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EFFICACY OF SOME INSECTICIDAL TREATMENT COMBINATIONS FOR THE MANAGEMENT OF FLEA BEETLE AND LEAF FOLDER OF MUNGBEAN

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Abstract

The most effective way to manage insect pests is by using a combination of insecticides rather than using them separately. The objective of this study was to assess the effectiveness of insecticidal treatment combinations against flea beetle (*Phyllotreta nigripes*) and leaf folder (*Cnaphalocrocis medinalis)* of mungbean during late Rabi season 2018. The mungbean variety, BARI Mung-6 was grown in the field and five treatment combinations viz., TC_1 = Nitro 505EC (Chlorpyrifos + Cypermethrin) + Bioneem plus 1EC (Azadirachtin), TC_2 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) + Bioneem plus 1EC (Azadirachtin), TC_3 = Nitro 505EC (Chlorpyrifos + Cypermethrin) + Tracer 45SC (Spinosad), TC_4 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) + Tracer 45SC (Spinosad) and TC_0 = Untreated control (water spray) were set in randomized complete block design (RCBD) with four replications. Insecticidal treatment combinations were applied at vegetative, flowering and podding stages of mungbean. All the treatments showed significantly different performance against flea beetle and leaf folder. TC_4 was the most effective combination for the reduction of flea beetle population which was followed by TC_2. On the other hand, TC_3 significantly reduced the leaf folder population which followed by TC_4. The highest yield (1589.63 kg ha^{-1}) and maximum (1.60) marginal benefit cost ratio (MBCR) were obtained from TC_4. It can be concluded that TC_4 and TC_3 were more effective among the insecticidal treatment combinations for management of flea beetle and leaf folder of mungbean, respectively.

Key words: Bioneem plus, Flea beetle, Leaf folder, Nitro, Tracer, Voliam flexi, Mungbean.

Introduction

Pulses are an important source of protein and also have proven evidence of their useful micronutrients, bioactive and functional properties (Philanto and Korhonen 2003). These are the most common items included in the daily diet of the people of Bangladesh. Mungbean [*Vigna radiata* (L.) Wilczek] is one of the most significant pulse crops in Bangladesh. It contributes about 11.53% of the total produced pulse crop in Bangladesh and ranks fifth among the pulse crops. Mungbean seed contains 24.5% protein and 59.9% carbohydrate. It also contains 75 mg calcium, 8.5 mg iron and 49 mg B-Carotene per 100 g of split dual (BARC 2013). The legume crop not only provides grain for human consumption but also fixes nitrogen in the soil. Additionally the plant has the ability to fix atmospheric nitrogen (58-109 kg ha^{-1}) through *Rhizobium* bacteria in a symbiotic process, which not only enables it to meet its own nitrogen requirement but also benefits the cereal crops successfully in various cropping systems (Ali 1992). Some of the constraints on mungbean production are lack of improved varieties, low yield, lack of promotion for research and extension focus, infestation of insect pests, lack of internal market system and incompatibility of the crop's success.

Insect pests are considered as the most important one. Insect pests' infestation is one of the distinct causes of

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crop's yield decline. Infestation of about twelve species of insect pests has been observed in the production of mungbean in Bangladesh (Rahman *et al.* 2000). Flea beetle (*Phyllotreta* spp. Fabricius) feeds on the cotyledons, making extensively numerous round holes on the leaves of the young plants and later the old damaged leaves eventually dry out. The damaged leaves of the plants dry out and its growth is rendered with few pods (Hossain 2015). The larvae of the leaf folder (*Cnaphalocrocis medinalis* Guen.) feed on the underside of the leaves when they are in the larval stage and continue to grow from that stage. These larvae feed on the edges of the leaves and fold them longitudinally inside. They stay inside the folded leaves and feed on green matter which in turn reduces the photosynthetic activity (Vaishali and Narangalkar 2020).

There are many options available to control these insect pests, but most of the farmers in Bangladesh usually use various types of single insecticide to control the insect pests. Whether the proper effects of these insecticides are known or not, these are used for quick effect. However, due to innovation of high yielding varieties, recent development of short duration varieties and increased market price of mungbean, farmers are now interested in cultivating mungbean following insect pests' management. But instead of individual use of any single insecticide, combined approach of insecticides bears a lot of advantages for managing any insect pests. Combined approach is a systematic plan which integrates different pest control insecticide into one program and suppressing insect pest's populations below the economic injury level (EIL). A spraying of Validamycin @ 2.5 ml L^{-1} in combination with Rynaxypyr @ 0.3 ml L^{-1} thrice at 15 d interval starting as blanket application from 15 days after transplanting is recommended as tank mix to control stem borer and leaf folder in rice (Rini Pal *et al.* 2018). Keeping all these limitations, this study aimed at assessing the suitable insecticidal treatment combination(s) for the management of flea beetle and leaf folder of mungbean.

Materials and Methods

Experimental location

The experiment was conducted at the farmer's field of Patuakhali district under southern region of Bangladesh to evaluate some insecticidal treatment combinations against insect pests i.e., flea beetle (*Phyllotreta* spp.) and leaf folder (*C. medinalis*) of mungbean and their yield during late Rabi season 2018. It was situated in between 22°14' and 22°29' north latitudes and in between 90°12' and 90°28' east longitudes (BANGLAPEDIA 2015). This area is adjacent to the Bay of Bengal and is located at 0.9 to 2.1 metre above mean sea level (Iftekhar and Islam 2004).

Land preparation and Seed sowing

The land was deeply cultivated and cross-plowed 4 times by power tiller followed by laddering. All the weeds and straw of the previous crops were removed from the field and large clods of soil were broken for the desired cultivation. The experiment was placed in a randomized complete block design (RCBD) with 4 replications. Each replication represented a block that was divided into five unit plots. The unit plot size was 4.0 m x 2.5 m ready for each treatment. The distance from block to block and plot to plot was 1.0 m and 0.5 m, respectively. The used mungbean variety was BARI Mung-6. On 31 January, mungbean seeds were sown at a rate of 45 kg ha^{-1} (BARI 2014) to maintain rows of 30 cm x 10 cm. Seed sowing was done at a depth of 6 - 7 cm and the seeds were covered manually by loose soil.

Fertilizer dose and Intercultural operations

Fertilizer was applied as per the fertilizer recommendation (BARI 2014). During final land preparation Urea, TSP (Triple Super Phosphate) and MoP (Muriate of Potash) were applied in the field @ 50-85-35 kg ha^{-1}, respectively. The fertilizers were properly mixed with the soil by spading and individual unit experimental plots were leveled. All intercultural activities such as thinning out, gap filling, weeding, irrigation and drainage etc. were done to ensure normal growth and development of the crops.

The insecticidal treatment combination (TC) arrangements of the experiment

The experiment comprised four treatment combinations of different insecticides including an untreated control. The treatment combinations were TC_1 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water; TC_2 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water, TC_3 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Tracer 45SC (Spinosad) @ 0.3 ml L^{-1} of water, TC_4 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Tracer 45SC (Spinosad) @ 0.3 ml L^{-1}

of water and TC_0 = Untreated control (water spray @ 500 L ha^{-1}). Overall, chemical pesticides are as effective in reducing pest densities and improving crop yield as commercially formulated bio-pesticides indicate that it is also workable in terms of pest suppression and production of marketable yield (Farhan *et al.* 2019).

Procedure of treatment application

Spray solutions of pre-determined concentrations of the respective treatment combinations were prepared by mixing with water as required in the sprayer just before spraying. It was always sprayed in the afternoon to avoid bright sunlight. Spray was done evenly to get full coverage of the whole plants. Care was taken to avoid any drift of spray mixture to the adjacent plots while spraying. These solutions were applied in the assigned plots as per the experimental design. According to the treatments combination, the second application was done three days after first application at each stage (e.g., vegetative, flowering and podding). Three days after the first application of chemical pesticide, bio-pesticide is sprayed as the second application so that the use of more than one pesticide does not have detrimental effect rather it has a combined results in managing the insect pests. Insecticides were sprayed three times in different stages (e.g., vegetative, flowering and podding). Cautions were taken to avoid any drift of the spray mixture to the adjacent plots at the time of the spray.

Data collection

Data were collected from incidence of flea beetle and leaf folder at different growth stages of the crop. Numbers of flea beetle and leaf folder were recorded at vegetative, flowering and podding stage. Data on flea beetle and leaf folder population were collected before and after 1 day of the treatment application from each unit plot. 10 randomly selected plants from the two middle rows of each plot were monitored individually by visual observation. The number of flea beetle and leaf folder were recorded at early in the morning (6.30 a.m.-9.00 a.m.) when the insects were relatively less active. The selected area 1.0 m^2 (1.0 m x 1.0 m) in the center of each unit plot was kept undisturbed to record yield data. Grain yields were expressed in kg ha^{-1}.

Statistical analysis

The collected data were statistically analyzed through the analysis of variance using WASP 1.0 Package. The population data were converted to square root ($\sqrt{x}$ + 0.5) values when some of the values are under 10 and especially when there are zero values in the data the transformation ($\sqrt{x}$ + 0.5) is recommended instead of ($\sqrt{x}$). Means were separated by critical difference (CD) values at 5% level of significance.

Calculating of marginal benefit cost ratio (MBCR):

The marginal benefit cost ratio (MBCR) for each treatment combination was calculated based on market price of mungbean, cost of insecticide and spraying. MBCR for each treatment was calculated by using the following formula:

$$\text{MBCR} = \frac{\text{Benefit over control}}{\text{Cost of treatment}}$$

Results and Discussion

Efficacy of insecticidal treatment combinations on the incidence of flea beetle

The insecticidal treatment combinations showed significant effect on the population of flea beetle (Table 1). After 1 day of spray application, the lowest number of flea beetle was observed in TC_4 treated plots followed by TC_2. In contrast, the highest number of flea beetle was found in control treatment which was significantly higher than all other treated plots. The similar trend was observed in all the growth stages (vegetative, flowering and podding). The results revealed that all the insecticidal treatment combinations significantly reduced the population of flea beetle infesting mungbean. At different growth stages, the highest percent reduction of flea beetle was found in TC_4 and the lowest was in TC_0 (Table 1). However TC_4 was the most effective insecticidal combination against flea beetle followed by TC_2 whereas TC_1 was found less effective against flea beetle infesting mungbean in the field condition. The experiment was observed to obtain a suitable insecticidal treatment combinations option against flea beetle and leaf folder of mungbean. The result of the study was partially similar with the findings of Hossain (2015) who reported that spraying of Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) at the concentration of 0.5 ml L^{-1} water also showed the best efficacy in reducing flea beetle infestation. Yadav *et al.* (2012) observed that Cyantraniliprole 100D, Thiamethoxam 25WG and Spinosad 45SC reduced the highest damage by flea beetle on grapes. Srinivasan *et al.* (2019) also assessed that the combination product (Spinetoram 10% w/w + Sulfoxaflor 30% w/w WG) were superior and effective in reducing the flea beetle damage on grapevine.

Efficacy of insecticidal treatment combinations on the incidence of leaf folder

The insecticidal treatment combinations have shown a significant effect on the population of leaf folder (Table 2). The lowest number of leaf folder was observed in TC_3 treated plots followed by TC_4. In contrast, the highest number of leaf folder was found in control treatment which was significantly higher than all the other treated plots. The similar trend was observed in all the growth stages (vegetative, flowering and podding). The results revealed that all the insecticidal treatment combinations had significantly reduced the population of leaf folder infesting mungbean. At different growth stages, the highest percent reduction of flea beetle was found in TC_3 and the lowest was in TC_0 (Table 2). However TC_3 was the most effective insecticidal combination against leaf folder followed by TC_4 whereas TC_2 was less effective against leaf folder infesting mungbean in the field condition. The result of the study was partially similar with the findings of Khuhro *et al.* (2014) who reported that insecticidal spraying of Tracer reduced the population of leaf folder on rice crop. Bhatnagar (2004) also reported that the combination of Cartap and Tricyclazole was the most effective in reduction of damage by rice leaf folder resulted the highest grain yield.

Yield and Marginal benefit cost ratio (MBCR)

Insecticidal treatment had a significant impact on the yield of mungbean. The highest yield (1589.63 kg ha^{-1}) was recorded in TC_4 applied plot followed by TC_2 (1208.80 kg ha^{-1}) and TC_3 (1189.70 kg ha^{-1}). On the other hand, the lowest yield was recorded 825.00 kg ha^{-1} in TC_0 treatment on mungbean (Table 3). The net return and marginal benefit cost ratio (MBCR) varied depending on cost of treatment combinations. TC_0 did not require any pest management cost. For insecticidal treatment combinations, cost of pesticides was involved. Thus the maximum (1.60) marginal benefit cost ratio (MBCR) was calculated from the combination TC_4 followed by TC_2 (1.56) and TC_3 (0.22). The minimum MBCR (0.21) was calculated from TC_1 (Table 3). The present findings are in accordance to the results found by Hossain (2015) who reported that the highest yield and maximum net return was obtained from Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) at the concentration of 0.5 ml L^{-1} water. Similarly, the result of the study was partially similar with the report of Islam and Bari (2014) who reported that the highest yield (1895 kg ha^{-1}) and the highest marginal benefit cost ratio (1.75) was obtained from Spinosad 45SC sprayed plot on chickpea.

Table 1. Efficacy of insecticidal treatment combinations on the incidence of flea beetle population at different growth stages of mungbean.

Insecticidal treatment combinations	Vegetative stage			Flowering stage			Podding stage		
	Number of flea beetle/plot		Reduction of flea beetle population (%)	Number of flea beetle/plot		Reduction of flea beetle population (%)	Number of flea beetle/plot		Reduction of flea beetle population (%)
	Before spray	After 1 day of spray		Before spray	After 1 day of spray		Before spray	After 1 day of spray	
TC_1	2.96 b	1.56 b	47.30	2.74ab	1.49 b	45.62	3.18 ab	1.82 b	42.77
TC_2	2.92 b	1.40 bc	52.05	2.52 b	1.31 bc	48.02	2.92 b	1.50 bc	48.63
TC_3	2.73 b	1.49 b	45.42	2.42 b	1.40 bc	42.15	2.95 b	1.73 bc	41.36
TC_4	2.73 b	1.22 c	55.31	2.24 b	1.09 c	51.34	2.73 b	1.27 c	53.48
TC_0	3.35 a	2.50 a	25.37	3.12 a	2.49 a	20.19	3.63 a	2.85 a	21.49
CV (%)	6.78	9.23	-	12.85	14.93	-	10.35	16.32	-
CD (0.05)	0.31	0.23	-	0.52	0.36	-	0.49	0.46	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. CD means critical difference which justifies the significant difference between treatments in comparing the individual treatments with the help of the critical difference,

TC_1 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water,

TC_2 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water,

TC_3 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Tracer 45SC (Spinosad @ 0.3 ml L^{-1} of water,

TC_4 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Tracer 45SC (Spinosad) @ 0.3 ml L^{-1} of water,

TC_0 = Untreated control (water spray) @ 500 L ha^{-1}.

Table 2. Efficacy of insecticidal treatment combinations on the incidence of leaf folder population at different growth stages of mungbean.

Insecticidal treatment combinations	Vegetative stage			Flowering stage			Podding stage		
	Number of leaf folder/plot		Reduction of leaf folder population (%)	Number of leaf folder/plot		Reduction of leaf folder population (%)	Number of leaf folder/plot		Reduction of leaf folder population (%)
	Before spray	After 1 day of spray		Before spray	After 1 day of spray		Before spray	After 1 day of spray	
TC_1	1.98 b	1.36 bc	31.13	2.60 b	1.65 bc	36.54	2.24 bc	1.31 b	41.52
TC_2	1.99 b	1.56 b	21.61	2.69 ab	1.73 b	35.69	2.29 b	1.40 b	38.86
TC_3	1.79 b	1.09 c	39.11	2.50 ab	1.18 d	52.80	2.00 d	0.97 c	51.50
TC_4	1.86 b	1.22 bc	34.41	2.29 c	1.40 cd	38.86	2.12 cd	1.09 bc	48.58
TC_0	2.44 a	2.29 a	6.15	2.92 a	2.45 a	16.10	2.55 a	1.98 a	22.35
CV (%)	13.41	16.95	-	6.39	12.18	-	4.90	15.09	-
CD (0.05)	0.42	0.39	-	0.26	0.32	-	0.17	0.31	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. CD means critical difference which justifies the significant difference between treatments in comparing the individual treatments with the help of the critical difference,

TC_1 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water,

TC_2 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water,

TC_3 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Tracer 45SC (Spinosad @ 0.3 ml L^{-1} of water,

TC_4 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Tracer 45SC (Spinosad) @ 0.3 ml L^{-1} of water,

TC_0 = Untreated control (water spray) @ 500 L ha^{-1}.

Table 3. Efficacy of insecticidal treatment combinations on leaf area damaged and Cost-benefit analysis of mungbean production.

Insecticidal treatment combinations	Yield (kg ha^{-1})	Increase yield over control (kg ha^{-1})	Additional return over control (Tk. ha^{-1})	Cost of insecticide application (Tk. ha^{-1})	Net return (Tk. ha^{-1})	Marginal benefit cost ratio (MBCR)
TC_1	1011.93 c	186.93	11215.80	9300.00	1915.80	0.21
TC_2	1208.80 b	383.80	23028.00	9000.00	14028.00	1.56
TC_3	1189.70 b	364.70	21882.00	17956.50	3925.50	0.22
TC_4	1589.63 a	764.63	45877.80	17656.50	28221.30	1.60
TC_0	825.00 d	-	-	-	-	-
CV (%)	2.39	-	-	-	-	-
CD (0.05)	43.03	-	-	-	-	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. CD means critical difference which justifies the significant difference between treatments in comparing the individual treatments with the help of the critical difference,

TC_1 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water,

TC_2 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Bioneem plus 1EC (Azadirachtin) @ 1.0 ml L^{-1} of water,

TC_3 = Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 1.0 ml L^{-1} of water + Tracer 45SC (Spinosad @ 0.3 ml L^{-1} of water,

TC_4 = Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) @ 0.5 ml L^{-1} of water + Tracer 45SC (Spinosad) @ 0.3 ml L^{-1} of water,

TC_0 = Untreated control (water spray) @ 500 L ha^{-1}.

For calculating marginal benefit cost ratio, the following prices were used: Bioneem plus 1EC @ Tk. 280/100 ml; Tracer 45SC @ Tk. 200/7 ml; Nitro 505EC @ Tk. 90/50 ml; Voliam flexi 300SC @ Tk. 320/100 ml; Market price of mungbean seed @ Tk. 60/kg; Labor cost @ Tk. 400/man day.

Conclusion

The application of TC_4 [Voliam flexi 300SC (Thiamethoxam + Chlorantraniliprole) + Tracer 45SC (Spinosad)] was the most effective combination in reducing the population of flea beetle while TC_3 [Nitro 505EC (Chlorpyrifos + Cypermethrin) + Tracer 45SC (Spinosad)] for the reduction of leaf folder. These treatments were superior and effective in controlling the flea beetle and leaf folder on mungbean. These results indicated that insecticidal treatment combinations were much more effective in case of reducing the population of insect pests of mungbean and increasing yield which also contributed the marginal benefit cost ratio. The above mentioned treatment combinations could be used by the growers and researchers for the management of flea beetle and leaf folder, respectively.

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