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Exploring sustainable approaches for managing pod borer insect in yard long bean

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Abstract

Yard long bean (*Vigna unguiculata* ssp. *sesquipedalis*) is an important vegetable legume in Bangladesh, yet its productivity is severely constrained by insect pests, particularly by the pod borer, *Euchrysops cnejus* F. This study evaluated the efficacy and economic viability of selected biopesticide and reduced-risk insecticide based management options against pod borer infestation in yard long bean during Kharif season of 2023 at Entomology Research Field, Bangladesh Agricultural Research Institute, Gazipur. Treatments included sanitation (hand picking and destruction of infested flowers and pods with larvae) combined with spraying biopesticides (*Bacillus thuringiensis*, *Celastrus angulatus*, matrine), a green chemical insecticide (spinetoram), farmers' conventional practice (emamectin benzoate), and an untreated control. Sanitation combined with spraying spinetoram resulted in the lowest flower (4.82%) and pod (5.25%) infestation and the highest yield (13.82 t ha^{-1}), followed closely by sanitation combined with spraying *B. thuringiensis* and farmers' conventional practice. However, the highest marginal benefit-cost ratio (8.89) was obtained with sanitation combined with spraying *B. thuringiensis*. The findings indicated that sanitation combined with spraying *B. thuringiensis*, was an effective, economically viable, and environmentally sustainable management strategy for pod borer.

Keywords: Biochamak, biotrin, biocure, *Euchrysops cnejus,* sanitation, *Vigna unguiculata*

Introduction

Yard long bean, *Vigna unguiculata* ssp. *sesquipedalis* is a popular leguminous vegetable grown in Bangladesh and plays a significant role in vegetable-based nutrition and farm income. Although traditionally grown during summer season, increasing market demand has encouraged farmers to cultivate this crop year-round. The productivity of this crop in Bangladesh remains substantially lower than that reported in many other Asian countries. There are many constraints in the production of the crop, of which attack of insect pests cause considerable yield loss of the crop. Previous studies have documented at least nine insect species attacking yard long bean at different growth stages (Uddin *et al.* 2013). Among them the pod borer, *Euchrysops cnejus* (Lepidoptera: Lycaenidae) is one of the most destructive pests, causing severe losses in both yield and market quality (Dutta *et al.* 2020). The larvae initially bore into flower buds and flowers, feeding on tender parts such as anthers and pollens and later infest developing pods by feeding on immature seeds (Patel *et al*. 1998). Heavy infestation leads to flower abortion, malformed pods, and significant yield reduction.

Management of pod borer in yard long bean relies predominantly on synthetic insecticides. Studies have shown that chemical insecticides remain the most commonly used control method in pulse and vegetable legume crops (Karim 1995). In intensive vegetable-growing areas of Bangladesh, farmers often apply pesticides indiscriminately, sometimes as frequently as three to four sprays per week. Such practices have resulted in pesticide resistance, resurgence of secondary pests (Hagen and Franz, 1973), health risks to farmers and consumers (Bhaduri *et al*. 1989) and environmental pollution (Fishwick 1988). The indiscriminate use of broad-spectrum insecticides is particularly concerning for yard long bean, which is consumed as a fresh vegetable. Excessive pesticide residues pose serious food safety risks and negatively affect export potential. Moreover, repeated application of conventional insecticides disrupts populations of natural enemies, undermining ecological pest regulation (Mrong *et al.* 2024).

In response to these challenges, biopesticides and reduced-risk or "green" chemical pesticides are gaining

popularity worldwide due to their lower toxicity, environmental compatibility, and suitability for integrated pest management (IPM) programs. Botanical insecticides, microbial pesticides such as *Bacillus thuringiensis*, and newer insecticides with novel modes of action can effectively manage pests while minimizing adverse effects on non-target organisms and human health. However, information on the comparative effectiveness and economic feasibility of such biorational management options against pod borer in yard long bean under Bangladesh agro-ecological conditions remains limited. Therefore, the present study aimed to evaluate the efficacy, and cost-effectiveness of selected biopesticides and green chemical insecticides integrated with sanitation practices, with the goal of identifying a sustainable and farmer-friendly management strategy for pod borer in yard long bean production.

Materials and methods

The field experiment was conducted in the research field of Entomology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur during Kharif 2023. Yard long bean seeds of Toki (Hybrid) variety were sown in a plot of 4.8m x 2.5m. The experiment was laid out in RCBD having 3 replications and 6 treatments including control. Standard agronomic practices were followed to raise the crop. Treatment applications were started as soon as the infestation of pod borer was noticed. The crop was fertilized with Cowdung 15 t ha^{-1}, Urea 50 kg ha^{-1}, TSP 150 kg ha^{-1}, MP 150 kg ha^{-1}, Gypsum 100 kg ha^{-1}, Zn Sulphate 12 kg ha^{-1} and Borax 12 kg ha^{-1} as prescribed by Rashid *et al*. (2009). Sucking pests especially the aphid, jassid and thrips were controlled with spraying Acetamipirid 50SP @ 1g/litre of water.

Treatments were initiated at the first appearance of pod borer infestation. The following management options were evaluated: T_1= Four times sanitation (hand-picking and destruction of infested flowers and pods containing larvae) plus four sprays of Bio-chamak 1% EW (*Celastrus angulatas*) at 2.5 ml/litre of water, applied at fortnightly intervals; T_2= Four times sanitation plus four sprays of Solaris (Spinetoram 11.7 SC) at 1.0 ml/ litre of water, applied at fortnightly intervals; T_3= Four times sanitation plus four sprays of Biocure (*Bacillus thuringiensis*) at 1g/ litre of water, applied at fortnightly intervals; T_4= Four times sanitation plus four sprays of Biotrin (Matrine) at 1.5 ml/ litre of water, applied at fortnightly intervals; T_5=

Table 1. Details of the pestcides used in the experiment

Trade name	Common name	Group/Class/ mode of action
Bio-chamak	*Celastrus angulatus*	Natural bio-pesticide derived from *Celastrus angulatus* - a type of perennial herb. Destroys the function of the insect's stomach, causing the insect to die quickly due to starvation.
Solaris	Spinetoram	A semi-synthetic insecticide derived from the soil bacterium *Saccharopolyspora spinosa*. It is a broad-spectrum insecticide and effective against a wide range of pests, including lepidopterous larvae, leafminers, and thrips. It works by disrupting the insect's nervous system.
Biocure	*Bacillus thuringiensis*	*Bacillus thuringiensis* (Bt) is a naturally occurring bacterium generally found in soils. Bt acts like a stomach poison where proteins react with the cells of the insect gut lining causing paralysis to the digestive system.
Biotrin	Matrine	Broad-spectrum botanical biopesticide extracted from plants like *Sophora flavescens*. Control a variety of pests viz. aphids, caterpillars, and thrips etc. It acts as a contact and stomach poison, paralyzing insects' nervous systems. It has also repellent action.
Proclaim	Emamectin benzoate	A semi-synthetic insecticide from the avermectin class used against variety of insect pests, particularly caterpillars. It works by disrupting the insect's nervous system, causing paralysis and death. It posses both contact and stomach action with good translaminar properties.

Farmers' practice: Eight weekly sprays of Proclaim 5 SG (Emamectin benzoate) at 1g/litre of water; T_6= Untreated control.

Details of the pesticides used in the experiment are given in Table 1. The pesticide spraying was started at the initiation of the pest attack. Numbers of healthy and infested flowers were counted and recorded from 20 randomly selected rachis per plot. At each harvest number and weight of healthy and infested pods were recorded and percent fruit infestation and yield (t/ha) was calculated. Moreover, marginal benefit cost ratios (MBCR) of different treatments were also calculated following Ali *et al.* (1996). Data were analyzed by using R software for analysis of variance following randomized completely block design (RCBD) and treatment means were separated by applying DMRT at 5 % level of significance.

Results

The incidence of flower infestation by *Euchrysops cnejus* differed significantly among treatments (Table 2). The lowest flower infestation was recorded in treatment T_2 (sanitation + spinetoram 11.7 SC), with a mean infestation of 4.82%, representing a 74.16% reduction compared with the untreated control. This level of infestation was statistically similar ($p \leq 0.05$) to that observed in T_5 (farmers' practice: emamectin benzoate; 5.82%), T_3 (sanitation + *Bacillus thuringiensis*; 6.02%), and T_1 (sanitation + *Celastrus angulatus*; 6.14%). In contrast, the untreated control (T_6) plots showed the highest flower infestation (18.65 %), which was significantly greater than all other treatments. Treatment T_4 (sanitation + matrine) showed a moderate level of flower infestation (6.97%), but remained significantly higher than T_2. Pod infestation by pod borer also varied significantly among treatments (Table 2). The lowest pod infestation (5.25%) was observed in T_2, which was statistically at par with T_3 (6.35%) and T_5 (6.55%). These treatments resulted in 73.91%, 68.44%, and 67.45% reductions in pod infestation, respectively, compared with the untreated control. The untreated control recorded the highest pod infestation (20.12%), indicating severe damage under unprotected conditions. Treatment T_4 resulted in a pod infestation of 9.32%, although significantly lower than the control.

Significant differences in pod yield were observed among the treatments (Table 3). The highest marketable pod yield was obtained from T_2, yielding 13.82 t ha^{-1}, which was statistically comparable to yields obtained from T_3 (13.02 t ha^{-1}) and T_5 (13.08 t ha^{-1}). These treatments resulted in yield increases of 47.02%, 38.51%, and 39.15%, respectively, over the untreated control. The untreated control produced the lowest yield (9.40 t ha^{-1}), reflecting the negative impact of high pod borer infestation. Treatment T_4 produced a moderate yield of

Table 2. Treatment wise flower and pod infestation of yard long bean by pod borer at BARI experimental field, Gazipur, during 2023

Treatments	Flower infestation by borer (%)	Flower infestation reduction over control (%)	Pod infestation by borer (%)	Pod infestation reduction over control (%)
T_1: Sanitation + Biochamak	6.14bc	67.08	7.32c	63.62
T_2: Sanitation + Solaris	4.82c	74.16	5.25d	73.91
T_3: Sanitation + Biocure	6.02bc	67.72	6.35cd	68.44
T_4 Sanitation + Biotrin	6.97b	62.63	9.32b	53.68
T_5: Farmers' practice (Proclaim 5 SG spray)	5.82bc	68.79	6.55cd	67.45
T_6: Untreated Control	18.65a	-	20.12a	-
CV%	10.92		7.89	

Means having same letter(s) in a column are not significantly different at P> 0.05 followed by DMRT

Table 3. Effect of different treatments on the yield of yard long bean at BARI, Gazipur, 2023

Treatments	Marketable yield (t/ha)	% Yield increase over control
T_1: Sanitation + Biochamak	12.45b	32.45
T_2: Sanitation + Solaris	13.82a	47.02
T_3: Sanitation + Biocure	13.02ab	38.51
T_4: Sanitation + Biotrin	11.02c	17.23
T_5: Farmers' practice (Proclaim 5 SG spray)	13.08ab	39.15
T_6: Untreated Control	9.40d	-
CV %	4.58	-

Means having same letter(s) in a column are not significantly different at P> 0.05 followed by DMRT

11.02 t ha^{-1}, whereas T_1 resulted in a yield of 12.45 t ha^{-1}, both significantly higher than the control but lower than T_2.

The correlation between flower infestation and pod infestation by pod borer in yard long bean is represented in Figure 1. The relationship was significant, and it was observed that pod infestation by pod borer in yard long bean increased with the increase of flower infestation. Whereas, the correlation between pod infestation and yield of yard long bean is represented in Figure 2. The relationship was significant and it was observed that around 87% yield would be affected by pod infestation in yard long bean crop.

The marginal benefit-cost ratio (MBCR) varied widely among treatments (Table 4). The highest MBCR (8.89) was obtained from T_3 (sanitation + *Bacillus thuringiensis*), indicating superior economic viability due to relatively low input costs combined with substantial yield gains. The farmers' practice (T_5) resulted in an MBCR of 3.81, reflecting moderate profitability. Despite its superior efficacy, T_2 produced the lowest MBCR (2.20) owing to the high cost of spinetoram. Treatments T_1 and T_4 recorded MBCR values of 2.84 and 2.61, respectively, indicating moderate economic returns. These results suggest that while spinetoram-based management offers excellent pest control, biopesticide-based approaches provide more economically sustainable options for smallholder farmers.

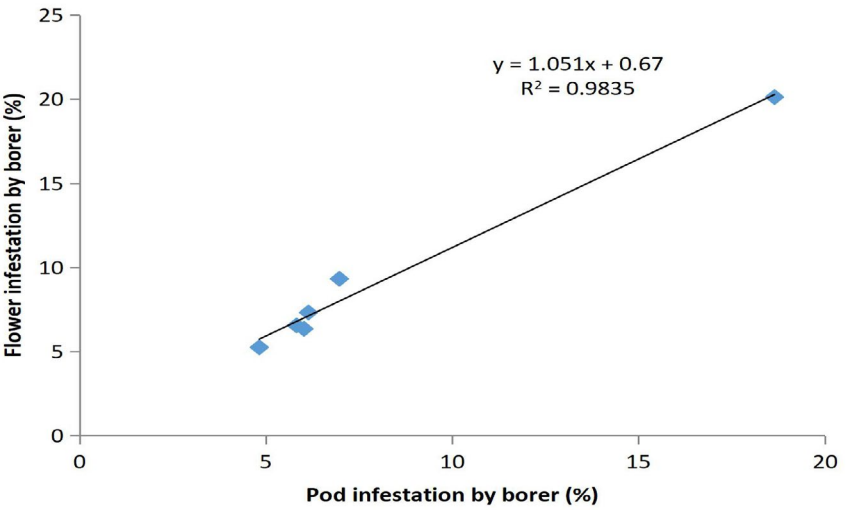

Figure 1. Relationship between flower infestation and pod infestation by borer in yard long bean.

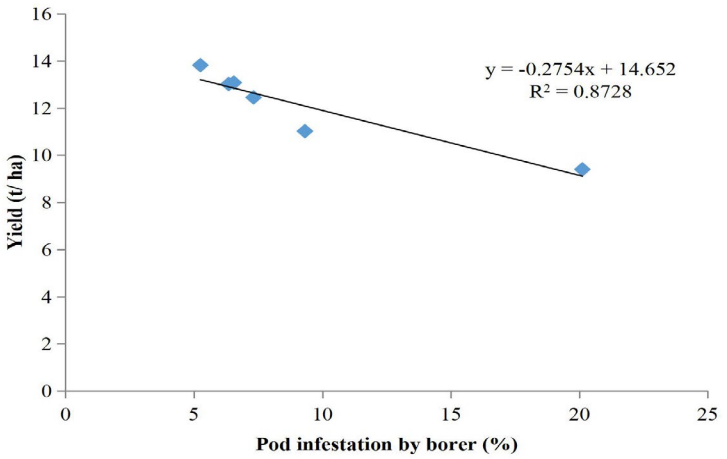

Figure 2. Relationship between pod infestation by borer and yield of yard long bean.

Table 4. Benefit cost analysis of different management options for the management of yard long bean pod borer

Treatments	Marketable yield (t/ha)	[1]Gross return (Tk/ha)	[2]Cost of treatment (Tk/ha)	Net return (Tk/ha)	Adjusted net return (Tk/ha)	Benefit/ cost ratio (Marginal BCR)
T_1: Sanitation + Biochamak	12.45	435750	27800	407950	78950	2.84
T_2: Sanitation + Solaris	13.82	483700	48400	435300	106300	2.20
T_3: Sanitation + Biocure	13.02	455700	12800	442900	113900	8.89
T_4: Sanitation + Biotrin	11.02	385700	15700	370000	41000	2.61
T_5: Farmers' practice (Proclaim 5 SG spray)	13.08	457800	26800	431000	102000	3.81
T_6: Untreated Control	9.40	329000	0.00	329000	-	-

[1]Farmgate price of yard long bean @ Tk. 35.00 per kg [2][Cost of Biochamak: @ Tk. 380/100 ml; Cost of Solaris: @ Tk. 22000/Litre; Cost of Biocure: @ Tk. 2000/Kg; Cost of Biotrin: @ Tk. 230/100ml; Cost of Proclaim 5 SG: @ Tk. 450/100 g**;** Cost of spray: Two laborers/spray/ha @ Tk 550.00/labour/day; Cost of sanitation: Two laborers/ha @ Tk 550.00/labour/day; Spray volume required: 500L /ha].

Discussion

In the present study, an attempt has been made to observe the effect of several biopesticides and a less toxic or green chemical pesticides in reducing pod borer infestation in yard long bean as IPM components. Presently, different bio-pesticides and less toxic green pesticides are getting popularity worldwide. Biopesticides provide several advantages over traditional chemical pesticides, which offer lower toxicity to non-target organisms, reduced environmental impacts, and less chance of developing resistance to insect pests. Moreover, new generation green chemical pesticides are safer and offer lower mammalian toxicity than older pesticides, making them suitable for integrated pest management (IPM) programs.

In our country, limited efforts have been given towards developing management approach with bio pesticides and less toxic green pesticides against pod borer of yard long bean. Dutta *et al*., (2020), reported that management package namely sanitation + spraying pesticide Antario (Bt+ abamectin) was effective in reducing flower and pod damage by pod borer, and higher yield and MBCR (10.09). However, Mrong *et al.,* 2024, observed that

management approach comprising of 3 sprays of Tracer 45 SC (Spinosad) @ 0.4 ml/L of water was effective, suitable and viable approach for suppressing pod borer of yard long bean, which offered satisfactory MBCR (7.7). Dutta *et al*. (2014) also reported sanitation along with spraying of spinosad 45SC can be successfully used to manage pod borer infestation in yard long bean. However, Uddin *et al*. (2015), observed that spinosad (Tracer 45 SC) and Emamectin benzoate (Proclaim 5 SG) were the most effective chemical insecticides to manage pod borer infesting yard long bean. In Cambodia Malacrino *et al*. (2019) in their studies on IPM of yard long bean observed that the costs of IPM were higher than conventional management, which contributed to lower profits in the IPM treatments in both seasons despite yields being as high as in conventional production. Therefore, future research should prioritise on increasing the profitability of IPM activities.

Findings of the present study clearly indicated that, considering MBCR, sanitation along with spraying Biocure @ 1g/ litre could be recommended for effective management of pod borer attacking yard long bean. Although, it was observed that, sanitation + Solaris 11.7 SC offered lowest pest incidence with highest yield, it provided the lowest MBCR (2.20), because of the high cost of Solaris 11.7 SC. It is to be noted here that, Solaris 11.7 SC is a green pesticide, and can effectivly control borer pests of different crops. So, its price should be within the reach of farming community for its higer adoption in yard long bean IPM Program.

Conclusion

Based on infestation reduction, yield performance, and economic analysis, the integration of sanitation (hand picking and destruction of infested flowers and pods with larvae) with *Bacillus thuringiensis* sprays can be recommended as a sustainable and cost-effective management strategy for pod borer in yard long bean production. Although spinetoram was highly effective, its adoption may be limited unless the cost becomes affordable for farmers.

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