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RESEARCH ARTICLE

ECO-FRIENDLY AND COST-EFFECTIVE MANAGEMENT OF TOMATO FRUIT BORER (*Helicoverpa armigera*) IN LAMJUNG DISTRICT OF NEPAL

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ABSTRACT

A field experiment was conducted in Besishahar Municipality, Lamjung to identify eco-friendly and effective pesticides against tomato fruit borer (*Helicoverpa armigera*). The experiment setup was designed in Randomized complete block design (RCBD) with 7 treatments viz. are T_1(Neem extract), T_2(*Bacillus thuringiensis*), T_3(Spinosad), T_4(HNPv), T_5(Tobacco extract), T_6(*Metarhizium anisopliae*) and T_7(control) and each treatment was replicated four times Spinosad gave highest percentage reduction of pest over control (PROC) 66.52% and 68.85% after the 1st and 2nd spray respectively. *Bacillus thuringiensis* was found to be another promising insecticide reducing the larval population with PROC (49.55%) after 2nd spray. The highest marketable fruit yield (48.50 ton/ha) and lowest fruit damage (8.53 ton/ha) were obtained from Spinosad treated plots followed by *Bacillus thuringiensis* with a marketable yield of 46 ton/ha and fruit damage of 11.47ton/ha. The highest benefit-cost ratio was obtained from spinosad (2.05) followed by *Bacillus thuringiensis* (1.94). Thus, spinosad and *Bacillus thuringiensis* could be the potential option for the management of tomato fruit borer and increasing the return.

KEYWORDS

Percentage reduction over control, Bacillus thuringiensis, benefit-cost ratio

1. INTRODUCTION

Tomato (*Lycopersicon esculentum L.*) is an important horticultural crop as it is widely used both as a fresh vegetable and in a variety of processed products (Subramanian, 2016). In Nepal, it ranks third after cauliflower and cabbage in terms of area and production. In the year 2018/19 tomato was grown in 22,566 ha land with the production of 406,434 metric tons (MoALD , 2018; MoALD, 2019). Tomato fruit borer (*Helicoverpa armigera*) is one of the major pests of tomato in Nepal causing damage to the developing fruits (Gauli et al., 2020). It inflicts direct loss in marketable fruit by 22-38% (Dhandapani et al., 2003). Young larvae feed on tender foliage; mature larvae bore circular holes in fruit and eat the inner content. Fruit damage results in disfiguration of surface and rotting due to secondary bacterial infection.

Increased use of chemical pesticides has been seen in developing countries like Nepal (Ecobichon, 2001). Repeated application of pesticides leads to loss of biodiversity and increased pest resistance, while its effects on other species facilitate pest resurgence (Damalas and Eleftherohorinos, 2013). It also causes soil-water contamination reduced the beneficial insect pest population. In humans, pesticide effects range from short-term hazards like skin and eye irritation, headaches, dizziness, and nausea to chronic impacts like cancer, asthma, and diabetes (Kim et al., 2016). The use of biopesticides can also effectively control the tomato fruit borer (Ravi et al., 2008). Hence there is a need to switch to an eco-friendly approach to control tomato stem borer using bio-pesticides and botanical extracts. The main objective of this study is to find the eco-friendly and effective bio-pesticides for controlling tomato fruit borer.

2. METHODOLOGY

a. Experimental detail

The experiment was conducted at Besishahar municipality of Lamjung district located at 28.1962° N latitude, 84.3857° E longitude at an altitude of 760 meters above sea level. The experiment was conducted in a randomized complete block design (RCBD) with 7 treatments and 4 replications. Plots sizes of 5*3 m^2 were made and seedlings were transplanted at the spacing of 60cm*40cm.

b. Planting material

Srijana hybrid, an indeterminate tomato variety released by the Nepal Agriculture Research council by crossing HRD-1 (female line) and HRD-17 (male line) was used for the experiment.

2.3 Cultural practices

The seeds were shown on 24 October 2020 and the transplanting of seedlings in the main field was done on November 20. A fertilizer dose of 20 ton/ha FYM and 180:150:70 kg NPK/ha was applied. One-third of Nitrogen and the entire dose of Phosphorus and Potash were applied during field preparation. The remaining dose of Nitrogen was applied in equal split at 25 and 50 days after transplanting. The first spray of insecticide, bio-insecticide and botanical extracts was done after 6 weeks

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of transplantation whereas the second spray was done 14 days after the first spray.

2.4 Treatment details

Table 1: Treatment details

Treatments	Treatment name	Trade name	Dose
T_1	(Neem extract)	Praramva (Azodiractin 0.3 % W/W)	2.5gm/ltr
T_2	(Bacillus thuringiensis)	Mahastra (Bacillus thuringiensis var. kurstaki 0.5% W.P)	2 ml/ltr
T_3	(Spinosad)	Tracer (spinosad 45 SC)	0.33ml/ltr
T_4	(HNPv)	HNPv	250LE/ha
T_5	(Tobacco extract)	Mahagro	3 ml/ltr
T_6	(*Metarhizium anisopliae*)	Kalicharan(*Metarhizium anisopliae* 2.0% 2*10^8 CFU /ml)	2ml/ ltr
T_7	(Control)	-	-

Note: LE: larval equivalent, CFU: colony-forming unit, HNPv: Helicoverpa nuclear polyhedrosis virus

2.5 Observations

2.5.1 Larval population

Pre-counting of the larval population was done before application of treatments, then after larval population was counted at 3 days interval up to 9 days after every spray.

Percentage reduction of pest over control (PROC) was calculated using the following formula,

PROC= $(1-(Ta*Cb)/(Tb*Ca))*100$ (Fleming and Ratnakaran, 1985)
PROC = Percentage reduction of pest over control,
Ta = Population in treatment after spray,
Ca = Population in control after spray,
Tb = Population in treatment before spray,
Cb = Population in control before spray

2.5.2 Mean fruit damage

During each harvest, the weight of borer affected fruits and total yield from the tomato plants were measured and mean fruit damage and marketable fruit yield was calculated

$$\text{Mean fruit damage}=\frac{\text{weight of borer affected fruits}}{\text{weight total fruit yield}}*100$$

Where,

Total fruit yield = weight of healthy fruit + weight of borer affected fruits
Marketable yield = total fruit yield- weight of borer affected yield

2.6 Statistical Analysis

The collected data were entered and compiled by using MS Excel and statistical analysis was done by R-studio. Analysis of variance (ANOVA) was performed and the significant differences between treatments were determined using Duncan's multiple range test (DMRT) at a 5% level of significance.

3. Result and Discussion

Table 2: Effect of different treatments against the larval population of tomato fruit borer (*Helicoverpa armigera*) population per plant after 1st, and 2nd spray in Lamjung 2020

Treatments	Percentage larval reduction after 1st spray				PROC	Percentage larval reduction after 2nd spray				PROC
	Pre count	DAS 3	DAS 6	DAS 9		Pre count	DAS 3	DAS 6	DAS 9	
T_1(Neem extract)	5.82	4.19^{e}	3.5^{de}	3.09^{de}	45.95	5.3^{d}	3.70^{e}	3.25^{d}	2.88^{d}	45.15
T_2(*Bacillus thuringiensis*)	5.90	4.06^{f}	3.29^{e}	2.89^{e}	50.12	5.03^{e}	3.43^{f}	2.95^{e}	2.51^{e}	49.55
T_3(Spinosad)	5.86	3.01^{g}	2.51^{f}	1.93^{f}	66.52	4.75^{f}	2.46^{g}	1.9^{f}	1.47^{f}	68.85
T_4(HNPv)	5.86	4.5^{b}	4.28^{b}	3.86^{b}	32.92	5.8^{ab}	4.59^{b}	4.09^{b}	3.71^{b}	35.55
T_5(Tobacco extract)	5.85	4.29^{d}	3.56^{d}	3.13^{d}	45.61	5.53^{c}	4.04^{d}	3.74^{c}	3.14^{cd}	42.78
T_6 (*Metarhizium anisopliae*)	5.90	4.39^{c}	3.91^{c}	3.50^{c}	39.68	5.65^{bc}	4.35^{c}	3.82^{c}	3.36^{c}	40.07
T_7(Control)	5.92	5.8^{a}	5.82^{a}	5.82^{a}		5.84^{a}	5.86^{a}	5.76^{a}	5.79^{a}	
F test-alpha=0.05	Ns	***	***	***		***	***	***	***	
LSD(P=0.05)		0.09	0.25	0.22		0.17	0.16	0.26	0.33	
SEM±		0.15	0.19	0.10		0.08	0.18	0.21	0.24	
CV%		1.48	4.34	4.31		2.15	2.69	4.76	3.26	

Note: DAS: Days after spray, PROC: percentage reduction of pest over control, LSD: Least significant difference, SEM: Standard error of mean, CV: coefficient of variance treatments means separated by Duncan's multiple range test and columns represented with the same letters are not significantly different among each other at 5%level of significance.

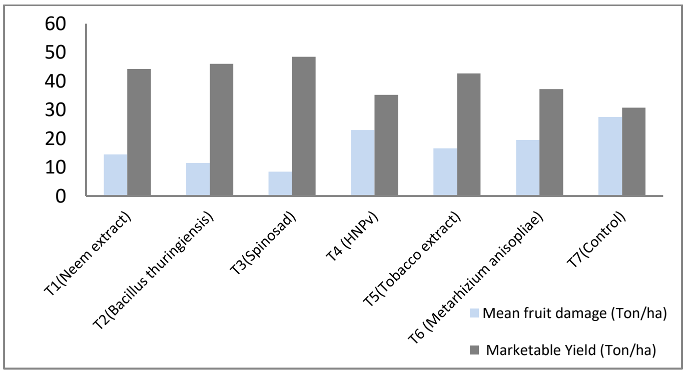

Figure 1: Diagrammatic representation of marketable yield and Mean fruit damage in ton per hector under different treatments application in Lamjung 2020.

All the insecticidal treatments were effective and significantly superior to control. The least fruit damage (8.53 ton/ha) was recorded on Spinosad followed by Bacillus thuringiensis (11.47 ton/ha), (Chatterjee & Mondal, 2012) also found that the chemical insecticide was more effective followed by bio-pesticides. The highest fruit damage (27.56 ton/ha) was recorded on control followed by HNPv (22.98). Whereas, maximum yield (48.5 ton/ha) was recorded on Spinosad followed by Bacillus thuringiensis (46.0 ton/ha). And the minimum yield was obtained from the control (30.75 ton/ha).

4. Benefit-Cost Ratio Analysis

The highest benefit-cost ratio (2.05) was obtained from Spinosad followed by Bacillus thuringiensis (1.94), whereas the lowest B: C ratio was obtained from control (1.31). The benefit-cost ratio analysis signifies that all the treatments are far superior to the control and the use of spinosad and Bacillus thuringiensis gives a significantly higher yield.

Table 4: Benefit cost ratio calculation

Treatments	Marketable yield	Cost of production Nrs/ ha	Total return Nrs/ha	B: C ratio
T_1(Neem extract)	44.25	711,208	1327500	1.87
T_2(*Bacillus thuringiensis*)	46.00	710,200	1380000	1.94
T_3(Spinosad)	48.50	711,080	1455000	2.05
T_4 (HNPv)	35.25	708,782	1057500	1.49
T_5(Tobacco extract)	42.75	711,600	1282500	1.80
T_6(*Metarhizium anisopliae*)	37.25	711,112	1117500	1.57
T_7(Control)	30.75	706,600	922500	1.31

5. Conclusions

It was observed that the maximum reduction of yellow stem borer populations over control and the maximum marketable yield was found in spinosad treated plots. *Bacillus thuringiensis* was found effective next to spinosad. Spinosad proved to be the most cost-effective with a high B: C ratio followed by *Bacillus thuringiensis* and Neem extract respectively. Thus, *Bacillus thuringiensis* can be use as effective bio- pesticides for management of tomato fruit borer.

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