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Threshold based spraying of flubendiamide for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis* (Lep.: Pyralidae)

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Abstract

Field experiment was conducted to determine the economic threshold for spraying of flubendiamide against the brinjal shoot and fruit borer. Flubendiamide was applied based on 10 thresholds including 2% shoot infestation, 5% shoot infestation, first fruit set + 2% fruit infestation, first fruit set + 5% fruit infestation, 2% fruit infestation, 5% fruit infestation, 2% shoot + 2% fruit infestation, 5% shoot + 2% fruit infestation, 5% shoot + 5% fruit infestation and schedule spray at 7 days interval. Flubendiamide applied at 2% shoot + 2% fruit infestation reduced the highest percent of shoot (87.46%) and fruit (81.43%) infestation over control and also produced the highest healthy (13.26 t/ha) and total fruit yield (13.77 t/ha) of brinjal and similar results were obtained for 5% fruit infestation. The highest benefit-cost ratio (BCR) was obtained (7.45) by application flubendiamide at 5% fruit infestation with 8 applications and that was the lowest (1.84) for schedule spray at weekly intervals with 16 sprays. Flubendiamide applied at 2% shoot + 2% fruit infestation had the BCR of 2.92 with the highest number of spray (19). Considering number of sprays, marketable yield of brinjal and also BCR, 5% fruit infestation was considered as economic threshold of flubendiamide spraying for the management of brinjal shoot and fruit borer.

Key words: flubendiamide, economic threshold, brinjal shoot and fruit borer, benefit cost ratio

چکیده

آزمایشات صحرایی به منظور تعیین آستانه‌ی زیان اقتصادی برای سم‌پاشی flubendiamide علیه جوانه‌خوار و میوه‌خوار بادمجان انجام گرفت. این سم بر اساس ده آستانه، شامل ۲٪ آلودگی جوانه، ۵٪ آلودگی جوانه، اولین میوه‌دهی + ۲٪ آلودگی میوه، اولین میوه‌دهی + ۵٪ آلودگی میوه، ۲٪ آلودگی میوه، ۵٪ آلودگی میوه، ۲٪ آلودگی جوانه + ۲٪ آلودگی میوه، ۵٪ آلودگی جوانه + ۲٪ آلودگی میوه، ۵٪ آلودگی جوانه + ۵٪ آلودگی میوه و سم‌پاشی در فواصل زمانی هفت روز، مورد آزمایش قرار گرفت. سم به‌کاررفته در آستانه‌ی ۲٪ آلودگی جوانه + ۲٪ آلودگی میوه، بالاترین درصد کاهش آلودگی روی جوانه (۸۷/٤٦٪) و میوه (۸۱/٤٣٪) را نسبت به شاهد نشان داد و هم چنین بالاترین محصول سالم (۱۳/۲۶ تن در هکتار) و مجموع محصول بادمجان (۱۳/۷۷ تن در هکتار) را تولید کرد. برای آستانه‌ی ۵٪ آلودگی میوه، نتایج مشابهی به‌دست آمد. بالاترین نسبت سود به هزینه (BCR) (۷/٤٥) با کاربرد flubendiamide در آستانه‌ی ۵٪ آلودگی میوه با ۸ بار سم‌پاشی و پایین‌ترین آن (۱/۸٤) با انجام ۱٦ بار سم‌پاشی هفتگی حاصل شد. کاربرد این سم در آستانه‌ی ۲٪ آلودگی جوانه + ۲٪ آلودگی میوه، دارای BCR به میزان ۲/۹۲ با بالاترین دفعات سم پاشی (۱۹ بار) بود. با در نظر گرفتن دفعات سم‌پاشی، تولید بازار پسند بادمجان و هم‌چنین BCR، آستانه‌ی ۵٪ آلودگی میوه به عنوان آستانه‌ی زیان اقتصادی سم‌پاشی flubendiamide برای مدیریت آفت جوانه‌خوار و میوه‌خوار بادمجان تعیین گردید.

واژگان کلیدی: flubendiamide، آستانه‌ی زیان اقتصادی، جوانه‌خوار و میوه‌خوار بادمجان، نسبت سود به هزینه

Introduction

Brinjal shoot and fruit borer (BSFB) (*Leucinodes orbonalis* Guenee) is a major insect pest of brinjal in Asia, which causes serious damage especially during the fruiting stage. The percent fruit infestation caused by the pest reached up to 90.86% (Rahman, 1997). Management practices to control this obnoxious pest are limited to frequent sprays of pesticides. The brinjal growers spray insecticides almost everyday or every alternate day in the brinjal field to combat the pest. They also use variety of insecticides belonging to different chemical groups (FAO, 2003). Alam *et al*. (2006) reported that over 95% of farmers applied more than 40 pesticide sprays per cropping season. 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 (Alam *et al*., 2003). However, most of the insecticides have failed to control the pest successfully in the field. Moreover, such schedules of insecticide application do not follow any basis of requirement or need. Therefore, need based application of insecticides can minimize the frequency of the insecticides spray. Application of insecticides at 10% fruit infestation or at the peak of adult emergence increased healthy fruit yield and reduced the number of spray to 4-7 compared with schedule spray of 16 applications against the pest (Islam *et al*., 1999). Rahman *et al*. (2006) reported that application of cypermethrin at first fruit set and at 2% level of infestation produced highest yield of brinjal and reduced the number of spray to only 10 compared with schedule spray of 20 applications. Therefore, an easily measurable index that would indicate the need of immediate application of insecticide might be a good indicator for optimal use of insecticide.

Flubendiamide, a new class of insecticide having new mode of action, showed strong insecticidal activity against lepidopterous insect pests including resistant strains (Tohnishi *et al*., 2005). It showed high effectiveness against the brinjal shoot and fruit bore in previous experiment for screening of insecticide. Moreover, it was found low toxic against beneficial arthropods and highly stimulating to soil microorganisms. Therefore, based on better efficacy, lowest side effects on arthropods biodiversity, minimum side effects on predaceous arthropods and stimulatory effects on soil microbial population, flubendiamide has been selected as the most promising new generation insecticide for the management of shoot and fruit borer of brinjal. However, its effectiveness has been evaluated on a schedule spray basis at weekly intervals, which required about 18 sprays per cropping season. Thus, the number of sprays required may be minimized if flubendiamide application is done following some indices instead of schedule spray at weekly interval. This would be more necessary in case of applying flubendiamide in addition to other control method(s) as the last resort. The present experiment was, therefore, undertaken to determine the economic threshold (ET) for the application of flubendiamide in suppressing the brinjal shoot and fruit borer so that minimum number of sprays is required for the management of this obnoxious pest.

Materials and methods

The experiment was laid out in the experimental field of the Entomology Department at the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Bangladesh during March to September 2006. The experiment was set in a randomized complete block design with three replications. The whole field was divided into three blocks of equal size having 2 m space between the blocks and 1.5 m between the plots. The unit plot size was 3 m × 3 m accommodating 15 plants/plot. The distance between rows was 1 m and that of the plants was 60 cm. Brinjal variety, "Uttara" was grown following the recommended practices as described by Rashid (1993).

The experiment comprised 11 treatments such as T_1 = flubendiamide 24WG 0.012% applied at 7 days interval, T_2 = flubendiamide 24WG 0.012% applied at 2% shoot infestation, T_3 = flubendiamide 24WG 0.012% applied at 5% shoot infestation, T_4 = flubendiamide 24WG 0.012% applied at first fruit set + 2% fruit infestation, T_5 = flubendiamide 24WG 0.012% applied at first fruit set + 5% fruit infestation, T_6 = flubendiamide 24WG 0.012% applied at 2% fruit infestation, T_7 = flubendiamide 24WG 0.012% applied at 5% fruit infestation, T_8 = flubendiamide 24WG 0.012% applied at 2% shoot + 2% fruit infestation, T_9 = flubendiamide 24WG 0.012% applied at 5% shoot + 2% fruit infestation, T_{10} = flubendiamide 24WG 0.012% applied at 5% shoot + 5% fruit infestation and T_{11} = untreated control.

Brinjal fields were visited regularly and the number of total and infested shoots was counted to determine the level of shoot infestation. The level of fruit infestation was determined by random observation and selection of 50 fruits/plot everyday. Flubendiamide 24WG was applied by mixing 2.5 g of insecticide with 5 liter of water (0.5 g of flubendiamide 24WG per liter of water i.e., 0.012% flubendiamide) and sprayed covering the whole plants. Five liters of spray material was required to spray three plots. The spraying was done in the afternoon to avoid bright sunlight and drift caused by strong wind and adverse effect on pollinating bees and other pollinators. Data were collected on the basis of some pre-selected parameters. The total number of shoots as well as the number of infested shoots was recorded from 10 plants of each plot at weekly intervals and the percent shoot infestation was calculated. Fruits were harvested at 7 days intervals and the number of healthy and infested fruits was recorded for calculating the percent fruit infestation. The weight of healthy and infested fruits was noted separately per plot per treatment. The cumulative plot yield of healthy and infested fruits of 10 harvests were transformed into healthy, infested and total yield per hectare in tons, respectively.

For benefit cost analysis, records of the costs incurred for labour, insecticide, application in each treatment, and that of control without insecticide were maintained. The price of the harvested marketable healthy fruits of each treatment and that of control were calculated at market rate. The result of benefit-cost analysis was expressed in terms of benefit-cost ratio (BCR). All the data collected were analyzed statistically after square root transformation. The analysis of variance (ANOVA) of different parameters was done and the means were separated for significant difference using the Duncan's multiple range test.

Results and discussion

The use of different thresholds as the basis of insecticide application required variable number of sprays for different treatments as shown in Table 1. The lowest number of spray (5) was needed for the threshold of 5% shoot infestation (T_3) and 8 sprays were required for the thresholds of 2% shoot infestation (T_2) and 5% fruit infestation (T_7). Flubendiamide applied at 2% shoot + 2% fruit infestation (T_8) required the highest number of spray (19) and 16 sprays were required for schedule application of flubendiamide at weekly interval. The findings agree with the findings of Islam *et al*. (1999) who reported that 16 sprays were required for schedule spray. Moreover, Naitam & Marked (2003) stated that application of insecticides at 5% fruit infestation needed 7 sprays. The data (table 1) also reveal that flubendiamide applied at 2% shoot + 2% fruit infestation had the lowest level of shoot infestation and showed the highest effectiveness in reducing the shoot infestation relative to the unsprayed control. Schedule spray of flubendiamide at 7 days interval reduced the similar level of shoot infestation over control. These findings are in accordance with that of Rahman *et al*. (2006), who reported that schedule spray at weekly interval and at 2% level of shoot and fruit infestation provided the maximum reduction of shoot infestation. However, these findings may vary with that of the others due environmental factors.

Spraying of flubendiamide based on the different thresholds significantly increased the number of healthy and total fruits/plant and decreased the number of infested fruits/plant relative to unsprayed field. Flubendiamide spraying at 2% shoot + 2% fruit infestation (T_8) produced the highest number of healthy fruits/plant (19.89) and increased the maximum percentage (70.79%) of healthy fruits/plant relative to the untreated control (table 2). Statistically similar results were obtained for the threshold of 5% fruit infestation (T_7).

Table 1. Effect of different treatments on shoot infestation of brinjal caused by brinjal shoot and fruit borer.

Treatments	No. of spray	Percent shoot infestation	Percent shoot infestation reduction over control
T_1	16	1.15 c	86.47 a
T_2	8	1.57 c	81.62 a
T_3	5	1.79 c	79.30 a
T_4	14	3.33 b	61.07 b
T_5	9	3.34 b	60.88 b
T_6	13	4.19 b	51.22 b
T_7	8	4.08 b	51.95 b
T_8	19	1.07 c	87.46 a
T_9	15	1.29 c	84.91 a
T_{10}	12	1.35 c	84.08 a
T_{11}	0	8.59 a	-
LSD	-	1.25	15.40
CV %	-	8.68	8.99

Means followed by the same letter in a column are not significantly different ($P > 0.01$, Duncan's multiple range test).

Considering the number of infested fruits/plant and percent decrease of infested fruits/plant over control, flubendiamide spraying on the same thresholds (2% shoot + 2% fruit infestation, 5% fruit infestation) showed the best performance (table 2). The highest number of infested fruits/plant was recorded from unsprayed control. The same table also reveals that spraying of flubendiamide based on the thresholds of 2% shoot + 2% fruit infestation gave the highest number of total fruits/plant and increased the maximum percentage of fruits relative to unsprayed control. However, the number of total fruits/plant did not significantly vary among the different thresholds of spraying flubendiamide.

Application of flubendiamide on the basis of different thresholds reduced the percent fruit infestation both by number and weight compared to unsprayed control. The lowest level of fruit infestation and maximum reduction of infestation over untreated control was obtained by application of flubendiamide for the threshold of 2% shoot + 2% fruit infestation (table 3) and statistically similar results were also obtained for the threshold of 5% fruit infestation. They provided more than 80% reduction of fruit infestation over the control. Schedule spray of flubendiamide at weekly interval had an intermediate level of fruit infestation and reduced more than 50% fruit infestation over control.

Table 2. Number of brinjal fruits per plant in different thresholds for sprayings of flubendiamide.

Treatments	Number of healthy fruits/plant	Percent increase over control	Number of infested fruits/plant	Percent decrease over control	Number of total fruits/plant	Percent increase over control
T_1	16.69 b	44.08 b	3.49 c	46.49 b	20.18 ab	11.12 b
T_2	15.27 bc	31.26 bc	4.89 b	25.03 c	20.16 ab	10.78 b
T_3	13.78 c	18.64 c	6.18 a	5.507 d	19.96 ab	9.80 b
T_4	19.53 a	68.35 a	1.71 d	73.77 a	21.24 a	16.87 a
T_5	19.18 a	64.63 a	1.78 d	72.68 a	20.96 a	15.11 a
T_6	19.36 a	66.89 a	1.68 d	73.29 a	21.04 a	15.93 a
T_7	19.13 a	64.43 a	1.89 d	71.05 a	21.02 a	15.50 a
T_8	19.89 a	70.79 a	1.40 d	78.49 a	21.29 a	16.92 a
T_9	19.60 a	68.60 a	1.58 d	75.72 a	21.18 a	16.38 a
T_{10}	19.36 a	70.46 a	1.84 d	71.75 a	21.20 a	16.73 a
T_{11}	11.67 d	-	6.53 a	-	18.20 b	-
LSD	1.84	14.60	0.74	11.29	2.24	3.61
CV %	4.51	10.94	10.61	8.09	4.68	10.60

Means followed by the same letter in a column are not significantly different (P > 0.01, Duncan's multiple range test).

Flubendiamide spraying at the threshold of 2% shoot + 2% fruit infestation produced the highest amount of healthy fruit of brinjal (13.26 t/ha) and increased 70.44% healthy fruit yield compared to control (table 4). Statistically similar results were found for the thresholds of first fruit set + 2% fruit infestation, first fruit set + 5% fruit infestation, 2% fruit infestation, 5% fruit infestation, 5% shoot + 2% fruit infestation and 5% shoot + 5% fruit infestation. However, infested fruit yield was found lowest in same thresholds with maximum reduction of infested yield over control. Accordingly, the highest amount of total fruit yield (13.77 t/ha) was recorded from the threshold of 2% shoot + 2% fruit infestation, which also increased maximum percentage of total fruit yield compared to control.

These results indicate that flubendiamide spray based on different threshold decreased the incidence of brinjal shoot and fruit borer, reduced fruit infestation and increased healthy as well as total yield of brinjal. The findings of this study support those of Islam & Karim (1994) and Naitam & Markad (2003) who reported that application of insecticides at 5% fruit infestation provided maximum reduction of fruit infestation and produced highest fruit yield of brinjal. However, Tewari & Sandana (1990) had set 6% fruit infestation as economic threshold for the management of the brinjal shoot and fruit borer. These findings also partially follow the results of Raman *et al*. (2006) who stated that application cypermethrin at first fruit set + 2% level of fruit infestation was the most effective threshold for the management of the pest. Moreover, 10% fruit infestation was selected as economic threshold by Islam *et al*. (1999). The difference in economic threshold as reported by different researchers is logical because of variation in infestation level or ecological factors.

Table 3. Effect of flubendiamide spray on fruit infestation of brinjal based on different thresholds.

Treatments	Percent fruit infestation		Percent reduction of fruit infestation over control	
	By number	By weight	By number	By weight
T_1	17.25 d	10.28 d	51.94 b	56.35 b
T_2	24.22 c	14.95 c	32.60 c	36.60 c
T_3	30.94 b	19.79 b	14.00 d	16.17 d
T_4	8.05 ef	4.62 e	77.56 a	80.40 a
T_5	8.48 ef	4.83 e	76.39 a	79.50 a
T_6	8.12 ef	4.63 e	77.40 a	80.38 a
T_7	8.98 e	5.15 e	75.02 a	78.14 a
T_8	6.67 f	3.72 e	81.43 a	84.19 a
T_9	7.42 ef	4.23 e	79.28 a	81.97 a
T_{10}	8.71 e	4.99 e	75.87 a	78.83 a
T_{11}	35.95 a	23.60 a	-	-
LSD	2.71	1.85	4.68	7.16
CV %	7.79	8.67	7.05	4.53

Means followed by the same letter in a column are not significantly different (P > 0.01, Duncan's multiple range test).

Table 4. Effect of flubendiamide spray on fruit yield of brinjal based on different thresholds.

Treatments	Healthy yield (t/ha)	Percent increase over control	Infested yield (t/ha)	Percent decrease over control	Total yield (t/ha)	Percent increase over control
T_1	11.12 b	42.93 b	1.28 c	46.67 b	12.40 b	21.89 bc
T_2	10.18 bc	30.85 bc	1.79 a	25.42 c	11.97 b	17.66 bc
T_3	9.19 c	18.12 c	2.27 b	5.42 d	11.45 bc	12.55 c
T_4	13.02 a	67.35 a	0.63 d	73.75 a	13.65 a	34.18 a
T_5	12.78 a	64.27 a	0.65 d	72.92 a	13.43 a	32.02 a
T_6	12.90 a	65.81 a	0.63 d	73.75 a	13.53 a	33.00 a
T_7	12.75 a	63.88 a	0.69 d	71.25 a	13.45 a	32.21 a
T_8	13.26 a	70.44 a	0.51 d	78.75 a	13.77 a	35.36 a
T_9	13.07 a	67.99 a	0.58 d	75.83 a	13.65 a	34.18 a
T_{10}	12.90 a	65.81 a	0.68 d	71.67 a	13.58 a	33.49 a
T_{11}	7.78 d	-	2.40 a	-	10.17 c	-
LSD	1.24	15.44	0.26	11.13	1.35	14.86
CV %	4.56	11.70	10.51	7.97	4.54	11.68

Means followed by the same letter in a column are not significantly different (P > 0.01, Duncan's multiple range test).

The BCR as worked out based on the expenses incurred and value of crops obtained against the different thresholds used in the present study for the control of brinjal shoot and fruit borer is presented in table 5. Spraying of flubendiamide at 5% fruit infestation gave the highest net return and BCR (7.45). Flubendiamide applied at threshold of 2% shoot + 2% fruit infestation produced the BCR of 2.92, which required the maximum number of sprays. Although flubendiamide spray based on threshold of 2% shoot + 2% fruit infestation gave the highest amount of marketable fruit yield compared to 5% threshold, the BCR was about 2.5 times higher. However, the lowest BCR (1.84) was obtained for schedule spray at 7 days interval. The findings agree with those obtained by Naitam & Markad (2003), who stated that application of insecticides at 5% fruit damage gave the highest BCR. Tewari & Sandana (1990) reported that 6% fruit infestation was the most effective threshold and gave the highest BCR. However, the findings do not agree with that of Islam *et al*. (1999), who reported that application of Fenom at 10% fruit infestation gave the highest BCR compared to schedule spray. However, the difference in economic threshold of the present study is acceptable because economic threshold for the management of crop pest varies with the market value of products, socioeconomic conditions, cost of pesticides etc.

Table 5. Economic analysis of different damage threshold based spray of flubendiamide for the management of brinjal shoot and fruit borer.

Treatments	No. of sprays	Cost of pest management (US$/ha)			Healthy fruit yield (t/ha)	Gross return (US$/ha)	Net return (US$/ha)	Adjusted net return (US$/ha)	Benefit-cost ratio (BCR)
		Insecticide	Labour	Total					
T_1	16	289.86	51.01	340.87	11.12	3223.19	2882.32	627.25	1.84
T_2	8	144.93	25.51	170.44	10.18	2950.73	2780.29	525.22	3.08
T_3	5	90.58	15.94	106.52	9.19	2663.77	2557.25	302.18	2.84
T_4	14	253.62	44.69	298.31	13.02	3773.91	3475.6	1220.53	4.09
T_5	9	163.04	28.70	191.74	12.78	3704.35	3512.61	1257.54	6.56
T_6	13	235.51	41.50	277.01	12.9	3739.13	3462.12	1207.05	4.36
T_7	8	144.93	25.51	170.44	12.75	3695.65	3525.21	1270.14	7.45
T_8	19	344.20	60.58	404.78	13.26	3843.48	3438.7	1183.63	2.92
T_9	15	271.74	47.83	319.57	13.07	3788.41	3468.84	1213.77	3.80
T_{10}	12	217.39	38.26	255.65	12.9	3739.13	3483.48	1228.41	4.81
T_{11}	0	0	0	0	7.78	2255.07	2255.07	-	-

Cost of insecticides: flubendiamide 24WG at US$ 72.46/kg.
Cost of spray: two labourers/spray/ha at US$ 1.6/day.
Spray volume required: 500 l/ha (Islam *et al*., 1999).
Market price of brinjal: Healthy fruit US$ 28.99/100 kg.

The overall results reveal that spraying of flubendiamide at 2% shoot + 2% fruit infestation against the brinjal shoot and fruit infestation reduced the shoot and fruit infestation, increased the marketable healthy fruit yield of brinjal. On the other hand, flubendiamide spray at 5% fruit infestation gave the similar results for yield of brinjal but reduced the number of insecticide application and increased about 2.5 times higher BCR. This would have positive impact on environment, reduce toxic residue load on brinjal fruits and finally the cost of control measure would be minimized significantly. Therefore, 5% fruit infestation may be considered as the best threshold for application of flubendiamide in managing the brinjal shoot and fruit borer of brinjal.

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References

Alam, S. N., Rashid, M. A., Rouf, F. M. A., Jhala, R. C., Patel, J. R., Satpathy, S., Shivalingaswamy, T. M., Rai, S., Wahundeniya, I., Cork, A., Ammaranan, C. & Talekar, N. S. (2003). 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*, 28, 1-66.

Alam, S. N., Hossain, M. I., Rouf, F. M. A., Jhala, R. C., Patel, M. G., Nath, L. K., Sengupta, A., Baral, K., Shylesha, A. N., Satpathy, S., Shivalingaswamy, T. M., Cork, A. & Talekar, N. S. (2006). Control of eggplant fruit and shoot and fruit borer in South Asia. *Technical Bulletin, AVRDC – The World Vegetable Center, Shanhua, Taiwan*, 36, 1-88.

FAO (Food and Agricultural Organization) (2003) *Eggplant integrated pest management*: *an ecological guide*. 177 pp. FAO, Rome, Italy.

Islam, M. N. & Karim, M. A. (1994) Integrated management of the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) at Joydebpur. Annual Research Report. Entomology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh. 125 pp.

Islam, M. N., Karim, M. A., Mannan, M. A., Chowdhury, J. C. S. & Islam, M. (1999) Integrated management of the brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) based on insecticide. *Bangladesh Journal of Entomology* 9, 75-85.

Naitam, N. R. & Markad, S. J. (2003) Evaluation of damage threshold based sprayings against brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. *Pest Management in Horticultural Ecosystems* 9, 63-65.

Rahman, A. K. M. Z. (1997) Screening of 28 brinjal line for resistance/tolerance against the brinjal shoot and fruit borer. Annual Research Report. Entomology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, Bangladesh. 130 pp.

Rahman, M. M., Latif, M. A., Yousuf, M. & Ali, M. (2006) Judicious use of cypermethrin for the management of brinjal shoot and fruit borer, *Leuciniodes orbonalis* Guenee. *Bangladesh Journal of Entomology* 16, 45-56.

Rashid, M. M. (1993) *Shabji biggan*. 1st ed. 526 pp. Bangla Academy, Dhaka, Bangladesh. [In Bangla].

Tewari, G. C. & Sandana, H. R. (1990) An unusual heavy parasitization of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen., by a new braconid parasite. *Indian Journal of Entomology* 52, 338-341.

Tohnishi, M., Nakao, H., Furuya, T., Seo, A., Kodama, H., Tsubata, K., Fujioka, S., Hirooka, T. & Nishimatsu, T. (2005) Flubendiamide, a novel insecticide highly active against lepidopterous insect pests. *Journal of Pesticide Science* 30, 354-360.

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