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MANAGEMENT OF APHID AND POD BORER OF COUNTRY BEAN USING BIO-RATIONAL PESTICIDES

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ABSTRACT

The study was conducted to evaluate the efficacy of some bio-rational pesticides, such as Biskatali and Neem leaf extracts, Tracer 45SC (Spinosad), Protect 5SG (Emamectin benzoate), Trix (liquid detergent), Neem and Mahogany oils against aphid and pod borer attacking country bean. Among the treatments, Tracer 45SC, Protect 5SG and Neem oil exerted the lowest aphid population and the lowest flower infestation at early, mid and late fruiting stages. Tracer 45SC, Protect 5SG and Neem oil revealed significantly lower levels of pod infestation compared to other treatments. Tracer 45SC, Protect 5SG and Neem oil also resulted significantly higher marketable yield than that of the control. The economic analysis of the treatments showed that the highest marginal benefit cost ratio was obtained from Tracer 45SC which was closely followed by Neem oil and Protect 5SG.

Keywords: Plant extract, oil, Emamectin benzoate, Spinosad, *Lablab purpureus*

Introduction

The important leguminous vegetable, country bean *Lablab purpureus* L., is cultivated about 20.9 thousand hectares of land in Bangladesh, and the annual production is 0.137 million metric tons (BBS 2018). Bean production in Bangladesh is severely affected by the infestation of aphid *Aphis craccivora* Koch (Hemiptera: Aphididae) and pod borer *Maruca vitrata* Fabricius (Lepidoptera: Pyralidae). Aphids attack the bean plants both in vegetative and reproductive stages and cause severe damage (Ahmed *et al*., 2019). Due to severe infestation, plants fail flowering and pod setting, and infested plants produce fruits having abnormal growth and shape, which may cause 26.0 - 39.0% yield loss (Ahmed *et al*. 2019). The pod borer larvae damage flower buds, flowers, green pods and seeds of country bean and thereby reduce 20.2 to 38.0% yield (Ahmed *et al*. 2015).

Bio-rational approaches in pest management incorporated pesticides which have specificity, safety to non-target organisms, decompose quickly, thereby resulting in lower exposures compared to conventional pesticides. According to the Environmental Protection Agency (EPA) of the United States of America, bio-pesticides are of three main categories namely microbial pesticides (in which a microorganism like bacterium, fungus, virus, or protozoan is the active ingredient), botanical pesticides (substances of plant origin) and biochemical pesticides (Rosell *et al*. 2008). Use of bio-rational pesticides against insect pest is however, a recent approach, which has drawn special attention to the entomologist all over the world. Bio-rational approaches such as plant extracts and oils are used in management programs of insect pests (Soares *et al*. 2019). Botanical extracts and oils have toxic effect on insect pests, and incapacitate their growth and reproduction (Ahad *et al.* 2016, Mazumder *et al.* 2016).

In Bangladesh, management of aphid and pod borer in country bean field is mostly relied on synthetic chemical insecticides because of its quick action and favorable cost-benefit ratio. Only a few attempts have been made to evaluate bio-rational management practices against insect pests (Miah *et al.* 2017). Considering the above facts of country bean and problems occurred due to the infestation of aphid and pod borer, the study was conducted to find out the effective bio-rational approaches for management of these insect pests of country bean.

Materials and Methods

The study was carried out in the experimental field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during October 2016 to March 2017.

The study site is situated at 24.12 N and 90.31 E with an elevation of 8.3 meter from the sea level.

Experimental design and cultivation of bean plants: The experimental field was divided into 24 equal plots (3m × 2m) with plot to plot distance of 0.5 m and block to block distance of 1.0 m. The experiment was set up in Randomized Complete Block Design (RCBD) with 3 replications of each treatment. The whole area of experimental field was divided into three blocks and each block was again divided into eight unit plots. The seeds of IPSA Seem-2 were collected from the Department of Horticulture, BSMRAU. Seedlings were raised in polyethylene bags. Twenty days old seedlings were transplanted in the experimental plots on November 12, 2017. Each plot contained only one row with 5 pits (60 cm distance from pit to pit). Fertilizers were applied according to the fertilizer recommendation guide **(**FRG 2018) and intercultural operations were done whenever necessary. Propping of each plant by bamboo sticks was done to facilitate creeping of the vine properly and to avoid their lodging.

Application of bio-rational pesticides: Seven bio-rational pesticide treatments were applied in the experimental field along with untreated plots (control). At the advent of the incidence of aphid, each treatment was applied in three plots and repeated six times at an interval of 7 days. The experimental treatments were Bishkatali and Neem leaf extracts, Tracer 45 SC (Spinosad), Protect 5SG (Emamectin benzoate), Trix (liquid detergent), neem and Mahogany oil, and control. Bishkatali and Neem leaf extracts were applied with concentration of 50ml/L water. Tracer 45 SC, Protect 5SG and Trix were applied with concentrations of 0.4ml, 2g/L and 20 ml/L water, respectively. Neem and Mahogany oils were applied with concentration of 5ml/L water. The treatments were applied with a hand sprayer. Bishkatali and Neem leaf extracts were prepared according to the method of Ahmed *et al*. (2019). Neem and Mahogany oils were collected from Bangladesh Agricultural Research Institute, Gazipur.

Observation of the abundance of aphid: To find out the significant reductions of aphid population with treatments and time, the abundance of aphid on the inflorescence was counted at 24, 48, and 72 h after first spray. The topmost inflorescence from the third plant of each row was used for counting the aphid abundance. The total number of bloomed flowers and the number of infested flowers of the topmost inflorescence from the third plant of each row were counted to calculate the flower infestation level. For this purpose, data were collected 72 h after the second (early blooming), fourth (mid-blooming), and sixth (late blooming) sprays. Three plants per treatment were evaluated for each observation.

Assessment of pod borer infestation: The experimental field was monitored daily to observe the infestation of pod borer. The damaged and undamaged pods were harvested ten times of which first three were considered as early fruiting stage, next four as mid fruiting stage and last three as late fruiting stage. At every harvest the number of infested pod in each treatment was calculated in to percentage.

Measurement of pod size and weight: The marketable mature pods (both fresh and infested) were harvested periodically. At the first harvest, 20 pods per treatment were randomly selected and their individual lengths and widths were measured using a millimeter scale, and the weights were taken using a digital balance (AG204, Mettler Toledo, Switzerland).

Estimation of pod yield and economic analysis: At every harvest, the plucked pods of each treatment were separated into marketable and infested categories and their weights were measured. The yield of each plot was converted into kg ha^{-1}. The economic analysis and marginal benefit-cost ratio (MBCR) were calculated based on the total expenditure for each treatment and the total return per hectare. The total expenditure for a treatment indicates the costs for labor and inputs. The gross return of a treatment is the total price obtained from the total yield of the treatment. The net return was calculated by subtracting the expenditure of a treatment from its gross return. The adjusted net return of each treatment was calculated by subtracting the net return of the control from the net return of the treatments. The MBCR is the result of the adjusted net return of a treatment divided by the total expenditure of the same treatment.

Data analysis: One-way analysis of variance followed by LSD was used for analyzing data.

Results and Discussion

The aphid populations on bean inflorescence at 24, 48 and 72 hours post treatments are presented in Table 1. The number of aphid at 24, 48 and 72 hours after spraying varied from 34.3 to 533.3, 29.3 to 557.3 and 33.3 to

Table 1. Effect of different bio-rational approaches on the population abundance of aphid on the inflorescence of country bean

Treatment	Number of aphid / inflorescence at		
	24 HAT	48 HAT	72 HAT
Biskatali leaf extract	102.7c	79.3c	83.7c
Neem leaf extract	79.7d	64.3d	69.3d
Tracer 45 SC	34.3g	29.3g	33.3g
Protect 5SG	47.3f	38.7f	42.3f
Trix	108.3b	87.0b	89.0b
Neem oil	49.7f	39.0f	43.7f
Mahogany oil	71.7e	48.3e	48.7e
Control	533.3a	557.3a	578.0a

Means within a column followed by same latter(s) are not different significantly by LSD at $p \leq 0.05$. HAT: Hours after treatment.

578.0 inflorescence^{-1}, respectively and the results differed significantly. All the treatments revealed significantly lower aphid population than control. The lowest numbers of aphid were found in Tracer 45SC treated plots.

Table 2 showed that flower infested by aphid at early, mid and late blooming stages among the treatments ranged from 17.7 to 35.4%, 14.4 to 37.5% and 13.3 to 40.4%, respectively and the results differed significantly. All the treatments showed significantly lower percentage of flower infestation than control. Among the treatments, the lowest percentages of infestation were found in the Tracer 45SC.

The effect of bio-rational pesticides on the pod infestation of country bean by pod borer is presented in table 3. Results showed that the pod infestation level at early, mid and late fruiting stages ranged from 4.5 to 12.2%, 3.4 to 14.1% and 4.5 to 14.4%, respectively, and the results differed significantly. All the treatments revealed significantly lower level of infestation compared to control and the lowest infestations were found in Tracer 45 SC plots.

Bio-rational insecticides have repellent, antifeedant and mortality effect on herbivore insects and affect their reproduction, growth and development thus reduces their population and infestation. In this study, the tested bio-rational insecticides revealed significantly lower level of abundance and infestation of pests. These findings are in accordance with Amin *et al*. (2017a) and Mohammad *et al.* (2018) who sequentially applied bio-pesticide, botanical and chemical insecticide to manage aphid and pod borer attacking yard long bean and observed reduction of population and infestation. Mortality and physiological effects of plant materials on different insects have been reported by many authors (Amin *et al*. 2017b, Amin *et al*. 2017c).

As indicated in Table 4, the length, width and weight of bean pods among the treatments ranged from 6.4 to 7.3 cm, 1.6 to 1.9 cm, and 4.6 to 5.1 g, respectively. All the treatments had significantly higher length, width and weight of pods compared to control. Neem and

Table 2. Effect of different bio-rational approaches on the flower infestation of country bean by aphid

Treatment	% Flower infestation at different stages		
	Early blooming	Mid blooming	Late blooming
Biskatali leaf extract	27.9b	27.1b	25.8b
Neem leaf extract	26.5c	25.3c	23.2d
Tracer 45 SC	17.7f	14.4f	13.3g
Protect 5SG	20.7e	19.2e	17.5f
Trix	25.6c	25.3c	24.4c
Neem oil	21.9e	20.0e	18.1f
Mahogany oil	23.7d	21.4d	19.8e
Control	35.4a	37.5a	40.4a

Means within a column followed by same latter(s) are not different significantly by LSD at $p \leq 0.05$.

Table 3. Effect of different bio-rational approaches on the pod infestation of country bean by pod borer

Treatment	% Pod infestation at		
	Early fruiting	Mid fruiting	Late fruiting
Biskatali leaf extract	8.1 bc	7.1 c	8.9 bc
Neem leaf extract	7.7 bc	6.1 d	7.4 c
Tracer 45 SC	4.5 e	3.5 f	4.5 ef
Protect 5SG	6.0 c	4.3 e	5.6 d
Trix	9.1 b	8.9 b	10.1 b
Neem oil	5.4 d	4.6 e	4.9 e
Mahogany oil	6.4 c	5.3 de	6.0 cd
Control	12.2 a	14.1 a	14.4 a

Means within a column followed by same latter(s) are not different significantly by LSD at $p \leq 0.05$.

Table 4. Morphometrics of country bean pods under management practices of aphid and pod borer using different bio-rational approaches

Treatment	Pod morphometrics		
	Length (cm)	Width (cm)	Weight (g)
Biskatali leaf extract	7.0 ac	1.8 bc	4.8 bc
Neem leaf extract	7.1 ac	1.8 ab	4.9 b
Tracer 45	6.4 d	1.7 d	4.7 cd
Protect 5SG	6.5 d	1.6 d	4.7 de
Trix	6.9 bc	1.7 c	4.7 de
Neem oil	7.3 a	1.9 a	5.1 a
Mahogany oil	7.2 ab	1.8 ab	5.01a
Control	6.8 c	1.7 cd	4.6 e

Means within a column followed by same latter(s) are not different significantly by LSD at $p \leq 0.05$.

Mahogany oil treated plants have identical and the highest pod length, width as well as pod weight. These results are in agreement with Ahmed *et al*. (2019) who observed significantly longer, wider and heavier pods of country bean in bio-rational treatments compared to control. In the present study, beans grown under control (untreated) conditions were shorter, narrower, and lighter. In addition, aphid nymphs and adults sucked sap from the developing pods, and borer caused infestation of these control beans without any hindrance, thereby affecting pod growth. However, the crops grown under different bio-rational treatments had longer, wider, and heavier pods because of the lower abundance and infestations of the insects.

The marketable yield among the treatments ranged from 10.7 to 14.4 t ha^{-1} and the results showed that bio-rational treatments exerted higher yields than control (Table 5). The costs of the different bio-rational management approaches obtained from the study showed that the cost was highest for Tracer 45SC (36725TK/ha). The highest gross return (432000 TK/ha), net return (395275 TK/ha), adjusted net return (74275 TK/ha) and MBCR (2.0) were also obtained from the Tracer 45SC (Table 5). The treatments reduced abundance and infestation of aphid and pod borer and contributed to higher yields. The yield reduction in the control treatment could be attributed to the feeding activities of the nymph and adult aphids and the larvae of pod borer. The gross return, net return, adjusted net return, and marginal benefit-cost ratio of the treatments varied with their management expenditure and their yield.

The tested bio-rational pesticides significantly reduced the abundance and infestation of aphid and pod borer in field condition and resulted higher yield of country bean. However, the approaches are slightly expensive but exerted higher marginal benefit-cost ratio. These environment friendly management tactics may be incorporated in the integrated management program of aphid and pod borer in bean fields.

Table 5. Yield of country bean and marginal benefit cost ration in different bio-rational management approaches agonist aphid and pod borer

Treatment	Pest Management cost (Tk/ha)	Yield (t/ha)	Gross return (Tk/ ha)	Net return (Tk/ha)	Adjusted net return (Tkha)	MBCR
Biskatali leaf extract	27625	12.5	375900	346325	27275	1.0
Neem leaf extract	27625	12.7	381900	352325	33275	1.2
Tracer 45	36725	14.4	432000	395275	74275	2.0
Protect 5SG	34825	14.1	421800	386975	65975	1.9
Trix	29225	12.7	381000	351775	30775	1.1
Neem oil	30850	13.7	411000	375050	54050	1.9
Mahogany oil	31600	13.3	399900	373630	43400	1.5
Control	00	10.7	321000	321000	-	-

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