Evaluation of Trap Crops as a Component of a Community-Wide Pink Bollworm Control Program

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Abstract

Trap crops were evaluated as a part of a community-wide pink bollworm (PBW) control program. We measured extraordinarily high numbers of PBW larvae in the trap crops in 1992, which indicated that the trap crops were attracting PBW moths from wide areas. However, we have no direct way of measuring any effect this would have on the main crop. Overall PBW populations were very low in 1993. While PBW numbers drastically declined in the community, this study offers no conclusive evidence as to whether trap crops are an effective component of a community-wide IPM program.

Introduction

Cotton growers in Pima County have been working together on a community-wide IPM program since 1991. The program is coordinated by the Marana-Avra Growers Task Force (MAGTF). An accompanying article in this publication describes the overall program (Thacker et al, 1994). This paper focuses on the trap cropping component of the program.

The principle of trap cropping has been known for centuries: the use of trap trees, or logs, was practiced in Europe over 200 years ago to control the spruce bark beetle (Bakke and Reige, 1982). This principle rests on the fact that virtually all pests show a distinct preference for certain plant species, cultivars, or crop growth stages. Attractive host plants are offered at a critical time in the pest's phenology, concentrating them in a small area where they can be economically destroyed (Hokkanen, 1991).

Isley (1934) suggested early fruiting varieties of cotton could be utilized to concentrate infestations of overwintering boll weevils where they could be easily destroyed. The effectiveness of this tactic has been demonstrated in Mississippi by Scott et al. (1974) and in Arizona by Moore and Watson (1990). However, Hokkanen (1991) reported that no trap crop system successfully adapted to practical use had involved any lepidopteran pests.

Pink bollworm moths are highly mobile; Glick and Noble (1961) collected PBW moths in airplane flights of up to 2000 feet above the ground, and Barriola et al. (1973) reported that overwintered PBW moths traveled at least 35 miles to infest an isolated field of cotton. Van Steenwyk et al. (1978) studied the local dispersive nature of the PBW and found that overwintering adult males were highly dispersive from a cotton field in the early spring before the plants began producing squares. Dispersal was suppressed in mid- to late spring, possibly due to the onset of square and nectar production in the field.

Female PBW moths have a limited time to lay eggs. Philipp and Watson (1971) showed that newly emerged PBW moths have a 3 to 7 day pre-oviposition period, after which they will oviposit for 6 to 12 days. Adkisson (1961) showed that female PBW moths lay 93% of all their eggs in the first 14 days of their adult lives.

Our hypothesis in this study is that we may be able to concentrate overwintered PBW moths in small trap crops of cotton planted ten to fourteen days earlier than the main crop. If female PBW moths actively search for suitable egg laying sites, then the trap crops would be much more attractive than the main crop during the short period of time when the only susceptible squares available are in the trap crop. If the female moth has such a preference and searching behavior, then the trap crops could serve to attract (and possibly retain) female moths for the seven to ten day period before susceptible squares appear in the main crop. If the female moths have a preference for older and larger squares, they may continue to concentrate on the trap crops while the main crop begins to set squares. This would keep many ovipositing PBW moths out of the main crop during a short but critical interval in the life cycle of the PBW.

A factor which limits the useful time interval of the trap crops is that if they are left standing long enough, the first in-field generation of PBW's could get started in them. Plowing the trap crops under when the first flowers appear will stop the development of all larvae before they reach the final instar. In the future, transgenic cottons which produce the BT (*Bacillus thuringiensis*) toxin would kill most of the larvae.

In 1991, we incorporated a pilot trap cropping study into the community-wide IPM program in the Avra Valley and Marana. Early season square infestations in the trap crops were too low for us to get any measure of the effectiveness of the technique. The MAGTF agreed to continue the study in 1992 and 1993, the results of which are reported here.

Materials and Methods

Trap Crop Planting:

Trap crop locations were selected throughout the area on set-aside and fallow land. Our objectives in locating the trap crops were:

1. Have at least one trap crop per square mile in the community, so that an overwintered PBW moth would not have over one-half mile to travel to a trap crop.
2. Stay away from power lines, schools, residences and other locations where aerial spraying would be difficult or restricted.
3. Locate the trap crops as twelve row strips to be sprayed in one pass of an airplane.

In 1992, we had nineteen trap crop locations in the community. In 1993, we had thirty-two trap crops. Growers planted the trap crops ten to fourteen days ahead of the main crop, in both 1992 and '93 beginning on March 25th and ending on April 5th (ca. 350 to 400 HU after January 1 in '92 and 400 to 500 HU in '93). All trap crops were twelve 38- or 40-inch rows wide, varying from one quarter to one third mile long (usually the length of the irrigation run). Another component of this community-wide program is the uniform optimal planting date; in 1992 and '93 none of the main crop was planted until April 15 (ca. 550 HU after January 1 in '92 and 585 HU in '93). This resulted in a minimum of ten days separation between the trap and main crops. In 1992 this amounted to a minimum 150 HU separation between the trap and main crops. Cold weather in early April 1993 resulted in a minimum spread of only 85 HU between the trap and main crops.

Pink Bollworm Moth Monitoring:

We maintained three gossyplure delta traps in each trap crop. The delta traps were located beside the trap crops to facilitate tractor work. One was placed at about fifty feet from each end of the twelve row strip and another in the middle. The use of pheromones has proven effective in trap cropping for boll weevils (Scott et al. 1974, Moore and Watson, 1990), and the traps gave us a method of monitoring male PBW moth populations. In 1992, the traps were emptied or replaced twice a week and the numbers of moths were recorded. Nightly moth catches were much lower in 1993, and we emptied or replaced the traps weekly.

Insecticide Applications:

To destroy PBW moths in the trap crops, we used an intensive aerial spraying program beginning just before the trap crops reached susceptible square and continued until just before the trap crops were destroyed. The application schedules were:

1992: Nine applications of azinphos methyl (Guthion) at 0.5 lb a.i. per acre began on May 22 (ca. 1235 HU after January 1) and continued on a three-day schedule until June 15 (ca. 1750 HU).

1993: Ten applications of azinphos methyl (Guthion) at 0.5 lb a.i. per acre began on May 22 (ca. 1248 HU after January 1) and continued on a three-day schedule until June 18 (ca. 1641 HU).

The applications were made by Quality Aviation with a Piper Pawnee. Each twelve-row trap crop was sprayed with one pass of the airplane, and one load of material covered all of the trap crops for each day's applications. The MAGTF paid for these applications.

Trap Crop Square Sampling for Pink Bollworms:

The objectives of this sampling were:

- To measure the PBW infestation in the trap crop squares, relative to infestation levels normally expected in the first susceptible squares of early planted cotton (in terms of heat units after January 1). Higher than normally expected infestation levels would indicate that PBW moths are converging on the trap crops.

- To measure any effect of insecticide applications on the success of PBW egg-laying in the trap crops.

For this evaluation, we selected pairs of trap crops for intensive sampling. Each pair was located on opposite sides of the same field and included a sprayed trap crop and an unsprayed check. The sampling protocol was:

1992: We had three pairs of trap crops: on the Pacheco CalMat farm, on the Murphey farm, and on the Worthey farm. Immediately after the last spray application on June 15, we pulled 500 susceptible square samples from each of the six trap crops and dissected the squares in the lab to count PBW larvae.

1993: We had four pairs of trap crops: on the Gladden farm, the Pacheco EVCO farm, the Murphey farm, and the Worthey farm. To improve the resolution of the statistical analysis, we sampled each trap crop on three sequential dates: June 16, 17, and 23. On each sampling date we pulled five 100 susceptible square samples from each of the eight trap crops and dissected the squares in the lab to count PBW larvae. We treated each 100 square sample as a sub-sample in the statistical analysis.

Trap Crop Destruction:

Growers plowed all of the trap crops under immediately after the last insecticide application or after we finished sampling. This was to insure that no second generation PBW's could complete their development in the trap crops and infest the main crop.

Boll Sampling in the Main Crop:

We monitored PBW infestations in the main crop as soon as bolls were present, and continued until the crop was terminated. These samplings represent about one-half of the 13,000 acres of main crop in the community.

Results and Discussion

Pheromone Trap Catches:

Early-season pheromone trap catches have been shown to reflect the magnitude of emergence from overwintering PBW populations (Chu and Henneberry, 1990). Our trap catches peaked at about 25 moths per night in 1992 (Figure 1) and at about 12 moths per night in 1993 (Figure 2). The pattern of moth emergence in both years reflects the spring PBW emergence described by Huber (1982).

The spray applications had no significant effect on the trap catches in either year. We analyzed the trap catches for the periods after insecticide applications began, and found no significant differences whatsoever (Table 1). This supports the findings of Van Steenwyk et al. (1978) that PBW moths are highly dispersive in the spring, before the onset of square and nectar production. In view of this dispersive nature of PBW moths, it is no surprise that spray applications on the small trap crops had no measurable effect on the numbers of moths caught in adjacent pheromone traps.

Infestation of Squares:

In 1992 we found a extraordinarily high level of PBW infestation in the first susceptible squares of the unsprayed trap crops (Table 2). Typical infestations at this point in the cotton plant's growth are usually so low that they are very difficult to measure. Watson (1992) found no PBW in intensive sampling early squares in Yuma, while his spring PBW emergence trapping data showed that high numbers of PBW moths were present. In spite of the very high infestation of PBW infestations in the sprayed trap crops relative to the unsprayed check, there was no significant difference between the two.

In 1993, PBW infestations were much lower (Table 2). However, we found more PBW larvae in the sprayed trap crops than in the unsprayed checks. This difference was significant at the 0.05 level, and was almost highly significant ($P > F = 0.014$). This was a year in which the plant bug pressure was unusually intense; especially thrips and lygus. The sprayed trap crops were probably released from the plant bug pressure. Squares in the sprayed trap crops were more numerous and were larger than in the unsprayed checks, hence the crop response to the release from plant bug pressure could be the reason for the higher infestations in the sprayed trap crops.

We had no way to get a direct, realistic comparison of these data with the later PBW infestations in the main crop. The main crop did not have any squares until 7-10 days after we took these data. Given the highly dispersive nature of PBW moths in the spring, we could not devise a sampling protocol to measure the effects of trap crops without introducing the confounding factors of trying to compare PBW populations in fields furthest from trap crops to fields where the trap crops existed.

Boll Infestations in the Main Crop:

In 1992, economic infestations of PBW did not develop until very late in the season (Figure 3). The infestation levels in 1993 were very low (Figure 4), and most of the short staple cotton did not develop an economic infestation of PBW for the entire season.

The lower levels of PBW in the bolls in 1993 is consistent with the lower pheromone trap catches we observed in 1993 versus 1992 (Figures 1 and 2).

Conclusions

Trap cropping is aimed at reducing PBW populations when they are at their lowest ebb of the year. Trying to measure these infinitesimal populations is very difficult, and none of the results from this study offer conclusive evidence as to whether trap crops are an effective means of PBW control.

An additional difficulty is that this study is part of a successful multi-component, community-wide IPM program (Thacker et al, 1994). PBW populations declined from 1992 to '93, both in terms of spring moth activity (Figures 1 and 2) and in boll infestations (Figures 3 and 4). It is very difficult to evaluate one component of the program separately from the others, when all components are being applied throughout the community.

The extraordinarily high levels of PBW in the trap crops in 1992 was very encouraging, because it indicates that the trap crops are drawing moths in from a large area. However, we have no direct way of measuring any effect this may have on the main crop. To be truly effective, the trap crops would have to concentrate female moths which emerge late enough to lay eggs on the main crop.

Our comparisons of the sprayed and unsprayed (check) trap crops only showed a significant difference in 1993. The cotton was under heavy plant bug pressure in 1993, and insecticide applications released the sprayed trap crops from this pressure. In taking our square samples, we had to hunt for squares in the unsprayed treatments and the ones we found were generally smaller than the squares in the sprayed trap crops.

We initiated this study to learn more about the behavior of the female PBW moth, and there is still a lot that we do not know.

Acknowledgments

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Table 1. Average moths per night caught in pheromone traps adjacent to sprayed trap crops and unsprayed trap crops in 1992 and 1993.

Year	1992	1993
Average Moths/Night in Unsprayed Check	8.3 a*	5.2 a*
Average Moths/Night in Sprayed	8.9 a	5.8 a
P > F	0.654	0.515
Coefficient of Variation	89.0%	86.0%

* Values within a column followed by the same letter are not significantly different at the 0.05 level.

Table 2. Percent of trap crop squares infested with PBW larvae in 1992 and 1993.

Year	1992	1993
Percent Squares w/ PBW in Unsprayed Check	3.400 a*	0.083 b*
Percent Squares w/ PBW in Sprayed	0.667 a	0.250 a
P > F	0.368	0.014
Coefficient of Variation	122.5%	224.5%

* Values within a column followed by the same letter are not significantly different at the 0.05 level.

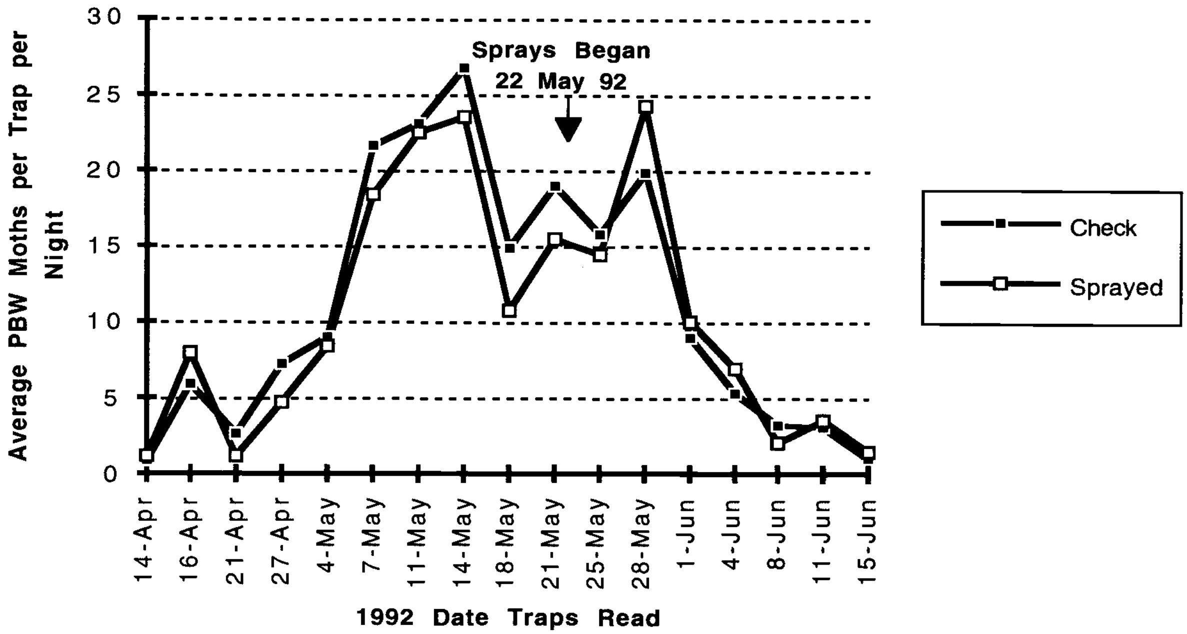

Figure 1. Average nightly PBW moth catches in check and sprayed trap crops in 1992.

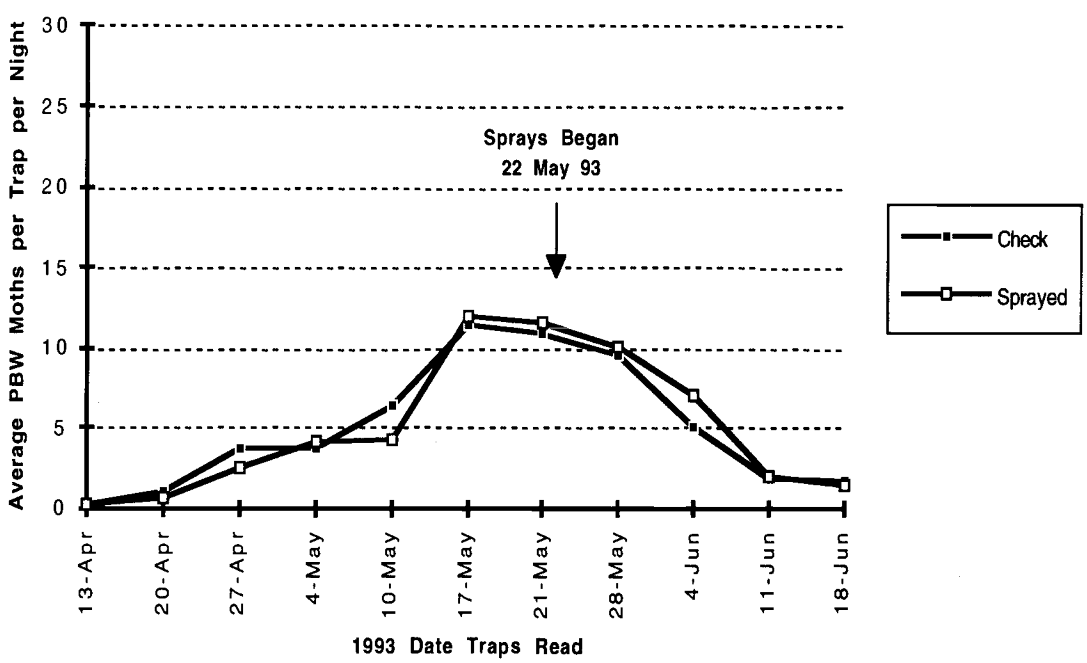

Figure 2. Average nightly PBW moth catches in check and sprayed trap crops in 1993.

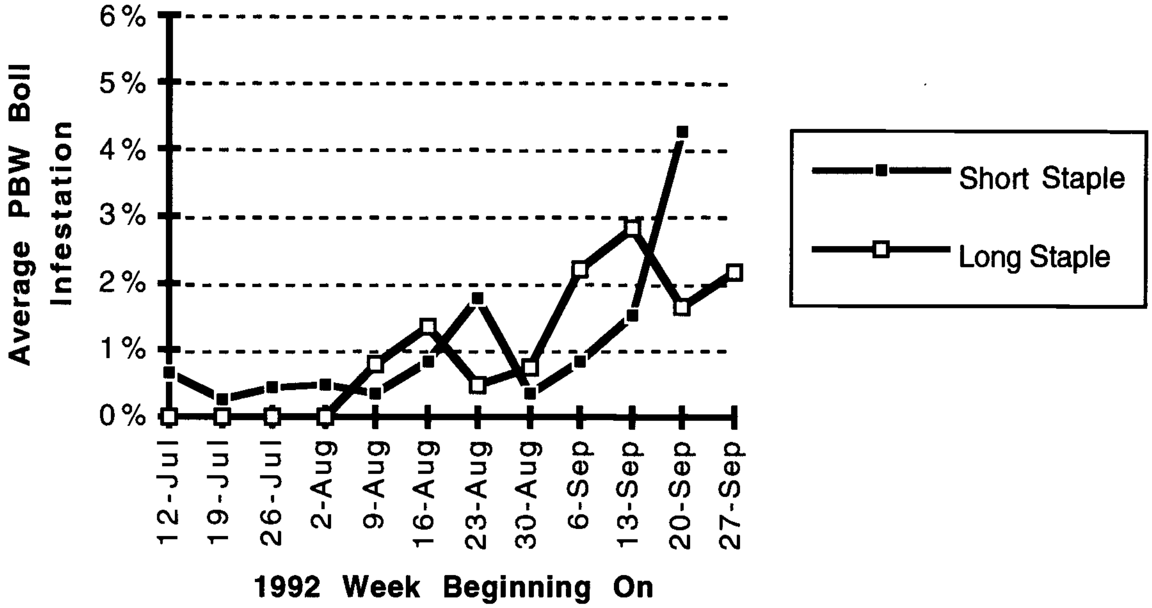

Figure 3. Average PBW infestarions in short staple and long staple bolls in 1992.

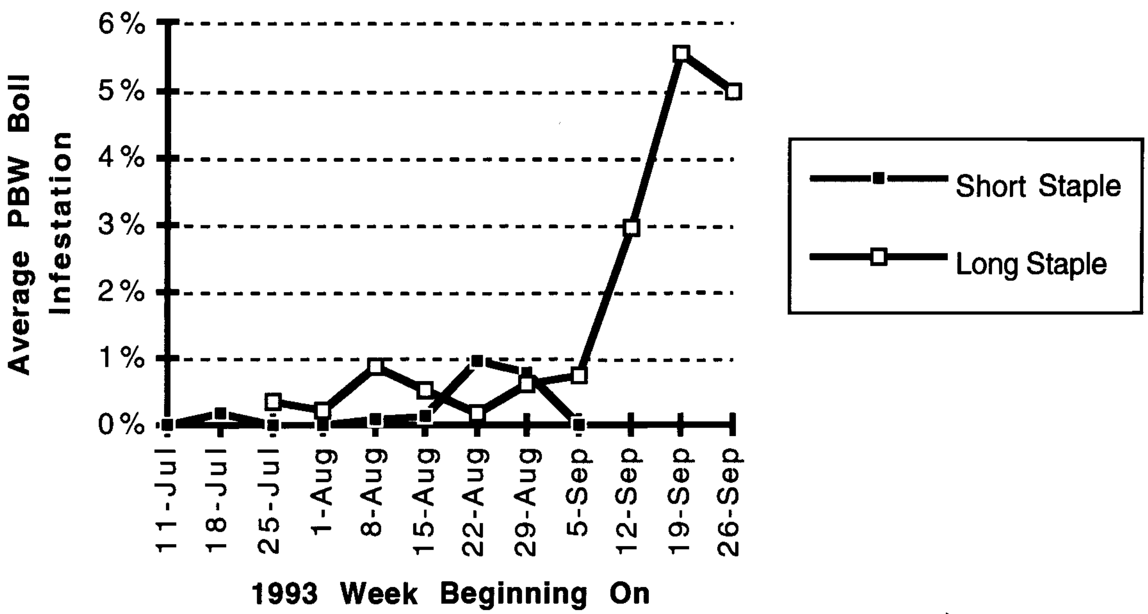

Figure 4. Average PBW infestations in short staple and long staple bolls in 1993.