Bangladesh j. entomol. (2023) 31(1), 99-110, www.bangladeshes.org *ISSN 1021-1004*

EFFICACY OF NEW AND CONVENTIONAL INSECTICIDES AGAINST LEAF MINERS AND LEAF FOLDERS OF COUNTRY BEAN

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ABSTRACT

Globally country bean (*Lablab purpureus*) is an excellent source of nutrients and an important delicious vegetable especially for the poor. But it is infested by various insects pests particularly leaf miner and leaf folder. A field experiment was conducted in RCBD from November 2021 to February 2022 to find out the potency of some novel formulated insecticides for managing the two major pests, leaf miners and leaf folders infesting BARI Shim-5 following RCBD. Five treatments with 3 different doses *viz*., T_1 = Cyproflanilide 10% DC (ACC-Cy), T_2 = Prophenophs 50% (Lambdacyhalothrin + Prophenos), T_3 = Pyriproxyfen (Pyrifen 10.8 EC) and T_4 = Noclaim 5 SG (Emamectin benzoate), and an untreated control were evaluated. Treatments were applied at 15 days interval and data were collected at 1st, 3rd, 5th, 7th days after treatments (DATs). All the treatments significantly reduced the infestation of leaf miners and leaf folders over untreated control. However, treated with Cyproflanilide 10% DC @ 0.60 ml L^{-1} of water was found to be effective against leaf miners (3.25, 3.42 and 3.33) and leaf folders (2.75, 2.92 and 3.34).

Keywords: Efficacy, insecticides, country bean, leaf miners, leaf folders.

INTRODUCTION

Among the legumes, the country bean (*Lablab purpureus* L.) is the excellent source of dietary protein for humans especially for poor populations throughout the world (Seetharamu *et al*. 2019). It is also rich for carbohydrates, vitamins, minerals and unsaturated fatty acids such as linoleic and oleic acids (Celmeli *et al*. 2018, Martinez *et al*. 2016). They are also important source of fodder for livestock (Chandra and Kushwaha 2012), atmospheric nitrogen fixer (Yadav *et al*. 2021) and green manure

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(Ewansiha *et al.* 2016). It is a delicious winter vegetable cultivated in large scale throughout Bangladesh (Salim *et al*. 2013, Khan *et al*. 2020, Rahman *et al*. 2022). However, farmers are facing serious problems during its cultivation due to insect pests (Soundaranjan *et al.* 2013). Generally, it is attacked by 22 species of insect pest including leaf miners and folders (Thejaswi *et al*. 2008). The leaf miners may cause up to 98% yield losses in mungbean (Hamza *et al*. 2023), 80-100% in soybean (Oztemiz 2012) while leaf folder estimated up to 95% in Bangladesh (Biswas and Islam 2012).

In fact, majority of the farmers use synthetic insecticides to manage insect pests of bean for quick knockdown (Lengai *et al*. 2019, Konlan *et al*. 2016). However, their indiscriminate use has a greater tendency to accumulate in the environment, disrupt the natural functioning of the ecosystem, hazardous to a wide range of non-target organism (Chowanski *et al*. 2014), development of pesticide resistance (Srinivasan *et al*. 2021) and pest resurgence (Patil *et al*. 2017). Hence researchers are now trying to adopt alternatives to broad-spectrum insecticides. Nowadays, the new generation insecticides molecules offered several advantages over conventional pesticides like high selectivity, excellent efficacy at low dosage, least harmful to beneficial insects and environment as well (Kodandaram *et al*. 2010). To solve the existing challenges, a field trial was carried out to find out the field efficacy of newly formulated safer insecticides, such as Cyproflanilide 10% DC, Lamda cyhalothrin + Profenophos 50%, Emamectin benzoate and Pyriproxyfen against the leaf miner and leaf folder attacking country bean.

MATERIALS AND METHODS

The experiment was conducted in the Rabi season in On Farm Research Center of Bangladesh Agricultural Research Institute (BARI), Rajbari, Dinajpur from November 2021 to February 2022.

Plant cultivation: BARI Shim-5, *Lablab perpureus* was collected from BADC of Sadar Upazila, Dinajpur town. After pit preparation, 3 seeds were sown in each pit followed by a light irrigation to ensure soil moisture content for germination. The field experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. Fifteen days after sowing, a single plant in each pit was kept. At optimum growth level each plant was stacking with bamboo stick to prevent lodging. Cow dung and other chemical fertilizers were applied according to the fertilizer recommendation guide (FRG 2012). Intercultural operations i.e., irrigation

and weeding were done as and when needed. Each treatment was divided into 3 different doses including untreated control.

Treatments: Five treatments as T_1= Cyproflanilide 10% DC (ACC-Cy) @ 0.30, 0.45, 0.60, T_2 = Prophenofos 50% (Lambdacyhalothrin + Prophenofos), @ 0.25, 0.50, 0.75, T_3 = Pyrifen 10.8 EC as (Pyriproxyfen) @ 0.5, 1.00, 1.50 ml L^{-1} water while T_4= Emamectin benzoate (Noclaim 5 SG) @ 0.75, 1.00 and 1.25 gm L^{-1} of water were used. Besides, an untreated control was maintained with water only. The insecticides were applied and evaluated against two major insect pests, leaf miners and leaf folders. A total of three sprays of each treatment were given at 4 pm at fifteen days interval by using hand sprayers (2 L). The experimental field was monitored keenly to observe the infestation by bean leaf miners and leaf folders. Then numbers of infested leaves were counted and recorded at 1, 3, 5 and 7 days of intervals after each spraying of treatment and maintained 3 replications.

Statistical analysis: The data were analyzed by using Statistics 10 software to test the significance of variance among the treatments and means are separated by using Tukey's HSD test.

RESULTS AND DISCUSSION

Effect of insecticides against leaf miner: The novel formulated insecticides had promising effects against the leaf miner infestation after 1st, 2nd and 3rd spray as compared to untreated control (Tables 1-3). Among the treatments, significantly ($P<$ 0.01, df = 12, F =5.12; $P<$ 0.01, df = 12, F =9.39; $P<$ 0.01, df = 12, F =21.64; $P<$ 0.01, df = 12, F =35.47) the lowest infested leaves were found as 5.00, 4.33, 1.33 and 2.33 in Cyproflanilide 10% @ 0.60 ml L^{-1} of water at 1st, 3rd, 5th and 7th DATs, respectively after 1st spray (Table 1). While the highest infested leaves $plant^{-1}$ were counted as 11.67, 12.33, 13.00 and 13.67 from untreated control at 1st, 3rd, 5th and 7th DATs, respectively. Similarly, significantly ($P<$ 0.01, df = 12, F =6.21; $P<$ 0.01, df = 12, F =8.79; $P<$ 0.01, df = 12, F =64.00; $P<$ 0.01, df = 12, F =30.72) the lowest infested leaves caused by leaf miners $plant^{-1}$ were recorded were 5.67, 4.67, 1.33 and 2.00 in Cyproflanilide 10% @ 0.60 ml L^{-1} of water treated plot but the highest were 11.67, 12.33, 12.67 and 13.33 were recorded $plant^{-1}$ from untreated control plots at 1st, 3rd, 5th and 7th DATs, respectively (Table 2). Owing to the treatments, significantly ($P<$ 0.01, df = 12, F =12.46; $P<$ 0.01, df = 12, F =18.14; $P<$ 0.01, df = 12, F =100.68; $P<$ 0.01, df = 12, F =49.92) the lowest mean leaf miner $plant^{-1}$ were observed as 5.00, 4.00, 1.67 and 2.33 in Cyproflanilide @ 0.60 ml L^{-1} of water

Table 1. Effect of novel formulated insecticides on the incidence of leaf miner at 1st spray during vegetative stage of country bean

Treatments	Doses (g/ml) L^{-1} water	Mean number of leaf miners $plant^{-1}$				Cumulative leaf miners $plant^{-1}$
		1 DATs	3 DATs	5 DATs	7 DATs	
Cyproflanilide	0.30	8.00 abcd	7.67 bcd	6.00 bcd	7.33 bcd	7.25
	0.45	7.00 bcd	6.00 bcd	4.33 cdef	4.67 efgh	5.50
	0.60	5.00 d	4.33 d	1.33 f	2.33 h	3.25
Profenofos	0.25	9.00 abcd	7.00 bcd	6.33 bcd	7.00 bcde	7.33
	0.50	7.33 bcd	6.33 bcd	4.67 cde	5.00 defg	5.83
	0.75	6.67 bcd	4.67 cd	2.67 ef	3.00 gh	4.25
Pyriproxyfen	0.50	10.33 ab	9.00 ab	8.33 b	9.00 b	9.17
	1.00	8.33 abcd	7.33 bcd	6.67 bc	7.33 bcd	7.41
	1.50	6.67 bcd	5.33 cd	4.00 cdef	4.67 efgh	5.17
Emamectin benzoate	0.75	9.67 abc	8.00 bc	7.00 bc	8.00 bc	8.17
	1.00	7.67 abcd	6.67 bcd	5.00 cde	5.67 cdef	6.25
	1.25	6.00 cd	5.00 cd	3.33 def	4.00 fgh	4.58
Untreated control	-	11.67 a	12.33 a	13.00 a	13.67a	12.66
CV (%)	-	17.77	17.50	19.55	13.79	

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey's test (α=0.05).

Table 2. Effect of novel formulated insecticides on the incidence of leaf miner at 2nd spray during flowering stage of country bean

Treatments	Doses (g/ml) L^{-1} water	Number of leaf miners $plant^{-1}$				Cumulative leaf miners $plant^{-1}$
		1 DATs	3 DATs	5 DATs	7 DATs	
Cyproflanilide	0.30	8.67 abcd	8.33 bcd	6.33 cde	7.00 cd	7.58
	0.45	7.33 bcd	6.33 bcde	4.33 fgh	5.00 def	5.75
	0.60	5.67 d	4.67 de	1.33 i	2.00 g	3.42
Profenofos	0.25	8.33 abcd	7.00 bcde	6.67 cd	8.00 bc	7.50
	0.50	7.67 bcd	6.67 bcde	4.67 efg	5.33 cdef	6.09
	0.75	6.00 cd	4.33 e	2.67 hi	3.00 fg	4.00
Pyriproxyfen	0.50	11.00 ab	9.33 ab	8.67 b	10.00 b	9.75
	1.00	9.00 abcd	7.33 bcde	6.00 cdef	7.00 cd	7.33
	1.50	7.33 bcd	5.67 bcde	5.00 def	4.00 efg	5.50
Emamectin benzoate	0.75	9.67 abc	9.00 abc	7.00 bc	8.00 bc	8.42
	1.00	8.00 abcd	7.00 bcde	5.33 cdef	6.00 cde	6.58
	1.25	6.00 cd	5.33 cde	3.00 ghi	4.33 defg	4.66
Untreated control	-	11.67 a	12.33 a	12.67 a	13.33 a	12.5
CV (%)	-	15.67	17.74	11.00	14.89	

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey's test (α=0.05).

treated plot at 1st, 3rd, 5th and 7th DATs, respectively while the highest were 13.00, 13.67, 14.33 and 15.0 from untreated control plots after 3rd spray (Table 3). The potency of treatments based on pooled mean infested leaves (3.33) plant^{-1} in all sprays followed as Cyproflanilide 10% @ 0.60 ml L^{-1} of water > Pyriproxyfen @ 1.50 ml L^{-1} of water > Emamectin benzoate @ 1.25 g L^{-1} of water > T_2 Profenofos @ 0.75 ml L^{-1} of water.

Results revealed that tested insecticides proved significantly very potent in combating leaf miners as compared to untreated control which appeared nearly free of damage. These findings indicated that such newer formulated insecticides can prevent damage of the plant from bean leaf miners. The present results are at par with Keshbhat *et al*. (2002). They concluded that the concentration of 0.15% prophenophos provided good results against soybean leaf miner *Aproaerema modicella*, a serious pest of soybean. Results of the present findings are also parallel with those of Ensaf and Satti (2015). They cited that Karate 5% (Lambda-cylalothrin) were effective in reducing leaf miners infestation. Motaphale *et al*. (2018) reported that the lowest population of leaf miner was found in Emamectin benzoate 5 SG @ (1.85

Table 3. Effect of novel formulated insecticides on the incidence of leaf miner at 3rd spray during pod setting of country bean

Treatments	Doses (g/ml) L^{-1} water	Mean number of leaf miners plant^{-1}				Cumulative leaf miners plant^{-1}
		1 DATs	3 DATs	5 DATs	7 DATs	
Cyproflanilide	0.30	7.33 cde	7.67 bcd	6.67 c	7.33 bcde	7.25
	0.45	6.67 de	6.00 bcdef	4.00 ef	4.33 ghi	5.25
	0.60	5.33 e	4.00 f	1.67 g	2.33 i	3.33
Profenofos	0.25	8.33 bcde	7.33 bcde	6.33 cd	7.67 bcd	7.42
	0.50	6.33 de	6.33 bcdef	4.33 e	5.00 efgh	5.50
	0.75	6.00 de	4.33 ef	2.33 fg	3.33 hi	4.00
Pyriproxyfen	0.50	10.67 ab	8.33 bc	9.00 b	9.67 b	9.42
	1.00	9.00 bcd	7.00 bcdef	7.00 c	7.00 cdef	7.50
	1.50	8.00 bcde	5.67 cdef	3.67 ef	4.67 fghi	5.50
Emamectin benzoate	0.75	10.00 abc	9.00 b	7.33 bc	9.00 bc	8.83
	1.00	7.67 bcde	6.67 bcdef	4.67 de	6.33 defg	6.34
	1.25	6.67 de	4.67 def	3.00 efg	3.67 hi	4.50
Untreated control	-	13.00 a	13.67 a	14.33 a	15.00 a	14.00
CV (%)	-	13.03	14.64	10.16	12.60	-

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey's test (α=0.05).

larvae/plant) treated plant at 3 days after first and second sprays. Kothalkar *et al*. (2015) reported that triazophos 40 EC 800 ml ha^{-1} recorded lower incidence of leaf miner at 3, 7 and 10 days after the sprays and found significantly superior (Kotak *et al*. 2020). 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). Sharma and Bhatti (2012) and Stansly *et al*. (2013) stated that imidacloprid and thiamethoxam can suppress the citrus leaf miners. An advantage is that both spinosad spraying and neonicotinoids incorporation in soil are reported to be safe or with little direct effect on the leaf miner's natural enemies (Rogers *et al*. 2014).

Effect of insecticides against bean leaf folder: All the tested novel formulated insecticides had profound effects against leaf folders as compared to untreated control after 1st, 2nd, and 3rd sprays (Tables 4-6). Among the treatments, significantly ($P< 0.01$, $df = 12$, $F =5.53$; $P< 0.01$, $df = 12$, $F =12.59$; $P< 0.01$, $df = 12$, $F =37.06$; $P< 0.01$, $df = 12$, $F =43.18$) the lowest infested leaves $plant^{-1}$ were recorded as 4.67, 3.00, 1.33 and 2.00 from Cyproflanilide 10% @ 0.60 ml L^{-1} of water treated plants at 1st, 3rd, 5th and 7th DATs, respectively after 1st spray (Table 4). But the highest folded leaves $plant^{-1}$ were found as 10.00, 11.00, 11.67 and 12.33 from untreated control at 1st, 3rd, 5th and 7th DATs, respectively. Likewise, significantly ($P< 0.01$, $df = 12$, $F =5.15$; $P< 0.01$, $df = 12$, $F =12.37$; $P< 0.01$, $df = 12$, $F =37.85$; $P< 0.01$, $df = 12$, $F =27.65$) the lowest folded leaves $plant^{-1}$ were recorded as 5.00, 3.00, 1.67 and 2.00 in Cyproflanilide 10% @ 0.60 ml L^{-1} of water treated plots after 1st, 3rd, 5th and 7th DATs, respectively after 2nd spray but the highest as 10.33, 10.00, 11.33 and 11.67 from untreated control. Also, statistically ($P< 0.01$, $df = 12$, $F =9.53$; $P< 0.01$, $df = 12$, $F =16.55$; $P< 0.01$, $df = 12$, $F =44.61$; $P< 0.01$, $df = 12$, $F =28.26$) the lowest folded leaves $plant^{-1}$ were counted as 5.00, 3.67, 2.00 and 2.67 in ACC-Cy @ 0.60 ml L^{-1} of water after 3rd spray while the highest as 10.67, 10.67, 11.67 and 11.67 from untreated control after 1st, 3rd, 5th and 7th DATs, respectively. Pooled results over periods of all sprays indicated that the plots treated with Cyproflanilide 10% @ 0.60 ml L^{-1} of water recorded the lowest (3.33) incidence of folded leaves followed by Profenofos @ 0.75 ml L^{-1} of water > Emamectin benzoate @ 1.25 g L^{-1} of water > Pyriproxyfen @ 1.50 ml L^{-1} of water in controlling the pest (Table 4).

The tested insecticides significantly reduced the folding leaves by leaf folder as compared to untreated control. The present findings are in line with Yasutaka *et al*. (2012) who reported that spinetoram has excellent insecticidal activity against

Table 4. Effect of novel formulated insecticides on the incidence of leaf folder at 1st spray during vegetative stage of country bean

Treatments	Doses (g/ml) L^{-1}	Mean number of leaf folders $plant^{-1}$				Cumulative mean
		1 DATs	3 DATs	5 DATs	7 DATs	
Cyproflanilide	0.30	7.33 abcd	6.00 bcde	5.00 bcde	6.33 bcd	6.17
	0.45	6.00 bcd	5.00 bcde	3.00 fgh	3.67 efg	4.42
	0.60	4.67 d	3.00 e	1.33 h	2.00 g	2.75
Profenofos	0.25	7.67 abcd	7.00 bcd	6.00 bcd	6.67 bc	6.83
	0.50	6.33 bcd	5.33 bcde	4.00 defg	4.33 def	5.00
	0.75	5.0 cd	4.00 de	2.33 gh	2.67 fg	3.50
Pyriproxyfen	0.50	8.00 abc	7.33 bc	6.67 bc	7.00 bc	7.25
	1.00	6.67 bcd	6.00 bcde	4.67 cdef	5.00 cde	5.59
	1.50	5.33 bcd	4.33 cde	4.00 defg	3.33 efg	4.25
Emamectin benzoate	0.75	8.33 ab	8.00 ab	7.00 b	8.33 b	7.92
	1.00	7.00 abcd	6.33 bcd	5.33 bcde	6.33 bcd	6.52
	1.25	5.67 bcd	4.67 cde	3.67 efg	4.00 efg	4.50
Untreated control		10.00 a	11.00 a	11.67 a	12.33 a	11.25
CV (%)	-	16.37	16.76	14.84	13.17	-

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey's test (α=0.05).

thrips, leafminer flies, and other lepidopteran insects. The present findings are in agreement with the results of Chhavi *et al*. (2018), Kulagod *et al*. (2011), and Sekh *et al*. (2007). They opined that flubendiamide proved to be highly effective against paddy leaf folder. Kumar *et al*. (2020) cited that spinetoram 0.8% GR @ 60 g/ha highly potent against rice leaf folder. Results of the present study are comparable with those of Soomro *et al*. (2020). They concluded the minimum folded leaves in Belt 480 SC (3.76%) leaves/plant compare to untreated control (28.96%). The application of flubendiamide 20 WG @ 25 g a.i./ ha recorded the lowest (12.51% leaf damage) incidence of pest *C. medinalis* of paddy and did not have any significant adverse effect on the spiders population in the paddy field when applied at evaluated doses (Zala and Sipai 2021).

The present study demonstrates that chemical control proves to be an effective strategy against pests like leaf miners and folder. All the tested chemicals e.g., Cyproflanilide, Profenofos, Pyriproxyfen and Emamectin benzoate yielded significant results. However, among the treatments, Cyproflanilide 10% DC @ 0.60 ml L^{-1} of water was observed more effective against bean leaf miners and leaf folders.

Table 5. Effect of novel formulated insecticides on the incidence of leaf folder at 2nd spray during flowering stage of country bean

Treatments	Doses (g/ml) L^{-1} water	Mean number of leaf folders $plant^{-1}$				Cumulative leaf folders $plant^{-1}$
		1 DATs	3 DATs	5 DATs	7 DATs	
Cyproflanilide	0.30	8.00 abcd	6.67 bc	5.00 cde	5.67 bcde	6.34
	0.45	6.67 bcd	4.33 cd	3.67 defg	4.00 defg	4.67
	0.60	5.00 d	3.00 d	1.67 g	2.00 g	2.92
Profenofos	0.25	8.33 abc	7.33 ab	5.67 bcd	6.33 bcd	7.04
	0.50	7.00 bcd	5.33 bcd	4.00 def	5.00 cdef	5.33
	0.75	5.67 cd	4.00 cd	2.33 fg	3.00 fg	3.75
Pyriproxyfen	0.50	9.00 ab	8.00 ab	7.33 b	7.67 b	8.00
	1.00	7.67 abcd	6.00 bc	4.67 cde	5.67 bcde	6.00
	1.50	6.67 bcd	4.33 cd	3.33 efg	3.67 efg	4.50
Emamectin benzoate	0.75	8.67 abc	7.67 ab	6.33 bc	6.67 bc	7.34
	1.00	7.33 abcd	5.67 bcd	4.33 cdef	5.33 bcdef	5.67
	1.25	6.33 bcd	4.00 cd	3.00 efg	3.33 efg	4.17
Untreated control		10.33 a	10.00 a	11.33 a	11.67 a	10.83
CV (%)	-	14.87	16.76	14.67	15.16	-

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey's test (α=0.05).

Table 6. Effect of novel formulated insecticides on the incidence of leaf folder at 3rd spray during podding stage of country bean

Treatments	Doses (g/ml) L^{-1} water	Mean number of leaf folders $plant^{-1}$				Cumulative mean
		1 DATs	3 DATs	5 DATs	7 DATs	
Cyproflanilide	0.30	7.00 bcd	6.67 bcd	5.00 bcd	6.00 bcde	6.17
	0.45	6.00 bcd	4.33 def	3.00 efg	3.67 fg	4.25
	0.60	5.00 d	3.67 f	2.00 g	2.67 g	3.34
Profenofos	0.25	7.67 bc	6.67 bcd	5.33 bcd	6.33 bcd	6.50
	0.50	6.33 bcd	5.00 cdef	3.67 defg	4.00 efg	4.75
	0.75	5.67 cd	4.00 ef	2.67 efg	3.33 fg	3.92
Pyriproxyfen	0.50	8.33 ab	8.00 b	6.67 b	7.33 b	7.58
	1.00	7.67 bc	6.33 bcde	4.33 cde	5.33 bcdef	5.92
	1.50	7.00 bcd	5.33 cdef	3.00 efg	4.33 defg	4.92
Emamectin benzoate	0.75	8.00 bc	7.33 bc	6.00 bc	6.67 bc	7.00
	1.00	6.67 bcd	5.67 bcdef	4.00 def	4.67 cdefg	5.25
	1.25	6.33 bcd	4.33 def	2.33 fg	4.00 efg	4.24
Untreated Control	-	10.67 a	10.67 a	11.67 a	11.67 a	11.17
CV (%)	-	11.35	13.76	14.49	14.21	-

Means (±SE) in a column followed by different letters indicate significant differences from the Tukey's test (α=0.05).

ACKNOWLEDGEMENTS

We thank MoST, GoB for supporting this study with a research grant and Auto Crop Care Ltd. for providing chemicals especially Cyproflanilide and Prophenofos.

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(MS Received for Publication 25 June 2023)