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ENVIRONMENT FRIENDLY MANAGEMENT APPROACHES AGAINST BRINJAL SHOOT AND FRUIT BORER

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ABSTRACT

The present study was conducted during October 2019 to April 2020 in the farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur to find out the most effective management option(s) against brinjal shoot and fruit borer with 6 treatments namely Phytoclean (40% Potassium salt of fatty acid) @3 ml l^{-1}, Fytomax PM (0.1% Azadirachtin) @5 ml l^{-1}, Tracer 45 SC (Spinosad) @0.4 ml l^{-1}, Biomax 1.2 EC (Abamectin) @1 ml l^{-1} of water, Neem Seed Extract (Azadirachtin) @ 50 g l^{-1} and untreated control. Results revealed that shoot infestation at pre-fruiting stage was the lowest in Fytomax PM (3.6%) and at fruiting stage in Tracer 45 SC treated plot (6.2%) and the lowest fruit infestation was obtained with Tracer 45 SC (6.7% n/n and 8.5% w/w) followed by Phytoclean (21.7% n/n and 16.8% w/w). All the treatments were bio-rational with the beneficial arthropods like lady bird beetle, syrphid fly, black ant and spider's presence on field during entire season. The significant highest marketable yield (32.9 t ha^{-1}) and Marginal benefit cost ratio (MBCR) (4.0) was found in the plot treated with Tracer 45 SC followed by Phytoclean treated plot.

Keywords: Abamectin, azadirachtin, biopesticide, *Leucinodes orbonalis*, neem, spinosad

Introduction

Brinjal *Solanum melongena* L. also known as aubergine or eggplant, is one of the most popular year round vegetables favored by the people in Bangladesh as well as across the world. (Harish *et al*. 2011). It is native to India and grown all over Bangladesh (Pareet 2006). Eggplant is extensively damaged by the brinjal fruit and shoot borer (*Leucinodes orbonalis*) which caused 31-86% fruit damage in Bangladesh (Alam *et al.* 2003). It is the most noxious and destructive pest of brinjal, attacks either sporadically or in outbreak every year throughout the Indian subcontinent (Chakraborti and Sarkar 2011).

To overcome this loss, different types of insecticides are used by the farmers of Bangladesh and they apply indiscriminately even at fruiting stage (Zafar *et al*. 2012). Fifty to seventy percent of the farmers preferred insecticide application on the brinjal at an interval of 1-2 days during flowering and fruiting stages (Ahmed *et al*. 2005). The combination of Chlorpyriphos 50% EC + Cypermethrin 5% EC, is respected to be the most effective and economically viable insecticide to manage the pest in eggplant crop (Sharma *et al.* 2012). Spraying frequency was reported 140 times or more in the 6-7 months cropping season and contributed to 32% of total cost of production (Alam *et al.* 2003).

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 and health hazards (FAO 2003). It was reported that 38.7% brinjal samples were contaminated with acephate, fenitrothion, quinalphos, cypermethrin, malathion and diazinon residues, in which 17.3% samples had residue above (maximum residue limit) MRL (Ahmed *et al*. 2013). However, the question of residual toxicity of pesticides in brinjal is another big threat to our vegetable exports in the foreign markets (Islam *et al.* 1999). Therefore, environment friendly management approach like biopesticides, botanicals, clean cultivation, mechanical control like hand picking and destroying of infested plant parts particularly shoots and fruits are necessary to reduce environment and health hazards and to manage this pest in eco-friendly way.

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 brinjal shoot and fruit borer. Considering the circumstances, the present study was conducted to evaluate the effectiveness of some eco-friendly management approaches against *L. orbonalis* of brinjal in the field.

Materials and Methods

The experiment was conducted in the experimental farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during October 2019 to April, 2020 following 6 treatment and 3 replications with Randomized Complete Block Design (RCBD). The treatments were Phytoclean (40% Potassium salt of fatty acid) @3 ml l^{-1}, Fytomax PM (0.1% Azadirachtin) @5 ml l^{-1}, Tracer 45 SC (Spinosad) @0.4 ml l^{-1}, Biomax 1.2 EC (Abamectin) @ 1 ml l^{-1} of water, Neem Seed Extract (Azadirachtin) @ 50 g l^{-1} and untreated control.

BARI Brinjal 7 (Shingnath) variety was used in this study. Manures and fertilizers were applied according to Rashid (1999) and intercultural operations such as irrigation, weeding, mulching and other operations were done throughout the cropping season for proper growth and development of the plants.

When the pest caused approximately 2% shoot infestation, the application of treatments was started. All the treatments were applied at 10 days interval and repeated 6 times up to last harvest. Data on shoot and fruit infestation, yield by number and weight were recorded. Total number of shoots and the number of infested shoots were recorded from 10 plants randomly selected in each plot at before and 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 abundance of different beneficial arthropods were recorded at 15 days interval during entire cropping season. 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 in Kg per plot of healthy as well as infested fruits was computed. For economic analysis, Marginal Benefit Cost Ratio (MBCR) 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 by using MSTAT-C software for analysis of variance (ANOVA) and the means were separated by using Duncan's Multiple Range Test (DMRT).

Results

All the environment friendly management approaches significantly reduced percent shoot infestation in pre-fruiting and fruiting stages compared to untreated control plot (Table 1). Shoot infestation ranged 3.6-16.4% at pre-fruiting and 6.2-3.9% at fruiting stages under different treatments. At pre-fruiting stage, the highest shoot infestation was recorded in untreated control plot (16.4%) and the lowest infestation (3.6%) was obtained with Fytomax PM which was statistically similar to Tracer 45 SC (3.7%), and Phytoclean (4.0%) treated plots followed by in Biomax 1.2 EC (7.1%) and Neem Seed Extract (7.9%) treated plots, respectively (Table 1).

At fruiting stage, the highest shoot infestation was observed in untreated control plot (39.5%) and the lowest infestation (6.2%) was obtained with Tracer 45 SC

Table 1. Effect of different treatments on brinjal shoot and fruit borer infestation

Treatments	% shoot infestation at pre-fruiting stage	% shoot infestation at fruiting stage	% fruit infestation (n/n)	% fruit infestation (w/w)
Phytoclean	4.0cd	14.7c	21.7c	16.8c
Fytomax PM	3.6d	20.6c	26.1c	22.6b
Tracer 45 SC	3.7d	6.2d	6.6d	8.5d
Biomax 1.2 EC	7.1bc	19.2c	24.9c	22.1b
Neem Seed Extract	7.9b	28.8b	39.8b	24.9b
Untreated control	16.4a	37.9a	47.1a	30.6a
CV (%)	8.9	9.7	8.4	8.5

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

which was statistically significant from other approaches followed by Phytoclean (14.7%), Biomax 1.2 EC (19.2%), Fytomax PM (20.6%) and Neem Seed Extract (28.8%) treated plots, respectively (Table 1).

In entire cropping season, significantly the lowest rate of fruit infestation (n/n) was found in Tracer 45 SC (6.7%) treated plot. The highest fruit infestation was obtained from untreated control plot (47.1%) followed by Neem Seed Extract treated plot (39.8%) with no significant difference between them. Percent infested fruit was recorded from Phytoclean, Biomax 1.2 EC and Fytomax PM were 21.7%, 24.9% and 26.1%, respectively with no statistical difference among them (Table 1).

The lowest rate of fruit infestation (w/w) was found in Tracer 45 SC (8.5%) treated plot. The highest fruit infestation was found in untreated control plot (30.6%) which was followed by Neem Seed Extract treated plot (24.9%), Fytomax PM (22.6%), Biomax 1.2 EC (22.1%) and Phytoclean (16.8%) treated plot, respectively. No statistical difference was noted in fruit infestation (w/w) by the treatments of Neem Seed Extract, Biomax 1.2 EC and Fytomax PM (Table 1).

All the treatments were bio-rational with the presence of beneficial arthropods like lady bird beetle, syrphid fly, black ant and spider's on field during entire season. The abundance of lady bird beetle and black ant was with the significant statistical variation in Tracer 45 SC and Biomax 1.2 EC treated plots with untreated control plot but no statistical variation was found with syrphid fly and spiders' among the treatments including untreated control (Table 2).

All the treatments produced significant quantity of marketable yield and decreased the quantity of infested yield compared to untreated control plot. Significantly the highest marketable yield (32.8 t ha^{-1}) was recorded from Tracer 45 SC plot which was higher than that of other treatments. The second highest yield of healthy fruits was found in Phytoclean sprayed plot (23.3 t ha^{-1}) which was statistically similar to Fytomax PM (20.5 t ha^{-1}) and Biomax 1.2 EC (20.7 t ha^{-1}) treated plots. The lowest yield of marketable fruits (14.4 t ha^{-1}) was recorded from untreated control which was statistically similar to that of Neem Seed Extract (18.8 t ha^{-1}), Biomax 1.2 EC and Fytomax PM plots (Table 03).

Table 2. Effect of different environment friendly management approaches on abundance of beneficial arthropods during entire cropping season (Mean of 12 observations)

Treatments	No. of lady bird beetle/plot	No. of syrphid fly/plot	No. of black ant/plot	No. of spider's /plot
Phytoclean	28.4a	1.3a	78.4a	7.4a
Fytomax PM	24.7a	1.5a	73.3ab	6.4a
Tracer 45 SC	18.6b	0.8a	65.2b	4.6a
Biomax 1.2 EC	16.3b	0.7a	64.1b	4.1a
Neem Seed Extract	26.9a	2.1a	72.8ab	5.4a
Untreated control	29.6a	1.9a	84.5a	6.6a
CV (%)	11.3	6.5	10.4	9.0

Table 3. Effect of different environment friendly management approaches against brinjal shoot and fruit borer on fruit yield (t ha^{-1})

Treatment	Yield (t ha^{-1})			% marketable yield increase over untreated control
	Marketable	Infested	Total	
Phytoclean	23.3b	3.6c	26.8b	61.2
Fytomax PM	20.5bc	4.5b	25.1b	42.4
Tracer 45 SC	32.9a	2.3d	35.2a	127.8
Biomax 1.2 EC	20.7bc	4.4b	25.2b	43.7
Neem Seed Extract	18.8c	4.7b	23.5bc	30.0
Untreated control	14.4c	6.0a	20.5c	-
CV (%)	8.9	7.0	8.4	-

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

Significantly the lowest weight of infested yield was recorded from Tracer 45 SC treated plot (2.3 t ha^{-1}) which was followed by Phytoclean sprayed plot (3.6 t ha^{-1}). Weight of infested yield was found in Fytomax PM, Biomax 1.2 EC and Neem Seed Extract treated plot were 4.5 t ha^{-1}, 4.4 t ha^{-1} and 4.7 t ha^{-1}, respectively. The highest weight of infested fruits was harvested from the untreated control plot (6.0 t ha^{-1}) which was statistically different from all other treatments (Table 3).

The management cost, gross return, net return, adjusted net return of different environment friendly management approaches used against brinjal shoot and fruit borer was calculated and presented in Table 4. The highest MBCR of 4.1 was obtained from the treatment with Tracer 45 SC and the second highest benefit cost ratio of 3.6 was recorded from the plot treated with Phytoclean followed by Fytomax PM sprayed plot (3.3) and Biomax 1.2 EC sprayed plot (3.2). The lowest benefit cost ratio of 2.5 was found with the Neem Seed Extract treated plot (Table 4).

Discussion

Chatterjee *et al.* (2009) revealed that the lowest mean shoot as well as fruit infestation (7.5 and 9.9%) was recorded in the plots treated with Spinosad 2.5 SC (50 g a.i. ha^{-1}). Singh *et al.* (2009) observed that Profenofos @ 0.1% and Spinosad @ 0.01% were most effective in reducing shoot infestation by *L. orbonalis* and resulted higher brinjal fruit yield. The results of the present study can be compared to those obtained by the finding by Aparna and Dethe (2006) who studied the bioefficacy of Spinosad during Kharif 2005 and 2006. The lowest fruit infestation percentage was found of 13.3%, 13.7%, 7.9% and 8.2% on number and weight basis. The results of the mean fruit damage (%) by *L. orbonalis* in first (2005) and second (2006) trials indicated that Spinosad was found to be effective in suppressing the fruit damage among the treatments tested.

Sparks *et al*. (1995) reported that Spinosad has relatively broad spectrum activity and has been effectively used for the control of many species of insect pests of Lepidoptera attacking various crops without any harmful effect to other arthropods. The present findings are comparable to the findings by Mittal and Ujagir (2005) who evaluated the newer molecule Spinosad (Tracer) 45% SC along with other insecticides. The results showed that among different treatments, the lower pod damage and lower number of *Helicoverpa armigera*, *Maruca vitrata* (Geyer) and *Melanagromyza obtusa* (Malloch) larvae were recorded in Spinosad 90 g ha^{-1} and Spinosad 73 g ha^{-1} treated plot. Adiroubane and Raghuraman (2008) reported that Spinosad (45 SC @225 g a.i. ha^{-1}) was effective along with Oxymatrine (1.2 EC @0.2%) applied against *L. orbonalis*. Spinosad was superior in producing marketable yield as it reduced the fruit damage without any harmful effect to the predators and was at par with oxymatrine. Similarly, Chatterjee *et al.* (2009) also reported that Flubendiamide, Spinosad and Chlorfenapyr were highly effective in reducing the damage caused by *L. orbonalis* on brinjal and led to increases in yield.

Effectiveness of Spinosad (Tracer) 45 EC along with other standard insecticides was tested against pigeon pea pod borer by Vishal and Ram (2005). Lower pod damage was observed in Spinosad 90g, Spinosad 73g, Spinosad 56g and Spinosad 45g treated plots compared to untreated control plot over two years. Chowdhury *et al*. (2017) found that the significant highest marketable yield (34.4 t ha^{-1}) was harvested in the plot treated with Tracer 45 SC (spinosad) followed by 22.8 t ha^{-1} with *Beauveria*

Table 4. Benefit cost ratio analysis of selected environment friendly management approaches against brinjal shoot and fruit borer

Treatments	Management cost (Tk)	Gross return (Tk)	Net return (Tk)	Adjusted net return (Tk)	BCR
Phytoclean	38312.0	465600.0	427288.0	138488.0	3.6
Fytomax PM	28224.0	411200.0	382976.0	94176.0	3.3
Tracer 45 SC	72680.0	657800.0	585120.0	296320.0	4.1
Biomax 1.2 EC	29764.0	415200.0	385436.0	96636.0	3.2
Neem Seed Extract	24640.0	375600.0	350960.0	62160.0	2.5
Untreated control	0.0	288800.0	288800.0	0.0	-

Market value of brinjal= 20 Tk./kg, cost of Phytoclean per spay= 5225.2 Tk ha^{-1}, Fytomax PM per spay= 3544.0 Tk ha^{-1}, Tracer 45 SC per spay= 10953.3 Tk ha^{-1}, Biomax 1.2 EC per spay= 3800.0 Tk ha^{-1}, Neem Seed Extract per spray = 2946.7 Tk ha^{-1}, Labor cost= 550 Tk. day^{-1}, No. of spray=6, sprayer rent= 30 Tk. day^{-1}.

bassiana, 1X109 CFU and 19.3 t ha^{-1} from Vertimec 1.8 EC (Abamectin) treated plot. In same study, the highest MBCR was found 3.1 with Tracer 45 SC (spinosad) treated plot which is similar with the present study. The findings of the present study indicated that the Tracer 45 SC was the most effective to manage infestation of BSFB in brinjal.

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