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Research Article

Impact of *Trichogramma chilonis* on Tomato fruit worm (*Helicoverpa Armigera* Hub.) in Tomato crop

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Abstract

To find out the effect of different density levels of Trichogramma chilonis against tomato fruit borer Helicoverpa armigera, an experiment was carried out at Agriculture Research Institute (ARI), Tarnab Peshawar during summer 2016. Experiment was laid out in Randomized Complete Block design consisted of four treatments including control was replicated five times each treatment having plot size 8x5 m2. Parasitized eggs of T. chilonis were taken in the following numeral T1 (400), T2 (800) and T3 (1200) and were applied twice respectively. Pest infestation, percent weight loss in fruits and yield data were recorded on different intervals. Results showed that the larval infestation of H. armigera varied according to the released level of the parasitoid. Minimum infestation (0.50) H. armigera larvae plant-1 was recorded in T3 followed by T2 (0.62), T1 (1.00). As maximum infestation were recorded in control (3.40). Higher yield of tomato was recorded in T3 (9160 kg ha-1) and lower in control (5920 kg ha-1). Similarly, lowest percent weight loss was recorded in T3 (12.40%) and maximum in control (43.58%). Based on lower larval infestation, minimum percent weight loss and higher yield, treatment T3 (1200 parasitized eggs) is here by recommended for the safe and effective management of H. armigera in tomato crop. The study was focused on reducing H. armigera infestation, increase in tomato yield and attain environmental safety by means of T. chilonis.

Keywords: Biopesticide; *Helicoverpa armigera*; Tomato; *Trichogramma chilonis*

Introduction

Tomato, *Lycopersicum escolentum* Mill, is one of the vital and broadly used vegetable crop which belongs to family Solanaceae. It is full of nutrients and delightful; very limited vegetables have such nutritional value. Tomato is the most significant vegetable crop cultured for its fleshful fruits and known as an important profitable and nutritive [1]. Tomato crop is cultivated in all areas of Pakistan. Different varieties of tomatoes are grown at 52,300 hectors area and the estimated production in 2011-2012 was 530,000 tones. Whereas cultivated area in Khyber Pakhtunkhwa during 2011- 2012 was 12,600 hectors with a production of 113200 tons [2].

In Pakistan tomato crop have minimum production. Factors responsible for its low production such as insect pests, diseases and poor seed quality. Among them insects pests have been reported for high yield loss [3]. In insects *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is the major pest which responsible for greater losses [4]. *H. armigera* infested 32-35 % tomato fruit in Pakistan [5]. In Peshawar, Khyber Pakhtunkhwa province 53% of tomato fruit damage was observed by Inayatullah [6].

H. armigera is the main pest which attacks many crops in Pakistan, such as Tomato, Chickpea, cotton as well as pigeon pea. These crops are constantly damaged by *H. armigera*, as the larval stage induce infestation and cause severe injury to tomato fruit and decrease its yield. Adult of the *H. armigera* generally lays eggs on leaves during the month of April and May. Larvae damage the leaves as well as flower and destroy the fruit of tomato. Damage caused by larva hinders the value of tomato fruit in the market and farmer faces large scale losses [7].

Parasitoids such *Trichogramma chilonis* are in lime light due to its efficient predation capability [8]. *T. chilonis* is a tiny wasp which belongs to the family Trichogrammatidae, this family has a wider host range and particularly feed on Lepidoptera. After the parasitization of lepidopteran eggs it turns black because of the internal development of the parasitoid and eventually adult wasp emerge from these parasitized black eggs [9]. Purpose of this study is to attain such a management pattern that can help in effective control *H. armigera* through *T. chilonis* and increase the tomato fruit production.

Materials and methods

Field experiment was carried out at Agriculture Research Institute (ARI) Tarnab, Peshawar in 2016. Mass production of *T. chilonis* for purpose of its release in field was performed as following.

Preparation of *Sitotroga cerealella* culture as host of *Trichogramma chilonis*

Fresh eggs of *Sitotroga cerealella* were brought from Nuclear Institute of Food and Agriculture Peshawar (NIFA) and were observed for mites infestation under microscope. Eggs having dark red colour were introduced in to the glass jars having sterilized wheat grains. In the laboratory, the jars were kept at 25°C ± 2°C temperature and 60 ± 5% R.H for the development of *S. cerealella*. When adult *S. cerealella* of emerged, vacuum pump was used for the collection of adults from jars and then transferred to plastic jars having wire gauze at the bottom. Jars having wire gauze at the bottom were placed in wheat flour where adults laid eggs. Wheat flour placed under plastic jar of adults was taken and sieved through mesh size of 80 mm in order to get the eggs after that were sieved through mesh size of 60 to get the egg clusters. In this way fresh eggs of *S. cerealella* were easily available to *Trichogramma* for the purpose of parasitization.

Rearing of *Trichogramma chilonis*

Fresh eggs of *S. cerealella* were collected and were transferred to plastic bottle covered with muslin cloth. Hard paper of size (2 x 3 Inch) was glued and eggs of *S. cerealella* were sprinkled thoroughly over hard paper. These cards were left for sometime in order to dry and then placed in glass jar for 24 h having *T chilonis* culture. After passage of 24 hours old cards were replaced with new cards having *S. cerealella* to the jar of *T chilonis* culture for the purpose of parasitization. In order to get *T. chilonis* culture in a smooth way, the process was repeated on daily basis.

Field preparation

Using normal cultural practices field was prepared for tomato. F_1 hybrid variety was used for trial. For the conduction of experiment the field was ploughed twice and seed beds were prepared in a good way in order to get good crop. Layout of experiment was Randomized Complete Block Design (RCBD) which consisted of five replications. Every replication consisted of three treatments and control. Plot size was 8×5 m^2 and a buffer zone of 3 meters between each treatment was maintained. Among the replications distance of 2 meters was kept.

Transplantation of tomato crop

Transplantation of tomato plants were done in the month of March before the initiation of flowering stage.

Release treatments

T. chilonis were applied twice in three treatments composition T_1 (400), T_2 (800) and T_3 (1200) eggs). Interval of one month

was kept between 1st and 2nd application of *T. chilonis.*

Data collection

Six plants were randomly selected plot^{-1} and number of eggs and larvae were recorded on the selected plants after one week interval. Ripened tomato fruits were collected from each plot separately, weight and number of fruits were recorded individually for each plot. Fruits which are damaged were weighed. By the addition of all tomato pickings total yield was recorded. The following formulas were used:

$$\text{Yield (kg ha}^{-1}) = \frac{\text{Yield plot}^{-1}}{\text{Plot size (m}^2)} \times 10000$$

$$\text{Percent weight loss} = \frac{\text{Weight of damaged fruits}}{\text{Total Weight of tomato fruits}} \times 100$$

Data analysis

Experiment was laid out in Randomized Complete Block Design (RCBD). Collected data was subjected to ANOVA and means were separated using LSD test (Statistix ver 8.1).

Results and discussion

Efficacy of different *T. chilonis* treatments were tested against tomato fruit borer (*H. armigera*) under field conditions at Agriculture Research Institute Tarnab, Peshawar during summer 2016.

Application of *T. chilonis*

Data were collected on 6 randomly selected plants per plot by observing number of *H. armigera* larvae started from 1st April 2016. Results in the table 1 revealed that in pre treatment data the number of *H. armigera* larvae plant^{-1} recorded were 2.66, 2.72, 2.68, 2.60 in T_1, T_2, T_3 and in T_4 check plot respectively. One week after application of *Trichogramma*, a maximum decline in mean population of fruit borer plant^{-1} was recorded in T_3 (2.52) followed by T_2 (2.58) and then T_1 (2.60), while significantly high population was recorded in check plots T_4 (2.86). Again no significant difference was found among T_1, T_2, T_3 and control. During the 2nd week after treatment significant decline in tomato borer mean population plant^{-1} was observed among the treated and control plots. Data recorded revealed that the population of fruit borer plant^{-1} in T_1, T_2 and T_3 were (2.38), (2.34) and (2.28) respectively. Among T_1, T_2 and T_3 no significant variance was recorded, while control plot was significantly different from the rest. Data recorded in 3rd week showed increased effectiveness by *T. chilonis*, where larval population plant^{-1} in T_1, T_2 and T_3 were (2.28), (2.20) and (2.16), while in control plots mean population of (3.54) larvae plant^{-1} was noted.

2nd Application of *T. chilonis*

Data in the table 1 revealed that before 2nd application *T. chilonis* high mean population of larvae plant^{-1} 3.60 was observed in control, while low mean pest density 2.02 larvae plant^{-1} was recorded in T_3 followed by T_2 (2.10) and T_3 (2.22) respectively. Data recorded after 1 week of *Trichogramma* release, the results show that decline was recorded in pest population in treated plots. In T_1 *H. armigera* population varied from 2.22 to 2.00. While in T_2 pest density decreased from 2.10 to 1.80 and in T_3 population decline recorded was from 2.02 to 1.52 larvae plant^{-1}. It was revealed that there was no significant difference among treatments. During 2nd week after release, decrease in pest density continued. Mean larval population plant^{-1} in T_1, T_2 and T_3 were 1.52, 1.26 and 0.98 respectively. During 3rd week decline in mean larvae population of tomato fruit borer plant^{-1} was observed in all treatments and control plots. Mean larval population of *H. armigera* plant^{-1} recorded in T_1, T_2 and T_3 were 1.00, 0.62 and 0.50 respectively. It was observed that T_3 was the most effective in reducing *H. armigera* larval population in comparison to the other treatments.

Piao and Yan **[10]** indicated that the presence of large number of parasitoids at

the time of pest occurrence will insure maximum parasitism. Presence of great number of parasitoid also increases the persistency of parasitoid wasps in the field conditions and hence maximizes the chances of parasitism and synchronization. Rajput *et al.* [11] applied increasing number of *Trichogramma* wasp which resulted in fall of tomato borer. As the number of parasitoid wasp is released in large number maximum decline in tomato borer population was found, which is similar to our study. Our results are in agreement with Hou *et al*. [12] who observed that parasitism percentage of *T. chilonis* over *H. armigera* in laboratory conditions. Results showed that parasitism level ranged from 72.2% to 97.6% which clearly indicates that if proper release program is planned and applied in a scientific way *T. chilonis* can effectively control *H. armigera*. Ahmad *et al.* [13] carried out an experiment on suppressing the population of sugarcane stem borer (*Chilo infuscatellus*) through *T. chilonis*. *T. chilonis* was most effective in reducing *H. armigera* population from (25.95 to 9.31) %. Similar observations were made by Puneeth and Vijayan [14] conducted a rearing experiment of *T. chilonis* on *H. armigera* and found that *T. chilonis* can be successfully reared on *H. armigera* and recorded parasitism of 58.54%, 93% hatchability and adult longevity of more than 6 days.

Table 1. Effect of *T. chilonis* treatments against *H. armigera* larval population in 2016

Treatment	1st Release				2nd Release			
	Before Release	1st week	2nd week	3rd week	Before Release	1st week	2nd week	3rd week
T_1	2.66	2.60	2.38b	2.28b	2.22	2.00b	1.52b	1.00b
T_2	2.72	2.58	2.34b	2.20b	2.10	1.80b	1.26b	0.62bc
T_3	2.68	2.52	2.28b	2.16b	2.02	1.52b	0.98b	0.50c
Control	2.60	2.86	3.48a	3.54a	3.60	3.72a	3.82a	3.40a
LSD value		0.98	0.92	0.84		0.56	0.68	0.46

Means in columns followed by dissimilar letters are statistically different at α = 0.05(LSD Test)
T_1= (400) eggs, T_2= (800) eggs, T_3= (1200) eggs

Yield data

Data in table 2 shows the result of mean yield and % weight loss after release of different *T. chilonis* densities against tomato fruit borer. Maximum yield (9160 kg ha^{-1}) was recorded for T_3 while minimum yield (5920 kg ha^{-1}) was recorded in control plot. Table 2 further reveals percent weight loss, minimum percent weight loss (12.40%) was reported from T_3 while minimum percent weight loss (43.58%) was reported from control. Usman *et al.* [15] found high yield (8428 kg ha^{-1}) by application of *T. chilonis* eggs which shows that use of *T. chilonis* eggs can aid in obtaining higher yield.

Table 2. Yield (kg ha^{-1}) and percent weight loss

Treatment	Yield kg ha^{-1}	(%) Weight loss
T_1	6920 b	20.24 b
T_2	7520 ab	15.10 bc
T_3	9160 a	12.40 c
Control	5920 b	43.58 a
LSD value	1.09	6.49

Means in columns followed by dissimilar letters are statistically different at α = 0.05(LSD Test)
T_1= (400) eggs, T_2= (800) eggs, T_3= (1200) eggs

Conclusion

From the current study it is cleared that use of *T. chilonis* in higher concentration against *H. armigera* resulted effective control in field condition. It is recommended to release appropriate numeral of eggs in field on regular interval in order to reduce *H. armigera*, larval population to achieve higher tomato yield and

environmental safety through use of biopesticide.

Author's contributions

Conceived and designed the experiments: N Nisar & SF Shah, Performed the experiments N Nisar & I Rasheed, Analyzed the data: F Amin & J Sarwar, Wrote the paper: N Nisar.

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