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Research Article

Screening of different insecticides against *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) and its effect on yield of tomato crop

Inam Rasheed, Syed Fahad Shah, Jawad Sarwar*, Amjad Usman, Maqsood Shah, Muhammad Usman, Fazli Amin and Numan Nisar
Department of Entomology,The University of Agriculture, Peshawar-Pakistan
**Corresponding author's email: jsarwaraup@gmail.com*

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Abstract

To investigate the comparative efficacy of different insecticides against tomato fruit borer (*Helicoverpaarmigera*) a study was conducted at Agricultural Research InstituteTarnab, Peshawar during 2016. Experiment was conducted using RCBD design and each treatment was replicated three times. Treatments include Emamectin Benzoate, Radiant, Trycard, Proclaim and control. All the treatments were applied twice with 10 days interval and data was recorded at different time intervals (24hrs, 48hrs, 72hrs, 5days, 7days and 10 days). Results revealed that in both the spray application of insecticides lowest mean of larval population was recorded in the plots treated with Radiant followed by Emamectin Benzoate, Trycard and Proclaim respectively. Control demonstrated the highest mean larval infestation. Similarly, the yield data revealed that the highest mean yield was recorded in the plot treated with Radiant (9452 kg ha^{-1}) while control showed minimum yield (5608 kg ha^{-1}). Most elevated percent weight loss (43.82 %) was recorded in check plot and the lowest percent weight loss (13.35 %) was recorded in the plot treated with Radiant. It was concluded that use of different insecticides not only reduced fruit losses but also increased yield. However, the insecticide radiant is recommended to be used in IPM programs against tomato fruit worm because of their quick biodegradable behavior and availability in the market at economical prices.

Keywords: *Helicoverpaarmigera*fruit damage;Synthetic Insecticides; Tomato yield

Introduction

Tomato (*Lycopersicon esculentum*) Mill placed in family Solanaceae and is one of the most importantproducts throughout the world and is most famous and broadly developed vegetables on the planet. The highest productivity of tomato is brought about by Spain having 66.81 tha^{-1}[1]. Tomato has put second in rank after potato. It is the most essential vegetables that individuals used to develop it in home gardens and by the market cultivators. Mostly it is utilized in a fresh and

processed form while in Pakistan people generally use it as a salad. Tomato is a decent source of vitamins A, B and C. Furthermore it helps in healing of wounds because of anti-microbial properties [2].

In Pakistan farmers grow the tomato crop an area of 57.4 thousand hectares having an average yield of 9719.51 kg per hectare. The normal production of tomatoes was observed 10.1 tons for each hectare [3]. The insect pests damage the crop in various stages and affect the quality and quantity of fruit adversely. Tomato crop has some serious insect pests which damage the yield of tomato very badly i.e, white flies, cutworms, thrips, aphids and fruit worm. In Pakistan the production of tomato is very low as compare to other countries. The production of tomato is very low because of many reasons among them the most important reason is insect pests [4].

Similar to all soft vegetables tomato is too prone to the insect pests and disease attack because of its tenderness and softness. It is attacked by a number of pests but tomato fruit borer is one of the major pest causing economic yield loss to the farmers, yield loss recorded up to 35% in tomato [5]. Tomato fruit borer is the most damaging pest of tomato, which is generally known as gram pod borer, american bollworm and tomato fruit borer. Young larvae feed only on foliage, flower buds and flowers, while the later instars of these borers drill into fruit and render them unmarketable [6].

Different management practices are used to minimize the insect pest infestation. The first choice is the total pest population decline, while the second one is saving the main crop at its certain time by the introduction of cultural practices i.e trap crops, deep ploughing and mechanical damage. But chemical control is the most effective management technique for pestscontrol, which is used in each and every crop by the farmers because of its ease of access, effortless in use and high return ratio [7]. Thus the objectives of this study are to observe the efficacy of different insecticides against *H. armigera* (Hubner) on tomato crop and to determine the yield of tomato crop after the application of different insecticides.

Materials and methods

Study was carried out to determine efficacy of different insecticides against tomato fruit borer *H. armigera* on tomato crop at Agriculture Research Institute, Tarnab Peshawar (Khyber Pakhtunkhwa, Pakistan) in 2016. Experiment was performed in Randomized Complete Block Design (RCBD) with five treatments each with three replications (Table 1). Size of plot was 4.5 ×21 m. Plant to plant and row to row distances were kept 45cm and 60cm respectively and variety of tomato under trial was F_1 hybrid.

Each treatment was replicated three times. Spray applications of all the tested insecticides were applied at the time of pest occurrence and was repeated with interval of 15 days. First application was applied at the occurrence of pest while the second application was applied with 15 days interval. Data was recorded on randomly selected 6 plants plot^{-1} and the observations on larval population, % weight loss and tomato yield (kg ha^{-1}) was recorded. Larval population of tomato fruit worm was recorded 24 hours before spray application and post treatment count was taken as (24, 48 and 72) hours and (5, 7 and 10 days) after application. Collected data was subjected to ANOVA and means was separated using LSD test (Statistix@8.1). The following formulas were used to calculate percent weight loss, tomato yield and increase over control.

Percent weight loss

Percent weight loss was recorded in all the plots separately by using the following formula.

Percent weight loss = Weight of damaged fruits/Total weight of tomato fruits x 100

Total tomato yield

Total tomato yield was recorded for all the plots, yield was then recorded to as kg ha^{-1} by using the following formula;

Yield (kg ha^{-1})=Total weight of Tomato $plot^{-1}$/Plot size (m^2) x 10000

Increase in yield over control (%)

% increase over control= A-B/ B x 100

A= Total Yield of a Treated Yield

B= Yield of control plot

Results and discussion

Effect of different insecticidal application on the larval population of *Helicoverpa armigera*

Table 2 revealed that insecticidal application had a significant impact in reducing larval population of tomato fruit borer in comparison to control. However no significant difference was recorded among treated plots. Data recorded after 1st spray (24h, 48h, 72h, 5 days, 7 days and 10 days) illustrated that Radiant was the most efficient insecticide against the larvae of tomato fruit borer (1.52, 1.32, 1.04, 0.59, 0.70 and 1.04 larvae/plant), followed by Emamectin Benzoate (1.61, 1.44, 1.22, 1.00, 1.09 and 1.31 larvae/plant), Trycard (1.67, 1.53, 1.30, 1.21, 1.31 and 1.53 larvae/plant), while Proclaim appeared to be the least effective insecticide (1.77, 1.56, 1.47, 1.46, 1.51 and 1.71 larvae/plant) but showed appreciating results in relation to the control.

Similar trend in the larval population has been observed after 2nd application. Radiant was the most efficient insecticide against the larvae of tomato fruit borer (1.33, 1.28, 1.07, 0.85, 0.66 and 0.44 larvae/plant), followed by Emamectin Benzoate (1.42, 1.39, 1.20, 1.00, 0.93 and 0.79 larvae/plant), Trycard (1.72, 1.49, 1.37, 1.19, 1.04 and 0.99 larvae/plant), while Proclaim found to be the least effective insecticide (1.92, 1.70, 1.50, 1.33, 1.20 and 1.07 larvae/plant) but showed appreciating results in relation to the control. Effective control of *H. armigera* with the aid of different insecticides has also beenreported by many researchers. **[8]** Tested emamectin benzoate against brinjal fruit borer and reported lower infestation (40.1%). **[9]** Reported the same effect of Radiant against tomato fruit borer as our study demonstrates. It was recorded 73% reduction in tomato fruit borer larvae infestation in radiant treated plot and concluded that radiant has best results against *H.armigera*. **[10]** Experimented different chemicals to control the population density of *H. armigera*. Results depicted that cypermethrin can effectively control the pest and aid in greater yield. **[11]** Applied different chemicals in a tomato field against *H. armigera* and observed that chemical control effectively reduce the infestation of *H. arimgera* in the field. **[12]** Applied combination of pesticides and plant extracts against *H. armigera* in tomato field. They found that application of insecticides and plant extracts greatly suppress the density of *H. armigera* and increase the production capacity resulting in the wellbeing of farmer. **[13]** Examined the infestation variance of *H. arimgera* on different crops and reported that *H. armigera* is destructive pest that can result in significant yield losses. To minimize losses from *H. armigera* he suggested that bio-control agents and chemical control should be used. However the present study shows that all the treatments applied during the course of experiment were statistically not significant from each other and provided synchronized results, yet radiant is the most appropriate insecticide because of its effectiveness in minimizing *H. armigera* infestation and less persistent in the environment as compared to the other insecticides.Similar results were reported by **[14]** who revealed that spinetoram (radiant) has short residual period of 11 days in reference to other treatments. **[15]** Reported that cypermethrin degradation takes upto 16 days.

Table 1. Treatment details

Treatments	Active Ingredients	Recommended dose
Emamectin Benzoate, 19% EC	Emamectin	2cc per liter of water
Radiant, 20% EC	Spinetoram	0.8cc per liter of water
Trycard, 10% EC	Cypermethrin	2cc per liter of water
Proclaim, 19% EC	Emamectin	2cc per liter of water

Table 2. Effect of different insecticidal application on the larval population of *H. armigera*

Treatments	*H. armigera* Larval population												
	Before 1st Spray	After 1st Spray						Before 2nd Spray	After 2nd Spray					
		24Hrs	48 Hrs	72 Hrs	5 days	7 days	10 days		24 Hrs	48 Hrs	72 Hrs	5 days	7 days	10 days
Emamectin Benzoate	1.94	1.61 b	1.44 b	1.22 b	1.00 bc	1.09 bc	1.31 bc	1.59	1.42 b	1.39 bc	1.20 bc	1.00 bc	0.93 bc	0.79 c
Radiant	2.03	1.52 ab	1.32 b	1.04 b	0.59 c	0.70 c	1.04 c	1.99	1.33 c	1.28 c	1.07 c	0.85 c	0.66 c	0.44 d
Trycard	2.01	1.67 b	1.53 b	1.30 b	1.21 b	1.31 b	1.53 bc	2.06	1.72bc	1.49 bc	1.37 bc	1.19 bc	1.04 b	0.99 bc
Proclaim	1.94	1.77 ab	1.56 b	1.47 b	1.46 b	1.51 b	1.71 b	2.12	1.92 b	1.70 b	1.50 b	1.33 b	1.20 b	1.07 b
Control	1.98	2.29 a	2.44 a	2.94 a	3.02 a	3.10 a	3.38 a	3.38	3.39 a	3.44 a	3.45 a	3.66 a	3.66 a	3.76 a
LSD value		0.59	0.48	0.44	0.54	0.53	0.66		0.52	0.37	0.42	0.38	0.34	0.26

Mean in column followed by dissimilar letters are statistically different at $\alpha = 0.05$ (LSD Test)

Marketable Yield, Infested Yield and Percent weight loss of tomato fruit

Table 3 showed the percent weight losses in different treatments. Results revealed that all the insecticides have significant difference with the control. Result further showed that the highest percent weight loss was recorded in control (43.82 %), while the plot treated with Radiant showed the lowest percent weight loss (13.35 %). Present study also showed that plots with lowest larval infestation gave higher marketable yield. As larvae of *H. arimgera* bore into the tomato fruit as a result the fruit become unfit for human consumption and also losses its market value. **[16]** Also highlighted the high marketable yield in plots managed with insecticides. **[17]** Also reported same impact from application of insecticides with low infestation and high marketable yield from treated plots. Our results are also comparable with **[18]** who reported that higher infestation of larvae results in lower yield.

Table 3. Marketable Yield, Infested Yield and % weight loss of tomato fruit affected by different insecticides

Treatments	Marketable yield (kg ha^{-1})	Infested yield (kg ha^{-1})	% weight loss
Emamectin Benzoate	6878 b	1444 d	17.90 bc
Radiant	8217 a	1233 e	13.35 c
Trycard	6243 c	1621 c	19.62 bc
Proclaim	5785 d	1763 b	24.08 b
Control	3103 e	2504 a	43.82 a
LSD value	1110.4	233.17	6.78

Means in columns followed by dissimilar letters are statistically different at α= 0.05 (LSD Test)

Total tomato yield (kg ha^{-1})

Average yield of tomato (kg ha^{-1}) was recorded in different plots treated with different insecticides, showed in (Table 4). Results revealed that all the insecticidal treatments have significant difference with the control. Data in the table revealed that maximum yield of tomato was observed in the plot treated with Radiant (9450kg ha^{-1}) while check plot showed (5607 kg ha^{-1}) which is minimum yield among all the plots. Present experiment was carried on a single tomato genotype, so the variation in the percent increase in weight of tomato over was possibly due to use of different pesticide. Our results are in coherence with **[19]** who registered that with application of insecticides effectively increase the yield. **[20]** Also revealed that management of field with various insecticides can enhance the production of tomato.

Table 4. Effect of different insecticides on tomato yield

Treatments	Yield (kg ha^{-1})	% increase over control
Emamectin Benzoate	8322 b	48.42
Radiant	9450 a	68.53
Trycard	7864 b	40.25
Proclaim	7548 b	34.61
Control	5607 c	-
LSD$_{(0.05)}$ Value	1006.7	

Means in columns followed by dissimilar letters are statistically different at α = 0.05 (LSD Test)

Conclusion and recommendations

All the tested insecticides showed effective control of tomato fruit worm and provided higher yield of tomato in comparison to control. However maximum yield production was registered for radiant followed by emamectin benzoate, trycard and proclaim. Furthermore radiant is cheap and easily

biodegradable in reference to other tested chemicals. It is therefore recommended to be used in IPM programs to reduce infestation of tomato fruit worm.

Authors' contributions

Conceived and designed the experiments: I Rasheed & SF Shah, Performed the experiments: I Rasheed, A Usman &NNisar, Analyzed the data: M Usman&F Amin, Wrote the paper: J Sarwar& M Shah.

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