Research Article

Management of Brinjal Fruit and Shoot Borer*leucinodes orbonalis* (Guenee) (Lepidoptera: Crambidae) through *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae) and Selective Use of Insecticides

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Abstract | The efficacy of Voliam flexi (thiamethoxam 17.6% + chlorantraniliprole 8.80%), Neem oil (5%), *Trichogramma chilonis* Ishii (Hymenoptera:Trichogrammatidae) was evaluated against brinjal fruit and shoot borer (*Leucinodes orbonalis*Guenee) (Lepidoptera, Crambidae) in brinjal (*Solanummelongena*) experimental field at the Agriculture Research Institute Tarnab, Peshawar, Khyber Pakhtunkhwa-Pakistan during 2016. The treatments were arranged in RCBD with three replications and the chemical and botanical insecticides were used with ten days interval while the*T. Chilonis* (500 eggs/cards) were released with thirty days intervals. A single variety of brinjal (Neelam) was used in the experiment. Significantly low infestation of shoots (8.19%) and fruits (6.23%) were recorded in the plots treated with Voliam flexi followed by Neem oil and *T. Chilonis* with 12.77 and 12.73%, and 14.01 and 16.37% shoots and fruit infestation, respectively. Significantly high infestation of shoots 20.35 and 25.78% fruits was recorded in control plot. The yield data showed that significantly maximum yield was recorded in Voliam flexi and Neem oil treated plots. It was concluded from the experiment that Voliam flexi is the best control measure against brinjal fruit and shoot borer, *L. orbonalis*. The effective treatment which resulted high marketable yield after synthetic insecticide was Neem Oil. Herefore, by sacrificing some yield of brinjal the Neem oil is recommended as an environment friendly management technique for brinjal shoot and borer.

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Introduction

Brinjal (*Solanummelongena* L.) is an important solanaceous summer crop cultivated in Pakistan. It is cultivated in many countries such as China, Turkey, India, Iraq and Pakistan (Thapa, 2010). The total yield of brinjal in Pakistan the annual production is 87,000 tons and it is grown on 9,000

ha (FAO, 2019). It has high amount of dietary fiber, vitamins (K, B6, niacin) and mineral nutrients such as magnesium, iron, potassium etc. (USDA, 2009).

There are some insect pests which are the main causes of low production of brinjal and these insect pests are the limiting factors in cultivation of brinjal (Chakraborti and Sarkar, 2011; Saimandir and Gopal, 2012). *Leucinodes orbonalis* Guenee is a monophagous pest (host is only brinjal) (Latif *et al*., 2009). Due to its feeding habit, it is a serious pest of brinjal and is an internal borer which causes severe damage to the tender shoots and fruits (Alam *et al*., 2006). About 12-16 % damage to shoots and 20-60% to fruits is caused only by larvae of brinjal fruit and shoot borer (Ahmad *et al*., 2008). The attack of this pest is very serious in summer and rainy season and causes more than 90% damage (Ara *et al*., 2007).

The usage of highly systemic poisons at a very high frequency makes the vegetables poisonous, ecologically unsafe and economically unviable (Sánchez-Bayo *et al*., 2013). In the short time, the insect is becoming tolerant to the chemicals, making it more complicated to control. Alternative to chemicals insecticides are the botanicals extracts which give efficient control similar to the synthetic insecticides and are ecologically friendly, so the center of attention should be on the use of the botanicals to tackle problems linked with other insecticides (Rahman *et al*., 2009). Biological control is also one of the safest control methods (Bale *et al*., 2008). It is the foundation of Integrated Pest Management (IPM). The biological control is very safeas natural enemies are almost host specific so they have no harmful effect on the non-target species and environment (Shenhmor *et al*., 2003).

The egg parasitoids of lepidopteran pests are *Trichogramma* spp. which are small tiny wasps that lay eggs inside the eggs of lepidopteran pests (Fatouros and Huigens, 2012). In 16 countries about 18 different species are mass reared to control lepidopteran pest of fruit and vegetables (Knutson, 2000). To produce a quality crop and control the losses caused by insects it is must to manage the pest population at proper time with appropriate measures. The novelty of the current study is a try to find the effectiveness of botanical, chemical and *T. chilonis* against the borers of brinjal in agro climatic conditions of Peshawar.

Materials and Methods

The experiment was carried out at Agriculture Research Institute (ARI), Tarnab, Peshawar, Pakistan during 2016.

Field preparation

The field size (390 meter^2) was prepared in the vicinity of ARI, which was further divided into 15 sub plots (each size 8 x3.25m^2) with a buffer zone of 2 m among the sub plots. Standard agronomic practices were followed throughout the experimental duration. There were three rows in each sub. The brinjal variety (Neelam) seedling transplanted in the 1st week of April in row to row distance 30 cm and plant to plant distance 65 cm (Habib *et al*., 2015).

Preparation of Trichogramma cards

The *Trichogramma chilonis* cards were prepared under laboratory conditions (25-30 °C and 70-80 % relative humidity) by using the methodology used by (Saljoqi *et al*., 2012) with slight modifications at entomological lab of ARI, Tarnab. The host *S. Cerealella* (adults) were collected from already established culture and were placed in the plastic jars (5-inch height × 4-inch diameter) having lid on their top and with fixed mesh cloth no 35-40 at the bottom. The jars were placed in plastic plates (6-inch diameter) having 2 table spoon of starch. The eggs laid by the *Sitotroga* in the starch were collected on daily basis with the sieve (with mesh no. 50-70). The collected eggs were kept for 2 hrs in ultra violet chamber for sterilization. The eggs were then spread uniformly on the sticky ivory card (3×6 cm having 500 *S. cerealella*on each card. The cards were transferred to glass jars containing adults of *T. chilonis* for parasitism. After 24 hrs parasitoid cards were collected from the jars and were kept in incubator (25°C and 60-70% RH) for the growth of *T. chinolis*. Cards having parasitoid eggs (near to emergence) were used for further field applications.

Treatments and experimental design

The treatments (Tricho cards one time release /month (T1), Tricho cards release ten days interval (T2), neem oil 5% (T3), Voliam flexi (thiamethoxam 17.6% + chlorantraniliprole 8.80) (T4), and Control (T5) were assigned in Randomized complete block design with three replications. To control the in and out movement of *T. chilonis* among the plots the barriers of polythene sheets of 6 feet height were fixed around each sub plot. Data was collected on the middle row of each sub plots.

Data collection

The data regarding the mean fruit and shoot infestation were collected on weekly basis for twelve weeks. The data was recorded on randomly selected 10 plants in each sub plot by counting the mean number of infested and non-infested fruits and shoots.

Data analysis

The recorded data was analyzed by software statistix 8.1 one way ANOVA and the means were separated by using Least Significant Difference (LSD) test at probability of P = 0.05 (Steel and Torrie, 1984).

Results and Discussion

Effect of different control measureson percent shoots infestation

The effect of various control measures on the percent shoot infestation in brinjal shows significant difference (Table 1). Minimum (8.19%) shoot infestation of was recorded in the voliam flexi treated plot, whereas maximum shoot infestation 17.27% was recorded in Tricho cards one time release in a month. No significant effect was recorded in the neem oil and Tricho cards at ten days interval. The highest shoot infestation of 20.35 % was recorded in control plot.

In the whole time interval, the voliam flexi plots showed less percent shoot infestation whereas, the first release of Tricho cards showed maximum percent shoot infestation. Our findings are in line with Kameshwaran and Kumar (2015) who stated that the chlorantraniliprole 20SC effectively reduced the shoots and fruit infestation. The significant negative of synthetic insecticides on brinjal fruit and shoot borer is also reported Islam *et al*. (2019). Neem oil results of this study are consistent with those of Rehman *et al*. (2009) that Neem oil effectively decreased the shoot and fruit infestation as compared to control. Mianali (2014) also reported that Neem oil and *T. chilonis* were most effective against *L. orbonalis* and give efficient protection as compared to control. The results regarding the efficacy of *T. chilonis* against *L. orbonalis* are also in line with the Singh *et al*. (2019) who stated that *L. orbonalis* infestation can be significantly minimized by the optimum release of *T. chilonis*.

Effect of different control measures on percent fruits infestation

The effect of various control measures on the percent fruit infestation in brinjal showed in (Table 2). The data shows that significant minimum fruit infestation of 6.23 % was recorded in the Voliam flexi treated plots whereas, the maximum percent fruit infestation of 22.68 % was recorded in the Tricho cards one time release. No significant effect was recorded in the neem oil and Tricho cards at interval of ten days. Furthermore, also no significant effect was recorded in the control plot and Tricho cards one time release. The result of Voliam flexi is similar to that of Kameshwaran and Kumar (2015) who concluded that chlorantraniliprole 20-SC is highly effective against brinjal fruit and shoot borer. These results are in line with Islam *et al*. (2019) who reported the minimum brinjal fruit infestation in the plots where synthetic chemical insects were applied. The results of Neem oil are also same to that of Nasiruddin (2010) who observed that Neem oil reduced the brinjal fruit infestation in comparison to control plot. Budhvat and Magar (2014) also reported that increasing the *T. chilonis* in field effectively decrease the fruit infestation. Similar results regarding the effectiveness of *T. chinois* against *L. orbonalis*is also stated by Singh *et al*. (2019) who reported the decrease inbrinjal fruit infestation by releasing the *T. chilonis*.

Table 1: *Effect of different control measure on percent shoots infestation during 2016.*

Treatments	1st Spray				2nd Spray				3rd Spray				Mean
	1st week	2nd week	3rd week	4th week	1st week	2nd week	3rd week	4th week	1st week	2nd week	3rd week	4th week	
Tricho cards one time	12.4 b	13.8 b	16.3 b	18.2 b	17.2 b	19.2 b	21.2 b	22.0 b	14.1b	16.1 b	17.2 b	19.1 b	17.27 b
Neem oil	8.66 d	11.0 d	13.4 d	15.4 d	12.0 d	14.0 d	16.3 d	17.4 d	8.6 d	10.6 d	11.6 d	13.1 d	12.77 c
Voliam flexi	5.95 e	8.55 e	11.0 e	13.0 e	6.03 e	8.0 e	10.0 e	10.5 e	3.72 e	5.72 e	6.72 e	8.92 e	8.19 d
Trichocard													
satten days	10.0 c	12.0 c	15.0 c	17.0 c	13.2 c	15.2 c	17.2 c	18.2 c	10.0 c	12.0 c	13.0 c	15.0 c	14.01 c
Control	16.9 a	19.3 a	22.1	24.1 a	19.1a	21.1 a	23.3 a	26.6 a	16.0 a	18.0 a	19.0 a	20.2 a	20.35 a
LSD	0.12	0.04	0.06	0.06	0.01	0.01	0.04	0.04	0.05	0.06	0.04	0.03	2.16

**Means having different alphabets in columns are statistically different from one another by Least 258 Significant Difference (LSD) test at 5% level of probability.*

Table 2: *Effect of different control measure on percent fruits infestation during 2016.*

	1st Spray				2nd Spray				3rd Spray				
Treatments	**1st week**	**2nd week**	**3rd week**	**4th week**	**1st week**	**2nd week**	**3rd week**	**4th week**	**1st week**	**2nd week**	**3rd week**	**4th week**	**Mean**
Tricho cards one time	15.3 b	17.2 b	19.1 b	19.1 b	22.2 b	27.0 b	32.5 b	35.8 a	18.7 b	19.9 b	22.6 a	23.1 b	22.68 a
Neem oil	8.59 d	9.98 d	11.2 d	11.6 d	9.25 d	12.4 d	14.9 d	18.9 bc	11.1 d	12.1 d	15.2 c	17.2 d	12.73 b
Voliam flexi	1.86 e	3.57 e	5.22 e	6.15 e	3.23 e	6.80 e	8.72 e	14.4 c	3.25 e	4.95 e	7.43 d	9.2 e	6.23 c
Tricho card													
Satten days	13.2c	14.7 c	13.4 c	15.26 c	13.6 c	15.9 c	18.7 c	22.7 b	14.2 c	16.1 c	18.2 b	20.0 c	16.37 b
Control	17.2 a	19.1 a	19.2 a	20.58 a	24.7 a	33.0 a	36.8 a	40.4 a	22.9 a	24.2 a	24.3 a	26.4 a	25.78 a
LSD	0.06	0.06	0.04	0.05	0.18	1.10	0.27	6.04	0.41	0.16	1.97	0.04	5.43

**Means having different alphabets in columns are statistically different from one another by least 261 significant difference (LSD) test at 5% level of probability.*

Table 3: *Effect of different control measure on yield of brinjal during 2016.*

Treatments	Yield Kg/plot	Yield Kg/ha
Tricho cards one time release	3.08 d	1185.9 d
Neem oil 5%	7.08 b	2725.6 b
Voliam flexi	8.22 a	3161.5 a
Tricho cards at interval of ten days	5.72 c	2202.6 c
Control	2.15 e	826.9 e
LSD	0.06	24.21

**Means having different alphabets in columns are statistically different from one another by least 267 significant difference (LSD) test at 5% level of probability.*

Effect of different control measures on yield of brinjal The data recorded on the yield is presented in Table 3. There was a significant effect recorded among all the treatments. Significantly a maximum yield of 3161.5kg ha^{-1} was recorded in Voliam flexi followed by Neem oil and Tricho cards at interval of ten days by recording 2725.6 $kg.ha^{-1}$ and 2202.6$kg.ha^{-1}$ respectively whereas, a minimum yield of 1185.9kg. ha^{-1} was recorded in Tricho cards one time release. These results are in conformity with the observations of Wargantiwar *et al.* (2010) because he reported that plot treated with chemical produce high yield. The results of neem oil are same to Rehman *et al.* (2009) who reported that plot treated with neem oil also produce maximum yield as to that of control. In case of Tricho cards our results are in line with the observations of Budhvat and Magar (2014) who reported that increasing the rate of *T. chilonis* in the field produce maximum yield as compared to less release of *T. chilonis* and control.

Conclusions and Recommendations

It can be concluded from the experiment that the Voliam flexi (differential-chemistry synthetic insecticide) significantly reduced the brinjal fruit and shoot infestation and also resulted maximum yield. After Voliam flexi, the neem oiland *T. chilonis* application also significantly reduced the shoot and fruit infestation and the obtained yield (Kg/ha) was also maximum over control. Due to environmental friendly effect of neem oil and *T. chilonis* these are recommended to the farmers by sacrificing some yield of brinjal.

Novelty Statement

Novelty of the study is the use of bio-control agent with selective insecticides against brinjal shoot borer which will helpful in minimizing the use of toxic insecticides.

Author's Contribution

Ahmad-Ur-Rahman Saljoqi: Designed the experiment and review the manuscript.
Sadar Iqbal: Conducted the research work.
Imtiaz Khan: Analyzed the data and write the manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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