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Efficacy of certain chemicals and biopesticides ag ainst brinjal shoot and fruit borer *Leucinodes orbonalis* (Guenee)

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Abstract
The present investigation was conducted during *kharif* July to December 2018 at Central agriculture field, SHUATS (Sam Higginbottom University of Agriculture, Technology and sciences, Prayagraj, Utter Pradesh (India). To determine efficacy of certain chemicals and biopesticides against brinjal shoot and fruit borer [*Leucinodes orbonalis* (Guenee)]. The result showed that the spinosad 45% SC was found most effective and showed (10.98) percent shoot infestation, (8.61) percent fruit infestation and (1:8.02) B:C ratio were recorded followed by Carbosulfan 25% EC (11.66), (9.24) and (1:7.60), Imidacloprid 17.8% SL (12.13), (9.82) and (1:6.44), Cypermethrin 25%EC (12.47), (10.19) and (1:5.16) Chlorpyriphos 20% EC (13.25), (10.42) and (1:5.02) Neem oil 2% (13.45), (10.88) and (1:4.99) NSKE 5% (14.50), (11.40) and (1:4.21) and Untreated control (18.33), (16.19) and (1:3.75) respectively.

Keywords: Bio-pesticides, brinjal, shoot and fruit borer, cost- benefit ratio, insecticide

1. Introduction
Brinjal or eggplant (*Solanum melongena* Linn.) is worldwide known as aubergine or guinea squash which is most popular and principle vegetable crop hence regarded as "King of vegetables belonging to the family “Solanaceae”, is one of the common and popular vegetables grown throughout the world. Brinjal is a versatile and economically important vegetable among small-scale farmers and low income consumers of the entire universe. It is the leading vegetable in the country and ranks first among summer and winter vegetables in terms of total acreage. Asia has the largest brinjal production which comprises about 90% of the total production area and 87% of the world production [7].

Brinjal is one of the widely used vegetable crops by most of the people and is popular in many countries *viz.*, Central, South and South East Asia, some parts of Africa and Central America**.** It is native of India and is grown throughout the country. It is an important vegetable grown in all the seasons. It is an important vegetable grown in all the seasons. Due to its nutritive value, consisting of minerals like iron, phosphorous, calcium and vitamins like A, B and C, unripe fruits are used primarily as vegetable in the country. It is also used as a raw material in pickle making and as an excellent remedy for those suffering from liver complaints. It has been reported as Ayurvedic medicine for curing the diabetes. In addition, it is used as a good appetizer, good aphrodisiac, cardiotonic, laxative and reliever of inflammation [5].

Brinjal is subjected to attack by number of insect pest right from nursery stage till harvesting. Among the insect pests infesting brinjal, the major ones are shoot and fruit borer, *Leucinodes orbonalis* (Guene.), whitefly, *Bemicia tabaci* (Genn.), leafhopper, *Amrasca biguttu labiguttula* (Ishida), and non-insect pest, red spider mite, *Tetranychus macfurlanei*. Of these, *L. orbonalis*is considered the main constraint as it damages the crop throughout the year. This pest is reported from all brinjal growing areas of the world including Germany, Burma, USA, Srilanka and India. It is known to damage shoot and fruit of brinjal in all stages of its growth. The infested fruits become unfit for consumption due to loss of quality and hence, lose their market value [5]. The study was chosen on the basis of their wide cultivation among small holder farmers in the region.

2. Materials and Methods

The present investigation was undertaken to evaluate efficacy of certain chemicals and biopesticides against brinjal shoot and fruit borer during *Kharif* season 2018 at Central Research Farm, SHUATS, Naini, Prayagraj (U.P.) Field trial was laid out in randomized block design (RBD) with 3 replications and 8 treatments including untreated control during *kharif* 2018-19 to evaluate the efficacy of five chemicals i.e., Spinosad 45% SC, Carbosulfan 25% EC, Imidacloprid 17.8% SL, Cypermethrin 25% EC, Chlorpyriphos 20% EC and bio pesticides Neem oil 2% and NSKE 5% against shoot and fruit borer on brinjal. Crop was raised in plots measuring 2x2 m with a spacing 60x60 cm between rows and plant, respectively. Transplanting was done on Aug 30th in 2018. Crop was raised according to all agronomic packages of practices under irrigated condition except the plant protection measure. Two rounds of insecticidal spray of different treatment were imposed on need basis during the crop season. All the treatments were imposed by using hand compression sprayer. First spray was given 45 days after transplanting (15th Oct 2018) and the remaining sprays was given at fortnightly intervals. The spraying was done during evening hours and care was taken to avoid drift of insecticides. No sprays were given in untreated control.

2.1 Data collection

Five plants were randomly selected from each plot and tagged. The total number of infested shoots and total number of shoots were recorded one day before application and 3rd, 7th and 14th days after application in each treatment. The results thus, obtained were converted into per cent shoot infestation with the following formula.

$$\% \text{ Shoot infestation} = \frac{\text{No. of infested shoot}}{\text{Total no. of shoot}} \times 100$$

Similar observation was taken for fruit infestation with the following formula

$$\% \text{ Fruit infestation} = \frac{\text{No. of infested fruit}}{\text{Total no. of fruit}} \times 100$$ [16]

2.2 Statistical analysis

Data were analyzed by using MSTAT software for analysis of variance. Percentage of shoot and fruit damaged by ESFB was transformed before analysis. ANOVA was made by F variance test and the pair comparisons were performed by Duncan's Multiple Range Test [4].

3. Results and Discussion

Table 1: The efficacy of chemicals and bio-pesticides against brinjal shoot and fruit borer [*Leucinodes orbonalis* (Guenee)] during *Kharif* season 2018 (First Spray): (% shoot infestation).

Treatments		Percent shoots infestation of *Leucinodes orbonalis*				
		One day before spray	After spray			
			3rd Day	7th Day	14th Day	Mean
T_1	Cypermethrin 25%EC	14.13 (22.01)*	13.79 (21.79)*	11.61 (19.92)*	12.84 (20.99)*	12.74 (20.90)*
T_2	Spinosad 45%SC	13.39 (21.46)*	11.86 (20.13)*	10.11 (18.53)*	10.97 (19.34)*	10.98 (19.34)*
T_3	Chlorpyriphos 20%EC	15.18 (21.42)*	14.23 (22.15)*	11.86 (20.13)*	13.66 (21.69)*	13.25 (21.33)*
T_4	Neem oil 2%	15.33 (22.99)*	14.36 (22.26)*	12.01 (20.27)*	14.00 (21.94)*	13.45 (21.50)*
T_5	Carbosulfan 25%EC	13.66 (21.62)*	12.95 (21.09)*	10.62 (19.01)*	11.42 (19.74)*	11.66 (19.95)*
T_6	NSKE 5%	16.45 (23.88)*	15.87 (23.45)*	13.33 (21.36)*	14.31 (22.18)*	14.50 (22.37)*
T_7	Imidacloprid17.8% SL	14.31 (22.20)*	13.17 (21.28)*	11.24 (19.58)*	12.00 (20.84)*	12.13 (20.37)*
T_0	Control	13.73 (21.71)*	16.66 (24.07)*	18.04 (25.12)*	20.29 (26.77)*	18.33 (25.33)*
Overall Mean		14.52	14.11	12.35	13.68	13.40
F- test		NS	S	S	S	S
S. Ed. (±)		3.95	1.52	1.15	1.58	0.81
C. D. (P = 0.05)		-	2.16	1.88	2.20	1.58

*Figures in parenthesis are arc sin transformed values.

Table 2: Efficacy of chemicals and bio-pesticides against brinjal shoot and fruit borer [*Leucinodes orbonalis* (Guenee)] during *Kharif* season 2018 (Second Spray): (% fruit infestation).

Treatments		Percent fruit infestation of *Leucinodes orbonalis*				
		One day before spray	After spray			
			3rd Day	7th Day	14th Day	Mean
T_1	Cypermethrin 25EC	11.08 (19.44)	10.11 (18.53)	9.38 (17.83)	11.08 (19.4)	10.19 (18.60)
T_2	Spinosad 45SC	11.81 (20.10)	8.96 (17.39)	7.51 (15.90)	9.38 (17.83)	8.61 (17.05)
T_3	Chlorpyriphos 20EC	13.33 (21.36)	10.28 (18.68)	9.62 (18.06)	11.38 (19.71)	10.42 (18.82)
T_4	Neem oil 2%	11.61 (19.92)	10.92 (19.29)	10.11 (18.53)	11.61 (19.92)	10.88 (19.25)
T_5	Carbosulfan 25%EC	12.01 (20.27)	9.62 (18.06)	8.00 (16.41)	10.10 (18.51)	9.24 (17.67)
T_6	NSKE 5%	11.38 (19.71)	11.24 (19.58)	10.97 (19.34)	12.01 (20.27)	11.40 (19.73)
T_7	Quinolphos 20%EC	11.24 (19.586)	9.79 (18.23)	8.96 (17.39)	10.73 (19.12)	9.82 (18.25)
T_0	Control	11.00 (19.36)	13.66 (21.68)	16.88 (24.25)	18.04 (25.12)	16.19 (23.69)
Overall Mean		10.68	10.57	10.17	11.79	10.84
F- test		NS	S	S	S	S
S. Ed. (±)		0.96	0.85	0.86	0.40	0.85
C. D. (P = 0.05)		-	1.61	1.62	1.11	1.61

*Figures in parenthesis are arc sin transformed values.

The data on the percent infestation of shoot infestation of *Leucinodes orbonalis* on third, seventh and fourteenth day after first application revealed that all the chemical treatments weresignificantly superior over control, (18.33% infestation).

Among all the treatments lowest per cent shoot, infestation was recorded in T_2 Spinosad (10.98), followed by T_5 Carbosulfan (11.66), T_7 Imidacloprid (12.13), T_1 Cypermethrin (12.47), T_3 Chlorpyriphos (13.25), T_4 Neem oil (13.45) and T_6 NSKE (14.50). The treatments T_6 NSKE (14.50) was least effective among all the treatments. (Table 2.)

In the present research work lowest percent shoot infestation was recorded in Spinosad treated plot (10.98%) similar findings were also reported by Shirale *et al*., (2012) reported that spinosad treated plot shown lowest percent infestation of *Leucinodes orbonalis* (10.49%) while the infestation in control plot was (40.32%) [12]. Devi *et al*., (2014) reported (10.55%) infestation in treated plots while the infestation in control plot was (18.18%). Similar findings were also reported (16.97%) [2].

Carbosulfan treated plot showed (11.66%) percent shoot infestation of *Leucinodes orbonalis* similar findings were also reported by Devi *et al*., (2014) noticed (14.53%) infestation of in *Leucinodes orbonalis* Carbosulfan treated plot while the infestation in control plot was (18.18%) [2]. Similarly Roy *et al*., (2016) reported that infestation in carbosulfan treated plots (3.33%), while the infestation in control plot was (10.33%) [11]. Mean percent infestation of Imidacloprid treated plot is (12.13%) which is reported by Tayde and Simon (2010) reported (19.20%) that the infestation in control plots was (24. 01%) [14]. Per cent infestation of cypermethrin treated plot is (12.47%) which is also found similar to (40.43%) reported by Anwar *et al*., (2015) while the infestation in control plot was 58.15% [1]. Similarly Dongarjal and Kumar A. (2017) reported (5.90%) infestation in cypermethrin treated plot while the infestation in control plot was (19.52%) [3]. Mean per cent infestation of chloropyriphos treated plot is (13.25%) similar findings were reported by Singh and Sachan (2015) **(**7.28%) infestation in chloropyriphos plot while the infestation (in control plot was 12.51%) [13]. Similarly Anwar *et al*., (2015) reported (46.57%) infestation in chloropyriphos treated plot while the infestation in control plot is (58.15%) [1]. Neem oil treated plots shown (13.45%) infestation similar findings were reported by Mathur *et al*., (2012) reported **(**5.69%) infestation in treated plot while the infestation in control plot is (15.50%) [9]. Similarly Rahman *et al*., (2009) reported (16.00%) infestation in neem oil treated plot while the infestation in control plot is (22.67) [10]. (14.50%) per cent infestation was found in NSKE treated plot. Similar findings were also Mandal *et al*., (2010) reported (0.29%) infestation in NSKE treated plot while the infestation in control plot is (0.39%) [6].

The data on the percent infestation of fruit infestation of *Leucinodes orbonalis* on 3rd, 7th, and 14th days after second application revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest per cent infestation of shoot and fruit borer was recorded in T_2 Spinosad (8.61), followed by T_5 Carbosulfan (9.24), T_7 Imidacloprid (9.82), T_1 Cypermethrin (10.19), T_3 Chlorpyriphos (10.42), T_4 Neem oil (10.88) and T_6 NSKE (11.40). The treatments T_6 NSKE (11.40) was least effective among all the treatments. Control plot T_0 (16.19) infestation.

In the present research work lowest percent fruit infestation was recorded in Spinosad treated plot (8.61%) similar Marmat and Tayde (2017) findings were reported that spinosad treated plot shown lowest percent infestation of *Leucinodes orbonalis* (7.27%) while the infestation in control plot was (29.40%) [8]. Devi *et al*., (2014) reported (8.38%) infestation in carbofuran treated plots while the infestation in control plot was (25.13%) [2]. Carbosulfan treated plot showed (9.24%) per cent infestation of *Leucinodes orbonalis* similar Devi *et al*., (2014) findings were also reported by noticed (11.85%) infestation of in *Leucinodes orbonalis* Carbosulfan treated plot while the infestation in control plot was (25.13%) [2]. Similarly Roy *et al*., (2016) reported that infestation in carbosulfan treated plots (8.89%), while the infestation in control plot was (12.59%) [11]. Mean per cent infestation of Imidacloprid treated plot was (9.82%) which is reported by

Tayde and Simon (2010) reported that (15.54%) while the infestation in control plot was (24.89%) [14]. Per cent infestation of cypermethrin treated plot (10.19%) which is also found similar to reported Anwar *et al.,* (2015) by infestation plot (40.43) while the infestation in control plot was (58. 15%) [1]. Similarly Kalawate and Dethe (2012) reported (13.40%) infestation in cypermethrin treated plot while the infestation in control plot is (29.77%) [5]. Mean per cent infestation of chloropyriphos treated plot is (10.42%) similar Singh and Sachan (2015) findings were reported is **(**7.33%) infestation in chloropyriphos plot while the infestation in control plot was (12.27%) [13]. Similarly Anwar *et al.,* (2015) reported (50.97%) infestation in chloropyriphos treated plot while the infestation in control plot is (67.18%) [1] Neem oil treated plots shown (10.88%) infestation similar findings were reported by Tripura *et al.,* (2017) reported (15.65%) infestation in treated plot while the infestation in control plot is (28.60%) [15]. (11.40%) per cent infestation was found in NSKE treated plot. Similar findings were also similarly Tayde and Simon (2010) reported (9.60%) infestation in NSKE treated plot while the infestation in control plot is (16.97%) [14].

4. Conclusion

From the critical analysis Spinosad 45SC and selected insecticide and bio-pesticides like Carbosulfan 25%EC followed by Quinolphos 20%EC, Cypermethrin 25EC, Chlorpyriphos 20EC, Neem oil 2% and NSKE 5% are showing result against *Leucinodes corbonalis* and can be a part of integrated pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not much harmful to beneficial insects and in increasing cost effectiveness.

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