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Parasitizing potential of four Trichogramma species on the eggs of pink bollworm, *Pectinophora gossypiella* (Saunders)

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Abstract
The laboratory studies were conducted to evaluate the parasitising efficacy of four *Trichogramma* species against the eggs of pink bollworm *Pectinophora gossypiella* (Saunders) The results revealed that the maximum (>87%) and minimum (<36%) parasitisation was obtained in the case of *Trichogrammatidae bactrae* and *Trichogramma japonicum*, respectively. The increasing order of percent adult emergence from the parasitised pink bollworm eggs were as *T. bactrae* (91.25) < *T. chilonis* (88.66) < *T. brasiliensis* (52.08) < *T. japonicum* (49.09). There was no significantly difference seen in the developmental period among the four species which ranged between 6.17 to 7.33 days. Our results indicated that *T. bactrae* and *T. chilonis* were relatively more effective in parasitising pink bollworm eggs. Hence these two species of Trichogramma can be safely included in bio intensive IPM programmes for managing insect pests in agro-ecosystems more effectively.

Keywords: Pink bollworm, *Trichogrammatoidea bactrae*, parasitisation

Introduction
The pink bollworm is a major pest of cotton, its infestation in cotton is increasing day by day (Naranjo, 1993) [13]. It lays eggs on squares, flowers and green bolls where the destructive larvae of pink bollworm usually devours flower buds, bolls and seeds therein, which results in malformation, rotting, premature or partial boll opening, reduction in fiber length and overall quality reduction in cotton crop due to staining of the lint. In general, long duration of *Bt* hybrids leads to multiple cycles of pink bollworm to flourish which ultimately leads to development of resistance, at the same time the hybrids being heterozygous in their genetic makeup also adds up the reason for the resistance development (Naik *et al.*, 2017) [9]. Other than these non-compliance of refugia and monophagous nature of pink bollworm are also the major factors but, the main being that the larval stage is usually buried within the cotton fruiting bodies making them unreachable by insecticidal sprays owing to which its management is a difficult task for cotton growers (Dastur and Asana, 1960) [2]. So, pink bollworm could be an appropriate host that could be easily controlled by biological control agent like Trichogramma as it being an egg parasitoid could terminate this pest at the earliest stage i.e. egg stage itself and could prove as a great tool to manage this pest effectively. Although Trichogramma being popular already, a deep and complete knowledge about its parasitising capacity at different parameters is of great necessity. So, the following study is under taken to see the efficacy of four Trichogramma species to parasitise the eggs of pink bollworm where in the parasitising potential, percent adult emergence were observed under laboratory conditions in order to identify the most effective species of Trichogramma among the tested species.

Methods and Material
Experiment was conducted in Insect Bio control laboratories at ICAR-CICR, Nagpur, India. Different species of Trichogramma used were *Trichogrammatoidae bactrae* (Nagaraja), *Trichogramma brasiliensis* (Ashmead), *Trichogramma japonicum* (Ashmead) and *Trichogramma chilonis* (Ishii). Eggs of *Corcyra cephalonica* were used as laboratory factitious host for all the species of parasitoids. Host culture (*Pectinophora gossypiella*) was maintained on artificial diet (Naik *et al.*, 2017) [9]. Each species of Trichogramma was reared in glass vials as described by Morison (1970) [7]. 27 ºC temperature and 65 percent relative humidity was maintained while rearing. The different life parameters, i.e. developmental period, percent parasitisation and percent adult emergence of all the egg parasitoid species, i.e. *T. bactrae, T. brasiliensis, T. japonicum* and *T. chilonis* in incubators was recorded.

Twenty percent honey solution was used as adult diet of Trichogramma. About 100 *Pectinophora gossypiella* eggs of same age i.e. (24hr) old were glued on paper cards and then, parasitised by 4 gravid females of each of the *Trichogramma* species in glass vials separately and six replications were made for each treatment and the egg-cards were examined for parasitization after 5 days of parasitoid release and the number of parasitised eggs were counted under stereo zoom microscope and percent parasitisation was worked out using following formula.

$$\% \text{ Parasitization} = \frac{\text{Number of eggs parasitised}}{\text{Total number of eggs exposed}} \text{ x } 100$$

The data regarding developmental period, percent parasitisation and percent adult emergence of the four species was obtained subsequently. Identification of male and female were made on the basis of type of antennae as identified by Pinto *et al.* (1978) [10]. Completely randomized design was used to analyse data and DMRT was applied to find the significance of our results.

Results and Discussion

Percent parasitisation

The results revealed that, under conditions of this test, the maximum parasitisation was shown by *Trichogrammatoidae bactrae* (87.83%), which was found most effective and resulted in, significant parasitisation of pink bollworm eggs over the rest of the treatments. Whereas *Trichogramma chilonis* (Ishii) was recorded with 83.83 percent parasitisation (Table 1) Mohammad Faheem Malik (2001) [6] reported that, the maximum percent parasitisation (95.81%) by *T. bactrae* against pink bollworm eggs under complete light conditions and Nadeem and Hadim (2008) [8] also recorded 88.4 and 87.5 percent parasitisation by *T. bactrae* and *T. Chilonis*, respectively at 30 ºC on the eggs of *Sitotroga cerealella* in laboratory condition. Whereas the remaining species were effective in descending order of their efficacy to parasitise *i.e. T. brasiliensis* followed by *T. japonicum* which observed with 50.83 and 35.85 percent parasitisation, respectively. Sangwan *et al*. (1972) [11] reported that, percent parasitisation by *Trichogramma brasiliensis* was 74.25 and 64.77 percent on spotted bollworms, *Earias insulana* (Boisd) and pink bollworms, *Pectinophora gossypiella* (Saund), respectively when the parasitoid was released at 7-10 days interval throughout the ovipositional period.

Percent adult emergence

The percent adult emergence from parasitised eggs of pink bollworm was recorded two days after completion of pupal period i.e. on ten days after release of *Trichogramma* species by counting the number of parasitised eggs with emergence holes.

Among all the *Trichogramma* species *T. bactrae* recorded highest 91.25 percent adult emergence which was significantly better over other species, Abraham and Pradhan (1976) [1] who recorded that, there was a significant improvement in adult emergence, fecundity and progeny production by *Trichogramma australicum* after rearing for 32-33 generations at increasing temperatures from 30-33 ºC. However, *T. chilonis* was recorded with 88.66 percent adult emergence followed by *T. brasiliensis*, with 52.08 percent emergence, Nadeem and Hadim (2008) [8] who also recorded 91.8 and 90.4 percent adult emergence by *T. chilonis* and *T. bactrae* respectively, at 30 ºC on the eggs of *Sitotroga cerealella* in laboratory conditions. Tuhan *et al.* (1987) [12] concluded that, there was a considerable reduction is bollworms infestation in cotton when *Trichogramma brasiliensis* was released at the rate of 20,000 adults per acre. However *T. japonicum* recorded significantly lowest percent adult emergence (49.09%).

Developmental period of *Trichogramma* species on eggs of pink bollworm

The data recorded on the variation in development period of different *Trichogramma* species on the eggs of pink bollworm, *Pectinophora gossypiella* (Saunders) (Table 1). There was no significantly difference seen in the developmental period which ranged between 6.17 to 7.33 days. Harrison *et al.* (1985) [4] concluded that, developmental time decreased with increase in temperature from 15, 20, 25, 30 and 35 ºC in both parasitoid species of *Trichogramma pretiosum* and *Trichogramma exiguum* Pinto on the eggs of *Heliothis virescens.* However Muhammad Faheem Malik (2001) [6] recorded the speed of development of *T. bactrae* to be ranged from 7.27 to 6.53 days at 30 to 40 ºC on the eggs of pink bollworm, *Pectinophora gossypiella* (Saunders).

Table 1: Efficacy of different *Trichogramma* species against pink bollworm eggs

Treatment No.	Treatment detail	Parasitisation (%)	Adult emergence (%)	Developmental period (Days)
T_1	*Trichogrammatoidae bactrae*	87.83^a (69.58*)	91.25^a (72.55*)	7.00 (2.64**)
T_2	*Trichogramma brasiliensis*	50.83^c (45.46)	52.08^c (46.43)	7.33 (2.70)
T_3	*Trichogramma japonicum*	35.85^d (36.73)	49.09^d (42.64)	6.83 (2.61)
T_4	*Trichogramma chilonis*	83.83^b (66.29)	88.66^b (69.27)	6.17 (2.48)
	F test	Sig	Sig	NS
	S.E.(m) ±	0.83	0.95	
	C.D.5%	2.45	2.79	-

* Values in parentheses are arc sine transformed
** Values in parentheses are square root transformed

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