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Potency of novel formulated insecticides against *Maruca vitrata* F. (Lepidoptera: Crambidae) on yard long bean

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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 aim of this research was to evaluate the four newly formulated insecticides- Lambdacyhalothrin + Profenofs, Emamectin benzoate, Spinosad, Azadirachtin against M. vitrata. Tap water alone was used as untreated control. The results showed that the promising effect of new chemistry insecticides against the pod borer infestation as compared to untreated control. The highest number of healthy pods plant^{1} (15.56, 13.89 and 13.22) were found from Spinosad @ 0.60 mlL^{-1} of water treated plots; while the lowest (4.78, 4.33 and 4.89) in the control treatment after 1st, 2nd and 3rd spray, respectively. The highest (9.99, 8.89 and 10.67) and the lowest (1.33, 1.11 and 1.22) number of infested pods plant^{-1} were obtained from untreated control and Spinosad treated plants after 1st, 2nd and 3rd spray, respectively. Maximum weight (97.40, 94.01 and 101.86 g) of healthy pods plant^{-1} was obtained from Spinosad treated plants but minimum (29.85, 29.67 and 36.13 g) in the control after 1st, 2nd and 3rd spray, respectively. Similarly, the lowest weight of infested pods (5.49, 4.71 and 5.50 g) plant^{-1} was calculated from Spinosad treated plants but the highest in the control (40.97, 39.02 and 49.14 g) treatments after 1st, 2nd and 3rd spray, respectively. Therefore, Spinosad may be used against the notorious pest of M. vitrata although role Emamectin benzoate, Lambdacyhalothrin + Profenofs and Azadirachtin cannot be ignored as compared to control treatment.

Key words: novel insecticides, *Maruca vitrata*, yard long bean, protection and yield

INTRODUCTION

Globally the yard long bean (*Vigna unguiculata* sub-sp. *sesquipedalis*) is an excellent source of less expensive dietary protein especially for the poor (Seetharamu *et al*. 2019). They are also exceptional as high quality fodder, atmospheric nitrogen fixer and a valuable green manuring crop (Cook *et al.* 2005). Although this is a summer vegetable but farmers cultivate this crop all over the year due to high market demand. But this crop is threatened by a number insect pest resulting huge losses (Oliveira *et al.* 2014). Among them, legume pod borer, *Maruca vitrata* F. (Lepidoptera: Crambidae), is the most destructive resulting up to 80% yield loss (Ahmed *et al.* 2015, Aktar *et al.* 2020). It is the most notorious pest as an extensive host range, high potential and wide-ranging distribution (Margam *et al.* 2011). The farmer mostly relies on the use of insecticides to control the bean pests for quick results (Lengai *et al*. 2019, Konlan *et al*. 2016).

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 globally to adopt alternatives of chemical. Uses of novel formulated insecticides are an excellent source of alternatives and stands top the most position to

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protect insect. They are incredible as selective in action, excellent efficacy at low dosage, less prone, readily bio-degradable, the least harmful to beneficial insects and eco-friendly (Kodandaram *et al.* 2010). Since the merits, they are relatively safe and fit well for sustainable agriculture. With these points of view, the present research was conducted to evaluate the four different newly formulated insecticides- Lambdacyhalothrin + Profenofos, Emamectin benzoate, Spinosad and Azadirachtin against the legume pod borer, *M. vitrata*.

MATERIALS AND METHODS

Experimental site and land preparation

The experiment was conducted in the research field of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. 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). 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 levelled prior to seed sowing.

Experimental protocol

Seeds of dwarf yard long bean variety- 'Matir borboti' were collected from the Bangladesh Agricultural Development Corporation (BADC) in Dinajpur, Bangladesh. 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 seedling in each pit was kept by thinning. Stacking was given for each plant with bamboo stick to protect the plant from lodging. Irrigation, weeding and other intercultural operations were done when needed. Fertilizers were applied according to the recommended doses (FRG, 2012). The study was arranged in randomized complete block design (RCBD) with 3 replications. The whole field was divided into 39 plots. The size of unit plot was 3.0 m × 2.0 m accommodating with a single pit. Plot to plot distance was maintained 1.0 m.

The four treatments were arranged as T_1 = Lambdacyhalothrin + Profenofos (ACC-35) @ 0.5, 0.75 ml/L of water; T_2 = Emamectin Benzoate (Noclaim 5 SG) @ 0.75, 1.0 g/L of water; T_3 = Spinosad (Success 2.5 SC) @ 0.4, 0.6 ml/L of water; and T_4 = Azadirachtin (Neemoz 0.1%) @ and 0.75 and 1.0 ml/L of water. Tap water alone was used as untreated control. The insecticides were sprayed 3 times with the help of knapsack sprayer at 15 days intervals at 5 pm for safety of pollinators. Data were collected separately from each treatment of each plot at 5, 10 and 15 days of intervals after 1st, 2nd and 3rd sprays. The number and weight of infested pods were recorded.

Statistical analyses

All the collected data of different parameters were compiled and arranged for statistical analysis using Statistix 10 software to test the significance of variance among the treatments and means were separated using Tukey's HSD test at 5% level of significance.

RESULTS AND DISCUSSION

The tested all insecticides had potential effect against the pod borer after 1st, 2nd and 3rd sprays as compared to untreated control (Tables 1-3). Significant difference (5: $P < 0.01$, $df = 8$, $F = 63.10$; 10: $P < 0.01$, $df = 8$, $F = 22.38$; 15: $P < 0.01$, $df = 8$, $F = 86.91$) was observed among the treatments on infested pod after 1st spray as compared with control. The highest (11.0, 9.66 and 9.33) and the lowest number (1.67, 1.00 and 1.33) of infested pods were recorded for untreated control and Spinosad at 0.6 ml L^{-1} water at 5, 10 and 15 days after 1st, 2nd and 3rd sprays, respectively (Table 1). The highest pooled mean infested pods were counted as 9.99 from the untreated control but the lowest (1.33) from Spinosad @ 0.60 ml L^{-1} water treated plots. Similarly, statistically (5: $P < 0.01$, $df = 8$, $F = 10.63$; 10: $P < 0.01$, $df = 8$, $F = 1.28$;15: $P< 0.01$, $df = 8$, $F = 109.18$) the lowest infested pods were recorded as 1.33, 1.00 and 1.00 from Spinosad @ 0.60 ml L^{-1} water treated plots; while the highest were 5.33, 9.33 and 12.0 in the untreated control at 5, 10 and 15 days, respectively after 2nd spray (Table 2). The highest (8.89) pooled mean number of infested pods plant^{-1} was counted from untreated control; whereas the lowest (1.11) from Spinosad @ 0.60 ml L^{-1} water treated plots. Significant (5: $P < 0.01$, $df = 8$, $F = 22.91$; 10: $P < 0.01$, $df = 8$, $F = 26.30$; 15: $P < 0.01$, $df = 8$, $F = 41.69$) difference was also observed among the treatments as compared with control. The lowest infested pods were recorded for Spinosad @ 0.60 ml L^{-1} water treated plots; while the highest infested pod was recorded for untreated control at 5, 10 and 15 days, respectively after 3rd spraying (Table 3). The highest (10.67) pooled mean number of infested pods plant^{-1} was recorded untreated control while the lowest (1.22) from Spinosad @ 0.60 ml L^{-1} water treated plots. The potency ranked of the treatments based on mean number of infested pods plant^{-1} followed as Spinosad @ 0.60 ml L^{-1} of water > Emamectin benzoate @ 1.0 g L^{-1} of water > Azadirachtin @ 1.0 ml L^{-1} of water > Lambdacyhalothrin + Profenofs @ 0.75 ml L^{-1} of water.

Results evident that treatments by novel formulated insecticides were effective against pod borer infestation on yard long bean had profound effects as compared to untreated control. This indicated that applied of such newly formulated insecticides encounter the damage of the long yard bean pods caused by legume pod borer. Similar results were obtained by Yadav and Singh (2014) that the lowest number of larva of spotted pod borer were found in cowpea when the plants treated with Spinosad @ 0.2 ml L^{-1} water while the highest from untreated control. Results of the present findings are to some extent similar with Aktar *et al.* (2020). The lowest number of infested pods plot^{-1} were recorded as 4.36 in country bean when treated with Emamectin benzoate followed by Cartap, Spinosad, Cypermethrin, Flubendiamide and Lufenuron (Aktar *et al.* 2020). The present findings are also comparable with the results of Kattula *et al.* (2017) that Spinosad 45 SC @ 0.014% in combination with Imidacloprid 17.8 SL @ 0.005% gave the lowest larvae plant^{-1} in cowpea; while the highest from untreated control. Ameta *et al.* (2011) also reported that Spinosad brought significantly the higher reduction percentage of pod damage due to pod borers against *Helicoverpa armigera* Hubner in pigeon pea.

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

Treatments	Doses (g/ml) L-1 water	Number of infested pod plant^{-1} 5 DATs	10 DATs	15 DATs	Pooled mean
T_1	0.50	4.33 b	5.00 b	2.67 bc	4.00
	0.75	2.67 bc	3.33 bcd	2.33 bcd	2.78
T_2	0.75	2.67 bc	4.67 bc	3.00 b	3.45
	1.00	1.67 c	2.00 cd	1.67 cd	1.78
T_3	0.40	2.33 c	3.00 bcd	2.00 bcd	2.44
	0.60	1.67 c	1.00 d	1.33 d	1.33
T_4	0.75	3.33 bc	2.67 bcd	3.00 b	3.00
	1.00	2.33 c	2.33 bcd	2.00 bcd	2.22
Untreated Control	-	11.00 a	9.66 a	9.33 a	9.99
CV (%)	-	17.85	24.94	14.86	-

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

Effect of treatments against *M. vitrata* on the weight of infested pods

The applied novel insecticides had promising effects against the pod borer after 1st, 2nd and 3rd sprays while compared to untreated control (Tables 4-6). Significant difference (5: $P < 0.01$, $df = 8$, $F = 63.10$; 10: $P < 0.01$, $df = 8$, $F = 22.38$; 15: $P < 0.01$, $df = 8$, $F = 86.91$) was observed among the treatments as compared with controls. The lowest infested weight of pods (6.77, 4.10 and 5.60 g) were recorded for Spinosad @ 0.6 ml L^{-1} water treated plots; while the highest (44.10, 39.60 and 39.20 g) infested pods were recorded for untreated control @ 5, 10 and 15 days, respectively after 1st, 2nd and 3rd sprays (Table 4). The highest pooled mean weight of infested pods were recorded as 40.97 g for the untreated control but the lowest (5.49 g) pooled mean wt. of infested pods were decreased for Spinosad @ 0.60 ml L^{-1} water treated plots. Significant (5: $P < 0.01$, $df = 8$, $F =$

10.88; 10: P < 0.01, df = 8, F = 38.39; 15: P < 0.01, df = 8, F = 142.42) difference was also observed among the treatments of the wt. of infested pod. The lowest weight (5.67, 4.20, 4.27 g) of infested pods were observed for Spinosad @ 0.6 ml L^{-1} water treated plots while the highest (23.03, 40.57 and 53.47 g) for untreated control at 5, 10 and 15 days, respectively after 1st, 2nd and sprays (Table 5). The highest pooled mean weight of infested pods were counted as 39.02 g from the untreated control but the lowest (4.71 g) from Spinosad @ 0.60 ml L^{-1} water treated plots. Significant difference (5: P < 0.01, df = 8, F = 77.69; 10: P < 0.01, df = 8, F = 70.38; 15: P < 0.01, df = 8, F =89.63) was also observed among the treatments as compared with control. The lowest weight of infested pods (4.17, 4.46 and 4.66 g) were recorded for Spinosad @ 0.6 ml L^{-1} water treated plots while the highest (57.73, 39.77 and 49.92 g) was for untreated control at 5, 10 and 15 days, respectively after 1st, 2nd and sprays (Table 6). The highest pooled mean weight of infested pods were counted as 49.14 g for untreated control but the lowest (4.43 g) were for Spinosad @ 0.60 ml L^{-1} water treated plots. The potency ranked of the treatments based on weight of pooled mean infested pods plant^{-1} followed as Spinosad @ 0.60 ml L^{-1} of water > Emamectin benzoate @ 1.0 g L^{-1} of water > Azadirachtin @ 1.0 ml L^{-1} of water > Lambdacyhalothrin+ Profenofs @ 0.75 ml L^{-1} of water.

Table 2. Effect of novel insecticides against *M. vitrata* on the number of infested pods plant^{-1} after 2nd spray

Treatments	Doses (g/ml) L-1 water	Number of infested pod plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	5.00 ab	4.67 b	4.33 b	4.67
	0.75	4.33 ab	3.67 bc	2.33 cde	3.44
T_2	0.75	2.67 bc	1.67 cd	3.00 bc	2.45
	1.00	1.33 c	1.33 cd	1.33 de	1.33
T_3	0.40	1.67 c	2.33 bcd	1.67 cde	1.89
	0.60	1.33 c	1.00 d	1.00 e	1.11
T_4	0.75	3.00 abc	3.33 bcd	2.67 cd	3.00
	1.00	2.67 bc	3.00 bcd	2.00 cde	2.56
Untreated control	-	5.33 a	9.33 a	12.00 a	8.89
CV (%)	-	26.79	23.89	16.75	-

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

Results revealed that applied insecticides were effective against the pod borer on yard long bean after all sprays as compared to untreated control. Efficacy of the tested insecticides was observed dose and time exposure dependent. Parallel trends of finding was cited by Thejaswi *et al*. (2009) that the least (14.38%) pod damaged in field bean were recorded when treated with Spinosad 2.5 SC 1ml L^{-1} water after 1st, 2nd and 3rd spray, respectively. Again, Jat ***et al***. (2017) reported that Spinosad 0.1% treated plot gave lowest 2.60 and 3.62% followed by *C indoxacarb* (0.01%), endosulfan (0.05%), at 7 and 14 days of spraying after 3rd spray. Our findings are also comparable with those of Randhawa and Saini (2015) that minimum 16.75 and 21.25% pod damage cause of two sprays of Spinosad 48 SC followed by Cypermethrin 25 EC, Profenophos 50 EC and Indoxacarb 15 EC @ 150, 250, 1250 and 500 ml ha^{-1}, respectively against pod borer, *M. vitrata* in pigeon-pea during the season Kharif 2010 and 2011. Game *et al.* (2018) reported that the Spinosad 45% SC treated plot provided the lowest infested fruits as 3.17, 3.45 and 3.37% at 3rd, 7th and 14th DATs followed by others at 2nd spray on tomato. Sreekanth *et al.* (2012) evaluated the lowest (17.38%) pod damage in pigeon-pea were recorded from Spinosad 0.1% treated plot but the highest in the control (45.84%) treatment. Chowdhury *et al.* (2021) exhibited that lowest 3.56% fruit infestation in the plots when treated with Spinosad @ 0.4 ml L^{-1} water.

Table 3. Effect of novel insecticides against *M. vitrata* on the number of infested pod plant^{-1} after 3rd spray

Treatments	Doses (g/ml) L-1 water	Number of infested pod plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	4.33 b	5.33 b	3.00 b	4.22
	0.75	3.67 bc	1.67 cd	1.33 cd	2.23
T_2	0.75	1.33 de	1.33 cd	1.67 bcd	1.44
	1.00	1.67 cde	1.67 cd	1.00 d	1.45
T_3	0.40	2.33 b-e	2.33 c	2.33 bcd	2.33
	0.60	1.00 e	1.00 d	1.67 bcd	1.22
T_4	0.75	3.33 bcd	2.67 cd	2.67 bc	2.89
	1.00	2.67 b-e	2.00 cd	2.00 bcd	2.22
Control	-	12.67 a	8.67 a	10.67 a	10.67
CV (%)	-	20.83	17.64	19.59	-

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

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

Treatments	Doses (g/ml) L^{-1} water	Weight (g) of infested pod plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	17.37 b	20.47 b	11.13 bc	16.32
	0.75	10.77 bc	13.63 bcd	9.70 bc	11.37
T_2	0.75	10.70 bc	19.10 bc	12.30 b	14.03
	1.00	6.83 c	8.10 cd	6.97 bc	7.30
T_3	0.40	9.43 c	12.23 bcd	8.33 bc	9.97
	0.60	6.77 c	4.10 d	5.60 c	5.49
T_4	0.75	13.47 bc	10.83 bcd	12.37 b	12.22
	1.00	9.40 c	9.63 bcd	8.27 bc	9.10
Control	-	44.10 a	39.60 a	39.20 a	40.97
CV (%)	-	17.57	24.96	15.11	-

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

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

Treatments	Doses (g/ml) L^{-1} water	Weight (g) of infested pod plant^{-1}			Pooled Mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	21.57 ab	20.57 b	19.60 b	20.58
	0.75	18.73 abc	16.13 bc	10.43 cde	15.09
T_2	0.75	11.50 bcd	7.10 de	13.30 bc	10.63
	1.00	5.73 d	5.87 de	5.93 de	5.84
T_3	0.40	7.20 d	10.27 cde	7.37 cde	8.28
	0.60	5.67 d	4.20 e	4.27 e	4.71
T_4	0.75	13.03 abcd	14.63 bcd	11.90 cd	13.19
	1.00	11.43 cd	12.87 bcde	9.07 cde	11.12
Control	-	23.03 a	40.57 a	53.47 a	39.02
CV (%)	-	26.58	21.01	14.58	-

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey test (α=0.05). T1= Lambdacyhalothrin+Profenofos (ACC-35), T2 = Emamectin Benzoate, T3 = Spinosad and T4 = Azadirachtin

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

Treatments	Doses (g/ml) L^{-1} water	Mean weight (g) of infested pod plant^{-1}			Pooled mean
		5 DATs	10 DATs	15 DATs	
T_1	0.50	19.67 b	24.73 b	14.43 b	19.46
	0.75	16.57 bc	7.77 cd	6.14 cd	10.16
T_2	0.75	7.50 cde	7.51 cd	7.63 bcd	7.55
	1.00	6.00 de	5.92 cd	7.87 bcd	6.59
T_3	0.40	10.60 b-e	10.86 cd	11.13 bcd	10.86
	0.60	4.17 e	4.46 d	4.66 d	4.43
T_4	0.75	15.00 bcd	12.37 c	12.77 bc	13.38
	1.00	12.01 bcde	9.29 cd	9.44 bcd	10.25
Control	-	57.73 a	39.77 a	49.92 a	49.14
CV (%)	-	19.25	17.36	18.47	-

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

CONCLUSION

The present study proved that chemical control to be an effective strategy against pod borer. All the tested chemicals i.e. Lambdacyhalothrin + Profenofos (ACC-35), Emamectin Benzoate, Spinosad and Azadirachtin yielded significant results in comparison with untreated control. However, among the treatments, Spinosad @ 0.60 ml L^{-1} of water was observed more effective against *M. vitrata.*

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