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COMPARISON OF IPM PACKAGES ON FLOWER THRIPS AND POD BORERS MANAGEMENT OF MUNGBEAN WITH RECOMMENDED PRACTICE

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ABSTRACT. Effectiveness of integrated management approaches using blue sticky trap, pheromone trap, bio and synthetic insecticides were evaluated against major insects, like flower thrips and pod borers of mungbean at Regional Agricultural Research Station, Rahmatpur, Barishal and Pulses Research Centre, Ishurdi, Pabna, Bangladesh, respectively, during two consecutive years of 2018 and 2019. All of the management packages significantly reduced flower infestation, thrips population and pod borer infestation in mungbean. The highest percentage of reduction of flower infestation, thrips population and pod borer infestation was found in IPM package-3: installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l + third spraying with (chlorantraniliprole + thiamethoxam), *i.e.* Virtako 40 WG) @ 0.15 g/l, followed by IPM package-1, IPM package-2 and recommended practice (spraying imidacloprid, *i.e.* Imitaf 20 SL @ 0.5 ml/l). The highest yield was also recorded from IPM package-3, which was statistically similar to IPM package-1, followed by IPM package-2 and recommended practice. Although the IPM package-3 provided the highest yield and return, followed by IPM package-1, but recommended practice (farmer's practice) gave the highest benefit because of higher cost of IPM components brought down the profit margin of IPM packages. The components of IPM package-1, *i.e.* biopesticides, are ecologically safer than that of IPM package-3 (synthetic chemical insecticides). So, considering environment friendliness, the IPM package-1: installation of blue sticky trap and pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l would be the best package for controlling flower thrips and pod borers of mungbean with higher yield in the insects prone areas, without harming the ecosystem.

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Keywords: integrated management; environment; yield; return; cost, benefit.

INTRODUCTION

Mungbean (*Vigna radiata* L.) is one of the important pulse crops in Bangladesh. It is grown mainly in the late rabi season in southern regions of Barishal division, after harvesting of Aman rice and in Kharif-I season, after harvesting of rabi crops in north-western, mid-western and south-western regions of Bangladesh. Due to availability of short duration varieties, farmers are becoming more interested to cultivate this valuable pulse crop. But due to the attack of insect pests, especially in the flowering and podding stage, cause significant yield loss. More than twelve species of insect pests were found to infest mungbean in Bangladesh (Rahman *et al*. 2000). Among them, flower thrips (*Megalurothrips distalis* Karny, *Megalurothrips usitatus* Bagnall and *Caliothrips indicus)* are associated mostly with the damage of tender buds and flowers of mungbean. Severe damage of thrips resulted flower shedding causing significant yield loss (Chhabra and Kooner, 1985; Lal, 1985). Pod borers (*Maruca virtata*, *Helicoverpa armigera and Euchrysops* spp) are another insect pests causing significant yield reduction. Pod borer damaged flowers, flower buds and developing or maturing pods (Poehlman, 1991). Pod borers are often cause serious problem resulting severe loss of the crop (Bakr, 1998).

Farmers usually do not take any measure to control the insect pests, due to its low profit margin. However, recent development of high yielding varieties and increased market prices of mungbean, farmers demanded for pest control measures. Normally, mungbean growers are using toxic insecticides to control insect pests without looking other management options, because of easy availability and effectiveness of insecticides. As insecticide is not environment safe, cause health hazard, create pest resistance and destroys of natural enemies. Therefore, it is urgent to find out the alternate management options for controlling the major insect pests of mungbean, which will be environmentally safe and sustainable. Keeping this in view, attempts have been made to developing safe and effective integrated management package using blue sticky trap, pheromone trap and bio and synthetic insecticides.

MATERIALS AND METHODS

The experiment was conducted in two locations, one at Regional Agricultural Research Station, Rahmatpur, Barishal, during late rabi 2018 and 2019, and other at Pulses Research Centre, Ishurdi, Pabna, Bangladesh, during Kharif-I, 2018 and 2019. Installing blue sticky trap and pheromone trap and application of bio and synthetic insecticides considered as treatments of the experiment, which were: T_1 = IPM Package-1: installing blue sticky trap and pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l, for flower thrips + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l for flower and pod borer insects, T_2 = IPM Package-2: installing blue sticky trap and pheromone trap + three spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l for flower thrips and borer pests, T_3 = IPM package-3: installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l, for flower thrips + third spraying with chlorantraniliprole (20%) + thiamethoxam (20%) (Virtako 40 WG) @ 0.15 g/l, for flower and pod borer insects, T_4= Recommended practice: three spraying of imidacloprid (Imitaf 20 SL) @ 0.5 ml/l of water, for flower thrips and pod borers and T_5= Untreated control (water spray only).

The experiment was laid out in randomized complete block design with three dispersed replications. The treatments were randomly allotted in each block. In Barishal, the seeds of BARI Mung-6 were sown on February 11, 2018, and January 29, 2019, and in Ishurdi, the seeds of BARI Mung-6 were sown on March 30, 2018, and March 28, 2019, in rows with the spacing of 30 cm. The unit plot size was 6 m × 4 m and. Urea, triple super phosphate, muriate of potash and boric acid were applied in the plots @ 40-90-40-7.5 kg/ha, during final land preparation. In Barishal, seeds were sown in 'zoo' condition (optimum soil moisture for germination), but in Ishurdi, post sowing flood irrigation was done to provide sufficient soil moisture for seed germination to get optimum plant population in all the treatments. The populations of the plant were maintained constant by keeping plant to plant distance of 7 cm.

Blue sticky trap and sex pheromone traps for *M. virtata* and *H. armigera* were installed (one trap/plot) at flower bud initiation stage and kept in the field up to harvest. Treatment-wise bio and synthetic insecticides were sprayed first at 100% flowering and second spray was done at peak flowering and podding stage and third spraying was done at seed developing stage.

The population data of flower thrips were collected before every spray application and after 24 hrs of each spraying. Thrips population was assessed from 20 opened flower randomly collected from two rows from each plot avoiding border and central four rows. The collected flowers were immediately opened on the white paper board and counted the adult and immature thrips present in the flowers. Central four rows were kept undisturbed for recording yield data. Numbers of pod borer moth caught in the pheromone traps were recorded at weekly intervals till harvest.

At maturity, all the pods were collected from 10 randomly selected plants from central four rows of each plot and examined. The infested (bored) and total numbers of pods were counted and the percent pod infestation was determined using the following formula:

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

The pods of central four rows of each plot were harvested. The pods were then threshed, grains were cleaned and dried in the bright sunshine. The grain yield was obtained from central four rows of each plot was converted into per hectare. The experimental data were analyzed by Statistix 10 software. The per cent infestation data were transformed by square root for statistical analysis. Mean comparisons for treatment parameters were compared using LSD All-Pairwise Comparisons Test at 5% level of significance.

The marginal benefit cost ratio (MBCR) was calculated on the basis of prevailing market prices of mungbean and cost of blue sticky trap, pheromone traps and insecticidal spraying. Marginal benefit cost ratio was calculated as follows:

$$\text{Marginal BCR (over control)} = \frac{\text{Marginal benefit over control}}{\text{Marginal cost over control}}$$

RESULTS AND DISCUSSION

Effect of IPM packages on flower infestation

The effect of integrated management approaches comprising installation of blue sticky traps, pheromone traps and application of bio and synthetic insecticides on flower infestation of mungbean are presented in *Table 1*. In both the location of Rahmatpur and Ishurdi, after 24 hrs of spraying all the IPM approaches significantly reduced flower infestation, compared to untreated control and also with recommended practice.

In Rahmatpur, during 2018, significantly the lowest number of thrips infested flower (1.00/ 20 flowers) and accordingly the highest reduction of flower infestation (90%) was observed in IPM package-3: (installing blue sticky trap + two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG) @ 0.15 g/l. The second lowest flower infestation (3.13/ 20 flowers) was found in IPM package-2 (installing blue sticky trap and pheromone trap + three spraying of Biomeem plus 1EC) @ 1 ml/l), which was at par with IPM package-1 (installing blue sticky trap and pheromone trap + two spraying of Biomeem plus 1EC @ 1 ml/l + third spraying with Success 2.5 EC @ 1.2 ml/l), followed by recommended practice, *i.e.* three spraying of imidacloprid (Imitaf 20 SL) @ 0.5 ml/l of water. The highest number flower infestation (10.13/ 20 flowers) was observed in untreated control plots. During 2019, the same trend of effect of IPM packages and recommended practice were observed in flower infestation and infestation reduction (*Table 1*).

In Ishurdi, during 2018, the lowest number of thrips infested flower (2.22/ 20 flowers) and, accordingly the highest reduction of flower infestation (85%), was observed in IPM package-3: (installing blue sticky trap + two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG @ 0.15 g/l), which was at par with IPM package-1, followed by IPM package-2 and recommended practice. The highest number flower infestation (14.55/ 20 flowers) was observed in untreated control. During 2019, the same trend of effect of IPM packages and recommended practice were seen in flower infestation and infestation reduction (*Table 1*).

Table 1 - Effect of different IPM packages on incidence of flower infestation in mungbean at RARS, Rahmatpur, Barishal and PRC, Ishurdi, Pabna during late rabi and Kharif-1, 2018 and 2019

Treatments	No. of thrips infested flowers / 20 open flowers				Reduction of flower infestation over control (%)			
	24 h after spray				24 h after spray			
	2018		2019		2018		2019	
	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi
IPM-1 (Blue Sticky T + Ph Trap + Bioneem +Success)	3.38 c	4.44 bc	3.88 c	4.83 cd	67	72	65	70
IPM -2 (Blue Sticky T + Ph Trap + Bioneem)	3.13 c	5.22 b	3.50 c	8.33 b	69	68	69	48
IPM-3 (Blue Sticky T +Intrepid +Virtako)	1.00 d	2.22 c	1.63 d	3.17 d	90	85	85	80
Recommen-ded practice (Imitaf spraying)	5.75 b	6.56 b	6.38 b	7.67 bc	43	56	43	53
Untreated control	10.13 a	14.55 a	11.13 a	16.17 a	-	-	-	-

Note: All means followed by same letters at each column were not significantly different by LSD All-Pairwise Comparisons Test at 5% level of significance.

IPM Packag- 1: installing blue sticky trap & pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l,
IPM Package-2: installing blue sticky trap and pheromone trap + three spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l,
IPM package-3: installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l + third spraying with chlorantraniliprole (20%) + thiamethoxam (20%) (Virtako 40 WG) @ 0.15 g/l**,**
Recommended practice: three spraying of imidachloprid (Imitaf 20 SL) @ 0.5 ml/l of water at flowering, podding and seed developing stage, **Untreated control** = Water spray only (500 L/ha).

Effect of IPM packages on thrips population in flowers

Thrips population varied significantly depending on the efficacy of the treatments (*Table 2*). In Rahmatpur, during 2018, the lowest thrips population (0.88/ 20 flowers) and, accordingly the highest percentage of population reduction (92%), was found in IPM package-3. The second lowest thrips population was observed in IPM package-2, which was par with IPM package-1, followed by recommended practice. The highest thrips population (11.13/ 20 flowers) was found in untreated control plots. During 2019, the same trend of thrips population was found in different IPM packages and recommended practice (*Table 2*).

In Ishurdi, during 2018, the lowest thrips population (3.33/ 20 flowers) and, accordingly the highest percentage of population reduction (87%), was found in IPM package-3, which was statistically similar to IPM package-1, followed by IPM package-2 and recommended practice. The highest thrips population (28.78/ 20 flowers) was found in untreated control plots. During 2019, the same trend of thrips population was found in different IPM packages and recommended practice (*Table 2*).

Table 2 - Effect of different IPM packages on incidence of thrips population in mungbean at RARS, Rahmatpur, Barishal and PRC, Ishurdi, Pabna during late rabi and Kharif-1, 2018 and 2019

Treatments	No. of thrips/20 open flowers				Reduction of thrips population over control (%)			
	24 h after spray				24 h after spray			
	2018		2019		2018		2019	
	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi
IPM-1 (Blue Sticky T + Ph Trap + Bioneem +Success)	3.50 c	7.33 bc	3.75 c	7.50 c	69	73	68	77
IPM -2 (Blue Sticky T + Ph Trap + Bioneem)	3.63 c	9.44 b	4.38 c	17.67 b	67	69	62	45
IPM-3 (Blue Sticky T + Intrepid + Virtako)	0.88 d	3.33 c	1.38 d	5.83 c	92	87	88	82
Recommen-ded practice (Imitaf spraying)	5.75 b	10.33 b	6.13 b	14.67 b	48	63	47	54
Untreated control	11.13 a	28.78 a	11.63 a	32.17 a	-	-	-	-

Note: All means followed by same letters at each column were not significantly different by LSD All-Pairwise Comparisons Test at 5% level of significance.

IPM Packag- 1: installing blue sticky trap and pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l,
IPM Package-2: installing blue sticky trap and pheromone trap + three spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l,
IPM package-3: installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l + third spraying with chlorantraniliprole (20%) + thiamethoxam (20%) (Virtako 40 WG) @ 0.15 g/l**,**
Recommended practice: three spraying of imidachloprid (Imitaf 20 SL) @ 0.5 ml/l of at flowering, podding and seed developing stage, **Untreated control** = Water spray only (500 L/ha).

These findings of flower infestation and thrips population suppression in mungbean flowers were agreed with the findings of Rahman (2019), who reported the best effect of IPM package consisting installation of blue sticky trap and two spraying of chlorfenapyr (Intrepid 10 EC), at flowering stage. Bhede *et al.* (2008) reported the best effect of imidacloprid for control of chilli thrips. Hossain *et al.* (2011), Hossain (2014) and Hossain *et al.* (2015) also found the excellent results of imidacloprid to reduce flower infestation and suppression of thrips population in mungbean flowers. Cermeli *et al*. (2002) observed the high efficacy (86% reduction over control) of imidacloprid in controlling thrips infestation in field bean. Rahman (2004) found the significant effect of botanicals, like azadiractin (neem oil), in reducing flower thrips population in mungbean.

Effect of IPM package on pod borer infestation

Pod borer infestation varied depending on the efficacy of the treatments (*Table 3*). In Rahmatpur, during 2018, pod borer infestation ranged from 4.12 to 27.27%. Significantly the lowest pod borer infestation (4.12%) and accordingly the highest pod infestation reduction (85%) was observed in IPM package-3 (installing blue sticky trap + two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG @ 0.15 g/l, which was statistically similar to IPM package-1 (installing blue sticky trap and pheromone trap + two spraying of Biomeem plus 1EC @ 1 ml/l + third spraying with Success 2.5 EC @ 1.2 ml/l), followed by IPM package-2 and recommended practice (three spraying of Imitaf 20 SL @ 0.5 ml/l). The highest pod infestation (27.27%) was found in untreated control plots. During 2019, pod borer infestation ranged from 12.31 to 47.43% and the same trend of pod borer infestation received by different IPM packages and recommended practice (*Table 3*).

In Ishurdi, during 2018, pod borer infestation ranged from 4.64 to 16.24%. Significantly the lowest pod borer infestation (4.64%) and, accordingly the highest pod infestation reduction (71%), was observed in IPM package-3 (installing blue sticky trap + two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG) @ 0.15 g/l. The second lowest pod infestation (6.47%) was observed IPM package-1, which was statistically identical to IPM package-2 and recommended practice. The highest pod infestation (16.24%) was found in untreated control. During 2019, pod borer infestation ranged from 4.33 to 15.83% and the same trend of pod borer infestation was observed in different IPM packages and recommended practice (*Table 3*). The integrated and cumulative effect of IPM components reduced more flower thrips and pod borer infestation in IPM plots as against the recommended practice (farmers practice).

These findings of pod borer management agreed with the findings of Rouf and Islam (2012) and Hossain (2015), who found the best efficacy of chlorantraniliprole + thiamethoxam (Voliam flexi 300 SC) in controlling pod borers of mungbean. Rahman (2019) reported the excellent effect of IPM package consisting installation of blue sticky trap and two spraying of azadiractin (Bioneem plus 1 EC) and third spraying with spinosad (Success 2.5 EC) at poding stage for controlling pod borers of mungbean. Hossain *et al.* (2011) also found the very good results of imidacloprid for controlling pod borers in mungbean. Rahman (2004) also reported the significant effect of botanicals like neem for reducing pod borer infestation in mungbean.

Table 3 - Effect of different IPM packages on pod borer's infestation in mungbean at RARS, Rahmatpur, Barishal and PRC, Ishurdi, Pabna during late rabi and Kharif-1, 2018 and 2019

Treatments	Pod infestation by pod borer (%)				Pod infestation reduction over control (%)			
	2018		2019		2018		2019	
	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi
IPM-1 (Blue Sticky T + Ph Trap + Bioneem + Success)	6.19 c	6.47 b	16.19 c	6.50 c	76	60	66	59
IPM -2 (Blue Sticky T + Ph Trap + Bioneem)	11.46 b	8.05 b	25.66 b	10.00 b	57	50	45	37
IPM-3 (Blue Sticky T + Intrepid + Virtako)	4.12 c	4.64 c	12.31 c	4.33 d	85	71	73	73
Recommen-ded practice (Imitaf spraying)	11.79 b	8.49 b	23.38 b	8.33 c	53	43	50	47
Untreated control	27.27 a	16.24 a	47.43 a	15.83 a	-	-	-	-

Note: All means followed by same letters at each column were not significantly different by LSD All-Pairwise Comparisons Test at 5% level of significance.

IPM Package-1: installing blue sticky trap and pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l,
IPM Package-2: installing blue sticky trap and pheromone trap + three spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l,
IPM package-3: installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l+ third spraying with chlorantraniliprole (20%) + thiamethoxam (20%) (Virtako 40 WG) @ 0.15 g/l**,** **Recommended practice:** three spraying of imidachloprid (Imitaf 20 SL) @ 0.5 ml/l of water at flowering, podding and seed developing stage, **Untreated control** = Water spray only (500 L/ha)

Pod borer moth catching in the pheromone traps

Pod borers moth of both *M. virtata* and *H. armigera* were caught in the pheromone traps of both the package of IPM package-1 and IPM package-2. During 2018, in Rahmatpur, moth starts captured in the trap from 20 March, when mungbean starts to flowering, and reached its peak between 10-17 April, when munbean were in peak flowering and podding stage and then, gradually, decreased and reached to zero at 1 May (*Figs. 1 and 2*). In Ishurdi, during 2018, moth catching started from 14 May when mungbean starts to flowering and reached its peak at 28 May, when munbean were in peak flowering and podding stage and then, gradually, decreased and reached to zero, at 18 June, in both the IPM package (*Figs. 3* and *4*).

During 2019 cropping season, in Rahmatpur, moth trapping started from 29 March and reached its peak at 19 April and then, gradually, decreased and reached to zero at 3 May (*Figs. 5 and 6*). But in Ishurdi, moth catching started from 9 May and reached its peak at 23 May and then, gradually, decreased and reached to zero, at 13 June (*Figs. 7 and 8*).

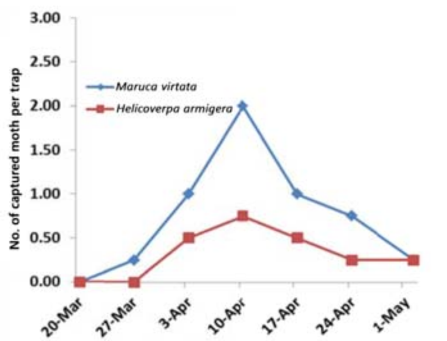

Figure 1 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 1 at RARS, Rahmatpur, Barishal during late rabi, 2018

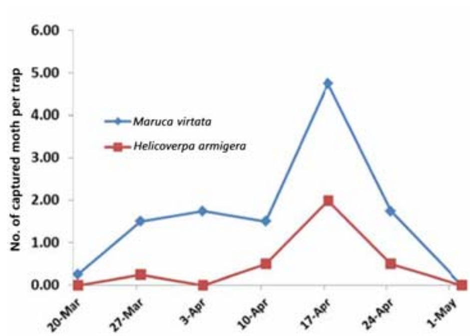

Figure 2 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 2 at RARS, Rahmatpur, Barishal during late rabi, 2018

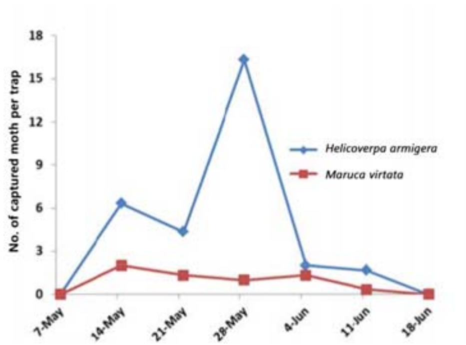

Figure 3 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 1 at PRC, Ishurdi during Kharif-I, 2018

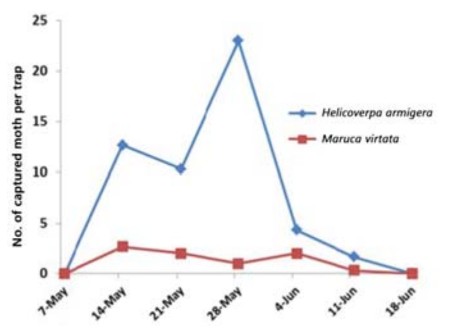

Figure 4 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 2 at PRC, Ishurdi during Kharif-I, 2018

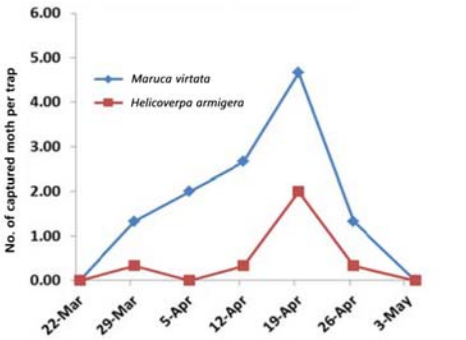

Figure 5 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 1 at RARS, Rahmatpur, Barishal during late rabi, 2019

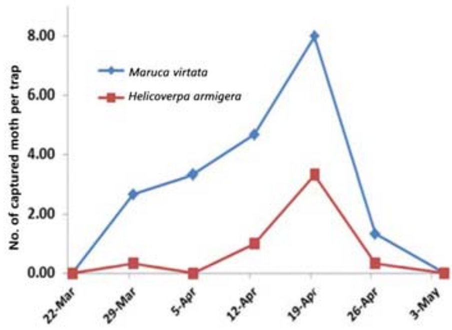

Figure 6 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 2 at RARS, Rahmatpur, Barishal during late rabi, 2019

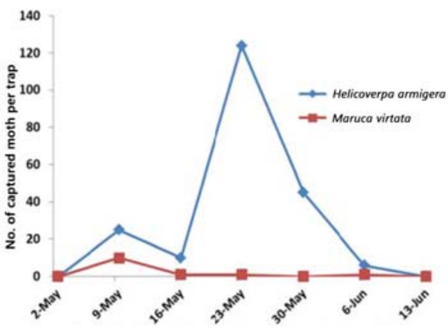

Figure 7 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 1 at PRC, Ishurdi during Kharif-I, 2019

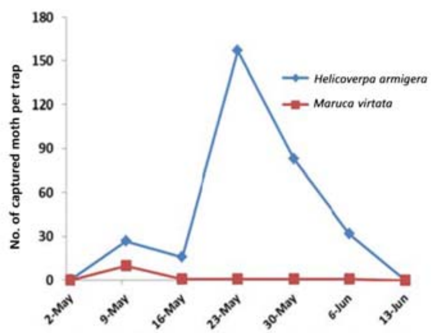

Figure 8 – Weekly catches of *Helicoverpa armigera* and *Maruca vitrata* in the pheromone traps of mungbean fields in IPM package 2 at PRC, Ishurdi during Kharif-I, 2019

It is seen that in Ishurdi location, *Helicoverpa* moth captured more than that of *Maruca* and the reverse was true in case of Rahmatpur location. This might be due in Ishurdi location the experiment was conducted at the Pulses Research Centre, Ishurdi. So, this is because of chickpea research in this farm, more *Helicoverpa* moth coming from the pupae of previous chickpea crop.

Effect of IPM packages on yield

Yield of mungbean varied significantly with the level of thrips and pod borer infestation, depending on the efficacy of different management packages (*Table 4*). In Rahmatpur, during 2018, yield increase over untreated control ranged from 23 to 62%. The highest yield (1342 kg/ha) was obtained from IPM package-3 (installing blue sticky trap

+ two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG @ 0.15 g/l, which was statistically identical to IPM package-1 (installing blue sticky trap and pheromone trap + two spraying of Biomeem plus 1EC @ 1 ml/l + third spraying with Success 2.5 EC @ 1.2 ml/l, followed by IPM package-2 and recommended practice (three spraying of Imitaf 20 SL @ 0.5 ml/l). The lowest yield (828 kg/ha) was recorded from untreated control plots. During 2019, yield increase over untreated control ranged from 27 to 44% and the yield trend was same as like as 2018 (*Table 4*).

Table 4 - Effect of different IPM packages on the yield of mungbean at RARS, Barishal & PRC, Ishurdi, Pabna during late rabi and Kharif-1, 2018 and 2019

Treatments	Yield (kg/ha)				Yield increased over control (%)			
	2018		2019		2018		2019	
	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi	Rahmatpur	Ishurdi
IPM-1 (Blue Sticky T + Ph Trap + Bioneem +Success)	1280 a	1048 ab	1132 a	1257 a	55	39	41	19
IPM-2 (Blue Sticky T + Ph Trap + Bioneem)	1195 b	966 bc	1053 b	1222 a	44	28	31	16
IPM-3 (Blue Sticky T + Intrepid + Virtako)	1342 a	1128 a	1160 a	1345 a	62	49	44	28
Recommen-ded practice (Imitaf spraying)	1019 c	912 c	1019 b	1280 a	23	21	27	21
Untreated control	828 d	756 d	804 c	1054 b	-	-	-	-

Note: All means followed by same letters at each column were not significantly different by LSD All-Pairwise Comparisons Test at 5% level of significance.

IPM Package-1: installing blue sticky trap and pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l, **IPM Package-2**: installing blue sticky trap and pheromone trap + three spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l, **IPM package-3:** installing blue sticky trap + two spraying of chlorfenapyr (Intrepid 10 EC) @ 1 ml/l + third spraying with chlorantraniliprole (20%) + thiamethoxam (20%) (Virtako 40 WG) @ 0.15 g/l**, Recommended practice:** three spraying of imidachloprid (Imitaf 20 SL) @ 0.5 ml/l of water at flowering, podding and seed developing stage, **Untreated control** = Water spray only (500 L/ha).

In Ishurdi, during 2018, yield increase over untreated control ranged from 21 to 49%. The highest yield (1128 kg/ha) was obtained from IPM package-3 (installing blue sticky trap + two spraying of Intrepid 10 EC) @ 1 ml/l + third spraying with Virtako 40 WG @ 0.15 g/l, which was statistically similar to IPM package-1 (installing blue sticky trap and pheromone trap + two spraying of Biomeem plus 1EC @ 1 ml/l + third spraying with Success 2.5 EC @ 1.2 ml/l), followed by IPM package-2 and recommended practice (three spraying of Imitaf 20 SL @ 0.5 ml/l). The lowest yield (828 kg/ha) was recorded from untreated control plots. During 2019, yield increase over untreated control ranged from 16 to 28%.

The highest yield was recorded from IPM package-3 (installing blue sticky trap + two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG @ 0.15 g/l, which was statistically similar to other IPM packages and recommended practices (*Table 4*).

Although, the grain yield was statistically identical, but IPM plots provided higher yield, compared to recommended practice (farmers practice)

Return and marginal benefit cost ratio (MBCR)

Return and benefit cost ratio are presented in *Tables 5* and *6*.

Table 5 - Cost and return analysis of IPM package and recommended practice for the management of flower thrips and pod borer of mungbean during late rabi and Kharif-1, 2018

Treatments	Yield (kg/ha)		Addl. yield over control (kg/ha)		Addl. retn over control (Tk/ha)		Cost of insecide appl. (Tk/ha)		Marginal benefit cost ratio	
	Rah	Isd	Rah	Isd	Rah	Isd	Rah	Isd	Rah	Isd
IPM-1 (BST + Ph + Bnem + Sucss)	1280	1048	452	292	31640	20440	17760	17760	1.78	1.15
IPM-2 (Blue Sticky T + Ph Trap + Bioneem)	1195	966	367	210	25690	14700	17400	17400	1.48	0.84
IPM-3 (Blue Sticky T + Intrepid + Virtako)	1342	1128	514	372	35980	26040	9550	9550	3.77	2.73
Recommended practice (Imitaf spraying)	1019	912	191	156	13370	10920	4125	4125	3.24	2.65
Untreated control	828	756	-	-	-	-	-	-	-	-

Addl. = Additional, appl. = application
For calculating income and benefit the following market prices were used: Mungbean = Tk. 70/kg, Blue sticky trap = Tk 50/trap (@80/ha), *Maruca* pheromone trap = Tk. 40/trap (@80/ha), *Helicoverpa* pheromone trap = Tk. 90/trap (@40/ha), Bioneem plus 1 EC = Tk. 280/100 ml, Success 2.5 EC = Tk. 90/25 ml, Intrepid 10 EC = Tk. 250/100 ml, Imitaf 20 SL = Tk. 230/100 ml. Labour wage for spraying insecticides = Tk. 400/day/labourer (8 h/day)

Table 6 - Cost and return analysis of IPM package and recommended practice for the management of flower thrips and pod borer of mungbean during late rabi and Kharif-1, 2019

Treatments	Yield (kg/ha)		Addl. yield over control (kg/ha)		Addl. retn over control (Tk/ha)		Cost of insecide appl. (Tk/ha)		Marginal benefit cost ratio	
	Rah	Isd	Rah	Isd	Rah	Isd	Rah	Isd	Rah	Isd
IPM-1 (BST + Ph + Bnem +Sucss)	1132	1257	328	203	22960	14210	17760	17760	1.29	0.80
IPM-2 (Blue Sticky T + Ph Trap + Bioneem)	1053	1222	249	168	17430	11760	17400	17400	1.00	0.68
IPM-3 (Blue Sticky T + Intrepid + Virtako)	1160	1345	356	291	24920	20370	9550	9550	2.40	2.13
Recommended practice (Imitaf spraying)	1019	1280	215	226	15050	15820	4125	4125	3.65	3.84
Untreated control	804	1054	-	-	-	-	-	-		-

Addl. = Additional, appl. = application
For calculating income and benefit the following market prices were used: Mungbean = Tk. 70/kg, Blue sticky trap = Tk 50/trap (@80/ha), *Maruca* pheromone trap = Tk. 40/trap (@80/ha), *Helicoverpa* pheromone trap = Tk. 90/trap (@40/ha), Bioneem plus 1 EC = Tk. 280/100 ml, Success 2.5 EC = Tk. 90/25 ml, Intrepid 10 EC = Tk. 250/100 ml, Imitaf 20 SL = Tk. 230/100 ml. Labour wage for spraying insecticides = Tk. 400/day/labourer (8 h/day).

In Rahmatpur, during 2018, the highest additional return (35980 Tk/ha) and accordingly the highest benefit (MBCR 3.77 come from IPM package-3, followed by recommended practice (MBCR 3.24). The IPM package-1 and IPM package-2 provided MBCR less than 2.

In Ishurdi, during 2018, the highest additional return (26040 Tk/ha) and accordingly the highest benefit (MBCR 2.73) come from IPM package-3, followed by recommended practice (MBCR 2.65).

The IPM package-1 and 2 provided MBCR 1.15 and 0.84, respectively. It is found that during 2018, the MBCR obtained from IPM package-3 and recommended practice, nearly similar in both the locations of Rahmatpur and Ishurdi.

During 2019, in Rahmatpur, the highest additional return (24920 Tk/ha) was calculated from IPM package-3, but the highest benefit (MBCR 3.65) come from recommended practice, followed by IPM package-3. The IPM package-1 and 2 provided MBCR little bit more than 1. In Ishurdi location, the highest additional return (20370 Tk/ha) was also calculated, but the highest benefit

(MBCR 3.84) also come from recommended practice, followed by IPM package-3. It is seen that during 2019 cropping season, in both the locations, the MBCR come from recommended practice were higher than that of IPM package 3 or others. This might be due to higher cost of IPM components brought down the profit margin and showed the lower MBCR than that of recommended practice (farmer's practice).

CONCLUSION

The two years consecutive studies on IPM module evaluated in mungbean, in comparison with the recommended practice (farmer's practice), confirm the worthiness of adoption of IPM module in terms of reduced flower thrips population, pod damage and enhanced return. The highest percentage of reduction of flower infestation, thrips population and pod borer infestation was found in the IPM package-3: installing blue sticky trap + two spraying of Intrepid 10 EC @ 1 ml/l + third spraying with Virtako 40 WG @ 0.15 g/l, followed by IPM packages-1, IPM packages-2 and recommended practice. The highest yield and accordingly additional return come from IPM package-3, followed by IPM package-1: installing blue sticky trap and pheromone trap + two spraying of Biomeem plus 1EC @ 1 ml/l + third spraying with Success 2.5 EC @ 1.2 ml/l. Overall the highest financial benefit (MBCR) obtained from recommended practice, followed by IPM package-3 and IPM package-1. This might be due to higher cost of IPM components brought down the profit margin and showed the lower MBCR of IPM package than that of recommended practice. Although IPM packages under this study are not financially profitable as recommended practice, but considering environment friendliness, the IPM package-1, *i.e.* installation of blue sticky trap and pheromone trap + two spraying of azadiractin (Biomeem plus 1EC) @ 1 ml/l + third spraying with spinosad (Success 2.5 EC) @ 1.2 ml/l would be the best package for controlling flower thrips and pod borers of mungbean, with higher yield in the insects prone cropping areas without harming the ecosystem.

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