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Research Article

Comparative potency of three insecticides against the infestation of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen.

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Abstract: Brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee, is a serious pest of brinjal or eggplant (*Solanum melongena* L.). Due to increasing levels of resistance of *L. orbonalis* to different insecticides there is an urgent need to test new chemicals. Studies were carried out in the Entomology Field Laboratory, Bangladesh Agricultural University (BAU) to evaluate the efficacy of three insecticides *viz*., impale 20SL (imidacloprid), advantage 20EC (carbosulfan), libsen 45SC (spinosad) against the infestation of *L. orbonalis*. All the tested insecticides were found to be effective in controlling brinjal shoot and fruit borer although spinosad was the most effective. Minimum shoot damage and maximum protection was provided by spinosad (libsen 45SC) which was followed by carbosulfan (advantage 20 EC) and imidacloprid (impale 20 SL). Similarly, minimum fruit damage and maximum protection was also provided by spinosad but in contrast with shoot damage, imidacloprid was found comparatively effective than carbosulfan although the difference was insignificant. Moreover, minimum fruit loss and maximum protection was provided by spinosad which was followed by imidacloprid and carbosulfan. Therefore, all the insecticides were found significantly effective in comparison with that in the water-treated control regarding shoot and fruit damage as well as fruit losses caused by *L. orbonalis*. In conclusion, the comparative efficacies of the selected insecticides were spinosad>imidacloprid>carbosulfan to protect shoot and fruit damage of brinjal caused by *L. orbonalis*.
Keywords: *Leucinodes orbonalis*, spinosad, imidacloprid, carbosulfan, efficacy, shoot and fruit damage.

INTRODUCTION

Brinjal (*Solanum melongena* L.) is one of the widely used vegetable crops by most of the people in Bangladesh [1] and is popular in many countries *viz*., Central, South and South East Asia, some parts of Africa and Central America [2]. It is an important vegetable grown in all the seasons. Due to its nutritive value, consisting of minerals like iron, phosphorous, calcium and vitamins like A, B and C, unripe fruits are used primarily as vegetable in the country. In Bangladesh, approximately eight insect species are considered as major pests causing damage to this crop [3]. Among them, brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen., Lepidoptera: Pyralidae) (BSFB) is one of the major constraints for brinjal production in Bangladesh. The BSFB is an internal feeder. The damage starts soon after transplanting of seedling and continues till the last harvest of the fruit. In early stage of growth, the newly hatched larvae bore into shoots and close the entry holes with their excreta and feed inside [4]. As a result of the larval activities within the shoot, transmission mechanism of the plant sap is affected causing withering of shoots which is known as dead heart. At fruiting stage, fruits are also affected by this larvae and market value reduces severely. The yield loss caused by this pest has been estimated up to 67% in Bangladesh.

In controlling BSFB effectively as well as getting blemish-free brinjal fruits, farmers are exclusively relying on different toxic and systemic insecticides. About 47% of the total insecticides used in vegetable are for controlling brinjal shoot and fruit borer, which is the highest (1.41 kg/ha) among the crop in Bangladesh. Survey conducted in Bangladesh indicated that farmers spray insecticides up to 84 times during a 6-7 months cropping season. The multiple and indiscriminate uses of insecticides against this pest cause several problems viz., insecticides resistance, toxic residues in fruits, killing of natural enemies and ultimately pest resurgence. The frequent use of systemic insecticides is ecologically unsafe and economically unviable also. It is not only costly but also detrimental to environment, human consumption and beneficial fauna of the ecosystem. Various newer and safer insecticides are currently available in Bangladesh. Among them, bacterial fermented insecticides like spinosad, emamectin, abamectin are most promising, target-dependent, safe and eco-friendly. On the other hand, imidacloprid is a new class of neonicotinoid insecticide which is potently replaced with different toxic and hazardous insecticides due to their unique mode of action (nicotinic acetylcholine receptor agonist or acetylcholine mimic) and comparatively less toxic to human and environment. Some recent studies show that imidacloprid gives an outstanding result against chewing and sucking insects [5-8]. Carbosulfan may be another choice in controlling BSFB because of its target action as well as effectively against chewing insects [9].

Therefore, the present research was undertaken to evaluate the field efficacy of three different insecticides *viz*., spinosad, imidacloprid and carbosulfan against *L. orbonalis* infestation as well as increasing of brinjal production.

MATERIALS AND METHODS

Efficacies of spinosad, imidacloprid and carbosulfan were evaluated against the brinjal shoot and fruit borer infestation at the farm of Bangladesh Agricultural University, Mymensingh during May to October 2012.

Brinjal seedlings

The variety, BARI (Bangladesh Agricultural Research Institute) begoon-8 was used in this study. Seedlings were collected from the Regional Agricultural Research Station (RARS), Jamalpur, Mymensingh.

Transplantation of seedlings and management

The experimental plots were prepared by ploughing and cross-ploughing followed by laddering. All the plots were prepared with proper proportions of manure and fertilizers. The unit plot size was 2m X 2m being 80 cm X 60cm plant spacing. The Randomized Complete Block Design (RCBD) was followed with three replications. All agronomic practices were started after seedling transplantation and continued up to fruiting stage.

Treatments

The experiments consisting of four treatment combinations; T1= Libsen 45 SC (spinosad) @ 1 ml/L water; T2 = Advantage 20 EC (carbosulfan) @ 3 ml/L water; T3 = Impale 20 SL (imidacloprid) @ 0.25 ml/L water; T4 = Untreated control. Each treatment was replicated three times.

Specifications of insecticides

Three different insecticides were used in this study *viz*., spinosad, imidacloprid and carbosulfan. Spinosad is a bioinsecticide based on the fermentation product of the soil bacterium *Saccharopolyspora spinosa* [10]. This compound has two unique modes of action, acting primarily on the insect nervous system at the nicotinic acetylcholine receptor, and exhibiting activity at the GABA receptor [11]. It has a low toxicity for mammals. Imidacloprid is a new class of neonicotinoid insecticide which works as the nicotinic acetylcholine receptor agonist or acetylcholine mimic. Carbosulfan is an organic compound under the class organocarbamate and it works by the inhibition of acetylcholinesterase in the central nervous system.

Data collection

Data were collected on percentage of infested shoot and fruit, estimation of fruit loss following the application of specified treatments. Data were also collected from control plot to make a comparison with insecticide treated plot. The percentage of shoot or fruit damage was calculated using the following formula;

Percentage of damage = Po/Pr X 100

Where,

P_r = Total number of average healthy shoot/fruit before treatment

Po = Total number of average infested shoot/fruit after treatment

Statistical analyses

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance (ANOVA) was done with the help of computer package MSTAT. The mean differences among the treatments were adjudged with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) when necessary [12].

RESULTS

Effects of spinosad, imidacloprid and carbosulfan against brinjal shoot infestation caused by *L. orbonalis*

At 7 days after first spraying, the shoot infestation was significantly ($p<0.01$) reduced when brinjal plants were treated with spinosad (13.6%), carbosulfan (19.6%) and imidacloprid (25.4%) in comparison with that in the water-treated control (62.4%) (Table1). Among three insecticides, spinosad provided minimum shoot damage and maximum protection which was followed by carbosulfan and imidacloprid. There had a significant difference between spinosad and imidacloprid efficacy regarding shoot infestation while the difference was insignificant between spinosad and carbosulfan. It was also noted that spinosad provided almost twofold efficacy than imidacloprid. Following 2nd spraying, the efficacy of three selected insecticides was found almost similar with first spraying (Table 2). The lowest shoot infestation was recorded from spinosad treated plot which was followed by carbosulfan and imidacloprid. The highest infestation was recorded from water-treated plot (Table 2).

Effects of spinosad, imidacloprid and carbosulfan against fruit infestation caused by *L. orbonalis*

The percent of fruit damage ranged from 10.58% to 50.38%. The fruit infestation was significantly ($p<0.01$) reduced by all selected insecticides in comparison with that in the water-treated control (Table 3). The highest infestation (50.38%) and lowest protection was observed in the control plot. On the other hand, spinosad provided minimum fruit damage (10.58%) and maximum protection (78.9%) which was followed by carbosulfan and imidacloprid (Table 3). There had no significant difference between imidacloprid and carbosulfan regarding the fruit infestation while the difference was significant between spinosad and carbosulfan or spinosad and imidacloprid. It was also noted that spinosad provided almost twofold and 1.5 fold efficacies compared to the carbosulfan and imidacloprid respectively.

Estimation of fruit losses caused by *L. orbonalis*

The percentage of loss was estimated on the basis of normal and infested fruits. The results are shown in the table 4. The percentage of losses ranged from 24.1-60% (Table 4). The maximum (60%) fruit reduction occurred in control plot where no treatment was applied because of favourable environment for infestation of brinjal shoot and fruit borer. The minimum loss (24.1%) and maximum protection (75.9%) was found from spinosad treated plot. This can be treated as most effective treatment. The second minimum loss (27.3%) as well as protection (72.7%) was observed in imidacloprid treated plot which was followed by carbosulfan (Table 4). In contrast with shoot and fruit infestation data, there had no significant differences among spinosad, imidacloprid and carbosulfan efficacy regarding percentage of fruit losses.

Table 1: Effectiveness of three different insecticides on shoot damage by *L. orbonalis* at 7 days after first spraying.

Treatments	Number of Normal shoots (before application)	Number of infested shoots (after application)	% of shoot damage	% protection over control
Spinosad (Libsen 45SC)	31.0	4.3	13.6c	78.2
Carbosulfan (Advantage 20 EC)	26.7	5.2	19.6bc	68.6
Imidacloprid (Impale 20 SL)	25.7	6.5	25.4b	59.3
Control	29.7	18.5	62.4a	
Level of significance			0.01	

In a column, means of similar letter (s) do not differ significantly as per DMRT.

Table 2: Effectiveness of three different insecticides on shoot damage by *L. orbonalis* at 7 days after second spraying.

Treatments	Number of Normal shoots (before application)	Number of infested shoots (after application)	% of shoot damage	% protection over control
Spinosad (Libsen 45SC)	61.0	3.7	6.10c	83.6
Carbosulfan (Advantage 20 EC)	46.3	8.2	17.5b	52.8
Imidacloprid (Impale 20 SL)	36.7	4.6	12.4b	66.6
Control	40.0	14.8	37.1a	
Level of significance			0.01	

In a column, means of similar letter (s) do not differ significantly as per DMRT.

Table 3: Effectiveness of three different insecticides on fruit damage by *L. orbonalis*

Treatments	Number of normal fruits (before application)	Number of infested fruits (after application)	% of fruit damage	% protection over control
Spinosad (Libsen 45SC)	6.33	0.67	10.58c	78.9
Carbosulfan (Advantage 20 EC)	6.00	1.33	22.17b	55.9
Imidacloprid (Impale 20 SL)	6.33	1.00	15.78b	68.7
Control	1.33	0.67	50.38a	
Level of significance			0.01	

In a column, means of similar letter (s) do not differ significantly as per DMRT.

Table 4. Estimation of fruit losses caused by *L. orbonalis* following treated with spinosad, imidacloprid and carbosulfan.

Treatments	Total number of fruits*, (P_0)	Total number of infested fruits, (P_r)	% of fruit protection P= (P_0-P_r/P_0)* 100	% of fruit losses, (100-P)
Spinosad (Libsen 45SC)	29	7	75.9	24.14b
Carbosulfan (Advantage 20 EC)	30	9	70.0	30.00b
Imidacloprid (Impale 20 SL)	44	12	72.7	27.30b
Control	25	15	40.0	60.00a
Level of significance				0.01

*Mean of four plants

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DISCUSSION

Brinjal shoot and fruit borer is the destructive and economically harmful pest of brinjal or eggplant in brinjal producing countries. Only cultural, mechanical or even bio-agents are not enough to control this destructive pest. Therefore, different insecticides from different groups are currently evaluating against BSFB infestation in the field level. In the present study, three different insecticides (spinosad, imidacloprid and carbosulfan) were selected to examine their efficacies against BSFB infestation as well increasing marketable brinjal production. The optimum doses were selected for all the insecticides according to the instructions provided by pesticides companies. Our data clearly showed that all the insecticides were highly effective against BSFB infestation and the differences were significant ($p<0.01$) when compared with water-treated control.

Among three, spinosad worked as the best insecticide considering the reduction of shoot and fruit infestation as well as increasing protection over control. Spinosad provided minimum shoot damage and maximum protection which was followed by carbosulfan and imidacloprid. There had a significant difference between spinosad and imidacloprid efficacy regarding shoot infestation while the difference was insignificant between spinosad and carbosulfan. It was also noted that spinosad provided almost twofold efficacies than imidacloprid. Spinosad is a bioinsecticide based on the fermentation product of the soil bacterium *Saccharopolyspora spinosa*. It is environmentally safe, quick biodegradable and no toxic residues in fruit during eating. A series of experiments have been conducted in different countries using spinosad alone or in combination with various components against BSFB infestation [13-24]. Field experiments were conducted for two cropping seasons during kharif 2005 and summer 2006 in India [10]. The study has reported that spinosad afforded moderate control of jassid, whitefly and aphid but was most effective against brinjal shoot and fruit borer. The present findings also clearly conformity with the result of Chowdhury *et al*. [14]. Following 2[nd] spraying, the efficacy of three selected insecticides was found almost similar with first spraying. Latif *et al.* [9] conducted experiments against BSFB infestation using nine insecticides from different groups and they found that carbosulfan was highly effective among nine insecticides although spinosad was not included in their study. Imidacloprid is a neonicotinoid systemic insecticide which has been effectively used against various crops including vegetables. Several research works has been conducted using imidacloprid against BSFB infestation and those works has suggested that imidacloprid effectively worked against BSFB infestation [9, 25].

The fruit loss was also estimated following treated with spinosad, carbosulfan and imidacloprid. The percentage of loss was estimated on the basis of total fruits and infested fruits. The percentage of losses ranged from 24.1-60. The maximum (60%) fruit reduction occurred in control plot where no treatment was applied, resulted favourable environment for infestation of brinjal shoot and fruit borer. The minimum loss (24.1%) and maximum fruit protection over control (75.9%) was found in spinosad treated plot. The second minimum loss (24.3%) as well as protection (72.7%) was observed in imidacloprid treated plot and which was followed by carbosulfan (30% loss while the protection was 70%).

Among three tested insecticides, spinosad has provided the maximum efficacy by reducing shoot and fruit infestation as well as increasing brinjal production. Spinosad has a very good contact and stomach activity against insect pests [13]. Although it is not systemic, possess translaminar movement when applied on the crop. BSFB is an internal feeder, once hatch the eggs, the neonate larvae immediately enter into the fruit and in the shoot by making bore. It was thought that when spinosad come in contact with neonate larvae before enter into the fruit or shoot, the larvae died through acetylcholine mimic action in the central nervous system [26]. Another possibility is that spinosad has ovicidal action and hence the progeny ultimately reduced in the spinosad treated plot and accordingly infestation level significantly reduced compared to other treatments. On the other hand, spinosad has low mammalian toxicity, shows no effects on the predatory insects, environmentally safe because of their quick biodegradability and no development of insect resistance.

The present field study thus revealed that the use of spinosad can be considered as an alternative to synthetic and persistent insecticides on brinjal crop more particularly in the situation where development of resistance and resurgence of pests was experienced. From the results, it can be concluded that spinosad can be included in the IPM on brinjal.

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