Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 2657-2660
Received: 07-07-2020
Accepted: 25-08-2020

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Seasonal abundance of brinjal shoot and fruit borer, *Leucinodes orbonalis* (Guenee.) On brinjal, *Solanum melongena* (L.) and its management

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Abstract
The experiments were conducted to observe the seasonal occurrence of *Leucinodes orbonalis* in relation to abiotic factors, and to assess the efficacy of few commonly used novel insecticides for the safer management of noxious insect, *L. orbonalis* on brinjal crop in kharif season 2012-13. *L. orbonalis* appeared in 2nd week of September (0.20 larvae/plant) i.e. 37th standard week and reached its peak (5.80 larvae /plant) during 49th standard week i.e. second week of December. The pest population suddenly decreased (0.40 larvae /plant) in last week of February i.e. 9th standard week due to the reason that no more new leaves and twigs were produced. Regarding the efficacy of insecticides Imidacloprid 17.8 SL @250 g a.i. /ha proved most effective closely followed by Indoxacarb 14.5 SC @50 g a.i. /ha and Dimethoate 30 EC @1 lit/ha. Maximum fruit yield i.e. (220.61q/ha.) was given by Imidacloprid 17.8 SL closely followed by Indoxacarb 14.5SC & Dimethoate 30 EC.

Keywords: Seasonal abundance, *Leucinodes orbonalis*, efficacy, management

Introduction
Solanum melongena. L., commonly known as egg plant or brinjal, belongs to the family-Solanceae. It is one of the most important solanaceous vegetables in South-East Asian countries including India, Bangladesh, Srilanka, China, Japan etc. It is a native of India-Burma region (Vavilov, 1926) [19], India is second largest producer of vegetables after China. Vegetable farming occupies an important place in Indian agriculture because of their nutritional, medicinal and economical values. The area, production and yield of brinjal in country was 612000ha, 10563mt, and 17.3mt/ha, respectively, during 2009-10 and 680000 ha, 11896 mt and 17.5 mt /ha, respectively, during 2010-11 (N.H.B 2010-11). Major Brinjal growing states in India are West Bengal, Orissa, Gujarat, Maharashtra, Madhya Pradesh, Uttar Pradesh, Uttrakhand etc. Singh *et al.* (2000) [15] reported that the borer infestation was 78.66 per cent on top shoot in vegetative phase and then shifted to flowers and fruits with infestation reaching 66.66 per cent in fruiting phase. Climatic factors such as temperature, relative humidity and rainfall are known to have a significant influence on insect population fluctuation. Knowledge of the seasonal abundance and population build-up trend is essential to ensure timely preparedness to manage pest problems and prevent crop losses and it also to help in the development of forecasting model which is a useful tool to predict likely incidence of insect pests on the crop (Sharma *et al.*, 2018; Sharma *et al.*, 2019) [11-13]. The use of insecticides has been found very effective in suppressing different insects attack on brinjal pest (Joshi and Sharma 1973, Singh and Kavadia 1989) [4, 4]. Hence the present investigation has been carried out with this objective to Study the seasonal abundance of *Leucinodes orbonalis L.* in relation to abiotic factors and evaluate the efficacy of different insecticides against shoot and fruit borer *L. orbonalis*.

Material and Methods
Field trials were conducted at Student Research Farm, C.S. Azad University of Agriculture and Technology, Kanpur U.P. during kharif season 2012-13, with a promising local grown variety type-3. The experimental site falls under subtropical climatic zone. The field is situated in alluvial tract of gangetic plains in central parts of Uttar Pradesh with assured irrigation facilities by tube well. The soil of experimental field is sandy loam with average fertility, under regular cultivation having well drainage facility. The experiment was laid out in Randomized Block design having 3 ×2 m^2 plots and separated by 1 m irrigation channel and 1 m plot border with 7 treatments and 3 replications. The seedlings of brinjal variety Type-3 were sown at the spacing of 60×60 cm between row to row and plans to plant.

The insecticidal spray solution was prepared by the following formula-

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

Spraying is done with the help of small hand atomizers sprayer. The experiment was laid out in RBD (Randomized Block Design) with seven treatments including untreated control; each replicated thrice. The first spraying was conducted after 30 days of transplanting followed by four sprays at a regular interval of 15 days.

Observations of seasonal abundance of *Leucinodes orbonalis*

An intensive survey was undertaken to record the mean number of *Helicoverpa armigera* (Hubner) population at weekly intervals from the appearance of larvae till the last picking of fruits ten plants were randomly selected from each replication and the number of larvae present were counted.

Observation on infested fruits

Observations were recorded after 15 days after each spray. The efficacy of each treatment against fruit borer was assessed by recording the number of infested and healthy shoot/ fruit from 10 randomly selected plants at each picking.

Evaluation of yield

The fruit yield was recorded separately for all plots during each picking and converted into kg/ plot and q/h for analyzing and comparison. 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 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 depicted in table - 1 shows that the population of brinjal shoot and fruit borer, *L. orbonalis* maintained fluctuating trend during the study period and varied from 0.2 to 5.80 larvae

per plant *L. orbonalis* appeared on during 2nd week of September i.e. 37 standard weeks. The pest population recorded as number of larvae per plant varied from 0.2 to 5.80. The larval population was low during the month of September ranging between 0.2to 2.20 larvae /plant. It increased from first week of December and reached its peak (5.80 larvae /plant) during 49th standard week i.e. 2nd of week December. In this month the rainfall was nil. During this period the parameters i.e. temperature and relative humidity (maximum and minimum) ranged from 7.74 ^{0}C to 25.60 ^{0}C and 36.42 to 75.57 per cent, respectively. These observations are supported by the earlier findings of Singh *et. al.*, (2000) [15] who reported the peak activity of this pest during last week of December. Sah *et. al.* (1965) [10] observed its maximum fruit infestation in the first week of January. However, Tiwari (2008) [17] recorded the peak population of by *L. orbonalis* in the first week of November for two successive years,

Efficacy of different insecticides on the incidence of *L. orbonalis* in brinjal is presented in Table.2. The results reveal that all the treatments were significantly superior in reducing the infestation of shoot and fruit borer resulting in increased the yield the minimum shoot damage (9.38 per cent) was recorded in the plot treated with Imidacloprid 17.8 SL @ 250 g a.i. /ha followed by Indoxacarb14.5SC @ 50.0g a.i. /ha where 11.06 per cent shoot damage was recorded. Imidacloprid 17.8SL proved significantly superior to Indoxacarb 14.5 SC. The minimum shoot damage (7.36 Per cent) was recorded with Imidacloprid @ 250 g a.i. /ha. Table 2. The effect of various treatments on fruit damage 15 days of 3rd spraying the data revealed that all the treatments were significantly superior over control. Among all the treatments Imidacloprid 17.8 SL @250 g a.i. /ha was most effective which gave 9.38per cent fruit damage and it was closely followed by Indoxacarb 14.5 SC@ 50 g a.i. /ha and Dimethoate 30 EC@ 1.0 lit/ha where fruit damage was observed 10.30 and 12.03 per cent, respectively. The other treatments i.e. Spinosad 45 EC@ 70 g a.i. /ha, Azadirachtin 1500ppm@ 0.15%, and *Bacillus thuringiensis* @0.1 % in which fruit damage was recorded from 14.39 to17.21 per cent, which were also statistically superior to check. The highest fruit damage 25.08 per cent was recorded in control plot. After 15 days of fourth spraying, Imidacloprid 17.8Sl @ 250 g a.i/ha gave again the best performance and recorded lowest fruit damage (7.11 per cent) as compared to other treatments whereas, Indoxacarb 14.5 SC @ 50g a.i. /ha, Dimethoate 30 EC @1.0lit/ha, Spinosad 45EC @70 g a.i/ha, Azadirachtin 1500 ppm @0.15%, provided 8.65, 9.97, 12.59 and 12.96 per cent fruit damage, respectively. The data recorded after 15 days of fifth insecticidal application, all the treatments were significantly superior over the control. The minimum fruit damage (4.60 per cent) was recorded with Imidacloprid 17.8 SL@ 250 g a.i/ha. The second effective treatment was Indoxacarb 14.5 SC %50g a.i./ha (6.62 per cent)fruit damage followed by Dimethoate 30EC 1.0lit/ha, Spinosad 45EC@70 g a.i./ha, Azadirachtin 1500 ppm @0.15 % and *Bacillus thuringiensis* @ 0.1% with 8.23, 11.07, 11.46, and 12.61 per cent fruit damage, respectively. At the last spraying again the maximum fruit damage (28.48 per cent) was recorded in control plot.

Mishra and Dash (2007). reported that alternate spraying of Azadirachtin 1500 ppm @ 1 lit /ha and Imidacloprid @0.025kg a.i. /ha in sequence at 10-15 days interval after 40 days of transplanting was most effective in controlling *L. orbonalis* in brinjal. These findings are also approved by Patil *et. al.* (2009) [7]. Who reported that thiamethoxam slowed the infestation of *L. orbonalis* (1.30%) followed by Imidacloprid (1.66%) and NSKE (1.86) in brinjal.

Table 3 reveals that all insecticides were significantly effective in reducing the infestation of brinjal shoot and fruit borer and thus increased the yield in comparison to control. The highest yield (220.61 q/ha) was obtained from the treatment Imidacloprid 17.8SL @250 g a.i. /ha. The Indoxacarb 14.5SC @50 g a.i. /ha was second most effective treatment which gave the yield 217.88 q/ha. The result is supported by Bhargav *et. al.* (2003) [3]. who reported that Imidacloprid (15- 20 g a.i. ha^{-1}) and Monocrotophos (360 g a.i. ha^{-1}) applied at 60, 75 and 90 days after transplanting against L. *orbonalis* and reduced the pest population at lowest level in treatment, Imidacloprid 20 g a.i. ha^{-1}. The treatment also gave highest yield of healthy fruits (170.2 q ha^{-1}) in brinjal.

Table 1: Population of *L. orbonalis* larvae on brinjal in relation to abiotic factors during kharif 2012-13.

Standard weeks	Periods	Rainfall	Temp.(ºC)			Relative Humidity (%)			Mean No. of larvae/plant
		Amount (mm)	Max.	Min.	Mean	Max.	Min.	Mean	
36	03Sept. 09Sept., 2012	3.68	32.88	24.77	28.83	88.14	68.28	78.21	0.20
37	10Sept. 16Sept., 2012	12.44	31.00	24.97	27.99	92.85	77.71	85.28	1.60
38	17Sept. 23Sept., 2012	0.28	32.65	23.35	28.00	90.00	67.57	78.79	1.80
39	24Sept. 30Sept., 2012	0	33.55	22.25	27.90	83.14	59.14	71.14	2.20
40	01Oct. 07Oct., 2012	0	35.00	20.57	27.79	85.57	43.71	64.64	2. 80
41	08Oct. 14Oct., 2012	0	33.45	18.21	25.83	84.14	44.14	64.14	3.60
42	15Oct. 21Oct., 2012	0	32.97	16.97	24.88	90.57	39.28	64.93	3.60
43	22Oct. 28Oct., 2012	0	30.30	14.32	22.31	85.42	39.42	62.42	4.20
44	29Oct. 04Nov., 20 12	0	29.40	12.02	20.71	89.71	38.42	64.07	4.40
45	05Nov. 11Nov., 2012	0	29.90	12.78	21.34	85.00	36.85	60.93	4.40
46	12Nov.18,Nov., 2012	0	28.20	10.94	19.57	89.14	46.14	67.64	5.20
47	18Nov. 25Nov., 2012	0	27.00	9.14	18.07	87.71	40.57	64.14	5.40
48	26Nov. 02Dec., 20 12	0	26.10	8.21	17.16	86.57	38.00	62.29	5.60
49	03Dec. 09Dec., 2012	0	25.60	7.74	16.67	75.57	36.42	56.00	5.80
50	10Dec. 16Dec., 2012	0	25.90	9.62	17.76	93.28	54.14	73.71	4.80
51	17Dec. 23Dec., 2012	0	20.20	7.98	12.27	89.57	60.71	75.14	4.40
52	24Dec. 30Dec., 2012	0	14.74	4.33	9.54	96.12	71.12	83.62	4.20
01	31Dec. 06Jan., 2013	0	15.48	3.64	9.56	96.85	67.42	82.14	4.20
02	07Jan. 13Jan., 2013	0	19.60	3.74	11.67	90.00	51.57	70.79	3.60
03	14Jan. 20Jan., 2013	0.65	22.94	9.38	16.16	93.42	69.71	81.57	3.20
04	21Jan. 27Jan., 2013	0	19.28	5.40	12.34	92.00	61.14	76.57	2.80
05	28Jan. 03 Feb., 2013	0	22.74	6.80	14.77	89.28	56.42	72.85	1.60
06	04Feb. 10Feb., 2013	10.7	22.22	10.02	16.12	92.28	64.85	78.57	1.40
07	11Feb. 17Feb., 2013	5.57	22.02	10.54	16.28	93.28	69.00	81.14	1.00
08	18Feb. 24Feb., 2013	1.05	23.62	10.88	17.25	91.85	68.57	80.04	0.60
09	25Feb. 03 March., 2013	0	25.98	11.74	18.86	88.71	56.57	72.64	0.40
SE	-	-	-	-	-	-	-	-	0.277
C.D at 5%	-	-	-	-	-	-	-	-	0.557
C.V.	-	-	-	-	-	-	-	-	10.617

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

S. No.	Treatment	Dose	% Shoot infestation 15 days after 1st spraying	% Shoot infestation 15 days after 2st spraying	%Fruit infestation 15 days after 3st spraying.	% Fruit infestation 15 days after 4st spraying	% Fruit infestation 15 days after 5st spraying
1.	Azadirachtin	0.15%	15.50 (23.151)	15.56 (22.563)	14.73 (22.559)	12.96 (21.072)	11.46 (19.774)
2.	Dimethoate	1.0lit /ha	12.83 (20.960)	9.18 (19.430)	12.03 (20.227)	9.97 (18.337)	8.23 (16.653)
3.	Spinosad	70 g a.i. /ha	15.47 (23.180)	14.18 (22.240)	14.39 (22.284)	12.59 (20.771)	11.07 (19.435)
4.	Imidacloprid	250ga.i. /ha	9.38 (17.812)	7.36 (15.730)	9.38 (17.822)	7.11 (15.449)	4.60 (12.372)
5.	*B.thuringiensis*	0.1%	16.12 (23.665)	14.34 (22.102)	17.21 (24.508)	14.37 (22.270)	12.61 (20.781)
6.	Indoxacarb	50 g a.i. /ha	11.06 (19.409)	11.09 (17.616)	10.30 (18.716)	8.65 (17.072)	6.62 18.896)
7.	Control	-	27.75 (31.789)	25.87 (30.561)	25.08 (30.041)	26.03 (30.841)	28.48 (32.253)
	SE	-	0.740	0.780	0.700	0.920	0.760
	CD at 5%	-	1.616	1.703	1.536	2.019	1.651

Note: Angular transform values given under in parenthesis.

Table 3: Yield of Brinjal fruits Subjected to different treatments

S. N0.	Common name	Dose	Fruit yield (kg/plot)			Total	Mean	%Increase yield over control	Total yield q/ha
			R_1	R_2	R_3				
1	Azadirachtin	0.15%	12.15	12.31	12.70	37.16	12.39	30.02	206.44
2	Dimethoate	1.0lit/ha	12.90	13.04	12.98	38.92	12.97	33.15	216.22
3	Spinosad	70 g a.i./ha	12.88	12.23	12.68	37.79	12.60	31.19	209.94
4	Imidacloprid	250g a.i./ha	13.22	13.38	13.11	3971	13.24	34.51	220.61
5	*B.thuringiensis*	0.1%	12.15	12.25	12.01	36.41	12.14	28.51	202.27
6	Indoxacarb	50 g a.i./ha	13.12	13.08	13.02	39.22	13.07	33.66	217.88
7	Control		8.13	9.15	8.72	26.00	8.67		144.44
	SE								0.220
	C D at 5%								0.491

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