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Efficacy of Insecticides in Decreasing the Population of Aphids (*Aphis fabae*) and Pod Borer (*Maruca vitrata*) in Country Bean

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A b s t r a c t

Country bean, *Lablab purpureus* Linn, is one of the most significant legume crops, although its growth and production are declining due to pest infestations, particularly from aphids and pod borers. This experiment aimed to determine the efficacy of three insecticides, viz. Confidor 70WG (Imidacloprid) @ 0.2 ml/L, Bio-neem Plus (Azadirachtin) @ 5 ml/L and BotaniGard® 22WP (*Beauveria bassiana*) @ 2 ml/L against bean aphid, *Aphis fabae* Scopoli and Pod borer, *Maruca vitrata* Fabricius. Four sprays were applied, and cumulative means were calculated. Data on aphids per plant, pod borers per flower, and pod were collected at 1, 3, and 7 days after spraying (DAS). Imidacloprid showed the highest reduction in the aphid population (84.77%), followed by Azadirachtin (70.96%) and *B. bassiana* (61.38%). Imidacloprid also reduced pod borers on flowers by 73.92%, while botanical and microbial insecticides showed slower effects with reductions of 37.69% and 33.85%, respectively. Imidacloprid was most effective in reducing pod borers on pods (66.38%). All treatments performed better than the control in lowering populations of aphids and pod borers. Imidacloprid produced the greatest increase compared to the control group, yielding 6.523 t/ha. Azadirachtin followed closely with a yield of 5.92 t/ha, and *B. bassiana* yielded 5.08 t/ha. Hence, Imidacloprid is suggested as an effective solution for controlling aphids and pod borers in bean cultivation in Bangladesh.

Key Words: Bean aphids, efficacy, insecticides, and pod borer.

Introduction

A widely grown and popular vegetable in Bangladesh is the country bean, *Lablab purpureus* Linn, referred to as "sheem" in general, which belongs to the Leguminosae family. Fresh pods and green seeds are consumed as vegetables, whilst mature and dried seeds are utilized as pulses. Beans contain a protein content that varies from 20 to 25% (Akpapunam, 1996).In addition, the pod also provides minerals like calcium, magnesium, phosphorous, potassium, iron, sulfur, and sodium (Gopalan *et al*., 1982).

Bangladeshi farmers suffer yearly production losses in country beans due to numerous insect pests' harsh attacks. Approximately 12-30% of country bean harvest is lost to pest infestations (Hossain, 1990). Conversely, rising temperatures and CO_2 emissions lead to irreversible droughts and rains, exacerbating pest issues and making conventional pest management techniques less effective (Amin *et al*., 2013). There are several pest species of country bean. Among them, bean aphids, Aphis fabae (Scopoli), and bean pod borer *Maruca vitrata* (Fabricious) are the most devastating insect pests (Allen, 1996).

Bean aphid (*Aphis fabae*) attacks plant tissue with toxic saliva (honeydew), which attracts saprophytic fungi on leaf surfaces, quickening ageingand shrinking photosynthetic area, depriving the plant and the developing grains in the pods of nutrients and decreasing yields (Chacko M., 2011). The pod borer's larvae were found to infest the terminal shoots, flower buds, flower and pods (Veeranna *et al*., 1999).

Nowadays, insect pest management approaches rely almost entirely on chemical insecticides because they produce immediate results. Since most of our population is illiterate, they arbitrarily employ pesticides (Sultana *et al*., 2020). Bangladeshi farmers, for example, spray insecticides 84 to 140 times per growing season, particularly in intense rural bean-producing areas such as Jessore (Anonymous, 2006).This overuse, misuse, and the way of using cause drifting loss to the nearest crop and in the atmosphere, which

results in pest resurgence, stimulation of the reproductive rate in certain pests, secondary pest outbreaks, mortality of beneficial insects, resistance of pest species, and finally environmental pollution (Alam *et al*., 2005).

Biological pesticides, often known as bio-pesticides, are effective and sustainable means to deal with insect problems. The Environmental Protection Agency (EPA) of the United States claims that bio-pesticides are insecticides made from naturally occurring substances, including bacteria, plants, animals, and minerals. Therefore, "bio-pesticides" refers to plant-incorporated protectants (PIPs), microbial pesticides, biochemical pesticides, and helpful insects (Osman *et al*., 2015).

Therefore, bio-rational insecticides such as bio-neem and *Beauveria bassiana*, along with imidacloprid, were selected for their efficacy against bean aphids and bean pod borers. This study was conducted to determine the relative efficacy of several insecticides against bean aphid and pod borer infestation in field conditions, giving farmers a low-cost and efficient way to control these insects.

Materials and Methods

Experimental site and location

The research was conducted at Bangladesh Institute of Nuclear Agriculture (BINA) Farm, Bangladesh Agricultural University campus, Mymensingh, located at 24.75° N latitude and 90.5° E longitudes at a mean elevation of 7.9 to 9.1m above the sea level. The soil of the field experiment area was under the Old Brahmaputra Alluvial Tract under the Agro-Ecological Zone 9 (UNDP & FAO, 1988), with sandy loam soil and texture that had good irrigation and drainage facilities. The mean annual temperature, rainfall, and relative humidity are 25°C, 200mm, and 79.8%, respectively (based on the last 10 years of data measured in the local weather yard).

Design of the field experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. Four sprayings with selected insecticides were given at 10-day intervals after pests (*Aphis fabae* and *Maruca vitrata*) had infested field conditions. Spraying was done between 9:00 and 11:00 AM to avoid bright sunshine and drift caused by strong wind.

Where Treatments are;

T1= Bio-neem plus1% EC (Azadirachtin) @ 2 mL/L,

T2= Bio-neem plus1% EC (Azadirachtin) @ 2 mL/L

T3= BotaniGard® 22 WP (*Beauveria bassiana*) @ 5 g/L

T4= Control (Untreated)

Land preparation and variety selection

The entire experimental field was divided into twelve plots. Among them, nine plots were treated with various treatments and the remaining three were used to study as untreated. As per recommendations, two adjacent unit plots and blocks were separated by 1 m apart from both sides to facilitate different intercultural operations. All the agronomic practices were done to develop healthy plants for conducting experiments. Bamboo stalking was made for propping, allowing easy standing and preventing the plant from lodging. A local variety of country beans named “Sheem Kartika” was selected for the experiment. Three seedlings were sown in each pit of the experimental plot.

Data Collection

Firstly, the pretreated data was collected by visual searches with the help of a magnifying glass and tally counter from each count it had been made a day before 1st spraying, and post-treatment counts were made @3, 7, and 10 days after each spray. Data were collected based on some parameters viz. the number of aphids per plant, percent reduction of aphid population, number of pod borer larvae per flower and pod, percent reduction of pod borer population, and the marketable yield of pods (t/ha). To estimate the mean number of aphids per plant, nine plants were randomly selected from three plots (3 plants/plot) and tagged with a marker for counting accuracy. Then, five twigs were selected randomly

Table 1. Bio- efficacy of selected pesticides on bean aphid in the field

Treatments	Mean no. of aphid population (5twig/plot)								CumulativeMean	(%) Reduction over control
	Before spray	1st spray	Before spray	2nd spray	Before spray	3rd spray	Before spray	4th spray		
T_1(Imidacloprid-Confidor)	35.33	11.67b	19.00c	6.00b	11.33b	2.56c	19.00c	2.22c	5.62c	84.77
T_2(Azadirachtin-Bioneem)	51.00	19.56b	17.00c	9.67b	10.66b	8.44b	17.00c	6.78b	11.12b	70.96
T_3(*Beauveria bassiana*-BotaniGard)	55.66	20.89b	37.00b	19.33b	19.00b	10.5b	37.00b	7.66b	14.61b	61.38
T_4 (Control)	35.00	48.44a	55.33a	42.33a	80.66a	39.89a	55.33a	29.25a	39.98a	
$LSD_{0.05}$		14.14	8.26	14.18	10.81	3.27	8.26	1.63	4.37	
Level of significance	ns	*	*	*	*	*	*	*	*	
CV(%)	36.75	28.16	12.89	24.01	17.9	16.41	12.89	7.09	15.33	

The means of similar letter (s) in a column do not differ significantly. **= Significant at 5% level, CV= Co-efficient of Variation, LSD= Least Significant difference

Table 2. Bio-Efficacy of selected insecticides against bean pod borer larvae on flower in the field

Treatments	Mean no. of pod borer larvae per flower				Cumulative Mean	(%) Reduction over control
	Before spray	2nd spray	Before spray	3rd Spray		
T_1(Imidacloprid-Confidor)	18.33	4.7c	11.00	2.0c	3.39c	73.92
T_2(Azadirachtin-Bioneem)	20.67	9.6b	15.00	6.7b	8.1b	37.69
T_3(*Beauveria bassiana*-BotaniGard)	14.66	9.6b	13.33	7.6b	8.6b	33.85
T_4(Control)	11.66	16.00a	16.00	10.0a	13.0a	
$LSD_{0.05}$		3.21		1.2	4.00	
Level of significance	ns	**	ns	**	**	
CV(%)	19.98	16.17	19.92	9.86	15.25	

The means of similar letter (s) in a column do not differ significantly. **= Significant at 5% level, CV= Co-efficient of Variation, LSD= Least Significant difference

from each plant, and insect populations were counted by visual searches before the spray date and at 1, 3, and 7 days after the first, second, third, and fourth spraying of insecticides. Finally, a mean value was found for nine plants and expressed as the number of aphids/plants. For estimating the mean number of pod borer larvae, similar procedures were followed as aphids. Mature pods were harvested from the experimental plots at 7-day intervals. After harvesting, infested and healthy pods were kept separately, and then the weight of healthy/marketable pods was recorded carefully. The final yield was expressed in tons per hectare. The percentage of reduction in aphids and pod borer population was calculated according to Zaman (2009). The data were analyzed statistically by variance analysis (ANOVA) with the help of the computer package MSTAT-C. The means were separated using Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) tests when necessary.

Results

Bio-efficacy of selected pesticides on bean aphids in the field

The comparative efficacy of the insecticides was evaluated by considering the mean aphid population in the field at four different sprays presented in Table 1. The cumulative mean of four sprays was 5.62, indicating that Imidacloprid (T1) caused the most significant reduction in the aphid population. Azadirachtin (T2) was 11.12, significantly lower than the control but less effective than imidacloprid. *Beauveria bassiana* (T3) treatment was 14.61, substantially lower than the control (Table 1).

Percent reduction of aphid population in the field

The highest percentage reduction of aphid population over control was observed from the plots treated with Imidacloprid (Confidor 70WG) (84.77%). The use of Azadirachtin (Bio-neem plus1% EC) (70.96%) and *Beauveria bassiana* (61.38%) caused comparatively lower control of the aphid population than Imidacloprid (Table 1).

Bio-Efficacy of selected insecticides against bean pod borer larvae on flowers in the field

The data of mean pod borer larvae/flower of two sprays and the cumulative mean of these sprays are presented in Table 2. The efficacy of Imidacloprid (T_1) against pod borer larvae/flower in the field condition was significantly reduced to 4.7 after 2nd spray which was further reduced to 2.0 after 3rd spray. The cumulative mean of two sprays was 3.39, which showed the highest pod borer larvae reduction from the chemical insecticide, Imidacloprid (T_1). Azadirachtin reduced the mean larval population from 9.6 to 6.7 following the 2nd and 3rdsprays which was lower than the control but less effective than Imidacloprid. The mean number of pod borer larvae with *Beauveria bassiana*(T_3) treatment was significantly reduced to 8.6, less effective than Imidacloprid.

Percent reduction of pod borer larvae/flower in the field

All the treatments significantly reduced the larval population over control. The highest percent (73.92%) of pod borer larvae/flowers were controlled by the use of Imidacloprid (T_1) treatment. However, the use of Azadirachtin (T_2) (37.69%) and *Beauveria bassiana* (T_3) (33.85%) showed comparatively lower control of larvae/flowers over control than T_1(Table 2).

Table 3. Efficacy of insecticides on pod borer larvae on pod in the field

Treatments	Mean number of pod borer larvae per pod				Cumulative Mean	(%) Reduction over control
	Before spray	3rd spray	Before spray	4th spray		
T_1(Imidacloprid-Confidor)	6.67	2.3b	11.0a	2.31c	2.31c	66.38
T_2(Azadirachtin-Bioneem)	9.7	3.11b	15.0a	4.01bc	3.56bc	48.18
T_3(*Beauveria bassiana*-BotaniGard)	6.0	3.2b	9.33b	4.98b	4.09b	40.47
T_4(Control)	3.0	6.5a	7.0a	7.23a	6.87a	-
$LSD_{0.05}$		1.34	2.30	1.2	1.64	-
Level of significance	Ns	**	**	**	**	-
CV(%)	31.346	17.83	10.92	9.802	12.24	-

The means of similar letter (s) in a column do not differ significantly. **= Significant at 5% level, CV= Co-efficient of Variation, LSD= Least Significant difference

Efficacy of insecticides on pod borer larvae on pod in the field

The number of pods damaged by pod borer larvae was monitored after the third and fourth applications of insecticides. After the third spray, it was observed that Imidacloprid (T1) treated plants had the fewest larvae per pod (2.3) (Table 3). Bio-neem plus (T2) showed a slightly higher number 3.11 than Imidacloprid and *Beauveria bassiana* (T3) showed an almost similar result (3.2) of bio-neem. Similarly, following the 4th spray, Imidacloprid (T1) treated plants again had the lowest number of larvae per pod (2.31). The use of Azadirachtin led to a slightly higher count (4.01 larvae per pod) compared to Imidacloprid, while the highest count (4.98 larvae per

pod) was observed with *Beauveria bassiana* (T3) (Table 3). Cumulative mean data proved that Imidacloprid showed much more efficacy against pod borer larvae than the two other treatments.

Percent reduction of pod borer larvae/pod in the field

It has been observed that the highest percentage (66.38%) of reduction of pod borer larvae over control was found in Imidacloprid (T_1) treated plants in field conditions. The least efficacy was recorded in *Beauveria bassiana* (T_3) treatment with 40.47% larval infestation. However, Azadirachtin showed a slight efficacy (48.18%) than *Beauveria bassiana* (Table 3).

Effectiveness of selected insecticides on yield data in field condition

The resultant effects on the yield of marketable and infested pods (ton/ ha) due to the application of three different insecticides were found to significantly increase the yield of marketable bean pods compared to untreated control (Table 3). The best result was found in Imidacloprid (T_2) treatment and mean yield of 6.523 t/ha, 48.75% more than the untreated plants. Yield of Azadirachtin (5.92 t/ha)) and *Beauveria bassiana (*5.08 t/ha) treated plants also showed satisfactory results. The percentage increase in yield was 43.53% and 34.27%, respectively (Table 4).

Table 4. Yield of bean for application of selected pesticides in the field

Treatments	Yield (t/ha)	(%) Increase over control
T_1 (Imidacloprid-Confidor)	6.52a	48.75
T_2 (Azadirachtin- Bioneem plus)	5.92ab	43.53
T_3 (*B. bassiana*-BotaniGard)	5.08b	34.27
T_4(Control)	3.34c	-
$LSD_{0.05}$	0.84	-
Level of Significance	**	-
CV (%)	8.09	-

The means of similar letter (s) in a column do not differ significantly. **= Significant at 5% level, CV= Co-efficient of Variation, LSD= Least Significant difference

Discussions

The study demonstrated that Imidacloprid (Confidor) is the most effective insecticide for reducing aphid populations on bean plants, achieving an 84.77% reduction. This is consistent with previous findings by Cermeli et al. (2002), who reported an 85.97% reduction in aphid populations with Imidacloprid. Azadirachtin (Bioneem) and Beauveria bassiana (BotaniGard) also showed significant efficacy but were less effective than Imidacloprid. On okra crops, Indira Gandhi *et al*. (2006) tested the efficiency of Neem oil as a seed treatment in comparison with Imidacloprid against aphids and jassids and found excellent protection by Neem oil from both the sucking pests up to 45 days after treatment. This result also matched the present study, in which neem-treated plants showed a mean percentage reduction of 70.96 after the fourth spray.

Kumar *et al.* (2014) observed similar results, with the maximum number of pod borer larvae reduced from imidacloprid, 17.8SL @ 0.003% treated plots, supporting this experiment. The treatment with Beauveria bassiana (T3) recorded the lowest efficacy, with a larval infestation of 40.47%. This finding was related to the results of Douro Kpindou *et al.* (2012) found pod borer mortality rates ranging from 58% to 74% through *Beauveria bassiana.* However, Azadirachtin exhibited slightly higher efficacy (48.18%) than Beauveria bassiana (Table 3).Rouf and Sardar (2011) and Ramasubramanian and Babu (1989) recorded a significant reduction in flower and pod damage due to spotted pod borer in *Lablab purpureus* with foliar application of neem seed kernel extract (NSKE).

The study's findings on the impact of insecticide treatments on bean pod yield are particularly noteworthy. The plots treated with Imidacloprid yielded 6.52 t/ha, a significant increase of 48.75% compared to the control. This result nearly matched the Jakhar *et al*. (2018) experiment, in which they observed that 7.625 (t/ha) of Imidacloprid 17.8 SL produced the highest bean (*Lablab purpueus*) yield.

Conclusions

The study concluded that all tested insecticides, viz. Imidacloprid, Azadirachtin, and *Beauveria bassiana* were effective against aphid and pod borer populations, returning the maximum marketable yield and minimum infested yield of beans. Of all the treatments, Imidacloprid was the most effective at eliminating insect pests and making healthy pods. This treatment, therefore, could be recommended to the farmers for the sustainable management of bean aphid and pod borer. Azadirachtin and *Beauveria bassiana* also performed well and can be recommended as bio-pesticides.

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