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Biological Control of Pink Bollworm (*Pectinophora gossypiella,* Lepidoptera: Gelechiidae) by *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae) in Cotton (*Gossypium barbadense*)

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Abstract: More than 144,000 adult *Trichogrammatoidea bactrae,* (Hymenoptera: Trichogrammatidae) were released in short staple, Pima 5-6 cotton (*Gossypium barbadense* L.) in Sewer Farm (SF), New Mexico State, USA. Total parasitization in Pink bollworm (*Pectinophora gossypiella* S., Lepidoptera, Gelechiidae, PBW) eggs in two replications was 14.72% and 18.53% respectively.

Key words: *Trichogrammatoidea bactrae; Pectinophora gossypiella; Gossypium barbadense;*

Introduction

Pink bollworm (*Pectinophora gossypiella* sawnders: PBW) is a major pest of cotton and its infestations in cotton is increasing day by day (Naranjo, 1993). One of the major factor causing economic decrease in cotton is the over use of pesticides for the control of PBW and the resulting outbreaks of secondary pests such as white flies. During the last 80 years some 160 species of parasitic Hymenoptera in 43 genera were collected with or reared from Pink bollworm. The genera *Apanteles*, *Bracon* and *Chelonus* among the Chalicidae contribute numerous species of potentially useful Pink bollworm parasitoids. Presently *Apanteles oenone* (Nixon), *Brachymeria* sp., *Chelonus* sp. nr. *curvimaculatus* (Cameron), *Goniozus cabo verde* (Legner), *Goniozus pakmanus* (Gordh), *Elasmus broomensis* (Naumaner and Sands) and *Trichogrammatoidea bactrae* (Nagaraja) have been imported from Argentina, Pakistan and Australia to USA for the control of *Pectinophora* and *Heliothis* spp.. Among these imported parasitoids *Apanteles* sp. and *Bracon* sp. have been field released (Ellington, 1994). Several attempts to established PBW failed in different cotton areas of the world (Noble & Hunt 1937, McGough & Noble 1955 and Hentz *et al.* 1997). Several PBW biological control agents were collected (Legner & Medved, 1979). None became established, but a few of them reduced the population of PBW in the season of release (Hentz *et al.*, 1997). Parasitic Hymenoptera are very effective and environmentally safe for the control of agricultural pests (Bhatty *et al.*, 2000). *Trichogrammatoidea spp.*, Hymenoptera, are all egg parasitoids of economically important Lepidoptera (Hutchison *et al.*, 1990) which can be used in IPM of cotton for the control of *P. gossypiella* (Malik, 2000). The objective of this attempt was to find the parasitization of *T. bactrae* in the field of short staple, Pima 5-6 cotton (*G. barbadense* L.) against PBW.

Materials and Methods

Sewer Farm, New Mexico State, USA was selected for the release of *T. bactrae*. No chemical insecticides were applied at this farm. Cotton plot in this farm was about 1.06 hectares and was irregular in shape. Pima 5-6, short staple, cotton (*G. barbadense* L.) was planted in the field.

Trichogrammatoidea bactrae were reared at 23 °C, 55% RH and 11/13 photoperiod on PBW eggs (Malik, 2000). The colony of the parasitoid was established in the Laboratory of the Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, USA . PBW eggs were obtained from the colonies locally established in the department. To assure the availability of the parasitoid, more than 150,000 PBW eggs were parasitized in 6 separate colonies which cycled at different times. The average field temperature during the PBW season in New Mexico State, USA ranged from 22 to 38 °C like cotton areas of Pakistan.

Releases were made early in the morning to give the parasitoid an opportunity to adjust the field temperature. Morning temperature used to be between 18 to 22 °C in that area.

Pink bollworm eggs were collected on blotting paper cards. The eggs cards were cut down into small pieces (500 PBW eggs/card) and werestapled to the upper side of a cotton leaf with eggs side down, in the middle portion of the plant on each of 50 randomly selected plants. Pink bollworm eggs on the cards were turned towards the leave's surface to avoid being eaten by predators. After 48 hours each egg card was brought back to the laboratory and placed in an air tight petri dish (50 x 9 mm) at 23 °C, 55% RH and 11/13 photoperiod for emergence. This was the control treatment.

The next morning 50 egg cards (500 PBW eggs/card) were again stapled in the same way on different plants on one side of the field (east) and newly emerged (1/2 hour old) adults were released randomly at other side of field (west). The distance from point of release of *T. bactrae* to the stapled host eggs was 60 m. Temperature at the time of release was 19°C and 17.5 °C but the average day temperature was 34.7 & 32.5 °C during Ist and 2nd replications respectively. Wind speed was 10 & 09 Km/h from east to west during the two replications respectively. After 48 hours, all samples were brought back to the laboratory in air tight petri dishes (50 x 9 mm) counted and allowed to emerge for 15 days at 23 °C, 55% RH and 11/13 (light/dark) photoperiod . Blackening of the vitelline membrane of the host egg means parasitization by *T. bactrae* (Hutchison *et al.*, 1990). Thus black PBW eggs were counted. The experiment was replicated with same procedure after 20 days of the first release. Plots were arranged in a randomized complete block design. Each PBW eggs card was consider as sample. The data were analyzed by SAS (SAS Institute Inc., 1990). Analysis of variance (ANOVA), to get the difference between the parasitization rate before and after release of *T. bactrae* in two replications, was used.

Results and Discussion

The rate of parasitization by *T. bactrae* in Pink bollworm egg cards stapled on cotton leaves in the field before the *T. bactrae* release was nil therefore ignored in later analysis (Table 1). The results suggested that *T. bactrae* is not native to USA (Hutchison *et al.*, 1990 & Ellington 1994). Out of 25,000 PBW eggs on cards, 11398 and 10,026 eggs remained in the Ist and 2nd replications respectively (Table 1). Others were probably destroyed by predators. This was the control. After the release of *T. bactrae* the percent parasitization in two replications was 14.72 and 18.53 respectively (Table 2). Analysis of variance showed that egg parasitization was significantly different in the two replications. Higher parasitization in the 2nd replication may be due to the effect of the 1st replication. Glenn & Hoffmann

Table 1: Number of *P. gossypiella* Eggs Parasitized by *T. bactrae* Before it's Release at the Sewer Farm in Two Replications.

Replication	No. of Eggs Stapled to Leaves	No. of Eggs Recovered	No. of Black Eggs (Parasitized by *T. bactrae*)	Percent Parasitization (*T. bactrae*)
Ist	25,000	11,398	00	0.00
2nd	25,000	10,026	00	0.00

Table 2: Number of *P. gossypiella* Eggs Parasitized by *T. bactrae* After it's Release at the Sewer Farm in Two Replications.

Replication	No. of *T. bactrae* Released	No. of Eggs Stapled	No. of Eggs Recovered	No. of Black Eggs (Parasitized by *T. bactrae*)	Percent Parasitization
1st	72,000	25000	9203	1355	14.72
2nd	72,000	25000	13310	2467	18.53

(1997) found 37 to 87.5% parasitization by *Trichogramma carverae* oatman & pinto, (Hymenoptera: Trichogrammatidae) against leafroller *Epiphyas postvittana* (Walker) in wine grapes. Lawson *et al*. (1997) got low rate of parasitization (< 14%) by *Trichogramma* spp. in *Choristoneura rosaceana* (Harris). Factors affect the rate of parasitization are often difficult to define (Hassan, 1994).

Wind speed affects adversely the distribution of the tiny parasitoids (Dyer & Landis, 1997). Glenn & Hoffmann (1997) attempted the release in mild wind (0.3 to 6.8 Km/h) while the wind was 10 & 09 km/h at the time of these two releases respectively. Glenn & Hoffmann (1997) and Lawson *et al.* (1997) stapled the host eggs cards on the upper surface of the leaves with open face while PBW eggs in this study were stapled on the upper side of the cotton leaves with egg surfaces down. which might cause problems to the parasitoids in host findings (Legner & Medved, 1979). Keller & Lewis (1985) reported that population density influences to the parasitization. Glenn & Hoffmann's (1997) high parasitization rate might also be due to the high population density of the parasitoid over host (3:1). Lawson *et al.* (1997) had 2:1 which resembles to this release that might be the reason of low parasitization in both cases. Thus future studies on release patterns and densities are required (Hope *et al.*, 1990, Hassan 1994 and Smith 1994). Temperature affects inversely the distribution of the parasitoid (Dyer & Landis, 1997). Glenn & Hoffmann (1997) carried out their releases in 23 °C while the temperatures were 19 & 17.5 °C at the time of two releases respectively but the maximum day temperatures were, 34.7 & 32.5 °C respectively. This temperature fluctuation might affect adversely to the distribution of the parasitoid (Dyer & Landis, 1997). Parasitization rate has indirect relations to the distance between the host and parasitoid (Lawson *et al.*, 1997). The distance between *T. bactrae* and the host eggs was 60 m while the distance was < 10 m in Glenn & Hoffmann's (1997) and > 30 m in Lawson's *et al.* (1997) releases.

Although these parasitization rates are not high enough for single factor control, when used in combination with other mortality factors, *T. bactrae* may be a useful mortality factor in PBW Integrated Pest Management (IPM) programs. Frequent releases of the parasitoid are necessary to get it established in the cotton areas of the world like Pakistan. To avoid economic damage by PBW in cotton, farmers could combine cultural, pheromone and biological control techniques.

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