Long-range dispersal of pink bollworm into the San Joaquin Valley

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Fig. 1. Sharma trap on a creosote bush.

Invasion of the pink bollworm, *Pectinophora gossypiella* (Saunders), into the San Joaquin Valley has been of great concern since this devastating cotton pest invaded the southern desert valleys in 1965.

The trap surveys conducted by the California Department of Food and Agriculture and the USDA, in conjunction with the sterile-moth release program, have been increasing the annual catch of pink bollworm moths in the San Joaquin Valley over the past five years. In the years 1973 through 1977, there were 25, 437, 245, 1474, and 7402 "native" moths captured respectively. About 80 percent or more of the native moths captured each year were in Kern County.

The effectiveness of the traps has increased, but the number of traps per acre of cotton in the valley has essentially remained the same (about 29,000 per year). In early August 1974, the trap lure was changed from Hexalure to the more attractive gossyplure, the sex pheromone of the pink bollworm. In 1977, the "delta" trap replaced the ice cream carton trap, and is about four times more effective.

Despite more effective trapping methods, many entomologists believe that some of the moths captured in 1977 went through their larval development in bolls in the San Joaquin Valley rather than being "blow-in" moths native to the southern valleys, Arizona, and Mexico.

In 1975, a study was conducted to learn more of the long-range dispersal of the pink bollworm. About 60 Sharma traps (fig. 1), baited with the sex pheromone gossyplure, were set out in the Colorado Desert areas between the Imperial, Palo Verde, and Coachella valleys. About 110 traps were set out from Riverside to the San Gorgonio Pass and in the high desert regions of the Antelope Valley and along the Mojave River (fig. 2).

Monitoring procedures

The traps were monitored weekly from late June through October in all areas. Monitoring continued through November in the triangular desert area between the Coachella, Imperial, and Palo Verde valleys. The survey continued to early January between the Coachella and Imperial valleys.

The trap lines were determined by the accessibility of roads and by restricted military installations. The length of the entire trap-line survey was about 900 miles and generally encompassed an area of about 30,000 sq. miles. The traps were hung about 1 meter from the soil surface on a wide variety of desert trees and shrubs or on wooden stakes placed near small shrubs. When a trap was missing or destroyed by vandals a new trap was placed on the same tree, shrub, or stake.

Colorado Desert

Moths were captured in all trap lines in the triangular area between the Coachella, Imperial, and Palo Verde valleys on June 30, from traps set out on June 21 and 22 (figs. 3 and 4). The number of moths captured reached a small peak around the first week in July. This corresponds to the first summer generation arising from the overwintering population. A second peak of moths occurred between August 4 and 11, corresponding to completion of the second summer generation. A second decline of moths captured continued from mid-August through the first week in September, when the third summer generation began to appear.

After early September, the number of moths captured in the southern desert increased markedly along all trap lines, reflecting completion of the fourth summer generation. The high numbers continued through October followed by a gradual decline through November, some of these moths representing the fifth summer generation which did not enter larval diapause in the fourth generation.

The greatest number of moths captured in the lower Colorado Desert areas occurred on the eastern and western fringe areas of the Coachella Valley—about 10 to 12 miles from the nearest cotton—and in an isolated alfalfa ranch in the Berrego Desert west of the Imperial Valley—about 20 miles from the nearest cotton (fig. 4).

The data from the southern desert areas show there is no area isolated from the pink bollworm, and that moths are continually flying between fields and from one cotton growing area to another. Any attempt to eradicate the pink bollworm would have to include southern California, Arizona, and all of northwestern Mexico.

Riverside and Mojave Desert

Eight moths were captured from July 27 through September 6 in the area from Riverside eastward to the San Gor-

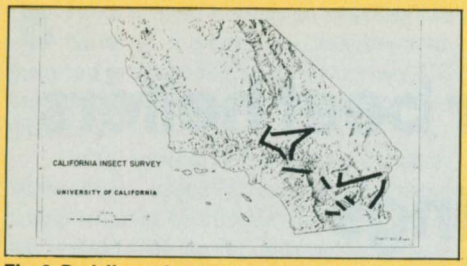

Fig. 2. Dark lines show areas of the survey traps.

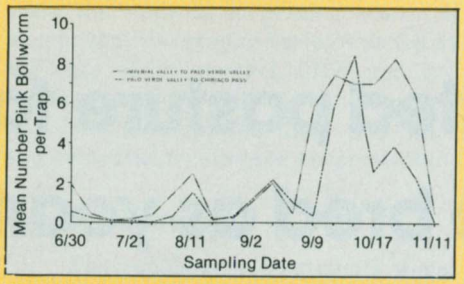

Fig. 3. Moths captured per trap per week in desert areas.

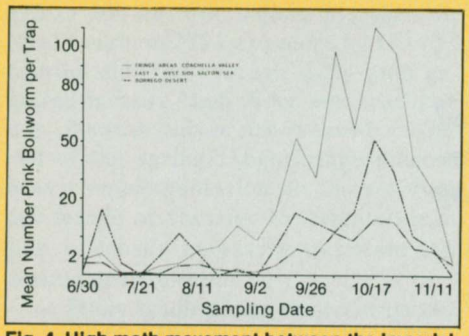

Fig. 4. High moth movement between the Imperial and Coachella valleys. The total number of moths captured in the 170 traps spread across 30,000 sq. miles indicates that thousands of moths are flying over southern California each year.

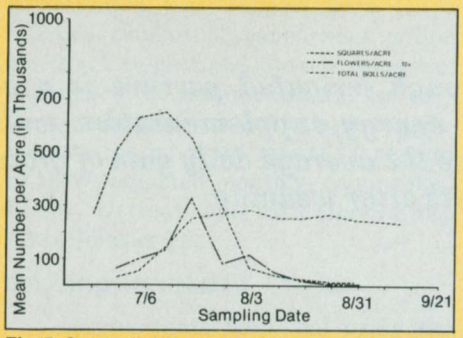

Fig. 5. Cotton field in Kings County (1974) showing characteristic squares, flowers, boll set and boll shed for San Joaquin Valley cotton fields.

gonio Pass leading to the lower desert valleys. Three moths were captured during the same period in the Antelope Valley and five in the Mojave River area. Cotton is not grown in these areas.

The largest number of moths captured in these areas occurred during the weeks of September 7 through 13 and 14 through 20 (see table). This coincides with two tropical wind and rain storms moving northwestward over southern California and into central California. These storms occurred September 7 to 11 and 16 to 17. A number of moths captured in the Antelope Valley during this period were less than 30 miles from San Joaquin Valley cotton fields. Similar storms occurred on August 1, 1974, September 9 to 11, 1976, and August 15 to 18, 1977.

Condition of captured moths

An important feature of the moths captured in all the survey traps is that the vast majority were newly emerged moths as indicated by non-tattered wings and complete wing and body scales.

The pink bollworm generally mates soon after emergence. Therefore, pink bollworm females blown into the San Joaquin Valley may well have mated and been ready to lay fertile eggs on arrival. It seems likely that offspring of moths blown into the valley by late summer storms could complete larval development and then enter winter diapause.

Survival

Pink bollworm larvae can overwinter in the San Joaquin Valley and in the warmer areas of Kern County. This has been shown by recent studies by the USDA. Earlier studies of V. M. Stern and R. Van Steenwyk (UC Riverside) also show that pink bollworm larvae overwintered in field cages and moths emerged in high numbers in 1974 and 1975 at Riverside. The Riverside climate is similar to that of the Arvin, Wheeler Ridge, and Maracopa areas of Kern County. During the same years, small numbers of larvae overwintered and moths emerged in cages in the Antelope Valley where temperatures in December and January often went below 20°F and the ground was frequently frozen to 4 to 5 inches below the surface.

Cotton growth

Our data suggest that the pink bollworm may not be nearly as serious a threat in the San Joaquin Valley as in the southern desert valleys. This conclusion comes from studies on cotton plant growth analysis in the San Joaquin Valley. These studies were conducted from 1968 to the present, and the growth of 60 cotton fields was studied in 1974 from Wheeler Ridge to Merced. The number of squares, flowers, bolls, and other plant growth data were examined weekly from mid-June through mid-September. Peak squaring usually occurs around mid-July. The number of squares varies for each field, ranging from one-half to one million per acre, and is not necessarily related to yield. Peak flowering occurs 7 to 10 days after the square peak.

The 1968 to 1974 data also show that about 90 percent of the cotton fields in the San Joaquin Valley have produced 95 percent or more of their cotton crop by the first week in August. At this time small bolls are shed, leaving only maturing bolls already set. Further boll set is markedly reduced because of the plants' inability to provide nutrients for new bolls (fig. 5). In the central part of the valley 90,000 pickable bolls per acre produces one bale (479 pounds lint).

Late re-planted fields in the San Joaquin Valley, late first-planted fields on the northern edge of the cotton belt, poor water and fertilizer management, and excessive lygus bug damage that causes plants to grow vegetatively account for the remaining 10 percent of the fields. Some of these fields profit by a long moderate fall climate, but for most of the valley, bolls set after mid-August rarely make pickable cotton.

The pink bollworm has less potential for damage in the San Joaquin Valley than in the southern desert valleys because of: the earlier maturing cotton crop; greatly reduced numbers of susceptible bolls available to attack in August by moths of the second summer generation; and higher winter mortality of diapausing larvae from winter rain and colder soil temperatures through most of the San Joaquin Valley.

Nevertheless, continued research is necessary on how water and fertilizer management affect crop maturity; earlier defoliation and picking of mature cotton crops followed immediately by plow-down; defoliation or desiccation of late flowers and non-pickable small bolls and other ecological, cultural, and sanitation practices. It seems prudent to seek cultural controls and better crop management practices for pink bollworm in the San Joaquin Valley rather than to rely on excessive use of pesticides.

Total Number of Pink Bollworm Moths Captured in Each Area Per Week

Date	Riverside to San Gorgonio Pass. 8 traps	Antelope Valley. 50 traps	Mojave River Area. 52 traps
Sept. 7-13	46	11	231
Sept. 14-20	43	27	62
Sept. 21-27	7	20	9
Sept. 28-Oct. 4	22	2	14
Oct. 5-11	6	0	0
Oct. 12-18	1	0	0
Oct. 19-25	7	0	0
Oct. 26-Nov. 1	1	0	0
Nov. 2-8	0	—	—

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