Research article **Bangladesh Journal of Entomology**
ISSN (Print): 1021-1004, ISSN (Online): 3007-3332, Website: www.bangladeshes.org
Bangladesh J. Entomol. (2024) 32(1): 45-59

IMPACT OF FOUR INSECTICIDES AGAINST *MARUCA VITRATA* F. (LEPIDOPTERA: CRAMBIDAE) ON YARD LONG BEAN

Tnjilul Hasin[1], Md. Rashedin[1], Md. Alamgir Hossain[1*], Hasan Fuad El Taj[1], Md. Abdul Alim[2]

[1]Department of Entomology, Faculty of Agriculture, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh

Received: 31 March 2024; Accepted: 1 June 2024

ABSTRACT

The vegetable growers are facing serious problem to legume pod borer, *Maruca vitrata* F. (Lepidoptera: Crambidae), the most destructive pest of yard long bean. The experiment was conducted during February to June 2022 in the experimental field of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University, Dinajpur. Four insecticidal treatments, Lambdacyhalothrin + Profenofos (ACC-35) (T_1), Emamectin benzoate (Noclaim 5 SG) (T_2), Spinosad (Success 2.5 SC) (T_3), Azadirachtin (Neemoz 0.1%) (T_4) and an untreated control (T_5) were evaluated against *M. vitrata*. All the insecticide treatments were found promising against the pod borer as compared to untreated control. However, the highest number of healthy pods plant^{-1} (15.56, 13.89 and 13.22) were found from Spinosad @ 0.60 ml L^{-1} of water treated plots while the lowest (4.78, 4.33 and 4.89) in the untreated control after 1st, 2nd and 3rd spray, respectively. The highest pooled mean healthy pods were obtained as 97.40, 94.01 and 101.86 g from Spinosad @ 0.6 ml L^{-1} of water treated plot but the lowest as 29.85, 29.67 and 36.13 g in the untreated control at 5, 10 and 15 days, respectively after 1st, 2nd and 3rd spray. The highest pooled mean protection over control were recorded as 87.29, 85.33 and 88.33% from Spinosad @ 0.6 ml L^{-1} of water treated plot while the lowest were 60.09, 40.01 and 62.07% from Lambdacyhalothrin+ Profenofos at 5, 10 and 15 days, respectively after 1st, 2nd and 3rd spray. Hence, farmers can use these tested insecticides especially Spinosad for effective management of *M. vitrata* in yard long bean.

Keywords: Legume pod borer, Lambdacyhalothrin, Profenophos, Spinosad, Emamectin benzoate, Azadiractin.

INTRODUCTION

Legumes are excellent source of proteins, vitamins and minerals in the diet of common people (Jayasinghe *et al.* 2015, Maphosa and Jideani 2017). They are also

*Corresponding author: *alamgir@hstu.ac.bd*

important as high quality livestock fodder, atmospheric nitrogen fixer and a valuable green manuring crop (Cook *et al.* 2005). This vegetable has also potential to export of both fresh and frozen conditions (Mian *et al.* 2016). Among the legume, yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*) is the most popular consumable edible legume in Southeast Asia (Malacrino *et al.* 2019). Although it is a summer vegetable but Bangladeshi farmers cultivate this crop throughout the year to meet high market demand. However, these crops are threatened by several insect pests resulting huge economic losses (Oliveira *et al.* 2014). Among them, legume pod borer, *Maruca vitrata* F. (Lepidoptera: Crambidae), is the most destructive pest resulting up to 80% yield loss (Ahmed *et al.* 2015, Aktar *et al.* 2020). It is the most destructive pest since an extensive host range, high damage potential and wide distribution (Margam *et al.* 2011). The farmers of Bangladesh have a high tendency to use indiscriminately toxic insecticides to control them for quick knockdown (Ahmed *et al.* 2020, Aktar *et al*. 2020).

In fact, chemical protection measures suffer so many serious drawbacks (Ambethar 2009). Their indiscriminate use causes ecological imbalance, resistance of pesticides, pest resurgence, secondary pests outbreak, creates phytotoxicity and environmental risks (Mweke *et al.* 2020). Hence, researchers are now trying to adopt alternatives of chemical globally. Uses of newly formulated insecticides are an excellent source of alternatives and stands promising position to protect. They are incredible due to selective in action, excellent efficacy at low dosage, less prone, readily bio-degradable, least harmful to beneficial insects and environmentally safe as well (Kodandaram *et al.* 2010). Considering these merits, they are relatively safe and fit well for sustainable agriculture. Therefore, keeping in view the importance of pod borer, a field trial was conducted to evaluate the four newly formulated insecticides against the legume pod borer.

MATERIALS AND METHODS

Experimental site and soil preparation: The experiment was conducted in the research field of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The experimental site was a medium high land belonging the AEZ-1 of Old Himalayan Piedmont Plain soil (p^H 5.52, EC 2.0 mS m^{-1}, contains medium organic matter).

Seeds of dwarf yard long bean variety (Matir borboti) were collected from the BADC of Sadar Upazila in Dinajpur. The land was ploughed and cross-ploughed several times with a power tiller to obtain a good tilth followed by laddering and spading. The stubbles of the crops and uprooted weeds were removed from the field and the land was then leveled prior to seed sowing. Three seeds were sown in each prepared pit followed by a light irrigation to ensure soil moisture for germination. After 15 days of sowing, one healthy plant in each pit were kept by thinning. Each plant was stacking with bamboo stick to save the plant from lodging. Irrigation, weeding and other intercultural operations were done as and when needed. Fertilizers were applied according to the recommended doses (FRG 2012). The whole field was divided into 27 plots. The study was arranged in randomized complete block design (RCBD) with 3 replications. The unit plot size was 3.0 m × 2.0 m accommodating with a single pit. Plot to plot distance was maintained 1.0 m.

Treatments and data collection: The treatments were T_1 = Lambdacyhalothrin + Profenofos (ACC-35) @ 0.5, 0.75 mL L^{-1} of water, T_2 = Emamectin Benzoate (Noclaim 5 SG) @ 0.75, 1.0 g L^{-1} of water, T_3 = Spinosad (Success 2.5 SC) @ 0.4, 0.6 mL L^{-1} of water, and T_4 = Azadirachtin (Neemoz 0.1%) @ 0.75, 1.0 ml L^{-1} of water. Besides, an untreated control was also maintained by applying water only. Treatments were applied 3 times with the help of knapsack sprayer at 15 days intervals at 4 pm for safety of pollinators. Data were recorded on number and weight of healthy pods and pod protection over control at 1st, 2nd and 3rd sprays after treatments. The pods were collected separately from at 5, 10 and 15 days of treatments application at podding stages of crops. Data were recorded at 5 days interval after spray of each treatment and evaluated the healthy pods, weight of healthy pods and percent protection over control.

Statistical analyses: All the collected data of different parameters were compiled and arranged for statistical analysis. Then the data were statistically analyzed using Statistix 10 software to test the significance of variance among the treatments and means were separated using Tukey's HSD test ($p<0.05$).

RESULTS

Effect of treatments against *M. vitrata* on healthy pods: The tested novel formulated insecticides had promising effects against pod borer after 1st, 2nd and 3rd sprays as compared to untreated control (Tables 1-3). Among the treatments, significantly (5: $P< 0.01$, $df = 8$, $F = 17.28$; 10: $P< 0.01$, $df = 8$, $F = 28.89$; 15: $P<$

0.01, *df* = 8, *F* = 28.65) the highest healthy pods were found as 14.0, 16.67 and 16.0 in Spinosad @ 0.60 ml L^{-1} water treated plots while the lowest as 4.67, 5.0 and 4.67 from the untreated control at 5, 10 and 15 days, respectively after 1st spray (Table 1). The highest pooled mean healthy pods were counted as 15.56 from Spinosad @ 0.60 ml L^{-1} water treated plots while the lowest (4.78) in the untreated control. Similarly, significantly ($P< 0.01$, *df* = 8, *F* = 36.0; $P< 0.01$, *df* = 8, *F* = 20.28; $P< 0.01$, *df* = 8, *F* = 27.39) the highest healthy pods were recorded as 13.67, 14.33 and 13.67 from Spinosad @ 0.60 ml L^{-1} water treated plots but the lowest as 3.0, 4.0 and 6.0 in the untreated control at 5, 10 and 15 days, respectively after 2nd spray (Table 2). The highest (13.89) pooled mean number of healthy pods $plant^{-1}$ was counted from Spinosad treated plot but the lowest (4.33) from the untreated control. Likewise, statistically ($P< 0.01$, *df* = 8, *F* = 22.91; $P< 0.01$, *df* = 8, *F* = 26.30; $P< 0.01$, *df* =8, *F* = 36.05) the highest healthy pods were recorded as 13.67, 14.33 and 13.67 from Spinosad @ 0.60 ml L^{-1} of water treated plots while the lowest as 5.67, 4.33 and 4.67 in the untreated control at 5, 10 and 15 days, respectively after 3rd spray (Table 3). The highest (13.22) pooled mean number of healthy pods $plant^{-1}$ was obtained from Spinosad treated plants but the lowest (4.33) in the untreated control.

Present results revealed that the tested biopesticides had profound toxic effects against the infestation of pod borer. The outcome showed that all treatments were diversely acted against pod borer and found potent in reducing pod borer infestation as compared to untreated control. In the first, second, and third sprays, all the tested insecticides triggers number of healthy pods. The present results are at par with Vishal and Ujagir (2005). They concluded that the highest healthy pod of red gram was registered with spinosad 45 SC @ 90g a.i ha^{-1} against *M. vitrata*. Results of the present findings are also parallel with those of Dahal *et al.* (2020). They concluded that the lowest damaged pod in cowpea was found from the Spinosad treated plot followed by Chlorpyriphos 50 + Cypermethrin 5 treatments. Novel innovative research illustrated that diverse IGRs have been tried by several researchers with a good degree of success against several species of pod borers (Haripriya 2019). An advantage is that both spinosad spraying and neonicotinoids incorporation in soil are reported to be safe or with little direct effect on another insect as leaf miner's natural enemies (Rogers *et al*. 2014). Motaphale *et al*. (2018) reported that the lowest population of leaf miner was found in Emamectin benzoate 5 SG @ (1.85). The treatment of profenofos + cypermethrin 44 EC was found to be more effective for the control of leaf miner (*Liriomyza trifolii*) (Setamou *et al*. 2010).

Table 1. Effect of insecticides against *M. vitrata* on the number of healthy pods plant^{-1} after 1st spray

Treatments/dose (g/ml) L^{-1} water		Number of healthy pods plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	7.33 bc	8.33 de	7.00 cde	7.55
	0.75	9.00 b	14.67 ab	7.67 cd	10.45
T_2	0.75	7.00 bc	7.33 de	7.33 cde	7.22
	1.00	8.33 bc	12.67bc	12.00 b	11.00
T_3	0.40	7.33 bc	14.00 abc	4.00 e	8.44
	0.60	14.00 a	16.67 a	16.00 a	15.56
T_4	0.75	8.67 b	8.00 de	8.00 cd	8.22
	1.00	13.67 a	10.67 cd	8.67bc	11.00
Untreated control	-	4.67 c	5.00e	4.67 de	4.78
CV (%)	-	14.82	11.67	14.20	-

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Table 2. Effects of insecticides against *M. vitrata* on number of healthy pods plant^{-1} after 2nd spray

Treatments/ (g/ml) L^{-1} water		Number of healthy pods plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	12.33 a	9.33 bc	12.33 ab	11.33
	0.75	13.33 a	14.67 a	13.00 ab	13.67
T_2	0.75	6.33 c	8.33 c	6.33 d	6.99
	1.00	13.00 a	9.00 bc	8.33 cd	10.11
T_3	0.40	6.00 cd	9.67 bc	7.67 d	7.78
	0.60	13.67 a	14.33 a	13.67 a	13.89
T_4	0.75	10.67 ab	11.33 abc	10.67 bc	10.89
	1.00	8.67 bc	12.33 ab	12.00 ab	11.00
Untreated control	-	3.00 d	4.00 d	6.00 d	4.33
CV (%)	-	11.50	12.28	9.79	-

Means in a column followed by different letters indicate significant differences from the Tukey test

(α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Table 3. Effect of insecticides against *M. vitrata* on number of healthy pods plant^{-1} after 3rd spray

Treatments (g/ml) L^{-1} water		Number of healthy pods plant^{-1}			Mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	8.67 bcd	6.00 de	7.00 c	7.22
	0.75	11.33 b	9.00 bcd	8.33 c	9.55
T_2	0.75	6.33 de	7.33 cde	8.67 c	7.44
	1.00	8.00 cde	9.33 bc	11.33 ab	9.55
T_3	0.40	10.33 bc	11.00 ab	7.00 c	9.44
	0.60	15.00 a	13.67 a	11.00 b	13.22
T_4	0.75	9.33 bc	11.00 ab	12.33 ab	10.89
	1.00	10.67 bc	12.67 a	13.33 a	12.22
Untreated control	-	5.67 e	4.33 e	4.67 d	4.89
CV (%)	-	10.74	11.08	8.77	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Effect of treatments against *M. vitrata* on weight of healthy pods: Treatments by novel formulated insecticides exhibited potential effects against pod borer on weight of healthy pods plant^{-1} as compared to untreated control (Tables 4-6). Statistically (5: $P< 0.01$, $df = 8$, $F = 18.18$; 10: $P< 0.01$, $df = 8$, $F = 33.0$; 15: $P< 0.01$, $df = 8$, $F = 11.14$) the highest weight of pods were recorded as 84.07, 104.37 and 103.77 g from Spinosad @ 0.6 ml L^{-1} of water while the lowest as 28.23, 31.03 and 30.30 g at 5, 10 and 15 days, respectively from untreated control plot after 1st spray (Table 4). The highest pooled mean (97.40 g) of healthy pods were obtained from Spinosad @ 0.6 ml L^{-1} of water treated plot but the lowest (29.85 g) in the untreated control. Also, among the treatments, significantly (5: $P< 0.01$, $df = 8$, $F = 47.11$; 10: $P< 0.01$, $df = 8$, $F = 21.53$; 15: $P< 0.01$, $df = 8$, $F = 34.73$) the highest weight of healthy pods as 88.55, 97.97 and 95.50 g were found from Spinosad @ 0.6 ml L^{-1} of water at 5, 10 and 15 days, respectively after 2nd spray while the lowest as 19.53, 27.27 and 42.20 g from untreated control plot (Table 5). The highest pooled mean (94.01 g) of healthy pods was observed from Spinosad treated plants while the lowest (29.67 g)

in untreated control. Also, statistically (5: $P< 0.01$, $df = 8$, $F = 25.60$; 10: $P< 0.01$, $df = 8$, $F = 28.61$;15: $P< 0.01$, $df = 8$, $F =5.67$) the highest weight of healthy pods plant^{-1} were observed as 105.94, 99.40 and 100.25 g from Spinosad @ 0.60 ml L^{-1} of water while the lowest as 39.91, 31.54 and 36.94 g from untreated control at 5, 10 and 15 days, respectively after 3rd spray (Table 6). The highest pooled mean weight of healthy pods (101.86 g) was achieved from Spinosad treated plants but the lowest (36.13 g) in the untreated control.

Results revealed that applied insecticides were found very potent in combating yard long bean pod borer as compared to untreated control. These findings indicated that such newer formulated insecticides can prevent damage of the pods from the invasion of legume pod borer. Similar results were obtained by Yadav and Singh (2014) who reported that the lowest number of larva of spotted pod borer were found in cow pea when the plants treated with Spinosad 0.2 ml L^{-1} water while the highest from untreated control treatment. Our results are to some extent similar with the findings of Aktar *et al.* (2020). They cited that the lowest number of infested pods plot^{-1} as 4.36 were recorded in country bean when treated with Emamectin benzoate followed by Cartap, Spinosad, Cypermethrin, Flubendiamide and Lufenuron. Again, Ameta *et al.* (2011) also reported that Spinosad brought significantly higher reduction of pod damage due to pod borers against *Helicoverpa armigera* Hubner in pigeon pea. The present findings are also comparable with the results of Kattula *et al.* (2017). They opined that Spinosad 45 SC @ 0.014% in combination with Imidacloprid 17.8 SL @ 0.005% gave the lowest larvae plant^{-1} in cowpea and the highest from untreated control. They concluded that the lowest weight of damaged pod in cowpea was found from the Spinosad treated plot followed by Chlorpyriphos 50 + Cypermethrin 5 treatments.

Effect of treatments against *M. vitrata* on pod protection over control by number: The novel formulated insecticides had profound effects against pod borer on pod protection over control by number after spray (Tables 7-9). Statistically (5: $P< 0.01$, $df = 8$, $F=6.09$; 10: $P< 0.01$, $df = 8$, $F =23.43$; 15: $P< 0.01$, $df = 8$, $F =4.81$) the highest protection was observed as 86.48, 89.64 and 85.74% from Spinosad @ 0.6 ml L^{-1} of water at 5, 10 and 15 days, respectively after 1st spray while the lowest as 60.64 and 48.24 from Lambdacyhalothrin+ Profenofos @ 0.50 ml L^{-1} of water (Table 7). The highest (87.29%) polled mean protection over control was recorded

Table 4. Effect of insecticides against *M. vitrata* on the weight of healthy pods plant^{-1} after 1st spray

Treatments/dose (g/ml) L^{-1} water		Weight (g) of healthy pods plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	43.80 bc	51.63 de	45.50 cde	46.98
	0.75	53.73 b	91 ab	49.63 cde	64.79
T_2	0.75	42.17 bc	45.47 de	48.13 cde	45.28
	1.00	50.10 bc	78.50 bc	78.07 b	68.89
T_3	0.40	41.98 bc	86.73 abc	26.12 e	51.61
	0.60	84.07 a	104.37 a	103.77 a	97.40
T_4	0.75	52.53 b	49.33 de	51.73 cd	51.19
	1.00	82.60 a	65.10 cd	56.43 bc	68.04
Untreated control	-	28.23 c	31.03 e	30.30 de	29.85
CV (%)	-	14.24	11.85	15.97	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Table 5. Effect of novel formulated insecticides against *M. vitrata* on the weight of healthy pods plant^{-1} after 2nd spray

Treatments/dose (g/ml) L-1 water		Mean weight (g) of healthy pods plant^{-1}			Pooled mean (g)
		5 DATs	10 DATs	15 DATs	
T_1	0.50	80.24 ab	62.73 bc	84.0 ab	75.66
	0.75	86.43 ab	96.03 a	91.17 ab	91.21
T_2	0.75	41.20 c	56.26 c	44.27 d	47.24
	1.00	84.41 ab	60.87 bc	58.90 cd	68.06
T_3	0.40	39.23 c	62.87 bc	54.08 d	52.06
	0.60	88.55 a	97.97 a	95.50 a	94.01
T_4	0.75	69.20 b	77.27 abc	74.30 dc	73.59
	1.00	88.54 a	83.13 ab	84.67 ab	85.45
Untreated control	-	19.53 d	27.27 d	42.20 d	29.67
CV (%)	-	9.95	11.85	8.59	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Table 6. Effect of novel formulated insecticides against *M. vitrata* on the weight of healthy pods plant^{-1} after 3rd spray

Treatments/dose (g/ml) L^{-1} water		Mean weight (g) of healthy pods plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	61.17 bcd	43.63 de	52.10 bc	52.3
	0.75	80.40 b	65.70 bc	61.97 abc	69.36
T_2	0.75	44.63 de	53.43 cd	64.40 abc	67.35
	1.00	56.63 cde	68.07 bc	57.47 abc	60.72
T_3	0.40	73.87 bc	81.03 ab	51.37 bc	68.76
	0.60	105.94 a	99.40 a	100.25 a	101.86
T_4	0.75	66.00 bc	80.13 ab	95.47 ab	80.53
	1.00	76.70 b	91.43 a	81.97 abc	83.36
Untreated control	-	39.91 e	31.54 e	36.94 c	36.13
CV (%)	-	10.20	10.60	23.81	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

from Spinosad treated plants while the lowest as 60.09% from Lambdacyhalothrin+ Profenofos. Similarly, significantly (5: $P< 0.01$, $df = 8$, $F =65.63$; 10: $P< 0.01$, $df = 8$, $F = 24.95$; 15: $P< 0.01$, $df = 8$, $F =10.30$) the highest protection over control was observed as 75.04, 89.28 and 91.66% from Spinosad @ 0.6 ml L^{-1} of water at 5, 10 and 15 days, respectively after 2nd spray but the lowest as 6.19, 49.94 and 63.91% from Lambdacyhalothrin+ Profenofos @ 0.50 ml L^{-1} of water (Table 8). The pooled mean highest protection over control (85.33%) acquired from Spinosad treated plants while the lowest as 40.01% from Lambdacyhalothrin+ Profenofos treated plants. Also, significantly (5: $P< 0.01$, $df = 8$, $F =5.35$; 10: $P< 0.01$, $df = 8$, $F = 18.44$; 15: $P< 0.01$, $df = 8$, $F =7.96$) the highest protection over control was observed as 92.10, 88.46 and 84.34% from Spinosad @ 0.6 ml/L of water at 5, 10 and15 days, respectively after 3rd spray while the lowest as 65.82, 48.52 and 84.34% from Lamda-cyhalothrin + Profenofos @ 0.50 ml L^{-1} of water (Table 9). The highest mean protection over control (88.33%) was recorded from Spinosad treated plants while the lowest as 40.01% from Lambdacyhalothrin+ Profenofos.

The results revealed that all treatments significantly could increase marketable pod yield of bean as compared to untreated control. These findings are in close

Table 7. Effect of insecticides against *M. vitrata* on pod protection over control by number plant^{-1} after 1st spray

Treatments/dose (g/ml) L-^{1} water		Protection (%) over control			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	60.64 b	48.24 d	71.38 ab	60.09
	0.75	72.39 ab	65.52 bc	75.02 ab	70.98
T_2	0.75	75.72 ab	51.65 cd	67.84 b	65.07
	1.00	85.11 a	79.29 ab	81.43 ab	81.94
T_3	0.40	78.81 a	69.61 b	77.56 ab	75.33
	0.60	86.48 a	89.64 a	85.74 a	87.29
T_4	0.75	69.72 ab	72.36 b	67.83 b	69.97
	1.00	78.81 a	76.21 ab	78.56 ab	77.86
Untreated control	-	-	-	-	-
CV (%)	-	7.79	7.17	6.69	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Table 8. Effect of insecticides against *M. vitrata* on % protection over control by number plant^{-1} after 2nd spray

Treatments/dose (g/ml) L^{-1} water		Pod protection (%) over control			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	6.19 c	49.94 e	63.91 c	40.01
	0.75	18.76 c	60.66 de	80.58 ab	53.33
T_2	0.75	49.93 b	82.10 ab	75.00 bc	69.01
	1.00	75.02 a	85.74 ab	90.91 a	83.90
T_3	0.40	68.66 a	75.02 bc	86.75 ab	76.81
	0.60	75.04 a	89.28 a	91.66 a	85.33
T_4	0.75	43.71 b	64.30 cd	77.75 abc	61.92
	1.00	49.92 b	67.84 cd	83.33 ab	67.03
Untreated control	-	-	-	-	-
CV (%)	-	11.22	6.55	6.09	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

Table 9. Effect of insecticides against *M. vitrata* on % protection over control by number plant^{-1} after 3rd spray

Treatments / dose (g/ml) L^{-1} water		Protection (%) over control			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	65.82 c	48.52 d	71.88 d	62.07
	0.75	71.03 bc	80.73 abc	87.53 ab	79.76
T_2	0.75	89.50 ab	84.66 ab	82.34 abcd	85.50
	1.00	86.81 ab	80.73 abc	90.62 a	86.05
T_3	0.40	80.94 abc	73.12 bc	78.16 bcd	77.40
	0.60	92.10 a	88.46 a	84.34 abc	88.30
T_4	0.75	73.71 abc	69.20 c	74.97 cd	72.63
	1.00	78.92 abc	76.93 abc	81.25 abcd	79.03
Untreated control	-	-	-	-	-
CV (%)	-	8.72	6.66	4.72	-

Means in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T_1= Lambdacyhalothrin+Profenofos (ACC-35) T_2 = Emamectin Benzoate T_3 = Spinosad and T_4 = Azadirachtin, DAT = Days after treatment.

proximity with Ahmed *et al.* (2020). They stated that Spinosad @ 0.6 ml L^{-1} was very effective against the legume pod borer that provided the highest (80.61%) pod protection over control while lowest (52.15%) damaged pods over control were recorded from Nitro 505EC @ 1.00 ml L^{-1} in yard long bean. Similar results was cited by Tejeswari and Kumar (2021) who reported that the Spinosad treated plot gave 80.4, 87.3 and 84.3 % larval reduction at 3rd, 7th and 14th DATs followed by all treatments in tomato. Ghosh *et al*., 2010 reported that, maximum 100% reduction of infested fruits over control treatment from Spinosad @ 73 and 84 g a.i. ha^{-1} treated plots at 3 and 7 DATs, respectively. Chowdhury *et al*. (2021) recorded the highest 80.69% reduction of infestation by number over control noticed when treated with Spinosad @ 0.4 ml L^{-1} water. Quite the opposite, the lowest 55.58% was found from Abamectin 1.8 EC @ 1.2 ml L^{-1} water. Sreekanth *et al*. (2012) evaluated the similar result of highest (62.2%) reduction over control in pigeon-pea with Spinosad 0.1% treated plot.

The present study demonstrated that chemical control proves to be an effective strategy against pests like leaf miners and folder. All the tested chemicals e.g., Lambdacyhalothrin + Profenofos, Emamectin benzoate, Spinosad and Azadirachtin showed significant results. However, among the treatments, Spinosad @ 0.60 ml L^{-1} of water was observed more effective against the yard long bean pod borer, *M. vitrata*.

ACKNOWLEDGEMENTS

We thank MOST, GOB for supporting this study with a research grant and Auto Crop Care Ltd. for providing chemicals especially Lambdacyhalothrin + Profenofos.

REFERENCES

AHMED, R. N., UDDIN, M. M., HAQUE M. A. & AHMED, K. S. 2015. Field evaluation of microbial derivatives for management of legume pod borer, *Maruca vitrata* F. in yard long bean. *J. Entomol. Zool. Stud*. **8**(3): 162-166.

AHMED, R. N., UDDIN. M. M., HAQUE, M. A. & AHMED, K.S. 2020. Effectiveness of insect growth regulators for management of legume pod borer, *Maruca vitrata* F. in yard long bean. *Fundam. Appl. Agric*. **5**(2): 248-255. doi: 10.5455/faa.100126.

AKTAR, S., UDDIN, M. M. & AHMED, K. S. 2020. Bio-efficacy of some novel insecticides and biopesticides for managing bean pod borer, *Maruca vitrata* Geyer. *J. Bangladesh Agric. Univ*. **18**(2): 221-226.

AMBETHAR, V. 2009. Potential of entomopathogenic fungi in insecticide resistance management (IRM): A review. *J. Biopest*. **2**(2): 177-193.

AMETA, O., SHARMA, U. S. & JEENGAR, K. 2011. Efficacy of flubendiamide 480 SC against pod borers, *Helicoverpa armigera* (Hubner) and *Maruca testulalis* (L.) in pigeon pea. *Indian J. Entmol*. **73**(3): 191-195.

CHOWDHURY, M. A. R., MONDAL, M. F., KHAN, A. U., HOSSAIN, M. S., AZAD, M. O. K. PRODHAN, M. D. H., UDDAIN, J., RAHMAN, M. S., AHMED, N., CHOI, K. Y. & NAZNIN M. T. 2021. Evaluation of biological approaches for controlling shoot and fruit borer (*Earias vitella* F.) of okra grown in peri-urban area in Bangladesh. Horticulturae.**7**: 7. https://doi.org/10.3390/horticulturae7010007.

COOK, B. G., B. C. PENGELLY, BROWN, S. D. J., DONNELLY L., EAGLES, D. A., FRANCO, M. A., HANSON, J., MULLEN, B, F., PARTRIDGE, I. J., PETERS, M. & SCHULTZE-KRAFT, R. 2005. Differential aphid colony establishment in *Dolichos lablab* varieties correlated with some plant specific factors that impact on aphid fecundity. *American J. Plant Sci*. **8**(4): 754-769.

DAHALA, S., GAUTAMB, B., SHARMAA, B., NEUPANEA, K., KANDELA, SANTOSH, SEDHAIA, S., TIWARIA G. & OJHA, L. N. 2020. Management options against pod borer (*Maruca testulalis* Geyer) and pod sucking bugs (*Riptorus dentipes*) of cowpea [*Vigna unguiculata* (l.) walp.]. *Tropical Agrobiodiversity (TRAB)*. **1**(1): 24-30.

FRG (Fertilizer Recommendation Guide). 2012. Bangladesh Agricultural Research Council, Farmgate, Dhaka.

GHOSH, A., CHATTERJEE, M. & ROY, A. 2010. Bio-efficacy of spinosad against tomato fruit borer (*Helicoverpa armigera* Hub.) (Lepidoptera: Noctuidae) and its natural enemies. *J. Hortic. For*. **2**(5): 108-111.

HARIPRIYA, K., S. JEYARANI, S. MOHANKUMAR & SOUNDARARAJAN. R. P. 2019. Field evaluation of biocontrol agents and biopesticides against spotted pod borer, *Maruca vitrata* G. on lablab. *Indian J. Agric. Res*. **53**(5): 599-603.

JAYASINGHE, R. C., PREMACHANDRA W. T. S. D. & NEILSON, R. 2015. A study on *Maruca vitrata* infestation of Yard-long beans (*Vigna unguiculata* subsp. *sesquipedalis*). **1**(1): 1-13. http://dx.doi.org/10.1016/j.heliyon.2015.e00014.

KATTULA, S. W., PANDYA, H.V., KUMAR, S. S. & KUMAR, S. G. 2017. Efficacy of Different Combination of Insecticides against cowpea pod borer in Cowpea [*Vigna ungiculata* (L.) Walp.]. *Int. J. Curr. Microbiol. App. Sci*. **6**(6): 2030-2037.

KODANDARAM, M. H., HALDER, J. & RAI, A. B. 2014. New insecticide molecules and entomopathogens against hadda beetle, *Henosepilachna vigintioctopunctata* infesting vegetable cowpea. *Indian J. Plant Prot*. **42**(4): 333-337.

MALACRINO, A., SENG, K. H, AN, C., ONG, S. & ROURKE, M. E. O. 2019. Integrated pest management for yard-longbean (*Vigna unguiculata* subsp. *sesquipedalis*) in Cambodia. *Crop Prot*. In press: 104811. doi: 10.1016/j.cropro.2019.05.005.

MAPHOSA, Y. & JIDEANI, V. A. 2017. The role of legumes in human nutrition. Functional Food-Improve Health through Adequate Food. **1**: 13. doi: 10.5772/intechopen.69127.

MARGAM, V. M., COATES, B. S., BA, M. N., SUN, W., BINSO-DABIRE, C. L., BAOUA, I, ISHIYAKU, M. F., SHUKLE, J. T., HELLMICH, R. L., COVAS, F. G., RAMASAMY, S., ARMSTRONG, J., PITTENDRIGH B. R. & MURDOCK, L. L. 2011. Geographic distribution of phylogenetically-distinct legume pod borer, *Maruca vitrata* (Lepidoptera: Pyraloidea: Crambidae). *Mol. Biol. Rep*. **38**: 893-903. doi: 10.1007/s11033-010-0182-3.

MIAN, M. Y., HOSSAIN, M. S. & KARIM, A. N. M. R. 2016. Integrated pest management of vegetable crops in Bangladesh. In: R. Muniappan, E. Heinrichs (Eds), Integrated Pest Management of Tropical Vegetable Crops. Springer, Dordrecht, Germany. doi: 10.1016/j.cropro.2019.05.005.

MOTAPHALE, A. A., BHOSLE, B. B. & KHAN, F. S. 2018. Effective management of leaf miner, *Aproaerema modicella* in Soyabean ecosystem. Int. J. Current. Microbiol. App. Sci. **6**: 40-147.

MWEKE, A., AKUTSE, K. S., ULRICHS, C., FIABOE, K. K. M., MANIANIA, N. K. & SUNDAY, E. S. 2020. Integrated management of *Aphis craccivora* in cowpea using intercropping and entomopathogenic fungi under field conditions. *J. Fungi*. **60**(6): 1-20.

OLIVEIRA, C. M., AUAD, A. M., MENDES, S. M. & FRIZZAS, M. R. 2014. Crop losses and the economic impacts of insect pests on Brazilian agriculture. *J. Crop Prot.* **56**: 50-54.

ROGERS, M. E., STANSLY, P. A. & STELINSKI, L. L. 2014. Florida citrus pest management guide: Asian citrus psyllid and citrus leaf miners. Series ENY-734; IFAS Extension, University of Florida.

SREEKANTH, M. & SESHAMAHALAKSHMI, M. 2012. Studies on relative toxicity of biopesticides to *Helicoverpa armigera* (Hubner) and *Maruca vitrata* (Geyer) on pigeonpea (*Cajanus cajan* L.). *J. Biopest*. **5**(2): 191-195.

TEJESWARI, K. & KUMAR, A. 2021. Comparative efficacy of chemicals with biopesticides against tomato fruit borer, *Helicoverpa armigera* (Hubner) on Tomato, *Solanum lycopersicum* (L.) under field conditions. *J. Entomol. Zool. Stud*. **9**(5):425-429.

VISHAL, M. & UJAGIR, R. 2005. Evaluation of naturalyte spinosad against pod borer complex in early pigeonpea. *Indian J. Plant Prot*. **33**(2): 211-215.

YADAV, N. K. & SINGH, P. S. 2014. Bio-efficacy of chemical insecticides against spotted pod borer, *Maruca testulalis* (Geyer) on Cowpea. *Int. J. Agric. Environ. Biotecnol*. **7**(1): 187-190.