UNDER PEER REVIEW

Effectiveness of Some Promising Insecticides for Managing Eggplant Shoot and Fruit Borer in Bangladesh

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 promising insecticides in comparison with conventional insecticides for management of 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 1ml/L of water]; T_2 [Calipso (Thiacloprid) at the rate of 1ml/L of water]; T_3 [Neem oil at the rate of 3ml/L of water]; T_4 [Neem Seed Karnel Extract at the rate of 100g/L of water]; T_5 [Nexaid (Gamma-cyhalothrin) at the rate of 1.5ml/L of water]; T_6 (Untreated Control). The result reveled that amongst newer insecticides Acimix 55 EC at the rate of 1ml/L of water was most effective in reducing shoot infestation (66.72%) and Calipso at the rate of 1ml/L of water was found most effective in reducing fruit infestation by number and weight (68.56 and 61.04%), over control followed (66.56, 53.7% respectively) by Acimix, whereas Neem Seed Kernel Extract @100gm/L of water from the field showed the least performance (19.40 and 9.17%, respectively). 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 branch per plant, fruit length and girth, number of fruit per plant, and single fruit weight of eggplant over control followed by Acimix whereas Neem Seed Kernel Extract @ 100g/L of water showed the least performance. Calipso 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) may be suggested to the farmers as per recommended dose for managing Eggplant shoot and fruit borer (ESFB) effectively and Calipso (Thiacloprid) may be tested further on large commercial plot before final recommendation.

Keywords: Promising insecticides, Effectiveness, Eggplant, Management, Eggplant Shoot and Fruit Borer

1. INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of the popular vegetables widely used by most of the people 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 t) [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 our country [3].

But, A horde of insect pests attack this crop due to cultivation throughout the year, out of which eggplant shoot and fruit borer (*Leucinodes orbonalis*) is most serious [4], which caused 31-86% fruit damage in Bangladesh. To overcome this loss, the eggplant growers spray insecticides almost every day or every alternate day in the eggplant field to combat the pest. They also use variety of insecticides belonging to different chemical groups [5]. Above 95% of farmers applied more than 40 pesticide sprays per cropping season [6]. Majority of the farmers (98%) of Bangladesh relied exclusively on the use of insecticides and more than 60% of farmers sprayed their crop 140 times or more in the 6-7 months cropping season [7].

UNDER PEER REVIEW

So, repeatedly and indiscriminately used of this same insecticide, insects become resistant, thus the new insecticides are comes to the market with different formulations to break down the resistance and try to reduce the frequency of application. So, it must be need to evaluate the effectiveness of new insecticides against the eggplant shoot and fruit borer at field level.

So, the present study was undertaken to measure the effectiveness of five promising insecticides in Bangladesh to manage eggplant shoot and fruit borer and find out the best one which is satisfactory control of insect pest population by their novel mode of action based on shoot and fruit infestation and as well as yield attributes.

2. MATERIALS AND METHODS

2.1. Study Site

The experiment was conducted in the central farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from last February to September, 2013. BARI Begun-8 was used for this experiment.

2.2 Design of Experiment

The field experiment comprising of five treatments with an untreated control was laid out in a Randomized Complete Block Design (RCBD) with three replications.

The treatments were: 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 Calipso (Thiacloprid) at the rate of 1ml/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 100g/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.

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

Data were recorded by counting the infested number of shoot, fruit and weight during each harvesting and also measure the infested fruit length, girth, number of branch, height of the plant and also fresh yield.

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 fruit infestation (%) at each such harvest was calculated by using the following formula:

$$\% \text{ Shoot/Fruit infestation (by number/weight)} = \frac{\text{Number/Weight of infested fruit}}{\text{Total number/weight of fruits}} \times 100$$

% Reduction of shoot/fruit infestation over control =

$$\frac{\text{\% Shoot/Fruit infestation in untreated control} - \text{\% Shoot/fruit infestation in treated plot}}{\text{\% Fruit infestation in untreated control plot}} \times 100$$

UNDER PEER REVIEW

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. Effectiveness of Five Selected Promising Insecticides on Eggplant Shoot and Fruit Borer (ESFB)

Comparative effectiveness of various treatments on eggplant shoot and fruit infestation was evaluated in terms of percent shoot and fruit infestation by number and by weight as well as calculated percent reduction of infestation over control.

The results presented in Table 1 revealed that significantly the lowest shoot infestation (6.45%) was observed in T_1 treated plot which was statistically similar but numerically different to T_2 (6.94%) treated plot, whereas the highest value for the same 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%).
Table 1 also indicated 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). It also represent that fruit infestation by number as well as by weight had the highest fruit infestation reduction over control was recorded in T_2 (68.41% and 61.04%, respectively). These were followed by 66.56% (by number*)* and 53.70% (by weight*)* in plot treated with T_1, The lowest reduction was observed 19.40% (by number*)* and 9.17% (by weight) in T_4 treated plots.

Table 1. Effectiveness of five selected promising insecticides on the infestation of eggplant shoot and fruit 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	-	-

UNDER PEER REVIEW

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 Calipso (Thiacloprid) at the rate of 1ml/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 100g/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]

**Mean of 3 replications; each replication is derived from mean of 9 recordings; each recording is made from 5 plants per treatment.*

3.2. Relationship between Shoot Infestation and Yield Attributes of Eggplant

Relationship between shoot infestation and yield attributes of eggplant is presented in the Figure 1. It was found that both number of branch and height per plant were found higher in the treatments where the shoot infestation of eggplant were found lower and vice-versa due to application of different management practices against eggplant shoot and fruit borer the best treatment (T_1 & T_2) reduced the highest percent of shoot infestation, but increased the maximum number of branch per plant as well as maximum number of height per plant.

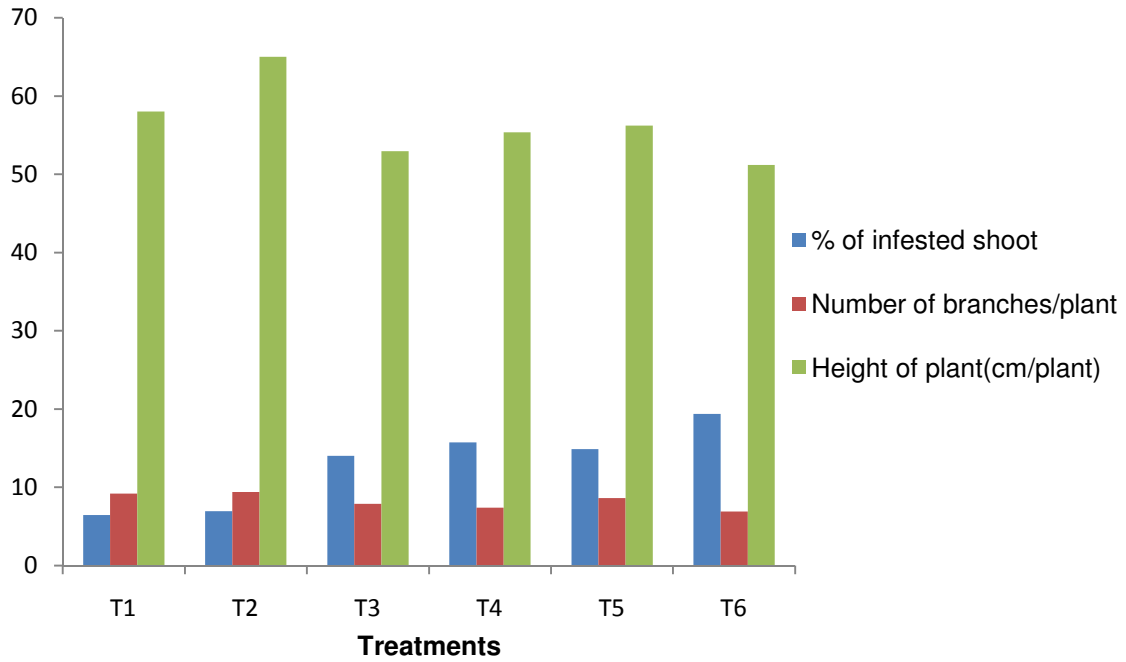

Fig. 1. Relationship between shoot infestation and yield attributes of eggplant

[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 Calipso (Thiacloprid) at the rate of 1ml/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 100g/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]

UNDER PEER REVIEW

3.3. Relationship between Infested Fruit Weight and Fruit Related Yield Attributes

Relationship between fruit infestation and yield attributes of eggplant is presented in the Figure 2. It was revealed that maximum normal length and girth of single fruit were found in the treatments where the fruit infestations by weight were found lower and vice-versa. These variations were found due to efficiency variations of different management practices applied against eggplant shoot and fruit borer. That is the best treatment (T_2) increased the maximum length and girth of single fruit by reducing the fruit infestation at minimum level.

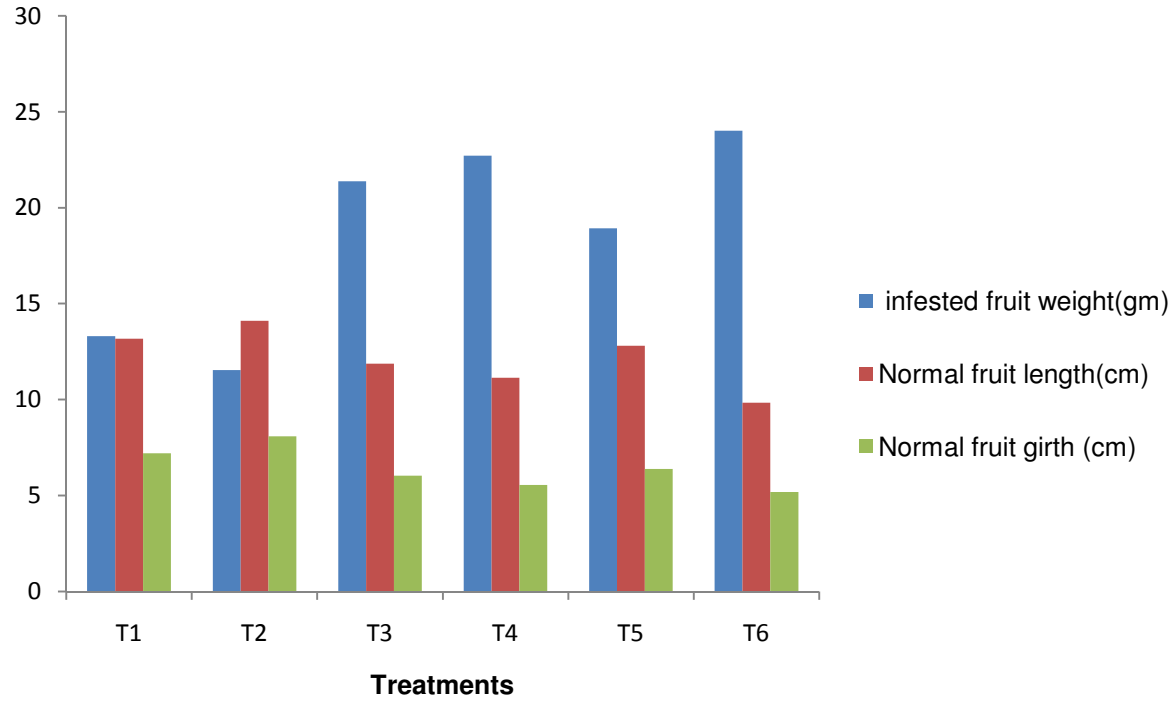

Fig. 2. Relationship between infested fruit weight and fruit related yield attributes

[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 Calipso (Thiacloprid) at the rate of 1ml/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 100g/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]

3.4. Effectiveness of Some Promising Insecticides on the Yield of Eggplant Fruit

The significant variations were observed among different treatments in terms of fresh fruit yield of eggplant due to application of different management practices against ESFB (Table 2). In case of yield of plot the highest yield (9.2167kg/plot) was observed in the plots treated with calipso (Thiacloprid) at the rate of 1ml/Litre of water at 7 days interval followed by Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) (8.91kg/plot), Nexaid (Gamma-cyhalothrin) (8.61kg/plot), Neem oil (8.41kg/plot) and Neem Seed Kernel Extract (7.58kg/plot) being statistically different. More or less similar trends of results were also observed among different treatments. In terms of yield of eggplant fruit calculating in ton/ha were the highest yield was recorded in (15.36 T/ha) in the plots treated with calipso @ 1ml/L of water at 7 days

UNDER PEER REVIEW

interval followed by Acimix (14.86 T/ha), Nexaid (14.35 T/ha), Neem oil (14.02 T/ha) and Neem Seed Kernel Extract (12.63 T/ha).

Considering the percent yield increase over control the highest (45.73%) increase was recorded in Calipso @ 1ml/Litre of water at 7 days interval followed by Acimix (40.98%), Nexaid (36.17%), Neem oil (33.01%) and Neem Seed Kernel Extract (19.89%).

From the above findings it was revealed that T_2 performed as the best management practices in increasing the fruit yield over control (45.73%) and lowest (19.81%) increase recorded in T_4. As a result, the trends of different management practices in terms of percent yield increase is $T_2 > T_1 > T_5 > T_3 > T_4 > T_6$.

Table 2. Effectiveness of five selected promising insecticides on the yield of 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 Calipso (Thiacloprid) at the rate of 1ml/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 100g/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]

**Mean of 3 replications; each replication is derived from mean of 9 recordings; each recording is made from 5 plants per treatment.*

4. DISCUSSION

Similar findings were reported by some researchers supporting the results of the present study. Only cypermethrin 10 EC at 1 ml/l of water sprayed after observing 5% level of fruit infestation can control ESFB effectively and economically [8]. The combination of Chlorpyriphos 50% EC + Cypermethrin 5% EC, being the most effective and economically viable insecticide to manage *L. orbonalis* in eggplant crop [9]. Nimbicidene was the least effective in controlling the BSFB and resulted lowest yield [10], but another researchers reported that Nimbicidene provided higher yield (13.02 t/ha) than Endosulfan [11]. Several researchers reported the best performance of Cypermethrin in producing highest yield of eggplant [12].

UNDER PEER REVIEW

Efficacy of cypermethrin and abamectin was moderate in winter but low in summer [13]. So, in our study Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) supports the previous results.

Calipso is a Thiacloprid group of insecticide that is feasible for chewing/sucking type insect but in this study we found its effectiveness better in lepidopteran insect, it's may be because when secondary pest outbreak such as aphid and whitefly (migrate from other plot) attacked in Calipso treated plot, than Calipso (Thiacloprid) insecticide effective most against that insect and may restrict further attack of ESFB. 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 [14]. So, due to lack of references we cannot suggest at this time, to use Calipso (Thiacloprid) for managing ESFB but may be used for controlling whitefly and aphid. So, It's need to investigate further in large commercial field before final recommendations.

5. CONCLUSION

In this study, among the five promising insecticides, Acimix 55 EC (Chlorpyrifos 50% + 5% Cypermethrin) and Calipso (Thiacloprid) perform better than other insecticides for managing ESFB effectively but here we suggest the farmers at this time to use only Acimix 55 EC rather than Calipso as per recommended dose for managing eggplant shoot and fruit borer as well as to get better yield.

REFERENCES

1. Harish DK, Agasimani AK, Imamsaheb SJ, Patil SS. Growth and yield parameters in brinjal as influenced by organic nutrient management and plant protection conditions. Research Journal of Agricultural Sciences. 2011; 2(2), 221-225.

2. BBS. Yearbook of Agricultural Statistics of Bangladesh. Statistics Division, Bangladesh Bureau of Statistics. Ministry of Planning, Government of the Peoples' Republic of Bangladesh; 2011.

3. Islam MR, and Meah MB. Association of *Phomopsis vexans* with Eggplant (*Solanum melongena*) Seeds, Seedlings and its Management. A Scientific Journal of Krishi Foundation. 2011;8-11.

4. Sardana HP, Arora S, Singh DK, Kadu LN. Development and validation of adaptable IPM in egg plant, *Solanum melongena* L. in a farmers participatory approach. Indian J. Pl. Prot. 2004;32(2),123-128.

5. FAO (Food and Agricultural Organization). Eggplant integrated pest management: an ecological guide, Rome, Italy; 2003.

6. Alam SN, Hossain MI, Rouf FMA, Jhala RC, Patel MG, Nath LK, Sengupta A, Baral K, Shylesha AN, Satpathy S, Shivalingaswamy TM, Cork A & Talekar NS. Control of eggplant fruit and shoot and fruit borer in South Asia. Technical Bulletin, AVRDC. The World Vegetable Center, Shanhua, Taiwan. 2006;36,1-88.

7. Alam SN, Rashid MA, Rouf FMA, Jhala RC, Patel JR, Satpathy S, Shivalingaswamy TM, Rai S, Wahundeniya I, Cork A, Ammaranan C, Talekar NS. Development of an integrated pest management strategy for eggplant fruit and shoot borer in South Asia. Technical Bulletin, AVRDC. The World Vegetable Center, Shanhua, Taiwan. 2003; 28,1-66.

8. Rahman S, Rahman MM, Alam MZ, Hossain MM. Development of an effective dose of cypermethrin for managing eggplant shoot and fruit borer (*Leucinodes orbonalis*). International Journal of Biosciences. 2014;5(9),354-359. DOI: http://dx.doi.org/10.12692/ijb/5.9.354-8

UNDER PEER REVIEW

9. Sharma DK, Haseeb M, Qamar M. Comparative potential of different botanicals and synthetic insecticides and their economics against *Leucinodes orbonalis* Guenee in eggplant. Journal of Plant Protection Research. 2012; 52(1),35-39. DOI: http://dx.doi.org/10.2478/v10045-012-0006-7

10. Jat KL, and Pareek BL. Field evaluation of ecofriendly insecticides against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee), Indian Journal of Plant Protection. 2001;29(1-2),75-85.

11. Srinivas G, Babu PCS. "Management of brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) using products and insecticides, advances in IPM for Horticultural Crops," In Proceedings of the first national symposium on pest management in horticultural crops. Environmental implications and thrust, Bangalore. 1998,87-93.

12. Dutton, A., H. Klein, J. Romeis, and F. Bigler. 2003. Prey-mediated effects of *Bacillus thuringiensis* spray on the predator *Chrysoperla carnea* in maize. Biological Control. 26(2),209-215. DOI: http://dx.doi.org/10.1016/S1049-9644(02)00127-5

13. Latif MA, Rhaman MM, Alam MZ. Efficacy of nine insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in eggplant. Journal of Pest Science. 2010;83(4),391-397. DOI: http://dx.doi.org/10.1007/s10340-010-0309-2

14. Srinivasan R. Insect and mite pests on eggplant: a field guide for indentification and arrangement. AVRDC–The World Vegetable Center, Shanhua, Taiwan. 2009;09-729,64.