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Vinayaka KS
Department of Entomology, CCS Haryana Agricultural University, CCSHAU, Hisar, Haryana, India

Balbir Singh
Department of Entomology, CCS Haryana Agricultural University, CCSHAU, Hisar, Haryana, India

SS Yadav
Department of Entomology, CCS Haryana Agricultural University, CCSHAU, Hisar, Haryana, India

Sudhanshu Bala Nayak
Department of Entomology, CCS Haryana Agricultural University, CCSHAU, Hisar, Haryana, India

Correspondence
Vinayaka KS
Department of Entomology, CCS Haryana Agricultural University, CCSHAU, Hisar, Haryana, India

Efficacy of Different Insecticides against brinjal fruit borer (*Leucinodes orbonalis* Guenee) and their impact on fruit yield

Vinayaka KS, Balbir Singh, SS Yadav and Sudhanshu Bala Nayak

Abstract
Due to increasing levels of resistance towards different insecticides there is a need to test the efficacy of some insecticides against *Leucinodes orbonalis*. So in this present study, seven insecticides such as Emamectin benzoate 5% SG, Chlorantraniliprole 18.5% SC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC, Azadirachtin 5% EC, *Bacillus thuringiensis* 5% WP, Spinosad 45% SC and Lambda cyhalothrin 5% EC belonging to different chemical groups were tested against L. *orbonalis* in the field during *kharif*, 2017 on brinjal variety BR 112. Studies on chemical control of *L. orbonalis* revealed that, treatments of Emamectin benzoate 5% SG and Chlorantraniliprole 18.5% SC were found most effective. The insecticides *viz*., Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP were found least effective against shoot and fruit borer. The remaining treatments *viz.,* Spinosad 45% SC, Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC were found moderately effective.

Keywords: Brinjal, fruit borer, *Leucinodes orbonalis*, botanicals

Introduction
Solanum melongena L. (Brinjal) belongs to the family Solanaceae and is widely grown in both tropical and temperate regions of the globe as a major vegetable crop (Rai *et al.,* 1995) [7]. In India the major brinjal growing states are Andhra Pradesh, West Bengal, Karnataka, Tamil Nadu, Maharashtra, Uttar Pradesh, Odisha, Bihar and Rajasthan. Globally, India ranks second and China ranks first in the production of brinjal and accounting for almost 50% of the world's area under its cultivation (Alam *et al*., 2003) [1]. It can be grown throughout the year and adapted to various agro-climatic regions and it is commercially grown as an annual but basically it is a perennial crop (Kalawate and Dethe, 2012) [4]. Among the insect pests damaging the brinjal, shoot and fruit borer, *Leucinodes orbonalis* (Guenee), the most destructive pest and causes yield loss ranging from 70-92 per cent (Chakraborti and Sarkar, 2011) [3]. Soon after transplanting of the brinjal seedlings, infestation starts and continues till harvesting. Drooping of shoots in young plants can be seen as damage by this pest; these wilted shoots eventually wither and die away. Flower buds and fruits will be bored by the larva in later stages. Despite of diverse ill effects, of the chemicals pesticides, insecticides use still constitutes major control option to tackle this pest. At the same time, frequent use of pesticides has made this insect tolerant to the chemicals, making it more difficult to control (Singh *et. al.*, 2008) [10]. Pesticides molecules of the new generation have been claimed to be effective as well as safer for non-target organism. In this context, it is essential to step up towards IPM as it is more reliable and eco-friendly than any other methods. Here we have given some of IPM oriented strategies which will be highly useful to growers of this region to manage these pests successfully.

Materials and Methods
An experiment was conducted under field conditions at the Regional Research Station, Bawal of CCS Haryana Agricultural University (CCS HAU) during *kharif*, 2017 in a Randomized block design (RBD) with 8 treatments and 3 replications to test the efficacy of seven insecticidal treatments along with control was determined during the observation period. brinjal variety BR 112 was shown in 3 × 3 m meter plot size with row to row and plants to plant spacing were maintained 60 cm and 60 cm, respectively. A total of three sprays of insecticides were applied against *L. orbonalis*, first spray was given at 5 per cent shoot damage

stage. However, second spray and third spray was given when pest population reached their ETL at the fruit initiation stage. Before spraying of insecticide, water was sprayed in the control plot to estimate the amount of water required for spray of insecticide for each plot. Knapsack sprayer was used for the application of insecticides. The observations were recorded on ten randomly selected and tagged plants from every plot in order to assess the bio-efficacy of various insecticides against shoot and fruit borer. The observations on shoot damage were recorded on a number basis. Whereas, in case of fruit infestation, number and weight of damaged fruits were recorded individually at every harvest of fruits. A day before spraying of insecticide, the damage was recorded individually from every treatment and at 3, 7, 10 and 14 days after every application of insecticide.

Table 1: Information of insecticides evaluated for their bio-efficacy against *L. orbonalis*

Sl. No.	Name of insecticide	Trade Name	Formulation	Dose/ha	Manufactures/Source
T1	Chlorantraniliprole	Coragen	18.5% SC	40 g a.i	Dupont
T2	Lambda cyhalothrin	TKS-Lamda	5% EC	15 g a.i	Tata Chemicals ltd
T3	Emamectin benzoate	Proclaim	5% SG	10 g a.i	Syngenta
T4	Spinosad	SpinTor	45% SC	187 g a.i	Bayer Crop Science india
T5	Pyriproxyfen + Fenpropathrin	Sumiprempt	5% EC + 15% EC	120 g a.i	Sumitomo Chemicals Co.Ltd
T6	*Bacillus thuringiensis*	BT-Biozyme	5% WP	500 g	Biostadt india limited
T7	Azadirachtin	Nimbecidine	5% EC	1%	T.Stanes and Company Limited
T8	Control				

Yield and economics: The yield of fruit from net plot was recorded for every treatment and converted to per hectare. The per cent yield increase over control plot was calculated by using formula below given by Pradhan, 1969.

$$\text{Yield increased (\%)} = \frac{T - C}{C} \times 100$$

Where
T= Yield of insecticidal treatment (kg/ha)
C= Yield of untreated control (kg/ha)

Results and Discussion

Efficacy of insecticides against *L. orbonalis* infesting brinjal fruits at first, second and third spray (Number basis).

The overall data presented in the Table-2 revealed that except the untreated control treatment, all insecticidal treatments registered significantly lowest per cent shoot damage of shoot and fruit borer. However, treatment of Emamectin benzoate 5% SG was found to be most effective owing to lowest per cent shoot damage during the experimental period which was followed by Chlorantraniliprole 18.5% SC. The treatments of Spinosad 45% SC, Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC and *Bacillus thuringiensis* 5% WP showed moderate effectiveness against shoot and fruit borer. Azadirachtin 5% EC was found to be least effective and reported higher per cent shoot damage of shoot and fruit borer. The treatments Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC, *Bacillus thuringiensis* 5% WP and Azadirachtin 5% EC were at par with one another.

During second and third spray the lowest per cent fruit infestation was recorded in Emamectin benzoate 5% SG sprayed plots which was followed by Chlorantraniliprole 18.5% SC and Spinosad 45% SC. The highest fruit infestation was reported in *Bacillus thuringiensis* 5% WP and Azadirachtin 5% EC treatments as compared to other insecticides. The remaining insecticides *viz*., Lambda cyhalothrin 5% EC and Pyriproxyfen 5% EC + Fenpropathrin 15% EC showed moderate effectiveness against shoot and fruit borer. The data showed that lowest fruit damage was reported by Emamectin benzoate 5% SG which was comparable with treatments of Chlorantraniliprole 18.5% SC and Spinosad 45% SC. The insecticides *viz.*, Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP were found least effective against shoot and fruit borer. The remaining treatments *viz.*, Lambda cyhalothrin 5% EC and Pyriproxyfen 5% EC + Fenpropathrin 15% EC were found moderately effective.

Bio-efficacy of insecticides against *L. orbonalis* infesting brinjal fruits (Weight basis)

The mean data of second and third spray revealed that Emamectin benzoate 5% SG was highly effective in controlling shoot and fruit borer which registered lowest fruit infestation. This treatment was followed by Chlorantraniliprole 18.5% SC, Spinosad 45% SC, Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC, Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP. It has been observed that lowest fruit damage was reported by Emamectin benzoate 5% SG which was followed by Chlorantraniliprole 18.5% SC and Spinosad 45% SC. The insecticides *viz.*, Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP were found least effective against shoot and fruit borer. The remaining treatments *viz.*, Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC were found to be moderately effective.

Earlier, Tayde and Simon (2010) noticed that the treatment Spinosad 45 SC @ 0.01 per cent was most effective insecticide with lowest fruit damage (6.87% on number basis and 7.35% on weight basis) as well as lowest per cent shoot infestation (9.84%). Wankhede and Kale (2010) [13] noticed that the lowest per cent shoot infestation was observed in the treatment Emamectin benzoate 5 SG @ 10g a.i./ha which was 5.0 and 4.8 per cent in *kharif* 2007 and *kharif* 2008, respectively. It was followed by Novaluron 10 EC @ 25 ml a.i./ha (5.7% and 5.2%). Misra (2011) [5] reported that treatment Chlorantraniliprole @ 40 and 50g a.i./ha were most effective and noticed 95 to 97 per cent decrease in per cent shoot infestation and also decrease in per cent fruit infestation on both number and weight basis were 87 to 90 per cent and 88 to 90 per cent, respectively. Anil and Sharma (2011) [2] observed that Emamectin benzoate, Novaluron and Spinosad showed 0.56, 0.96 and 1.25 per cent shoot damage and fruit infestation of 16.58, 23.46 and 23.35 per cent by shoot and fruit borer.

Table 2: Efficacy of insecticides against *L. orbonalis* infesting brinjal fruits on number basis during first, second and third spray

Treatments	Before spray	Per cent shoot infestation days after first spray					Before spray	Per cent shoot infestation days after second spray					Before spray	Per cent shoot infestation days after third spray				
		3 DAS	7 DAS	10 DAS	14 DAS	Mean		3 DAS	7 DAS	10 DAS	14 DAS	Mean		3 DAS	7 DAS	10 DAS	14 DAS	Mean
T1	27.00	17.56 (24.77)	11.96 (20.23)	11.67 (19.97)	13.34 (21.42)	13.63 (21.59)	33.94	23.54 (29.02)	21.26 (27.45)	23.34 (28.88)	24.72 (29.81)	23.21 (28.79)		22.79 (28.51)	19.21 (25.99)	24.19 (29.46)	25.14 (30.09)	22.83 (28.51)
T2	27.80	22.25 (28.14)	15.65 (23.30)	16.43 (23.91)	19.31 (26.06)	18.41 (25.35)	32.00	27.07 (31.35)	24.41 (29.60)	26.64 (31.07)	28.25 (32.10)	26.59 (31.03)		25.70 (30.46)	22.92 (28.60)	25.90 (30.59)	27.98 (31.95)	25.62 (30.40)
T3	26.61	15.95 (23.54)	9.12 (17.57)	10.84 (19.22)	11.31 (19.65)	11.80 (19.99)	32.83	21.53 (27.64)	18.82 (25.71)	20.57 (26.97)	23.42 (28.94)	21.08 (27.31)		22.11 (28.04)	18.22 (25.26)	19.70 (26.34)	24.08 (29.38)	21.02 (27.25)
T4	27.40	20.82 (27.15)	13.60 (21.64)	14.55 (22.42)	16.68 (24.10)	16.41 (23.82)	31.91	25.68 (30.44)	23.65 (29.09)	24.06 (29.37)	26.08 (30.70)	24.86 (29.90)		24.90 (29.93)	23.21 (28.80)	23.12 (28.73)	25.38 (30.25)	24.15 (29.42)
T5	27.85	23.98 (29.32)	16.60 (24.04)	18.36 (25.37)	21.44 (27.58)	20.09 (26.57)	32.56	28.19 (32.06)	26.03 (30.67)	27.90 (31.88)	29.32 (32.78)	27.86 (31.84)		27.59 (31.68)	24.06 (29.37)	26.36 (30.89)	28.33 (32.15)	26.58 (31.02)
T6	27.43	25.96 (30.63)	18.95 (25.80)	20.66 (27.03)	24.09 (29.39)	22.41 (28.21)	33.26	30.87 (33.75)	29.02 (32.59)	30.91 (33.77)	31.54 (34.16)	30.58 (33.56)		28.92 (32.53)	27.69 (31.74)	30.95 (33.80)	31.86 (34.36)	29.85 (33.10)
T7	26.38	24.74 (29.83)	17.95 (25.06)	19.12 (25.92)	22.12 (28.05)	20.98 (27.21)	32.89	31.07 (33.87)	27.64 (31.71)	28.64 (32.35)	31.09 (33.88)	29.61 (32.95)		29.79 (33.07)	26.51 (30.98)	28.88 (32.50)	30.32 (33.41)	28.87 (32.49)
T8	26.53	28.47 (32.25)	28.89 (32.51)	28.72 (32.40)	29.72 (33.03)	28.95 (32.54)	32.98	33.59 (35.42)	34.82 (36.16)	36.36 (37.08)	39.78 (39.10)	36.13 (36.94)		36.04 (36.89)	35.90 (36.81)	38.10 (38.11)	40.37 (39.44)	37.60 (37.81)
CD at 5%	NS	(1.48)	(1.82)	(2.21)	(1.58)	(1.77)	NS	(1.96)	(1.70)	(1.05)	(2.21)	(1.73)		(2.49)	(2.03)	(2.59)	(2.33)	(2.36)

Figures in parentheses are angular transformed values, DAS- Days after spraying

Table 3: Effectiveness of insecticides against *L. orbonalis* infesting brinjal fruits on weight basis during first, second and third spray

Treatments	Before spray	Per cent shoot infestation days after first spray					Before spray	Per cent shoot infestation days after second spray					Before spray	Per cent shoot infestation days after third spray			
		3 DAS	7 DAS	10 DAS	14 DAS	Mean		3 DAS	7 DAS	10 DAS	14 DAS	Mean		3 DAS	7 DAS	10 DAS	14 DAS	Mean
T1	27.00	17.56 (24.77)	11.96 (20.23)	11.67 (19.97)	13.34 (21.42)	13.63 (21.59)	33.74	24.54 (29.69)	21.59 (27.68)	23.23 (28.82)	25.16 (30.10)	23.63 (29.07)		23.41 (28.93)	20.25 (26.74)	22.55 (28.35)	24.77 (29.84)	22.74 (28.46)
T2	27.80	22.25 (28.14)	15.65 (23.30)	16.43 (23.91)	19.31 (26.06)	18.41 (25.35)	32.14	27.24 (31.46)	25.55 (30.36)	27.11 (31.37)	28.91 (32.52)	27.20 (31.42)		27.46 (31.60)	24.06 (29.37)	26.3 (30.85)	27.15 (31.40)	26.24 (30.80)
T3	26.61	15.95 (23.54)	9.12 (17.57)	10.84 (19.22)	11.31 (19.65)	11.80 (19.99)	32.81	22.66 (28.42)	19.29 (26.05)	21.48 (27.61)	23.67 (29.11)	21.77 (27.79)		21.75 (27.79)	18.47 (25.45)	19.54 (26.23)	23.50 (28.99)	20.81 (27.11)
T4	27.40	20.82 (27.15)	13.60 (21.64)	14.55 (22.42)	16.68 (24.10)	16.41 (23.82)	32.08	24.81 (29.87)	23.50 (28.99)	24.76 (29.84)	26.08 (30.70)	24.78 (29.85)		23.82 (29.21)	23.08 (28.71)	24.04 (29.36)	24.91 (29.94)	23.96 (29.30)
T5	27.85	23.98 (29.32)	16.60 (24.04)	18.36 (25.37)	21.44 (27.58)	20.09 (26.57)	33.81	28.62 (32.34)	27.03 (31.32)	28.33 (32.15)	29.85 (33.11)	28.45 (32.23)		28.16 (32.05)	26.81 (31.18)	27.53 (31.64)	29.43 (32.85)	27.98 (31.93)
T6	27.43	25.96 (30.63)	18.95 (25.80)	20.66 (27.03)	24.09 (29.39)	22.41 (28.21)	34.66	32.33 (34.65)	29.92 (33.16)	31.85 (34.35)	33.37 (35.28)	31.86 (34.36)		31.37 (34.06)	28.28 (32.12)	31.25 (33.98)	32.83 (34.95)	30.93 (33.77)
T7	26.38	24.74 (29.83)	17.95 (25.06)	19.12 (25.92)	22.12 (28.05)	20.98 (27.21)	32.70	30.67 (33.62)	28.69 (32.38)	30.26 (33.37)	32.12 (34.52)	30.43 (33.47)		30.83 (33.72)	29.32 (32.78)	30.26 (33.37)	31.44 (34.10)	30.46 (33.49)
T8	26.53	28.47 (32.25)	28.89 (32.51)	28.72 (32.40)	29.72 (33.03)	28.95 (32.54)	34.73	36.72 (37.29)	38.21 (38.18)	39.50 (38.93)	41.73 (40.23)	39.04 (38.65)		43.35 (41.17)	45.29 (42.29)	46.09 (42.75)	48.38 (44.07)	45.75 (42.57)
CD at 5%	NS	(1.48)	(1.82)	(2.21)	(1.58)	(1.77)	NS	(1.25)	(2.08)	(1.28)	(1.34)	(1.48)		(2.54)	(1.82)	(1.70)	(1.66)	(1.93)

Figures in parentheses are angular transformed values,
DAS- Days after spraying

Shirale *et al*. (2012) [8] reported treatment of Spinosad 45 per cent, Chlorfenapyr 10 per cent, Indoxacarb 14.50 per cent, Flubendiamide 39.35 per cent and Chlorantraniliprole 18.50 per cent registered 10.5, 11.5, 12.6, 9.4 and 8.2 per cent shoot infestation, respectively. Where, in case of fruit infestation they recorded 13.1, 15.9, 15.6, 10.9 and 8.8 per cent on number basis however on weight basis it existed 12.5, 14.8, 14.6, 10.4 and 8.4 per cent fruit infestation. The lowest per cent fruit infestation on number and weight basis recorded in treatment Spinosad 72 g a.i./ha during *kharif* (13.34 and 13.69%) and summer season (7.89 and 8.21%), respectively. However, this treatment recorded maximum marketable brinjal fruit yield of 20.41 t/ha (Kalawate and Dethe, 2012) [4]. Similarly, Sinha and Nath (2012) [11] observed Chlorantraniliprole as the most effective insecticide with lowest fruit damage.

Yield of brinjal fruits

The fruit yield data of brinjal crop presented in Table 4 showed that significantly higher (22.90 tonnes/ha) yield of fruits was obtained when Emamectin benzoate 5% SG was sprayed on the crop followed by Chlorantraniliprole 18.5% SC (20.69 tonnes/ha). The control treatment registered lowest fruit yield (9.31 tonnes/ha). However, yield of brinjal fruits in treatments *viz*., Spinosad 45% SC, Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC, Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP showed 19.34, 17.32, 15.36, 13.43 and 12.21 tonnes/ha, respectively.

Table 4: Yield performance of different insecticidal treatments

Sr. No.	Treatment	Dose/ha	Yield (Tonnes/ha)
T1	Chlorantraniliprole 18.5% SC	40 g a.i	20.69
T2	Lambda cyhalothrin 5% EC	15 g a.i	17.32
T3	Emamectin benzoate 5% SG	10 g a.i	22.90
T4	Spinosad 45% SC	187 g a.i	19.34
T5	Pyriproxyfen 5% EC + Fenpropathrin 15% EC	120 g a.i	15.36
T6	*Bacillus thuringiensis* 5% WP	500 g	12.21
T7	Azadirachtin 5% EC	1%	13.43
T8	Control		9.31
C.D. at 5%			2.44

The fruit yield data of brinjal showed that significantly maximum yield of fruits was obtained when Emamectin benzoate 5% SG was sprayed on crop. This treatment was followed by Chlorantraniliprole 18.5% SC. The control treatment registered lowest fruit yield. However, yield of brinjal fruits in treatments *viz*., Spinosad 45% SC, Lambda cyhalothrin 5% EC, Pyriproxyfen 5% EC + Fenpropathrin 15% EC was moderate. And lowest yield was obtained in Azadirachtin 5% EC and *Bacillus thuringiensis* 5% WP sprayed plots.

In past, Kalawate and Dethe (2012) [4] observed Spinosad and Emamectin benzoate were most effective insecticides which showed highest yield of brinjal fruits. Singh *et al*. (2009) [9] observed yield of brinjal fruits in treatments *viz*.,Novaluron 0.01 per cent, Profenofos 0.1 per cent, Indoxacarb 0.015 per cent and Spinosad 0.01 per cent, which recorded 270.30 q/ha, 310.50 q/ha, 275.60 q/ha and 305.70 q/ha, respectively. Anil and Sharma (2011) [2] noticed that treatments Emamectin benzoate, Novaluron and Spinosad had reported 63.13, 69.73 and 74.53 q/ha yield of brinjal fruits, respectively. The yield variation with the treatments was may be due to the different dose of insecticides and different ecological conditions in particular locations.

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