Research Article

To study the effect of natural enemy *Trichogramma chilonis* (Ishii) against spotted bollworm (*Earias Vittella* F.) on okra

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Abstract

The present study was conducted at the Pussia Goth near Tandojam during the year 2016, to study the effect of natural enemy *Trichogramma chilonis* (Ishii.) against spotted bollworm (*Earias Vittella* Fabricius) on okra. Observations on spotted bollworm population were recorded at once per week. Pre-treatment observation was recorded one day before release and post-treatment observation was recorded three and five days after release. The reduction percentage was also calculated. The maximum population of spotted bollworm recorded in 6th week was (17.66±1.72) and minimum population in 10th week was (14.33±0.29) in control plot during 1st to 10th weeks duration, respectively. The natural enemies were released at the interval of 10 days. However, the population in treated plot after 3 days of (*T. chilonis*) releases the maximum population of spotted bollworm was recorded in 2nd week (8.89±1.24) and minimum population in 10th week (6.19±0.29) during 1st to 10th week duration, respectively. Peak level of spotted bollworm was observed during 1st and 2nd weeks afterward the spotted bollworm population was declined in a linear sequence from 3rd to 10th weeks. Similarly, after 5 days (*T. chilonis*) releases, the maximum population of spotted bollworm was recorded in 1st week (10.16±1.33) and minimum population in 10th week (8.00±0.41) during 1st to 10th week duration, respectively. Peak level of spotted bollworm was observed during 1st and 2nd weeks afterward the spotted bollworm population was declined in a linear sequence from 3rd to 10th weeks. Moreover, the results showed that spotted bollworm populations were considerably declined in treated plots due to the presence of *T. chilonis* as compare to control plot.

Keywords: Biological agent; Okra; Population; Spotted bollworm

Introduction

Okra, *Abelmoschus esculentus* (L.) belongs to family Malvaceae is Kharif season vegetable

as well as cash crop of Pakistan. It is originated from Africa and Asia. This is famous vegetable used as human food in the

country with great interest. This vegetable almost grown throughout the world during warm season [1-3]. A number of factors which influenced the productivity of okra crop. Among them, insect pests are the major factor which destroyed the okra crop and produced almost 69 percent damaged in yield losses [4, 5]. Among insects, bollworms, spotted bollworms and American bollworms are dominant pests which damaged the okra in early and late developmental stages. The magnitude of infestation and the nature of extent of injury vary with plant variety, seasons and localities [5]. Despite massive applications of broad-spectrum insecticides, the action of natural enemies plays an important role in reducing insect pest infestation, both through inundative releases or as natural control agents [6]. Biological control is often viewed as a promising alternative or complement to pesticides in integrated pest management programs [7]. The successes and failures of biological control have been extensively reviewed [8]. Factors that can influence the effectiveness of biological control agents include agent specificity (generalist or specialist), the type of agent (predator, parasitoid, or pathogen), the timing and number of releases, the method of release, synchrony of the natural enemy with the host, field conditions, and release rate [9]. The use of *Trichogramma* species as bio-control agent is a recognized alternate of insecticides throughout the world. *Trichogramma chilonis* (Ishii) in Pakistan parasitizes the egg of *Acigona steniellu* (Hanps.), *Agrotis ipsilon* (Hfn.), *Autographa nigrisigna* (Walk.), *Chilo infuscatellus* (Sn.), *C. partellus* (Swinh.), *Emmalocera depressella* (Swinh.), *Heliothis armigera* (Hbn.), and *Spodoptera litura* (F.) indicating its potential for biological control of these insect pests [10]. *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) are minute polyphagous wasps, commonly recognized as 'stingless wasps. It has been

used in sugarcane, corn, cotton, vegetables and fruits crops as bio-agent for the control of lepidopterous pests in more than 32 million hectares each year around the world for the control of pests since 20 years. The release of *T. chilonis* in China, Switzerland, Canada and former USSR reduced the damage up to 70 to 92% on sugarcane [11]. These tiny parasitoids lay their eggs in eggs of other species. *Trichogramma* represent around 80 genera from the Trichogrammatidae family with over 800 species worldwide [12-15]. Keeping in view the above facts and figures this study was conducted to equate the efficacy of *Trichogramma chilonis* against spotted bollworm (*Earias Vittella* F.) on okra.

Materials and methods

The experiment was carried out at the experimental area of Pussia Goth near Tandojam during 2016 to monitor the effect of natural enemy *Trichogramma chilonis* (Ishii.) against spotted bollworm of okra. The variety (Sabzpari) of okra was sown on area of 106' x 66' ft. By drilling method of sowing with all other agronomical practices were carried out as usual for this experiment. Observations on spotted bollworm population were recorded once per week. Six releases were made during the cropping season at the rate of 6 cards per acre. *Trichogramma* were released (as pupae) inside the host eggs ready to emerge as adults and they were glued to cards. *Trichogramma* wasps were emerged from cards in two to five days. Selected five plants for each treatment for recording spotted bollworm population and 05 leaves were observed from top, middle and bottom for spotted bollworm infestation. Pre-treatment observation was recorded one day before release and Post-treatment observations were recorded 3 and 5 days after release.

Calculating reduction percentage

The reduction percentage was calculated according [16] by the following formula:

$$\text{Percentage Mortality} = \frac{\frac{Ta - Tb}{Ta} \times \frac{Cb - Ca}{Cb}}{1} \times 100$$

Where,

Tb = Number of spotted bollworm in the treated plots before treatment.

Ta = Number of spotted bollworm in the treated plots after treatment.

Cb = Spotted bollworm population in the control plots before treatment.

Ca = Spotted bollworm population in the control plots after treatment.

The data of pests and natural enemies were also recorded from control plot for comparison. Collected data were interpreted in spreadsheet of Microsoft excel. Then further data analysis ANOVA was carried out through software Statistix 8.1 [17].

Results and discussion

In order to study the effect of natural enemy *Trichogramma chilonis* (Ishii.) against spotted bollworm of okra, the experiment was carried out at the Pussia Goth near Tandojam during the year 2016. The results are presented in (Table 1, 2, 3) their analysis of variance as shown as (Table 4,5).

Mean population of spotted bollworm on okra crop after *Trichogramma chilonis* cards releases

The data (Table 1) indicated that spotted bollworm population in control plot was counted as 16.32±1.41, 16.33±1.24, 17.32±1.87, 14.47±1.76, 14.98±1.75, 17.66±1.72, 15.32±1.58, 16.52±1.51, 16.21±1.46 and 14.33±0.29 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th weeks duration, respectively. The population of spotted bollworm in okra crop was observed as zigzag trend in control plot (where no biological control) was applied. The data further demonstrated that the observation between weeks was found non-significant (P>0.05) difference in spotted bollworm population in okra crop. The maximum population was recorded in 6th week (17.66±1.72) of observation and minimum population of spotted bollworm was observed in 10th week (14.33±0.29) in control plot.

Table 1. Mean population of spotted bollworms in control plot on okra crop

Observation weeks	Pest population of control plot
1 st	16.32±1.41 ab
2 nd	16.33±1.24 ab
3 rd	17.32±1.87 a
4 th	14.47±1.76 bcd
5 th	14.98±1.75bcd
6 th	17.66±1.72a
7 th	15.32±1.58 bc
8 th	16.52±1.51 ab
9 th	16.21±1.46 ab
10 th	14.33±0.29 bcd
Mean± S.E	15.95±1.46

Values in the column with same letters did not differ significant at P-value <0.05

The data (Table 2) showed that spotted bollworm population in Pre-treatment plot was counted as 14.42±2.58, 15.50±2.56, 13.38±1.51, 13.98±2.05, 15.06±2.34, 12.56±1.53, 14.40±2.60, 15.02±2.40,

15.82±2.48 and 13.56±2.24 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th weeks duration, respectively. The population of spotted bollworm in okra crop was observed as crisscross trend in control plot (where no

biological control) was applied. The data further demonstrated that the observation between weeks was found non-significant ($P>0.05$) difference in spotted bollworm population in okra crop. The maximum population was recorded in 9th week (15.82 ± 2.48) of observation and minimum population of spotted bollworm was observed (12.56 ± 1.53) in 6th week in pre-treatment plot. However, the results regarding spotted bollworm population in treated plot after 3 days of *Trichogramma chilonis*(Ishii.) cards releases was counted as 8.23 ± 1.41 , 8.89 ± 1.24 , 7.89 ± 1.87 , 7.94 ± 1.76 , 7.87 ± 1.75 , 7.79 ± 1.72 , 6.78 ± 1.58 , 6.75 ± 1.51 , 6.24 ± 1.46 and 6.19 ± 0.29 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th weeks duration, respectively. Peak level of spotted bollworm was observed during 1st and 2nd weeks afterward the spotted bollworm population was declined in a linear sequence from 3rd to 10th weeks. Moreover, statistical analysis showed significant ($P<0.05$) difference in spotted bollworm population between the different observation weeks in okra crop. The maximum population was recorded in 2st week (8.89 ± 1.24) of observation and minimum population of spotted bollworm

was observed in 10th week (6.19 ± 0.29) in treated plot after 3 days. Similarly, after 5 days *Trichogramma chilonis* (Ishii.) releases, the results indicated that spotted bollworm population was counted as 10.86 ± 1.71 , 10.16 ± 1.33 , 9.98 ± 1.97 , 9.82 ± 1.51 , 9.77 ± 1.43 , 9.62 ± 1.63 , 8.81 ± 1.50 , 8.69 ± 0.72 , 8.20 ± 0.71 and 8.00 ± 0.41 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th weeks duration, respectively. Peak level of spotted bollworm was observed during 1st and 2nd weeks afterward the spotted bollworm population was declined in a linear sequence from 3rd to 10th weeks. Moreover, statistical analysis showed significant ($P<0.05$) difference in spotted bollworm population between the different observation weeks in okra crop. The maximum population was recorded in 1st week (10.86 ± 1.71) of observation and minimum population of spotted bollworm was observed in 10th week (8.00 ± 0.41) in treated plot after 5 days. The results further showed that spotted bollworm populations were considerably declined in treated plots due to the presence of *Trichogramma chilonis* (Ishii.) as compare to control plot.

Table 2. Mean population of spotted bollworm on okra crop after *Trichogramma chilonis* (Ishii.) cards releases on different weeks

Observation weeks	Pre-treatment observations	Treated plots	
		3 Days After <i>Trichogramma</i> releases	5 Days After <i>Trichogramma</i> releases
1 st	14.42 ± 2.58 ab	8.23 ± 1.41 a	10.86 ± 1.71 a
2 nd	15.50 ± 2.56 a	8.89 ± 1.24 ab	10.16 ± 1.33 ab
3 rd	13.38 ± 1.51 ab	7.89 ± 1.87 ab	9.98 ± 1.97 ab
4 th	13.98 ± 2.05 ab	7.94 ± 1.76 abc	9.82 ± 1.51 abc
5 th	15.06 ± 2.34 ab	7.87 ± 1.75 abcd	9.77 ± 1.43 abcd
6 th	12.56 ± 1.53 b	7.79 ± 1.72 abcd	9.62 ± 1.63 abcd
7 th	14.40 ± 2.60 ab	6.78 ± 1.58 bcd	8.81 ± 1.50 bcd
8 th	15.02 ± 2.40 ab	6.75 ± 1.51 bcd	8.69 ± 0.72 bcd
9 th	15.82 ± 2.48 a	6.24 ± 1.46 cd	8.20 ± 0.71 cd
10 th	13.56 ± 2.24 ab	6.19 ± 0.29 d	8.00 ± 0.41 d
T-value	44.59	21.64	33.25

Values in the column with same letters did not differ significant at P -value <0.05

Reduction percentage of spotted bollworm

The data (Table 3) indicated that 59.89% and 66.65% reduction was examined in treated plots after three and five days *Trichogramma chilonis* (Ishii.) cards releases respectively as

compare to control (untreated) plot. It was observed that *Trichogramma chilonis* (Ishii.) is useful biological agent for integrated pest management program.

Table 3. Reduction percentage of spotted bollworm of okra crop after three and five days *Trichogramma chilonis* (Ishii.) cards releases

Name of Specie	Population in control plot	Population in treated plot after 3 days	Reduction (%)	Population in treated plot after 5 days	Reduction (%)
Spotted bollworm	647.21	387.65	59.89	431.38	66.65

Table 4. One sample t-test for spotted bollworm population after 3 days *Trichogramma chilonis* (Ishii.) cards releases

95% confidence interval							
Variable	Mean	SE	Lower	Upper	T	DF	P
Control plot	11.232	0.2073	7.9231	10.614	48.21	49	0.0000
After 3 days <i>T. chilonis</i> cards releases	14.465	0.3241	16.648	16.116	48.51	49	0.0000

Table 5. One sample t-test for spotted bollworm population after 5 days *Trichogramma chilonis* cards (Ishii.) releases

95% confidence interval							
Variable	Mean	SE	Lower	Upper	T	DF	P
Control plot	11.232	0.2073	7.9231	10.614	48.21	49	0.0000
After 5days <i>T. chilonis</i> cards releases	15.611	0.3310	15.604	16.185	47.65	49	0.0000

Farmers mainly rely on insecticides for the management of insect pests. Insecticides are costly and indiscriminate use has induced insect resistance to the insecticides and caused environmental pollution [18]. The magnitude of infestation and the nature of extent of injury vary with plant variety, seasons and localities [19]. The use of *Trichogramma* species as bio-control agent is a recognized alternate of insecticides throughout the world indicating its potential for biological control of these insect pests [10]. *Trichogramma chilonis* Ishii (Hymenoptera: Trichogrammatidae) are minute polyphagous wasps, commonly

recognized as stingless wasps. The results showed that spotted bollworm population in control plot was counted as 16.32 ± 1.41 , 16.33 ± 1.24 , 17.32 ± 1.87 , 14.47 ± 1.76 , 14.98 ± 1.75 , 17.66 ± 1.72 , 15.32 ± 1.58 , 16.52 ± 1.51 , 16.21 ± 1.46 and 14.33 ± 0.29 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th weeks duration, respectively. However, the results regarding spotted bollworm population in *Trichogramma chilonis* treated plot after 3 days was counted as 8.23 ± 1.41 , 8.89 ± 1.24 , 7.89 ± 1.87 , 7.94 ± 1.76 , 7.87 ± 1.75 , 7.79 ± 1.72 , 6.78 ± 1.58 , 6.75 ± 1.51 , 6.24 ± 1.46 and 6.19 ± 0.29 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th

weeks duration, respectively. Similarly, after 5 days *Trichogramma chilonis* (Ishii.) releases, the results indicated that spotted bollworm population was counted as 10.86 ± 1.71 , 10.16 ± 1.33 , 9.98 ± 1.97 , 9.82 ± 1.51 , 9.77 ± 1.43 , 9.62 ± 1.63 , 8.81 ± 1.50 , 8.69 ± 0.72 , 8.20 ± 0.71 and 8.00 ± 0.41 during 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th and 10th weeks duration, respectively. The data further indicated that 59.89% and 66.65% reduction was examined in treated plots after three and five days *Trichogramma chilonis* (Ishii.) cards releases respectively as compare to control (untreated) plot. It was observed that *Trichogramma chilonis* (Ishii.) is useful biological agent for integrated pest management program. According to [20] reported that for the highest yield of parasitoid production, it is important to use younger *Trichogramma* for parasitization. [21] Achieved superior results with the application of bio-control agents in combination with BT cotton resulting in least infestation by insect pests and maximum seed yield of 3657 kg/ha. The parasitism percentage of *Trichogramma chilonis* (Ishii.) was observed significantly higher in bio-control treated conventional cotton. [22] Reported that *H. armigera* population (49.71%) was notice for variety NIAB-111 in 2nd week (September) and 54.99% *E. insulana* were recorded for variety SLH-279 in 1st week (August) compared to NIAB-111 (52.66%). They recommended that for successful bio-control *Trichogramma chilonis* (Ishii.) may be used. [23] Showed that integration of bio control agents such as *Chrysoperla carnea* and *Trichogramma chilonis* (Ishii.) individually as well as jointly with insecticides proved as effective as chemical control using recommended insecticides against sucking insect pests and spotted bollworms. The integrated control proved economical as it reduced the number of insecticide sprays

from 8 in the chemical control to 2 in the integrated control treatments.

Conclusions

On the basis of the present findings, it was concluded that *Trichogramma chilonis* may be useful bio-control agent for the integrated pest management program in okra crop. It was further concluded that the okra crop significantly improves the yield per acre by using this biological agent compared to control plot. *Trichogramma chilonis* is a cheap and economic way for the integrated pest management program. *Trichogramma chilonis* should be released in okra crop to suppress spotted bollworms.

Authors' contributions

Conceived and designed the experiments: S Ahmed, Performed the Experiments: SA Shahwani, S Ahmed & MA Khetran, Analyzed the Data: S Ahmed & MI Jakhro Contributed reagents/ Materials/ Analysis tools: M Amin Wrote the paper: S Ahmed & S Ahmed.

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