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Studies on the seasonal incidence of brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) and its effective management

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Abstract
The experiment were conducted to observe the seasonal abundance of *L. orbonalis* in relation to abiotic factors (temperature, relative humidity, rainfall etc.), to evaluate the efficacy of some commonly used insecticides against brinjal shoot and fruit borer *L. orbonalis* on brinjal crop in *kharif* 2018-19. Result showed that the population of *L. orbonalis* appeared on 4th week of August (0.20 larvae/plant) i.e. 35th Standard Meteorological Week (SMW) & reach its peak (14.5 larvae/plant) during 43rd SMW i.e. last week of October. The pest population suddenly decreased (0.2 larvae/plant) in the last December i.e. 52nd SMW due to the reason that no more leaves & twigs were produce. Regarding efficacy of insecticide Emamectin benzoate 5%SG @ 200g a.i./ha prove most effective which are closely followed by Flubendamide 48SC @ 75 ml/ha & Dimethoate 30 EC @ 1 lit/ha. Obviously maximum fruit yield i.e. 227.18 q/ha was given by Emamectin benzoate 5%SG which was closely followed by Flubendamide 48SC & Dimethoate 30EC. ICBR of Emamectin benzoate 5%SG 1: 31.06 was maximum. Similar trend in percent increase yield over control was observed in this investigation.

Keywords: *Leucinodes orbonalis*, brinjal, seasonal incidence, fruit and shoot borer

Introduction
Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics, being grown extensively in India, Bangladesh, Pakistan, China and Philippines. It is also popular in Egypt, France, Italy and United States. In India. In India, the major brinjal growing states are Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, West Bengal, Madhya Pradesh, Bihar, Jharkhand, Uttar Pradesh, *etc*. It is an important vegetable grown in all the seasons. In India, brinjal is grown in an area of 7,29,000 hectares with an estimated annual production of 1,26,000,00 metric tonnes with a productivity of 17.28 metric tonnes per hectare in 2017-18 (NHB 2018). In Uttar Pardesh, brinjal is grown in an area of 7830 hectares, with an annual production of 2,68,820 metric tonnes and a productivity of 17.63 metric tonnes per hectare which is less than the national average. It contributing 2.17% of total brinjal production of India (NHB 2018). In brinjal cultivation, there are several constraints, which are responsible for reduction in yield amongst them, insect pests are one of the most important factor. It has been reported that this crop is damaged by one hundred forty (140) species of insect pests at different stages of the crop growth (Prempong *et al*. 1977) [1]. Among the insect-pests infesting brinjal, the major ones are brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guen.), whitefly, *Bemisia tabaci* (Genn.), leafhopper, *Amrasca biguttula biguttula* (Ishida), Epilachna beetle, *Henosepilacha vigintioctopunctata* (Fab.) and red spider mite, *Tetranychus macfurlanei* (Baker and Pritchard) of these, *L. orbonalis* is considered the main constraint as it damages the crop throughout the year. It is known to damage shoot and fruit of brinjal in all stages of its growth. The yield loss due to the insect-pests is to the extent of 70-92 per cent (Eswara Reddy and Srinivas, 2004) [2]. *Leucinodes orbonalis* Guenee. is considered to be a major pest as it damages the crop throughout the year. It is known to damage shoots and fruits of brinjal in all stages of its growth. The larva of the borer confines its feeding activities on shoots in the early stages of crop and on fruits during later stages. The yield loss due to the pest is to the extent of 70-92 per cent. In early stage of the crop growth, shoot and fruit borer larva bores into the shoots resulting in drooping, withering and drying of the affected shoots. During the reproductive stage, tiny larva bores into the flower buds and fruits, the infested bored hole are invariably plugged with excreta.

The infested fruits become unfit for consumption. Insecticidal control is one of the common means against the fruit borer, many of the insecticides applied are not effective in the satisfactory control of this pest. Brinjal, being a vegetable crop, use of chemical insecticides will leave considerable toxic residues in the fruits. Beside this, sole dependence on insecticides for the control of this pest has led to insecticidal resistance by the pest (Harish *et al*. 2011) [3]. Indiscriminate use of pesticides particularly at fruiting stage and non adoption of safe waiting period leads to accumulation of pesticide residues in vegetables.

Material and Methods

Field experiment was conducted at student farm of university. C.S. Azad University of Agriculture and Technology, Kanpur U.P. during kharif season 2018-19. The experimente was laid out in randomized block design having 3x3 m^2 plots and separated by 1m irrigation channel with 7 treatment (including control) and three replication. The transplanting was done on 23 August 2018. All the plants of variety Type – 3 were transplanted in the field. The soil type of experimental field was sandy loam with average fertility. The field was well leveled having good drainage and adequate irrigation facility. Geographically, the district Kanpur Nagar falls in subtropical zone and situated between the parallels of 25° 26' and 26° 58' north latitude and 79°31'and 80° 34' east longitude. It is situated at elevation of 125.9 metre above the level in gangetic alluvial of central U.P. The climate of kanpur nagar is sub tropical with hot dry summer and severe cool in winter. The average weather parameter during crop period of present investigation in *kharif* season of 23August 2018 to 31 December 2018. The data was recorded from transplanting to up requirement of fruit picking. Meteorological observations on temperature, relative humidity (RH) and rainfall were recorded from observatory of university.

The insecticidal spray solution was prepared by the following formula-

$$\text{Amount of formulation} = \frac{\text{Concentration required \%} \times \text{Volume required (liter)}}{\text{Concentration of toxicant in insecticidal formation}}$$

The first spraying was applied after 30 days of transplanting followed by five spraying on an interval of 15 days. Five sprays of insecticides were applied and their effect was studied in terms of shoots and fruit infestation. The data on shoot and fruit infestation were recorded after 7 days after each spraying

Observations Seasonal abundance of *L. orbonalis*

To observe the seasonal abundance of brinjal shoot and fruit borer the observations were made on ten shoots or fruits/plot at weekly interval from transplanting to last picking of fruit in control plot. Meteorological observations on temperature, relative humidity and rainfall were recorded from the observatory of the university.

Efficacy of insecticides against *L. orbonalis*

Observations were recorded on healthy and infested plants in each plot on 15 days after each spray. However, the performance of each treatment against fruit borer was assessed by recording the number of infested and healthy shoot/fruit from 5 randomly selected plants at each picking

Evaluation of yield

The fruit was recorded separately for all plots during each picking and converted into kg/plot and q/ha for analyzing and comparison. The observations were analyzed statistically to compare the treatments effects. The percent increase yield over control was calculated by following formula:

Per cent increase yield over control = T- C×100 / T

Where, C = Percent fruit infestation in control plot, T= Percent fruit infestation in treated plots by different insecticides

The mean original data of percentage damage was calculated as percentage damage was calculated as percentage reduction over control with following formula

Damage percentage = T- C×100 / C

Where, C = Percent damage of control, T = Percent damage of treated plot

The observations were analyzed statistically to compare the treatment effects. The data for finding out infestation percentage of pest were transformed using angular transformation. The data were pooled to find out the infestation in respective treatment and statistical analysis was made to determine the overall effect of each treatment. Standard error and C.D. at 5% of significance were worked out. The mean values were then compared with each other on the basis of critical difference among themselves to find out significant superiority between them. The data was transformed to back values to compare with each other

Results and Discussion

The data showed (table -1) that the population of *L. orbonalis* appeared on 1st week of September i.e. 35th standard meteorological week (SMW). The pest population was recorded as number of larvae per plant varied from 0.2 to 14.5. The larval population was low during mid of the month of September and varied from 0.2 to 0.8 larvae/plant. The pest population increased from last week of October and reached its peak i.e. 14.5 larvae/plant during 43rd SMW i.e. last week of October. In this month the rainfall was nill. During this period the weather parameters like maximum and minimum temperature ranged from 33.1 ^{0}C to 14.2 ^{0}C, respectively, and relative humidity (maximum and minimum) 70% and 30%, respectively, were recorded. The pest population started decline in 44th SMW to 49th SMW; which varied from 4.5 to 1.2 larvae / plant, respectively. The population of pest suddenly decrease in the last of December i.e. 51th and 52th SMW, where the number of larval population per plant was 0.4 and 0.2, respectively. These observations were supported by earlier findings of Prabhjot *et al*., (2014) [4] who, reported that the incidence of pest population was recorded on shoots as well as fruits of brinjal crop. Maximum numbers of larvae (10 larvae/90 plants) were recorded in the 42nd and 43rd SMW. Shukla and Khatri (2010) [5] also reported that the larval infestation of the pest occurred first time in the week of August (16.66% shoot damage). The peak of shoot damage (86.66%) was recorded from the last week of October.

To determine the efficacy of some safer insecticides against brinjal shoot and fruit borer *L. orbonalis* is presented in

Table.2. In first spraying of insecticides results showed that all the treatments were significantly effective in reducing the infestation of *L. orbonalis*. Treatments "Emamectin benzoate 5%SG @ 200g a.i./ha" provided minimum infestation against tested insect i.e. 8.78% which was statistically at par with Flubendamide 48SC@ 75ml a.i. / ha and Dimethoate 30EC@ 1.0 lit / ha by providing 11.45% and 12.88% insect infestation, respectively, and they were statistically superior over control in which 27.68% insect infestation was recorded.. Azadirachtin 1500ppm @ 0.15% differed significantly to all other treatments by providing 19.88% insect infestation although it differed significantly with control. All the treatments were significantly superior over control in which maximum i.e. 27.68% insect infestation was recorded. Second spraying result showed that Emamectin benzoate 5%SG @ 200g a.i. / ha gave minimum infestation i.e. 8.63% which was statistically at par with Dimethoate 30EC@ 1.0 lit / ha and Flubendamide 480SC@ 75ml a.i. / ha by providing 9.33% and 10.33% insect infestation respectively, and they were statistically superior over control in which 27.68% insect infestation was recorded. Third spraying results showed for fruit infestation all the treatments were significantly effective in reducing the fruit infestation of *L. orbonalis* Guenee. Here again Emamectin benzoate 5%SG @ 200g a.i. / ha gave minimum infestation against tested insect i.e. 9.92% which was statistically at par with Flubendamide 48SC@ 75ml a.i. / ha and Dimethoate 30EC@ 1.0 lit / ha by providing 10.37% and 12.65% infestation, respectively. All the treatments were significantly superior over control in which maximum i.e. 26.18% infestation was recorded. A quite similar trend irrespective of fruit damage was recorded after 4th spray of tested insecticides. Result showed that all the treatments were significantly effective in reducing the infestation of *L. orbonalis*. Emamectin benzoate 5%SG @ 200g a.i. / ha gave minimum infestation against tested insect i.e. 7.42% which was statistically at par with Flubendamide 48SC@ 75ml a.i. / ha by providing 8.32% infestation and statistically superior over control in which 26.53% insect infestation was recorded. Fifth spraying data presented Table 2, result showed that all the treatments were significantly superior in reducing the infestation of *L. orbonalis*. Emamectin benzoate 5%SG @ 200g a.i. / ha at last spray gave minimum infestation i.e. 4.38% which was statistically superior to all the treatments as well as control in which 29.87% insect infestation was recorded. All the treatments were significantly superior over control in which maximum i.e. 27.68% infestation was recorded. The effectiveness of Emmactin benzoate, Flubendamide and Dimethoate against brinjal shoot and fruit borer *L. orbonalis* has also been reported by various workers *viz*. Dutta *et al*. (2007) [6]; Jagginavar *et al*. (2009) [7]; Wankhade and Kale (2010) [8]; Nailk *et al*. (2011) [9]; Jyoti and Basavanagaud (2012) [10]; Pachori *et al*. (2013) [11]; Dattatray *et al*. (2017) [12] and Ramkinkar *et al*. (2017) [13], Shah *et al*.,(2012) [14] reported the order of effectiveness was emamectin benzoate 5 SG @ 0.0025% (89.56%) > flubendiamide 480 SG @ 0.01% (83.70%) > rynaxypyr 20 SC @ 0.006% (81.04%) > lufenuron 5 EC @ 0.005% (74.62%) > novaluron 10 EC @ 0.01% (69.03%) > indoxacarb 15.5 SC @ 0.007% (67.46%) based on per cent reduction in shoot damage and emamectin benzoate (75.06%) > flubendiamide (63.02%) > rynaxypyr (61.55%) > lufenuron (49.93%) > novaluron (47.69%) > indoxacarb (45.34%) > thiodicarb (41.08%) based on per cent reduction in fruit damage.

Table 3 showed The maximum fruit yield was obtained from Emamectin benzoate 5%SG @ 200g/ha treated plot which gave 13.63 kg fruits/plot and it was statistically superior overall the treatments. The Flubendamide 48SC @75ml/ha was second most effective treatment with fruit yield of 13.27 kg/plot followed by Dimethoate 30%EC @1.0 lit/ha, Spinosad 45EC @ 150ml/ha, Fipronil 5%SC @ 750ml/ha, and Azadirachtin 1500ppm @0.15% which provided fruit yields of 12.78, 12.60, 12.52 and 11.52 kg/plot, respectively. The minimum fruit yield was recorded control i.e. 8.23 kg/plot. Results of Dutta *et al.*, (2007) [15] showed that emamectin benzoate 5 SG proved good level of efficacy providing 82.8 per cent reduction of BSFB population over control and it was concluded that this pest might have developed resistance against the tested insecticides. Naik *et al*. (2008) [16] reported that spinosad at 0.015% were the most effective in the reduction of shoot infestation of *Leucinodes orbonalis*, aside from recording higher aubergine fruit yield.

Table 1: Population of *L. orbonalis* larvae on brinjal in relation to abiotic factors during kharif 2018 – 19

Standard meteorological week	Dates of weeks	Rainfall (mm)	Temperature (ºc)		Relative humidity		Wind speed (km/hr)	Mean No. of larvae / plant
			Max.	Min.	Max.	Min.		
34	20 Aug.- 26 Aug.,2018	122	31.9	24.9	93	77	5.5	0.0
35	27 Aug.- 02 Sept.,2018	42.3	31.6	25.7	90	77	4.0	0.2
36	03 Sept.- 09 Sept.,2018	110.2	30.8	23.9	90	79	5.1	0.5
37	10 Sept.- 16 Sept.,2018	19.6	32.4	23.5	85	63	7.1	0.8
38	17 Sept.- 23 Sept.,2018	3.0	32.7	23.6	82	61	6.5	1.1
39	24 Sept.- 30 Sept.,2018	8.6	33.9	22.7	78	53	4.3	2.5
40	01 Oct.- 07 Oct.,2018	-	35.6	20.6	73	40	3.1	4.3
41	08 Oct.- 14 Oct.,2018	-	34.0	19.8	77	40	3.3	6.7
42	15 Oct.- 21 Oct.,2018	-	35.2	16.6	70	29	2.5	10.3
43	22 Oct.- 28 Oct.,2018	-	33.1	14.2	70	30	2.0	14.5
44	29 Oct.- 04 Nov.,2018	-	32.0	14.4	76	36	1.7	4.5
45	05 Nov.- 11Nov.,2018	-	28.3	12.8	82	44	2.6	4.2
46	12 Nov.- 18 Nov.,2018	-	29.5	10.6	84	34.4	2.7	3.9
47	19 Nov.- 25 Nov.,2018	-	28.5	11.3	80	34	2.7	3.4
48	26 Nov.- 02 Dec.,2018	-	26.6	11.6	90	43	1.8	2.8
49	03 Dec.- 09 Dec.,2018	-	24.8	8.8	89	38	1.3	1.2
50	10 Dec.- 16 Dec.,2018	-	22.8	8.3	90	46	2.6	0.6
51	17 Dec.- 23 Dec.,2018	-	22.5	5.3	87	35	1.9	0.4
52	24 Dec.- 31 Dec.,2018	-	21.1	34.6	87	34	5.8	0.2

Table 2: Effect of various treatments on shoot and fruit damage caused by *L. orbonalis* spraying

S. No	Treatment	Doses	Shoot infestation (%) 7 days after 1st spraying	Shoot infestation (%) 7 days after 2nd spraying	Shoot infestation (%) 7 days after 3rd spraying	Shoot infestation (%) 7 days after 4th spraying	Shoot infestation (%) 7 days after 5th spraying
1	Fipronil	750 ml / ha	16.07 (23.66)	15.48 (23.19)	14.57 (22.46)	12.82 (21.56)	11.28 (19.64)
2	Dimethoate	1.0 lit / ha	12.88 (21.05)	9.33 (17.76)	12.65 (20.85)	9.52 (17.95)	8.27 (16.74)
3	Spinosad	150 ml / ha	14.73 (22.55)	14.68 (22.55)	14.77 (22.63)	12.50 (20.70)	11.62 (19.91)
4	Emamectin benzoate	200g a.i. / ha	8.78 (18.42)	8.63 (17.05)	9.92 (18.35)	7.42 (15.79)	4.38 (12.11)
5	Azadirachtin	0.15%	19.88 (27.32)	18.20 (26.72)	20.13 (27.52)	16.82 (24.64)	15.27 (23.47)
6	Flubendamide	75 ml a.i. / ha	11.45 (19.82)	18.72 (10.33)	10.37 (18.81)	8.32 (16.40)	6.83 (15.12)
7	Control	75 ml a.i. / ha	27.68 (31.75)	27.88 (31.88)	26.18 (30.79)	26.53 (30.98)	29.87 (33.15)
	SE(d)		1.46	1.61	1.28	0.95	1.19
	CD at 5%		3.19	3.51	2.78	2.08	2.59

Note: Angular transform values given under in parenthesis.

Table 3: Yield of brinjal fruits (q / ha) from different treatment

S. No.	Treatment	Doses	Fruit yield (kg/plot)			Total	Mean	% Increased yield over control	Total yield (q/ha)
			R1	R2	R3				
1	Fiproni	750 ml/ha	14.31	9.45	13.81	37.57	12.52	51.91	208.44
2	Dimethoate	1.0 lit/ha	13.27	14.62	10.44	38.34	12.78	55.91	212.94
3	Spinosad	150 ml/ha	16.06	9.67	12.06	37.80	12.60	52.99	209.93
4	Emamectin benzoate	200 g/ha	13.27	15.21	12.42	40.90	13.63	65.04	227.18
5	Azadirachtin	0.15%	9.18	13.05	12.33	34.56	11.52	39.89	191.94
6	Flubendamide	75 ml/ha	11.47	14.38	13.96	39.81	13.27	61.20	221.18
7	Control		9.00	7.87	7.83	24.7	8.23		137.21
	SEd					0.94			
	CDat 5%					2.05			

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