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Studies on host sex pheromone interaction in parasitization behaviour of *Trichogramma chilonis* Ishii (Trichogrammatidae: Hymenoptera) in brinjal ecosystem

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Abstract
The brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee is the most noxious and destructive pest of brinjal and widely distributed in South Asian countries. In this present study the behavioural approach of use of sex pheromone is found compatible with augmentative biocontrol *Trichogramma chilonis* Ishii suggested for *L. orbonalis*. The laboratory study indicated that the maximum number of parasitization in *Corcyra* card + pheromone lure (77 eggs/ card) which is higher than in host egg placed alone (73.33 eggs/ card). In field condition also a maximum numbers of parasitization was observed in brinjal cropped plot imposed with sex pheromone trap (29.04 eggs/ card) compared to brinjal sole cropped plot (28.59 eggs/ card). The findings of the present study has greater potential for inclusion in the organic cultivation of brinjal crop in the light of emerging demand for the organic produce in the WTO era.

Keywords: host sex pheromone, *Trichogramma*, interaction

Introduction
Brinjal, *Solanum melongena* (L.) is the economically important vegetable crop cultivated throughout the India (Javed *et al*., 2017) [1]. Among the pests the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee is the most serious and destructive pests on brinjal crop. The wide range of insecticides including synthetic pyrethroids are regularly being used for the control of *L. orbonalis* and their indiscriminate use leads to resurgence of sucking pests like whitefly, aphid and mite (Srinivasan, 2009) [5]. So there is imperative need for Integrated Pest Management (IPM) mediated pest management system. Among the different IPM option available, the use of sex pheromone and augmentative release of biocontrol agent become the prospective alternative to sole use of chemical pesticides in brinjal crop. Therefore, the present study was concentrated and assessing the compatibility of behavioural approach of use of pheromone and this finding leads to reduce the indiscriminate use of insecticides in brinjal cultivation against brinjal shoot and fruit borer, *L. orbonalis.*

Materials and Methods
Studies on influence of *L. orbonalis* sex pheromone on parasitization behaviour of *T. chilonis* (Laboratory experiment)
Influence of pheromone lure on parasitization behaviour of *T. chilonis* was assessed through no-choice test by placing the unparasitized *Corcyra* egg card in zip bags having parasitized egg card either with or without pheromone lure. Among the 24 zip bags, the 12 bags were with pheromone lure along with the unparasitized *Corcyra* cards and remain 12 zip bags were maintained only the individual bags having 0.5 cc Corcyra egg card with 0.02 cc parasitized egg. These bags were placed in well ventilated dark place. After three days, the exposed *Corcyra* cards were collected treatment wise and observed for the number of parasitized eggs which were differentiated by their dark black color. The individual cards were kept in laboratory undisturbed for further observations to work out extend of parasitization and parasitoid emergence.

Studies on performance of *L. orbonalis* sex pheromone under coriander intercropped system (Field experiment)
The brinjal (var. KKM1) crop of one acre was planted and divided into four equal quarters in which pheromone traps were installed in diagonal quarters. Remaining two diagonal quarters having brinjal crop without pheromone trap was considered as control for comparison. The influence of pheromone trapping system on parasitization behaviour of *T. chilonis* egg parasitoid was studied by augmentative release on *T. chilonis* fortnight interval. The egg parasitoid *T. chilonis* was released at the rate of 2cc/ acre. The total of 80 trichocard pieces having approximately 0.025cc. In a 0.25 acre treatment plot the required 0.5cc trichocard was cut in 20 pieces and it was distributed at uniform distance across the entire plot. The interaction effect of pheromone trapping system on parasitization behaviour of *T. chilonis* was assessed by bait card technique (sentinel egg card technique) using laboratory host *Corcyra cephalonica* egg. (Niranjana, 2015) [3].

Result
Studies on influence of *L. orbonalis* sex pheromone on parasitization behaviour of *T. chilonis* Laboratory study
The results of the experiment taken up to study influence of pheromone on parasitization behaviour of *T. chilonis* on brinjal crop are furnished in Table 1. In the first observation, a maximum mean number of parasitization (85.00 eggs/

card) was observed in *Corcyra* card + pheromone lure and was higher than that of parasitized eggs (73.33 eggs/ card) observed in host egg placed alone (Figure 10). In observation II also, a highest level of parasitized eggs was recorded in *Corcyra* card + pheromone lure (69.00 eggs per card) and was minimum level in host egg placed alone (59.25 eggs/ card).

Field evaluation

In field condition the moth catches data from traps placed in intercropped plot and brinjal sole crop was recorded on weekly basis throughout the cropping period and compared (Table 2). In the observation I, a maximum number of parasitization was recorded in brinjal crop plot imposed with sex pheromone trap (43.50 eggs/ card) compared to a minimum number of parasitization recovered in brinjal sole cropped plot (42.75 eggs/ card). In observation II, the mean parasitization ranged from 25.25 eggs per card in brinjal sole cropped plot and 26.00 eggs in brinjal crop imposed with sex pheromone trap. In subsequent observation III, a highest mean number of parasitization was observed in brinjal crop with sex pheromone trap (39.25 eggs/ card) and a minimum level of parasitization was noticed in brinjal sole cropped plot (36.75 eggs/ card). In the fourth observation, the mean number of parasitization observed ranged from 9.59 eggs per card in brinjal sole cropped plot and 11.00 eggs in brinjal crop with sex pheromone trap. In terms of overall mean data, the maximum numbers of parasitization was observed in brinjal cropped plot imposed with sex pheromone trap (29.04 eggs/ card) than the brinjal sole cropped plot (28.59 eggs/ card).

Table 1: Influence of *L. orbonalis* pheromone on parasitization behaviour of *T. chilonis* (laboratory studies)

Experiment	Mean number of parasitized eggs/card	
	Laboratory host egg with Pheromone	Laboratory host egg without Pheromone
1	85.00(9.25)	73.33(8.59)
2	69.00(8.34)	59.27 (7.73)
SEm	1.54	1.50
CD (0.05)	NS	NS

Figures in the parentheses are based on square root transformation.

Table 2: Influence of *L. orbonalis* pheromone on parasitization behaviour of *T. chilonis* under field condition (On-station)

Treatment	Mean number of parasitized eggs/card				
	Exp1	Exp 2	Exp 3	Exp 4	Mean
Plot with Brinjal alone	42.75 (6.58)	25.25 (5.07)	36.75 (6.10)	9.59 (3.18)	28.59
Plot with Brinjal + Pheromone trap	43.50 (6.63)	26.00 (5.15)	39.25 (6.30)	11.00 (3.39)	29.94
SEm	0.642	0.253	0.232	0.285	
CD (0.05)	NS	NS	1.917	NS	

Figures in the parentheses are based on square root transformation.

Discussion

The egg parasitoid, *T. chilonis* is a potential parasitoid recommended for the management of *L. orbonalis* because of its wider adoptability and broader host range. Information on compatibility of pheromone trapping system with augmentative release of *T. chilonis* is not available or attempted in brinjal pest management system. The only report available was by Noldus *et al.* (1991) [4]. They studied the egg parasitoid *T. chilonis* released on platforms loaded with host sex pheromone and found the residence times, walking times and path lengths of *T. chilonis* in pheromone loaded air than in clean air. In the present study under laboratory condition, a increased level of parasitization was recorded when *Corcyra* card exposed with pheromone lure. In field studies, the maximum numbers of parasitization was observed in brinjal cropped plot imposed with sex pheromone trap than in control plot. There is no published information available on the performance of *T. chilonis* under intercropping system. The information reported in the present study on the compatibility of intercropping and pheromone and *T. chilonis* on *L. orbonalis* management is new report. There are few publications available on additive influence of host sex pheromone on parasitization behaviour of *T. chilonis*. Milonas *et al.* (2009) [2] found that the egg parasitoid *T. oleae* were significantly attracted to host pheromone.

Conclusion

It can be concluded from the present study, the behavioural approach of use of sex pheromone is found compatible with augmentative biocontrol *Trichogramma chilonis* Ishii suggested for *L. orbonalis* management.

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