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Management of the pink bollworm *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) by mating disruption in cotton fields

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Abstract

The efficacy of mating disruption of pink bollworm *Pectinophora gossypiella* (Saunders) was evaluated by monitoring its population with pheromone baited traps as well as by sampling flowers and bolls to record damage levels in cotton fields in 1988 and 1989, in central Greece. PB-rope dispensers were used at a rate of 1000 per hectare in the treated fields, each field covered an area of 10 and 15 ha in the first and second year, respectively. These treated fields were compared with control fields in which 2–3 insecticide sprays were applied. The dispensers reduced pink bollworm catches in pheromone traps and reduced crop damage. The direction of cotton rows in relation to the prevailing wind had a significant effect on moth catches and needs to be taken into account when using dispensers. Mating disruption was effective in preventing damage when applied early season, but damage levels were not proportionally reduced in relation to the reduction of trap catches. Sufficient gossyplure for reducing moth catches in the traps was in pheromone dispensers even 90 days in the field.

Keywords: Mating disruption; Gossyplure; Crop damage; Pink bollworm; Lepidoptera; Cotton; *Pectinophora gossypiella*

1. Introduction

The pink bollworm *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) is considered to be one of the most injurious cotton pests, because it is difficult to control with insecticides. Many eggs are laid on the sutures or under the bracteoles at the base of the boll, particularly on bolls up to 14 days old, so hatching larvae can penetrate flowers or bolls within 20–30 min (Hutchison et al., 1988) or within 2 h (Ingram, 1994). Sometimes several sprays have been applied, which leads to outbreaks of secondary pests, otherwise regulated by natural enemies.

As an alternative method of controlling pink bollworm, Ouye and Butt (1962) demonstrated that virgin males were attracted to an extract of homogenized mating pairs. "Hexalure" attractive to males, was described by Green et al. (1969), but then Hummel et al. (1973) identified the natural sex pheromone of pink bollworm, a 1:1 mixture of the Z,Z- and Z,E-isomers of 7,11-hexadecadienyl acetate, named "gossyplure". Gossyplure has been used for monitoring of pink bollworm (Bariola et al., 1973; Kaae et al., 1977; Qureshi et al., 1984; 1993; Buchelos et al., 1999) but it has also been widely used for control by mating disruption (Gaston et al., 1977; Brooks et al., 1979; Staten et al., 1987; Critchley et al., 1991; El-Deeb et al., 1993; Cardé and Minks, 1995; Kehat et al., 1999; Urquijo and Manzano, 2002).

Mating disruption is achieved when gossyplure is dispersed at high doses in cotton canopy, and can result in low damage levels. PB-rope dispensers provide high-dose-rate release of pheromone over a long period that

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significantly reduced moth catches in traps (Flint et al., 1985; Staten et al., 1987). A microencapsulated pheromone formulation, has been applied aerially, but its effectiveness was reduced after the end of July, but gave similar effectiveness to insecticide sprays (Critchley et al., 1983).

The objective of this work was to evaluate the effect of several factors on efficacy of mating disruption on pink bollworm catches in pheromone traps and damage levels. These factors were: (a) the cotton variety, (b) the direction of planting lines in relation to the prevailing wind, (c) the damage levels at the inner or peripheral part of a cotton field where mating disruption was applied and (d) whether establishment of dispensers early in the season offers adequate control of pink bollworm till the end of the growing season. Finally, the pheromone release rate was examined throughout the season.

2. Materials and methods

This study was conducted at cotton fields located near Thiva in the area of Boeotia, central Greece in 1988 and 1989. Each year, one or more cotton fields were treated with mating disruption of *P. gossypiella*, whereas another field located 600–800 m away from the treated field(s), was treated with conventional insecticides. Control and pheromone treated fields were almost always surrounded with cotton fields, in which conventional control measures were applied. In both control and treated fields similar fertilization, cultivation and irrigation practices were applied. Irrigation normally took place every 15 days.

2.1. Population monitoring

The population abundance of pink bollworm was recorded in both control and treated fields using Zoecon traps (Zoecon, California, USA) baited with 1 mg of gossyplure (48:52 ratio of Z,Z- and Z,E-isomers). Baited traps were hung at the top level of the plant canopy and the baits renewed at intervals of 15–20 days, throughout the sampling period.

2.2. Mating disruption

Mating disruption was applied by placing 1000 PB-rope dispensers per ha, made by Shin-Etsu Chemical Co. Ltd. (Tokyo, Japan). Each dispenser was 200 mm long and 2.5 mm in diameter, and contained 78 mg (AI) of gossyplure. Dispensers were twisted by hand around the main stem of plants, above the first or second pair of real leaves. Mating disruption, which actually reflects communication disruption, was estimated using the formula: % Disruption = control plot catch − treated plot catch/control plot catch × 100 (Critchley et al., 1991).

2.3. Damage estimation

The percentage infested plant parts by *P. gossypiella* was estimated by collecting samples in both control and treated fields. In the beginning flowers were sampled and after the end of July bolls were randomly collected. Samples were carefully examined for the presence of or damage caused by pink bollworm larvae.

2.4. Pheromone release rate

In both years, 10 of the dispensers, established in the central part of each field, were marked and the amount of the gossyplure they contained was estimated by measuring the length of the liquid column remaining in each of them at 10 and 15 day intervals in 1988 and 1989, respectively.

2.5. Experimental procedure

In 1988, PB-rope dispensers were placed in two rectangular cotton fields of 10 ha each. The cotton varieties Zeta-2 and Sindos were planted in the first (T_1) and in second (T_2) treated fields, respectively. In each treated field four traps and in each control field one trap were placed. The control fields (C_1 and C_2) were 10 ha each and planted with the same cotton variety as that of the treated fields and located 800 and 600 m away from T_1 and T_2 treated fields, respectively. The traps in the treated fields were placed at equal distances along the field diagonal. In the field T_1 planting lines were perpendicular whereas in T_2 planting lines were parallel to the direction of the prevailing wind.

The traps were placed in all fields on 20 April. Moth catches in the traps were recorded at 3 d intervals until early September. PB-rope dispensers were established on 8 June in T_1 and on 6 June in T_2 fields. Plants were sampled at about 10-day intervals from early July until harvest.

At each sampling date, 100 samples were randomly collected from each field following diagonal transects. In the treated field T_1 100 samples were taken both from the central part (T_{1C}) (1 ha) and from the peripheral (T_{1P}) part of the field.

In each of the control fields (C_1 and C_2) three insecticide sprays were applied; in C_1 field spraying took place on 20 July, 12 and 28 August whereas C_2 field was sprayed on 18, 30 July and 14 August.

In 1989, PB-rope dispensers were applied in a cotton field of 15 ha, which was planted with the cotton variety Zeta-2. The control field was located 600 m away from the treated field. In the treated (T_3) and control fields (C_3) three and one traps were placed on 24 May,