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ECO-FRIENDLY MANAGEMENT OF SHOOT AND FRUIT BORER (*Earias vittella* FAB.) USING BOTANICALS AND BIO-CONTROL AGENT

R. Afroz[1], M. M. Rahman[2] and M. R. Ali[3]

ABSTRACT

A study was conducted at the Sher-e-Bangla Agricultural University, Bangladesh during May 2011 to August 2011 to evaluate the effectiveness of botanicals and parasitoid for the management of okra shoot and fruit borer (*Earias vittella* Fab.). The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising eight treatments viz., T_1 = Neem oil @ 4ml/l of water sprayed at 7 days interval, T_2 = Neem seed kernel extract @ 50 g/l of water sprayed at 7 days interval, T_3 = Neem leaf extract @ 200g/l of water at 7 days interval, T_4 = *Trichogramma evanescens* @ 0.5g/plot at 7 days interval, T_5 = *Trichogramma evanescens* @ 0.25g/plot at + neem oil @ 4ml/l of water sprayed at 7 days interval, T_6 = *Trichogramma evanescens* @ 0.25g/plot + neem seed kernel extract @ 50g/l sprayed at 7 days interval, T_7 = *Trichogramma evanescens* @ 0.25g/plot + neem leaf extract @ 200g/l of water at 7 days interval, T_8 = Untreated control. Among the treatments T_5 (Spraying of neem oil @ 4ml/l of water + release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval) performed the best in terms of percent reduction of shoot infestation (96.50), flower bud infestation (83.33%) and fruit infestation by weight (86.90%).

Keywords: okra shoot and fruit borer, shoot infestation, flower bud infestation, fruit infestation

INTRODUCTION

Okra or lady's finger (*Abelmoschus esculentus* L.) is a popular and most common vegetable crop in Bangladesh and in other tropical and sub-tropical parts of the world (Tindall, 1986). It is locally known as bhendi or dheros. It belongs to the family Malvaceae and originated in tropical Africa (Thomson and Kelly, 1979). Though okra is produced mainly in the kharif season but it can be grown throughout the year. Okra is an important summer vegetable in Bangladesh which plays an important role to meet the demand of vegetables of the country when vegetables are scanty in the market (Ahmed, 1995; Rashid 1999). About 38,508 metric tons of okra is produced from 9786 hectares of land per year in Bangladesh, (BBS, 2009). Okra production in Bangladesh is affected by many factors, among them insect pest attack is the major one. Since okra belongs to the family Malvaceae, nineteen insect pests and four mites have been reported on okra (Anon., 2000). The losses caused by these pests vary from season to season depending upon environmental factors. Among them, okra shoot and fruit borer (OSFB) *Earias vittella* Fab. (Lepidoptera: Noctuidae) is the most obnoxious and detrimental pest of okra in Bangladesh. The occurrence and seasonal abundance of *E. vittella* is maximum in shoots from July to October (Dash *et al.*, 1987). *Earias* spp. causes damage ranging from 52.33 to 70.75 percent (Pareek and Bhargava, 2003). In general the overall damage due to insect pest mounts to 48.97 percent loss in pod yield (Kanwar and Ameta, 2007). Farmers always desire quick curative action for controlling this notorious insect pest of okra. So, the farmer of Bangladesh solely depends on chemical insecticide to control the pest. It is usually found that the vegetable growers apply 10-12 sprays in a season and thus the fruits, which are harvested at the short intervals, are likely to retain unavoidably high level of pesticide residues which may be highly hazardous to consumers. Due to indiscriminate use of pesticides, the pest has developed resistance, besides that pesticides are hazardous to human health, reduce the density of beneficial insect and soil micro-organisms. High levels of pesticide residues have been detected in cabbage, cauliflower, tomato, capsicum, leafy greens, okra and brinjal (Awasthi, 1998).

[1]MS Student, [2&3]Professor, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207

Therefore, it needs to develop alternate methods of pest management other than the use of insecticides (Greathead, 1986). Botanicals possess an array of properties including insecticidal activity and insect growth regulatory activity against many insect and mite pests (Prakash *et al.*, 1990). The advantages of botanicals over synthetic chemicals are low mammalian toxicity, no reported development of resistance, less hazardous to non-target organisms, no pest resurgence problem, no adverse effect on plant growth, negligible application risks, low cost and easy availability. In addition, the use of biological control agent like an egg parasitoid *Trichogramma evanescens* would be compatible with botanicals to work side by side against the target insect pest and safeguard the environment, avoid pesticide resistance and impede development of resurgence and upset. Therefore, the present study was undertaken to evaluate some promising botanicals and bio-control against okra shoot and fruit borer.

MATERIALS AND METHODS

The present study was conducted to develop an IPM package for combating okra shoot and fruit borer in the experimental farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, during May 2011 to August 2011. The experimental field was medium high land and p^H of the soil ranged from 5.47-5.63 under the Agro-ecological Zone 28. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The land was well prepared ploughing, cross-ploughing followed by harrowing and leveling. Cow dung and other chemical fertilizers were applied as recommended by Haque (1993) for okra. The entire experimental field was divided into three blocks. Each block was divided into eight plots. Two adjacent unit plots and blocks were separated by 1m apart. Each experimental plot comprised of 3m x 2m area and the total area covered 12m x 20.5m. Seeds of BARI dheros-1 were sown in the experimental plots on 1st May, 2011 at the rate of 60 seeds / plot. The row to row and plant to plant spacing were maintained at 60 cm x 50 cm, respectively. The comparative effectiveness of the following eight treatments against okra shoot and fruit borer was evaluated on the basis of reduction of this pest infestation: T_1 = Neem oil @ 4ml/l of water sprayed at 7 days interval, T_2 = Neem seed kernel extract @ 50 g/l of water sprayed at 7 days interval, T_3 = Neem leaf extract @ 200g/l of water at 7 days interval, T_4 = *Trichogramma evanescens* @ 0.5g/plot at 7 days interval, T_5 = *Trichogramma evanescens* @ 0.25g/plot at + neem oil @ 4ml/l of water sprayed at 7 days interval, T_6 = *Trichogramma evanescens* @ 0.25g/plot + neem seed kernel extract @ 50g/l sprayed at 7 days interval, T_7 = *Trichogramma evanescens* @ 0.25g/plot + neem leaf extract @ 200g/l of water at 7 days interval, T_8 = Untreated control. Data on infestation by okra shoot and fruit borer under different management treatments were counted and recorded from 5 randomly selected plants at two days interval by the presence of bores and excreta on flower bud, shoot and fruit respectively during both vegetative and reproductive stages separately. The following parameters were considered for evaluating the effectiveness of each treatment in suppressing okra shoot and fruit borer infestation: total number of shoots, flower bud per plant, number of infested shoots,, flower bud per plant, weight of total fruits per plant, weight of infested fruits per plant. The percent infestation of shoot/flower bud/fruit was calculated using the following formula:

$$\%\ \text{infestation of shoot/flower bud/fruit} = \frac{\text{No. of infested shoots/ flower buds/fruits}}{\text{Total no. of shoots/ flower buds/fruits}} \times 100$$

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT program (Gomez and Gomez, 1976). The treatment means were separated by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of management practices on shoot infestation of okra by OSFB

Significant differences were observed among different management practices against OSFB in terms of percent shoot infestation by number at the vegetative stage, early fruiting stage and late fruiting stage (Table 1). At vegetative stage, the highest percent of shoot infestation (25.89 %) was recorded in T_8 (untreated control) which was statistically different from all other treatments (Table 1) and was followed (16.22 %) by T_3 (spraying of neem leaf extract @ 200g/l of water) and T_7 (11.67 %) comprised of spraying of neem leaf extract @ 200g/l of water + *Trichogramma evanescens* egg parasitoid @ 0.25 g/plot at 7 days interval. On the other hand, the lowest percent of shoot infestation (0.87 %) was recorded in T_5 (spraying of neem oil @ 4ml/l of water + *Trichogramma evanescens* egg parasitoid @ 0.25 g/plot at 7 days interval) which was followed (3.01 %) by T_6 (spraying of water based neem seed kernel extract @ 50g/l of water + *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval). The intermediate level of infestation was recorded (5.00 %) in T_4 (*Trichogramma evanescens* egg parasitoid @ 0.5 g/plot at 7 days interval) which was followed by T_1 (6.67 %) comprised of spraying of neem oil @ 4 ml/l of water at 7 days interval and T_2 (8.27 %) comprised of spraying of water based neem seed kernel extract @ 50g/l of water at 7 days interval.

Table 1. Effect of different management practices on shoot infestation by okra shoot and fruit borer (OSFB) at different growth stage of Okra during May-August, 2011

Treatments	% Shoot infestation				
	Vegetative stage	Early fruiting stage	Late fruiting stage	Mean infestation	% reduction over control
T_1	6.67 de	4.23 d	3.00 d	4.81 d	71.45
T_2	8.27 d	4.77 d	3.08 d	5.20 d	69.14
T_3	16.22 b	10.67 b	8.17 b	11.69 b	30.62
T_4	5.00 e	2.57 e	2.07 d	3.21 e	80.95
T_5	0.87 g	0.5 f	0.40 e	0.59 f	96.50
T_6	3.01 f	2.23 e	1.60 de	2.28 e	86.47
T_7	11.67 c	8.17 c	6.22 c	8.69 c	48.44
T_8	25.89 a	13.67 a	11.00 a	16.85 a	-
$LSD_{(0.01)}$	1.92	1.65	1.42	1.47	-
CV (%)	8.12	11.59	13.19	9.06	-

In column, means containing same letter indicate significantly similar under DMRT at 1% level of significance. Values are the means of three replications.

T_1 = Spraying of neem oil @ 4ml/litre of water at 7 days interval; T_2 = Spraying of water based neem seed kernel extract @ 50g/litre of water at 7 days interval; T_3 = Spraying of water based neem leaf extract @ 200g/litre of water at 7 days interval; T_4 = Release of *Trichogramma evanescens* egg parasitoid @ 0.5g/plot at 7 days interval; T_5 = Spraying of neem oil @ 4ml/litre of water + *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_6 = Spraying of water based neem seed kernel extract @ 50g/litre of water + *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_7 = Spraying of water based neem leaf extract @ 200g/litre of water + *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_8 = Untreated control.

At early fruiting stage, the highest shoot infestation of 13.67% was observed in control treatment which was followed by the treatment having water based neem leaf extract @ 200g/l of water (T_3) that was 10.67 % shoot infestation and T_7 (8.17 %) (Table 1). On the other hand, the lowest shoot infestation (0.5%) was recorded in the plots which were treated with neem oil @ 4ml/l of water + *Trichogramma evanescens* egg parasitoid @ 0.25 g/plot at 7 days interval (T_5). The second lowest shoot infestation (2.23 %) observed in T_6 treatment which was statistically similar to that of T_4 (2.57 %) treatment. The intermediate level of infestation was recorded in T_1 (4.23 %) which was statistically similar to that of T_2 (4.77 %). At late fruiting stage, the highest percent of shoot infestation (11.00%) recorded in control plot which was followed by T_3 (8.17 %) and T_7 (6.22 %) treatment (Table 1). On the other hand, the lowest percent of shoot infestation

(0.40 %) was recorded in T_5 followed by T_6 (1.60 %). During the total cropping season, the lowest shoot infestation (0.59 %) was recorded in the plot which was treated with neem oil @ 4ml/l of water + *Trichogramma evanescens* egg parasitoid @ 0.25 g/plot at 7 days interval (T_5). The second lowest shoot infestation was observed in T_6 (2.28 %). On the other hand, the highest shoot infestation (16.85 %) was recorded in control plot (T_8) which was followed by T_3 (11.69 %) and T_7 (8.69 %) treatment. The intermediate level of infestation was recorded in T_4 (3.21 %) followed by T_1 (4.81 %) and T_2 (5.20 %) treatment (Table 1). Considering the percent reduction of shoot infestation over control, the highest reduction (96.50 %) was recorded in T_5 (Table 1) which was followed by T_6 (86.47 %) treated plot. On the other hand, the lowest reduction of shoot infestation was recorded in T_3 (30.62 %) followed by T_7 (48.44 %) treated plot. The intermediate level of infestation was recorded in T_4 (80.95 %) followed by T_2 (69.14 %) and T_1 (71.45 %).

From the above mentioned findings it was revealed that the T_5 performed as the best in reducing the shoot infestation (96.50 %) caused by okra shoot and fruit borer followed by T_6 (86.47 %) and T_4 (80.95 %). On other hand, the lowest reduction of shoot infestation was recorded in T_3(30.62 %) followed by T_7 (48.44 %) and T_2 (69.14 %). It was also revealed that the percent shoot infestation was increased at vegetative stage of okra and declined during the fruiting stage. As a result the trend of percent reduction of shoot infestation over control caused by okra shoot and fruit borer was $T_5 > T_6 > T_4 > T_1 > T_2 > T_7 > T_3$ (Table 1). Shukla *et al.* (1997) reported that before fruiting stage shoot infestation reached at a peak of 8.5%.

Effect of management practices on flower bud infestation of okra by OSFB

Significant differences were observed among different management practices against OSFB in terms of percent flower bud infestation by number at the vegetative stage, early fruiting stage and late fruiting stage (Table 2). At vegetative stage of the okra, the highest percent of flower bud infestation (6.40 %) was recorded in T_8 (untreated control) which was statistically different from all other treatments (Table 2). This was followed (4.27 %) by T_3 (spraying of neem leaf extract @ 200g/L of water) and T_7 (2.79 %) comprised of T_3 plus release of *Trichogramma evanescens* egg parasitoid @ 0.25 g/plot at 7 days interval. On the other hand, the lowest percent of flower bud infestation (0.12 %) was recorded in T_5

Table 2. Effect of different management practices on flower bud infestation by OSFB at different growth stage of Okra during May-August, 2011

Treatment	% Flower bud infestation				
	Vegetative stage	Early fruiting stage	Late fruiting stage	Mean infestation	% reduction over control
T_1	1.50 de	22.00 d	6.34 d	9.95 de	59.05
T_2	1.80 d	23.10 d	7.26 d	10.72 d	55.88
T_3	4.27 b	37.00 b	14.83 b	18.70 b	23.04
T_4	1.30 e	19.43 de	5.54 d	8.76 e	63.95
T_5	0.12 g	11.11 f	0.91 f	4.05 g	83.33
T_6	0.93 f	16.94 e	3.33 e	7.07 f	70.91
T_7	2.79 c	30.67 c	11.83 c	15.10 c	37.86
T_8	6.40 a	46.58 a	19.91 a	24.30 a	--
$LSD_{(0.01)}$	0.32	4.25	1.86	1.40	--
CV (%)	5.46	6.76	8.75	4.66	--

In column, means containing same letter indicate significantly similar under DMRT at 1% level of significance. Values are the means of three replications

[T_1 = Spraying of neem oil @ 4ml/l of water at 7 days interval; T_2 = Spraying of water based neem seed kernel extract @ 50g/l of water at 7 days interval; T_3 = Spraying of water based neem leaf extract @ 200g/l of water at 7 days interval; T_4 = Release of *Trichogramma evanescens* egg parasitoid @ 0.5g/plot at 7 days interval; T_5 = Spraying of neem oil @ 4ml/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_6 = Spraying of water based neem seed kernel extract @ 50g/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_7 = Spraying of water based neem leaf extract @ 200g/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_8 = Untreated control.]

(spraying of neem oil @ 4ml/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25 g/plot at 7 days interval). This was followed (0.93 %) by T_6 (spraying of water based neem seed kernel extract @ 50g/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval). This was followed (1.30 %) by T_4 comprising release of *Trichogramma evanescence* egg parasitoid @ 0.5 g/plot at 7 days interval , T_1 (1.50 %) comprising the spraying of neem oil @ 4 ml/l of water at 7 days interval and T_2 (1.80 %) spraying of water based neem seed kernel extract @ 50g/l of water at 7 days interval. Considering the percent flower bud infestation by OSFB at early fruiting stage, the highest percent of flower bud infestation (46.58 %) was observed in untreated control plot which was statistically different from all other treatments (Table 2). This was followed by T_3 (37.00 %) and T_7 (30.67 %). On the other hand, the lowest percent of flower bud infestation (11.11 %) was recorded in T_5. This was followed by T_6 (16.94 %) and T_4 (19.43 %). This was followed by T_1 (22.00 %) which was statistically similar to that of T_2 (23.10 %). In terms of percent flower bud infestation at late fruiting stage, the highest percent of flower bud infestation (19.91 %) recorded in untreated control plot which was statistically different from all other treatments (Table 2). This was followed by T_3 (14.83 %) and T_7 (11.83 %). On the other hand, the lowest percent of shoot infestation (0.91 %) was recorded in T_5. This was followed by T_6 (3.33 %), T_4 (5.54 %) and the later was statistically similar to that of T_1 (6.34 %) and T_2 (7.26 %). Considering the mean flower bud infestation through the cropping season, the highest flower bud infestation (24.30 %) by OSFB was recorded in untreated control plot which was statistically different from all other treatments (Table 2). This was followed by T_3 (18.70 %) and T_7 (15.10 %). On the other hand, the lowest percent of flower bud infestation (4.05 %) was recorded in T_5. This was followed by T_6 (7.07 %), T_4 (8.76 %) and T_1 (9.95 %) and T_2 (10.72 %). In terms of percent reduction of flower bud infestation over control, the highest reduction (83.33 %) was recorded in T_5 (Table 2). This was followed (70.91 %) by T_6 and T_4 (63.95 %). On the other hand, the lowest reduction (23.04 %) was recorded in T_3 followed by T_7 (37.86 %), T_2 (55.88 %) and T_1 (59.05 %).

From the above mentioned findings it was revealed that the T_5 performed the best treatment in reducing the flower bud infestation (83.33 %) caused by okra shoot and fruit borer followed by T_6 (70.91 %) and T_4 (63.95 %). On other hand, the lowest reduction of flower bud infestation over control was recorded in T_3 (23.04 %) followed by T_7 (37.86 %), T_2 (55.88 %). As a result the trend of percent reduction of flower bud infestation over control caused by okra shoot and fruit borer was $T_5 > T_6 > T_4 > T_1 > T_2 > T_7 > T_3$ (Table 2).

Effect of management practices on fruit infestation of okra

Significant differences were observed among different management practices against OSFB in terms of percent fruit infestation by weight at the early fruiting stage, mid fruiting stage and late fruiting stage (Table 3). In case of early fruiting stage of the okra, the highest percent of fruit infestation (8.63 %) was recorded in untreated control which was statistically different from all other treatments (Table 3). This was followed (6.33 %) by T_3 and T_7 (5.72 %) treated plots. On the other hand, the lowest percent of fruit infestation (0.50 %) was recorded in T_5 and this was followed (2.47 %) by T_6, T_4 (3.40 %), T_1 (3.77 %) and T_2 (4.37 %) treated plots. Considering the percent fruit infestation by OSFB at mid fruiting stage, the highest percent of fruit infestation (21.31 %) was observed in untreated control which was statistically different from all other treatments (Table 3). This was followed by T_3 (17.72 %) and T_7 (12.08 %). On the other hand, the lowest percent of fruit infestation (4.12 %) was recorded in T_5 and this was followed by T_6 (6.91 %) and T_4 (8.05 %) which was statistically similar to that of T_1 (8.58 %), T_2 (8.83 %) treated plots. In terms of percent fruit infestation at late fruiting stage, the highest percent of fruit infestation (13.33 %) recorded in untreated control plot which was statistically different from all other treatments (Table 3). This was followed by T_3 (8.32 %) and T_7 (5.14 %) treated plots. On the other hand, the lowest percent of fruit infestation (1.05 %) was recorded in T_5 and this was followed by T_6 (2.23 %), (3.21 %) which was statistically similar to that of T_1 (3.35 %), followed by T_2 (3.83 %). Considering the mean fruit infestation through the cropping season, the highest fruit infestation (14.43 %) by OSFB was recorded in control plot which was statistically different from all other treatments (Table 3). This was followed by T_3 (10.79 %) and T_7 (7.65 %). On the other hand, the lowest percent of fruit infestation (1.89 %) was recorded in T_5 and this was followed by T_6 (3.87 %), T_4 (4.89 %), T_1 (5.23 %) and T_2 (5.68 %). In terms of percent reduction of fruit infestation over control, the highest reduction (86.90 %) was recorded in T_5 (Table 3). This was followed by T_6 (73.18 %) and T_4 (66.11 %). On the other hand, the lowest reduction (25.22 %) was recorded in T_3, followed by T_7 (46.98 %), T_2 (60.64 %) and T_1 (63.76 %).

Table 3. Effect of different management practices on fruit infestation by weight at different growth stage of Okra during May-August, 2011

Treatment	% Fruit infestation by weight				
	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean infestation	% reduction over control
T_1	3.77 cd	8.58 de	3.35 d	5.23 de	63.76
T_2	4.37 c	8.83 d	3.83 cd	5.68 d	60.64
T_3	6.33 b	17.72 b	8.32 b	10.79 b	25.22
T_4	3.40 d	8.05 de	3.21 d	4.89 e	66.11
T_5	0.50 f	4.12 f	1.05 e	1.89 g	86.90
T_6	2.47 e	6.91 e	2.23 de	3.87 f	73.18
T_7	5.72 b	12.08 c	5.14 c	7.65 c	46.98
T_8	8.63 a	21.31 a	13.33 a	14.43 a	--
$LSD_{(0.01)}$	0.90	1.79	1.55	0.74	--
CV (%)	8.40	6.73	12.63	4.47	--

In column, means containing same letter indicate significantly similar under DMRT at 1% level of significance. Values are the means of three replications

[T_1 = Spraying of neem oil @ 4ml/l of water at 7 days interval; T_2 = Spraying of water based neem seed kernel extract @ 50g/l of water at 7 days interval; T_3 = Spraying of water based neem leaf extract @ 200g/l of water at 7 days interval; T_4 = Release of *Trichogramma evanescens* egg parasitoid @ 0.5g/plot at 7 days interval; T_5 = Spraying of neem oil @ 4ml/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_6 = Spraying of water based neem seed kernel extract @ 50g/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_7 = Spraying of water based neem leaf extract @ 200g/l of water plus release of *Trichogramma evanescens* egg parasitoid @ 0.25g/plot at 7 days interval; T_8 = Untreated control.]

From the above mentioned findings it was revealed that the T_5 performed as the best treatment in reducing the fruit infestation (86.90 %) caused by okra shoot and fruit borer and was followed by T_6 (73.18 %) and T_4 (66.11 %). On other hand, the lowest reduction of fruit infestation over control was recorded in T_3 (25.22 %) followed by T_7 (46.98 %) and T_2 (60.64 %). It was also revealed that the percent fruit infestation by weight was increased in the fruiting stage of okra and declined there after. As a result the trend of percent reduction of fruit infestation over control caused by okra shoot and fruit borer was $T_5 > T_6 > T_4 > T_1 > T_2 > T_7 > T_3$.

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