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Assessment of insecticidal treatment combinations in mungbean against thrips and pod borer complex

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Abstract

The experiment was conducted at the farmers' field of Itbaria of Patuakhali sadar upazila under Patuakhali district, Bangladesh during late rabi season in 2018 to find out the suitable insecticidal treatment combinations against thrips and pod borers of mungbean by various treatment combinations, including chemicals, botanicals and biological. Experiment was laid out in a randomized complete block design with five insecticidal treatment combinations and all the combinations were replicated four times. The mungbean variety, BARI Mung-6 was grown in the field and four insecticidal treatment combinations were viz., T_1 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Azadirachtin (Bioneem plus 1EC)], T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)], T_3 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Spinosad (Tracer 45SC)], T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] and T_0 [Untreated control]. The treatments were applied at reproductive stages of plant. The treatments showed significantly different performance against thrips (*Megalurothrips distalis*), gram pod borer (*Helicoverpa armigera)* and legume pod borer (*Maruca vitrata)* on mungbean. The lowest population of thrips, gram pod borer and legume pod borer was found in T_4 treated plot which showed maximum percent reduction of insect pests. The percent pod infestation by pod borers was found lowest in the T_4 treatment. The maximum yield (1589.63 kg/ha) and the highest marginal benefit cost ratio (MBCR) (1.60) were also obtained from T_4. It can be concluded that T_4 was more effective among the insecticidal treatment combinations for controlling thrips and pod borer complex of mungbean which was followed by T_2.

Introduction

Pulses are the most common item in the daily diet of the people of Bangladesh. Pulses are two to three times richer in protein than cereal grains and have remained the least expensive source of protein for people since the dawn of civilization (Kay, 1979). Undoubtedly, they have been considered as poor man's meat for the underprivileged people who cannot afford animal protein (Ali and Gupta, 2012). Mungbean (*Vigna radiata* L. Wilczek) is one of the most important pulse crops of Bangladesh. It contains 24% protein, 3.2% minerals and 59.6% carbohydrate. It also contains 154 mg calcium, 9.1 mg iron and 38 mg β-carotine per 100g of split daul (Nene, 2006). Its ability to fix atmospheric nitrogen (58-109 kg/ha) in symbiotic association with *Rhizobium* bacteria, which not only enables it to meet its own nitrogen requirement but also benefits the succeeding cereal crops in various cropping systems (Ali, 1992 cited by Pratap *et al.,* 2013). It contributes only about 11.53% of the total pulse production in Bangladesh and ranks fifth among the pulse crops (BARC, 2013). Some of the constraints limiting mungbean production include absence of improved varieties, low yield potential of the crop, lack of research and extension focus, attacking of insect pests, low domestic market and inconsistency of the crop's performance.

Insect pests are considered as the most important ones. The reasons of this low yield are numerous but yield losses due to insect pest complex are distinct one. More than twelve species of insect pests are found to infest mungbean in Bangladesh (Anonymous, 1998), among them stem fly (Lal, 1985; Rahman, 1987), aphid and whitefly (Rahman *et al.,* 1981), thrips (Rahman *et al.,* 1981; Hossain *et al.,* 2004), jassid (Baldev *et al.,* 1988; Hossain *et al.,* 2009), hairy caterpillar (Rahman *et al.,* 1981) and pod borers (Rahman *et al.,* 1981, Hossain *et al.,* 2004) are considered major ones. Both nymph and adults of thrips (*Megalurothrips distalis* Karny) nourish

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on pollen and scratch flower parts by sucking the plant sap causing flower drop resulted in less pod formation. Severe infestation of thrips resulted flower shedding causing significant yield loss (Lal, 1985). Heavy infestation of pod borer attacks at flowering and pod filling stage. Pod borer damages flowers, flower buds and developing or mature pods (Poehlman, 1991; Hossain, 2014.). In the field, gram pod borer (*Helicoverpa armigera)* and legume pod borer (*Maruca vitrata)* is considered to be major insect pests in Bangladesh. The larvae bore into the young pods, remain there and feed on the seeds inside.

Farmers generally use different synthetic chemicals against different insect pests. Though many options are available for the management of these insect pests, farmers in Bangladesh mostly use synthetic chemicals because of their quick knock down effect with or without knowing the bad effects of these chemicals. Information regarding insecticidal management practices of insect pests in mungbean is not very available. However, recent development of high yielding and short duration varieties and increased market value of mungbean, farmers become interested on the cultivation of mungbean following pest management measures. But instead of individual use of any single management tool, integrated approach bears a lot of advantages for managing any pest. Integrated approach is a systematic plan which combines different pest control tactics into one program and suppressing pest populations below the economic injury level (EIL). Keeping all these constraints in view, the present study was carried out to find out the suitable treatment combination(s) of different types of insecticides against thrips and pod borers of mungbean.

Materials and Methods

Land preparation and seed sowing

The land was prepared at 'joe' condition by deep ploughing and cross-ploughing four times by power tiller followed by laddering until the desired tilth. All the weeds, residues and stubbles of the previous crops were removed from the field and the large clods were broken into smaller pieces to obtain a desirable tilth of soil for sowing of mungbean seeds. Then the individual plots (4.0 m x 2.5 m) were prepared. BARI Mung-6 was used as experimental material and seeds were sown @ 30 kg/ha (BARI, 2011) in the rows maintaining a spacing (30 cm x 10 cm) for better growth and development of the plants. Seed sowing was done at a depth of 6-7 cm and the seeds were covered by loose soil with the help of hand.

Fertilizer dose and intercultural operations

The fertilizers were applied as per fertilizers recommendation guide (BARI, 2011). Urea, TSP and

MoP were applied in the field uniformly @ 50-85-35 kg/ha, respectively during the final land preparation. The fertilizers were then mixed properly with the soil by spading and individual unit experimental plots were levelled. All intercultural operations were done as and when necessary to ensure normal growth and development of crops.

Preparation of the insecticidal treatment combinations

The experiment comprised four treatment combinations of various insecticides including an untreated control. The treatment combinations of the experiment were assigned as follows: (1) T_1 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Azadirachtin (Bioneem plus 1EC) @ 1 ml/L of water; (2) T_2 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Azadirachtin (Bioneem plus 1EC) @ 1 ml/L of water; (3) T_3 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water; (4) T_4 =Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water; (5) T_0 = Untreated control (water spray @ 500 l/ha).

Procedure of spray application

The spray solutions at the pre-fixed concentration of the respective treatment combinations were prepared in Knapsack sprayer by mixing with water as required just before spraying. The spray solutions were sprayed in the assigned plots as per the package design. The first insecticide was sprayed afterwards the second insecticide was sprayed at three days interval as per package design. The spraying was always done in the afternoon to avoid bright sunlight. The spray was done uniformly to obtain complete coverage of whole plants of the assigned plots. Caution was taken to avoid any drift of the spray mixture to the adjacent plots at the time of the spray.

Data collection

The data were recorded from incidence of thrips, gram pod borer and legume pod borer during different growth stages of the crop. Number of thrips, gram pod borer and legume pod borer was recorded at flowering stage and podding stage. The data on the population of thrips, gram pod borer and legume pod borer were collected before and after 1 day of spraying of second insecticide of the treatment combination from each unit plot. Thrips population was assessed from 10 open flowers which were randomly collected from two rows of each side of the plot avoiding border and central four rows. The collected flowers were immediately opened on the white paper and counted the thrips. To find out the incidence total pod borers were collected from all the plants of each plot (plot size: 10.0 m^2). The selected 1m^2 (1m x 1m) area of the center of each unit plot was kept undisturbed for recording yield data. Grains were recorded from 1 m^2 area per plot wise and the yield was expressed in kg/ha.

Calculating of % pod infestation

For collecting data on the percentage of pod borer infested pods, the number of infested pods and the total number of pods from randomly selected 10 plants from each unit plot were counted at ripening stage and recorded. The following formula was used for taking the infestation percentage.

$$\% \text{ Pod infestation} = \frac{\text{Total number of infested pods}}{\text{Total number of pods}} \times 100$$

Calculating of marginal benefit cost ratio (MBCR)

The marginal benefit cost ratio (MBCR) for each treatment combination was calculated on the basis of market price of mungbean, cost of insecticide and spraying. MBCR was measured by using the following formula described by Elias and Karim (1984).

$$\text{Marginal benefit cost ratio (MBCR)} = \frac{\text{Adjusted net return}}{\text{Total management cost}}$$

Statistical analysis

The collected data were statistically analyzed through the analysis of variance using Web Agri Stat Package (WASP 1.0). The population data were transformed to square root (√x + 0.5) values. Means were separated by critical difference (CD) values at 5% level of significance.

Results and Discussion

Efficacy of insecticidal treatment

The insecticidal treatment combinations also showed significant influence on the incidence of thrips (Table 1). The lowest number of thrips (1.41/10 open flowers at flowering and 1.35/plot at podding stage) was observed in T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] treated plot followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)] treated plot having significant difference between them. The highest number of thrips (2.35/10 open flowers at flowering and 2.45/plot at podding stage) was found in T_0 [Untreated control] plot which was significantly higher than all other combination treated plots. Similarly T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] showed the best performance in reduction of thrips population over control followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)] whereas T_1 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Azadirachtin (Bioneem plus 1EC)] was less effective against thrips infesting mungbean in field condition (Table 1).

The results found in this study could not be compared with any other findings since these combinations were different from the other researchers. In a field study to obtain a suitable insecticidal treatment combinations option against thrips of mungbean,the result of the study was partially similar with the findings of Kansagara *et al.* (2018)who reported that insecticidal spraying of Spinosad 45SC @ 0.0135% was found most effective for the control of thrips on mungbean.In case of spraying of Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) at the concentration of 0.5 ml/L water, the scientific information against thrips of mungbean is not available.

Reduction of thrips population over control

The highest reduction (40.00%) of thrips over control was in T_4 followed by T_2 (36.60%), T_3 (32.34%) and T_1 (25.11%) at flowering stage. Thus the order of insecticidal treatment combinations in reducing thrips infestation on mungbean was $T_4 > T_2 > T_3 > T_1$ (Fig. 1). At podding stage the highest reduction (44.90%) in number of thrips over control was in T_4 followed by T_2 (43.67%), T_3 (36.33%) and T_1 (31.43%). Thus the order of insecticidal treatment combinations in reducing thrips infestation on mungbean was $T_4 > T_2 > T_3 > T_1$ (Fig. 2).

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

Insecticidal treatment combinations	Flowering stage			Podding stage		
	No. of thrips/10 open flowers		Reduction of thrips population (%)	No. of thrips/10 open flowers		Reduction of thrips population (%)
	Before spray	After 1 day of spray		Before spray	After 1 day of spray	
T_1	3.17 b	1.76 b	44.48	2.84 d	1.68 b	40.85
T_2	3.20 b	1.49 d	53.44	3.12 b	1.38 c	55.77
T_3	3.05 c	1.59 c	47.87	2.93 cd	1.56 b	46.76
T_4	3.10 bc	1.41 e	54.52	3.07 bc	1.35 c	56.03
T_0	3.46 a	2.35 a	32.08	3.32 a	2.45 a	26.20
CV (%)	2.42	2.78	-	3.89	6.25	-
CD (0.05)	0.11	0.07	-	0.18	0.16	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. The data were transformed to square root ($\sqrt{x}$ + 0.5) values; T_1 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_2 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_3 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_4 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_0 = Untreated control (water spray) @ 500 l/ha.

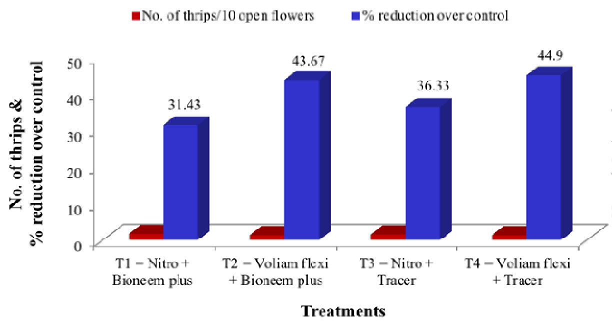

Fig. 1. Population of thrips/10 open flowers after 1 day of spraying of 2nd insecticide and % reduction over control

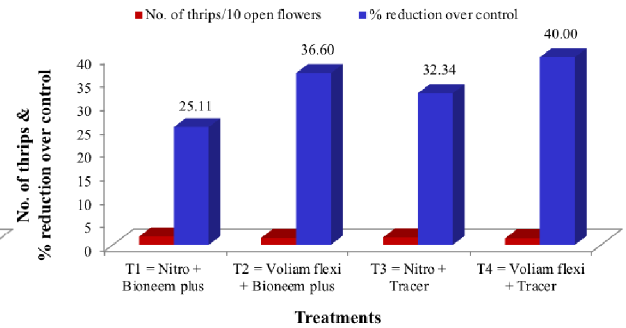

Fig. 2. Population of thrips/10 open flowers after 1 day of spraying of 2nd insecticide and % reduction over control under insecticidal treatment combinations at podding stage

Efficacy of insecticidal treatment combinations on the incidence of pod borers' population

The insecticidal treatment combinations at different growth stages (flowering stage and podding stage) showed significant influence on the incidence of gram pod borer (Table 2) and legume pod borer (Table 3). The lowest number of gram pod borer (*H. armigera*) and legume pod borer (*M. vitrata*)(1.09/plot and 1.06/plot at flowering and 0.97/plot and 1.09/plot at podding stage, respectively) was observed in T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] treated plot followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)] treated plot having significant difference between them. Other combinations had intermediate level of gram pod borer (*H. armigera*) and legume pod borer (*M. vitrata*). However, the highest number of gram pod borer (*H. armigera*) and legume pod borer (*M. vitrata*)(2.32/plot and 2.05/plot at flowering and 1.92/plot and 2.29/plot at podding stage, respectively) was found in T_0 [Untreated control] plot which was significantly higher than all other combination treated plots. Similarly T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] showed the best performance in reduction of gram pod borer (*H. armigera*) and legume pod borer (*M. vitrata*) both population over control followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)] whereas T_1 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Azadirachtin (Bioneem plus 1EC)] was less effective against gram pod borer (*H. armigera*) and legume pod borer (*M. vitrata*) infesting mungbean in field condition. The results found in this study could not be compared with any other findings since these combinations were different from the other researchers. In a field study to obtain a suitable insecticidal treatment combinations option against pod borers of mungbean, the result of the study was partially similar with the findings of Hossain (2014) evaluated that spraying of Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) at the concentration of 0.5 ml/L water also showed the best performance in reducing pod borers infestation to other tested practices. Likewise, Sarkar *et al.* (2015) reported that spraying of Spinosad (Success 2.5SC) application appeared as the best performance in controlling population of pod borers on mungbean.

Table 2. Efficacy of insecticidal treatment combinations on the incidence of gram pod borer population at different growth stages

Insecticidal treatment combinations	Flowering stage: No. of gram pod borer (*H. armigera*) / plot (10m^2) – Before spray	Flowering stage: No. of gram pod borer (*H. armigera*) / plot (10m^2) – After 1 day of spraying of 2nd insecticide	Flowering stage: Reduction of gram pod borer (*H. armigera*) population (%)	Podding stage: No. of gram pod borer (*H. armigera*) / plot (10m^2) – Before spray	Podding stage: No. of gram pod borer (*H. armigera*) / plot (10m^2) – After 1 day of spraying of 2nd insecticide	Podding stage: Reduction of gram pod borer (*H. armigera*) population (%)
T_1	2.34 b	1.47 b	37.18	2.32 b	1.49 ab	35.77
T_2	2.34 b	1.31 b	44.02	2.12 bc	1.35 bc	36.32
T_3	2.83 a	1.40 b	50.53	2.24 b	1.40 abc	37.50
T_4	2.82 a	1.09 b	61.35	1.87 c	0.97 c	48.13
T_0	3.15 a	2.32 a	26.35	2.96 a	1.92 a	35.14
CV (%)	8.047	19.349	-	7.284	23.792	-
CD (0.05)	0.335	0.453	-	0.258	0.533	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. The data were transformed to square root ($\sqrt{x+0.5}$) values; T_1 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_2 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_3 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_4 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_0 = Untreated control (water spray) @ 500 l/ha.

Table 3. Efficacy of insecticidal treatment combinations on the incidence of legume pod borer population

Insecticidal treatment combinations	Flowering stage			Podding stage		
	No. of legume pod borer (*M. vitrata*) / plot (10m^2)		Reduction of legume pod borer (*M. vitrata*) population (%)	No. of legume pod borer (*M. vitrata*) / plot (10m^2)		Reduction of legume pod borer (*M. vitrata*) population (%)
	Before spray	After 1 day of spraying of 2nd insecticide		Before spray	After 1 day of spraying of 2nd insecticide	
T_1	2.28 b	1.49 b	34.65	2.34 b	1.56 b	33.33
T_2	2.12 b	1.31 bc	38.21	2.29 b	1.47 bc	35.81
T_3	2.33 b	1.40 bc	39.91	2.49 b	1.54 b	38.15
T_4	2.22 b	1.06 c	52.25	2.39 b	1.09 c	54.39
T_0	2.96 a	2.05 a	30.74	3.04 a	2.29 a	24.67
CV (%)	7.90	18.43	-	8.13	17.54	-
CD (0.05)	0.29	0.42	-	0.32	0.43	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. The data were transformed to square root ($\sqrt{x}$ + 0.5) values; T_1 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_2 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_3 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_4 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_0 = Untreated control (water spray) @ 500 l/ha.

Reduction of pod borers' population over control

The highest reduction (53.02%) of gram pod borer over control was in T_4 followed by T_2 (43.53%), T_3 (39.66%) and T_1 (36.64%) at flowering stage. Thus the order of insecticidal treatment combinations in reducing gram pod borer infestation on mungbean was $T_4 > T_2 > T_3 > T_1$ (Fig. 3). The highest reduction (49.48%) of gram pod borer over control was in T_4 followed by T_2 (29.69%), T_3 (27.08%) and T_1 (14.58%) at podding stage. Thus the order of insecticidal treatment combinations in reducing gram pod borer infestation on mungbean was $T_4 > T_2 > T_3 > T_1$ (Fig. 4).

The highest reduction (48.29%) in number of legume pod borer over control was in T_4 followed by T_2 (36.01%), T_3 (31.71%) and T_1 (27.32%) at flowering stage. Thus the order of insecticidal treatment combinations in reducing legume pod borer infestation on mungbean was $T_4 > T_2 > T_3 > T_1$ (Fig. 5). The highest reduction (52.40%) in number of legume pod borer over control was in T_4 followed by T_2 (35.81%), T3 (32.75%) and T_1 (31.88%) at podding stage. Thus the order of insecticidaltreatment combinations in reducing legume pod borer infestation on mungbean was $T_4 > T_2 > T_3 > T_1$ (Fig. 6).

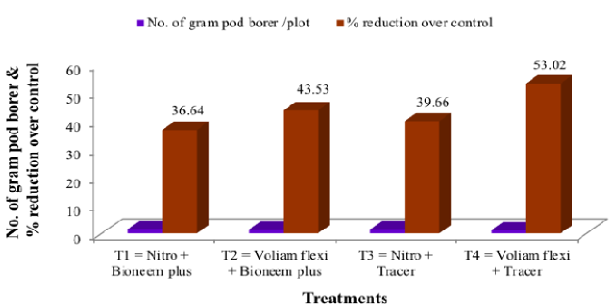

Fig. 3. Population of gram pod borer/plot after 1 day of spraying of 2nd insecticide and % reduction over control under insecticidal treatment combinations at flowering stage

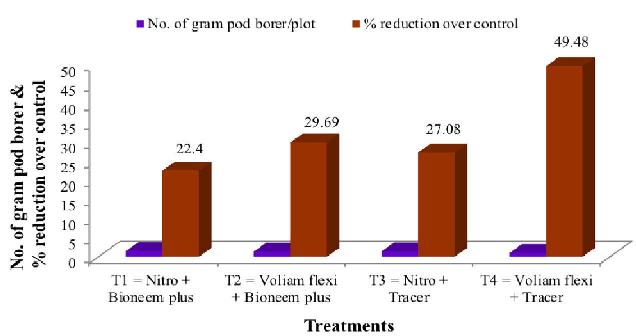

Fig. 4. Population of gram pod borer/plot after 1 day of spraying of 2nd insecticide and % reduction over control under insecticidal treatment combinations at podding stage

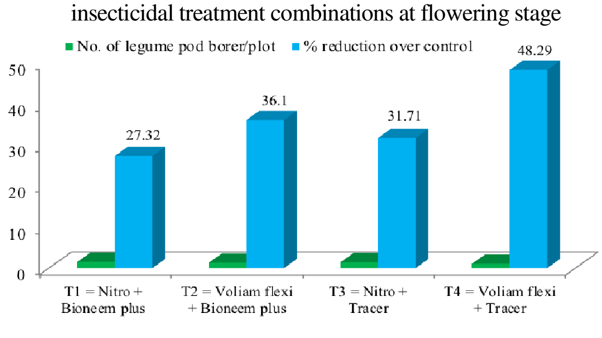

Fig. 5. Population of legume pod borer/plot after 1 day of spraying of 2nd insecticide and % reduction over control under insecticidal treatment combinations at flowering stage

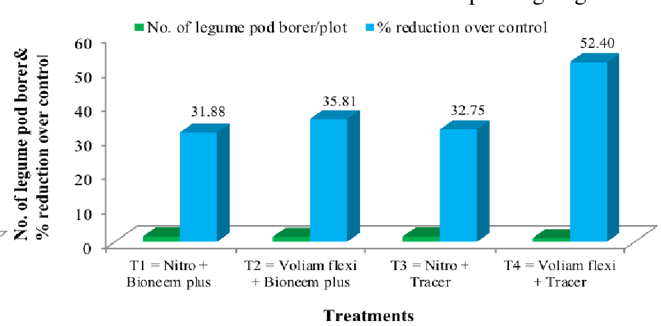

Fig. 6. Population of legume pod borer/plot after 1 day of spraying of 2nd insecticide and % reduction over control under insecticidal treatment combinations at podding stage

Pod infestation by pod borers at ripening stage

All the insecticidal treatment combinations showed significantly lower percent pod damage than untreated control. The percentage of infested pods ranged from 2.39 to 13.47% (Table 4). The lowest infestation was observed in T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] (2.39%) followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin(Bioneem plus 1EC)] (4.86%). However, the highest infestation of pods was 13.47% in T_0 [Untreated control] followed by T_1 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Azadirachtin(Bioneem plus 1EC)] (8.16%).The results found in this study could not be compared with any other findings since these combinations were different from the other researchers. The above findings are partially comparable with the result of Hossain (2015) who reported that Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) treated plots had significantly the lowest pod infestation. Likewise, Islam and Bari (2014) reported that Spinosad 45SC revealed the best performance reducing pod damage on chickpea.

Table 4. Efficacy of insecticidal treatment combinations on pod infestation by pod borers and Cost-benefit analysis of mungbean production

Insecticidal treatment combinations	Pod infestation by pod borer complex (%)	Cost of management (Tk.)	Yield (ton/ha)	Gross return (Tk.)	Net return (Tk.)	Adjusted net return (Tk.)	Marginal benefit cost ratio (MBCR)
T_1	8.16 b	9300.00	1.01	60715.80	51415.80	1915.80	0.21
T_2	4.86 c	9000.00	1.3	72528.00	63528.00	14028.00	1.56
T_3	6.29 bc	17956.50	1.19	71382.00	53425.50	3925.50	0.22
T_4	2.39 d	17656.50	1.59	95377.80	77721.30	28221.30	1.60
T_0	13.47 a	-	0.83	49500.00	49500.00	-	-
CV (%)	20.28	-	-	-	-	-	-
CD (0.05)	2.20	-	-	-	-	-	-

In a column means having dissimilar letter(s) differ significantly as per 0.05 level of probability. CV = Coefficient of Variation, CD = Critical Difference; T_1 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_2 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Azadirachtin(Bioneem plus 1EC) @ 1 ml/L of water;
T_3 = Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_4 = Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) @ 0.5 ml/L of water + Spinosad (Tracer 45SC) @ 0.3 ml/L of water;
T_0 = Untreated control (water spray) @ 500 l/ha; 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 and Voliam flexi 300SC @ Tk. 320/100 ml. Market price of mungbean seed @ Tk. 60/kg. Labor cost @ Tk. 400/man day.

Yield and marginal benefit cost ratio (MBCR)

Yield was significantly affected by the application of insecticidal treatment combinations. The highest yield (1589.63 kg/ha) was recorded in T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] applied plot where the maximum reduction of thrips and pod borers population was found followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)] (1208.80 kg/ha) and T_3 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Spinosad (Tracer 45SC)] (1189.70 kg/ha). On the other hand, the lowest yield was recorded 825.00 kg/ha in T_0 [Untreated control] plot because less reduction of thrips and pod borers was recorded on mungbean field (Table 4).

Cost-benefit analysis of insecticidal treatment combinations applied against thrips and pod borers on mungbean. The net return and Marginal Benefit Cost Ratio (MBCR) varied depending on cost of treatment combinations. The T_0 [Untreated control] did not require any pest management cost. For insecticidal treatment combinations, cost of pesticides was involved. Thus, the highest (1.60) Marginal Benefit Cost Ratio (MBCR) was calculated from the combination T_4 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Spinosad (Tracer 45SC)] followed by T_2 [Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) + Azadirachtin (Bioneem plus 1EC)] (1.56) and T_3 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Spinosad (Tracer 45SC)] (0.22). The minimum MBCR (0.21) was calculated from T_1 [Chlorpyrifos + Cypermethrin (Nitro 505EC) + Azadirachtin (Bioneem plus 1EC)] (Table 4). The results found in this study could not be compared with any other findings since these combinations were different from the other researchers. The above findings are partially comparable with the result of Hossain (2015) who reported that the highest yield and the highest net return was obtained from Thiamethoxam + Chlorantraniliprole (Voliam flexi 300SC) at the concentration of 0.5 ml/L water, yet the scientific information is not available. Likewise, 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) and the highest marginal benefit cost ratio (1.75) was obtained from Spinosad 45SC sprayed ploton chickpea.

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