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Bio-rational management of rose bollworm, *Helicoverpa armigera*

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ABSTRACT

A field experiment was conducted at farmer's field of Vowal village, Gazipur, Bangladesh during January to May 2021 to develop an effective bio-rational based management approach against rose bollworm, *Helicoverpa armigera*. Six treatments, such as: T_1: Sex pheromone Mass trapping T_2: Sex pheromone Mass trapping + Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of water at 10 days interval; T_3: Sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval; T_4: Sex pheromone Mass trapping + spraying of Spinosad (success 2.5 SC) @ 1.2 ml/L of water at 10 days interval; T_5: Farmers practice (spraying of synthetic insecticides, Proclaim 5SG @ 1g/L) at 7 days interval; T_6: Untreated control were evaluated following RCB design with three replications. The results indicated that T_3 treatment, Sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval showed the best performance reducing plant and flower infestation and increasing marketable yield followed by T_4 treatment, Sex pheromone Mass trapping + spraying of Spinosad (Success 2.5SC) @ 1.2 ml/L of water at 10 days interval. In case of maximum marginal benefit cost ratio, T_4 treatment showed best performance.

INTRODUCTION

Rose (Rosa spp. L) is known as the queen of flowers belonging to the family Rosaceae which has 400 species and 100 cultivars with special fragrance, various colours and size (Kim et al., 2003). It is grown throughout the world although several species of roses are native to India. Among the cut flowers, all over the world rose stands first (Gowda et al., 1984). Commercial flower production is increased in Bangladesh day by day. In the year 2022-23 total 32120 tons of flowers were produced on 3,930 acres of land in Bangladesh where roses dominated the domestic production which was more than two-thirds (67%), almost 22,000 tons (BBS 2022). Rose plant is affected by many insects, mites, diseases, and nematodes creating a serious threat to rose cultivation. Commonly found and regular pests are thrips, aphids, scales, whiteflies, bollworm, leafhoppers, chaffers, termites, and mites. Insect and mite pests on rose can cause 28–95% damage individually or in groups (Hegde et al., 2020).

Helicoverpa armigera (Hubner, 1808) (Lepidoptera: Noctuidae) is a polyphagous pest

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with a wide host plant range. Worldwide, *H. armigera* has been reported on over 180 cultivated hosts and wild species related to at least 45 plant families (Venette et al., 2003). Its host plants are economically important crops in Asia, Africa, Oceania and Europe (EPPO, 2006). Among other crops like tomato, cotton, sorghum, pigeon pea, chickpea, cowpea etc are the most important hosts. Groundnut, okra, peas, field beans, soybeans, lucerne, *Phaseolus* spp., tobacco, potatoes, maize, *Dianthus* spp., *Rosa* spp., *Chrysanthemum* spp., a number of fruit trees and forest trees could also be potential hosts for *H. armigera* (Multani, 2002, Demirozer, 2012). This pest is known for its voracious feeding habits, which can lead to substantial yield losses and economic damage.

Rose is an important cash crop and cultivating commercially in Bangladesh, but production of this crop is highly constrained by a number of insect pests (Haque et al., 2013). Among them, rose bollworm (*H. armigera*) is an important one. It bores the developing buds causing irregular shape, reduces attractiveness and market value. Till now, no effective control measures for rose bollworms are available to farmers. Farmers of the flower growing areas often use two or more insecticides in a cocktail form to protect the pest from demand. It is our general tendency to take smell from rose. Use of insecticides in rose is therefore, very dangerous for users. Furthermore, this practice has a lot of side effects. The traditional approach to managing *H. armigera* has relied heavily on the use of chemical insecticides. However, the extensive use of these chemicals has led to several challenges, including the development of insecticide resistance, environmental contamination, and adverse effects on non-target organisms, including beneficial insects and pollinators (Kranthi et al., 2002).

In recent years, there has been a growing emphasis on developing sustainable and eco-friendly pest management strategies, often termed bio-rational approaches. Bio-rational management involves the use of biological control agents, pheromones, insect growth regulators, and other environmentally benign methods that specifically target the pest without harming the surrounding ecosystem (Mohan and Gujar, 2003).

Sex pheromones are species-specific, meaning they attract only *H. armigera* males without affecting non-target organisms, including beneficial insects such as pollinators and natural predators. This specificity ensures that the ecological balance in the agricultural environment is maintained (Witzgall et al., 2010).The use of sex pheromones as a bio-rational management strategy for *H. armigera* offers a sustainable and effective alternative to traditional chemical control methods.In this experiment an attempt has been made to develop an effective bio-rational based management option against rose bollworm.

MATERIALS AND METHODS

Study area

The experiment was conducted at farmer's field of Vowal village, Gazipur, Bangladesh during January to May 2021 to develop an effective and bio-rational based management option against rose bollworm.

Treatments

There were six treatment: T_1: Sex pheromone Mass trapping; T_2: Sex pheromone Mass trapping + Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of water10 days interva; T_3: Sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval; T_4: Sex pheromone Mass trapping + spraying of Spinosad (Success 2.5SC) @ 1.2 ml/L of water at 10 days interval; T_5: Farmers practice (spraying of synthetic insecticides, Proclaim 5 SG @ 1 g/L) 7 days interval; T_6: Untreated control.

Experimental design and data collection

The experiment was laid out in a RCB design with three replications. Treatments were applied just after first bollworm infestation. The infested and healthy flowers were counted during data collection. Foliar sprays were done by knap-sack sprayer. Data on numbers of healthy and infested plant, flowers by bollworm from whole plot was recorded weekly. On the other hand, percent plant infestation and flower infestation (visual estimation) by bollworm were calculated.

Economic analysis

For economic analysis treatments costs were recorded to compute the Marginal Benefit Cost Ratio (MBCR). The monetary return from the yield was calculated on the basis of farm gate price during January to May 2021. Major parameters of economic analysis were computed according to following formulas:

Gross return = Yield × Sale price,
Net return = Gross return – Cost of treatment
Adjusted return = Net return - Return from control

$$\text{Marginal Benefit Cost Ratio} = \frac{\text{Adjusted return}}{\text{Cost of treatment}}$$

Data analysis

The data recorded on different parameters were analyzed statistically by using Statistics 10 software for analysis of variance. Differences between treatment's means were compared by LSD test at 1% level of probability.

RESULTS AND DISCUSSION

Efficacy of different treatments against rose bollworm infestation

Efficacy of different treatments against rose bollworm infestation is presented in Table 1. The lowest plant infestation was observed in T_3 treatment comprising (sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval (10.78%) followed by T_4 treatment (sex pheromone Mass trapping + spraying of Spinosadat 10 days interval) (14.67%), T_2 treatment (Sex pheromone Mass trapping + Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of waterat 10 days interval) (16.44%), T_5 Treatment (spraying of synthetic insecticides, Proclaim 5 SG @ 1 g/Lat 7 days interval) (22.56%) and T_1 treatment (sex pheromone Mass trapping) (31.11%) respectively where T_3 treatment was statistically identical with T_4 treatment and T_4 treatment was statistically identical withT_2 treatment. Accordingly, the percent reduction of plant infestation over control was also highest in T_3 treatment (74.13%) followed by T_4 treatment (64.79%), T_2 treatment (60.54%) and T_5 treatment (45.86%). On the other side, in case of flower damage, the lowest infestation was found in T_3 treatment (12.78%) followed by T_4 treatment (19.00%), T_2 treatment (25.29%) and T_5 treatment (26.00%), respectively and T_2 was statistically identical with T_5 treatment. The per cent reduction of flower infestation over control also showed the similar trend i.e. the highest in T_3 treatment (72.61%) followed by T_4 treatment (59.88%), T_2 treatment (45.81%) and T_5 treatment (44.28%), respectively.

Table1: Efficacy of different treatments against rose boll worm on plant and flower infestation during January to May 2021

Treatments	% Plant infestation	% Reduction over control	% flower infestation	% Reduction over control
T_1	31.11b	25.34	36.00b	22.86
T_2	16.44d	60.54	25.29c	45.81
T_3	10.78e	74.13	12.78e	72.61
T_4	14.67de	64.79	19.00d	59.88
T_5	22.56c	45.86	26.00c	44.28
T_6	41.67a	-	46.67a	-
LS	**		**	
CV (%)	9.58%		11.51%	

Mean followed by the same letters in a column did not differ significantly by LSD at 1% level of probability

[Treatments: T_1:Sex pheromone Mass trapping, T_2: Sex pheromone Mass trapping + Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of water at 10 days interval;T_3: Sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval;T_4: Sex pheromone Mass trapping + spraying of Spinosad (Success 2.5SC) @ 1.2 ml/L of water at 10 days interval;T_5:Farmers practice(spraying of synthetic insecticides, Proclaim 5 SG @ 1 g/L of water at 7 days interval;;T_6:Untreated control]

Lande et al. (2008) observed field efficacy of bio-rational modules against bollworm complex on rain fed cotton and found bio-rational module comprising application of Neem seed extract, *T. Chilonis*, spinosad, HNPV, *Bt* k and IPM module comprising Novaluron, *T. chilonis* , HNPV 500, and Beta-cyfluthrin perform best to reduce bollworm population and increase of cotton yield compare to module comprising of chemicals.

Effect of different treatment on Marketable yield

Effect of different treatment on Marketable yield of Rose during January to May 2021is presented in Table 2. The highest marketable yield (168333 flower stick/ha) was recorded in T_3 treatment (Sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval) followed by T_4 treatment (spraying of Spinosad, Success 2.5SC @ 1.2 ml/L of water at 10 days interval) (140667flower stick/ha), T_2 treatment (Sex pheromone Mass trapping + Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of water) (106667flower stick/ha) ,T_5 treatment (spraying of synthetic insecticides, Proclaim 5 SG @ 1 g/Lat 7 days interval) (95333flower stick/ha) and T_1 treatment (Sex pheromone Mass trapping) (81333flower stick/ha) respectively. The percent increase of marketable yield per plant over control was highest in T_3 treatment (161.65%) followed by T_4 treatment (118.65%), T_2 treatment (65.8%), T_5 treatment (48.18%) and T_1 treatment (26.42%), respectively.

Table 2: Effect of different treatment on Marketable yield of Rose during January to May 2021

Treatments	Marketable yield/ha	% Increased Marketable yield over control
T_1	81333cd	26.42
T_2	106667c	65.8
T_3	168333a	161.65
T_4	140667b	118.65
T_5	95333c	48.18
T_6	64333d	
LS	**	
CV (%)	9.12	

[Treatments: T_1:Sex pheromone Mass trapping, T_2: Sex pheromone Mass trapping + Azadirachtin (Bio-neem plus 1EC) @ 1ml/L of water at 10 days interval; T_3: Sex pheromone Mass trapping + spraying of HNPV @ 0.2 g/L of water at 10 days interval; T_4: Sex pheromone Mass trapping + spraying of Spinosad (Success 2.5SC) @ 1.2 ml/L of water at 10 days interval; T_5: Farmers practice (spraying of synthetic insecticides, Proclaim5SG at 7 days interval); T_6: Untreated control]. Mean followed by the same letters in a column did not differ significantly by LSD at 1% level of probability

Table 3: Cost and return analysis of rose under different treatments against rose bollworm

Treatments	Marketable yield/ha	Gross return(Tk/ha)	Cost of treatment(Tk/ha)	Net return(Tk/ha)	Adjusted return(Tk/ha)	MBCR MBCR
T_1	81333	243999	3750	240249	47250	12.6
T_2	106667	320001	11750	308251	115252	9.80
T_3	168333	504999	21750	483249	272250	12.51
T_4	140667	422001	14774	407227	214228	14.50
T_5	95333	285999	8000	277999	85000	10.62
T_6	64333	308415	-	308415	-	-

Cost of Sex pheromone trap and lure with installation cost: @TK 150/trap. Required 25 trap/ha.
Cost of Azadirachtin (Bioneem plus 1EC):@Tk 3000/L; Cost of HNPV: @Tk 40,000/KG
Cost of Spinosad (success 2.5 SC): @Tk 3760/L; Cost of Emamectin benzoate (proclaim 5 SG @ 1g/L): @Tk 3000/kg; Cost of spray: One labourers/spray/ha @ Tk 500.00/day. Spray volume required: 500L /ha
Total 4 sprays were applied during the study period.
Farm gate price of rose: @3Tk/ stick flower

Rafiei et al., 2008 observed highest bollworm population reduction and highest cotton yield production though bio-rational management at cotton field. Mohammad et al., 2018 also found similar kind of results in bio-rational management of okra bollworm.

Benefit cost analysis

Benefit cost analysis of different treatments for managing rose boll worm is presented in Table 3. The highest marginal benefit cost ratio (MBCR) 14.50 was found in T_4 treated plot (Sex pheromone Mass trapping + spraying of Spinosad) followed by12.6 in T_1 treated plot (Sex pheromone Mass trapping), 12.51 in T_3 treated plot (Sex pheromone Mass trapping + spraying of HNPV), 10.62 in T_5 treated plot (spraying of Proclaim5SG @ 1g/L) and 9.80 in T_2 treatment (Sex pheromone Mass trapping + Azadirachtin). Treatment 3 performed best to reducing plant and flower infestation and increasing marketable yield of rose but its MBCR was slightly low due to higher price of the treatment. Other researcher also found higher MBCR from bio-rational management compare to chemical managements (Rahman et al., 2016; Mohammad et al., 2018 and Rashid et al., 2022).

CONCLUSION

Treatment 3, Sex pheromone Mass trapping+ spraying of HNPV @ 0.2 g/L of water at 10 days interval showed the best performance reducing plant and flower infestation and increasing marketable yield followed by Treatment 4, Sex pheromone Mass trapping + spraying of Spinosad (success 2.5 SC) @ 1.2 ml/L of water at 10 days interval. Treatment 4 showed maximum marginal benefit cost ratio. Both treatments obtained more than 10 MBCR and showed better results to control rose ballworm and increasing of marketable rose yield.

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