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Bioefficacy of some insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee on brinjal under Hisar agro-climatic conditions during *kharif* season

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Abstract: A field experiment was conducted to study the bioefficacy of some insecticides against *Leucinodes orbonalis* during *kharif* season of 2014 on brinjal var. BR-112 at Entomology Research Area of CCS Haryana Agricultural University, Hisar. Five foliar sprays of insecticides *viz.,* cypermethrin 25EC @ 43.75 g a.i/ ha, fenvalerate 20EC @ 40 g a.i/ ha, deltamethrin 2.8EC @ 14 g a.i/ ha, chlorpyriphos 20EC @ 200 g a.i/ ha, Prempt 20EC @ 150 g a.i/ ha, malathion 50EC @ 250 g a.i/ ha and Nimbecidine 0.03% @ 3 ml/l were evaluated and it was found that all the insecticides proved significantly superior (at 5% level) to control (untreated) in reducing the damage of shoot and fruit borer in brinjal. Among all, deltamethrin proved most effective in reducing shoot damage (60.40%) and fruit damage, on number basis (88.87%) and weight basis (88.89%) over control. Deltamethrin recorded the highest marketable fruit yield of 132.27q/ha and lowest was found in case of Nimbecidine (33.53 q/ha). Highest (1:8.7) cost to benefit ratio was recorded in deltamethrin followed by fenvalerate (1:8.5), cypermethrin (1:6.5), chlorpyriphos (1:4.5), Prempt (1:1.9), malathion (1:0.6) and Nimbecidine (1: -0.3). From these findings, it was revealed that synthetic pyretheroids being the most effective and economic over other insecticides, may be incorporated in IPM practices followed against brinjal shoot and fruit borer.

Keywords: Deltamethrin, Insecticides, *Leucinodes orbonalis*, Shoot, Fruit damage

INTRODUCTION

Brinjal, *Solanum melongena* (L.) (family solanaceae) is an important dietary vegetable crop grown extensively in India. This family contains more than 2450 plant species distributed in 95 genera (Mabberley, 2008). It is cultivated in South Asian region (Bangladesh, India, Nepal, Sri lanka) accounting for almost 50% of the world's area under its cultivation (Alam *et al*., 2003). In India, it is one of the most common, popular and principal vegetable crop grown through out the country except higher altitudes. Production of brinjal in india was estimated to be 12706 thousand tonnes over an area 680 thousand hectare for the year 2014-15. However, Haryana state ranks 10th nationally in terms of production (317.90 thousand tonnes) with its meager 2.54% share in the national production of this crop (AGRICOOP, 2015) . Several biotic and abiotic factors are responsible for lowering down the yield of brinjal. Among them, insect pests are the important factors which greatly affect the quality and productivity of brinjal crop. Shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) is the most destructive pest of brinjal both at vegetative and reproductive stage causing a 40-80% loss in the yield (AVRDC, 2003). The small moth with dirty whitish wings and speckled marking lays eggs on young leaves/ flowers/ calyx of the fruits. After hatching (with in 6 hrs) the young larvae bores into the petiole/ midrib of leaves/ growing shoots/ flower buds/ fruits and closes the bore hole with frass, after entering it will feed inside the midribs/ flower/ ovary of flower and in the pulp of fruit. The damaged shoots and the damaged flowers droop down and the damaged fruits get rotten from inside. The entry hole on the fruit is not visible as this is covered with frass and only the faded depression of entry hole is seen. The large one or more round exit holes are visible on the fruits. Such fruits loose their market value. A number of insecticides have been reported to be effective in reducing pest infestation level and increasing fruit yields, but some insecticides leads to several problems like toxic residues, elimination of natural enemies, environmental disharmony and development of resistance. In the context of this, it was planned to study the efficacy of some insecticidal treatments to manage *L. orbonalis*, under agro-climatic conditions of Hisar.

MATERIALS AND METHODS

Study area: A field trial was conducted to evaluate the efficacy of some synthetic and plant based insecticides against brinjal shoot and fruit borer at the Entomology

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Research Area of CCS Haryana Agricultural University, Hisar on brinjal var. BR-112 during *kharif* season of 2014. The crop was transplanted in the 1st week of May in the field plots each measuring 3 m × 3 m at spacing 75 cm × 60 cm from row to row and plant to plant. The crop was raised as per recommended agronomical practices. There were eight treatments *viz.*, cypermethrin 25EC, fenvalerate 20EC, deltamethrin 2.8EC, chlorpyriphos 20EC, Prempt 20EC, malathion 50EC and Nimbecidine 0.03% including one control (unsprayed) and each treatment was replicated three times in a randomized block design (Gomez and Gomez, 1984). Five foliar sprays of insecticides *viz.*, cypermethrin 25EC @ 43.75 g a.i/ ha, fenvalerate 20EC @ 40g a.i/ ha, deltamethrin 2.8EC @ 14g a.i/ ha, chlorpyriphos 20EC @ 200g a.i/ ha, Prempt 20EC @ 150 g a.i/ ha, malathion 50EC @ 250 g a.i/ ha and Nimbecidine 0.03% @ 3 ml/ L were given starting from fruit initiation at 10 days interval. Five plants were randomly selected from the each plot and tagged for recording the intensity of infestation of borer in shoots and fruits. The first instar larvae enter the growing shoots resulting into dropping down of the shoots. The damaged shoots attacked by brinjal shoot and fruit borer gave wilting symptoms (Fig.1&2). In this way, the wilted or damaged shoots and healthy shoots were counted in each plot and per cent infested shoots were calculated. The total number of healthy and damaged shoots were recorded starting from 7 days before spray and continued at weekly interval till the end of all the insecticidal applications. At the onset of fruits, they damage the fruits by feeding inside it (Fig.3). The entry hole on the infested fruit is not visible as either the hole is recovered or it is covered with frass and only the faded depression of the entry hole is seen. The large one or more rounded holes are visible on the fruits, which are called exit holes. The damaged and healthy fruits were counted and weighed at every picking. The data were converted into per cent damage on number and weight basis. The marketable fruit yield was also recorded and calculated on hectare basis. Per cent shoot and fruit infestation reduction over untreated check in different treatments was calculated using modified Abbott's formula (Abbott, 1925). Finally, the benefit cost ratio for each treatment was calculated. All the mathematical calculations were done according to the formula given below

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

$$\text{\% Fruit damage (number basis)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

$$\text{\% Fruit damage (weight basis)} = \frac{\text{Weight of infested fruits}}{\text{Total weight of harvested fruits}} \times 100$$

% Reduction of shoot and fruit damage (Abbott's formula) =

$$\frac{\text{Control plot infestation - Treatment plot infestation}}{\text{Control plot infestation}} \times 100$$

$$\text{Cost benefit ratio} = \frac{\text{Net benefit over control}}{\text{Total cost of insecticidal spray}}$$

Statistical analysis: Data obtained from insecticidal treatments were analysed statistically using OPSTAT-ANOVA and means were compared for significance using CD at 5% level (Sheoran, 2010)

RESULTS AND DISCUSSION

Shoot damage: The data pertaining to the efficacy of various insecticides against *Leucinodes orbonalis* on shoot damage are presented in Table 1. It is evident from this table that the shoot damage before spray in all the treatments including control ranged from 7.93 to 10.05 per cent. The difference among the treatment was found non-significant at 5% level. It indicates that the damage in all the treatments was uniform. The pooled mean shoot damage of all the five spray varied between 5.25 to 9.43 per cent and indicate that all the treatments were significantly superior over control in reducing the shoot damage. The lowest damage was found in deltamethrin 2.8EC @ 14g a.i/ ha which was significantly superior (at 5%) to all other treatments in lowering down the shoot damage. It is evident from the table that among the pyretheroids, deltamethrin was superior over other two pyretheroids *viz.* fenvalerate and cypermethrin followed by organophosphates, where as plant based insecticide (Nimbecidine), however, was significantly better than control but inferior to all other insecticides. Deltamethrin attributed to highest reduction (60.40%) in shoot damage over control followed by fenvalerate (50.90%), cypermethrin (50.30%), chlorpyriphos (49.85%), prempt (49.47%), malathion (43.96%) and nimbecidine (28.88%).

Fruit damage (on number basis): From pooled mean (Table 1), it was found that the fruit damage ranged from 5.37 to 36.71% in all the treatments. The lowest damage was found in deltamethrin 2.8EC @ 14g a.i/ ha which was significantly superior to all other treatments in lowering down the fruit damage. It is evident from the table that all the treatments were significantly different from each other. Among all the treatments synthetic pyretheroids performed better than oraganophosphate and plant based insecticide. Maximum damage was observed in plant based insecticide (Nimbecidine), however it was significantly better than control at 5% level, but inferior to all other treatments. Highest per cent reduction over control in fruit infestation on number basis was found in case of deltamethrin (88.87%) followed by fenvalerate (82.82%), cyperme-

Fig. 1. *Bore holes made by larvae.*

Fig. 2. *Drooping down of damaged shoot.*

Fig. 3. *Larva feeding on internal tissues of shoot and fruit.*

thrin (77.85%), chlorpyriphos (58.68%), prempt (45.30%), malathion (40.01%) and nimbecidine (23.93%).

Fruit damage (on weight basis): The overall information (Table 1) came out from pooled mean of all the five pickings indicate that the fruit damage on weight basis in all the treatments varied between 4.29 to 30.33 per cent. All the treatments were significantly different from each other but better than control. The lowest fruit damage 4.29% was found in deltamethrin , which was significantly superior (at 5% level) than all other insecticides including other synthetic pyretheroids (cypermethrin, fenvalerate), organophosphates (malathion, chlorpyriphos), prempt and minimum damage was found in case of plant based insecticide. Nimbecidine was found inferior to all other insecticides but better than control (38.61%). The per cent reduction over control in fruit infestation on weight basis was recorded maximum in plots treated with deltamethrin 88.89% followed by fenvalerate (83.32%), cypermethrin (77.83%), chlorpyriphos (59.10%), prempt (47.32%), malathion (40.49%) and least in case of nimbecidine (21.45%).

The present studies are in conformity with the findings of Agnihotri *et al*., (1990) who observed that deltamethrin 0.00125% and cypermethrin 0.01% gave highest reduction in shoot and fruit borer damage. Findings of Sharma and Chhibber (1999) are also in agreement with the results of present investigation as they also obtained the best results with decamethrin @ 20 g a.i/ha with lowest shoot and fruit damage (number and weight basis) as compared to betacyfluthrin @ 25 g a.i/ha. Singh and Nath, (2007) also reported that the application of deltamethrin @ 25 g a.i./ha was effective in lowering the fruit damage on number and weight basis in brinjal as compared to chlorpyriphos @ 500 g a.i/ha. These are also slightly supported with the findings of Basha *et al*. (1982); Mehta *et al*. (1998); Abrol and Singh, (2003); Kumar and Srivastava (2009); Duara *et al*. (2011) and Sajjad *et al*. (2015).

Yield and economics: At the end of experiment, the marketable fruit yield (Table 1) of all the pickings was added and transformed into quintals on hectare basis. Among all the treatments deltamethrin proved to be the best in producing highest marketable yield (132.37 q/ha) followed by fenvalerate (110.60 q/ha), cypermethrin (91.73 q/ha), chlorpyriphos (84.80 q/ha), Prempt (55.80 q/ha), malathion (43.53 q/ha) and Nimbecidine (33.53 q/ha). The lowest fruit yield was recorded in control (23.87 q/ha). Deltamethrin was found significantly superior (at 5%) over all other treatments in giving the highest yield. The highest (1:8.7) cost to benefit ratio was also recorded in deltamethrin followed by fenvalerate (1:8.5), cypermethrin (1:6.5), chlorpyriphos (1:4.5), Prempt (1:1.9), malathion (1:0.6) and Nimbecidine (1: -0.3) (Table 2). Highest

Table 1. Efficacy of various insecticides against *L orbonalis* damage on brinjal shoots and fruits during *kharif* 2014.

Treatments	Dose (g a.i /ha)	Per cent shoot damage			Per cent fruit damage				Yield (q/ha)
		Before spray	After spray*	Per cent reduction over control	Damage (on number basis)**	Per cent reduction over control	Damage (on weight basis)**	Per cent reduction over control	
Cypermethrin 25EC	43.75	8.00 (16.40)	6.59 (14.87)	50.30	10.69 (19.07)	77.85	8.56 (16.99)	77.83	91.73
Fenvalerate 20EC	40	8.17 (16.58)	6.51 (14.77)	50.90	8.29 (16.72)	82.82	6.44 (14.68)	83.32	110.60
Deltamethrin 2.8EC	14	8.23 (16.65)	5.25 (13.23)	60.40	5.37 (13.38)	88.87	4.29 (11.95)	88.89	132.27
Chlorpyriphos 20EC	200	8.03 (16.44)	6.65 (14.94)	49.85	19.94 (26.50)	58.68	15.79 (23.40)	59.10	84.80
Malathion 50EC	250	9.00 (16.40)	7.43 (15.81)	43.96	28.95 (32.54)	40.01	23.16 (28.76)	40.49	43.53
Prempt 20EC	150	7.93 (17.36)	6.70 (14.98)	49.47	26.40 (30.90)	45.30	20.34 (26.80)	47.32	55.80
Nimbecidine 0.03%	3 ml/ l	10.05 (18.46)	9.43 (17.88)	28.88	36.71 (37.27)	23.93	30.33 (33.40)	21.45	33.53
Control		9.60 (17.03)	13.26 (21.34)		48.26 (43.99)		38.61 (38.40)		23.87
SE(m)±		(0.60)	(0.30)		(0.38)		(0.27)		(1.75)
C.D. at 5 per cent		N.S	(0.92)		(1.17)		(0.82)		(5.36)

Figure in parentheses are angular transformed values; * Mean of 5 observations (spray); ** Mean of 5 pickings

Table 2. Cost-benefit ratio of different insecticidal treatments against shoot and fruit borer on brinjal during *Kharif* 2014.

Treatments	Dose/ Ha	Amount of insecticide used/ha	Cost of insecticide /ha	Labour cost (Rs/ha)	Total cost of insecticidal sprays (Rs/ha)	Yield (Kg/ ha)	Gross Income	Net gain (Rs)	Net profit over control (Rs)	CBR
Cypermethrin	175 ml	875 ml	395	3200	3595	9173	36692	33097	23549	1:6.5
Fenvalerate	200 ml	1L	430	3200	3630	11060	44240	40610	31062	1:8.5
Deltamethrin	500 ml	2.5L	1250	3200	4450	13227	52908	48458	38910	1:8.7
Chlorpyriphos	1L	5L	1250	3200	4450	8480	33920	29470	19922	1:4.5
Malathion	1L	5L	1825	3200	5025	4353	17412	12387	2839	1:0.6
Prempt	1L	5L	1250	3200	4450	5580	22320	17870	8322	1:1.9
Nimbecidine	1.5L	7.5L	2775	3200	5975	3353	13412	7437	-2111	1: -0.3
Control						2387	9548	9548		

Cost of insecticides: Cypermethrin- Rs 450/L; Fenvalerate- Rs 430/L; Deltamethrin- Rs 500/L; Chlorpyriphos- Rs 250/L; Malathion- Rs 365/L; Prempt- Rs 250/L; Nimbecidine- Rs 370/L;**Cost of brinjal**: Rs 4/kg; **Labour cost**: Rs 320/day yield and cost-benefit ratio in case of synthetic pyretheroids were also indicated by Agnihotri *et al*. (1990); Mehta *et al*. (1998); Sharma and Chhibber (1999); Saha *et al*. (2014); Singh and Kumar (2011) which is in conformity with the present findings.

Conclusion

It can be concluded from the results that pyretheroids attributed better management over other group of insecticides *viz.,* organophosphates (chlorpyriphos), insecticide mixture (Prempt) where as plant based insecticide (Nimbecidine) showed the minimum effect on the shoot and fruit borer, *L. orbonalis*, when the insecticidal spray was done at 10 days interval starting from fruit initiation stage. The overall superiority of deltamethrin in comparison to other insecticide treatments has marked effect on reduction of pest damage in the shoot (60.40%) and fruit on number basis (88.87%) and weight basis (88.89%). Thus, resulting in higher yield (13227 kg/ha) and economic returns (1: 8.7). Hence synthetic pyretheroids may be incorporated in IPM practices followed against shoot and fruit borer.

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