Jahangirnagar University J. Biol. Sci. **11**(1 & 2): 81-91, 2022 (June & December)

Integrated management of flea beetle and thrips on mungbean in coastal habitat

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Abstract

An experiment was conducted to evaluate the effectiveness of five IPM packages in controlling flea beetles and thrips on mungbeans. The results showed that the lowest number of flea beetles (1.67/plot), the highest reduction in flea beetle population the over control (72.17%), the lowest leaf area damaged (3.33%) and the lowest percent reduction in damaged leaf area versus control (72.99%) was recorded from plots treated with Package 2 (Virtako 80WG @ 0.15 g/L water + white sticky trap). The lowest number of thrips populations (1.00/20flowers), the highest reduction in thrips population versus control(85.0%), the lowest number of damaged flowers (2.33/plant), and the highest reduction in infested flowers over control (79.44%)observed in plots treated with Package 1 (Bioneem plus 1% EC at the rate of 1 ml/L water + white sticky trap). There was a negative correlation between the numbers of flea beetles and thrips with total yield. A negative relationship was observed between flea beetle leaf area infestation and total yield, and between thrips flower infestation and total yield from different IPM packages. This study concluded that IPM package 2 was the most effective package for controlling flea beetles and IPM package 1 was good enough for controlling thrips in mungbeans.

Key words: Mungbean, flea beetle, thrips, IPM packages, total yield.

INTRODUCTION

Mungbean (*Vigna radiate* L. Wilczek) belongs to the family Legume family and is one of the most promising legumes in Bangladesh. It plays an important role as a source of low-protein grain-based diet for the people of Bangladesh. In addition, it has the ability to fix atmospheric nitrogen (58-109 kg/ha) in symbiotic association with Rhizobium bacteria, which not only covers its own needs, but also promotes subsequent cereal crops in various cultivation systems, thus enriching soil fertility (Anjum *et al*., 2006; Pratap *et al*., 2013). However, there are many limitations to its low yield, insect pests are considered important (Islam *et al*., 2021).

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Mungbean crops are susceptible to various types of insect pests that attack mungbeans at every stage from seedling to harvest, but budding is the most preferred stage to attract insects (Lal *et al.*, 1981). There are 64 species of insects (Lal, 1985) that infest mungbean crops during the sowing, vegetative and flowering stages while pod worms damage flower buds, flowers and pods of mungbeans (Rahman, 1991). Including aphids, caterpillars, pod borers (*Helicovevrpa armigera*) and whitefly (Rahman *et al*., 1981), thrips (*Megalurothrips distalis* Karny) (Rahman *et al.*, 1981; Hossain *et al*., 2004), stemfly (Rahman, 1987) are considered the most important in Bangladesh. Flea beetles feed on the cotyledons, making the severe myriad round holes on the leaves of young plants and eventually drying out the older damaged leaves. The damaged leaves dry up and plant growth is rendered with few pods (Hossain, 2015). Both nymphs and adults of thrips (*M. distalis* Karny) feed on pollen and scratch flower parts by sucking the sap, which causes flower dropping resulting in less pod formation.

Heavy infestation with thrips led to flower dropout, resulting significant yield losses (Lal, 1985). Several studies have been conducted to control insect pests by chemical insecticides and listed mungbean pests (Litsinger *et al.*, 1988; Singh & Singh, 1977). For example, Ahmad *et. al*. (1998) showed that 0.03% dimethoate or 0.04% monocrotophos effectively reduced the insect pest complex of mungbeans when applied 45 and 60 days after sowing. Using of synthetic insecticides as the only control method leads to environmental pollution, danger to humans, animals, wild life and beneficial insects. An integrated management approach offers benefits for managing each pest rather than using a single control approach. An integrated approach is a systematic action that combines more than one pest control tactic into a pest populations suppression program to keep pest densities below economic damage levels. Therefore, the present experiment was conducted to determine the appropriate integrated management approach against flea beetles and mungbean thrips.

MATERIALS AND METHODS

The field experiment was conducted at Sonakhali farmer’s field, Barguna Sadar to evaluate the effectiveness of five IPM packages to control flea beetle and thrips on mungbean from January to April 2018. The area lies between latitudes 22°10' and 22°21' north and longitudes between 90°21' and 90°38' east. It borders the Bay of Bengal. Geographically, the field was located at north latitude and east longitude at a altitude of 2.75 m above mean sea level. The soil of the trial field belongs to Ganges Tidal Floodplain Agroecological Zone (Iftekhar & Islam, 2004). The soils of the test area were non-calcareous and non-saline, from silty to heavy clay in texture and slightly acidic (dry season) in reaction (pH 5.5-6.7 at Bargunasadar). Soil fertility status is generally poor with a low organic matter content. The major area (80%) is medium high land (SRDI, 1997). The land was prepared in ‘Joe’ conditions (soil favourable for sowing seed) by deep ploughing and cross-ploughing three times followed by laddering with a power tiller until desired tilth was achieved for sowing mungbean seeds in the last week of January, 2016.

All weeds, residues and stubbles from previous crops were removed from the field. The fertilizers were applied according to the Fertilizers Recommendation Guide (BARI, 2011). The sources of N, P_2O_5 and K_2O were applied as DAP @ 50 kg/ha, triple superphosphate (TSP) @ 85 kg/ha and muriate of potash (MOP) @ 35 kg/ha, respectively. The total amount of urea, the total amounts of TSP and MOP were each evenly applied to the field during the final land preparation, respectively. The fertilizers were then properly mixed with the soil by spading and individual trial plots were leveled. The experiment was designed in a randomized complete block design (RCBD) with three replications (Gomez & Gomez, 1984). The entire field was divided into 4 unit blocks represented replications and each unit block was divided into 6 sub unit plots. The total number of plots was 24 and the size of the individual plot was 4.0 m x 3.0 m. The distance between two unit plots was 0.75m and between block to block was 1m. BARI Mung- 6 was used as the study material. All seeds were subjected to a germination test before sowing. In all cases, the germination rate was more than 90%. Seeds were sown on January 31, 2018 at a rate of 20 kg/ha. The seeds were continuously placed in the line at a depth of 4-5 cm and covered with loose soil land. The distance between the rows 15 cm and between the plants 10 cm.

Integrated management approaches: Package 1- Azadirachtin (Bioneem plus 1% EC) @ 1ml/L water & White sticky trap, Package 2 - Virtako 40 WG @ 0.15g/L water &white sticky trap, Package 3 - sex pheromone trap &white sticky trap, Package 4 – Chlorphyrifos + Cypermethrin (Nitro 505 EC) @ 1ml/L water & white sticky trap, Package 5 - Bioneem plus 1% EC @ 1ml/L water &sex pheromone trap and control.

Procedure of spray application: Insecticides were procured from Biotech division, Ispahaniagro Ltd. and local market. The spray solutions having the pre-determined concentration of the respective treatments were prepared in a knapsack sprayer by mixing with water as needed immediately before afternoon spraying. The spray solutions produced in this way were sprayed in the assigned plots according to the treatment concept. Spraying was always done in the afternoon to avoid bright sunlight. The sprays were applied evenly to obtain complete coverage of whole plants in the assigned plots. Care was taken to ensure no spray mixture drifted into the adjacent plots at the time of spraying.

Intercultural operations: Intercultural operations were done as needed to ensure normal plant growth and development. The detail cross-cultural operations were as follows:

Irrigation and drainage: Irrigation was used as needed. If moisture is needed, water should be added to the experimental plots. A proper drainage system was also developed to drain out excess water.

Thinning: Because the seeds were continually sown into the line, there were so many seedlings, that needed to be thinned out. Seedling emergence was completed within 10 days after sowing (DAS). Crowded seedlings were thinned twice to maintain a plant to plant spacing of 10 cm. The first thinning was done after 15 days of sowing to remove unhealthy and out of row seedlings. The second thinning was done 10 days after the first thinning.

Weeding: Some common weeds were found in the mungbean field. First weeding was done at 30 DAS and then once a week to keep the plots free of weeds and to keep the soil loose and aerated throughout the period of plant growth.

Data Collection: Tenday's intervals and data at different growth stages were collected and recorded by direct counting in the early afternoon (4.0-6.0 pm). Plants per square meter (1m× 1m) plants were randomly selected from each plot. In flea beetles, different parameters were measured at 36 DAS. For thrips, 20 flowers were randomly collected and opened on white paper and the thrips were counted in two stages such as 50% flowering phase and pod initiation phase, respectively.

Flea beetle population and infestation: Damage caused by flea beetles was recorded by visual eye from infested and healthy leaves/plant as per square meter plants of each plot. Data on the number of insects were recorded at an interval of 12 days from the first appearance. Flea beetle data were collected once (36 DAS) from the vegetative stage.

Percentage of damaged leaves area/plant by flea beetle: The leaf area of 5 representative leaves from randomly selected 5 plants of each unit plot was recorded on a leaf area meter (Model LI-3100C) and the mean leaf area was calculated. The percentage of leaf area/plant damaged by flea beetle was determined by visual estimation. Infestation of mungbean leaf areas/plants was recorded at different times of plant growth (at different DAS). The total leaf area damage was counted and the percentage of leaf area damage was calculated from the selected and marked plant of each plot. This includes 3 healthy leaves and 2 infested leaves. The mean of this was recorded for each plot and expressed in cm^2. The percentage of damaged leaf area was calculated using the following formula:

Percentage of damaged leaves area = $\frac{B}{A} \times 100$

Where,
A= Total leaves area checked
B= Damaged leaves area

$$\text{Percentage of damage leaves} = \frac{\text{Damage leaves area per plant}}{\text{Total leaves area checked per plant}} \times 100$$

Number of thrips on infested flower: For information, the data on the number of thrips from infested flowers were included. The thrips population was determined from 20 open flowers, randomly collected from two rows in each side of the plot, avoiding edge rows. 100% of the data was collected at the flowering stage. The flowers collected were immediately opened on the white paper and the thrips counted. The selected 1 m^2 area in the center of each plot was kept undisturbed for recording yield data.

Percentage of damaged flowers by mungbean thrips: Data on the percentage of flowers infested with thrips, the number of infested and total flowers from 10 randomly selected infested inflorescences from each m^2/plot were counted. Data was collected from 100% flowering stage.

$$\% \text{ flower infestation} = \frac{\text{Total number of infested flowers}}{\text{Total number of flowers}} \times 100$$

Harvesting: The pod maturity of mungbeans is not uniform as the plants flower over a longer period of time. This makes it difficult to decide when to harvest. In general, harvesting should begin when1/2 to 2/3 of the pods are ripe. In Rabi season, the pod should be picked after it has turned black. Mungbeans were harvested twice at 67-74 DAS. First, only mature pods were harvested at 67 DAS (April 8, 2018) when about 80% of the pods turned black. These pods were harvested at 74 DAS (second time on April 15, 2018) after ripening. The harvested crop of 1 m^2 area from each unit plot was bundled separately. Grains were recorded from 1 m^2 area per plot and yields were expressed in kilograms (kg) per hectare.

Statistical analysis: The data collected were analyzed statistically by analysis of variance (ANOVA) using software package WASP 1.0. Means were separated by CD values (critical difference) at a 5% level of significance.

RESULTS AND DISCUSSION

Effectiveness of different integrated approaches on the incidence and damage of flea beetle: The effect of integrated management approaches on flea beetle population and damaged leaf area are presented in Table 1. The number of flea beetles varied significantly ranging from 1.67 to 6.0/plot. The lowest mean number of flea beetles (1.67/plot) was observed in plots treated with Package 2, which was statistically similar to Package 5 (2.33/plot) (Table 1). The highest mean number of flea beetles was observed in untreated control plots (8.0/plot), which were statistically different from other treatments. Accordingly, the highest percentage of flea beetle population reduction (72.17%) versus control was found in plots treated with Package 2, followed by Package 5 (61.17%), Package 3 (55.50%), Package 1 (44.50%) and Package 4 (38.83%) (Table 1).

In case of leaf area damage, the percentage of leaf area damage varied significantly ranging from 3.33% to 12.33%. The least damaged leaf area (3.33%) was observed in plots treated with Package 2, which was statistically similar to Package 4 (3.677%) followed by Package 3 (4.67%), Package 5 (5.67%) and Package 1 (6.33%), while the highest mean leaf area damage (12.33%) was observed in untreated control plots. Accordingly, the highest percentage (72.99%) reduction in damaged leaf area over the control was found in Package 2, followed by Package 4 (70.23%), Package 3 (62.12%), Package 5 (54.01%) and Package 1 (48.66%) (Table 1).

Table 1. Effectiveness of different IPM packages on the incidence of flea beetle attacking mungbean

Management packages	Number of flea beetle/plot	Reduction of flea beetle population over control (%)	Leaf area damaged by flea beetle (%)	Reduction of leaf area damaged over control (%)
Package 1	3.33bc	44.50	6.33b	48.66
Package 2	1.67d	72.17	3.33e	72.99
Package 3	2.67bcd	55.50	4.67cd	62.12
Package 4	3.67b	38.83	3.67de	70.23
Package 5	2.33cd	61.17	5.67bc	54.01
Control	6.00a	-	12.33a	-
Level of significance	**	-	**	-
CV (%)	22.05	-	10.10	-

** Significant at 1 % level

Means within the same column followed by the same letter are not significantly different from each other by CD (critical difference) values. Values are the average of three replicates.

Effects of different integrated approaches on flower infestation and thrips population: The effects of integrated management approaches on flower infestation and thrips population are presented in Table 2. The number of flower infestation varied significantly depending on the potency of the IPM package ranging from 2.33 to 11.33/plant. The least flower damage (2.33/plant) was observed in plots treated with Package 1, followed by Package 2(3.0/plant), Package 3(4.0/plant), Package 4 (4.67/plant) and Package 5 (6.67/plant). The highest flower damage was observed in control plots (11.33/plant), which was statistically different from other treatments. The highest percentage of damaged flowers (72.99%) was found in plots treated with Package 2, followed by Package 4 (70.23%), Package 3 (62.12%), Package 5 (54.01%) and Package 1 (48.96%).

Among the thrips population, the number of thrips varied significantly ranging from 1.0 to 8.0. The lowest mean number of thrips populations (1.0/flower) was observed in Package 1 treated plots, followed by Package 2 (1.3/flower), Package 3 (1.67/flower), Package 4 (2.33/flower) and Package 5 (3.0/flower), while the highest thrips were observed in untreated control plots (7.0/flower), which were statistically different from other treatments. Accordingly, the highest percentage of thrips population reduction (85.0%) was found in Package 2 treated plots versus control, followed by Package 4 (81.42%), Package 3 (76.14%), Package 5 (66.71%) and Package 1 (57.14%) (Table 2).

Table 2. Effectiveness of different IPM packages on flower infestation and thrips population of mungbean

Management packages	No. of thrips infested flower/plant	Reduction of infested flower over control (%)	No. of thirps/ flower	Reduction of thrips over control (%)
Package 1	2.33 d	79.44	1.00 d	85.00
Package 2	3.00 cd	73.52	1.33 cd	81.42
Package 3	4.00 bcd	61.78	1.67 bcd	76.14
Package 4	4.67 bc	58.78	2.33 bc	66.71
Package 5	5.67 b	49.96	3.00 ab	57.14
Control	11.33 a	-	7.00 a	-
Level of significance	**	-	**	-
CV (%)	19.68	-	42.62	-

** Significant at 1 % level

Means within the same column followed by the same letter are not significantly different from each other by CD (critical difference) values. Values are the average of three replicates.

Relationship between flea beetle population and yield: Total yield affected by flea beetle infestation per square meter of plant. The result showed that there was a strong negative correlation between the number of flea beetles and the total yield. It indicated that the yield decreased progressively as the flea beetle increased. A linear regression was fitted between flea beetle frequency and total yield (Figure 1). The correlation coefficient (r) was 0.72 and the contribution from regression (R^2 = 0.5195, when Y = -73.77x + 1472.4) was 52.0%.

Fig. 1. Relationship between flea beetle population and yield of mungbean

Relationship between thrips population and yield: Total yield was moderately affected by the presence of thrips per plant. The result showed that there was a negative correlation between the number of thrips and the total yield. It indicated that yield progressively decreased as thrips increased. A linear regression was fitted between thrips abundance and total yield (Figure 2). The correlation coefficient (r) was 0.29 and the contribution from regression (R^2 = 0.0849, when Y= -24.095x + 1314.9) was 8.5%.

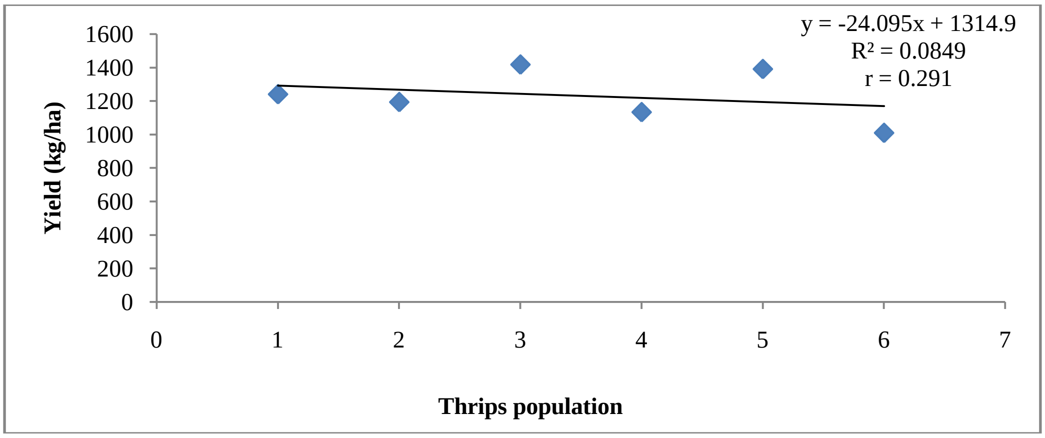
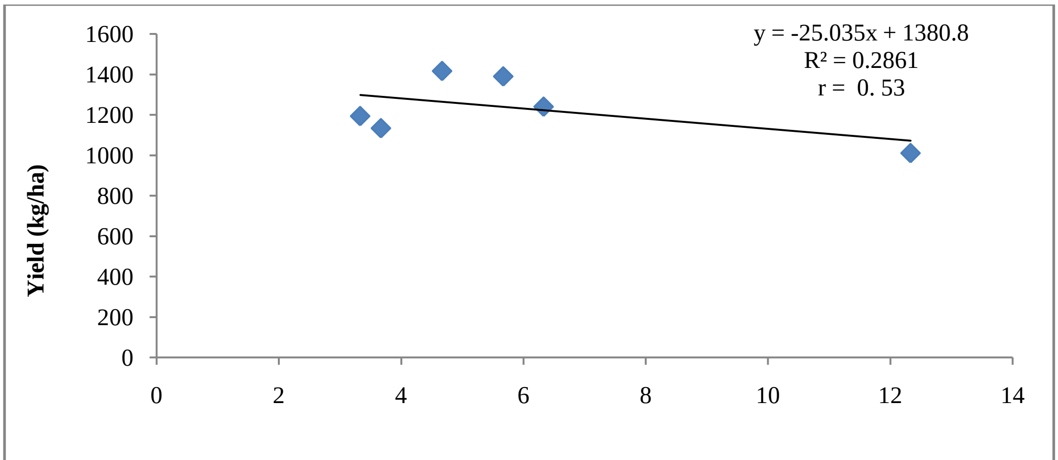


Fig. 2. Relationship between thrips incidence and yield of mungbean obtained from different treatments

Relationship between leaf area infestation and yield: A negative relationship was observed between percentage leaf area infestation and total yield for different treatments, suggesting that with infestation there was a progressive decline in yield with increasing percentage leaf area infestation. A linear regression was fitted between percentage leaf area infestation and total yield (Figure 3). The correlation coefficient (r) was 0.53 and the contribution from regression (R^2 = 0.2861; when Y = - 25.035x + 1380.8) was 28.61%.



Leaf area infestation

Fig. 3. Relationship between flea beetle infestation and yield of mungbean

Relationship between flower infestation and yield: A negative relationship between flower infestation and total yield was observed for several cultivars, suggesting that with there has been a progressive decline in yield as thrips flower infestation increased. A linear regression was fitted between flower infestation and total yield (Figure 4). The correlation coefficient (r) was 0.556 and the contribution from regression (R^2 = 0.3089, when Y = - 26.509x + 1367.5) was 30.89%.

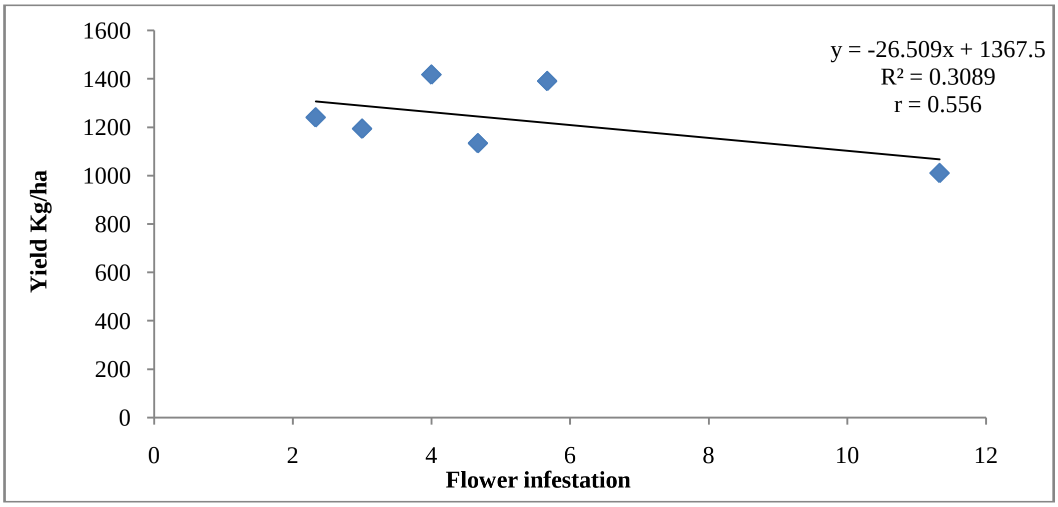


Fig. 4. Relationship between flower infestation and yield of mungbean obtained

From different IPM packages: The lowest number of flea beetle (1.67/plot), the lowest percent leaf area damaged (3.33%), the highest percentage of flea beetle population (72.17%) and leaf area damaged (72.99%) reduction over control were found in IPM Package 2 treated plots. The lowest number of thrips populations (1.0/20-flowers), damaged flowers (2.33/ plant), the highest percentage of thrips populations (85.0%) and damaged flowers (72.99%) reduction over control were found in plots treated with Package 1 and 2.

Flea beetles cause significant loss at various stages of the crops up to harvest, damaging leaves that wither and hamper plant growth with minimal pods. This result is supported by (Echezona *et al*., 2010). The incidence and development of the flea beetle is highly dependent on the prevailing weather conditions, which consistent with Khan *et al.* (2018). The results of the present study showed that the adults feed on the cotyledons and leaves of young plants, which make numerous round holes, which was also confirmed by Hossain *et al.* (2012) and Prodhan *et al.* (2008). The lowest numbers of thrips and thrips infested flowers were found in applied plot of Package 1, consistent with the results of Islam *et al*. (2020).

Conclusion: Integrated management package 2 was the best package for flea beetle management and IPM package 1 was good for thrips control in mungbeans.

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