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Comparable Efficacy of Some IPM Packages on the Suppression of Pod Borer (*Euchrysops cnejus*) in Yard Long Bean

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ABSTRACT: A study was undertaken to evaluate the effectiveness of some IPM tools for the suppression of pod borer (*Euchrysops cnejus*) attacking yard long bean. The experiment was conducted at She-e-Bangla agricultural University, Sher-e-Bangla Nagar Dhaka, during March to September 2007 & comprised of nine treatments. Those were T1: Mechanical control (hand picking of larvae) at 7 days interval; T2: Neem oil @ 5ml/ L of water at 7 days interval; T3 : Neem oil @ 5 ml /L of water + Mechanical control at 7 days interval; T4 : Suntap 50 SP@ 3 g /L of water at7 days interval; T5 : suntap 50 SP @ 3 g /L of water +Mechanical control at 7days interval; T6 : Shobicron 425 EC @ 2 ml / L of water at 7 days inrterval ; T7: Shobicron 425 EC @ 2 ml /L of water +Mechanical control at 7 days interval; T8: Neem seed kernel @ 10 g /L of water + Mechanical control at 7 days interval & T9: Untreated control. Data recorded on infestation level, yield contributing characters & yield of yard long bean revealed that performance of treatment T3 (Neem oil @ 5 ml /L of water + Mechanical control at 7 days interval) was superior throughout the season as compared to others; the lowest performance in the control treatment (T9). The highest healthy pods by number (59.80) & by weight (993.87 g), similarly the lowest infestation per plant by number (7.06 %) & by weight (72.62 g) was recorded in T3 treatment. The highest healthy pod length (54.20 cm) the height length of edible portion (48.64 cm) of partially infested pod, the highest yield (22.15 ton /ha) was recorded in the T3 treatment; while the lowest healthy pod length (44.60 cm), lowest edible portion (30.11cm) of partially infested pod and the lowest yield (14.74 ton / ha) was recorded in the control treatment (T9). The highest benefit cost ratio (3.53) was recorded in the T3 treatment while the lowest benefit cost ratio (1.23) in T8 treatment.

Key words: IPM tools, Suppression, Pod borer, Yard long bean

Introduction

Among the vegetables, the yard long bean, *Vigna sesquipedalis* is a delicious vegetable belonging to the Leguminosae family. It is a rich source of essential vitamins and commonly grown during kharif season. It contains 4.2 g protein, 110 mg calcium, 4.7 mg iron, 2.4 mg vitamin A and 35 mg vitamin C per 100 g serving. The importance of yard long bean is of high significance from growing season point of view. In Bangladesh, vegetables are produced less than 30% in kharif season and more than 70% in rabi season (Hossain and Awrangzeb, 1992). Yard long bean is grown almost in all districts of Bangladesh. Its cultivation intensity is found in Dhaka, Jessore, Comilla, Noakhali and Chittagong, but for the last ten years it has been seen growing extensively in Jessore, Khulna, Chittagong region as well (Aditya, 1993). Despite the prospect of yard long bean high incidences of insect pests have limited the crop into its low yield and poor quality. Farmers in our country face various problems including the availability of quality seeds, fertilizer and manures, irrigation facilities, modern information in the fields of technical and instrumental inputs, pests and diseases in cultivation of the crop (Rashid, 1993), Among them, insect pests are the most important and cause significant yield losses in every season and every year. The yield loss in yard long bean due to insect pests is reported to be about 12-30% (Hossain and Awrangzeb, 1992). According to Alam (1969), it is attacked by nine different insect species and one species of pod borer. An FAO panel meeting held in Bangkok in 1975 identified the bean pod borer, as a legume pod borer (Reddy, 1975). Dina (1979) and Baker *et al.* (1980) found that it is a serious insect pest of leguminous vegetables Butani and Jotwani (1984) found that lepidopterous larvae as pests causing damage by boring tender or mature pods. Bean pod borer is able to establish itself from vegetative to reproductive stage. At the early stage of plant growth, the bean pod borer attack the crop making clusters of leaves, tendrils and young shoots of the plant and later at flowering and pod setting stages of plants. The insect bore into these reproductive organs, where the insect feeds internally (Karim, 1993). There are several pest control methods for controlling bean pod borer, as cultural (Sharma, 1998), natural and applied biological (Karim, 1995) and chemical control measures (Rahman and Rahman, 1988). Bean pod borers frequently feed internally on infested plant parts, while living inside the clusters or pods, insecticide applications, particularly a single application, may often fail to provide successful control of the pest (Begum, 1993; Rahman, 1989). As a result, multiple applications of control measure are required for controlling this pest. A survey on pesticide use in vegetables conducted in 1988 revealed that only about 15% and 16% of the farmers received information from the pesticide dealers and extension agents respectively (Islam, 1999). In most of the cases, the farmers either forgot the instructions or did not care to follow those instructions and went on using insecticides at their own choice or experience. Some farmers believed that excess use of insecticide could solve the insect pests' problem. As a result, harmful impact of insecticides on man, animal, wild life, beneficial insects and environment is imposing a serious threat. Indiscriminate uses of insecticides are reported to cause insecticide resistance in insect pests, resurgence and secondary pests out break. The accumulation of insecticide residues in food is increasing at an alarming rate. So there is every reason of human health hazards due to these detrimental toxicants. Keeping the above situation in mind, the present study was undertaken to fulfill the following objectives to determine the effectiveness of some chemical and non-chemical control methods and their combination against pod borer and to develop a suitable management technique for controlling the pod borer;

Materials and Methods

The experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Dhaka, during March to September, 2007 to evaluate the effectiveness of some IPM tools for the management of pod borer (*Euchrysops cnejus*) of yard long bean. In this study removal of infested bean pod, spraying of neem oil and chemical insecticide along with an untreated control and some of their integrations were utilized. To evaluate the effectiveness of some IPM tools for the management of pod borer of yard long bean, the following treatments were tested- T_1: Mechanical control (removal of infested pod); T_2: Neem oil @ 5 ml/L of water; T_3: Neem oil @ 5 ml/L of water + T_1; T_4: Suntap 50SP @ 3 g/L of water; T_5: Suntap 50SP @ 3 g/L of water + T_1; T_6: Shobicron 425EC @ 2 ml/L of water ; T_7: Shobicron 425 EC @ 2 ml/L of water + T_1 ;T_8: Neem seed kernel 10 g/L of water + T_1; T_9: Untreated control. The experiment was laid out with seven treatments including one untreated control and replicated three times using Randomized Complete Block Design (RCBD).

The soil was well prepared and good tilth was ensured for commercial crop production. The target land was divided into 27

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equal plots (2 m × 2 m) with plot to plot distance 1m and block to block distance 1m. Each plot contains 4 pits (30 cm × 30 cm ×20 cm), pit to pit distance 1m. Standard dosages of cowdung and fertilizers were applied as recommended by Rashid (1993) for yard long bean @ 12kg of cowdung, 60 gm urea, 100 gm TSP and 100 gm MP respectively per pit. Again 30gm urea was applied as top dressing after each flush of flowering and fruiting in three equal splits. The seeds of BARI yard long bean-1 were collected from Bangladesh Agricultural Research Institute (BARI). For rapid and uniform germination the seeds of yard long bean were soaked for 12 hours in water. Seeds were then directly sown in the middle of March, 2007 in polyethylene bags (12 cm × 18 cm) containing a mixture of equal proportion well decomposed cowdung and loam soil. Seeds were sown in bags and irrigated regularly. Seedlings were placed in a shady place and were transplanted on April 15, 2007 in the pits of the experimental field after 15 days of germination. At the time of transplanting, polyethylene bag was cut and removed carefully in order to keep the soil intact with the root of the seedling. After transplanting, a light irrigation was given. Subsequent irrigation was applied in all the plots as and when needed. After 7 days of transplanting, a single healthy seedling with luxuriant growth per pit was allowed to grow and discarding the others. Propping of each plant by bamboo sticks (1.75 m) was provided on about 1.5 m high from ground level for additional support and to allow normal creeping. Data were collected on the basis of the number and weight of healthy and infested fruits in each treatment. The marketable fruits were harvested at every alternate day intervals at early, mid and late fruiting stages.
The number of healthy fruits and infested fruits were counted and the percent fruit initiation for each treatment was calculated by using the following formula:

% Fruit infestation by number =

$$\frac{\text{Number of Infested fruit}}{\text{No. of Healthy fruit} + \text{No. of Infested fruit}} \times 100$$

After harvest at each fruiting (early, mid and late) stage, the total fruits were sorted into healthy and infested once for each treatment. On the basis of weight of healthy fruit and infested fruit the percent fruit infestation was calculated.
% Fruit infestation by weight =

$$\frac{\text{Weight of infested fruit}}{\text{Wt. of healthy fruit} + \text{Wt. of infested fruit}} \times 100$$

Fruit yield was measured by adding the total harvest attaining from all harvest in individual plot and converted into per hectare yield.

Increase or decrease over control was calculated using the following formula:

% increase over control =

$$\frac{\text{Value in treated plot} - \text{value in untreated plot}}{\text{Value in untreated control plot}} \times 100$$

% decrease over control =

$$\frac{\text{Value in untreated control plot} - \text{value in untreated plot}}{\text{Value in untreated control plot}} \times 100$$

The economic analysis of economic of Benefit cost ratio (BCR) was analyzed on the basis of total expenditure of the perspective treatment along with the total return from that particular treatment. Finally the benefit cost ratio (BCR) was calculated by utilizing the formula:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Adjusted net return}}{\text{Total management cost}}$$

The data obtained for different parameters were statistically analyzed to find out the significance of the difference among the treatments. The mean values of all the parameters were evaluated and analysis of variance was performing by the ‘F’ (variance ratio) test. The significance of the difference among the treatment combinations means was estimated by the least significant difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Statistically significant variation was recorded in number of healthy fruit per plant at early, mid and late harvesting stage for different IPM tools, which were used for suppressing of pod borer in yard long bean under the present trial presented in Table 1-3. In terms of healthy fruit per plant, the highest number of healthy fruit (17.00) was recorded in T_3 [Neem oil @ 5 ml/L of water + Mechanical control (removal of infested pod)] which was statistically similar with T_2 (Neem oil @ 5 ml/L of water) (16.20) and T_5 (Suntap 50SP @ 3 g/L of water + Mechanical control) (15.80) respectively, followed by the treatment T_4 (Suntap 50SP @ 3 g/L of water) (14.20) and T_7 (Shobicron 425EC @ 2 ml/L of water + Mechanical control) (14.00), respectively. On the other hand, the lowest number of healthy fruit (10.40) was recorded in T_9 (untreated control plot), which was followed by T_1 (Mechanical control) (12.40), T_8 (Neem seed kernel @ 10 g/L of water + Mechanical control) (13.40) and T_6 (Shobicron 425 EC @ 2 ml/L of water) (13.00), respectively. Considering the infested fruit per plant, the lowest number of infested fruit (1.00) was recorded in T_3 which was statistically similar with T_2 (1.20) and T_5 (1.40), respectively and followed by T_4 (1.60), T_6 (1.80) and T_7 (1.80), respectively. On the other hand, the highest number of infested fruit (2.80) was recorded in T_9 untreated control plot, which was statistically identical with the treatment T_1 (2.40) and followed by the treatment T_8 (2.00) (Table1). The rate of fruit infestation per plant was the lowest (5.52%) in $T_{3,}$ which was statistically similar with T_2 (6.96%) and T_5 (8.12%) followed by T_4 (10.21%), T_7 (11.30%) and T_6 (11.86%). On the other hand, the highest percentage of infested fruit (21.16%) was recorded in T_9 followed by T_1 (16.23%) and T_8 (13.32%).
In terms of healthy fruit per plant, the highest number of healthy fruit (28.20) was recorded in T_3, which was statistically similar with the treatment T_2 26.80), T_5 (26.60) and T_4 (25.20), respectively and followed by the treatment T_7 (24.60) and T_6 (24.00), respectively. On the other hand, the lowest number of healthy fruit (17.20) was recorded in T_9 (untreated control plot), which was followed by T_1 (Mechanical control) (2.00) and T_8 (22.20), respectively. Considering the infested fruit per plant, the lowest number of infested fruit (2.40) was recorded in T_3 which was followed by T_2 (3.00), T_5 (3.00) and T_4 (3.40), respectively (Table 1). On the other hand, the highest number of infested fruit (4.80) was recorded in T_9 (untreated control), plot which was statistically identical with T_1 (4.40) and followed by T_8 (4.00). Again, T_6 (3.80) and T_7 (3.60) performed moderate number of infested fruits. The rate of fruit infestation per plant was the lowest (7.88%) in T_3, which was statistically similar with T_2 (10.07%) and T_5 (10.14%) followed by T_4 (11.86%), T_7 (12.79%) and T_6 (12.69%). On the other hand, the highest percentage of infested fruit (21.98%) was recorded in untreated control plot ($T_{9)}$ which was followed by T_1 (18.16%) and T_8 (15.29%)(Table2).

Table 1. Effect of different control options for suppressing pod borer of yard long bean at early harvesting stage by number during July to September, 2007

Treatments	At early stage		
	Healthy pod (No.)	Infested pod (No.)	% infestation
T_1	12.40 c	2.40 ab	16.23 b
T_2	16.20 a	1.20 ef	6.96 f
T_3	17.00 a	1.00 f	5.52 f
T_4	14.20 bc	1.60 cde	10.21 de
T_5	15.80 ab	1.40 def	8.12 ef
T_6	13.40 c	1.80 cd	11.86 cd
T_7	14.00 bc	1.80 cd	11.30 cd
T_8	13.00 c	2.00 bc	13.32 c
T_9	10.40 d	2.80 a	21.16 a
$LSD_{(0.05)}$	1.810	0.461	2.536
CV(%)	7.45	15.00	12.60

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Mechanical control (removal of infested pod); T_2: Neem oil @ 5 ml/L of water; T_3: Neem oil @ 5 ml/L of water + T_1; T_4: Suntap 50SP @ 3 g/L of water; T_5: Suntap 50SP @ 3 g/L of water + T_1; T_6: Shobicron 425EC @ 2 ml/L of water; T_7: Shobicron 425EC @ 2 ml/L of water + T_1; T_8: Neem seed kernel 10 g/L of water + T_1; T_9: Untreated control

Table 2. Effect of different control options for suppressing pod borer of yard long bean at mid harvesting stage by number during July to September, 2007

Treatments	At mid stage		
	Healthy pod (No.)	Infested pod (No.)	% infestation
T_1	20.00 de	4.40 ab	18.16 b
T_2	26.80 ab	3.00 e	10.07 ef
T_3	28.20 a	2.40 f	7.88 f
T_4	25.20 abc	3.40 de	11.86 de
T_5	26.60 ab	3.00 e	10.14 ef
T_6	24.00 bc	3.80 cd	13.69 cd
T_7	24.60 bc	3.60 cd	12.79 cd
T_8	22.20 cd	4.00 bc	15.29 c
T_9	17.20 e	4.80 a	21.98 a
$LSD_{(0.05)}$	3.168	0.468	2.454
CV(%)	7.67	7.52	10.47

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Mechanical control (removal of infested pod); T_2: Neem oil @ 5 ml/L of water; T_3: Neem oil @ 5 ml/L of water + T_1; T_4: Suntap 50SP @ 3 g/L of water; T_5: Suntap 50SP @ 3 g/L of water + T_1; T_6: Shobicron 425EC @ 2 ml/L of water; T_7: Shobicron 425EC @ 2 ml/L of water + T_1; T_8: Neem seed kernel 10 g/L of water + T_1; T_9: Untreated control

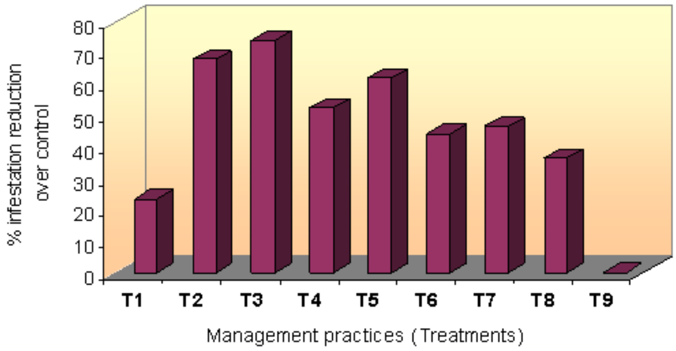
Table 3. Effect of different control options for suppressing pod borer of yard long bean at late harvesting stage by number during July to September, 2007

Treatments	At late stage		
	Healthy pod (No.)	Infested pod (No.)	% infestation
T_1	11.20 bc	2.60 b	18.84 b
T_2	13.20 ab	1.60 ef	10.79 fg
T_3	14.60 a	1.40 f	8.73 g
T_4	12.60 ab	2.00 cde	13.77 def
T_5	13.20 ab	1.80 def	11.99 ef
T_6	12.00 bc	2.20 bcd	15.49 cd
T_7	12.40 ab	2.00 cde	14.16 de
T_8	11.40 bc	2.40 bc	17.31 bc
T_9	10.00 c	3.20 a	24.23 a
$LSD_{(0.05)}$	2.048	0.458	2.978
CV(%)	9.63	12.40	11.44

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Mechanical control (removal of infested pod); T_2: Neem oil @ 5 ml/L of water; T_3: Neem oil @ 5 ml/L of water + T_1; T_4: Suntap 50SP @ 3 g/L of water; T_5: Suntap 50SP @ 3 g/L of water + T_1; T_6: Shobicron 425EC @ 2 ml/L of water; T_7: Shobicron 425EC @ 2 ml/L of water + T_1; T_8: Neem seed kernel 10 g/L of water + T_1; T_9: Untreated control

In terms of healthy fruit per plant, the highest number of healthy fruit (14.60) was recorded in T_3, which was statistically similar with the treatment T_2 (13.20), T_5 (12.60), T_4 (12.60) and T_7 (12.40), respectively and followed by T_6 (12.00), T_8 (11.40) and T_1 (11.20), respectively (Table 1). On the other hand, the lowest number of healthy fruit (10.00) was recorded in T_9 (untreated control plot). Considering the infested fruit per plant, the lowest number of infested fruit per plant (1.40) was recorded from the treatment T_3 which was statistically similar with the treatment T_2 (1.60) and T_5 (1.80) (Table 1). On the other hand, the highest number of infested fruit (3.20) was recorded in T_9 untreated control plot which was followed by the treatment T_1 (2.60) and followed by the treatment T_8 (2.40). Again the treatment T_6 (2.20) and T_7 (2.00) performed moderate number of infested fruits. The rate of fruit infestation per plant was the lowest (7.73%) in T_3 which was statistically similar with T_2 (10.79%) and followed by T_5 (11.99%), T_4 (13.77%), T_7 (14.16%) and T_6 (15.49%). On the other hand, the highest percentages of infested fruit (24.23%) was recorded from T_9 (untreated control plot), which was followed by T_1 (18.84%) and T_8 (17.31%) (Table3). From the above findings, it was observed that the effect of neem oil was the best from all other treatment components in controlling pod borer. This finding is similar with other authors. Jacobson and Sheila (1994) reported that the leaf extract of neem tested against the leaf caterpillar of brinjal, *Selepa docilis* Bult. at 5% concentration had a high anti-feedant activity with a feeding ratio of 28.29 followed by 3% having only medium antifeedant properties with 23.89. Fagoonee (1986) used neem in vegetable crop protection in Mauritius and showed that neem seed kernel extract was found to be effective. He also found that neem extract alternate with insecticides gave best protection against *Helicovarpa armigera.* The comparative effectiveness of different management practices on percent infestation reduction over control at different fruiting stage for management of pod borer is shown by Figure 1, 2 and 3. In terms of early fruiting stage (Figure 1), the highest percent (74.04%) reduction of infestation over control was found in T_3, followed by T_2 (67.83%), T_5 (62.03%) and T_4 (52.56%) and the lowest (23.61%) in T_1 treatment, followed by T_8 (36.53%) and T_6 (44.17%). Considering the mid fruiting stage (Figure 2), The highest percent (63.98%) reduction of infestation over control was found in the treatment T_3, followed by T_2 (54.76%), T_5 (52.33%) and T_4 (45.18%) and the lowest (16.91%) in T_1 treatment, followed by the treatment T_8 (29.71%) and T_6 (36.95%) .

Fig. 1. Effect of different management practices on percent infestation reduction over control at early fruiting stage



Again, in terms of late fruiting stage (Figure 3), the highest percent (64.45%) reduction of infestation over control was found in T_3, followed by T_2 (55.71%), T_5 (50.47%) and T_4 (45.36%) and the lowest (23.54%) in T_1 treatment, followed by the treatment T_8 (29.91%) and T_6 (36.75%). The highest number of healthy fruit per plant (59.80) was recorded in T_3 (Neem oil @ 5 ml/L of water + Mechanical control), which was statistically similar with the treatment T_2 (Neem oil @ 5 ml/L of water) (56.20) and T_5 (Suntap 50SP @ 3 g/L of water + Mechanical control) (55.60), respectively followed by the treatment T_4 (Suntap 50SP @ 3 g/L of water) (52.00) and T_7 (Shobicron 425EC @ 2 ml/L of water + Mechanical control) (51.00) , respectively (Table 3). On the other hand, the lowest number of healthy fruit (37.60) was recorded in T_9 (untreated control plot), which was followed by the treatment T_1 (Mechanical control) (43.60), T_8 (Neem seed kernel @ 10 g/L of water + Mechanical control) (46.60) and T_6 (Shobicron 425EC @ 2 ml/L of water) (49.40), respectively. The lowest number of infested fruit per plant (4.80) was recorded from the treatment T_3 which was followed by the treatment T_2 (5.80) and T_5 (6.20), T_4 (7.00), T_6 (7.80) and T_7 (7.40), respectively(Table-4).

Fig. 2. Effect of different management practices on percent infestation reduction over control at mid fruiting stage

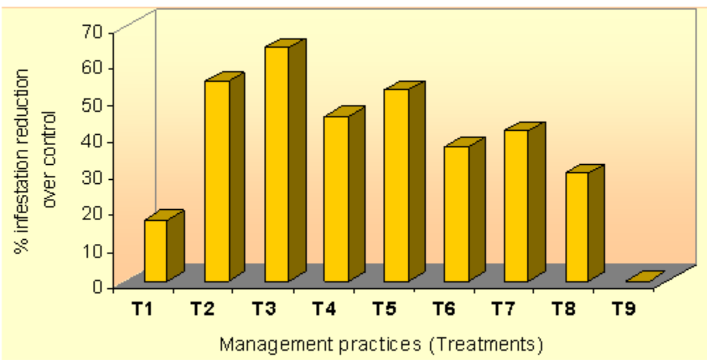
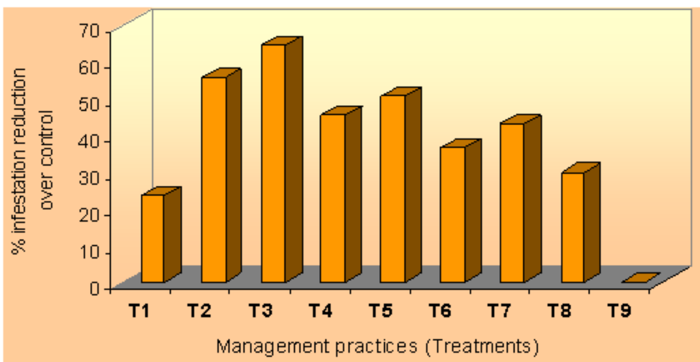


Fig. 3 Effect of different management practices on percent infestation reduction over control at late fruiting stage



On the other hand, the highest number of infested fruit (10.80) was recorded in T_9 (untreated control plot), which was followed by T_1 (9.40) and T_8 (8.40). The lowest fruit infestation per plant in number (7.06%) was recorded in T_3 treatment which was followed by T_2 (8.73%), T_5 (9.25%), T_4 (10.84%), T_7 (11.54%) and T_6 (12.19%). On the other hand, the highest infested fruit (17.81%) was recorded in T_9 which was followed by T_1 (15.38%) and T_8 (13.39%) (Table3). The highest reduction over control (60.36%) throughout the cropping season by. number was recorded in T_3 and the lowest (13.64%) was in T_1.

Table 4. Effect of different control measures for the suppressing of pod borer of yard long bean throughout the growing season in terms of fruit per plant by number and weight during July to September, 2007

Treatments	Yard long bean by number				Yard long bean by weight (gm)			
	Healthy pod	Infested pod	% infestation	% Reduction over control	Healthy Pod	Infested pod	% infestation	% Reduction over control
T_1	43.60 e	9.40 b	15.38 b	13.64	727.45 e	142.53 b	16.42 b	20.79
T_2	56.20 ab	5.80 e	8.73 e	50.98	937.75 b	87.05 g	8.49 f	59.04
T_3	59.80 a	4.80 f	7.06 f	60.36	993.87 a	72.62 h	6.81 g	67.15
T_4	52.00 bc	7.00 d	10.84 d	39.14	868.82 c	105.98 ef	10.86 e	47.61
T_5	55.60 ab	6.20 e	9.25 e	48.06	928.28 b	95.72 fg	9.35 f	54.90
T_6	49.40 cd	7.80 cd	12.19 cd	31.56	821.03 cd	118.23 cd	12.60 d	39.22
T_7	51.00 c	7.40 d	11.54 d	35.20	848.28 c	112.45 de	11.70 de	43.56
T_8	46.60 de	8.40 c	13.39 c	24.82	776.42 de	127.38 c	14.09 c	32.03
T_9	37.60 f	10.80 a	17.81 a	--	625.82 f	163.73 a	20.73 a	--
$LSD_{(0.05)}$	4.166	0.789	1.460	--	54.41	11.01	1.107	--
CV(%)	4.79	6.07	7.15	--	3.76	5.58	5.18	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Mechanical control (removal of infested pod); T_2: Neem oil @ 5 ml/L of water; T_3: Neem oil @ 5 ml/L of water + T_1; T_4: Suntap 50SP @ 3 g/L of water; T_5: Suntap 50SP @ 3 g/L of water + T_1; T_6: Shobicron 425EC @ 2 ml/L of water; T_7: Shobicron 425EC @ 2 ml/L of water + T_1; T_8: Neem seed kernel 10 g/L of water + T_1; T_9: Untreated control

The highest weight of healthy fruit per plant (993.87 g) was recorded in T_3 (Neem oil @ 5 ml/L of water + Mechanical control), which was followed (937.75 g and 928.28 g) with T_2 (Neem oil @ 5 ml/L of water) (Table 4). On the other hand, the lowest weight of healthy fruit (625.820 g) was recorded in T_9 (untreated control plot) which was followed by T_1 (Mechanical control) (727.45 g) and T_8 (Neem seed kernel @ 10 g/L of water + Mechanical control) (776.42 g), respectively. Again moderate weight of total healthy fruit was recorded in T_4 (Suntap 50SP @ 3 g/L of water) (868.82 g), T_7 (Shobicron 425EC @ 2 ml/L of water + Mechanical control) (848.28 g) and T_6 (Shobicron 425EC @ 2 ml/L of water) (821.03 g), respectively.

The lowest weight of infested fruit per plant (72.62 g) was recorded in T_3 which was followed by T_2 (20.00 g), T_5 (23.40 g), T_4 (26.83 g), T_6 (30.22 g) and T_7 (30.07 g), respectively (Table 2). On the other hand, the highest weight of infested fruit (163.73 g) was recorded in T_9 (untreated control plot), which was followed by T_1 (142.53 g) and T_8 (127.38 g).

The lowest fruit infestation per plant in weight (6.81%) was recorded in T_3 which was followed by T_2 (8.49%), T_5 (9.35%), T_4 (10.86%), T_7 (11.70%) and T_6 (12.60%). On the other hand, the highest infested fruit (20.73%) was recorded from T_9 (untreated control plot), which was followed by T_1 (16.42%) and T_8 (14.09%) (Table 4). The highest reduction over control (67.15%) throughout the cropping season by weight was recorded in T_3 and the lowest (20.79%) was in T_1. The pod borers were found to cause 38% yield loss through flower and pod damage and have been reported as the most important pests of pigeon pea in Bangladesh (Rahman *et al.,* 1981)

The highest yield per hectare (22.15 ton) was recorded in T_3 (Neem oil @ 5 ml/L of water + Mechanical control), which was statistically similar (21.39 ton, 21.23 ton, 20.05 ton and 19.62 ton) with T_2 (Neem oil @ 5 ml/L of water), T_5 (Suntap 50SP @ 3 g/L of water + Mechanical control), T_4 (Suntap 50SP @ 3 g/L of water) and T_7 (Shobicron 425EC @ 2 ml/L of water + Mechanical control), respectively (Table 5). On the other hand, the lowest yield per hectare (14.74 ton) was recorded from T_9 (untreated control, which was closely followed (16.02 ton, 17.42 ton and 18.28 ton) by T_1 (Mechanical control), T_8 (Neem seed kernel @ 10 g/L of water + Mechanical control) and T_6 (Shobicron 425EC @ 2 ml/L), respectively. The highest increase over control (20.27%) was recorded for T_3 and the lowest (8.68%) was recorded in T_1. The pod borers were found to cause 38% yield loss through flower and pod damage and have been reported as the most important pests of pigeon pea in Bangladesh (Rahman *et al.,* 1981).

This study indicated that the IPM tools T3 comprising neem oil @ 5 ml/lit of water + mechanical control applied at 7 days after interval might be considered as the best component on the basis of its effectiveness in reducing pod borer infestation, increasing total yield and healthy pod yield.

Economic analysis of different control measures were integrated for the control of yard long bean pod borer, *E. cnejus*, is presented in Table 5. In this study, the untreated control (T_9) did not require any pest management cost. But the costs were involved in mechanical control T_1 (6000 Tk./ha) for the removal of the infested fruit/part of fruit. The cost for the treatment of neem oil @ 5 ml per liter of water T_2 (22000 Tk./ha) was incurred for neem oil, trix liquid detergent, preparation and its application. For Suntap 50SP @ 3 g/L of water applied (22000 Tk./ha) treatments. The cost was involved for insecticide and its application. For Shobicron 425 EC @ 2 ml/L of water applied (21000 Tk./ha) treatments. The cost was involved for insecticide and its application. Mechanical control included with others added the value of pesticides and mechanical control. Considering the controlling of yard long bean pod borer highest benefit cost ratio (3.53) was recorded in T_2 (Neem oil @ 5 ml/L of water followed by T_2 (3.28), T_5 (2.74), T_4 (2.62), T_1 (2.20) and the lowest benefit cost ratio was recorded in T_9 (1.23), and followed by T_6 (1.53) and T_8 (1.93) (Table 5).

Table 5. Cost of production of yard long bean for different pod borer due to the effect of different control measures during July to September, 2007

Treatments	Cost of pod borer Management (Tk./ha)	Yield of yard long bean (t/ha)	Gross return (Tk./ha)	Net Return (Tk./ha)	Adjusted net return (Tk./ha)	Benefit cost ratio
T_1	6000	16.02	240,300	234,300	13,200	2.20
T_2	22000	21.39	320,850	298,850	77,750	3.53
T_3	26000	22.15	332,250	306,250	85,150	3.28
T_4	22000	20.05	300,750	278,750	57,650	2.62
T_5	26000	21.23	318,450	292,450	71,350	2.74
T_6	21000	18.28	274,200	253,200	32,100	1.53
T_7	25000	19.62	294,300	269,300	48,200	1.93
T_8	18000	17.42	261,300	243,300	22,200	1.23
T_9	--	14.74	221,100	221,100	--	--

T_1: Mechanical control; T_2: Neem oil @ 5 ml/L of water; T_3: Neem oil @ 5 ml/L of water + Mechanical control; T_4: Suntap 50SP @ 3 g/L of water; T_5: Suntap 50SP @ 3 g/L of water + Mechanical control; T_6: Shobicron 425EC @ 2 ml/L of water; T_7: Shobicron 425EC @ 2 ml/L of water + Mechanical control; T_8: Neem seed kernel 10 g/L of water + Mechanical control; T_9: Untreated control

From the present study, the cooperative evaluation of some IPM components against pod borer of Yard long bean indicated that the neem oil @ 5 ml/lit of water + mechanical control spread at reproductive stages would be the best practices for reducing pod borer infestation and damage of yard long bean . As there was an increasing tendency of pod borer infestation beginning from early to late fruiting stages, control measure should be taken at early and mid fruiting stages for effective and profitable yard long bean cultivation. But control actions at flower initiation and late fruiting stages would not be economically sound because of lower number of fruits in the plant. Therefore, neem oil spray might be selected as non hazardous component of IPM against pod borer for economic yard long bean cultivation in Bangladesh.

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