Cultural Control and Pink Bollworm Populations

C. C. Chu and T. J. Henneberry

USDA, ARS, Western Cotton Research Laboratory, Phoenix, Arizona 85040-8830

Abstract

A cotton management program in the Imperial Valley, CA was designed to reduce pink bollworm, Pectinophora gossypiella (Saunders), populations. The program established 1 March as the earliest planting date, 1 September for defoliant or plant growth regulator application and 1 November for cotton stalk destruction and plowdown. In-season gossyplure-baited pink bollworm male moth activity monitoring and immature green cotton boll inspections for larval infestation were encouraged as decision making aids to determine the need for additional control action. Male pink bollworm moth catches in gossyplure-baited Lingren and delta sticky traps were significantly reduced each year from 1990 to 1994 following the initiation of the management program in 1989. Fewer larvae per cotton boll occurred in the years from 1990 to 1992. Fiber quality of commercial cotton sampled was also improved from 1989 to 1994, as compared to the 1984 to 1988 average. Cotton production, in general, was reduced during 1989 to 1994 in areas surrounding Imperial Valley and may have contributed partially to reduced populations in Imperial Valley.

Introduction

Overwintering pink bollworms *Pectinophora gossypiella* (Saunders), populations are particularly vulnerable to suppression strategies (Watson 1980, Henneberry 1986). Pink bollworm diapausing larvae overwinter in immature cotton bolls, trash, and soil (Bariola 1984). Diapause larvae begin to appear in late August to early September. A regulatory program mandating a cotton treatment on 1 September with a defoliant or plant growth regulator, and plowing shredded cotton stalks by 1 November was initiated in the Imperial Valley, CA on 1 January 1989 (Weddle et al. 1990). We compared 1981 to 1988 seasonal male pink bollworm population data to 1989 data before the regulatory program went into effect and since 1990 we evaluated the effect of the regulatory program on pink bollworm populations.

Materials and Methods

Pink Bollworm Male Moth Populations. From 1981 to 1988 four gossyplure-baited (0.1 mg per rubber septum) traps (Lingren et al. 1980) were placed in each of two to 13 cotton fields about 3.2 ha in size at the USDA-ARS

Irrigated Desert Research Station, Brawley, CA. From 1989 to 1994, two to four gossyplure-baited traps were placed in four to 13 cotton fields. In all years, traps were checked daily during the growing season and male moths counted. Also, from 1989 to 1994, gossyplure-baited delta traps, two per field, were placed in commercial cotton fields. Traps were checked twice a week during the growing season.

Pink Bollworm Larval Populations. Pink bollworm larval densities in cotton bolls at the USDA-ARS Irrigated Desert Research Station were determined by taking weekly immature green boll (14 to 21 d-old bolls) samples in June through August, 1989 and in July and August, 1990 and 1991. On average, 25 bolls were sampled from each field weekly. Bolls were incubated in screen ventilated plastic boxes in an outdoor screen house for at least 2 weeks, then larvae, pupae and adults were counted in the boxes and dissected bolls.

Immature green boll samples also were taken weekly from commercial cotton fields from July to September 1989 and June to September in 1990 and 1991, and July and August in 1992. One hundred bolls were picked per field (25 per quadrant) each wk. Boll samples were held in ventilated boxes as described for 2 weeks or more and moths, pupae, and larvae in the boxes and in dissected bolls were counted and recorded.

Cotton Acreage, Lint Yields and Quality from Commercial Cotton Fields. Cotton acreage grown and lint yield data were also obtained from the Imperial County Agricultural Commissioner's Office, El Centro, CA. Lint quality data were obtained from a cotton ginning company (R. Bedwell, Planter's Gin, Brawley, CA, 1994). Cotton lint was classified for color (whiteness) and leaf grade (leaf particles in lint) and expressed as percentages of cotton in middling Grade 31, the highest grade for Western cotton (USDA 1993). Data were summarized as mean cotton yield from 1984 to 1988 and as yield and lint quality for each individual year from 1989 to 1994.

Results and Discussion

Seasonal Distribution of Pink Bollworm Male Moths Caught Prior to the Initiation of the Regulatory Program (1981 to 1988 Monthly Averages) - Irrigated Desert Research Station. Mean numbers of pink bollworm male moths caught per Lingren trap per night from 1981 to 1988 were 0.2 in March and April. Numbers increased in May, June and July to 1.6, 4.8, and 12.0, respectively, with peak catches of 200 in August followed by decreased numbers of 161.0 per trap per night in September.

Pink Bollworm Male Moth Captures - Irrigated Desert Research Station. The mandated cotton crop treatment with a defoliant or plant growth regulator was first enforced in the Imperial Valley, CA on 1 September 1989. Thus, the impact of the September treatment was not realized until the growing season of 1990. As a consequence, mean numbers of pink bollworm male moths caught per trap and the seasonal distribution during the 1989 growing season (Fig. 1) were similar to the mean numbers caught during the season from 1981-1988. Beginning in 1990, the first year following the mandatory crop termination, trap catches each year were lower throughout the growing season as compared to 1989 and the 1981 to 1988 averages. In 1994, one native pink bollworm male moth was caught each month in June, July, and August.

Commercial Fields. The mean number of male moths caught per gossyplure-baited delta trap per night in commercial cotton fields ranged from 0.41 to 7.88 during the growing season from April to September 1989 (Fig. 1). Moth trap catches in 1990 were lower for April, May, and June and greater in July, August, and September as compared to those in 1989. In 1991 and 1992, moth trap catches were lower each year and each month than the numbers caught in 1989. In 1993, the greatest moth trap catch of 1.36 moths per trap per night occurred in September. Fewer moths were caught in 1994 with a peak catch of 0.15 moths per trap per night occurring in May, and no moths were caught in August and September.

Pink Bollworm Larval Populations - Irrigated Desert Research Station. Pink bollworm boll infestations in 1989 were 1.3, 22.4 and 19.4 larvae per 100 bolls in June, July and August, respectively (Fig. 2). In July of 1990 and 1991, larval infestations in bolls were 1.2 and 4.3 larvae per 100 immature green bolls, respectively. One heavily infested field adjacent to a residential area was the primary cause of the high larval infestation of 73.4

larvae per 100 bolls experienced in August, 1990. The high level infestation was probably because cotton was grown there in previous years and had never been treated with insecticide due to the proximity of the urban development.

Commercial Fields. In 1989, mean numbers of pink bollworm larvae in immature green bolls in commercial cotton fields ranged from 22.9 to 91.6 larvae per boll (Fig. 2). In 1990, the first year following initiation of the mandatory cotton termination, the number of larvae per 100 immature bolls ranged from 2.0 in June to 27.2 in September and remained at these or lower levels during the growing seasons of 1991 and 1992. Yearly mean numbers of larvae per 100 bolls were 68.0 in 1989, and decreased to 11.3, 7.1 and 7.5 in 1990, 1991, and 1992, respectively.

Cotton Acreage, Lint Yields, and Lint Qualities in Commercial Cotton Fields from 1984 to 1994 in the Imperial County, CA. Annual cotton production from 1984 to 1988 was about 9,454 ha (Table 1) (Imperial County Agricultural Crop and Livestock Reports 1977-1984). Cotton production was reduced to about 5,250 ha in 1989 and to about 3,710 ha in 1994 (from about 3,872 to 2,790 ha in Imperial Valley). Average lint yield was 6.2 bales per ha during 1984-1988 and 5.7 bales per ha in 1989. Yields ranged from 4.9 to 5.4 bales per ha from 1991 to 1990. Yields increased to 6.7 bales per ha in 1993 and to 6.9 bales per ha in 1994. Prior to the implementation of the mandatory short-season cotton management system, the mean percentage of cotton classified as top lint grade was 54% (1984-1988). Percentages of cotton classified as top grade lint ranged from 90 to 99% from 1990 to 1994.

Cotton plants exhibit perennial growth habits and may continue vegetative growth and reproductive cycles year round if temperature, nutrition and moisture are adequate. In Arizona and southern California, the first fruiting cycle occurs from June to August. After a 1-2 week "cut out" period, plants resume flowering and fruit setting until October. The cotton bolls set in the first cycle of fruiting contribute about 85% of the total bolls produced in the cotton season (Kimball et al 1977). The occurrence of pink bollworm diapausing larvae coincides with the second fruiting cycle (Fig. 3). Termination of cotton growth to reduce the numbers of immature green bolls as a source of food and shelter after early September reduces the number of larvae in the overwintering generation (Henneberry 1986). The impact of this approach on reduction of pink bollworms in subsequent years is illustrated dramatically in our work in Imperial Valley.

Average cotton lint yield, from 1984 to 1988, prior to the initiation of the short-season program was 6.2 bales per ha. Average lint yield, from 1990 to 1994, following initiation of the short-season program was 5.9 bales per ha. These data suggest that under high pink bollworm densities, bolls that set during the second fruiting cycle contribute little to the total yield (Bennett et al 1967). Improved cotton management, development of earlier maturing varieties, and reduction of cotton production on marginal land for short-season management probably resulted in increased cotton yields in 1993 and 1994. Further, lint quality also improved following the establishment of the short-season cotton management system. The mean classification percentage of top grade cotton lint in the period from 1984 to 1988 was 54%. Lint grade classifications in 1989 and thereafter increased significantly because higher quality lint was harvested from the first fruiting cycle.

Results from the sampled cotton fields in the Imperial Valley, CA indicate that the short-season cotton system has been very effective in reducing pink bollworm densities and boll damage. Continuation of the short-season cotton system in Imperial Valley should result in further suppression of the pink bollworm population. However, some diapausing larvae occur as early as 25 August. Also, there apparently remain a few fields where pink bollworm larvae still occur in high densities. Miller et al (1993) reported that a field in Niland, CA, located north of the Imperial Valley, had a high pink bollworm infestation in 1992, and 7.5-13.5% larvae were in diapause between August 20 and 22. The authors suggested that the early pink bollworm larval diapause was induced by early cotton defoliation as a result of a high *B. argentifolii* infestation. These results suggest a selection pressure for early diapause because of diminishing pink bollworm food sources and/or moisture stress of plants. It is also possible that other short-season cotton management methods could be selecting for early pink bollworm diapause. These factors must be addressed in future research in relation to the short-season cotton management for cultural control of the pink bollworm.

References

Bariola, L. A. 1984. Pink bollworm: Factors affecting survival of diapause larvae and emergence of overwintered moths in the spring in central Arizona. USDA--ARS, ARS--6.

Bennett, O. L., L. J. Erie, and A. J. Mackenzie. 1967. Boll fiber and spinning properties of cotton as affected by management practices. USDA Technical Bulletin. 1372.

Henneberry, T. J. 1986. Pink bollworm management in cotton in the southwestern United States. USDA--ARS, ARS--51.

Imperial County Agricultural Crops, and Livestock Report. 1977--1984. Imperial County Agricultural Commissioner's Office, El Centro, CA.

Kimball, B. A., D. L. Kittock, T. J. Henneberry, and L. A. Bariola. 1977. Computer program for predicting the reduction of pink bollworm populations by chemically terminating late--season bolls in cotton. ARS W--48, Oct. 1977, USDA--ARS.

Lingren, P. D., J. Burton, W. Shelton, and J. R. Raulston. 1980. Night vision goggles: for design, evaluation and comparative efficiency determination of pheromone trap for capturing live adult male pink bollworms. J. Econ. Entomol. 73: 622--630.

Miller, T. A., M. Salama, R. C. Weddle, and S. Sivasupramaniam. 1993. New test reveals early diapause in pink bollworm. Calif. Agric. 47: 24--26.

USDA. 1993. The classification of cotton. United States Department of Agriculture. Agric. Marking Service, Agric. Handbook 566, 23pp.

Watson, T. F. 1980. Methods for reducing winter survival of the pink bollworm, pp. 24--32. *In* H. Graham (ed.), Pink Bollworm Control in the Western United States. U.S. Dept. Agric., Sci. and Educ. Admin. ARM--W--16.

Weddle, R., S. Birdsall, R. Staten, C. C. Chu, and T. J. Henneberry. 1990. Progress report on the effect of shortening the cotton growing season on pink bollworm population in commercial cotton fields in Imperial Valley, CA, pp. 37--42. *In* Proceedings. Cotton Insect and Production Meeting, Holtville, CA.

Table 1. Cotton hectares and average lint yield per hectare in commercial cotton fields in the Imperial County, CA from 1984 to 1994.

	Average	Years					
	1984-88	1989	1990	1991	1992	1993	1994
Hectares (ha)	9,454[b]	5,250	4,459	3,614	1,713	2,937	3,710
Lint (bales/ha)	6.2	5.7	5.4	4.9	5.2	6.7	6.9
Top grade %[a]	54	92	90	94	90	99	99

[a] Grade 31 or above.
[b] Total cotton production in the Imperial County.

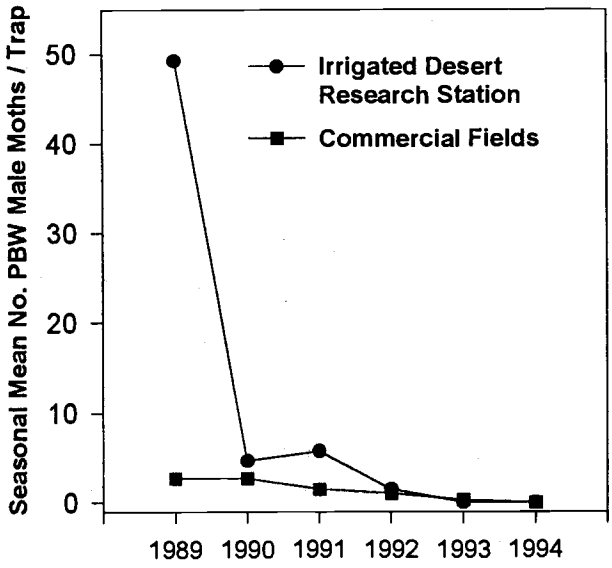

Figure 1. Seasonal mean number of pink bollworm male moths caught in gossyplure-baited traps at the Irrigated Desert Research Station, Brawley, CA and in commercial cotton fields in Imperial Valley, CA from 1989 to 1994.

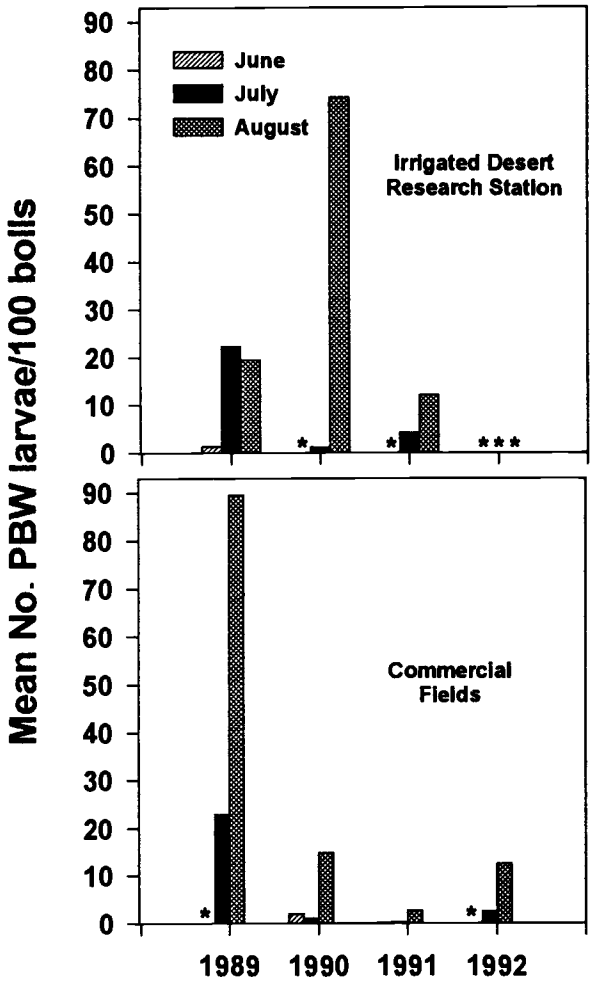

Figure 2. Mean numbers of pink bollworm larvae per 100 incubated immature cotton bolls from the Irrigated Desert Research Station and in commercial cotton fields in the Imperial Valley, CA from 1989 to 1992. * indicates no samples taken.

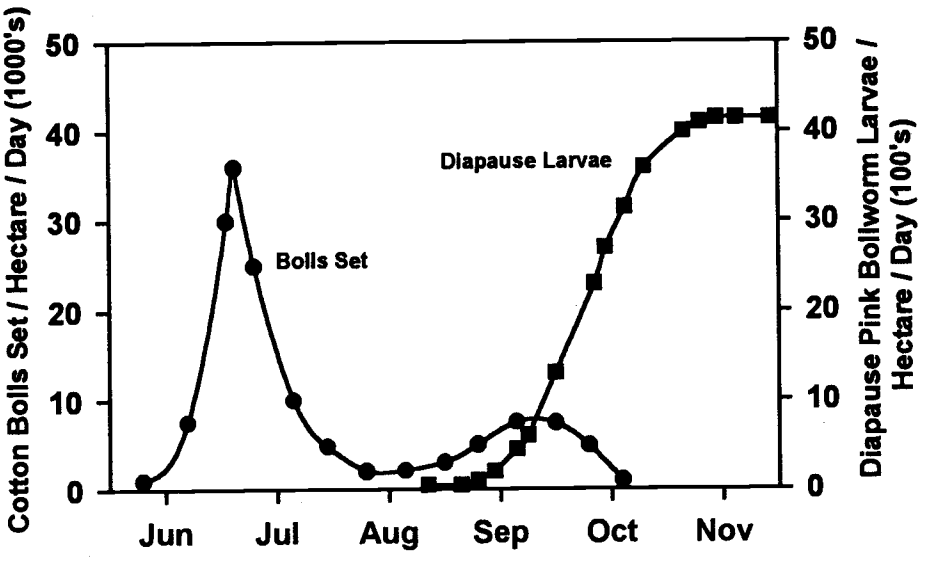

Figure 3. Seasonal cotton plant flowering in relation to occurrence of diapause pink bollworm larvae in the southwestern United States.