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EFFECTIVENESS OF SOME SELECTED INSECTICIDES AND BOTANICALS AGAINST OKRA SHOOT AND FRUIT BORER

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Abstract

An experiment was conducted to evaluate the effectiveness of some selected insecticides and botanicals against okra shoot and fruit borer *Earias vittella* F. under field conditions. The insecticides tested were Relothrin 10EC @ 1ml l^{-1}, Marshal 20EC @ 2ml $l^{-1}$and Riva 2.5 EC @ ml l^{-1}; and the botanicals were NSKE @ 50g l^{-1}, Neem leaf extract @ 100g l^{-1} and Bishkatali leaf extract @ 100g l^{-1}. An additional treatment of Mechanical control (hand picking) and an untreated control were maintained in the experiment for comparison. All treatments were applied at 15 days interval. Shoot infestation was the lowest in Marshal 20EC treated plot (4.34% at pre-fruiting and 3.55% at fruiting stage) and the highest was in untreated control plot (21.4%). The lowest fruit infestation by okra shoot and fruit borer was obtained with Marshal 20EC (5.07% n/n and 3.65% w/w) followed by Relothrin 10EC (5.43% n/n and 4.27% w/w) and the highest infestation was observed under untreated control plot (19.67% n/n and 19.81% w/w). The reduction of fruit infestation over untreated control ranged from 56.93-81.55% by number and 43.47-74.22% by weight. The highest marketable yield (10.46 t ha^{-1}) was obtained in Marshal 20EC treated plot followed by in Relothrin 10EC 10.30 t ha^{-1} with the maximum benefit cost ratio (BCR) 6.72.

Keywords: Insecticides, botanicals, *Earias vittella*, okra, Okra shoot and fruit borer.

Introduction

Okra (*Abelmoschus esculentus* L.) is an annual widely grown vegetable crop in Bangladesh. But the crop is severely hampered by a number of insect pests, especially okra shoot and fruit borer, jassid and whitefly. Among them, okra shoot and fruit borer, *Earias vittella* F. (Lepidoptera, Noctuidae) is the most damaging pest of okra (Butani and Jotwani, 1984). Srinivasan and Krishnakumar (1983) reported up to 40-50% damage of okra fruits by this pest in some areas of South-East Asian countries. In Bangladesh, *E. vittella* is noted as major insect pest of okra causing tremendous yield losses (Ali, 1992).

Several management practices have been reported to combat this pest (Kabir, 2007; Haque, 1998), however, use of insecticide is the main reliable tool (Parkash, 1988).

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A wide range of organophosphorus, carbamate and synthetic pyrethroids of various formulations have been recommended to control the pest (Chattopadhyay, 1991; Borah, 1997). Sahoo and Pal (2003) reported that spraying carbosulfan at 15 days interval showed the lowest fruit damage of okra. Ambekar *et al.* (2000) reported that cypermethrin at 0.1% showed effective against *E. vittella* and recorded the lowest infestation. Vishwanath and Singh (2008) described that foliar application of Lambda-Cyhalothrin at flowering and fruit initiation stages was the most effective against *E. vittella*. However, indiscriminate and non-judicious use of insecticides may result in a series problem related to both loss of their effectiveness and in the long run, it develops insect resistance (Alam *et al.*, 2003), pollution (FAO, 2003) and health hazards (Chinniah *et al.*, 1998). Various non-chemical approaches like use of botanicals, clean cultivation, mechanical control like hand picking and destroying of infested plant parts particularly shoots and fruits are common practices used for suppressing the insect pests (Hasan, 1994).

Due to lack of knowledge and unavailability of non-chemical pest management approaches, growers of Bangladesh mostly depend on insecticides to keep the crop production steady. Appropriate knowledge and availability of botanical pest management approaches and their integration with selective chemicals may give better results against okra shoot and fruit borer. Considering the circumstances, the present study was conducted to evaluate the effectiveness of three insecticides and three botanicals for effective and economic management of *E. vittella* in okra field.

Materials and Method

Experimental site and design

The study was conducted in the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during March to July 2010. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 3m × 2m and separated by 1m and block to block distance was 2m.

Growing of okra

Seeds of okra cultivar Arka Anamika were soaked in water for 24 hours and sown in the pit in the field. Two to three seeds were sown in each pit maintaining line to line distance of 60 cm and finally plant to plant distance 40 cm. Each unit plot received 21 plants. Gap filling was done by transplanting seedlings from the stock. Manures and fertilizers were applied according to Rashid (1999) and intercultural operations such as irrigation, weeding, mulching, thinning and other operations were done accordingly. One spray with Imitaf 20 SL @ 0.25 ml l^{-1} water within 30 days after seed sowing (DAS) was done to control whitefly (*Bemisia tabaci*).

Preparation of botanicals

Neem seed karnel extract: Mature seeds of neem (*Azadirachta indica*) were collected, sun dried and grounded into powder. The powder was soaked in water @ 50g/300 ml of water for overnight. The mixture was filtered through nylon net and maintained the volume of 1000 ml.

Biskatali and neem leaf extract: Fresh Bishkatali (*Polygonum hydropiper*) and neem leaves (*Azadirachta indica*) were collected for the preparation of leaf extract one day before application. The leaves were cut into small pieces and 500g leaves were blended thoroughly in an electric blender. The blended leaves were mixed with two liters of water and the mixture was kept overnight to enhance extraction. The mixture was then sieved and maintained the volume at 5 liters.

Application of treatments

The experimental field was monitored regularly to observe the initiation of infestation When the pest caused approximately 2% shoot infestation, the application of treatments was started. The experimental treatments were Marshal (Carbosulphan) 20EC @ 2ml l^{-1}, Ripcord (Cypermethrin) 10EC @ 1ml l^{-1} water, Riva 2.5EC (Lambda-cyhallothrin) @ 1ml l^{-1}water, Neem seed kernel extract (NSKE) @ 50 g l^{-1} water, Neem leaf extract @ 100g l^{-1} water, Bishkatali leaf extract @ 100g l^{-1} water, Mechanical control (hand picking). All the treatments were applied at 15 days interval and repeated 4 times up to last harvest.

Collection and analysis of data

Data on shoot infestation and fruit yield by number were recorded. Total number of shoots and the number of infested shoots were recorded from 5 plants randomly selected in each plot at before flowering, after flowering to fruit initiation and at fruiting stages at 7 days interval. The number of healthy and infested fruits and their weight per plot were recorded at each harvest. The infestation of the pest was expressed in percentage based on total number of shoot and fruit (n/n) and weight (w/w) of fruit.

The cumulative yield (g) per plot of healthy as well as infested fruits was computed. The final yield was expressed in ton per hectare. For economic analysis, BCR was calculated on the basis of total expenditure of the respective spray schedule along with the total return from that particular spray schedule. The data were analyzed statistically by analysis of variance (ANOVA) and the means were separated by using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Rate of shoot infestation

Effects of various treatments on percent shoot infestation by okra shoot and fruit borer at pre fruiting and fruiting stages is presented in Table 1. Shoot infestation

ranged 4.34-21.43% at pre-fruiting and 3.55-21.42% at fruiting stages under different treatments. The highest shoot infestation was observed in untreated control plot and the lowest infestation was obtained with Marshall spray at both pre-fruiting and fruiting stages. The reduction of shoot infestation over untreated control ranged from 40.32 to 79.75% at pre-fruiting stage and 49.81 to 83.41% at fruiting stage. The highest reduction in shoot infestation was achieved with Marshal 20EC treated plot followed by Relothrin 10EC (76.33%), Riva 2.5EC (69.03%), NSKE (65.70%), Neem leaf extract (60.84%) and Bishkatali leaf extract (52.92%) treated plots.

At fruiting stage, reduction in shoot infestation over control ranged from 49.81-83.41% under different treatments including untreated control. The highest reduction was also obtained with Marshal 20EC treated plot followed by Relothrin 10EC (79.24%), Riva 2.5EC (76.99%), NSKE (69.89%), Neem leaf extract and Bishkatali leaf extract (58.30%) sprayed plots. The lowest shoot infestation was recorded from Marshal 20EC (3.55%) treated plot, which was statistically similar to Riva 2.5EC (4.93%) and Relothrin 10EC (4.45%) treated plots. The higher shoot infestation was recorded from mechanical control plot (10.75%) which was significantly similar with Bishkatali leaf extract (8.93%) and Neem leaf extract (7.45%) treated plots.

Results revealed that among the treatments the efficacy of insecticides was better than the three plant extracts. Among the insecticides, the most effective was Marshal 20EC followed by Relothrin 10EC and Riva 2.5EC. Of the three botanicals, Neem seed kernel extract (NSKE) was most effective followed by Neem leaf extract and Bishkatali leaf extract (Table 1). In a similar study, In-Hu *et al.* (2004) reported that Proclaim showed 87.00% shoot infestation reduction over control. Islam *et al.* (1999) recommended that the minimum acceptable level of shoot infestation reduction over control was 80.00%.

Table 1. Effect of chemical, botanical and mechanical treatments on the rate of shoot infestation by okra shoot and fruit borer at pre-fruiting and fruiting stages

Treatments	Pre-fruiting stage		Fruiting stage	
	% Shoot infestation	% Infestation reduction over control	% Shoot infestation	% Infestation reduction over control
Marshal 20EC	4.34c	79.75	3.55f	83.41
Riva 2.5EC	6.63bc	69.03	4.93def	76.99
Relothrin 10EC	5.07bc	76.33	4.45ef	79.24
Neem seed kernel extract	7.35bc	65.70	6.45cde	69.89
Neem leaf extract	8.39bc	60.84	7.54cd	65.23
Bishkatali leaf extract	10.00bc	52.92	8.93bc	58.30
Mechanical control	12.79b	40.32	10.75b	49.81
Untreated control	21.43a	-	21.42a	-
CV (%)	8.59	-	16.75	-

Means within the same column with a common letter(s) do not differ significantly (P=0.05) according to DMRT.

Rate of fruit infestation (n/n and w/w)

The lowest rate of fruit infestation (n/n) was obtained in plots sprayed with Marshal 20EC (5.07%) followed by Relothrin 10EC (5.43%) and these were statistically similar but significantly lower compared to other treatments (Table 2). The rate of fruit infestation obtained 6.68% in Riva 2.5EC, 7.46% in Neem seed kernel extract, 9.99% in Neem leaf extracts, 10.25% in Bishkatali leaf extract treated plots. The highest rate of fruit infestation (n/n) was obtained in untreated control plots (19.67%) followed by Mechnical control plots (11.12%) and these were statistically different from each other.

The rate of reduction of fruit infestation (n/n) over untreated control was obtained with Marshal 20EC (74.22%) followed by Relothrin 10EC (72.38%), Riva 2.5EC (66.00%), NSKE (62.04%), Neem leaf extracts (49.21%). The least effective treatments to reduce fruit infestation were Mechnical control (43.47%) followed by Bishkatali leaf extract (47.90%) (Table 2).

The lowest fruit infestation (w/w) was obtained in plots sprayed with Marshal 20EC (3.65%) followed by Relothrin 10EC (4.27%) and Riva 2.5EC (5.51%) differences were statistically significant. The rate of fruit infestation obtained 5.76% in Neem seed kernel extract, 7.37% in Neem leaf extracts, 7.83% in Bishkatali leaf extract treated plots. The highest rate of fruit infestation (w/w) was obtained in untreated control plots (19.81%) followed by Mechnical control plots (8.53%) and these were statistically different with each other.

Reduction (% w/w) of fruit infestation over untreated control ranged from 56.93-81.55%. The highest reduction was achieved with Marshal 20EC followed by Relothrin 10EC (78.41%) and Riva 2.5EC (72.17%). Among the botanicals, 70.91, 62.76 and 60.46% reduction was achieved with foliar spray of NSKE, Neem leaf extract and Bishkatali leaf extract, respectively. The lowest reduction of 56.93% was obtained with Mechanical control (Table 2).

In a similar type of study, Pawar *et al.* (1988) reported that single spray of Endosulfan with concentration 500 g ha^{-1} followed by 3 applications of Cypermethrin or Fenvalerate at 50 g ha^{-1} at an interval of 14 days was the most effective for the control of *E. vitella* infesting okra. On the other hand, Alagar and Sivasubramaniam (2006) recorded the highest percentage of okra fruit damage reduction (48.93%) and higher yield (14.75 tha^{-1}) with 5% NSKE.

Among the materials, Marshal 20EC was noted as the most effective material to suppress okra shoot and fruit borer. Similar study was conducted by Kabir (2007) and obtained 12.76%-92.52% reduction in fruit infestation over control. In the present study, the reduction of infested fruit over untreated control was higher (72.17-81.55%) in three insecticide treated plots compared to botanicals (60.46-70.91%).

Table 2. Effect of insecticides, botanicals and mechanical treatments on rate of fruit infestation by okra shoot and fruit borer

Treatments	Rate of infestation (n/n)		Rate of infestation (w/w)	
	% Infestation	% Reduction over untreated control	% Infestation	% Reduction over untreated control
Marshal 20EC	5.07f	74.22	3.65 f	81.55
Riva 2.5EC	6.68e	66.00	5.51 d	72.17
Relothrin 10EC	5.43f	72.38	4.27 e	78.41
Neem seed kernel extract	7.46d	62.04	5.76 d	70.91
Neem leaf extract	9.99c	49.21	7.37 c	62.76
Bishkatali leaf extract	10.25c	47.90	7.83 c	60.46
Mechanical control	11.12b	43.47	8.53 b	56.93
Untreated control	19.67a	-	19.81 a	-
CV (%)	7.06	-	6.83	-

Means within a column with a common letter(s) do not differ significantly (P=0.05) according to DMRT.

Yield of okra (t ha^{-1})

The plots treated with Marshal 20EC produced significantly the highest marketable yield of okra per hectare (10.46 t ha^{-1}), which was statistically similar to that obtained from the Relothrin 10EC (10.30 t ha^{-1}) treated plot. The marketable fruit yield of okra was obtained from the plot treated with NSKE (9.89 t ha^{-1}) which was significantly different from all other treatments. The yield in Riva 2.5EC treated plot was 8.50 t ha^{-1} and Neem leaf extract treated plot produced 7.92 t ha^{-1}, were significantly different from each other and the rest of the treatments. Comparatively the lower yield of marketable fruit was obtained in Bishkatali leaf extract (7.34 t ha^{-1}) treated plot and Mechanical control (7.35 t ha^{-1}) plot which were statistically similar. The lowest marketable yield was harvested from untreated control plot (6.47 t ha^{-1}) and this was significantly lower compared to all other treatments (Table 3).

Significantly the highest infested fruit yield of okra (1.60 t ha^{-1}) was obtained in untreated control plot followed by mechanical control plot (0.68 t ha^{-1}) which was similar to Neem leaf extract (0.63 t ha^{-1}) treated plot. Statistically similar infested fruit yield was obtained in NSKE (0.60 t ha^{-1}) treated plot, Bishkatali leaf extract (0.62 t ha^{-1}) and also Neem leaf extract treated plots. The lowest infested fruit yield was obtained in Marshal 20EC (0.40 t ha^{-1}), which was significantly different from all other treatments. The lower infested fruit yield was obtained in Riva (0.49 t ha^{-1}) sprayed plot, which was followed by Relothrin 10EC (0.46 t ha^{-1}) and they were statistically similar.

The percent increase of marketable yield over untreated control plot was the highest (61.67%) in the plot sprayed with Marshal 20EC followed by Relothrin 10EC (59.20%) treated plot and NSKE (52.90%). The lowest percent increase in healthy fruit yield over untreated control was Bishkatali leaf extract (13.45%) treated plot which was followed by mechanical control plot (13.65%). Percent marketable yield increase over untreated control was lower in Riva 2.5EC (31.48%) and Neem leaf extract (22.46%).

The present finding of yield increase over control may be discussed with those of other authors. Choudhury and Dadheech (1989) reported that cypermethrin sprayed at weekly interval starting from the first flowering provided 25.00% increased yield over untreated control. Sardana and Kumar, 1989 observed that weekly application of Neem *(Azadirachta indica)* oil at 2% was effective for controlling *E. vittella* on okra. Neem oil was found as effective as Monocrotophos at 0.05%, and can therefore, be recommended for use in an integrated control scheme against this pest. In the present study, the NSKE provided appreciable yield increase (52.90%) over control compared to Relothrin (59.20%) and Marshal (61.67%). But it was considerably higher than that of Riva 2.5EC (31.48%). So, use of NSKE may be an alternate tools for safer management of okra shoot and fruit borer.

Table 3. Okra fruit yield obtained by shoot and fruit borer management using insecticides, botanicals and mechanical treatments

Treatments	Yield (t ha^{-1})		
	Marketable	Infested	% marketable yield increase over untreated control
Marshal 20EC	10.46a	0.40e	61.67
Riva 2.5EC	8.50c	0.49d	31.48
Relothrin 10EC	10.30a	0.46d	59.20
Neem seed kernel extract	9.89b	0.60c	52.90
Neem leaf extract	7.92d	0.63bc	22.46
Bishkatali leaf extract	7.34e	0.62c	13.45
Mechanical control	7.35e	0.68b	13.65
Untreated Control	6.47f	1.60a	-
CV (%)	6.90	6.05	-

Means within the same column with a common letter(s) do not differ significantly (P=0.05) according to DMRT.

Economic analysis of different control measures

The management cost of different treatments used against okra shoot and fruit borer was calculated and presented in Table 4. The highest gross return of Tk. 2,61,500.00 ha^{-1} was obtained with the Marshal 20EC followed by Relothrin 10EC (Tk. 2,57,500.00), NSKE (Tk. 2,47,250.00), Riva 2.5EC (Tk. 2,12,675.00), Neem leaf extract (Tk. 1,98,075.00), mechanical control (Tk. 1,83,825.00) and Bishkatali leaf extract (Tk. 1,83,500.00).

The highest net return of Tk. 2,47,300.00 per hectare was obtained with the Marshal 20EC followed by Relothrin 10EC (Tk. 2,45,100.00), NSKE (Tk. 2,31,350.00), Riva 2.5EC (Tk. 2,03,275.00), Neem leaf extract (Tk. 1,86,395.00), mechanical control (Tk. 1,76,625.00) and Bishkatali leaf extract (Tk. 1,74,484.00).

The highest adjusted net return of Tk. 85,550.00 ha^{-1} was obtained with the Marshal 20EC followed by Relothrin 10EC (Tk. 83,350.00), NSKE (Tk. 69,600.00), Riva 2.5EC (Tk. 41525.00), Neem leaf extract (Tk. 24,645.00), mechanical control (Tk. 14,875.00) and Bishkatali leaf extract (Tk. 12,734.00) (Table 4).

The highest benefit cost ratio (6.72) was obtained with Relothrin 10EC followed by Marshal 20EC (6.02), Riva 2.5EC (4.42), NSKE (4.37), Neem leaf extract (2.11), Mechanical control (2.07) and Bishkatali leaf extract (1.41). The cause of lower of these treatments were due to comparatively lower yield and higher cost of management against okra shoot and fruit borer (Table 4).

The economics of pest management of okra shoot and fruit borer were studied by Srinivasan and Krishnakumar (1983) in Karnataka, India, for 3 growing seasons. Disulfoton granules @ 1 kg a.i. ha^{-1} applied at the time of sowing, followed by 1% carbaryl sprays at 40, 50 and 60 days after germination, gave the maximum crop yield and net income.

The findings of the present study indicated that the insecticide Relothrin 10EC, Marshal 20EC and Riva 2.5EC are effective to manage infestation of okra shoot and fruit borer in okra. The result of this study reveal that NSKE showed effective result in suppressing okra shoot and fruit borer infestation and also cost effective. Although it provides moderate level of economic benefit but it has no hazard to health and environment compared to insecticide application.

Table 4. Benefit cost ratio analysis of selected insecticides and botanicals along with mechanical control for the management of okra shoot and fruit borer

Treatments	Management cost (Tk)	Gross return (Tk)	Net return (Tk)	Adjusted net return (Tk)	BCR
Marshal 20EC	14200.00	261500.00	247300.00	85550.00	6.02
Riva 2.5EC	9400.00	212675.00	203275.00	41525.00	4.42
Relothrin 10EC	12400.00	257500.00	245100.00	83350.00	6.72
Neem seed kernel extract	15900.00	247250.00	231350.00	69600.00	4.37
Neem leaf extract	11680.00	198075.00	186395.00	24645.00	2.11
Bishkatali leaf extract	9016.00	183500.00	174484.00	12734.00	1.41
Mechanical control	7200.00	183825.00	176625.00	14875.00	2.07
Untreated control	0.00	161750.00	161750.00	-	-

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