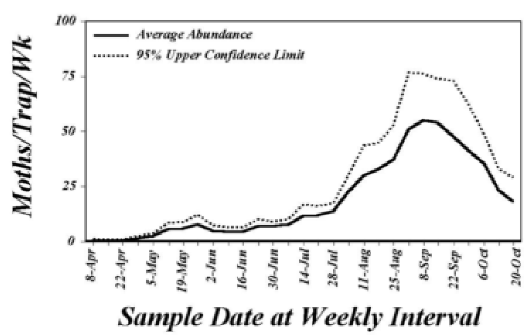

Figure 1. Average bollworm male moth activity and 95% upper confidence limit based on weekly trapping in Hardeman county 1982-1996.

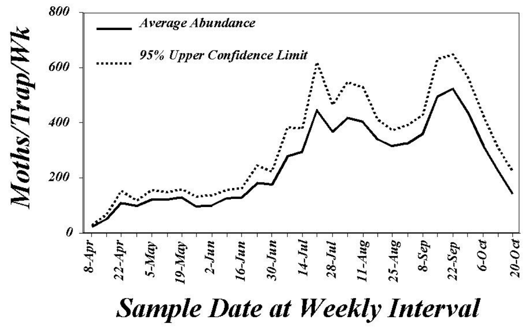

Figure 2. Average tobacco budworm male moth activity and 95% upper confidence limit based on weekly trapping in Hardeman and Haskell counties 1981-1996.

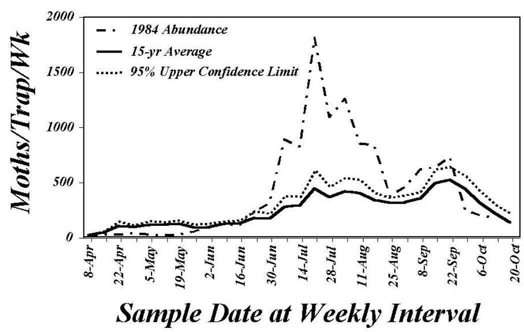

Figure 3. Bollworm male moths trapped in 1984, year of highest abundance, compared to average abundance and 95% upper confidence limit.

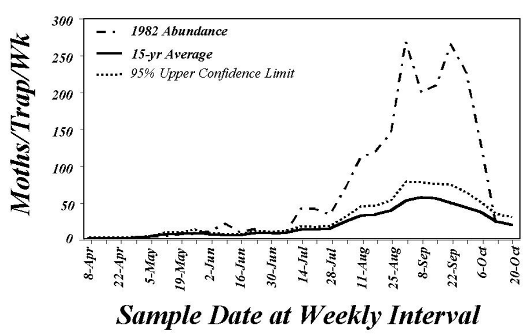

Figure 4. Tobacco budworm male moths trapped in 1984, year of highest abundance, compared to average abundance and 95% upper confidence limit.

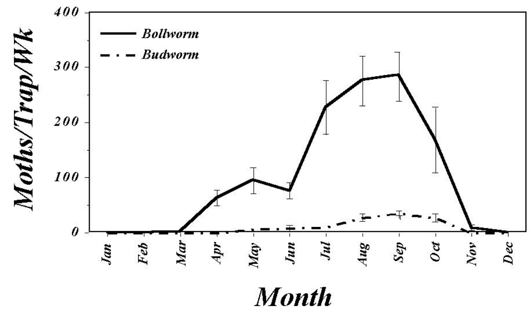

Figure 5. Monthly average number of bollworm and tobacco budworm male moths captured per trap week in pheromone-baited traps in Knox County TX, 1991-1996.

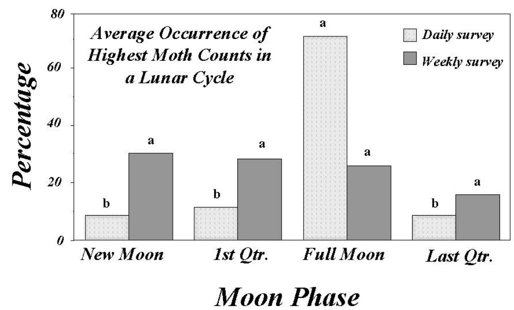

Figure 6. Percentage of bollworm moths captured during each moon phase as affected by trapping frequency. Values within weekly survey or daily survey followed by the same lowercase letter are not significantly different (P>0.05).

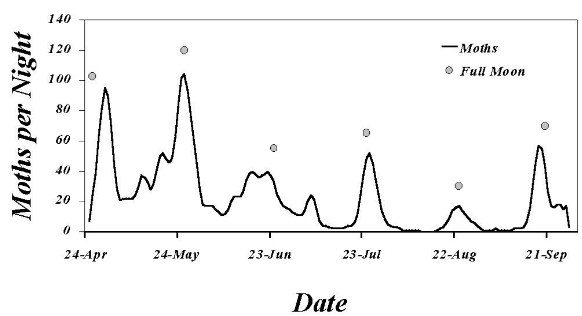

Figure 7. Average number of bollworm male moths captured daily in Haskell, Knox and Wilbarger counties, 1983.

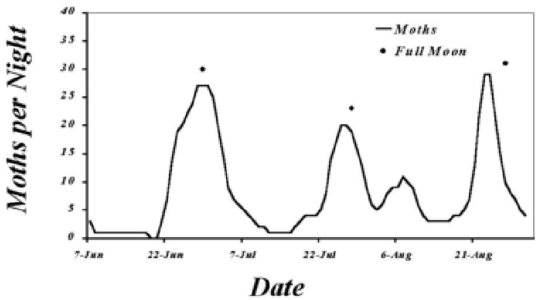

Figure 8. Number of tobacco budworm male moths captured in Wilbarger County, 1988.