International Journal of Bio-resource and Stress Management https://pphouse.org/ijbsm.php

Crossref

IJBSM April 2023, 14(4):581-589 Print ISSN 0976-3988 Online ISSN 0976-4038 Article AR3441

Research Article Natural Resource Management

DOI: HTTPS://DOI.ORG/10.23910/1.2023.3441

Evaluation of Different Integrated Management Strategies against Thrips (Thysanoptera: Thripidae) on Mung Bean

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ABSTRACT

The study was conducted in the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during April–June, 2021 to evaluate the effectiveness of integrated management approaches against thrips on mung bean. The treatments comprising seed treatment, blue sticky trap and bio-pesticides i.e. Tracer 45SC (Spinosad), Biotrin 0.5% AS, Ecomec 1.8EC or synthetic chemical insecticides i.e. Confidor 70 WG, Actara 25WG, Stargate 48SC, Novastar 56EC and an untreated control were evaluated against thrips. The efficacy of the integrated management packages differed significantly against the thrips species *Megalurothrips usitatus* and *Thrips palmi*. Among them, the integrated management approach comprising seed treatment+blue sticky trap+Stargate 48SC was the most effective and reduced the highest percent of total thrips population on top trifoliate leaves and terminal shoots (84.46% and 80.77%, respectively) at vegetative stage and on flower buds and flowers (81.26% and 80.54%, respectively) at reproductive stage of mung bean. The lowest flower bud and flower infestation (17.35% and 21.66%, respectively) and shedding (13.32% and 8.41%, respectively) and the highest number of pod (34.28 plant^{-1}), pod length (9.29 cm), seed (10.82 pod^{-1}), 1000 seed weight (34.10 g) and yield (1642.19 kg ha^{-1}) of mung bean was found in the integrated management package including seed treatment+blue sticky trap+Stargate 48SC followed by the management strategy comprising seed treatment+blue sticky trap+Confidor 70 WG and seed treatment+Blue sticky trap+Actara 25WG.

KEYWORDS: Management, mung bean, pesticide, seed treatment, thrips, trap

***Citation* (VANCOUVER):** Mim et al., Evaluation of Different Integrated Management Strategies against Thrips (Thysanoptera: Thripidae) on Mung Bean . *International Journal of Bio-resource and Stress Management,* 2023; 14(4), 581-589. HTTPS://DOI.ORG/10.23910/1.2023.3441.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

RECEIVED on 12th February 2023 RECEIVED in revised form on 21st March 2023 ACCEPTED in final form on 08th April 2023 PUBLISHED on 21st April 2023

1. INTRODUCTION

The mung bean [*Vigna radiata* (L.) Wilczek] is one of the most significant crops of the Fabaceae family. It has become a highly successful short-duration grain legume crop due to its vast adaptability, minimal input needs and ability to boost soil fertility by using symbiotic bacteria Rhizobium present in root nodules (Isaev et al., 2020). The pulse has a balanced composition of nutrients, including protein, dietary fiber, vitamins, minerals, and large concentrations of bioactive substances (Gan et al., 2017). It is ideally suited for summer, but also can be an excellent fit for crop rotations (Chadha, 2010, Kholliev and Dusmanov, 2016). Mung bean is widely grown, but suffers from several biotic and abiotic stress factors that reduce its production and grain quality (Pratap et al., 2021). Insect pests are one of the key factors accounting for 42 and 58% of the losses in the mung bean's pre- and post-flowering stages, respectively (Malik, 1992), and limiting the yield (Islamov et al., 2021). On mung bean, there are over 60 different insect species, and nearly 34 of them are major pests (Lal and Ahmad, 2002). One of the primary insect pests of mung beans, thrips (Thysanoptera: Thripidae), significantly reduces crop production (Hossain et al., 2004, Rahman et al., 2000). *Megalurothrips usitatus* is native to Asia, where it is ubiquitous and frequently observed on Fabaceae (Chen, 1980, Fan et al., 2013, Tang et al., 2015, Soto-Adames, 2020). Its attack reduces mung bean production by 13% to 64% (Farajallah, 2013). *M. usitatus* feeds on vegetative buds, rasps the tops of unopened trifoliate leaves, and sucks plant fluid that is oozing out of vegetative plant parts. During the early phases of flowering, male and female thrips are randomly distributed inside the flowers. Both larvae and adults ingest the plant juice in addition to eating pollen and other flower parts. This type of damage results in blooms falling off and affects the formation of pods. Even more significant economically are losses resulting from petal and fruit deformity and scarring (Zhang et al., 2007, Duff et al., 2015, Khan et al., 2022). *Thrips palmi* damages plants economically both via its feeding behavior and through its capacity to spread diseases like the Peanut Yellow Spot Virus (PYSV) and the Watermelon Bud Necrosis Virus (WBNV) in tropical and subtropical regions (Gopal et al., 2010). Thrips population can increase quickly in the appropriate circumstances (Rhainds and Shipp, 2003). So, safe and efficient thrips control is necessary for increased mung bean yield.

Insect pest management, in its broadest sense, refers to all efforts to suppress their increase (Negalur et al., 2017). Blue sticky traps are the most alluring to *M. usitatus* which can be used for mass-tapping (Yan et al., 2017). Chemical pesticides are used extensively to control the *M. usitatus* population (Hossain, 2015, Yasmin et al., 2019), but their efficacy is limited since thrips are hidden inside flowers (Liu et al., 2018). Besides, almost all conventional synthetic pesticides have been rendered ineffective against sucking insects through adaptation which led to significant yield losses and environmental hazards. (Palumbo et al., 2001). Under these circumstances, it becomes necessary to find out effective and eco-friendly management strategies for controlling thrips. The integrated pest management approach that requires the rational integration of several management techniques is the most efficient way to reduce the pest population below ETL (Singh and Singh, 2015). Keeping in view the above facts, the present investigation was undertaken to develop and evaluate integrated management approaches combining seed treatment with blue sticky trap, bio-pesticides, or synthetic chemical insecticide against thrips on mung bean.

2. MATERIALS AND METHODS

2.1. Experiment Location and Duration

The study was conducted to develop integrated management approaches against thrips infesting mung bean in the experimental field of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, Bangladesh from April–June, 2021. The experimental area was located at 23.77° N latitude and 90.37° E longitude with an elevation of 8.2 m from the sea level.

2.2. Experimental design

The experiment was set up using a Randomized Complete Block Design (RCBD) with three replications. In total, the experiment included 27 (3×9) unit plots. Each unit plot measured 3×2 m^2 in size. Block-to -block and plot-to-plot separations were 1 m and 0.5 m, respectively. Random distribution was used to disperse the experiment's treatments among the test plots.

2.3. Crop establishment

The plots allocated for sowing seeds were well-prepared and had good tilth. The manures were thoroughly incorporated into the plot's soil using a spade. The recommended dose of fertilizers was: urea 45 kg, TSP 80 kg, MP 35 kg, Zypsum 50 kg, and Boron 10 kg ha^{-1} (Anonymous, 2017). The seeds of BARI Mung-8 were used as experimental materials for the study. Before sowing, the seeds were treated with Cruiser 70WS. Seeds were treated according to Jagadish and Gowda (1994) with few modifications. 500 g of mung bean seeds were taken in a plastic container, and then 10 ml of water, 3–4 drops of gum (sticker), and 1 g of Cruiser 70 WS (Thiamethoxam) were added to this and stirred thoroughly. Drops of additional water were added as needed, stirring vigorously after each addition. The container's lid was firmly sealed and given a 30-second vigorous shaking. After air drying for four hours in the shade, the treated seeds were then sowed. The seeds were directly sown in rows with a spacing of 30 cm. Plants were kept 10 cm apart from one another to maintain a consistent plant population. Following the sowing of seeds, irrigation, and other cross-cultural tasks were completed.

2.4. Treatments

The experiment comprised of nine treatments including an untreated control and these were as follows:

Treatment 1: Seed treatment+blue sticky trap; Treatment 2: Seed treatment+blue sticky trap+Tracer 45SC (Spinosad) @ 0.5 ml l^{-1} of water; Treatment 3: Seed treatment+blue sticky trap+Biotrin (Matrin 0.5% AS) @ 1 ml l^{-1} of water; Treatment 4: Seed treatment+blue sticky trap+Ecomec 1.8EC (Abamectin) @ 1 ml l^{-1} of water; Treatment 5: Seed treatment+blue sticky trap+Confidor 70 WG (Imidacloprid) @ 0.2 g l^{-1} of water; Treatment 6: Seed treatment+blue sticky trap + Actara 25WG (Thiamethoxam) @ 0.2 g l^{-1} of water; Treatment 7: Seed treatment+blue sticky trap+Stargate 48SC (Clothianidin) @ 0.5 ml l^{-1} of water; Treatment 8: Seed treatment+blue sticky trap+Novastar 56EC (Bifenthrin+Abamectin) @ 1 ml l^{-1} of water; Treatment 9: Untreated Control

2.5. Installation of blue sticky traps

The sticky traps were made with blue color plastic sheets and the size of each sheet was 12 inches × 8 inches. Colorless and transparent insect-trapping adhesive grease was uniformly applied as a thin layer on both surfaces of each trap at weekly intervals. These traps were erected above the crop canopy in a windward direction with the help of bamboo poles for proper visibility and convenient handling. A blue sticky trap was first installed (one trap $plot^{-1}$) at the vegetative stage (21 days after sowing) and was kept in the field up to harvest. Thrips stuck on the glue of the traps were observed using a hand magnifying lens at weekly intervals.

2.6. Pesticides application

The actual amount of each bio-pesticide and synthetic chemical insecticide was taken in a knapsack sprayer and thoroughly mixed with water and sprayed in the respective plot. Three sprayings of bio-pesticides and synthetic chemical insecticides were done during the reproductive stage, first at 40 days after sowing (DAS), second at 47 DAS, and third at 54 DAS.

2.7. Thrips identification

The beating method was used to collect adult thrips samples from the mung bean field by shaking the leaves, terminal shoots, flower buds and flowers over a white plate. The samples were then transferred to 30 ml vials containing 70% ethanol using a small, soft brush before being put onto microscope slides for identification. The samples were brought to the laboratory of the Department of Entomology, where they were processed and adult thrips were recognized as species using the criteria of Palmer (1987), Mound (2005), and Hoddle et al. (2012).

2.8. Counting thrips

The number of adult *M. usitatus* and *T. palmi* was counted using the beating method on a white plate from ten top trifoliate leaves and terminal shoots twice at the vegetative stage starting from the first incidence of thrips and from ten flower buds and flowers five times at the reproductive stage at weekly intervals from ten randomly selected plants of each plot avoiding border plants.

2.9. Percent Infestation and shedding of flower buds and flowers by thrips

Percent infestation and shedding of flower buds and flowers by thrips were calculated by using the following formulae-

Percentage of flower bud or flower infestation= (Number of infested flower bud or flower/Number of total flower bud or flower)×100 ……….(1)

Percentage of flower bud or flower shedding= (Number of shedding flower bud or flower/Number of total flower bud or flower)×100 ……….(2)

2.10. Yield contributing characters and yield of mung bean

When the pods reached maturity, harvesting was done 3 times. From 10 sample plants, all the pods were detached, numbered, and the average number of pods $plant^{-1}$ was computed at each harvest. After harvesting 10 pods chosen at random, the average pod length and number of seeds pod^{-1} were noted. 1000 seed weight was also gathered from each plot at each harvest. Data on seed yield was converted for each plot into kg ha^{-1}.

2.11. Statistical analysis

Data were subjected to one-way analysis of variance to determine any significant difference in the effects of the different treatments. Statistical analysis was carried out using Statistix 10.0 software to indicate the significant difference among the treatment means by ANOVA. The mean separation was done at $p<0.05$ using Tukey's test.

3. RESULTS AND DISCUSSION

3.1. Thrips population at vegetative stage

Thrips population found in mung bean included *Megalurothrips usitatus* and *Thrips palmi* where *M. usitatus* was the dominant species in all the treatments. Significant variations in the efficacy of different integrated management approaches combining seed treatment with colored sticky traps and pesticides were observed in respect of thrips (*M. usitatus* and *T. palmi*) incidence 10 top trifoliate leaves^{-1} and 10 terminal shoots^{-1} at the vegetative stage (Table 1). The treatment (T_7) comprising seed treatment+blue sticky trap+Stargate 48SC was found very effective to control both species of the thrips population. The lowest mean number of adult *M. usitatus* and *T. palmi* (3.46 and 2.62, respectively) with the total number of both the thrips species (6.09) 10 top trifoliate leaves^{-1} and that of *M. usitatus* and *T. palmi* (4.81 and 3.72, respectively) with the total number of both the thrips species (8.54) 10 terminal shoots^{-1} were observed in seed treatment+blue sticky trap+Stargate 48SC (T_7) treated plots. These were followed by the seed treatment+blue sticky trap+Confidor 70 WG (T_5) and seed treatment+blue sticky trap+Actara 25WG @ 0.2 g (T_6) treated plots at the vegetative stage of mung bean. The treatment (T_7) comprising seed treatment+blue sticky trap+Stargate 48SC reduced the highest percent of total thrips from both top trifoliate leaves (84.46%) and terminal shoots (80.77%) of mung bean. On the other hand, the highest incidence of *M. usitatus* and *T. palmi* (22.33 and 16.87) with the total number of both the thrips species (39.20) 10 top trifoliate leaves^{-1} and that of *M. usitatus* and *T. palmi* (25.17 and 19.26, respectively) with the total number of both the thrips species (44.43) 10 terminal shoots^{-1} were observed in untreated control (T_9) plots (Table 2). The findings of the current study were mostly validated by other authors as well. Thrips populations were observed on mung beans during the vegetative and flowering stages by Azam et al. (2008). The color preferences of several thrips species in various crops have been studied in many research. A substantial number of thrips were caught on blue and light blue sticky traps, according to research by Tang et al. (2016) on the behavior of thrips in various colored sticky traps on cowpea. It was reported that seed treatment of mung bean reduced the population of thrips up to 20 days after sowing. Seal (2011) reported that several neonicotinoid pesticides gave 42% to 75% control of *T. palmi*, with clothianidin providing a higher level (>70%) of control than the others.

Table 1: Efficacy of the IPM approaches on the incidence of thrips on top trifoliate leaves and terminal shoots of mung bean at vegetative stage

Treatments	Mean No. of thrips 10 top trifoliate leaves^{-1}			% reduction of thrips over control	Mean No. of thrips 10 terminal shoots^{-1}			% reduction of thrips over control
	M. usitatus	*T. palmi*	Total thrips		*M. usitatus*	*T. palmi*	Total thrips	
T_1	12.17^b	10.88^b	23.05^b	41.19	13.17^b	11.43^b	24.60^b	44.63
T_2	8.52^c	7.43^c	15.95^c	59.31	8.93^c	7.52^c	16.45^c	62.97
T_3	8.80^c	7.67^c	16.47^c	57.98	9.23^c	7.86^c	17.09^c	61.53
T_4	8.17^c	7.08^c	15.25^c	61.09	8.56^c	7.23^{cd}	15.80^c	64.43
T_5	4.85^e	3.14^f	8.00^f	79.59	5.54^e	4.27^e	9.81^{ef}	77.92
T_6	5.17^e	4.36^e	9.53^e	75.68	5.96^e	4.53^e	10.50^e	76.36
T_7	3.46^f	2.62^f	6.09^f	84.46	4.81^e	3.72^e	8.54^f	80.77
T_8	6.32^d	5.85^d	12.17^d	68.95	7.19^d	6.13^d	13.32^d	70.02
T_9	22.33^a	16.87^a	39.20^a	-	25.17^a	19.26^a	44.43^a	-
SEm±	0.32	0.19	0.35	-	0.32	0.33	0.43	-
CD (*p*:0.05)	1.12	0.67	1.25	-	1.16	1.18	1.52	-

In a column means having similar letter(s) are statistically identical at 5% level by Tukey test; T_1: Seed treatment+blue sticky trap; T_2: Seed treatment+blue sticky trap+Tracer 45SC (Spinosad); T_3: Seed treatment+blue sticky trap+Biotrin 0.5%AS; T_4: Seed treatment+blue sticky trap+Ecomec 1.8EC; T_5: Seed treatment+blue sticky trap+Confidor 70 WG; T_6: Seed treatment+blue sticky trap+Actara 25WG; T_7: Seed treatment+blue sticky trap+Stargate 48SC; T_8: Seed treatment+blue sticky trap+Novastar 56EC; T_9: Untreated control

3.2. Thrips population at reproductive stage

The population of thrips 10 flower buds^{-1} and 10 flowers^{-1} varied significantly among different IPM packages used in this study (Table 2). The lowest mean number of adult *M. usitatus* and *T. palmi* (5.10 and 4.41, respectively) with the total number of both the thrips species (9.52) 10 flower buds^{-1} and that of *M. usitatus* and *T. palmi* (5.78 and 5.47, respectively) with the total number of both the species (11.25) 10 flowers^{-1} was recorded in seed treatment+blue sticky trap+Stargate 48SC (T_7) treated plots at reproductive stage of mung bean. The results were followed by seed

Table 2: Efficacy of the IPM approaches on the incidence of thrips on flower buds and flowers at flowering stage of mung bean

Treatments	Mean No. of thrips 10 flower buds^{-1}			% reduction of thrips over control	Mean No. of thrips 10 flower^{-1}			% reduction of thrips over control
	M. usitatus	*T. palmi*	Total thrips		*M. usitatus*	*T. palmi*	Total thrips	
T_1	14.21^b	13.10^b	27.32^b	46.63	15.10^b	14.48^b	29.58^b	48.85
T_2	9.76^{cd}	9.22^c	18.98^{cd}	62.92	12.22^c	10.56^{cd}	22.78^c	60.61
T_3	10.52^c	9.35^c	19.88^c	61.16	12.40^c	11.71^c	24.11^c	58.31
T_4	9.17^{de}	8.73^c	17.90^d	65.03	11.59^c	8.23^e	19.82^d	65.73
T_5	5.63^{gh}	4.88^f	10.51^g	79.46	6.55^e	6.07^f	12.63^{fg}	78.16
T_6	6.76^{fg}	6.21^e	12.97^f	74.66	7.07^{de}	6.23^f	13.30^f	77.00
T_7	5.10^h	4.41^f	9.52^g	81.26	5.78^e	5.47^f	11.25^g	80.54
T_8	7.96^{ef}	7.41^d	15.37^e	69.97	8.16^d	8.08^e	16.24^e	71.92
T_9	28.06^a	23.13^a	51.19^a	-	31.43^a	26.40^a	57.84^a	-
SEm±	0.37	0.23	0.35	-	0.45	0.25	0.49	-
CD (p=0.05)	1.33	0.81	1.25	-	1.60	0.88	1.75	-

In a column means having similar letter(s) are statistically identical at 5% level by Tukey test; T_1: Seed treatment+blue sticky trap; T_2: Seed treatment+blue sticky trap+Tracer 45SC (Spinosad); T_3: Seed treatment+blue sticky trap+Biotrin 0.5%AS; T_4: Seed treatment+blue sticky trap+Ecomec 1.8EC; T_5: Seed treatment+blue sticky trap+Confidor 70 WG; T_6: Seed treatment+blue sticky trap+Actara 25WG; T_7: Seed treatment+blue sticky trap+Stargate 48SC; T_8: Seed treatment+blue sticky trap+Novastar 56EC; T_9: Untreated control

treatment+blue sticky trap+Confidor 70 WG (T_5) and seed treatment+blue sticky trap+Actara 25WG (T_6) treated plots. In contrast, the highest mean number of *M. usitatus* and *T. palmi* (28.06 and 26.40, respectively) with the total number of both the thrips species (51.19) 10 flower buds^{-1} and that of *M. usitatus* and *T. palmi* (31.43 and 26.40, respectively) with the total number of both the thrips species (57.84) 10 flowers^{-1} was recorded in the untreated control (T_9) plots which was followed by seed treatment+blue sticky trap (T_1) treatment. The highest percent reduction of thrips from flower buds and flowers (81.26% and 80.54%, respectively) was observed in seed treatment+blue sticky trap+Stargate 48SC (T_7) treatment. Roth et al. (2016) reported that flowers of cross-pollinated plants are frequently blue, violet, and yellow, which is attractive to insects. Abamectin provided over 60% reduction of *T. palmi* on the bean. Above 70% flower infestation reduction was observed in the white sticky trap (WST)+Chlorfenapyr sprayed plots (Hossain et al., 2018). Nadeem et al. (2016) reported that Mospilan 20 SP treated plots comparatively showed the least population of thrips inflorescence^{-1} but not significantly different from Actara 25 WG which was followed by Confidar 200 SL. Jensen (1995) reported that Spinosad exhibited very little thrips control, which was also consistent with the findings of the current study.

3.3. Percent infestation and shedding of flower buds and flowers

Significant variations were observed among the different IPM packages in terms of percent flower bud and flower infestation and shedding of mung bean. The lowest percent of flower bud infestation (17.35%) was recorded in seed treatment+blue sticky trap+Stargate 48SC (T_7) treatment, which was followed by seed treatment+blue sticky trap+Confidor 70 WG (T_5) and seed treatment+blue sticky trap+Actara 25WG (T_6) treatments respectively. On the other hand, the highest percent of flower bud infestation was recorded in the untreated control (T_9) (70.21%), which was significantly different from others and followed by Seed treatment+blue sticky trap T_1 (Figure 1).

The lowest percent of flower bud shedding (13.32%) was recorded in seed treatment+blue sticky trap+Stargate 48SC (T_7) treatment, which was followed by seed treatment+blue sticky trap+Confidor 70 WG (T_5) and seed treatment+blue sticky trap+Actara 25WG (T_6) treatments respectively. On the other hand, the highest percent of flower bud shedding was recorded in the untreated control (T_9) (33.44%), which was significantly different from others and followed by Seed treatment+blue sticky trap T_1 (Figure 2).

In case of flower infestation by thrips, the lowest percent infestation (21.66%) was recorded in seed treatment+blue sticky trap+Stargate 48SC (T_7), which was followed by seed treatment+blue sticky trap+Confidor 70 WG (T_5) and seed treatment+blue sticky trap+Actara 25WG (T_6) treatments respectively. On the other hand, the highest percentage of flower infestation (78.99%) was recorded in the untreated control (T_9) (Figure 3).

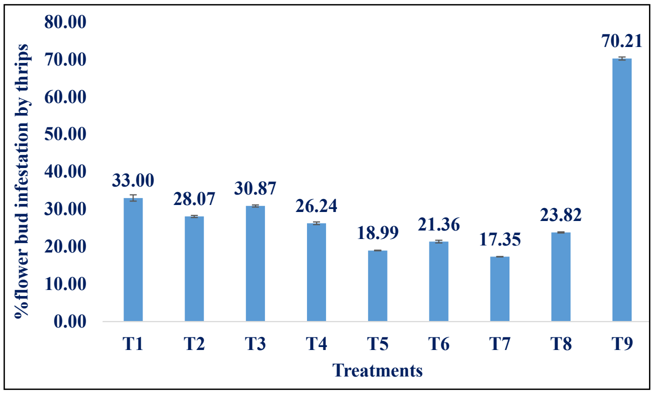

Figure 1: Percent flower bud infestation of mung bean by thrips

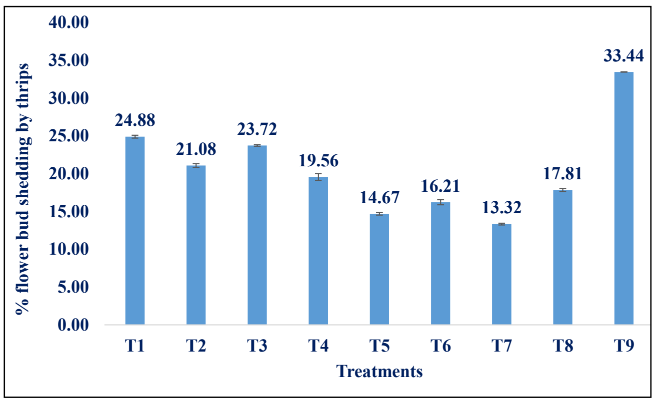

Figure 2: Percent flower bud shedding of mung bean by thrips

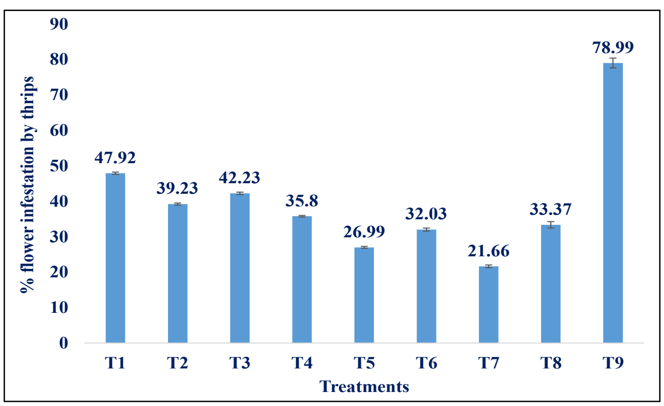

Figure 3: Percent flower infestation of mung bean by thrips

The lowest percent shedding of flowers (8.41%) was recorded in seed treatment+blue sticky trap+Stargate 48SC (T_7), which was followed by seed treatment+blue sticky trap+Confidor 70 WG (T_5) and seed treatment+blue sticky trap + Actara 25WG (T_6) treatments respectively. On the other hand, the highest percentage of flower shedding (28.26%) was recorded in the untreated control (T_9) (Figure 4). Infestations of flower buds and flowers as well as shedding by thrips on mung bean or other leguminous crops were also discussed by other authors. Tamo et al. (1993) reported that thrips was an important pest of the reproductive structures including the flower

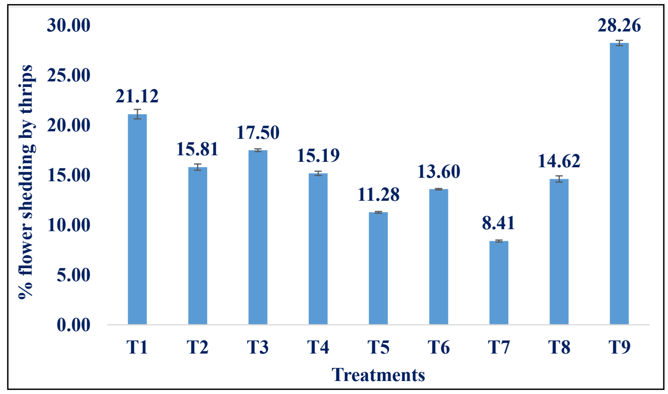

Figure 4: Percent flower shedding of mung bean by thrips

bud and flowers of cowpea. Early feeding by thrips results in flower buds and flower shedding, which negatively affects pod setting. Hossain (2015) reported that the application of imidacloprid at different growth stages of mung bean suppressed the thrips population and flower infestation significantly. Hossain et al. (2020) observed that the integrated management approaches including blue sticky trap and synthetic chemical insecticides significantly reduced thrips population and flower infestation in mung bean.

3.4. Yield contributing characters and yield of mung bean

Significant variations were observed in the number of pods plant^{-1}, pod length, number of seeds pod^{-1}, 1000 seed weight, and yield due to the effect of different integrated management approaches against thrips infesting mung bean (Table 3). The maximum number of the pod (34.28 pods plant^{-1}), pod length (9.29 cm), seeds (10.82 seeds pod^{-1}), 1000 seed weight (34.10 g), and yield (1642.19 kg ha^{-1}) were found in the IPM package comprising seed treatment+blue sticky trap+Stargate 48SC (T_7) which was statistically identical and followed by the IPM package combining seed treatment+blue sticky trap+Confidor 70 WG (T_5). Whereas, the minimum number of the pod (22.47 pods plant^{-1}), pod length (6.17 cm), seeds (6.74 seeds pod^{-1}), 1000 seed weight (29.57 g,) and yield (1140.18 kg ha^{-1}) were recorded in the untreated control plots (T_9), which were followed by IPM package combining seed treatment+blue sticky trap (T_1) treatment. Singh and Singh (2015) supported the present findings and reported that IPM module i.e., mung bean with seed treatment of Imidacloprid 600 FS (5 ml kg^{-1}) followed by one spray of NSKE (5%) at 30 days after sowing (DAS) and chemical insecticide Triazophos 40 EC 0.04% of the crop, were effective in reducing the incidence of thrips and gave higher grain yield than farmer's practices. Shah and Maula (2010) found that seed treatment with Imidachlorpid 70 WS (5 g kg^{-1} seeds)+Poultry manure (3 t ha^{-1})+Sequential release of bio-control agents (*Trichogramma chilonis*+*Bracon hebetor*)+Spray with detergent @ 2 g l^{-1} of water was effective to control thrips and increased the yield of mung

Table 3: Effect of IPM packages to manage thrips and its impact on yield contributing characters and yield of mung bean

Treatments	No. of pods plant^{-1}	Pod length (cm)	No. of seeds pod^{-1}	1000 seed weight (g)	Yield (kg ha^{-1})
T_1	26.42^{e}	7.17^{d}	7.26^{de}	30.35^{ef}	1375.22^{f}
T_2	27.99^{cde}	7.45^{cd}	7.80^{cd}	31.64^{cde}	1481.95^{de}
T_3	27.29^{de}	7.28^{cd}	7.49^{de}	30.87^{def}	1434.34^{ef}
T_4	28.76^{cd}	7.54^{bcd}	7.98^{cd}	32.02^{bcde}	1530.12^{cd}
T_5	33.57^{ab}	8.82^{a}	10.17^{a}	33.65^{ab}	1629.55^{ab}
T_6	32.20^{b}	8.14^{b}	9.20^{b}	33.21^{abc}	1582.86^{abc}
T_7	34.28^{a}	9.29^{a}	10.82^{a}	34.10^{a}	1642.19^{a}
T_8	29.39^{c}	7.89^{bc}	8.49^{bc}	32.28^{bcd}	1567.67^{bc}
T_9	22.47^{f}	6.17^{e}	6.74^{e}	29.57^{f}	1140.18^{g}
SEm±	0.53	0.18	0.25	0.49	20.71
CD (p=0.05)	1.90	0.65	0.90	1.75	73.74

In a column means having similar letter(s) are statistically identical at 5% level by Tukey test; T_1: Seed treatment+blue sticky trap; T_2: Seed treatment+blue sticky trap+Tracer 45SC (Spinosad); T_3: Seed treatment+blue sticky trap+Biotrin 0.5%AS; T_4: Seed treatment+blue sticky trap+Ecomec 1.8EC; T_5: Seed treatment+blue sticky trap+Confidor 70 WG; T_6: Seed treatment+blue sticky trap+Actara 25WG; T_7: Seed treatment+blue sticky trap+Stargate 48SC; T_8: Seed treatment+blue sticky trap+Novastar 56EC; T_9: Untreated control

bean. The findings were also supported by Hossain et al. (2018).

4. CONCLUSION

The integrated application of seed treatment+blue sticky trap+Stargate 48SC remarkably reduced the *M. usitatus,* and *T. palmi* populations as well as the infestation and shedding of flower buds and flowers, which also had an impact on increasing the yield contributing characters and yield of mung bean. The results were followed by the IPM packages containing seed treatment+blue sticky trap+Confidor 70WG and seed treatment+blue sticky trap+Actara 25WG, respectively. Seed treatment and early blue trap installation may reduce pesticide sprayings against thrips.

5. FURTHER RESEARCH

Further investigation is needed for mass trapping and controlling of *M. usitatus* and *T. palmi* infesting mung bean using the IPM package seed treatment+blue sticky trap+Stargate 48SC in different locations. The IPM packages combining seed treatment with blue trap and other neonicotinoids i.e., Confidor 70 WG, Actara 25WG can also be tested elsewhere against thrips on mung bean for the validation of the research work.

6. ACKNOWLEDGEMENT

The authors would like to acknowledge the Sher-e-Bangla Agricultural University Research System (SAURES) for the financial and technical support in conducting the investigation.

7. CONTRIBUTION OF AUTHORS

A.T. Mim contributed to project design, data collection, analysis and paper writing, M. Ali contributed to project design and paper writing, S. Yasmin contributed to project design, data analysis and paper writing.

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