The boll weevil may be spreading

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Numbers increasing in lower deserts

The boll weevil was first found in the United States in about 1892. Infestations reported in Arizona in the 1960s are thought to have come from a boll weevil population in northern Mexico. Localized but damaging levels of the boll weevil, *Anthonomus grandis* Boheman, occurred in cultivated cotton in 1965 and 1966, as did growing numbers of pink bollworm, *Pectinophora gossypiella* (Saunders).

Mandatory plowdown of cotton stalks after harvest and planting dates to ensure a host-free period eliminated economically important boll weevil infestations. Minor infestations were detected from 1966 to 1977; however, plowdown and planting date regulations were relaxed in Arizona in 1978. The next documented boll weevil infestation was on August 31, 1978, in a western Maricopa County (Arizona) field of stub cotton (perennial cotton from previous year's plants) near Gila Bend. Arizona infestations have spread since then, and boll weevil adults and infested bolls were found in southern California cotton fields in 1982.

Boll weevil populations are now established in California and, since numbers are increasing each year in the lower deserts, the potential for this insect to invade the San Joaquin Valley is also increasing. Average trap catches in the Bard-Winterhaven area and the remainder of Imperial County between planting time and November 27 in 1982, 1983, and 1984, were 64, 4,175, and 8,330, respectively. Similar increases in numbers of trapped boll weevil and in-field infestations have occurred in the Parker Valley and the Yuma areas in Arizona, and in the Palo Verde Valley, California.

The boll weevil in the southeastern U.S. Cotton Belt has caused millions of dollars in annual losses. The potential for permanent establishment of the insect as a pest in western cotton production systems is unknown. The need for information on the boll weevil under desert southwest growing conditions has prompted preliminary studies on the activity and occurrence of the insect in California.

Biology

The boll weevil develops from egg to adult in as little as 17 days at 86°F to 88 days at 59°F. Feeding and egg-laying occur on cotton squares and bolls. Females may lay more than 200 eggs, puncturing the fruiting form with their mouthparts, depositing a single egg in the puncture cavity, and then sealing it with excrement.

Under Arizona and California field conditions, immature bolls that set during the first fruiting cycle are also susceptible to infestation, even though squares are plentiful. In contrast, boll weevils in the Southeast seldom infest bolls until late in the growing season. It is obvious from the short life cycle that many generations may occur within the growing season, although previously reported research indicates that the high reproductive potential of the insect is not realized under the arid high temperatures of Arizona and southern California.

In the desert, some adult boll weevils overwinter outside bolls and cotton-plant field trash, but most overwinter in cells created by pupating larvae within immature bolls left in the field. Some of the overwintering population reproduces throughout the year, and females may lay

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Although boll weevil adults and larvae feed mainly in the unopened flowers, or squares, of the cotton plant, they also attack developing bolls. Infested bolls may remain on the plant but fail to open and fluff normally (left).

Jack Kelly Clark

When squares are available, adult boll weevils chew into them with their snouts, consuming pollen, stamens, and pistils, leaving behind bright yellow frass. Eggs are laid in punctures similar to feeding punctures and are sealed with frass.

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The "C" shape characterizes the boll weevil larva, which forms a chamber of frass as it feeds on seeds of a developing cotton boll. Below, the boll weevil pupa inside the larval chamber.

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eggs and start infestations whenever host material is available.

Adults emerge from bolls throughout the winter when the average temperature is 55°F or higher, and they may emerge as late as the end of May. Emergence of weevils that develop in late-season bolls (October and November) begins in late December to early January, peaks in late January through February, and declines thereafter to late May. Burial of the infested bolls reduces adult emergence.

Many of the boll weevils emerging from December through mid-March die (suicidal emergence), but a small percentage may survive until early May. Moist conditions in bolls and plant trash enhance survival. Weevils that emerge early in the spring do not have a source of cotton for food needed for reproduction. Plants of *Sphaeralcea* spp. (the most abundant is globe mallow) are commonly found throughout the cotton-growing areas in Arizona and California, however, and have been shown to be an alternative source of food for adult boll weevils.

Female weevils that survive until cotton squares are available feed and lay eggs on them. Most damaged squares begin to abscise on the second day after the feeding puncture occurs and about 65 percent fall to the ground. Early in the growing season, before full plant canopies form in cotton fields, soil surface temperatures may reach 140°F; where these temperatures are above 100°F for prolonged periods, boll weevil mortality is high in the shed squares.

Monitoring and control

Adult boll weevil activity early and late in the cotton-growing season can be detected with traps baited with Grandlure, the synthetic boll weevil aggregation pheromone. In the southeastern Cotton Belt, trap catches of more than 2.5 boll weevils per field per week during the appearance of the first one-third grown squares indicate a need for control action. That threshold has been adjusted, both up and down, for some areas within the California eradication program.

Boll weevil populations in Arizona and California, unlike those in most areas of the Southeast but similar to those in the subtropical areas of Texas, remain physiologically active throughout the year.

California and Arizona state agencies, the federal government, the Universities of California and Arizona, and the Mexican government are cooperating in an effort to eradicate or reduce population levels of the boll weevil to non-economic levels.

The most important component of existing control technology is creating a host-free period of two to three or more months through the establishment of planting dates and early crop termination and plowdown. Survey and detection systems with Grandlure-baited traps identify areas of potential infestation. Boll weevils in these areas are treated with insecticides at the pinhead-square plant development stage, followed by applications at five- to six-day intervals during the development of one or two boll weevil generations. Insecticides are also applied during the season when in-field infestations are discovered or trap catches adjacent to fields indicate that treatments would be beneficial.

Preliminary research

During the fall and winter of 1982-83, the California Department of Food and Agriculture (CDFA) conducted extensive trapping to detect and monitor boll weevils in the Palo Verde Valley, California. In the fall of 1983, we selected a 24-acre field reported to have had high trap catches during 1982-83 to study the occurrence and development of infestations. Grandlure-baited traps placed in the field on September 21 were checked every seven days until December 7, 1983. Baits were changed every 14 days.

Applications of ultra-low-volume malathion (triggered by the California eradication program) were made on October 28, November 3, 10, 16, 22, and 29. Beginning on September 28, we collected 200 green bolls per day from the treated field to evaluate the effect of the treatments on boll weevil infestations. The bolls were placed in ventilated plastic sweater boxes

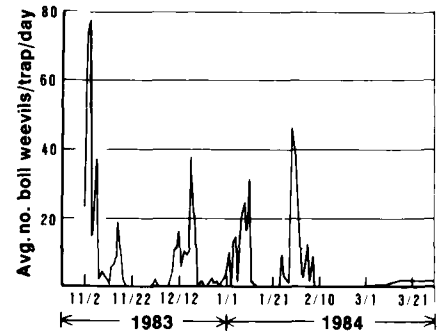

Fig. 1. Average boll weevil catches varied greatly in traps placed to monitor movement of weevils west from infested fields in Arizona.

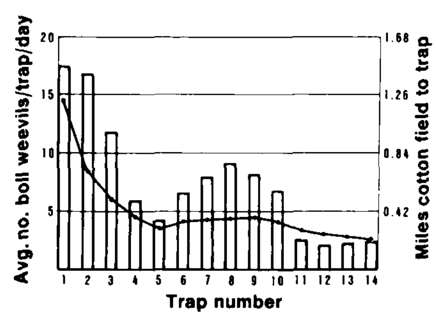

Fig. 2. Average trap catches were highest close to the Colorado River (trap 1), decreasing with distance from the river (#14).

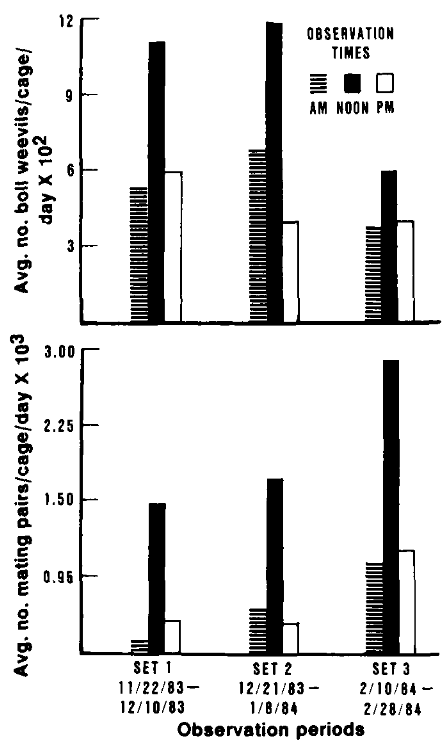

Fig. 3. Weevil numbers on cage screens and mating activity were greater at midday than in morning and late afternoon.

for two weeks and then examined for boll weevil adults, pupae, and larvae.

No boll weevils were caught in traps before September 30, but numbers increased (0.2 to 0.3 per trap per day) in mid- to late October. Weevil catches declined sharply (less than 0.05 per trap per day) after the second malathion application and did not increase thereafter. Apparently, the treatments reduced boll weevil trap catches, but numbers caught were low and no data from untreated fields are available for comparison. It is possible that the decline in trap catches was due to normal weevil movement out of the field as it dried after the last irrigation.

No boll weevils were found in bolls collected from the field during September 28 to November 10. Emerged adults or larvae in bolls were found on eight of the sampling days between November 11 and December 7, 1983, showing that an active in-field infestation had begun.

We studied boll weevil movement west from the Parker Valley, Arizona, into the California desert by installing 14 Grandlure-baited traps about a half mile apart with the first trap on the California side approximately 50 yards from the Colorado River and the last trap north and west at the San Bernardino County line. Traps were installed November 1 to November 11, 1983, and checked daily through March 31, 1984.

Boll weevil catches varied (fig. 1). The most weevils were caught in traps closest to the Colorado River and thus to infested cotton fields in Arizona (fig. 2). The highest numbers were in early November, and peaks also occurred in mid-December and early and late January. Catches decreased in late February through March.

Since relatively little is known about the biology of the boll weevil in the southwestern desert cotton-growing area, we began studies to detect reproduction and activity cycles of late-season trapped weevils.

Live weevils caught daily in traps from November 3 to 21 were placed in screen-ventilated holding boxes with 25 to 50 immature cotton bolls. On November 22, all live weevils (532) were divided into four samples. Each sample (133) was placed in a 3-square-foot screen cage over soil covered with approximately 3 inches of tamarisk needles. The procedure was repeated for live boll weevils (250 per cage) trapped between November 23 and December 20, except that the floors of the cages were covered with cotton trash (stalks, leaves). Similarly, two cages over soil covered with tamarisk needles were seeded with live weevils collected between December 21, 1983, and February 9, 1984 (350 per cage). These three time intervals are referred to in figure 3 as sets 1, 2, and 3.

In one field test to monitor movement of the boll weevil, the capture of adult weevils ranged as high as 80 per trap in Grandlure pheromone traps placed every half mile north and west from the Colorado River. Traps were checked daily.

Immature cotton bolls (10 per cage) were placed in each cage for weevil food and egg-laying. The bolls were replaced weekly during the studies. These bolls and all those provided for food in screen-ventilated holding boxes were opened and examined for boll weevil forms to determine whether reproduction occurred during the study period of November 3, 1983, to February 9, 1984.

Some feeding activity occurred on bolls placed in outdoor screen cages throughout the winter, as indicated by the numerous feeding punctures. Maximum numbers of feeding punctures were recorded from weevils placed in the cages on November 22. However, we found no infested bolls. This result is difficult to explain, since we found some live weevil progeny in the bolls placed for food in screen-ventilated holding boxes during the three collection periods showing that reproduction did occur.

Boll weevil activity was recorded in the cages between 8:00 and 10:30 a.m., noon and 1:30 p.m., and 3:30 and 5:00 p.m. Numbers of weevils on the cage screens, as well as mating pairs, were recorded daily for each observation period for all cages until February 29, 1984. Activity of weevils declined to nil by about 18 days after they were placed in the cages; therefore, we report data only for those 18-day periods. We estimated activity by plotting normalized activity values (numbers of single boll weevils or mating pairs per date or observation time divided by the numbers of boll weevils placed in cages for observation).

Mating activity and occurrence of all weevils on cage walls were greater at midday than in the morning or late afternoon (fig. 3). These results indicate that midday insecticide applications would probably be the most effective for weevil control. However, honey bees and other beneficial insects active during the day might be endangered.

Discussion

The future status of the boll weevil as an economically important pest in Arizona and California cotton production systems remains unclear. Crop sanitation and establishment of a host-free period reduced boll weevil populations in Arizona to noneconomic levels during the mid-1960s. When mandatory plowdown of cotton plants and trash as well as restricted planting dates were observed, the boll weevil was of minor importance. Arizona has recently reinstated similar cotton production regulations, and the same degree of success in reducing boll weevil populations may occur. If these cultural practices have a more limited effect, however, greater emphasis on sanitation practices and a longer host-free cotton period may be the most important components of integrated pest management systems developed to keep populations below economic injury levels and prevent movement of the pest to California's San Joaquin Valley.

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