Integration of pheromones and biological control for the management of cotton bollworms in Pakistan

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Abstract. The management of cotton bollworms in a semi-isolated area through the use of inundative releases of the egg parasitoid *Trichogramma chilonis* (Hymenoptera: Trichogrammatidae) in conjunction with pheromones suppressed populations of the pink and spotted bollworms to sub-economic levels. The parasitoid was more effective against pink bollworm than spotted bollworm. Applications of either pheromones or parasitoids by themselves were less effective when compared to the combined treatment. The level of parasitism in the cotton field was comparatively low in June and July but gradually increased during August and September. Maximum parasitism was recorded in November. Studies indicated that temperature affected the establishment of the parasitoid, and populations increased significantly when favourable conditions prevailed in the cotton field.

1. INRODUCTION

The pink bollworm, PBW, *Pectinophora gossypiella* (Lepidoptera: Gelechiidae) is a pest of great economic importance in many cotton-growing countries. The control of this pest depends largely on the application of pesticides, which has precipitated the development of resistance. As a result, in order to achieve effective control, more chemical applications per season are needed [1]. Furthermore, control of this pest using insecticides becomes ineffective due to the concealed feeding habits of the larvae inside the cotton bolls [2]. The continued application of insecticide to manage this pest also can lead to serious outbreaks of secondary pests in cotton [3, 4].

Alternative control strategies, such as mating disruption with synthetic pheromone [5, 6] and conservation of natural enemies [7], are being studied for their potential role in an integrated pest management program for PBW. Although effective control of PBW using mating disruption has been reported in Pakistan [5, 6], secondary infestations by the spotted bollworm, *Aerias vittella* (Lepidoptera: Noctuidae), require additional insecticide applications for their control. As such, the full potential of mating disruption may only be achieved if it is integrated with other environmentally friendly techniques that can control the other bollworm species. The egg parasitoid, *Trichogramma chilonis* has the potential to control all three species of cotton bollworms and would integrate well with mating disruption on an area-wide basis.

2. MATERIALS AND METHODS

Studies were conducted in a semi-isolated area (202.35 ha) planted with cotton. The area was divided into five blocks that received one the following treatments. The first block was treated with *Trichogramma chilonis* which had been reared on eggs of the Angoumois grain moth (*Sitotroga cerealella*) in the laboratory. The parasitoid colony was maintained at 25±2°C and 60±70% relative humidity. To prepare the parasitoids for release, eggs of the Angoumois grain moth were glued to white paper cards and exposed to adult parasitoids for 24 h. The parasitoids were released in the field by attaching the cards with parasitized eggs to cotton leaves at 14 d intervals at the rate of 20,000 parasitoids per hectare for the duration of the season. The second block was treated with commercially available PBW and spotted bollworm pheromones at the prescribed rates [8, 9]. The third block received a combination of

parasitoids and pheromones. The fourth block was treated with conventional insecticides, receiving a total of six sprays during the season. The fifth block was untreated and served as a control.

The presence and establishment of the parasitoids in the cotton fields was ascertained using sentinel cards of Angoumois grain moth eggs prepared as described above. These cards were left in the field for 24 h and then brought back to the laboratory. The assessment was repeated every 15 days. In addition, field infestations of pink and spotted bollworms were recorded at weekly intervals. The data were analyzed statistically using the DMR test.

3. RESULTS AND DISCUSSION

Pink and spotted bollworms were effectively controlled in blocks receiving the combination of pheromones and egg parasitoids (Table 1). Infestations of both species in the insecticide treated blocks were comparable to those found in the pheromone plus parasitoid treatments. However, infestations detected in the block that received only parasitoids or only pheromones was much higher than in the other treatments. In the case of PBW on flowers, this difference was significant. Spotted bollworm infestations were higher than PBW in all the treatments. This might be due the possibility that the spotted bollworm pheromone became less effective over time because of degradation and isomerization of active ingredients by ultraviolet light [9].

Table 1. Mean percent infestation by pink bollworm, *Pectinophora gossypiella*, and spotted bollworms, *Aerias vittella*, in the different experimental blocks

Treatments	Percentage Infestation by			
	PBW		Spotted bollworm	
	Flowers	Green Bolls	Flowers	Green Bolls
Pheromones + Parasitoids	5.91 d	4.52d	9.11 c	8.21 c
Pheromones	8.90 c	8.03 c	11.32 c	14.12 b
Parasitoids	12.54 b	11.39 b	14.64 b	13.89 bc
Insecticides	6.88 d	6.97 c	10.50 c	9.80 c
Untreated Control	22.14 a	16.25 a	31.19 a	23.93 a

Means followed by the same letters are not significant ($P < 0.05$).

Pink and spotted bollworm infestations were significantly lower in all treatments as compared to the untreated controls suggesting that all treatments had some degree of field effectiveness. However, parasitoid establishment in the field was low during the warmest moths and gradually increased as the temperature and relative humidity became more favourable (Table 2). Parasitoid establishment started increasing in August and maximum parasitism rates were recorded during November. Our results suggest that temperature in the field plays an important role in the establishment and field persistence of the parasitoids.

Our results suggest that pheromones by themselves did not control the infestation of both species of bollworms as effectively as the use of combined treatments (parasitoids plus pheromones). However, the true treatment effects may have been obscured because the distance between our different blocks may have been too small (~50m). Henneberry et al. [10] suppressed PBW with pheromones to a significant degree when compared with results

Table 2. Mean percent parasitism by *Trichogramma chilonis* after releases into cotton fields

Month	Percent parasitization after releases		
	1 day after release	7 days after release	14 days after release
June	E 0.5 a	0.0	0.0
July	E 0.26 a	0.0	0.0
August	D 1.13 a	D 0.44 b	0.0
September	C 8.44 a	C 1.57 b	C 0.88 b
October	B 15.37 a	B 5.19 b	B 2.04 c
November	A 22.51 a	A 8.88 b	A 7.12 b

Letters on the left and right sides of the mean values show intra and inter column variations.
Means followed by the same letters are not significant ($P < 0.05$).

recorded in insecticide treated blocks. However, their experiments were conducted in large isolated areas. Parasitoids have long been recognized as an important insect suppressive tool and in many cases they have controlled the target pest to a degree where no further control treatments have been necessary. Nonetheless, biological control has not always provided adequate control [11]. Our preliminary results suggest that the application of parasitoids in combination with pheromones might be appropriate for the control of the lepidopteran pest complex in cotton in Pakistan. Studies in large isolated blocks should be conducted to assess the full potential of combining these environmentally friendly tactics.

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