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Cost: benefit analysis of newer insecticides used in control of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) at Gwalior region of Madhya Pradesh

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Abstract
An experiment was conducted to evaluate the Cost benefit analysis of different newer insecticides used for control of brinjal root and shoot borer (*Leucinodes orbonalis* Guenee) during Rabi season 2018-2019 at Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M. P.) India. During the study brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee was the major pest found infesting brinjal crop in Gwalior. Results of study revealed that all the treatments were found significant superior over control. The economics pattern of newer insecticides viz., Spinosad 45 SC, followed by Indoxacarb 14.5 SC and Emamectin benzoate 5 SG. It can be concluded that maximum control of brinjal shoot and fruit borer, provided through the insecticide Spinosad 45 SC after two spray at recommended interval and doses.

Keywords: Brinjal, newer insecticides, pest, yield, *Leucinodes orbonalis*, B: C ratio

Introduction

Vegetables are very rich source of vitamins. Daily consumption of required dose of vegetables provides taste, increases appetite and enough fibre for digestion to prevent constipation (Kumar A. *et al.* 2017) [9]. Key role is played by vegetables in neutralizing the acids produced through the digestion of foods. Vegetables are also a good sources of carbohydrates, proteins, vitamin A, vitamin C, vitamin B, and minerals. Brinjal (*Solanum melongena* L.), also known as eggplant is an important solanaceous vegetable crop grown in sub-tropics, and tropic regions of India. It is a indigenous vegetable (Choudhary B. 1970, Pareet DJ 2006) [4, 12]. It contributes 9 percent of the total vegetable production of the country (Sarsaiya V. *et al.* 2020) [22]. In India, brinjal is grown in an area of 730.4 thousand ha with the production of 12801 thousand metric tons and productivity with 17.5 metric tons/ha. Anonymous (2018) [2]. In Madhya Pradesh, it is grown in an area of 51.35 thousand hectares, with a production of 1073.63 metric tons (Anonymous 2018) [2]. It is consumed by different people in many countries viz., Central, South and South East Asia, some parts of Africa and Central America (Harish DK *et al.* 2011) [6]. The per 100 gm of edible portion contains calories (24.0), sodium (3.0 mg), moisture content (92.7%), copper (0.12 mg), carbohydrates (4.0%), potassium (2.0 mg), protein (1.4 g), sulphur (44.0 mg), fat (0.3 g), chlorine (52.0 mg), fibre (1.3 g), vitamin A (124.0 I.U.), oxalic acid (18.0 mg), folic acid (34.0 µg), calcium (18.0 mg), thiamine (0.04 mg), magnesium (15.0 mg), riboflavin (0.11 mg), phosphorus (47.0 mg), B-carotene (0.74 µg), iron (0.38 mg), vitamin C (12.0 mg), zinc (0.22 mg) and amino acids (0.22) (Gopalan C. *et al.* 2007) [5]. It contains potassium, which maintains electrolyte balance in the body. Thus help in neutralizing the effects of sodium in the entire human body and thus aiding in blood pressure control. Brinjal shoot and fruit borer is regarded as one of the most destructive pest attacking brinjal at every stage of its development (Sangma CD *et al.* 2019) [15]. Owing to the accessibility of brinjal production throughout the year, it suffers very significantly by insect-pests damage. Brinjal is attacked by almost 142 species of insect pests, four species of mites and nematodes in different parts of the world (Prempong and Bauhim, 1977, Sohi, 1996, Butani and Verma, 1976, Nayar *et al.*, 1976) [14, 21, 3, 11]. Brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) is very severe, endemic pest of brinjal all over India causing potential damage to the crop (Sheojat *et al.* 2022) [16]. Around 6 percent losses caused by shoot and fruit borer throughout India (Alam *et al.* 2003) [1]. Despite diverse ill effects of the chemicals pesticides, insecticides use still constitutes major control option to tackle this pest (Singh *et al.*, 2008) [19]. With a view to find out the efficacy and economics of newer insecticides, an attempt has been made to study these factors in the management of Brinjal shoot and fruit borer, Leucinodes orbonalis Guenee in the Gwalior region of M.P.

Material and Methods

The study were conducted during *Kharif* season of 2018-2019 at the research farm of College of Agriculture, Gwalior, Madhya Pradesh. It deals with the economics of treatment of shoot and fruit borer (*Leucinodes orbonalis* Guen.) on Brinjal (*Solanum melongena* L.). An investigation on Cost benefit analysis of different newer insecticides use in for control of brinjal root and shoot borer (*Leucinodes orbonalis* Guenee) was carried out during Rabi season 2018-2019. Experiment was laid out in RBD design. The total plot size was kept 3 m x 4.2 m (Gross) with spacing 60 cm x 60 (plant x row). Eight treatments including control were taken and kept control without spray. The treatment was applied from the initiation of infestation till the harvest of the crop at 15 days interval. Observation were made on five tagged plants and were randomly selected from net plot area of each plot. The harvested fruits of each plot were carefully observed after each picking to ascertain fruit infestation by brinjal (*Leucinodes orbonalis* Guenee). The data based on yield parameters were worked out statistically and analyzed after suitable transformation. The observations were recorded at weekly interval of the crop. Healthy and damaged fruits due to shoot and fruit borer were recorded and weighed separately during each picking. The yield was recorded in Kg/net plot and then it was converted on hectare basis.

Table 1: Details of Treatments

S. No.	Treatments	Formulations	Dose^{-1}
1.	Chlorantraniliprole	18.5 SC	55 g^{-1}
2.	Flubendiamide	20 WG	300 g^{-1}
3.	Thiacloprid	21.7 W/W	300 ml^{-1}
4.	Carbosulfan	25 EC	1000 ml^{-1}
5.	Indoxacarb	14.5 SC	500 ml^{-1}
6.	Emamectin benzoate	5 SG	150 g^{-1}
7.	Spinosad	45 SC	180 ml^{-1}
8.	Control		

Results and Discussion

Effects of newer insecticides on brinjal yield cost benefit ratio

Based on the data presented in Table 3 cumulative healthy marketable fruit yield in all the insecticidal treatments recorded significantly higher fruit yield as compared to control (776 kg/ha). Among the treatments Spinosad 45 SC @ 180 ml a. i./ha was found to be most efficient as it recorded highest fruit yield (1693 kg/ha) followed by indooxacarb 14.5 SC @ 500 ml a. i./ha (1603 kg/ha), Emamectin benzoate 5 SG @ 150 gm a. i./ha (1572 kg/ha), Carbosulfan 25 EC @ 1000 ml a. i./ha (1552 kg/ha), Thiacloprid 21.7 W/W @ 300 ml a. i./ha (1492 kg/ha),Chlorantraniliprole 18.5 SC @ 55 gm a. i./ha (1421 kg/ha) and Flubendiamide 20 WG @ 300 gm a. i./ha (1381 kg/ha). The mean yield per plot was only 776 kg/ha in control plots and was significantly lowest when compared with fruit yield in various insecticidal treatments (Table 3). The yield increase over control was highest with Spinosad (917 kg/ha) treatment followed by indoxacarb (827 kg/ha), Emamectin benzoate (796 kg/ha), and Carbosulfan (776 kg/ha) treatments. The present findings are in line with the findings of Khare and Sneha (2021) [8] who reported that the brinjal crop was best protected against the brinjal shoot and fruit borer using Spinosad 45 percent SC with a fruit yield of 250 q/ha. Singh *et al.* (2021) [18] reported spinosad 45 SC @ 0.5 ml/l was the best with the least fruit damage (12.66%) with maximum yield (25.39 and 26.99 t/ha), chlorantraniliprole and emamectin benzoate were the next best treatment. Shirale *et al.* (2012) [17] reported Chlorantraniliprole 18.50% SC gave a significantly higher yield as compared to the plots (528.52 quintals/ha).

Table 2: Effect of newer insecticides on fruit infestation (on weight basis) due to brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee.

Treatment Number	Treatment Names	% fruit infestation weight basis	
		One day (before) spray	(Mean after two sprays)
T_1	Chlorantraniliprole	8.50 (16.85)	4.69 (12.29)
T_2	Flubendiamide	8.45 (16.78)	4.99 (12.73)
T_3	Thiacloprid	8.60 (16.95)	3.93 (11.18)
T_4	Carbosulfan	8.45 (16.78)	4.18 (11.55)
T_5	Indoxacarb	9.45 (17.82)	3.28 (10.12)
T_6	Emamectin benzoate	9.05 (17.43)	3.64 (10.75)
T_7	Spinosad	9.35 (17.72)	3.11 (9.85)
T_8	Control	8.10 (16.44)	8.45 (16.89)
	SEm(±)	(0.11)	(0.40)
	C.D. at 5%	(0.33)	(1.15)

Table 3: Economics of treatments for the control of fruit and shoot infestation of brinjal crop

Treatments	Fruit yield (kg/ha)	Increased yield over control (kg/ha)	Cost of increased yield over Control (Rs/ha)	Cost of the treatments (Rs/ha)	Net profit (Rs/ha)	Cost benefit ratio
Chlorantraniliprole 18.5 SC @ 55 gm a. i./ha	1421	645	6453	3680	2773	1:0.75
Flubendiamide 20 WG @ 300 gm a. i./ha	1381	605	6050	3630	2420	1:0.66
Thiacloprid 21.7 W/W @ 300 ml a. i./ha	1492	716	7158	3670	3488	1:0.95
Carbosulfan 25 EC @ 1000 ml a. i./ha	1552	776	7763	3786	3977	1:1.05
Indoxacarb 14.5 SC @ 500 ml a. i./ha	1603	827	8267	3666	4601	1:1.25
Emamectin benzoate 5 SG @ 150 gm a. i./ha	1572	796	7965	3625	4340	1:1.19
Spinosad 45 SC @ 180 ml a. i./ha	1693	917	9174	3620	5554	1:1.53
Control	776	0	-	-	-	-
SEm(±)	170					
C.D. at 5%	520					

*Brinjal market price Rs. 10 per kg

**Cost of insecticides: as per market rate

***Labour cost Rs. 263/- (Total labour2 per ha for one spray and per picking)

Data recorded on economics of different treatments revealed that all the treatments gave profit. Maximum net profit (Rs. 5554/ha) was recorded by Spinosad 45 SC, followed by Indoxacarb 14.5 SC (Rs. 4601/ha) and Emamectin benzoate 5 SG (Rs. 4340/ha). However, the on basis of cost benefit ratio Spinosad 45 SC (1.65) was most economical followed by Indoxacarb 14.5 SC (1.80) and Emamectin benzoate 5 SG (1.84). The present results were supported by Kushwaha and Painkra (2016) [10] who reported Chlorantraniliprole (1:5.48) had the highest B:C ratio, followed by flubendiamide (1:4.91), spinosad (1:4.65), and indoxacarb (1:4.65). (1:4.44). Kameshwaran and Kumar (2015) [7] reported highest CBR with chlorantraniliprole 20 EC @ 40 g a. i./ha and lowest with indoxacarb 14.5 SC @ 75 g a. i./ha.The results are also accordance with Sinha *et al.*, (2010) [20] who reported that Indoxacarb recorded yield of 22.552 mt/ha when applied at 140 g/ha and 20.744 mt/ha at 70 g/ha compared to only 14.632 mt/ha in the control. Patra *et al.* (2009) [13] were also reduced that the highest marketable fruit yield was harvested by indoxcacarb with 126.90 q ha^{-1}, respectively.

Conclusion
Since all the newer insecticides were significantly superior over control in reducing brinjal shoot and fruit borer after two application. Cost economics for all the treatments was worked out on the basis of the incurred input cost and market price of the produce at the time of experimentation. Maximum net profit (Rs. 5554/ha) was recorded Spinosad 45 SC, followed by Indoxacarb 14.5 SC (Rs. 4601/ha) and Emamectin benzoate 5SG (Rs. 4340/ha). More emphasis should be given on best IPM approaches to cobat brinjal shoot and fruit borer with best research techniques. As brinjal shoot and fruit borer defeat is a major concern as it causes yearly economic loss in India and across the world.

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