Efficacy of Some Integrated Pest Management (IPM) Techniques against Okra Shoot and Fruit Borer (*Earias vittella* Fab.)

ABSTRACT

The experiment was laid out at the central field of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during February 2022 to June 2022 to determine the efficacy of some integrated pest management tools against okra shoot and fruit borer (*Earias vittella* Fab.) in okra. The study comprised of seven treatments, viz. T_1= Barrier crop (maize), T_2= T-Bird perches 2m long@ 3/plot at distinct distances, T_3= Pheromone trap@ 15/ha with lures, T_4= Hand picking of larvae at regular basis, T_5= *Bacillus thuringiesis* through two applications of Bt toxin on vegetative and flowering stage@ 1g/liter of water, T_6= Proclaim 5 SG (Emamectin Benzoate) @ 1g/liter of water and NLE (neem leaf extract) @ 3g/liter of water, T_7= untreated control. All the sprayings were done at 7 days interval. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. All the treatments were applied in okra at different developmental stages against shoot and fruit borer. Among the treatments, T_6 gave maximum number of shoots (15.07) with less infested shoots (1.95) and infestation percentage was minimum (12.93). At the same time, the highest shoot infestation percentage (63.40) was also recorded from T_7 treatment. The minimum fruit infestation (8.77) was also obtained from T_6 treatment with minimum fruit infestation percentage (24.89), whereas; again, T_7 illustrated maximum infestation percentage (44.36) of fruit. The treatment T_6 yielded maximum (14.78 t/ha) okra that is very close to T_5 (13.72 t/ha) and T_4 (13.50 t/ha). So, the treatment T_6 showed the best performance compared to rest other treatments. But considering the environmental and human health issues, farmers can use the T_5 and T_4 as they don't involve any risk factor compared to chemical pesticides as well as their yield is approximately same as to T_6 treatment.

Keywords: Integrated pest management; okra shoot & fruit borer; Earias vittella; Bacillus thuringiesis.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L.), sometimes referred to as ladies' finger and a member of the Malvaceae family, is a significant vegetable crop. It grows in the world's tropical and subtropical regions. Okra is the most consumed vegetable in Afghanistan, Bangladesh, Ghana, Japan, India, Burma, Iraq, and Pakistan [1]. While okra is produced mostly in the kharif season, but it may be grown throughout the year. Okra is a major summer vegetable in Bangladesh which plays a vital function to meet the need of vegetables of the country when veggies are sparse in the market. About 55,905 metric tons of okra is produced from 28,515 acres of land per year in Bangladesh [2].

Okra is a well-liked, wholesome fruit or vegetable. An edible portion of okra fruit weighing 100 grams contains moisture of 89.6 grams, protein of 1.9 grams, fat of 0.2 grams, fiber of 1.2 grams, phosphorus of 56.0 grams, sodium of 6.9 grams, sulfur of 30 grams, riboflavin of 0.1 grams, oxalic acid of 8 grams, minerals of 0.7 grams, carbohydrates of 6.4 grams, calcium of 66 grams, iron of 0.35 grams, potassium of 103 grams, thiamine of 0 [3]. The immature fruits of okra, which are often prepared as vegetables, are the major reason it is grown. Also popular are okra soups and stews. White-eyed seeds that are black or brown when ripe are occasionally roasted and used as a replacement for coffee. Tender fruits are utilized in soups and gravies because they contain a lot of mucilage.

Attacks by insect pests are just one of the many factors that have an impact on the production of okra in Bangladesh. There are 72 kinds of insects known to damage okra, of which the jassid, shoot and fruit borer, aphid, whitefly, mealybug, and leaf roller are the most destructive [4]. The spotted bollworm, also known as the okra shoot and fruit borer (OSFB), is the most devastating of the many insect pests since it directly destroys okra fruits [5].

The OSFB larvae affect both the vegetative and reproductive phases of okra. Larvae feed on internal tissues, flower buds, and fruits during the reproductive stage while boring into new shoots during the vegetative stage. The resulting early death of the infected shoots [6]. Fruits with infestations develop distorted shapes, which significantly reduces their market value. Just OSFB in Bangladesh damages 52.33–70.75% of okra fruits [7,8]. Many farmers still favor chemical pesticides because of how simple they are to use, how quickly they work, and how simple they are to apply [9]. We cannot, however, completely rule out the challenges that come with using chemical pesticides, such as the development of target pest resistance, the reappearance of sucking insects, secondary pest outbreaks, the eradication of non-target organisms, pollution, and risks to consumer health [10,11].

Therefore, it is needed to develop alternative methods of pest management other than the solely use of insecticides. Recently, a large number of IPM tools have been reported as an effective control measure of insect pests in okra. As a result, the study was conducted to evaluate the efficiency of various IPM tools for the management of okra shoot and fruit borer in okra.

2. MATERIALS AND METHODS

2.1 Location and Duration

The experiment was undertaken and conducted at the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during October 2021 to September 2022.

2.2 Soil Condition

The soil of the research field was medium high land with adequate irrigation facilities and low organic matter content. The selected plot was above flood level and sufficient sunshine was available having available irrigation and drainage facilities during the experimental period.

2.3 Crop Husbandry

BARI Okra-2 seed was used as the experimental material, which was collected from vegetable division, Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

2.4 Land Preparation

The soil was well prepared and good tilth condition was ensured for commercial crop production. The target land was divided into 21 equal plots (3.0 m × 1.5 m) with plot-to-plot distance of 0.5 m and block to block distance is 1.0 m. The land of the experimental field was ploughed with a power tiller. Later on, the land was ploughed three times followed by laddering to obtain desirable good tilth. The corners of the land were spaded, and larger clods were broken into smaller pieces. After ploughing and laddering, the stubbles and uprooted weeds were removed and then the land was ready.

2.5 Design of Experiment

The field layout and design of the experiment were followed immediately after land preparation. The experiment was conducted with Randomized Complete Block Desin (RCBD) with three replications. The following seven treatments were applied as mentioned below.

2.6 Integrated Pest Management (IPM) Tools

Neem leaf extract, Relothrin and Bt toxin were sprayed in assigned plots and dosages by using hand sprayer and knapsack sprayer as per requirement (Table 1).

2.7 Intercultural Operation

Before sowing seeds, the germination test was done to ensure 90% germination. Seeds were then directly sown in the main field containing a mixture of equal proportion well decomposed cow dung and loam soil. After sowing seeds, the plots were irrigated regularly. After germination, the seedlings were sprayed with water by a hand sprayer. Soil was spaded 3 or 4 days for a week.

The 15 days old healthy seedlings of the selected variety were nursed by gap filling in the pits of the randomly selected each unit plot assigned for each treatment in the main field. After gap filling, a light irrigation was given. Subsequent irrigation was applied in all the plots as and when needed. Weeding and mulching in the plot were done, whenever necessary.

2.8 Data Collection

For data collection five plants per plot were randomly selected and tagged. Data collection was started at flower initiation up to fruit harvest. The data were recorded on shoot and fruit (by number and by weight) infested by okra shoot and fruit borer larvae. All the data were collected at 7 days interval. The following formula was used to compute the percent shoot infestation:

$$\% \text{ shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

Table 1. Different Integrated Pest Management (IPM) tools (Treatments) applied under the present study

Treatments	Description
T_1	Barrier crop (maize)
T_2	T-Bird perches 2m long @ 3/plot at distinct distances
T_3	Pheromone trap @ 15/ha with lures
T_4	Hand picking at regular basis
T_5	*Bacillus thuringiensis* through two applications of Bt toxin on vegetative and flowering stage @ 1 g/liter of water
T_6	Proclaim 5 SG (Emamectin Benzoate) @ 1g/liter of water and NLE (Neem leaf extract) @ 3g/l of water spraying alternately at 15 days interval
T_7	Untreated Control

2.9 Statistical Analysis

The collected data on various parameters were statistically analyzed by Statistix 10 computer software package program. The mean for all the treatments were calculated and analyses of variance for all the characters were performed by F-variance test. The significance of difference between the pairs of treatment mean was compared by the LSD test at 5% level of probability.

3. RESULTS AND DISCUSSION

The findings from this research are discussed below under some subheadings:

3.1 Shoot Infestation at Vegetative Stage

The highest total number of shoot was found from T_6 treatment (15.07) which is statistically similar with T_4 (14.25) and T_5 (13.32) (Table 2). The treatment T_5 and T_3 are also similar in case of total number of shoots. There is no significant variation among T_2, T_1 and T_7 where they gave 9.83, 8.67 and 8.66 numbers of shoots respectively. The lowest no 1.95 of shoots were observed from T_6 (1.95) that is statistically similar with T_5 (2.40). The treatment T_2, T_3 and T_4 were similar in results for infested shoot that were 4.88, 4.49 and 4.23 respectively. The infested shoot 5.49 from T_1 was similar with T_7. The lowest percentage of shoot was 12.93 that is found from T_6 treatment followed by T_5 (18.02) treatment whereas; the maximum shoot infestation was found from T_7 (63.40) followed by T_1 (60.78) treatment. There is also significant variation among the T_2 (49.64), T_3 (39.28) and T_4 (29.68) treatment for percentage of shoot infestation (Table 2). Above results is supported by Rahman et al. [12] findings. They found that Emamectin benzoate + Abamectin @ 0.50 g/L provided the lowest shoot (6.71%) infestation by brinjal shoot and fruit borer (BSFB) in brinjal. They also found that the highest shoot (27.40%) infestation was recorded from control untreated plots which is similar to our results.

3.2 Plant Infestation at Final Harvest

From the Table 3, it is revealed that, the lowest number of plant infestation was found from T_6 (4.26) followed by T_2 (4.27), T_3 (4.78) and T_5 (4.79) that are statistically similar in number. Although the maximum infested plant (5.66) was observed in T_7 treatment followed by T_4 (5.54) and T_1 (5.23), they are statistically similar in results. The maximum percentage of plant infestation was found from T_7 (47.17) followed by T_4 (46.16) that were statistically similar with T_1 (43.58), T_3 (39.83) and T_5 (39.92) (Table 2). The lowest percentage of plant infestation was (35.5) found from T_6 followed by T_2 (35.58) treatment but they were statistically similar in results for percentage of plant infestation.

3.3 Fruit Infestation at Late Fruiting Stage

The highest total number of fruits per plant was observed from T_6 (35.23) followed by T_4 (33.09), T_5 (32.47), T_3 (29.82) and T_2 (28.93). There is no significant variation among these mentioned treatments in case of total fruits per plant

(Table 4). The lowest number of fruit found from T_7 (27.86) that was statistically similar in result with T_1 (28.37). The lowest fruit infestation was recorded from T_6 (8.77) which were significantly varied from rest of other treatments. As a result, the lowest percentage of fruit infestation was also observed from T_6 (24.89) followed by T_5 (35.32) treatment. The treatment T_7 and T_1 gave similar impact in case of fruit infestation percentage that were (44.36) and 43.46) respectively although the treatment T_7 was highest in position for fruit infestation percentage (Table 4). Our results are closely supported by Chandran et al. [13]. They obtained that applying synthetic chemical insecticide significantly reduced the percentage of fruit damage in okra.

3.4 Yield Attributing Characteristics and Yield

3.4.1 Plant height

From the Table 5, it is clear that the maximum plant height was observed from T_4 (245.9) which is significantly differ from rest of all other treatments. The treatment T_6 (223.1) was the second highest in case of plant height followed by T_5 (221.6) but they were statistically similar. The lowest plant height was recorded from T_1 (194.2) followed by T_7 (195.8) while there is no significant variation among these treatments (Table 5).

3.4.2 Single fruit weight

The highest individual pod weight was recorded for T_4 (16.10) treatment followed by T_6 (14.97) and T_5 (14.56). There is no statistical difference among these treatments in terms of single pod weight. The lowest single pod weight was observed from T1 (12.63) followed by T_7 (12.66) (Table 5).

Table 2. Effect of different treatments in controlling okra shoot and fruit borer in terms of number of shoots/plant

Treatments	Total shoots	Infested shoots	% Shoot infestation
T_1	8.67 d	5.27 a	60.78 a
T_2	9.83 cd	4.88 ab	49.64 b
T_3	11.43 bc	4.49 b	39.28 c
T_4	14.25 a	4.23 b	29.68 d
T_5	13.32 ab	2.40 c	18.02 e
T_6	15.07 a	1.95 c	12.93 f
T_7	8.66 d	5.49 a	63.40 a
CV (%)	12.61	11.11	1.27
LSD (0.05)	2.45	0.78	0.83

In the column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 5% level of probability. Seven treatments, viz. T_1 = Barrier crop, T_2= T-Bird perches 2m long @ 3/plot at distinct distances, T_3 = Pheromone trap @ 15/ha with lures, T_4 = Hand picking at regular basis, T_5 = Bacillus thuringiensis through two applications of Bt toxin on vegetative and flowering stage @ 1 g/liter of water, T_6 = Proclaim 5 SG (Emamectin Benzoate) @ 1 g/liter of water and NLE (Neem leaf extract) @ 3 g/liter of water spraying alternately at 15 days interval, T_7 = Untreated Control

Table 3. Effect of different treatments in controlling okra shoot and fruit borer in terms of number of plants/plot

Treatments	Total plants	Infested plants	% Plant infestation
T_1	12	5.23 ab	43.58 ab
T_2	12	4.27 bc	35.58 bc
T_3	12	4.78 abc	39.83 abc
T_4	12	5.54 ab	46.16 a
T_5	12	4.79 abc	39.92 abc
T_6	12	4.26 c	35.5 c
T_7	12	5.66 a	47.17 a
CV (%)	-	11.86	11.64
LSD (0.05)	-	0.98	8.11

In the column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 5% level of probability. Seven treatments, viz. T_1 = Barrier crop, T_2= T-Bird perches 2m long @ 3/plot at distinct distances, T_3 = Pheromone trap @ 15/ha with lures, T_4 = Hand picking at regular basis,

T_5 = Bacillus thuringiensis through two applications of Bt toxin on vegetative and flowering stage @ 1 g/liter of water, T_6 = Proclaim 5 SG (Emamectin Benzoate) @ 1 g/liter of water and NLE (Neem leaf extract) @ 3 g/liter of water spraying alternately at 15 days interval, T_7 = Untreated Control

Table 4. Effect of different treatments in controlling okra shoot and fruit borer in terms of number of fruits/plant

Treatments	Total fruits / plant	Infested fruits	% Fruit infestation
T_1	28.37 b	12.33 b	43.46 a
T_2	28.93 a	12.11 b	41.85 b
T_3	29.82 a	11.69 b	39.20 c
T_4	33.09 a	12.99 b	39.25 c
T_5	32.47 a	11.47 b	35.32 d
T_6	35.23 a	8.77 a	24.89 e
T_7	27.86 b	12.36 b	44.36 a
CV (%)	11.40	10.78	1.61
LSD (0.05)	6.05	2.21	1.63

In the column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 5% level of probability. Seven treatments, viz. T_1 = Barrier crop, T_2= T-Bird perches 2m long @ 3/plot at distinct distances, T_3 = Pheromone trap @ 15/ha with lures, T_4 = Hand picking at regular basis, T_5 = Bacillus thuringiensis through two applications of Bt toxin on vegetative and flowering stage @ 1 g/liter of water, T_6 = Proclaim 5 SG (Emamectin Benzoate) @ 1 g/liter of water and NLE (Neem leaf extract) @ 3 g/liter of water spraying alternately at 15 days interval, T_7 = Untreated Control

Table 5. Effect of different treatments in yield attributing characteristics and yield of okra

Treatments	Plant height(cm)	Single pod weight(g)	Yield/plot(kg)	Yield/ha(t/ha)
T_1	194.2 e	12.63 b	7.19 b	11.98 d
T_2	203.4 d	13.40 ab	7.66 ab	12.76 c
T_3	211.7 c	13.67 ab	7.76 ab	12.93 c
T_4	245.9 a	16.10 a	8.10 ab	13.50 b
T_5	221.6 b	14.56 ab	8.23 ab	13.72 b
T_6	223.1 b	14.97 ab	8.87 a	14.78 a
T_7	195.8 e	12.66 b	7.23 b	12.05 d
CV (%)	11.47	11.12	10.33	1.83
LSD (0.05)	3.47	2.54	1.43	0.47

In the column, means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 5% level of probability. Seven treatments, viz. T_1 = Barrier crop, T_2= T-Bird perches 2m long @ 3/plot at distinct distances, T_3 = Pheromone trap @ 15/ha with lures, T_4 = Hand picking at regular basis, T_5 = Bacillus thuringiensis through two applications of Bt toxin on vegetative and flowering stage @ 1 g/liter of water, T_6 = Proclaim 5 SG (Emamectin Benzoate) @ 1 g/liter of water and NLE (Neem leaf extract) @ 3 g/liter of water spraying alternately at 15 days interval, T_7 = Untreated Control

3.4.3 Yield per hectare

The maximum yield was found from T_6 (14.78) followed by T_5 (13.72) and T_4 (13.50) whereas; T_5 and T_4 was statistically similar in results in terms of total yield per ha (Table 5). The treatment T_2 (12.76) and T_3 (12.93) was statistically similar for total yield. The lowest yield was recorded from T_1 (11.98) which is also statistically similar with T_7 (12.05) treatment (Table 5).

4. CONCLUSION

It was observed that the synthetic pesticide along with botanicals gave comparatively better management against shoot and fruit borer than other IPM tools. In case of control treatment, the infestation was devastating. As a result, the total healthy yield production was hampered for untreated control plot. So, for getting maximum healthy produces farmers can use synthetic pesticides combinedly with botanicals followed by Bt toxin, pheromone trap and other treatments. Most importantly regular pest monitoring and hand picking of borer larvae can give also satisfactory results.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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