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MANAGEMENT OF COTTON PINK BOLLWORM *PECTINOPHORA GOSSYPIELLA* (SAUNDERS) WITH *TRICHOGRAMMA BACTRAE* AND *TRICHOGRAMMA BRASILIENSIS*

V. Chinna Babu Naik*, V. S. Nagrare, K. B. Subbireddy, Sujit Kumbhare, Pratik Wawdhane and T. Prabhulinga

Division of Crop Protection, ICAR-Central Institute for Cotton Research, Nagpur 440010
*Email: chinnaenton@gmail.com (corresponding author)

ABSTRACT

A field trial was conducted at ICAR-CICR research farm, Nagpur, during Kharif 2016-2017 and 2017-2018 to evaluate the efficacy of egg parasitoid *Trichogramma bactrae* (Nagaraja) and *Trichogramma brasiliensis* (Ashmead) along with insecticides as check for management of cotton pink bollworm. In 2016-2017, results showed least number of exit holes were in *T. brasiliensis* treated plots followed by chemical treatment and *T. bactrae.* However, number of mines per 10 green bolls seen lowest in *T. bactrae* followed by chemical treatment and *T. brasiliensis* with respect to control. The average reduction in larval population over control was lowest in *T. brasiliensis* followed by *T. bactrae* and chemical control. During 2017-18 data revealed that, number of exit holes was lowest in the plots sprayed with chemical insecticides and it was at par with *T. bactrae*. However, lowest number of mines on epicarp was noticed in the plots imposed with *T. bactrae* followed by chemical insecticides. The significantly lowest per cent locule damage was noticed in the chemical treatment. Though the infestation of pink bollworm in the form of boll and locule damage was significantly low in insecticides treated plots but it was comparable with *T bactrae* and *T. brasiliensis* released plots.

Key words: *Trichogramma bactrae*, *T. brasiliensis,* egg parasitoids, insecticides, pink bollworm, cotton

Pink bollworm, *Pectinophora gossypiella* (Saunders) is a worldwide insect pest of cotton causing significant economic loss to cotton production. It is a major concern in almost all cotton growing countries, including the top four cotton producing nations, India, China, USA and Pakistan. Yield losses estimates were 61% in the USA (Schwartz, 1983), 20.2% in India (Agarwal and Katiyar, 1979), 17-26% in China (Luo et al., 1986) and 20-30% in Pakistan (Mallah et al., 2000). Many researchers proposed technological options viz., insecticide applications (Toscano et al, 1974; Haynes et al, 1986), pheromones (Huber et al, 1979; Haynes et al, 1986), gossyplure (Henneberry and Clayton, 1982; Henneberry et al, 1981), parasitoids (Hutchison et al., 1990), host-searching kairomones (Chiri and Legner, 1983) short season cotton (Chu et al., 1996) and integrated approaches (Henneberry and Naranjo, 1998) etc. to manage the pest. However, invention of transgenic Bt cotton producing Cry1Ac and Cry2Ab toxins reported to be an important, economical and viable option not only against pink boll worm but to a complex of lepidopteron pests attacking the crop.

This leads to huge acceptance and wide area coverage mainly due to significant reduction in pesticide applications otherwise cotton was the top most consumer of pesticides especially in India. The high level of pink bollworm larval incidence was recorded on BG-II in central India after 2014 and after 2015 and 2016 in south India. The larval recovery rates were high at 37.6 to 71.8% during the four-year period from 2014 to 2017. This development necessitates additional control measures to sustain cotton production. Mass-rearing and release of egg parasitoids, *Trichogramma* spp. represents an important tactic of biointensive IPM strategy and successfully used against many larval pests including cotton bollworms (Cock, 1985; Ahmad et al., 1998; Malik, 2000; Charles et al*.,* 2000 and Nadeem et al., 2009). Egg parasitoids, *T. chilonis* and *T. japonicum* are common biological control agents that have been successfully used in biological control programs in corn, rice, sugarcane and cotton in India. Parasitoid *Trichogramma* is cosmopolitan in distribution and capable of parasitizing on pink bollworm eggs; use of 10-15 cards/acre (Ahmad et al*.,* 2011). The other advantages associated with *Trichogramma* are low cost in comparison with chemical pesticides, ease of application, availability, ecofriendly and most importantly pest control before the damage. Besides pink bollworm, there is a complex of lepidopteran pests associated with cotton ecosystem which can also be controlled by *Trichogramma.* Keeping this in view, a field experiment was conducted to evaluate pest management potential of two *Trichogramma* spp., viz., *T. bactrae* (Nagaraja) and *T. brasiliensis* (Ashmead) against pink bollworm.

MATERIALS AND METHODS

The field experiment was conducted during Kharif 2016-2017 and 2017-2018 at ICAR-CICR research farm, Nagpur to evaluate the efficacy of egg parasitoid for the management of cotton pink bollworm. During both the year experiments were conducted on non Bt cotton (Var. Suraj) in a completely randomized block design (CRBD) with a plot size 10 x 12 m with plant spacing of 60 x 10 cm. The treatments consist of two *Trichogramma* species (*T. bactrae* and *T. brasiliensis*) released at 60000/acre at two specific crop stages viz., flowering (40-45 days) and boll formation stage (60-75 days); an insecticidal treatment of three alternate sprays of profenophos 50EC (2ml/L), thiodicrab 75WP (1g/ l) and cypermethrin 25EC (1ml/L) at 40, 60 and 80 days respectively after germination. A control plot was also kept which accounts for the natural incidence of the pest. The initial cultures of both *T. bactrae* and *T. brasiliensis* were obtained from ICAR-NBAIR, Bangaluru and mass reared on eggs of *Corcyra cephalonica* (Stainton) under laboratory conditions. For field release, one day old parasitized eggs glued on to a paper cards (30x18cm) were pinned on to a leaf at about 50 cm height above ground. All the treatments were replicated four times separate with 19 rows of pigeon pea between each replication block to avoid the possible cross parasitisation between the replication blocks. The recommended best agronomic practises were followed.

The pink bollworm infestation was estimated at weekly intervals from a randomly collected 10 bolls by destructive sampling from 115 to 164 days after planting which coincides with the flower initiation to boll opening stage of the tested varieties. The data recorded were number of larvae, exit hole, mines on the epicarp/ 10 bolls. Locule damage was also estimated with respect to the number of locules damaged to the total number of locules tested. The recorded damage numbers and % locule damage were subjected to square root and angular transformations, respectively. The transformed data were subjected to ANOVA using MSTATC software package.

RESULTS AND DISCUSSION

Results obtained in the field study conducted during 2016-17 showed an average least number of exit holes in *T. brasiliensis* treated plots (0.25 holes/ 10 green bolls) followed by chemical treatment (0.31) and *T. bactrae* (0.38). Although the results were non significant over the period of testing, a major significant difference was noticed on 152 DAS where all the treatments were superior over control (Table 1). The results of number of mines/ 10 green bolls clearly showed a non significant relationship between the treatments, except for 113 DAS, where the lowest number of mines on epicarp was noticed in *T. bactrae*, chemical treatment and *T. brasiliensis* (0, 0.25 and 0.75 mines/ 10 green bolls green bolls, respectively) with respect to control (5.25 mines/10 green bolls) (Table 2). Besides, the trend observed during the study period also showed a numerical superiority of the treatment over control. The data on number of larvae/10 green bolls showed significant variation between treated and control. The average reduction in larval population over control was reported to be 75.1, 69.7 and 78.2 % in *T. bactrae, T. brasiliensis* and chemical control, respectively (Fig. 1). This reduction in larval population was significantly depicted in percent locule damage which accounts to around 3 % in all the treatments as against 9.58 % in control (Table 3).

In 2017-18, least number of exit holes were observed in the plots sprayed with chemical insecticides (0.39 exit holes/ 10 G.B) and it was at par with *Trichogramma bactrae* by recording 0.50 exit holes. However, *T. brasiliensis* proved ineffective by recording 0.92 holes although there were less number of holes observed in untreated control (0.61 holes/ 10 G.B) (Table 1). Number of mines per 10 green bolls showed non-significant differences. However, lowest number of mines on epicarp was noticed in the plots imposed with *T. bactrae* (3.25 mines/ 10 G.B) followed by chemical insecticides (3.39 mines/ 10 G.B) (Table 2). Similarly, number of larvae per 10 green bolls results found non-significant. However, numerically less number of larvae was observed in the plots sprayed with chemical insecticides by recording 1 larva per 10 green bolls followed by *Trichogramma bactrae* (3 larvae/ 10 G.B) (Fig 1). Significantly lowest per cent locule damage was noticed in the chemicals treatment (3.8%) and it was at par with *T. bactrae* by recording 10.70 %. The plots imposed with *T. brasiliensis* proved ineffective in controlling pink bollworm by recording maximum number of mines, larvae and highest per cent locule damage (Table 3).

The larval population, green boll, open boll and locule damage by pink bollworm were lower in

Table 1. Number of exit holes- *P. gossypiella*

Treatments	No. of Exit hole/10 green bolls (2016-17)									No. of Exit hole/10 green bolls (2017-18)								
	107 DAS	113 DAS	118 DAS	127 DAS	132 DAS	138 DAS	144 DAS	152 DAS	Mean	107 DAS	113 DAS	118 DAS	127 DAS	132 DAS	138 DAS	144 DAS	152 DAS	Mean
T_1 (*Trichogramma bactrae*)	0.5 (0.97)	0 (0.71)	0 (0.71)	1 (1.13)	0.25 (0.84)	0.5 (0.93)	0.5 (0.97)	0.25 (0.84)	0.38	0.25 (0.87)	0 (0.71)	0 (0.71)	0.25 (0.87)	0 (0.71)	0.75 (1.12)	0 (0.71)	2.75 (1.80)	0.5
T_2 (*Trichogramma brasiliensis*)	0 (0.71)	0.25 (0.84)	0.25 (0.84)	0 (0.71)	0.5 (0.93)	0.25 (0.84)	0.5 (0.97)	0.25 (0.84)	0.25	0.5 (1.00)	0.25 (0.87)	1 (1.22)	0 (0.71)	0 (0.71)	3 (1.87)	0.5 (1.00)	3 (1.87)	1.03
T_3 (Profenophos + Thidocarb + Cypermethrin)	0.25 (0.84)	0 (0.71)	0.25 (0.84)	0.5 (0.97)	0 (0.71)	0.5 (0.93)	1 (1.18)	0 (0.71)	0.31	0 (0.71)	0.25 (0.87)	0 (0.71)	0 (0.71)	0 (0.71)	1.75 (1.50)	0 (0.71)	1.25 (1.32)	0.41
T_4 (Natural Control)	0.5 (0.97)	0.75 (1.06)	0 (0.71)	0.25 (0.84)	0.5 (0.97)	0 (0.71)	0.75 (1.06)	1.5 (1.35)	0.53	0.75 (1.12)	0.5 (1.00)	0 (0.71)	0.25 (0.87)	0 (0.71)	3.25 (1.94)	0 (0.71)	0.25 (0.87)	0.63
SEM	0.38	0.13	0.1	0.18	0.11	0.18	0.2	0.12	0.06	0.3	0.3	0.35	0.14	–	0.43	0.25	0.94	0.11
CD	N.S	NS	NS	NS	NS	NS	NS	0.37	NS	N.S	N.S	N.S	N.S	–	1.37	N.S	N.S	0.37

(Values transformed with square root transformation)

Table. 2. Number of mines on the epicarp- *P. gossypiella*

Treatments	No of Mines on the Epicarp/10 Green Bolls (2016-17)									No of Mines on the Epicarp/10 Green Bolls (2017-18)								
	107 DAS	113 DAS	118 DAS	127 DAS	132 DAS	138 DAS	144 DAS	152 DAS	Mean	107 DAS	113 DAS	118 DAS	127 DAS	132 DAS	138 DAS	144 DAS	152 DAS	Mean
T_1 (*Trichogramma bactrae*)	0 (0.71)	0.25 (0.84)	3.75 (2.04)	2.75 (1.79)	6.75 (2.65)	7.5 (2.77)	8.5 (2.86)	1.5 (1.28)	3.88	1.25 (1.32)	1.75 (1.50)	3.50 (2.00)	4.25 (2.18)	0.25 (0.87)	0.75 (1.12)	8.25 (2.96)	9.00 (3.08)	3.25
T_2 (*Trichogramma brasiliensis*)	0.75 (1.06)	0.25 (0.84)	3.75 (2.03)	2 (1.46)	7 (2.52)	7.25 (2.76)	6.5 (2.62)	2 (1.26)	3.69	1.75 (1.50)	1.25 (1.32)	4.25 (2.18)	4.25 (2.18)	0.75 (1.12)	2.50 (1.73)	14.00 (3.81)	8.50 (3.00)	4.14
T_3 (Profenophos + Thidocarb + Cypermethrin)	0.25 (0.84)	0.75 (1.06)	3.25 (1.93)	2.25 (1.65)	9.75 (3.18)	9 (3.08)	4.5 (2.14)	1.5 (1.17)	3.91	0.50 (1.00)	2.50 (1.73)	2.25 (1.66)	4.50 (2.24)	0.25 (0.87)	0.75 (1.12)	9.25 (3.12)	11.00 (3.39)	3.50
T_4 (Natural Control)	5.25 (2.39)	0 (0.71)	2.25 (1.64)	4.25 (2.02)	12 (3.31)	9.25 (2.95)	5.25 (2.38)	0.75 (1.00)	4.88	1.25 (1.32)	1.50 (1.41)	5.75 (2.50)	7.50 (2.83)	1.25 (1.32)	0.00 (0.71)	10.50 (3.32)	2.75 (1.80)	3.39
SEM	0.10	0.12	0.15	0.34	0.39	0.36	0.26	0.44	0.14	0.52	0.67	0.96	0.75	0.46	0.74	2.13	1.59	0.49
CD	0.32	NS	NS	NS	NS	NS	NS	NS	NS	0.32	NS	NS	NS	NS	NS	NS	NS	NS

Values transformed with square root transformation

Table 3. Locule damage by *P. gossypiell* (Values transformed with square root transformation)

Treatments	% locule Damaged/10 Green bolls (2016-17)									% locule Damaged/10 Green bolls (2017-18)								
	107 DAS	113 DAS	118 DAS	127 DAS	132 DAS	138 DAS	144 DAS	152 DAS	Mean	107 DAS	113 DAS	118 DAS	127 DAS	132 DAS	138 DAS	144 DAS	152 DAS	Mean
T_1 (*Trichogramma bactrae*)	5 (2.35)	2.28 (1.48)	0.5 (0.97)	3.06 (1.74)	2.16 (1.51)	2.88 (1.71)	3.2 (1.91)	5.13 (2.3)	3.03	1.25 (1.32)	7.36 (2.80)	2.6 (1.76)	1.32 (1.35)	0.66 (1.08)	8.58 (3.01)	10.7 (3.34)	30.5 (5.57)	7.87
T_2 (*Trichogramma brasiliensis*)	1.30 (1.34)	4.28 (2.16)	0.88 (1.09)	3.63 (2.02)	4.48 (1.6)	2.63 (1.72)	4.13 (2.1)	6.88 (2.19)	3.53	3.13 (1.90)	4.28 (2.19)	6.45 (2.64)	1.32 (1.35)	1.88 (1.54)	8.01 (2.92)	22.5 (4.80)	26.6 (5.20)	9.27
T_3 (Profenophos + Thidocarb + Cypermethrin)	8.8 (3.05)	1.7 (1.33)	1.25 (1.27)	1.98 (1.56)	1.38 (1.35)	0.5 (0.97)	4.29 (2.14)	4.95 (2.25)	3.11	3.25 (1.94)	3.14 (1.91)	0 (0.71)	0 (0.71)	4.38 (2.21)	5.03 (2.35)	3.8 (2.07)	16.1 (4.07)	4.46
T_4 (Natural Control)	15.1 (3.95)	8.8 (2.82)	2.63 (1.76)	3.38 (1.95)	5.28 (2.4)	6.45 (2.63)	8.8 (3.05)	26.23 (5.04)	9.58	5.67 (2.48)	7.38 (2.81)	0 (0.71)	3.28 (1.94)	6.88 (2.72)	15.95 (4.06)	13.7 (3.76)	23.9 (4.93)	9.6
SEM	3.25	0.33	0.18	0.25	0.46	0.26	0.19	0.61	0.16	2.15	1.25	2.08	1.38	1.85	0.83	3.32	9.66	1.56
CD	N.S	1.05	NS	NS	NS	0.84	0.61	1.96	0.52	N.S	N.S	N.S	N.S	N.S	2.66	10.61	N.S	N.S

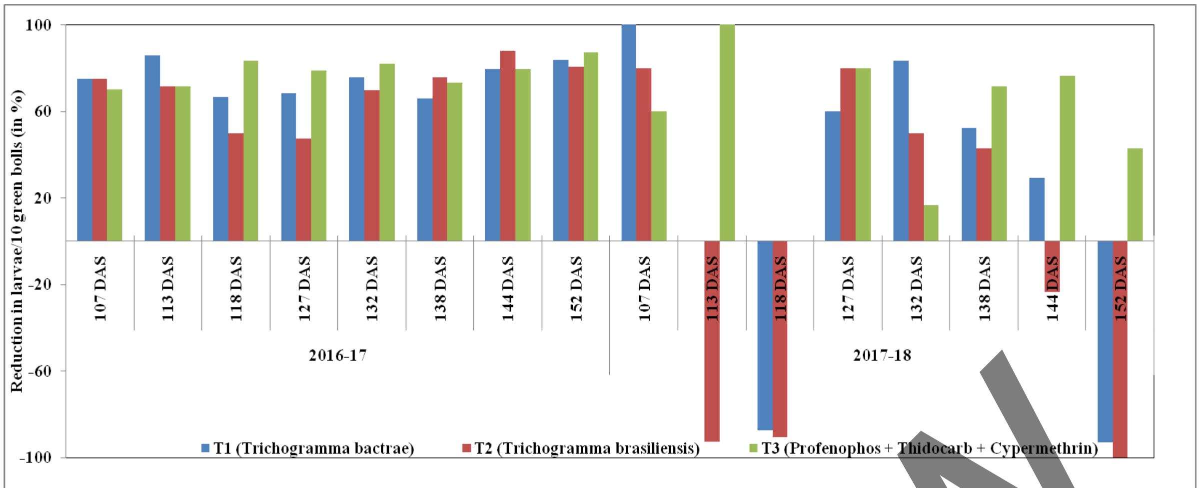

Fig. 1. Reduction in larval population of pink bollworm over treatments

insecticide treatments that were comparable with *T. bactrae* and *T. brasiliensis* releases. This signifies that the parasitoid release was as effective as chemical pesticide applications. All these treatments were superior to control where substantial damage was reported. However, there was a significant difference between the larval populations and damage levels between the years of study which can be attributed to differences in adult emergence, rate of parasitization, pest density, plant phenology (King and Coleman, 1989), synchronization between parasitoid release and host egg availability, age of the egg etc. Even though synchronization is achieved the rate of parasitization depends on wind speed (Dyer and Landis, 1997), temperature, density of host eggs, distance between release and host egg, photoperiod (Malik, 2001), other management practices followed especially type and time of insecticide treatments in or nearby fields (Hassan, 1994).

Trichogramma are cheaper in cost with respect to chemical pest management (Almeida, 1996). Combinations of biological agent *Trichogramma* and chemical control have proved successful for control of pink bollworm (Sarwar, 2017). In Egypt, Mesbah et al. (2003) evaluated the efficiency of releasing *T. bactrae* for the control of cotton bollworms (Pink bollworm and Spotted bollworm) compared to insecticides, in cotton fields. Parasitoid releases proved best results in reducing PBW infestations compared to both insecticides and check treatments. Hence, the extent of control of pink bollworm through the release of two egg parasitoids *Trichogramma bactrae*, *Trichogramma brasiliensis* are comparable with chemical pesticides and can be integrated in current IPM recommendation for Pink bollworm management.

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