ECO-FRIENDLY MANAGEMENT APPROACHES OF PRODANIA CATERPILLAR AND DIAMONDBACK MOTH IN CABBAGE

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ABSTRACT

The study was conducted in the Department of Entomology of Bangabandhu Sheikh Mujibur Rahman Agricultural University during November 2020 to March 2021 to evaluate some selected eco-friendly management approaches against prodania caterpillar and diamondback moth (DBM) attacking cabbage. The treatments used in the study were Abom 1.8 EC (Abamectin) @ 1.2 ml l^{-1}, Tracer 45 SC (Spinosad) @ 0.4 g l^{-1}, Neem Seed kernel Extract (NSKE) @ 50 g l^{-1}, Fytomax PM (0.1% Azadirachtin) @ 5 ml l^{-1} of water at 15 days interval. The untreated control and as a check Proclaim 5 SG (Emamectin Benzoate) @ 1ml l^{-1} was used for comparison. The study revealed that the treatment using Tracer 45 SC (Spinosad) @ 0.4 g l^{-1} of water at 15 days interval showed the best results. This treatment resulted the lowest number of diamondback moths (0.4 $head^{-1}$) and prodania caterpillars (0.2 $head^{-1}$), as well as the lowest rate of head infestation by prodania caterpillar and/or diamondback moth (3.9% by n/n and 3.7% by w/w). Additionally, Tracer 45 SC (Spinosad) @ 0.4 g l^{-1} showed the highest marketable head yield (59.8 t ha^{-1}) and MBCR (7.8).

Keywords: Bio-rational insecticides, botanicals, Spinosad, *Spodoptera*, *Plutella xylostella.*

INTRODUCTION

Cabbage, *Brassica oleracea* var. *capitata* L. is the most common and popular cruciferous winter vegetable crop in Bangladesh. The annual production of cabbage is 217 thousand tons and yield 16.8 t ha^{-1} that's contributes 23.5% of the total winter vegetables production which ranked fifth among the vegetables produced in Bangladesh (BBS 2017). The crop is extensively grown in the kitchen and commercial garden. However, the average yield of cabbage in Bangladesh is low. There are many reasons responsible for such poor yield, among them infestation of insect pests are considered as the most important ones. Biswas and Mian (1993)

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reported 14 different species of insect pests found to be associated with cabbage. The cabbage crop is attacked by a large number of insect pests every year including diamondback moth (*Plutella xylostella*), whitefly (*Bemisia tabaci*), armyworm (*Spodoptera sp*.), cabbage looper (*Trichoplusia binotalis*) and cabbage butterfly (*Pieris brassicae*) are predominant during its growth period (Shuaib *et al.* 2007). In Bangladesh, Ahmed (2008) reported that cabbage caterpillar viz., prodania caterpillar and diamondback moth causes damage 3.99% to 13.44% on leaves and 23.33% to 58.33% on plants depending on the varieties. This type of damage is called 'windowing' since it gives the appearance of translucent windows on the leaf. As a result of feeding, the plants either fail to form compact cabbage heads or produce deformed heads. It can reduce more than 50% yield in some cabbage genotypes (Bhat *et al.* 1994). The yield losses due to the infestation of diamondback moth was recorded up to 12.0 and 20.7 t ha^{-1} in the first season and 27.0 and 48.7 t ha^{-1}, respectively in the second season (Bhatia 1994). Farmers of Bangladesh are mostly depending on the toxic synthetic pesticides to combat those pests' attack. But in many cases the increasing and indiscriminate uses of synthetic insecticides have totally failed to control the pests. These insecticidal controls of the insect pests of cabbage are not only expensive but also left over residues on the sprayed surface of the crops or in the soils; destroying natural enemies which become a matter of great concern of human health and environmental pollution (Rikabdar 2000). Therefore, the present study was designed for the evaluation of the effectiveness of some selected eco-friendly management approaches against prodania caterpillar and diamondback moth attacking cabbage.

MATERIALS AND METHODS

The experiment was conducted in the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during November 2020 to March 2021 containing 18 plots (3 × 2 m^2) using 6 treatment including an untreated control and 3 replications with Randomized Complete Block Design (RCBD). The treatments were as follows:

T_1= Abom 1.8 EC (Abamectin) @ 1.2 ml l^{-1}, T_2= Tracer 45 SC (Spinosad) @ 0.4 g l^{-1}, T_3= Neem Seed Extract (Azadirachtin) @ 5 g l^{-1}, T_4= Fytomax PM (0.1% Azadirachtin) @ 5 ml l^{-1}, T_5= Proclaim 5 SG (Emamectin Benzoate) @ 1 ml l^{-1}, T_6= Untreated control.

The cabbage seedling of variety Atlas-70 was transplanted in the field maintaining plant to plant distance 60 cm and row to row distance 45 cm. Application of manures and fertilizers was done according to the recommended fertilizer doses for cabbage production hectare^{-1} by Fertilizer Recommendation Guide (FRG 2012). Intercultural operations such as gap filling, weeding, earthing up, irrigation, etc. were done as and when required for ensuring and maintaining the normal growth of crops.

When the pest caused approximately 2% plant infestation, the application of treatments was started. All the treatments were applied at 15 days interval and repeated 4 times up to the last harvest. Data on larval population infested head^{-1}, head infestation and yield by number and weight were recorded. The number of healthy and infested head and their weight plot^{-1} were recorded at each harvest. The infestation of the pest was expressed in percentage based on total number of heads (n/n) and weight (w/w). The cumulative yield in kg plot^{-1} of healthy as well as infested heads was computed. For economic analysis, Marginal Benefit Cost Ratio (MBCR) was calculated on the basis of total expenditure of the respective spray schedule along with the total return from that particular spray schedule. The abundance of different beneficial arthropods like ladybird beetle, syrphid fly, black ant and spider's were recorded at 15 days interval during entire cropping season. The data were analyzed by using MSTAT-C software for analysis of variance (ANOVA) and the means were separated by using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Larval population of diamondback moth and prodania caterpillar in cabbage with their rate of head infestation : Significant variation was found with different eco-friendly management approaches against the number of diamondback moth and prodania caterpillar with the rate of head infestation in cabbage. Significantly the highest number of diamondback moth (4.5 larvae head^{-1}) was recorded in untreated control plot, followed by Abom 1.8 EC (2.7 larvae head^{-1}), NSKE (2.6 larvae head^{-1}) and Fytomax PM (2.2 larvae head^{-1}) treated plots. Tracer 45 SC and Proclaim 5 SG treated plots showed the lowest and statistically similar larval abundance head^{-1} of cabbage (0.4 and 0.7 larvae head^{-1}, respectively).

Significantly the highest number of prodania caterpillar (2.32 larvae head^{-1}) was obtained in untreated control plots, in contrast, the lowest and statistically similar number of caterpillars was found with Tracer 45 SC and Proclaim 5 SG treated plots

(0.2 and 0.3 larva head^{-1}, respectively). Abom 1.8 EC, NSKE and Fytomax PM treated plots showed statistically similar abundance of prodania larvae which was lower than that of untreated control plot (1.4, 1.1 and 1.2 larvae head^{-1}, respectively).

The highest rate of head infestation by number was recorded in untreated control plot having 33.3% infestation and the lowest infestation rate was obtained in Tracer 45 SC treated plot with 3.7% infestation. Abom 1.8 EC, Fytomax PM and NSKE treated plots showed statistically similar percent of head infestation (16.7%, 18.5%, 20.4%, respectively) which was lower than that of Proclaim 5 SG treated plot (13.0%). Similar results were found in head infestation by weight in all the treatments including untreated control (Table 1).

Reddy *et al*. (2017) reported that, prodania caterpillar is one of the important insect pests of crops in the Asian tropics and the pest was found to occur in cabbage growing areas and they can feed on the entire leaf tissues. Diamondback moth (*Plutella xylostella* L.) is reported as a primary pest that causes heavy loss of the cabbage field by larval feeding (Parajuli and Paudel 2019). Seasonal abundance of diamondback moth recorded on cabbage in India revealed that the infestation of diamondback moth (larva) was first recorded on 31st January with an initial population of 0.20 plant^{-1}. The population increased gradually in successive weekly counts and reached a peak of 12.05 plant^{-1} on 27th March and thereafter (Goudegnon *et al*. 1999). Sultana (2016) found that the lowest number of common cutworm (0.46) and diamondback moth (0.85) was recorded in the Bt (EG 7841) + SNPV treated plots.

Table 1. Effect of different eco-friendly management approaches on larval population of diamondback moth and prodania caterpillar and rate of head infestation on cabbage grown during Rabi season 2020-21

Treatment	Larval population of diamondback moth head^{-1}	Larval population of Prodania caterpillar head^{-1}	Rate (%) of head infestation (n/n)	Rate (%) of head infestation (w/w)
Abom 1.8 EC	2.7b	1.4b	16.7b	16.6b
Tracer 45 SC	0.4c	0.2c	3.7d	3.7d
NSKE	2.6b	1.1b	20.4b	20.4b
Fytomax PM	2.2b	1.2b	18.5b	18.5b
Proclaim 5 SG	0.7c	0.3c	13.0c	13.0c
Untreated control	4.5a	2.3a	33.3a	33.3a
CV (%)	9.3	7.9	7.5	7.9

Means within a column followed by same letter(s) are not different significantly (P=0.05) according to Duncan's Multiple Range Test (DMRT).

Effect of eco-friendly management approach on natural enemies : The data in Table 2 has represented the effect of different eco-friendly management approaches on the abundance of beneficial arthropods of the studied cabbage fields. All the treatments were bio-rational with the beneficial arthropods namely ladybird beetle, syrphid fly, black ant and spider's presence on field during entire season. The abundance of ladybird beetle and black ant was with the least significant statistical variation in Tracer 45 SC and Biomax 1.2 EC treated plots with untreated control plot but no statistical variation was found with syrphid fly and spiders' among the treatments including untreated control (Table 2).

Efad *et al*. (2021) found that Azadirachtin, Spinosad and Abamectin were bio-rational with the beneficial arthropods like ladybird beetle, syrphid fly, black ant and spider's presence on field during entire season in brinjal. In their study, the abundance of ladybird beetle and black ant was with the least significant statistical variation in Spinosad and Abamectin treated plots with untreated control plot but no statistical variation was found with syrphid fly and spiders among the treatments including untreated control.

Table 2. Effect of different eco-friendly management approaches on abundance of beneficial arthropods plot^{-1} (3 × 2m^2) during entire cropping season (Mean of 12 observations)

Treatments	No. of ladybird beetle plot^{-1}	No. of syrphid fly plot^{-1}	No. of black ant plot^{-1}	No. of spider's plot^{-1}
Abom 1.8 EC	27.2a	1.3a	76.2a	7.3a
Tracer 45 SC	23.5a	1.4a	71.2ab	6.3a
NSKE	17.4b	0.8a	63.1b	4.5a
Fytomax PM	15.1b	0.7a	61.9b	4.0a
Proclaim 5 SG	25.7a	2.0a	70.7ab	5.3a
Untreated control	28.4a	1.9a	82.4a	6.5a
CV (%)	11.3	6.5	10.5	9.0

Means within a column followed by same letter(s) are not different significantly (P=0.05) according to Duncan's Multiple Range Test (DMRT).

Yield and yield contributing characters

The lowest marketable yield (37.1 t ha^{-1}) was recorded in untreated control plots, whereas the highest marketable yield (59.8 t ha^{-1}) was obtained from Tracer 45 SC treated plot. Proclaim 5 SG, Abom 1.8 EC, Fytomax PM and NSKE treated plots gave 52.2 t ha^{-1}, 47.6 t ha^{-1}, 46.4 t ha^{-1} and 44.9 t ha^{-1}, respectively, (Table 3).

The weight of infested head was the highest in untreated control plot (18.5 t ha^{-1}), conversely, the lowest was obtained from the pot treated with with Tracer 45 SC (2.3 t ha^{-1}) followed by Proclaim 5 SG (7.8 t ha^{-1}). NSKE, Fytomax PM, Abom 1.8 EC and Tracer 45 SC treated plots showed 11.5, 10.5, 9.5 and 2.3 t ha^{-1} infested head, respectively.

There was not any significant variation in total yield obtained from the treated plots including untreated control. The findings indicated a range of 55.6 to 62.1 t ha^{-1} total yield of cabbage was obtained in this study (Table 3).

In Bangladesh, Ahmed (2008) reported that prodania caterpillar causes damage 3.99% to 13.44% on leaves and 23.33% to 58.33% on plants depending on the varieties. It can reduce more than 50% yield in some cabbage genotypes (Bhat *et al*. 1994). Munmun *et al*. (2020) found that the significantly the highest head yield of cabbage (33.40 t ha^{-1}) was recorded from Nitro 505EC (Chlorpyriphos + Cypermethrin) treatment followed by Bio-clean (D-Lemonine 5% SL) (33.18 t ha^{-1}) and the lowest in untreated control plot (26.87 t ha^{-1}). The yield of cabbage ha^{-1} was comparably higher in this present study.

The yield losses due to the infestation of diamondback moth (*Plutella xylostella* L.) was recorded up to 12.0 and 20.7 t ha^{-1} in the first season and 27.00 and 48.7 t ha^{-1} respectively in the second season (Bhatia 1994). The loss of yield up to 30% was considered tolerable as an alternative to severe pest damage, in situations where infestation levels are high. These insect pests cause more serious damage to cabbage in the summer season (Andrea 2006).

Table 3. Effect of different eco-friendly management approaches on yield of cabbage (t ha^{-1}) grown during Rabi season 2020-21

Treatment	Yield (t ha^{-1})			% marketable yield increase over untreated control
	Marketable	Infested	Total	
Abom 1.8 EC	47.6bc	9.5bc	57.1a	28.2
Tracer 45 SC	59.8a	2.3d	62.1a	61.3
NSKE	44.9c	11.5b	56.3a	21.0
Fytomax PM	46.4c	10.5b	56.9a	25.0
Proclaim 5 SG	52.2b	7.8c	59.9a	40.7
Untreated control	37.1d	18.5a	55.6a	-
CV (%)	9.1	11.4	8.7	-

Means within a column followed by same letter(s) are not different significantly (P=0.05) according to Duncan's Multiple Range Test (DMRT).

Economic analysis : The management cost, gross return, net return, adjusted net return of different environment friendly management approaches used against diamondback moth and prodania caterpillar was calculated and presented in Table 4. The highest MBCR of 7.8 was obtained from the plots treated with Tracer 45 SC and the second highest benefit cost ratio (6.9) was recorded from the plot treated with Proclaim 5 SG, followed by Abom 1.8 EC sprayed plot (4.3) and Fytomax PM sprayed plot (3.9). The lowest benefit cost ratio (3.7) was found with the NSKE treated plot.

Sparks *et al*. (1995) reported that Spinosad has relatively broad spectrum activity and has been effectively used for the control of many species of insect pests of Lepidoptera attacking various crops without any harmful effect to other arthropods. Efad *et al*. (2021) found the highest MBCR of 4.08 from the treatment Tracer 45 SC amongst selected environmental friendly approaches against brinjal shoot and fruit borer. With the similar kind of study using the eco-friendly IPM packages by Sultana (2016) found that the highest benefit cost ratio 4.32 was obtained from the treatment with Pheromone mass trapping + Bt (EG 7841) + SNPV and the second highest benefit cost ratio of 4.09 was recorded from the plot treated with Hand picking + Pheromone mass trapping + Bt (EG 7841) followed by Pheromone mass trapping + Bt (EG 7841) treated plot (3.81). The lowest benefit cost ratio of 2.26 was found in the treatment with cypermethrin10 EC. The marginal benefit cost ratio of this study was relatively higher compare to the study by Sultana (2016).

Table 4. Marginal benefit cost ratio (MBCR) analysis of selected eco-friendly management approaches against arthropod pests in cabbage grown during Rabi season 2020-21

Treatments	Management cost (Tk ha^{-1})	Gross return (Tk ha^{-1})	Net return (Tk ha^{-1})	Adjusted net return (Tk ha^{-1})	MBCR
Abom 1.8 EC	19960.0	475500.0	455540.0	84740.0	4.3
Tracer 45 SC	25942.0	597900.0	571958.0	201158.0	7.8
NSKE	16546.0	448500.0	431954.0	61154.0	3.7
Fytomax PM	18936.0	463600.0	444664.0	73864.0	3.9
Proclaim 5 SG	19040.0	521800.0	502760.0	131960.0	6.9
Untreated control	0.0	370800.0	370800.0	0.0	

Market value of Cabbage= Tk. 10.0 Kg^{-1}.

CONCLUSION

Management approach comprising of Tracer 45 SC (Spinosad) @ 0.4 g l^{-1} of water at 15 days interval might be an effective, suitable and viable tool for suppressing prodania caterpillar and/or diamondback moth attacking cabbage.

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