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Efficacy of biopesticides and chemical insecticides on brinjal shoot and fruit borer (*L. orbonalis*) during kharif season under agro climatic condition Prayagraj (U.P)

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Abstract
Brinjal (Eggplant) *Solanum melongena* Linnaeus is one of the prominent and profitable vegetable crops grown in warm and humid environmental conditions. Brinjal is one of the significant solanaceous vegetable crops growing all throughout India. It is commercially very accessible and profitable vegetable to farmers. The brinjal is a rich source of minerals including calcium, phosphorus, proteins, vitamins, and several essential biochemicals. Insect pests infestation is one the major constraints for commercial production in all brinjal growing areas. It is cultivated throughout the year, even in the hot summer season. It is more vigorous during the hot weather conditions, mainly during the rainfall period than the cooler season due to the influence of climatic conditions on the life cycle. It takes more time to complete its life period in winter than summer months. Shoot and fruit borer causes severe loss to the fruits in autumn and the entire crop can be devastated. The site selected was uniform, cultivable with typical sandy loam soil having good drainage. The experiment was laid out in Randomized Block Design with three replication which consisting of fourteen treatments *viz*., *Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium l1ecanii*, *Bacillus thuringiensis*, Neem seed kernel extract, Neem leaf extract, Neem oil 5% EC, Deltamethrin 2.8%EC, Chlorpyriphos 20% EC, Spinosad 45% EC, Lamdacylothrin 5% EC, Profenophos 40% + cypermethrin 4% EC and chlorpyriphos 50% + cypermethrin 5% EC).

Keywords: Brinjal shoot and fruit borer, infestation and reduction percentage

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. It is one of the common and popular vegetable crop originated in India. Now it is cultivated as a vegetable in all of the world's tropical, subtropical and warm temperate regions. It is one of the most important vegetable in the Indian subcontinent where it is grown over almost 50% of the world's area under its cultivation (Alam *et al.*, 2003) [1]. 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. Mannan *et al.*, (2015) [6]. 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, cardio tonic, laxative and reliever of inflammation Kalawate and Dethe (2012) [5]. The major brinjal growing states in India are West Bengal, Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Orissa, Uttar Pradesh, Bihar and Rajasthan. The undersides of leaves, green stalks, flower buds, and fruit calyces are all places where the female moths lay their eggs. This pest's larvae burrow into the petioles, midribs, and tender shoots of big leaves, generating droppings before flowering. Later, the juvenile larvae bore into the flower buds, closest sensitive branch, and fruits. They immediately stuff faeces into the entrance hole. Fruit tissues that have immature larvae eating inside them render them inappropriate for human consumption and commercialization.

The main issue in eggplant farming is the shoot and fruit borer. The yield loss varies from season to season and from location to location can reach between 85-90% Patnaik (2000) and Lopez *et al.*, (2010) [2, 4].

Materials and Methods

The present investigation was conducted at the Central Research Farm of "Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The geographical co-ordinates of Prayagraj have 25° 57" N latitude and 87° 19" E longitude and an altitude of 98 m above mean sea level. The Prayagraj regions have sub-tropical and semi-arid climate with monsoon commencing from July and with drawing by the end of September. The temperature goes up to 48 ℃ during summer and goes down to 2.5 ℃ in winter. The site selected was uniform, cultivable with typical sandy loam soil having good drainage. For conducting studies we were used biopesticides and chemical insecticides neem products, agricultural implements, organic manure and fertilizers. whereas equipments knapsack sprayer, measuring cylinder, buckets, labels, threads, polythene bags, chemicals balance, weighing balance, labours etc provided by the Department of Entomology.

Cultural operations

Preparatory tillage

The soil texture was completely made fine by plugging followed by two harrowing. The field was cleaned by picking weed, stubbles of previous crop and their plants. Firstly we prepared nursery of brinjal crop seeds sowing on raised beds to keep safe form the water logging situation. The experimental plots were laid out as per the statistical design.

Sowing of seeds on raised bed

The seeds of Brinjal crop "Pusa Purple Long" were sown on 23/6/2019 and 20/7/2019 to raise the seedling in nursery. From the seventh days after the seed germination keep regular light irrigation at interval and weeding were done up to transplanting of seedling to the main field.

Transplanting of seedling and gap filling

The seedling were transplanted approximately after four weeks, in the main field on 21.7.2019 and 31.7.2020, to maintain the plant population gap filling was done till fifteen days.

Preparation of Plant Products Solution

Neem Seed Kernel Extract (NSKE) 5 percent

Firstly we were collect undamaged ripe neem fruits (barriers), which are yellow and fresh were gathered from neem trees. The outer layer of the pulp was removed from the seeds. After cleaning, the seeds were spread out under shade on cloth to dry for a few days. The dried seeds were stored. The five kilograms clean neem seeds were grinded using electric grinder until a fine powder was obtained. The powder was sieved using test sieves to remove larger particles. The powder was tightly packed in muslin cloth and soaked into 10 liters water for overnight then five gram soap powder was added to dissolve the active substances in the neem powder and to make them sticky and spreads well to the leaf surface. The resulting solution was repeatedly stirred manually for several times and was left to stand for 24 hours. After thorough stirring, the solutions were repeatedly filtered through fine gauze in order to remove larger particles and obtain clear liquid.

Preparation of Neem leaf extract

We were collected fresh healthy neem leaves from tree of neem (*Azadirachta indica*) in poly bags, brought to lab and washed thoroughly in water, dried in shade and powdered using a pulverizer and stored in plastic containers. The shade dried leaves were ground in an electrical grinder to make a fine powder. Its aqueous extract was prepared by using 1 kg of dried leaves with 1 liter of distilled water. The extract was squeezed through fine meshed rayon cloth and finally filtered through Whatman filter paper. The filtrate (w/v) was used as test biopesticide for foliar application on experimental plant.

Neem Oil 0.5 percent

Five gram insecticidal soap or other detergent was added in one liter of warm water there after added 5 ml. Neem oil in this solution. It is very essential to add the insecticidal soap or other detergent with the warm water before adding Neem oil. The active substances in the neem oil to make them sticky and spreads well to the leaf surface. Then slowly add the oil while stirring vigorously. Use the mixture within eight hours, using by the knapsack sprayer.

Methods of recording observation

a) On the number of shoot basis

The borer damage in shoot was recorded from first week of August after transplanting on five randomly selected brinjal plants per plot at weekly interval in each treatments by counting the number of damaged shoots per plant to total number of shoots of the plant. Percentage of damaged shoots was worked out by following formula, (Rahman *et al.*, 2009) [3].

$$\text{Percent shoot infestation} = \frac{\text{Number of infested shoots}}{\text{Total number of shoots}} \times 100$$

b) On the number of fruit basis

In case of fruit infestation, the observations were recorded in each treatment from five selected plants The borer damage in fruits appeared during third week of September was recorded on number basis from total number of damaged and healthy fruits by using following formula, (Rahman *et al.*, 2009) [3].

$$\text{Percent fruit infestation} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits.}} \times 100$$

Preparation and application of spray solutions

From the commercial formulation, the quantity of the insecticide was worked out by using the following formula.

$$V = \frac{C \times A}{a.i.}$$

Where
V = Volume or weight of commercial insecticide required
C = Concentration of commercial insecticide
A = Amount of spray required
a.i. =% of active ingredient

The insecticide solution was freshly prepared at the site of experiment just before spraying. The required quantity of insecticide per plot was first thoroughly mixed in a small quantity of water and it was then poured into the bucket

containing the remaining quantity of water. The spray solution was thoroughly mixed before spraying and stirred frequently during the time of spray. The spray was done by Knapsack sprayer. The spraying operations were performed in the evening hours. (Between 4 to 6 pm).

Result and Discussion

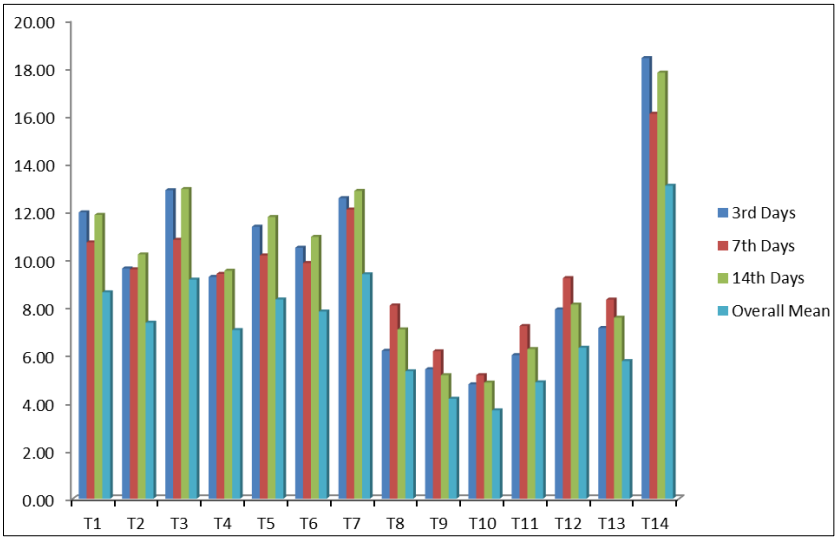
Percent shoot infestation

It is observed from data presented in Table 1 and Fig 1 that all the treatment were significantly superior over untreated control showing lowest infestation of shoot damage. The minimum percentage of shoot infestation was recorded in Spinosad 45% EC and it was significantly superior over other treatments showing 4.78, 5.16, 4.85, 3.69% shoot damage at 3rd, 7th, 14th overall mean after fourth spray. Followed by Chlorpyriphos 20% EC that observed 5.41, 6.16, 5.16, 4.18%. Both these treatment were significant to each other and superior over other treatment. Where the maximum percentage of shoot infestation (18.42, 16.09, 17.80, 13.08) was found in Control.

The efficacy of different selected bio and chemical insecticides on 3rd, 7th, 14th and overall mean after fourth spray is depicted in Table 1 and Fig 1 which revealed that all the treatment were significantly superior over control. Among the treatment Spinosad 45% EC was recorded highest reduction of *Leucinodes orbonalis shoot borer* (74.03, 67.86, 72.46, 71.73) over control respectively followed by Chlorpyriphos 20% EC (70.65, 61.59, 70.93, 68.05), Lamdacylothrin 5% EC (67.38, 55.04, 64.72, 62.80), Deltamethrin 2.8% EC (66.39, 49.72, 60.07, 59.20) and chlorpyriphos 50% + cypermethrin 5% EC (61.27, 48.17, 57.40, 55.98) reduction shoot borer over control respectively. The minimum shoot protection over control found in Verticilium l1ecanii (29.95) at 3rd days and Neem oil 5%EC (25.02, 27.35, 33.65, 28.18) at 7th, 14th and overall mean after fourth spray.

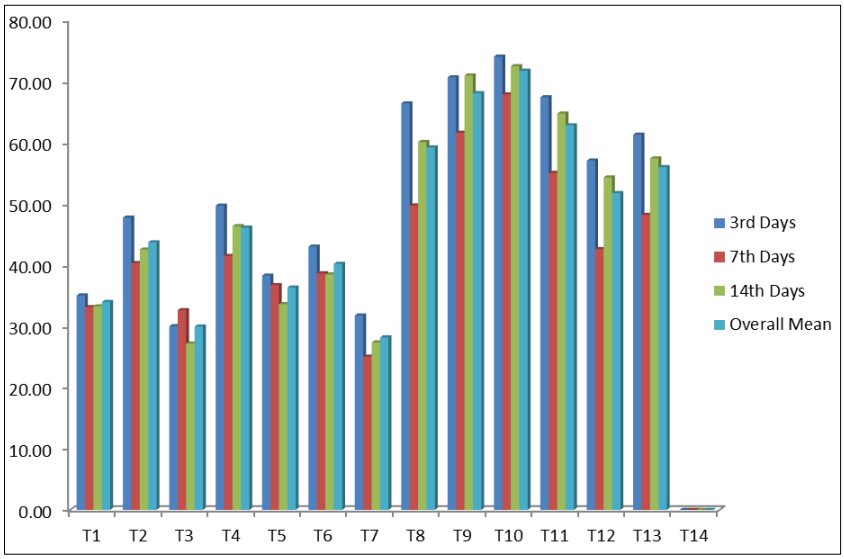
Table 1: Comparative effect of biopesticide and insecticides on (%) shoots infestation and reduction of Brinjal against shoot borer, *Leucinodes orbonalis* at before 4th spray in (Pooled)

Treatment No.	Treatments details	4th Spray (Pooled)							
		Shoot infestation (%)				Shoot reduction (%)			
		3rd Days	7th Days	14th Days	Overall mean	3rd Days	7th Days	14th Days	Overall mean
T1	*Beauveria bassiana*	11.97	10.71	11.86	8.63	35.01 (37.27)	33.11 (34.95)	33.24 (35.15)	33.96 (35.62
T2	*Metarhizium anisopliae*	9.62	9.59	10.21	7.36	47.73 (43.69)	40.30 (39.39)	42.52 (40.68)	43.70 (41.37
T3	*Verticillium l1ecanii*	12.89	10.82	12.94	9.16	30.01 (33.22)	32.62 (34.80)	27.16 (31.37)	29.95 (33.16
T4	*Bacillus thuringiensis*	9.27	9.40	9.53	7.05	49.68 (44.81)	41.47 (40.08)	46.34 (42.89)	46.09 (42.76
T5	Neem seed kernel extract	11.37	10.17	11.77	8.33	38.26(38.18)	36.71 (37.28)	33.60 (35.36)	36.31 (37.05
T6	Neem leaf extract	10.49	9.85	10.94	7.82	43.00 (40.96)	38.64 (38.42)	38.46 (38.32)	40.17 (39.33
T7	Neem oil 5% EC	12.56	12.09	12.86	9.38	31.75 (34.27)	25.02 (29.80)	27.35 (31.30)	28.18 (31.99
T8	Deltamethrin 2.8% EC	6.18	8.08	7.08	5.33	66.39 (54.57)	49.72 (44.83)	60.07 (50.82)	59.20 (50.30
T9	Chlorpyriphos 20% EC	5.41	6.16	5.16	4.18	70.65 (57.21)	61.59 (39.65)	70.93 (57.38)	68.05 (55.58
T10	Spinosad 45% EC	4.78	5.16	4.85	3.69	74.03 (59.37)	67.86 (55.46)	72.46 (58.43)	71.73 (57.88
T11	Lamdacylothrin 5% EC	6.00	7.22	6.25	4.86	67.38 (55.19)	55.04 (47.90)	64.72 (53.57)	62.80 (52.41
T12	Profenophos 40% + cypermethrin 4% EC	7.91	9.22	8.12	6.31	57.05 (49.05)	42.58 (40.72)	54.30 (47.46)	51.74 (45.99
T13	chlorpyriphos 50% + cyperamethrin 5% EC	7.13	8.32	7.57	5.75	61.27 (51.52)	48.17 (43.95)	57.40 (49.25)	55.98 (48.43
T14	Control	18.42	16.09	17.80	13.08	0.00	0.00	0.00	0.00
	F- test	S	S	S	S	S	S	S	S
	C .D 5%	0.91	1.07	0.99	0.419	4.94	6.25	4.98	3.031
	SEd.(±)	0.44	0.52	0.48	0.204	2.40	3.04	2.42	1.475



(a): (%) shoots infestation

Fig 1: Comparative effect of biopesticide and insecticide on (%) shoots infestation and reduction of Brinjal against shoot borer, *Leucinodes orbonalis* at before and 4th spray in (Pooled)



(a): (%) shoots reduction

Fig 2: Comparative effect of biopesticide and insecticide on (%) fruit infestation and reduction of Brinjal against fruit borer, *Leucinodes orbonalis* at 4th spray in (2019)

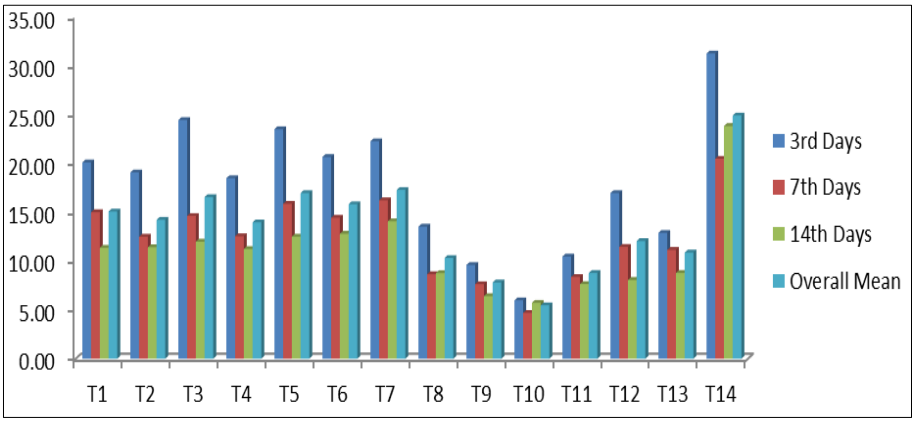
Percent fruit infestation

Fruit infestation and reduction% at 3rd, 7th, 14th and overall mean after first spray (number basis) the data on% fruit infested and reduction fruit due to fruit borer on number basis after 1st spray in (Table 4.29 and Fig. 4.6). The results were statistically significant. All the treatments were significantly superior over control.

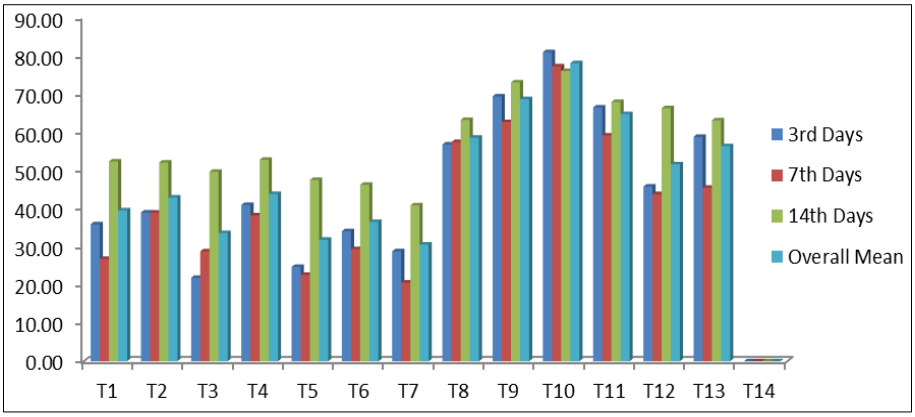
The data on Comparative effect of biopesticide and insecticide of treatment at 3rd, 7th, 14th and overall mean after first spray against *Leucinodes orbonalis* on fruit infestation number basis indicated that all the treatment were significant superior over untreated control.

Table 2: Comparative effect of biopesticide and insecticide on (%) fruit infestation and reduction of Brinjal against fruit borer, *Leucinodes orbonalis* at 4th spray in (2019)

Treatment No.	Treatments details	4th Spray (2019)							
		Fruit infestation (%)				Fruit reduction (%)			
		3rd Days	7th Days	14th Days	Overall mean	3rd Days	7th Days	14th Days	Overall mean
T1	*Beaveria bassiana*	20.08	14.99	11.35	15.06	35.86 36.528	26.79 30.998	52.30 46.317	39.50 38.89
T2	*Metrihizium anisopliae*	19.06	12.49	11.40	14.21	38.93 38.595	38.90 38.572	52.00 46.157	42.88 40.900
T3	*Verticillium l1ecanii*	24.42	14.60	11.98	16.54	21.84 27.700	28.78 32.317	49.61 44.772	33.57 35.39
T4	*Bacillus thuringiensis*	18.47	12.53	11.23	13.95	40.93 39.661	38.20 37.611	52.75 46.575	43.80 41.40
T5	Neem seed kernel extract	23.48	15.84	12.49	16.95	24.70 29.629	22.63 28.329	47.47 43.545	31.81 34.31
T6	Neem leaf extract	20.64	14.43	12.79	15.81	34.05 35.588	29.36 32.700	46.20 42.816	36.48 37.12
T7	Neem oil 5%EC	22.25	16.21	14.06	17.26	28.80 32.308	20.60 26.742	40.81 39.689	30.54 33.48
T8	Deltamethrin 2.8%EC	13.51	8.65	8.76	10.30	56.76 48.958	57.39 49.358	63.16 52.631	58.53 49.92
T9	Chlorpyriphos 20% EC	9.59	7.62	6.40	7.80	69.33 56.481	62.62 52.329	72.98 58.743	68.61 55.96
T10	Spinosad 45% EC	5.97	4.69	5.72	5.47	80.90 64.456	77.21 61.578	75.98 60.659	78.03 62.07
T11	Lamdacylothrin 5% EC	10.45	8.37	7.64	8.77	66.43 54.655	59.11 50.252	67.87 55.471	64.70 53.56
T12	Profenophos 40% + cypermethrin 4% EC	16.95	11.43	8.05	12.04	45.74 42.534	43.75 41.304	66.25 54.571	51.56 45.89
T13	chlorpyriphos 50% + cyperamethrin 5%EC	12.87	11.14	8.77	10.86	58.73 50.051	45.44 42.377	63.06 52.587	56.31 48.62
T14	Control	31.22	20.45	23.81	24.88	0.00	0.00	0.00	0.00
	F- test	S	S	S	S	S	S	S	S
	C .D 5%	3.94	2.74	1.23	1.510	12.48	13.29	4.90	5.878
	SEd.(±)	1.91	1.33	0.60	0.735	6.07	6.46	2.38	2.859



(a): (%) fruit infestation



(b): (%) fruit reduction

Fig 3: Comparative effect of biopesticide and insecticide on (%) fruit infestation and reduction of Brinjal against fruit borer, *Leucinodes orbonalis* at 4th spray in (2019)

Discussion

Percent shoot infestation: The efficacy of different selected bio and chemical insecticides on 3rd, 7th, 14th and overall mean after fourth spray is depicted in Table 1 and Fig 1 which revealed that all the treatment were significantly superior over control. Among the treatment Spinosad 45% EC was recorded highest reduction of *Leucinodes orbonalis shoot borer* (74.03, 67.86, 72.46, 71.73) over control respectively followed by Chlorpyriphos 20% EC (70.65, 61.59, 70.93, 68.05), Lamdacylothrin 5% EC (67.38, 55.04, 64.72, 62.80), Deltamethrin 2.8% EC (66.39, 49.72, 60.07, 59.20) and chlorpyriphos 50% + cypermethrin 5% EC (61.27, 48.17, 57.40, 55.98) reduction shoot borer over control respectively. The minimum shoot protection over control found in Verticilium l1ecanii (29.95) at 3rd days and Neem oil 5% EC (25.02, 27.35, 33.65, 28.18) at 7th, 14th and overall mean after fourth spray.

Percent fruit infestation: The best effective treatments was spinosad 45% EC which recorded minimum% fruit infestation *i.e.* (5.97, 4.69, 5.72, 5.47) at 3rd, 7th, 14th and overall after first spray. It was followed by chlorpyriphos 20% EC, Lamdacylothrin 5% EC, deltamethrin 2.8% EC, chlorpyriphos 50% + cyperamethrin 5% EC and profenophos 40% + cypermethrin 4% EC The maximum fruit infestation (31.22, 20.45, 23.81, 24.88) was found in control (water spray) fruit damage respectively.

The reduction (%) of Brinjal fruit borer over control was highest (80.90, 77.21, 75.98, 78.03%) in the Spinosad 45% EC treated plot followed by Lamdacylothrin 5% EC, deltamethrin 2.8% EC, chlorpyriphos 50%+cyperamethrin 5% EC and profenophos 40% + cypermethrin 4% EC. The minimum reduction (28.80, 20.60, 40.81, 30.54%) protection found in Neem oil 5% EC.

Conclusion

The present experiment provides a basic study for management of shoot and fruit borer. It can be concluded that Spinosad 45% EC proved to be the best treatment in managing the *Leucinodes orbanolis.* The results revealed that the treatment Spinosad 45% EC proved to be the best treatment in managing the shoots and fruit borer at 3rd, 7th, 14th, 21st and overall mean after 1st, 2nd, 3rd, and 4th spray on Brinjal experiment with pooled data respectively.

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