Fall Armyworm Symposium


MONITORING ADULT POPULATIONS OF THE FALL ARMYWORM

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ABSTRACT

Blacklight traps and pheromone-baited cylindrical electric grid traps were used to monitor seasonal populations of the fall armyworm, Spodoptera frugiperda (J. E. Smith), in Louisiana and Florida, respectively. Disposable sticky traps baited with pheromone, (Z)-9-dodecen-1-ol acetate, also have been used extensively in surveys for the adult fall armyworm (FAW) in Georgia and Florida. These traps are relatively inexpensive, easy to transport and assemble, and they can be deployed in situations where electric power is unavailable. Sticky traps are generally most effective in capturing FAW males when positioned ca. 1 m above the ground in and around preferred hosts such as corn, peanuts, and improved, highly fertilized grasses such as coastal bermuda.

The number of adult fall armyworms, Spodoptera frugiperda (J. E. Smith), in any area is influenced by many factors including time of year, distribution and abundance of wild and cultivated hosts, cropping patterns, weather, and dispersal from or immigration into the area. It is desirable to have a simple, inexpensive procedure for sampling adult fall armyworms (FAW) which will reveal significant fluctuations in population density and which can be used in conjunction with a developmental model and meteorological data to forecast potential outbreak situations. This paper reviews the different types of traps currently used for sampling adult FAW.

LIGHT TRAPS

Blacklight traps have been used for years as a tool for surveying many insect pests including the FAW (Henton 1974). This species is one of 20

1Lepidoptera: Noctuidae.
2This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended. Also, mention of a proprietary product does not constitute an endorsement by the USDA.
insects included in the weekly Cooperative Plant Pest Report. The data contained in this report is not necessarily indicative of actual FAW populations because of differences in collection intervals, frequency of reporting trapping data, trap placement, and possible incorrect identifications.

The basic design of most blacklight traps is similar. The lamp is placed between vertical baffles above a funnel. The light may be left on continuously or turned off during the day with a photoelectric switch. Insects approach the light and either dive into the funnel or strike the baffles and fall into the funnel. The funnel directs the moths to a chamber (usually a bucket) where they are killed by a fumigant. A relatively fast kill is necessary to maintain an identifiable specimen. Harding et al. (1966) and Smith et al. (1974) describe in detail a 15-W blacklight trap recommended for survey purposes.

The size of light trap catches is influenced by the density and activity of the insect population (Williams 1939, 1940). Also the insect’s activity under the pressure of changing environmental influences such as moonlight, barometric pressure, surface wind velocity, humidity, temperature, and crop phenology can cause light trap catches to fluctuate widely, even on an hourly or nightly basis.

Except for the data included in the Cooperative Economic Insect Report, there is virtually no published information on the effectiveness of light traps for capturing FAW. P. S. Callahan and Joan Chafin (unpublished data) conducted a survey of several noctuid pests with 15-W blacklight traps located on the campus of Louisiana State University in Baton Rouge over a 4-year period (1967-60). Results of their investigations with the FAW are shown in Figures 1 and 2. These data suggest that the FAW probably does not overwinter in the Baton Rouge area, since it was not captured in light traps until late spring of each year. Figure 2 shows that both sexes of the FAW were attracted to light traps with ca. 63% of the captures being females. Approximately 85% of the females captured had mated 1 or more times as evidenced by the presence of a spermatophore in the bursa copulatrix.

**Pheromone Traps**

Female moths of the FAW produce a sex pheromone that attracts males prior to courtship and mating; hence females can be used in traps as bait to lure and capture males (Snow and Copeland 1969). Live females may not be readily available, and rearing expenses are excessive compared to the cost of synthetic pheromone. Although female moths used as bait in traps effectively attract males, extreme environmental conditions may cause erratic and unpredictable pheromone production behavior and a subsequent decrease in the capture of male moths. The identification and synthesis of the sex pheromone of the FAW has made large area surveys, dispersal studies, and on-site field detection procedures a practical reality.

Two compounds have been identified as sex pheromones for the FAW, (Z)-9-tetradecen-1-ol acetate (Sekul and Sparks 1967) and (Z)-9-dodecen-
Fig. 1. Seasonal occurrence of the fall armyworm at Baton Rouge, LA, as determined with a 15-W blacklight trap (data provided courtesy of P. S. Callahan, Insect Attractants, Behavior, and Basic Biology Research Laboratory, Gainesville, FL.)

1-ol acetate (Sekul and Sparks 1976). Mitchell and Doolittle (1976) demonstrated that (Z)-9-tetradecen-1-ol acetate is not attractive to males in the field although it is a sexual stimulant in laboratory bioassays (Sekul and Sparks 1967). However, (Z) 9-dodecen-1-ol acetate (Z 9 DDA) is highly attractive to male FAW in the field (Mitchell and Doolittle 1976). Rather high levels of the E isomer (1-11%) of 9-dodecen-1-ol acetate can be present in formulations without any appreciable loss in attractiveness to FAW,
Spodoptera frugiperda
which is fortunate since commercial preparations of the Z isomer usually contain some E isomer and removal is expensive and time consuming. When a very high degree of attraction is required the use of highly purified material is advantageous.

Several different types of dispensers including polyethylene vials and bottle caps, rubber septa and laminated plastic dispensers (Hercon®) have been used to evaporate the FAW pheromone from traps. Plastic vials (1.25 ml, Olympic Plastic Co., Los Angeles, CA) and bottle caps (OS-6 natural polyethylene closures, Scientific Products) have been used most extensively in research and survey by the writer, and they have proven quite effective. Both types of dispensers release the pheromone at the rate of ca. 300 ng/min at 27°C and 0.4 m/s wind velocity. The dispensers are usually loaded with 25 mg pheromone. This load will last 3 to 4 weeks in the field depending upon the temperature.

Traps of various design have been used to detect or measure FAW populations and to evaluate chemical attractants against natural populations of this species. To be effective, the trap must not only be capable of capturing (or killing) the insects, but it must also have the capacity to contain an accurate sample of the population. A trap that reaches capacity in 1 night (or even in 1 h) may provide misleading information, depending on when the trap is cleaned or replaced.

Tingle and Mitchell (1975) tested 7 trap designs (Fig. 3) for capturing the FAW. an electrocutor grid trap (Mitchell et al. 1972); a double-cone trap similar to that of Kaan and Shorey (1972); an omni-directional trap for pink bollworms, Pectinophora gossypiella (Saunders), designed from that of Sharma et al. (1973); a modified pink bollworm trap; and 3 sticky traps available from Zocon Corp., Palo Alto, CA (Phercon® 1C, Sector® XC-26, and Sector 1). The electrocutor grid was the most effective of the traps tested. It captured 10-12 times more FAW than any of the other traps, and its capacity is limited only by the size of the collection container. Because of its effectiveness in capturing FAW, as well as many other moth species, the electrocutor grid is used widely as a research and survey tool even though it is expensive to construct and has the disadvantage of requiring an electric power source (115-120V AC). The latter problem has been overcome by the recent development of a 12V DC battery-powered unit (Bodine Model 12BZ, The Bodine Co., 236 Mt. Pleasant Road, Collierville, TN 38017) designed to operate the electrocutor grid for ca. 2 weeks between battery changes (Mitchell et al. 1978).

The Pherocon 1C stick trap was the most effective of the other 6 trap designs tested by Tingle and Mitchell (1975). The effectiveness of these traps is affected by many factors including the number of insects captured and the accumulation of insect scales, dirt, and other debris. Also, the capacity and efficiency of the sticky trap changes with insect populations and as a result of deterioration by rain, dust, and wind. Birds also may remove insects from these traps. The Pherocon 1C trap can be used effectively as a research and

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Fig. 2. Sex and mating status of fall armyworm moths captured in 15-W blacklight traps, Baton Rouge, LA. (Data provided courtesy of P. S. Callahan, Insect Attractants, Behavior, and Basic Biology Research Laboratory, Gainesville, FL.)
Fig. 3. Pheromone traps evaluated for capture of fall armyworm males: Electrcutator grid (grid), double-cone (D-C), pink bollworm (PBW), modified pink bollworm (MPBW), Pherocon 1C (PC), Sector XC-26(XC-26), and Sector 1(S-1).

A survey tool if its limitations are recognized and taken into account. For example, new and used traps should not be mixed in quantitative experiments. In survey studies, the trap's sticky liner (bottom) should be replaced on a regular basis, preferably once a week when insect populations are low. When moth catches increase, it may be necessary to change the liner daily. The top of the Pherocon 1C trap can be changed less frequently.

Fall armyworm pheromone, purchased in 100 g lots currently costs ca. $3.25/g. Since 23 mg will last about a month, pheromone would cost ca. $0.08/month for each trap in operation (electrocutor grid or sticky trap). A complete Pherocon 1C trap (top and liner) costs ca. $1.02; replacement liners for these traps cost ca. $0.41 each. If one assumes that the top of each trap will last a month and the liner must be changed weekly, then the cost at current prices would be ca. $2.25/month for each trap in operation. It is possible that homemade traps could be used in place of the commercially prepared traps to reduce costs. Based upon my own experience it has generally been less expensive and time consuming to use commercially manufactured traps especially if a large number of traps is involved.

The location of pheromone traps and the number per unit area are both important considerations in any trapping system. Host plant preferences of the moths change depending upon the time of year, availability, and flower-
ing cycles of the host plant. Tingle and Mitchell (1979) have conducted studies on the placement of traps in and around preferred hosts of the FAW including corn, peanuts, and improved pastures. In North Central Florida, FAW generally are captured first in and around young corn during the spring, in peanuts during mid- and late-summer and in areas planted to improved, highly fertilized grasses such as coastal bermuda in the late summer and fall. Pheromone sticky traps are routinely positioned ca. 1 m above the ground on metal poles in and around these crops. Studies have shown this to be an effective and convenient height, and trap catches are not significantly affected as long as the host, e.g., corn, is at or below the level of the trap. Traps positioned inside and around the periphery of corn fields are almost equally effective in capturing FAW moths. Traps located in fields where the corn is >1 m in height are less effective in capturing FAW than similar traps located along the periphery of the field. In peanuts, more FAW moths are captured in sticky traps located inside the field (ca. 25 m) than along the edges.

Pheromone trap densities of 1, 2, 4 and 10/4 ha were tested in field corn early in the 1977 growing season when adult FAW populations were extremely low (captures ranged from 0 to 7.4/trap per night) (Tingle and Mitchell 1979). Under these conditions, there was no significant difference in the mean number of moths captured per trap whatever the trap density. Hence, 1 trap/4 ha can be used to survey for the FAW when populations are low. Further research must be conducted before this type of data can be used to predict egg and larval populations of the FAW or schedule insecticide applications in a control program.

LITERATURE CITED


RESEARCH NEEDS FOR MODELING
PEST MANAGEMENT SYSTEMS INVOLVING
DEFOLIATORS IN AGRONOMIC CROP SYSTEMS

C. S. BARFIELD AND J. W. JONES

ABSTRACT

A framework for stepwise construction of a pest management model is presented and placed in context with the so-called systems approach. Laboratory and field data from 1 year's studies involving a defoliator, a foliar pathogen and the peanut plant, *Arachis hypogea* L. cv. 'Early Bunch', are presented as examples of primary research information needed to construct an IPM model. Developmental information on the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), is presented.

Measurements have been made on the alterations in peanut plant growth rate processes as functions of defoliation and/or pathogen, *Cercospora* leafspot, infection. Suggestions for future experiments that will provide data critical to model construction and validation are given.

The fall armyworm, *Spodoptera frugiperda* (J. E. Smith), is a member of a complex of defoliators annually inflicting damage to crops in the southeast and central U.S. (Luginbill 1928). The severe infestation of fall armyworm in field corn in 1977 resulted in devastation to many crops secondarily attacked by this pest. Scientists were once again reminded of their lack of knowledge on the ecology and natural history of fall armyworm dispersal and host plant selection. Others have called attention to the potential of the fall armyworm as an economic, polyphagous pest (Chittenden 1900, Hinds and Dew 1915, Luginbill 1928, Vickery 1929, Labrador 1967).

Research has been conducted on several aspects of fall armyworm biomics. Hinds and Dew (1915), Luginbill (1928), and Lincoln and Isley (1945) wrote general articles on fall armyworm biology and control. Host plant resistance has been utilized against the fall armyworm on millet (Leueck 1970, 1972), Bermuda grass (Leueck et al. 1968, Leueck and Skinner 1970), maize (Widstrom et al. 1972) and peanuts (Leueck and Skinner 1971).