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Efficacy of certain biorationals against shoot and fruit borer (*Leucinodes orbonalis* Guenee) of brinjal (*Solanum melongena* L.)

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Abstract
An experimental field was carried out at the Central field, Department of Entomology SHUATS, Allahabad during *Kharif* of 2016. Eight treatments were evaluated against *Leucinodes orbonalis* i.e., Cypermethrin 25% EC @ 2 ml/lit, Spinosad 45% SC @ 0.5 ml/lit, Neem oil @ 20 ml/lit, Pongamia oil @ 30 ml/lit, NSKE @ 50 gm/lit, Garlic bulb extract @ 50 ml/lit, Neem leaf extract @ 50 ml/lit and Untreated control. Three sprays were carried out which revealed that among the chemical insecticides and biopesticides Spinosad 45 SC, Cypermethrin 25 EC, Neem oil, NSKE, Pongamia oil recorded the minimum shoot infestation i.e. (6.87), (8.57), (9.27), (9.60), and (10.93) percent respectively. The highest yield and benefit cost ratio was recorded in Spinosad 45 SC (195.22 q/ha and 1:7.06 respectively).

Keywords: cost- benefit ratio**,** biorationals, chemical insecticide, cypermethrin, *leucinodes orbonalis*, brinjal

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. 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. Kalawate and Dethe (2012) [4]. 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* (Guen.), whitefly, *Bemicia tabaci* (Genn.), leafhopper, *Amrasca biguttula biguttula* (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 yield loss due to the pest is to the extent of 70-92 per cent (Adiroubane *et al*, 2008) [1] The infested fruits become unfit for consumption due to loss of quality and hence, lose their market value. It is also reported that there will be reduction in vitamin C content to an extent of 68 per cent in the infested fruits. It was reported that the shoot and fruit borer (on shoot) were more prevalent during vegetative phase of crop. The yield loss by this pest varied from 0.08-1.11 q/ha on the basis of inconsumable pest of damaged fruits and 0.46- 3.80 q/ha (Ashadul *et al*, 2014) [2] when whole of the damaged fruits were taken into consideration. It was reported that the borer infestation was 78.66% on top shoots in vegetative phase (Murgesan *et al*, 2009) and then shifted to flowers and fruits within festation reaching 66.66% in fruiting phase. (Yadav *et al.* 2015) [9]. Therefore, the present experiment was conducted to evaluate some biorationals along with chemical insecticides for an effective integrated management of shoot and fruit borer in brinjal.

Materials and Methods
The experiment was conducted during *Kharif* season 2016 at the Central Field of "Sam Higginbottom University of Agriculture, Technology and Sciences" Allahabad, U.P., India, in

Allahabad, U.P., India, in a randomized block design with eight treatments, using variety Banaras purple round in a plot size of (2m x 1m) at a spacing of (60 x 45cm) with recommended package of practices excluding plant protection. The observation of the pests was recorded from five randomly selected plants from every plot. Three insecticidal sprays were administrated at 15 days interval starting from 35 days after sowing. The treatments include Spinosad @ 0.5 ml, Cypermethrin @ 2 ml, Neem oil, Pongamia oil, NSKE, Garlic bulb extract, Neem leaf extract along with untreated control. The spraying was done after the population reaching its economic threshold level i.e. the incidence of the borer on the shoot and the fruit were recorded from the five randomly selected plants. Observations were recorded one day before spray, 3rd, 7th, 14th days after spraying. The assessment of the shoot damage was done by calculating the number of damaged shoots and total number of the healthy shoots observed from five randomly selected plants per plot and expressed in percentage. Brinjal fruits were harvested at weekly intervals. The percent fruit damage was total number of affected fruits from each plot. The total yield of the marketable fruits obtained from different treatments was calculated and converted by considering the additional cost (cost of insecticides and operational charges) and benefit (compared to untreated control) in the respective treatments.

Results and Discussion

In case of shoot and fruit borer, all the three sprays revealed that the data on the mean (3, 7 & 14 DAS) were significantly superior over control. Among all the treatments, minimum per cent infestation of shoot and fruit borer was recorded in Spinosad (6.87%) as compared to control (16.97%).

The percent fruit infestation of shoot and fruit borer on mean of second and third spray revealed that all the treatments were significantly superior over control. Among all the treatments, lowest per cent infestation of fruit was recorded in Spinosad (7.15%) as compared to Control (26.17). Kalawate and Dethe (2012) [4]. Also reported the efficacy of spinosad gave the similar findings as most effective treatment was recorded in spinosad. Singh and Sachan (2015) [8], Sharma and Anil (2010) [7], Kushwaha and Painkra (2016). Spinosad found to be the best treatments that is in line with the findings of also supported.

The yields among the treatment were significant. The highest yield was recorded in Spinosad 45 SC (195.22 q/ha) followed by Cypermethrin (188.10 q/ha), Neem oil (181.30q/ha), Pongamia oil (177.40 q/ha), NSKE (175.50 q/ha), Garlic bulb extract (165.20) Neem leaf extract (102.50 q/ha) as compared to Control (85.52 q/h). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was Spinosad (1:7.06), followed by Cypermethrin (1:6.97), Neem oil (1:6.69), Pongamia oil (1:4.10), NSKE (1:6.55), Garlic bulb extract (1:3.86), Neem leaf extract (1:3.74) as compared to Control (1:3.30).

Kalawate and Dethe (2012) [4] who suggested that Spinosad is a valuable Biorational in the management of *L. orbonalis*.

From the analysis of the present findings, it can conclude that shoot and fruit borer population increased with maximum temperature and decreased with decline in minimum temperature. Spinosad 45 SC, Cypermethrin 25 EC and selected biopesticides like followed by Neem oil, NSKE, and Pongamia oil are showing good result against (*Leucinodes orbonalis*) 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.

Table 1: Effect of Biorationals against shoot and fruit borer (*Leucinodes orbonalis* Guenee) of Brinjal. (Ist, IInd and IIIrd Spray)

Treatments		I st Spray Percent of shoot infestation					II nd Spray Percent of fruit infestation					III rd Spray Percent of Fruit Infestation				
		Before Spray	3 DAS	7 DAS	14 DAS	Mean	Before Spray	3 DAS	7 DAS	14 DAS	Mean	Before Spray	3 DAS	7 DAS	14 DAS	Mean
T_0	Control (Water Spray)	11.50 (19.82)	14.20^{a} (22.14)	16.20^{a} (23.73)	20.50^{a} (26.92)	16.97^{b} (24.32)	20.50 (26.92)	21.20^{a} (27.42)	23.10^{a} (28.73)	24.50^{a} (29.67)	22.93^{b} (28.61)	24.50 (29.67)	26.20^{a} (30.79)	28.50^{a} (32.27)	33.50^{a} (35.37)	29.40^{a} (32.83)
T_1	Cypermethrin 25EC @ 2ml/l	10.50 (18.91)	6.50^{ef} (14.77)	8.50^{d} (16.95)	9.80^{e} (18.24)	8.27^{a} (16.71)	9.80 (18.24)	5.30^{d} (13.31)	8.30^{ef} (16.74)	10.50^{e} (18.91	8.03^{e} (16.47)	10.50 (18.91)	7.20^{d} (15.56)	9.20^{d} (17.66)	10.00^{d} (18.43)	8.80^{d} (17.26)
T_2	Spinosad 45SC @ 0.05ml/l	11.50 (19.82)	5.60^{f} (13.69)	6.10^{e} (14.30)	8.90^{e} (17.36)	6.87^{d} (15.19)	10.20 (18.63)	4.90^{d} (12.79)	7.90^{f} (16.32)	8.30^{e} (16.74)	7.03^{e} (15.38)	12.30 (20.53)	6.40^{d} (14.65)	7.20^{e} (15.56)	8.20^{d} (16.64)	7.27^{d} (15.64)
T_3	Neem oil @ 20 ml/l	11.50 (19.82)	7.80^{de} (16.22)	8.50^{d} (16.95)	11.50^{cde} (19.82)	9.27^{b} (17.72)	11.50 (19.82)	8.50^{c} (16.95)	9.50^{ef} (17.95)	12.50^{cd} (20.70)	10.17^{d} (18.59)	13.80 (21.81)	10.20^{c} (18.63)	11.20^{c} (19.55)	12.50^{c} (20.70)	11.30^{c} (19.64)
T_4	Pongamia oil @ 30 ml/l	12.00 (20.27)	9.50^{bc} (17.95)	10.50^{bcd} (18.91)	12.80^{cd} (20.96)	10.93^{e} (19.31	12.80 (20.96)	9.50^{bc} (17.95)	11.20^{cd} (19.55)	14.00^{c} (21.97)	11.57^{cd} (19.88)	14.00 (21.97)	11.50^{c} (19.82)	12.20^{c} (20.44)	13.50^{c} (21.56)	12.40^{c} (20.62)
T_5	NSKE @ 50 gm/l	10.50 (18.91)	8.50^{cd} (16.95)	9.50^{cd} (17.95)	10.80^{de} (19.19)	9.60^{c} (18.05)	10.80 (19.19)	8.50^{c} (16.95)	10.00^{de} (18.43)	12.50^{cd} (20.70)	10.33^{cd} (18.75)	12.50 (20.70)	11.50^{c} (19.82)	12.00^{c} (20.27)	12.50^{c} (20.70)	12.00^{c} (20.27)
T_6	Garlic bulb extract @ 50 ml/l	12.50 (20.70)	10.50^{b} (18.91)	11.30^{bc} (19.64)	13.50^{be} (21.56)	11.77^{d} (20.06)	13.50 (21.56)	10.50^{b} (18.91)	12.20^{c} (20.44)	14.00^{c} (21.97)	12.23^{c} (20.47)	14.00 (21.97)	11.00^{c} (19.37)	11.50^{c} (19.82)	13.20^{c} (21.30)	11.90^{c} (20.18)
T_7	Neem leaf extract @ 50 ml/l	11.05 (19.42)	10.33^{b} (18.75)	11.83^{b} (20.12)	16.00^{b} (23.58)	12.72^{b} (20.89)	11.50 (19.82)	10.33^{b} (18.75)	15.05^{b} (22.83)	20.00^{d} (26.57)	15.13^{b} (22.89)	20.05 (26.60)	14.05^{b} (22.01)	16.05^{b} (23.62)	21.85^{b} (27.87)	17.32^{b} (24.59)
F- test		NS	S	S	S	S	NS	S	S	S	S	NS	S	S	S	S
S. Ed. (±)		3.202	0.679	0.939	1.212	0.537	3.489	0.762	0.820	1.134	0.922	4.914	0.748	0.755	0.856	1.132
C. D. (P = 0.05)		6.788	1.439	1.991	2.570	1.138	7.397	1.616	1.737	2.404	1.954	10.417	1.587	1.600	1.816	2.400

Figures in parenthesis are arc sin transformed values. DAS- days after spray

Table 2: Economics of Cultivation:

S. No:	Treatment	Yield q/ha	Total cost of yield (₹) (C)	Common cost (₹)	Treatment cost (₹)	Total cost (₹) (B)	C: B ratio
01	Cypermethrin 25 EC	188.10	282150	38840	1605	40445	1:6.97
02	Spinosad 45 SC	195.22	292830	38840	2615	41455	1:7.06
03	Neem oil	181.30	271950	38840	1800	40640	1:6.69
04	Pongamia oil	177.40	165460	38840	1450	40290	1:4.10
05	NSKE	175.50	263250	38840	1312	40152	1:6.55
06	Garlic bulb extract	165.20	154954	38840	1200	40040	1:3.86
07	Neem leaf extract	102.50	153750	38840	2200	41040	1:3.74
08	Control	85.52	128280	38840	------	38840	1:3.30

Cost of yield per quintal ₹ 1500.

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