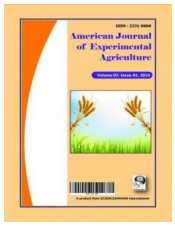

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Effectiveness of Some Potential Insecticides for Controlling Eggplant Shoot and Fruit Borer in Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors, designed field experiment. Author SR managed the write and corrections to the manuscript. All authors read the drafts of this manuscript and approved its final version.

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ABSTRACT

The experiment was conducted in the central farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, Bangladesh during February to September, 2013 to evaluate some potential insecticides in comparison with conventional insecticides for controlling eggplant shoot and fruit borer (ESFB), *Leucinodes orbonalis*. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and six treatments applied at 7 days interval. The treatments were T_1 [Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) at the rate of 1 ml/L of water]; T_2 [Calypso (Thiacloprid) at the rate of 1 ml/L of water]; T_3 [Neem oil at the rate of 3 ml/L of water]; T_4 [Neem Seed Karnel Extract at the rate of 100 g/L of water]; T_5 [Nexaid (Gamma-cyhalothrin) at the rate of 1.5 ml/L of water]; T_6 (Untreated Control). The results revealed that amongst different treatments Acimix 55 EC was most effective in reducing shoot infestation (66.72%) and Calypso was found most effective in reducing fruit infestation over control by number

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(68.56%) and weight (61.04%). The best treatment, though, T_1 and T_2 reduced the highest level of shoot and fruit infestation respectively, they increased the maximum level of plant and fruit related yield attributes. T_2 increased the maximum height, number of branches per plant, fruit length and girth, number of fruits per plant, and single fruit weight of eggplant over control followed by Acimix whereas Neem Seed Kernel Extract showed the least performance. Calypso also increased the highest fruit yield (15.36 t/ha) over control followed by Acimix (14.86 t/ha). So, Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) and Calypso (Thiacloprid) may be suggested to the farmers for controlling Eggplant shoot and fruit borer (ESFB) at shoot and fruit infestation time respectively.

Keywords: Insecticides; botanicals; eggplant; control; Leucinodes orbonalis.

1. INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of the popular vegetables and is favored by many people of various countries specially Central, South and South East Asia [1]. It is one of the top ten vegetables grown in the world. Eggplant is the second most important vegetable crop of Bangladesh in respect of total land area (70,750 acre) and production (2,15,490 ton) annually [2]. It is available in the country throughout the year, especially during the lean period when the seasonal vegetables are in scarcity in the market. Eggplant is regarded as a cash crop in Bangladesh [3].

Various insects attack on this crop due to cultivation throughout the year, out of which eggplant shoot and fruit borer (*Leucinodes orbonalis*) is most serious [4], which causes enormous losses [5]. Only the larvae of this pest cause damage to shoots from 12-16% and fruits from 20-60% [6-7]. It is very active during the rainy and summer seasons and often causes more than 90% damage [8-9]. The yield loss has been estimated up to 90% [10] in Bangladesh and up to 95% [11] in India. To overcome this loss, the eggplant growers spray insecticides almost every day or every alternate day to combat the pest. They also use variety of insecticides belonging to different chemical groups [12]. More than 95% of farmers sprayed 40 different pesticides per cropping season in eggplant field [13]. Majority of the Bangladeshi farmers (98%) relied exclusively on the insecticides and more than 60% of farmers sprayed their crop 140 times or more in the 6-7 months cropping season [14].

Thus, insects become resistant due to indiscriminately and repeatedly used of the same insecticides. So, the effectiveness of new insecticides against the eggplant shoot and fruit borer at field level need to be evaluated.

So, the present study was undertaken to measure the effectiveness of five potential insecticides in Bangladesh to combat eggplant shoot and fruit borer and to determine which can control the pest effectively based on shoot and fruit infestations and yield attributes.

2. MATERIALS AND METHODS

2.1 Study Site

The experiment was conducted in the central farm (open field condition) of Sher-e-Bangla Agricultural University (SAU), Dhaka from February to September, 2013. BARI Begun-8 was used for this experiment, it is a variety; released from Bangladesh Agricultural Research Institute (BARI). Climatic condition of the experimental site was under the sub-tropical monsoon climate, which is characterized by the Rabi season (October to March) and heavy rainfall during kharif season (April to September). There was few or no rainfall during the month of February and March.

2.2 Experimental Design

The field experiment comprising of five treatments with an untreated control was laid out in a Randomized Complete Block Design (RCBD) with simultaneous three replications. A total of eighteen plots were made having equal size (3 m X 3 m) with one meter space between the plots. Fifteen pits were made in each plot at a distance of 100 cm between the rows and 60 cm between pits in a row. Fertilizer application was done as recommended dose; supplementary irrigation, weeding and other intercultural operations were done when necessary. Insecticides were sprayed by knapsack sprayer starting from 14th April 2013 to the last of August 2013.

The treatments were: T_1 = Spraying of Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) at the

rate of 1 ml/L of water at 7 days interval, T_2 = Spraying of Calypso (Thiacloprid) at the rate of 1 ml/L of water at 7 days interval, T_3 = Spraying of Neem oil at the rate of 3 ml/L of water at 7 days interval, T_4 = Spraying of Neem Seed Kernel Extract at the rate of 100 g/L of water at 7 days interval, T_5 = Spraying of Nexaid (Gamma-cyhalothrin) at the rate of 1.5 ml/L of water at 7 days interval, T_6 = Untreated Control.

2.2.1 Preparation neem seed kernel extract

One hundred gram fresh neem seed was blended by electric blender then it was mixed with 1 L of water. The solid materials were separated from mixture by sieve.

2.3 Data Recording

For calculating percent fruit infestation, data on the number and weight of healthy, infested and total fruits harvested per plot were recorded at each harvest. Harvesting was done nine times throughout the fruiting season (June 2013 to September 2013).

Percent Shoot or fruit infestation and reduction of shoot or fruit infestation over control were calculated by using the following formula:

% Shoot or Fruit infestation (by number or by weight) = (Number or Weight of infested shoot or fruit/ Total number or weight of shoot or fruits) X 100.

% Reduction of shoot or fruit infestation over control = (% Shoot or Fruit infestation in untreated control - % Shoot or fruit infestation in treated plot) / % Shoot or fruit infestation in untreated control plot X 100.

2.4 Data Analysis

The data collected on different parameters were statistically analyzed using the MSTAT-C computer package. Mean values were ranked and compared by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

3. RESULTS

3.1 Effect of Five Selected Potential Insecticides on Shoot and Fruit Infestation

Comparative effectiveness of various treatments on eggplant shoot and fruit infestation was evaluated in terms of percent shoot and fruit infestation as well as calculated percent reduction of infestation over control (Table 1).

The results presented in Table 1 revealed that significantly the lowest fruit infestation by number (14.77%) and weight (18.33%) were observed in T_2, whereas the highest value for the same was recorded in T_6 (control). The fruit infestation by number and weight had the highest fruit infestation reduction over control was also recorded in T_2 (68.41% and 61.04%, respectively).

Percent shoot infestation was lowest (6.45%) was recorded in T_1 treated plots, whereas the highest value was recorded in T_6 (control). It also revealed that highest shoot infestation reduction over control was recorded in T_1 (66.72%) followed by T2 (64.19%).

So, treatments T_1 and T_2 are better than other treatments in reducing both shoot and fruit infestation by number and weight respectively.

3.2 Effectiveness of Some Potential Insecticides on the Plant Growth of Eggplant

The comparative effectiveness of various treatments on the plant growth of eggplant has been evaluated in terms of height of plant and number of branches per plant and also percent (%) increase over control is presented in Table 2.

Among the five selected insecticides the highest number of branches (9.41%) per plant was recorded in the plots treated with T_2 followed by T_1 (9.20%), T_5 (8.61%), T_3 (7.88%) and T_4 (7.38%) which were not statistically identical. On the other hand, the lowest number of branches per plant (6.89%) was recorded in untreated control plots (T_6).

In case of percent increase of number of branches per plant over control, the highest increase (36.50%) was found in T_2 followed by T_1 (33.46%), T_5 (25.00%), T_3 (14.31%), and T_4 (7.10%) treated plots during cropping season. The trend of results in terms of increasing the number of branches per plant is $T_2>T_1>T_5>T_3>T_4>T_6$.

Among the treatments significantly the highest plant height (65.03 cm) and percent increase of plant height over control (27.06%) was observed in T_2 treated plots which was statistically different from other treatments.

Table 1. Effect of five selected potential insecticides on shoot and fruit infestation caused by eggplant shoot and fruit borer (ESFB)

Treatment	Shoot infestation (%)	*Reduction of shoot infestation (%) over control	*Fruit infestation (%)		*Reduction of fruit infestation (%) over control	
			by number	by weight	by number	by weight
T_1	6.45 c	66.72	15.64 e	21.78 e	66.56	53.7
T_2	6.94 c	64.19	14.77 e	18.33 f	68.41	61.04
T_3	14.03 b	27.68	33.60 c	38.53 c	28.15	18.09
T_4	15.76 b	18.76	37.70 b	42.73 b	19.40	9.17
T_5	14.89 b	23.25	21.91 d	31.81 d	53.15	32.38
T_6	19.40 a	-	46.78 a	47.05 a	0	0
$LSD_{(0.05)}$	3.09	-	2.95	3.37	-	-
CV (%)	13.19	-	5.71	5.57	-	-

*In a column, means followed by same letter(s) are not statistically different by DMRT at 5% level of significance. [T_1 = Spraying of Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) at the rate of 1 ml/L of water at 7 days interval; T_2 = Spraying of Calypso (Thiacloprid) at the rate of 1 ml/L of water at 7 days interval; T_3 = Spraying of neem oil at the rate of 3 ml/L of water at 7 days interval; T_4 = Spraying of neem seed kernel extract at the rate of 100 g/L of water at 7 days interval; T_5 = Spraying of Nexaid (Gamma-cyhalothrin) at the rate of 1.5 ml/L of water at 7 days interval; T_6 = Untreated Control]; *Mean of 3 replications; each replication is derived from mean of 9 recordings; each recording is made from 5 plants per treatment*

Table 2. Effectiveness of five selected promising insecticides on the plant growth during the management of eggplant shoot and fruit borer (ESFB)

Treatment	Number of branches/plant	% Increase over control	Height of plant (cm)	% Increase over control
T_1	9.2a	33.462	58.0ab	13.33
T_2	9.41a	36.50	65.03a	27.06
T_3	7.88c	14.31	52.93b	3.42
T_4	7.38d	7.1	55.38b	8.21
T_5	8.61b	25	56.21b	9.83
T_6	6.89e	0	51.18b	0.00
$LSD_{(0.05)}$	0.43	-	8.162	-
CV (%)	2.88	-	7.95	-

In a column, means followed by same letter(s) are not statistically different by DMRT at 5% level of significance. [T_1 = Spraying of Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) at the rate of 1 ml/L of water at 7 days interval; T_2 = Spraying of Calypso (Thiacloprid) at the rate of 1 ml/L of water at 7 days interval; T_3 = Spraying of neem oil at the rate of 3 ml/L of water at 7 days interval; T_4 = Spraying of neem Seed Kernel Extract at the rate of 100 g/L of water at 7 days interval; T_5 = Spraying of Nexaid (Gamma-cyhalothrin) at the rate of 1.5ml/L of water at 7 days interval; T_6 = Untreated Control]

3.3 Effectiveness of Some Potential Insecticides on the Fruit Behavior

The significant results among different chemical treatments were observed in respect of fresh fruit of eggplant by length and girth during the control of eggplant shoot and fruit borer throughout the cropping season. Among the five selected insecticides treated plots the fresh fruit by length and girth was the highest (14.10 cm and 8.08 cm respectively) was recorded in the plots treated with T_2 which was significantly different from other treatments.

In terms of percent fresh fruit by length and girth increase over control also presented in Table 3. Significantly the highest increase of percent fresh fruit by length and girth over control (43.40% and 55.91% respectively) was found in T_2 treated plots which was not statistically identical from other treatments.

3.4 Effectiveness of Some Potential Insecticides on the Yield of Eggplant Fruit

The significant results were found among different treatments in terms of fresh fruit yield of eggplant due to application of different chemical practices against ESFB (Table 4). The highest yield was recorded in T_2 treated plots followed by

Table 3. Effectiveness of five selected potential insecticides on the fruit behavior by length and girth

Treatment	Fresh fruit length (cm)	% Increase over control	Fresh fruit girth (cm)	% Increase over control
T_1	13.17b	33.95	7.21b	39
T_2	14.10a	43.40	8.08a	55.91
T_3	11.87d	20.69	6.04d	16.51
T_4	11.14d	13.27	5.56e	7.19
T_5	12.80c	30.19	6.38c	13.13
T_6	9.83f	0.00	5.18f	0.00
$LSD_{(0.05)}$	0.13	-	0.09	-
CV (%)	1.66	-	4.35	-

In a column, means followed by same letter(s) are not statistically different by DMRT at 5% level of significance. [T_1 = Spraying of Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) at the rate of 1 ml/L of water at 7 days interval; T_2 = Spraying of Calypso (Thiacloprid) at the rate of 1 ml/L of water at 7 days interval; T_3 = Spraying of neem oil at the rate of 3ml/L of water at 7 days interval; T_4 = Spraying of neem seed kernel extract at the rate of 100 g/L of water at 7 days interval; T_5 = Spraying of Nexaid (Gamma-cyhalothrin) at the rate of 1.5 ml/L of water at 7 days interval; T_6 = Untreated Control]

Table 4. Effectiveness of five selected potential insecticides on the yield of eggplant fruit during the total cropping season

Treatment	Yield of fresh fruits		
	*(kg/plot)	*(Ton/ha)	% Increased over control
T_1	8.91 ab	14.86 ab	40.98
T_2	9.21 a	15.36 a	45.73
T_3	8.41 c	14.02 c	33.01
T_4	7.58 d	12.63 d	19.89
T_5	8.61 bc	14.35 bc	36.17
T_6	6.32 e	10.54 e	-
$LSD_{(0.05)}$	0.45	0.76	-
CV (%)	3.08	3.08	-

*In a column, means followed by same letter(s) are not statistically different by DMRT at 5% level of significance. [T_1 = Spraying of Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) at the rate of 1ml/L of water at 7 days interval; T_2 = Spraying of Calypso (Thiacloprid) at the rate of 1 ml/L of water at 7 days interval; T_3 = Spraying of neem oil at the rate of 3 ml/L of water at 7 days interval; T_4 = Spraying of neem seed kernel extract at the rate of 100 g/L of water at 7 days interval; T_5 = Spraying of Nexaid (Gamma-cyhalothrin) at the rate of 1.5 ml/L of water at 7 days interval; T_6 = Untreated Control]; *Mean of 3 replications; each replication is derived from mean of 9 recordings; each recording is made from 5 plants per treatment*

T_1 treated plots in terms of yield/kg/plot and yield/ton/ha. Significantly the lowest yield was found in control plots (T_6). The highest percent yield increase over control was observed in T_2 treated plots followed by T_1 treated plots.

4. DISCUSSION

Chlorpyriphos 50% + Cypermethrin 5% EC Mainly used for controlling bollworm, thrips, shoot & fruit borer, beetle in various agriculture crop like cotton, okra, eggplant etc [15]. It has no phytotoxic effect if used as recommended dose. It acts as strong contact, stomach and respiratory action [16]. Only cypermethrin 10 EC at 1 ml/l of water sprayed after observing 5% level of fruit infestation can control ESFB effectively and economically [17] because of cypermethrin is a pyrethroids group of insecticide and it acts as a sodium channel modulators in the nervous system of the insect. The combination of Chlorpyriphos 50% EC + Cypermethrin 5% EC, being the most effective and economically viable insecticide to manage *L. orbonalis* in eggplant crop [18]. Nimbicidene was the least effective in controlling the BSFB and resulted lowest yield [19], but another researchers reported that Nimbicidene provided higher yield (13.02 t/ha) than Endosulfan [20]. Several researchers reported the best performance of Cypermethrin in producing highest yield of eggplant [21]. Efficacy of cypermethrin and abamectin was moderate in winter but low in summer [22]. So, in our study Acimix 55 EC (Chlorpyrifos 50% + 5%

Cypermethrin) supports the previous results. It is noticeable that, due to used of synthetic pyrethroids for the control of eggplant shoot and fruit borer, leading to whitefly, aphid and mite resurgence [23]. For considering eco-friendly plant health management, and retain natural enemy in field level Neem extract is very effective for controlling ESFB [24].

Calypso (thiacloprid) is one of a group of insecticides called neonicotinoids, which work by interfering with an insects' nervous system [25]. It acts as an agonist of the acetylcholine receptor and is known to have a very selective toxicity, which is attributable mostly to its higher affinity for the insect than for the vertebrate nicotinic acetylcholine receptor [26–28]. Thiacloprid is extremely effective against various sucking and mining pests including Apple maggot, Second generation codling moth, Oriental fruit moth, First generation spotted tentiform leafminer, Leafhoppers, Aphids, Japanese beetle, Mullein bug, Second and third generation spotted tentiform leafminer and so on [29]. Exposure to this compound can be through contact or ingestion. Its excellent systemic properties and lasting action make it suitable for foliar, soil, and seed treatments [30]. In this experiment we found that this insecticide is very much effective against lepidopteran insect mainly Eggplant Shoot and Fruit Borer (ESFB). It is more effective in fruit infestation time rather than shoot infestation time in eggplant agroecosystem. This is first time reported in Bangladesh that, this insecticide is effective for controlling ESFB.

5. CONCLUSION

In this study, amongst the five potential insecticides, Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) and Calypso (Thiacloprid) perform better than other insecticides for controlling ESFB effectively. Calypso is better than Acimix 55 EC in respect of decrease fruit infestation, increase plant height and brunches, increase fresh fruit length and girth, and finally yield. Between these two insecticides Acimix 55 EC is most effective in shoot infestation time and Calypso is most effective in fruit infestation time though they are statistically similar (but numerically different). So, we suggest the farmers use the Acimix 55 EC when ESFB attacks on shoot and in fruit infestation time (after observing 5% of fruit infestation) Calypso may be used for controlling ESFB as per recommended dose. It might be a suggestion to the farmers not to use insecticide indiscriminately but also used as a rational manner to get better yield as well to keep the environment sound from toxic materials.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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