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EFFICACY OF BIO-RATIONAL AND MICROBIAL INSECTICIDES AGAINST FRUIT BORER (*HELICOVERPA ARMIGERA* HUB.) ATTACKING TOMATO

M. J. AL-HABIB, M. A. R. CHOUDHURY*, M. A. MALEQUE, B. DAS & A. ULLAH KHAN

Department of Entomology, Sylhet Agricultural University, Sylhet-3100, Bangladesh

ABSTRACT

The experiment was carried out during winter 2019 in the field of Agricultural Training Institute, Sylhet, Bangladesh to find out the effective ecofriendly insecticides to control fruit borer *Helicoverpa armigera* Hub. attacking tomato plants. The study was conducted with three treatments viz., *Bacillus thuringiensis* @ 2.0 mg L^{-1}, Spinosad 45 SC@ 0.4ml L^{-1}, Abamectin 1.8 EC @ 1.2 ml L^{-1} of water and untreated control. Results revealed that the number of healthy fruits increased by 72.85% over control due to spraying of Spinosad 45 SC and it was followed by *Bacillus thuringiensis* (32.78%) and Abamectin 1.8 EC (26.82%). The highest number of healthy fruits (274.00) was harvested from Spinosad 45 SC treated plot and the lowest number (100.6) from untreated control plot. The yield in different treatments ranged from 12.43 -17.58 t ha^{-1}. The highest adjusted net return (Tk. 225800.70) and BCR (Tk. 8.74) were obtained from Spinosad 45 SC treated plot. The second highest BCR of 8.70 was calculated from *Bacillus thuringiensis* (Bt) treated plot and the lowest BCR of 5.02 was found in Abamectin 1.8 EC treated plot. All the treated insecticides reduced the infestation of fruit borer, but Spinosad 45 SC was found most effective.

Keywords: *Helicoverpa armigera*, *Solanum lycopersicum*, yield, benefit-cost ratio, biorational and microbial.

INTRODUCTION

Tomato (*Solanum lycopersicum*) is a self-pollinated annual crop is one of the most important, popular and nutritious fruits in Bangladesh which belongs to the family Solanaceae. It is widely grown all over the world and consumed in many countries. Due to high soil fertility and favorable weather conditions, tomato grows abundantly in Bangladesh (Ahmed 2002). The Bangladeshi farmers face many constraints during

*Corresponding author : choudhurymar.entom@sau.ac.bd

tomato production. Several major factors viz., lack of limited availability of good quality seeds of improved varieties, inadequate of hybrid variety, insect pests and diseases infestation are responsible for low yield of tomato in Bangladesh. Among the factors, insect pests are the main constraints. The insect, fruit borer *Helicoverpa armgera* (Lepidoptera: Noctuidae) is a highly damaging pest (Muthukumaran & Selvanarayanan 2013) causing significant yield loss of tomato (Talekar *et al.* 2006). It is polyphagous with high mobility, high fecundity, and facultative diapause pest (Fitt 1989) attacking more than 181 plant species from 45 families including a wide range of industrial, ornamental, cereal, legume and vegetable crops throughout the world as well as in Bangladesh (Durairaj *et al.* 2005, Mehrvar 2009).

Tomato fruit borer causes 20 to 60% yield loss in tomato (Dhandapani *et al.* 2003, Talekar *et al.* 2006, Mustafiz *et al.* 2015, Faqiri & Kumar 2016), 40 to 50% damage to tomato crop (Pareek & Bhargava 2003). In Jashore, the infestation of *H. armigera* on tomato went up to 46.85% (Alam *et al*. 2007).

The farmers of Bangladesh usually control the insect pests by applying chemical insecticides because these are readily available, very easy to apply and give very quick results. But the indiscriminate and overuse of chemical insecticides are not economical in the long run because they pollute the environment, leave harmful residues, exert adverse effect on beneficial insects, and can lead to the development of resistant strains among the target organisms (Naseby *et al.* 2000). Subsequently, some researchers have focused their efforts on developing alternative inputs to synthetic chemicals for controlling the insect pests. The use of biological control and bio-rational insecticides are some of the notable alternatives. Pest control materials that are relatively non-toxic to people with few environmental side effects are sometimes called "bio-rational" pesticides. To minimize the different hazardous problems of chemical insecticides, the utilization of bio-rational and microbial insecticides is essential to adopt as an ecologically viable and an alternate insect pest management strategy. In Bangladesh, the use of bio-rational insecticides to manage the tomato fruit borer (TFB) is not very common. Considering the above points, the present study was conducted to find out the most effective bio-rational and microbial insecticides against tomato fruit borer.

MATERIALS AND METHODS

Experimental site with climatic condition: The study was carried out in the field of Agricultural Training Institute, Sylhet, Bangladesh during winter 2019. The site is situated 24° 54' 04"N and 91° 54' 58" E and 19 m elevation from the sea level.

The soil of the experimental site is deep brown in texture and highly acidic in nature (Rahman *et al*. 2003).

Collection of seeds and raising of seedlings: Tomato hybrid Raja seeds were collected from the local market of Sylhet, Bangladesh and the seedlings were raised following proper management.

Experimental design, transplanting of seedlings and application of treatments: The experiment was laid out in a randomized complete block design with three replications.

The individual plot size was 3 m × 3 m, maintaining distance 60 cm between rows and 30 cm between plants. Thirty five-days old seedlings were transplanted in the well prepared experimental plots. There were 15 plants in each unit plot. The entire field was divided into three blocks of equal size, with a space of 1 m between the blocks, and again each block was subdivided into five plots. All treatments were applied four times at an interval of 10 days from the commencement of infestation.

Fruit collection and calculation of yield per hectare: Fruits were harvested at 5-days intervals and the number of healthy and infested fruits were recorded per plots. Fruits were harvested 12 times and recorded during the entire fruiting season to calculate the yield per hectare.

Economic analysis: The benefit-cost ratio (BCR) was analyzed based on the total crop production expenditure and net return obtained from each treatment. In this experiment, BCR was determined for a hectare of land.

Steps for measuring benefit-cost ratio: This cost was calculated by adding all labor expenses and inputs for each treatment for all vegetative and fruiting times, including the control plot. The yield of each treatment was converted to tons per hectare.

By multiplying the marketable return by the tomato unit price during that time, the gross return was determined. Cutting out treatment management costs from gross return measured net returns.

The adjusted net return was calculated by extracting the net return of the control plot from the net return of a particular treatment.

Adjusted net return = Net return of a particular treatment – net return of control plot.

Finally, the benefit-cost ratio (BCR) was determined by dividing the adjusted net return by the total management cost for each treatment as follows:

$$BCR = \frac{\text{Adjusted net return}}{\text{Total management cost}}$$

Data analysis: Data were statistically analyzed by R version 3.3.1 (R Development Core Team, 2016).

RESULTS

The highest number of healthy fruits plot^{-1} (274.00) was harvested from plots sprayed with Spinosad 45 SC which was statistically different from all other treatments. In contrast the minimum number of healthy fruits plot^{-1} (100.66) was collected from the untreated control plot (Table 1). The second highest number of healthy fruits (233.66) was harvested from the *Bacillus thuringiensis* (Bt) treated plot which was followed by Abamectin 1.8 EC (227.66) treated plot and they were statistically identical (Table 1).

Effect of different bio-rational and microbial insecticides on yield (t ha^{-1}) has been evaluated in terms of total fruit yield, healthy fruit yield or marketable yield and infested fruit yield obtained in each treatment during the entire cropping season (Table 2).

Significantly the highest marketable yield (17.11 t ha^{-1}) was recorded from Spinosad 45 SC treated plot which was followed by *Bacillus thuringiensis (*16.33 t ha^{-1}) and

Table1. Effect of different bio-rational and microbial insecticides on the fruit infestation rate (%) of tomato

Treatments	Number of healthy fruits plot^{-1}	Increase of healthy fruits over control (%)
Bacillus thuringiensis (Bt)	233.66 ab	32.78
Tracer 45SC (Spinosad)	274.00 a	72.85
Vertimec 18EC (Abamectin)	227.66 ab	26.82
Control	100.66 b	-
CV (%)	15.45	

Means within the same letter(s) within a column do not differ significantly ($p \leq 0.05$) according to DMRT.

Table 2. Effect of different bio-rational and microbial insecticides on the fruit yield ($t\ ha^{-1}$) of tomato

Treatments	Yield ($t\ ha^{-1}$)			Marketable yield increase over control (%)
	Marketable yield	Infested yield	Total yield	
Bacillus thuringiensis (Bt)	16.33a	1.40 b	17.73a	60.25
Tracer 45SC (Spinosad)	17.11a	0.47 c	17.58a	67.90
Vertimec 18EC (Abamectin)	13.30b	0.94 b	14.24b	30.52
Control	10.19c	2.24 a	12.43c	-
CV (%)	9.0	4.68	8.35	

Means within the same letter(s) within a column do not differ significantly ($p \leq 0.05$) according to DMRT.

it was statistically identical. The lowest yield of healthy fruits (10.19 $t\ ha^{-1}$) was recorded from control plot (Table 2). Significantly the least infested yield (0.47 $t\ ha^{-1}$) was recorded from Spinosad 45 SC treated plot and the highest (2.24 $t\ ha^{-1}$) was found in the control plot.

The total yield was the highest (17.58a $t\ ha^{-1}$) in Spinosad 45 SC treated plot and the lowest (12.43 $t\ ha^{-1}$) in the untreated control plot. The second highest total yield of was found in Abamectin 1.8EC (14.24 $t\ ha^{-1}$) treated lot and the lowest from untreated control plot.

The analysis of the yield increase over control indicated that biorational insecticide Spinosad 45 SC showed the highest increase (67.90%) of marketable fruit yield over the control followed by *Bacillus thuringiensis* (60.25%) and Abamectin 1.8 EC (27.97%) treated plots (Table 2).

The highest benefit cost ratio (8.84: 1.00) was obtained from Spinosad 45 SC treated plot and the next highest benefit cost ratio (8.74: 1.00) was found in the *Bacillus thuringiensis* treated plot. The lowest benefit cost ratio (5.02: 1.00) was obtained from Abamectin 1.8 EC treated plot (Table 3).

DISCUSSION

The highest percent reduction of infested fruit $plot^{-1}$ over control was found in the Spinosad 45 SC treated plot. The present findings on the efficacy of Spinosad are similar with the previous findings reported by Sidde Gowda *et al.* (2003). Very recently, Nath *et al.* (2020) noted 16.8 to 21.5% fruit infestation in the tomato field

Table 3. Economic analysis of different bio-rational and microbial insecticides used to control fruit borer of tomato

Treatments	Cost of control (Taka)	Marketable yield (t ha^{-1})	Gross return (Taka)	Net return (US Dollar)	Adjusted net Return (Taka)	BCR
Bt	22991.76	16.33	593029.36	570037.60	200100.56	8.70
Spinosad tracer	25530.56	17.11	621268.56	595738.00	225800.70	8.84
abamectin	18760.72	13.30	482895.60	464134.00	94196.96	5.02
untreated control	0.00	10.19	369937.04	369937.04	0.00	

Means within the same letter(s) within a column do not differ significantly ($p \leq 0.05$) according to DMRT.

using IPM and chemical control treatments. In these findings Spinosad 45 SC for two years was highly effective against pigeonpea fruit borer; *H. armigera* at four dosages, viz., 45, 56, 73 and 90 g a.i. ha^{-1}. The highest weight of healthy fruit plot^{-1} was recorded from Spinosad 45 SC treated plot and the lowest weight of healthy fruits plot^{-1} was recorded from the control plot which was followed by Abamectin 1.8 EC. The highest increase was recorded in Spinosad 45 SC treated plot and the lowest was obtained from Abamectin 1.8 EC treated plot. Similar results were observed by Islam et al. (2020) who recorded 81.82% healthy and 18.18% infested fruits when the tomato plants were treated with Spinosad. Nath *et al.* (2020) observed that the lowest fruit damage (16.8%) in the IPM package of chemical control. The highest weight of infested fruit plot^{-1} was recorded from Spinosad 45 SC treated plot and the lowest weight of infested fruits plot^{-1} was recorded from Spinosad 45 SC. The highest reduction was recorded in Spinosad 45 SC treated plot and the lowest in *Bacillus thuringiensis* applied plot. The findings are consistent with the results of Islam *et al.* (2020) who found 48.09% protection of fruits infestation when Spinosad was used. Effect of different bio-rational and microbial insecticides on yield has been evaluated in terms of total fruit yield, healthy fruit yield or marketing yield and infested fruit yield obtained in each treatment during the entire cropping season. Similarly, Islam *et al.* (2020) found similar results when the highest marketable yield (24.01 t ha^{-1}) and lowest infested yield (2.26 t ha^{-1}) were obtained from Spinosad treated plots. The highest benefit cost ratio was obtained from Spinosad 45 SC treated plot and the lowest benefit cost ratio was obtained in Abamectin 1.8 EC treated plot. Abdelgaleil *et al.* (2015) determined the effectiveness spinosad insecticides against tomato fruit borer. Considering the above points, if may be concluded that the bio-rational and microbial pesticides are cost-effective management techniques against tomato fruit borer which can keep the population of the borer pest below the economic threshold and ensured the increased yield.

CONCUSSION

It might be concluded that eco-friendly management tools viz., Spinosad 45 SC is very effective tool for the management of *H. armigera* in field conditions. The microbial insecticide *B. thuringiensis* @ 2 g L^{-1} of water sprayed at 10 days interval could be the second environment friendly approach against tomato fruit borer.

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