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Sandeep Kumar
Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh, India

Sumit Kumar Singh
Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh, India

Y.P Malik
Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh, India

Correspondence
Sumit Kumar Singh
Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh, India

Evaluation of several insecticides, against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen. on brinjal at Kanpur agro climatic region

Sandeep Kumar, Sumit Kumar Singh and Y.P Malik

Abstract
The present investigation was carried out at Students Instructional Farm, Chandra Shekher Azad University of Agriculture and Technology, Kanpur (U.P.) during 2014-15. Application of nine insecticides were evaluated against brinjal fruit and shoot borer, *Leucinodes orbonalis* Guen, on two variety Azad B-3 (V_1), Type-3 (V_2) of Brinjal. The minimum shoot damage (10.20 and 08.51 percent) was recorded in the plots treated with imidacloprid 17.8 SL @ 0.02%, followed by imidacloprid 17.8 SL @ 0.015% (12.50 and 10.43 percent). The maximum shoot damage recorded in *Bacillus thuringiensis* @ 0.75kg/ha (20.07 and 16.76 percent) followed by (28.86 and 24.09 percent) in control plot. The maximum control treatment was Imidacloprid 17.8 SL @ 0.02% is (64.65 and 64.67%) and minimum *Bacillus thuringiensis* @ 0.75kg/ha (30.45 and 30.42%). The minimum fruit damage (09.50 and 08.08 percent) was recorded in the plots treated with imidacloprid 17.8 SL @ 0.02%, followed by imidacloprid 17.8 SL @ 0.015% (11.65 and 09.90 percent). The maximum fruit damage recorded in *Bacillus thuringiensis* @ 0.75kg/ha (18.71 and 15.90 percent) followed by (26.89 and 23.27 percent) in control plot. The maximum control treatment was Imidacloprid 17.8 SL @ 0.02% is (64.67 and 65.27%) and minimum *Bacillus thuringiensis* @ 0.75kg/ha (30.42 and 31.67%).

Keywords: Brinjal, Chemical insecticides, *Leucinodes orbonalis*

Introduction
Botanically brinjal is known as *Solanum melongena* L. (2n=24) popularly known as eggplant belongs to family Solanaceae and India is its center of origin and diversity. Brinjal is one of the most commonly grown vegetable crops of the country. India produces about 7.676 MT of brinjal from an area of 0.472 M ha with an average productivity of 16.3 mt/ha. Leaves and seed of brinjal are also used as necrotic and stimulants respectively Nadkarni, 1927. It is the most-consumed and most-sprayed vegetable in India, where it is grown on more than 5,00,000 hectares, making it one of the main sources of cash for many farmers. Brinjal is well adapted to high rainfall and high temperatures and is among the few vegetables capable of high yields in hot-wet environments. Brinjal is good source of Vitamin A, Thiamine, Ascorbic acid and Phosphorus. They are also known to have alkaloid solanine in root and leaves. Brinjal is also a popular vegetable in China, Japan, Egypt, Italy, USA, Syria, Philippines, Thailand, Indonesia, France, and Turkey. Its immature fruits are used as vegetable and extensively used in various culinary preparations. Brinjal has got much potential as raw material in pickle making and dehydration Industries. It is highly productive and usually finds its place as the poor man's vegetable. Some medicinal uses of brinjal include treatment of diabetes, asthma, cholera, and bronchitis. The national share of brinjal in overall total production of vegetable is 8.3% during 2012-2013. In India overall ranking wise production of brinjal, West Bengal possesses the top rank from the production of 2.97 m. tones and 1.61 m. ha. followed by Odisha and Andhra Pradesh. The brinjal crop is attacked by about 140 species of insect pests Dwivedi *et al*., 2014 [2]. BSFB, L. orbonalis (Lepidopetra: Pyralidae) is the key pest throughout Asia Purohit and Khatri, 1973 [6]; Kuppuswamy and Balasubramanian, 1980 [3]; Allam *et al*., 2003 [1]. In India, this pest has a countrywide distribution and has been categorized as the most destructive and most serious pest causing huge losses in brinjal Patil, 1990 [5].

Materials and Methods
Studies on management of brinjal shoot and fruit borer *Leucinodes orbonalis* Guenee. In brinjal (*Solanum melongena* L.) were conducted at Student's Instructional Farm, C.S.A.

University of Agriculture and Technology, Kanpur (U.P.) during 2014-15. Thirty days old nursery of Azad B-3 and Type-3 was planted in Factorial randomized block design with 20 treatments and 3 replications. The plot size for each treatment was 3.0m x 3.6m and the spacing between rows and plants was maintained 60 cm x 60 cm respectively. In case of T_1 to T_{10} required amount of formulations was measured, dissolved in required amount of water and sprayed in the evening hours at the rate of 400 litre solution/ha with the help of Pneumatic Knapsack Sprayer fitted with flat cone nozzle as and when the shoot/fruit damage reached/crossed 5% in any one of treatments. Shoot damage was recorded at 15 days interval on each plot and percent Shoot damage was computed. Number and weight of healthy and damaged fruits of whole plot except one border row was recorded separately at each picking percent shoot and fruit damage was calculated from the data thus obtained and transformed into square root. The experiment was carried out with 20 treatments on untreated control each replication. The first spray of each treatment was applied after 30 day of transplanting and repeated four time having 15 day interval. Observation was recorded on healthy and infested shoot and fruit selected in each plot on 15 days interval after each spray. However, the performance of each treatment against fruit borer assessed by recording the number of infested and healthy shoot/fruit from 5 randomly selected plant at each picking.

Results and Discussion

Evaluation of several insecticides on the incidence of *L. orbonalis* in brinjal are presented in Table 1 to 4, the result revealed that all the treatments were significantly effective in reducing the infestation of shoot and fruit borer and increasing the yield significantly as compared to control. The first spray was given after 30 days of transplanting and data was recorded 15 days after spraying was presented in Table-1. The minimum shoot damage (10.20 percent) was recorded in the plots treated with imidacloprid 17.8 SL @ 0.02% followed by imidacloprid 17.8 SL @ 0.015% (12.50 percent) and the efficacy was better than other treatments. The next in order of effectiveness of treatment were Nimbicidine 300 ppm 0.5%, Nimbicidine 300 ppm 0.25%, Nimbicidine 300 ppm 0.15%, Cypermethrin 10 EC @ 0.05%, Cypermethrin 10 EC @ 0.01%, *Bacillus thuringiensis* @ 1kg/ha, *Bacillus thuringiensis* @ 0.75kg/ha, and in which 14.57, 16.47, 17.45, 17.67, 18.32, 19.20 and 20.07 percent shoot damage were recorded respectively. The maximum shoot damage (28.86 percent) was recorded in control plot. The maximum control treatment was Imidacloprid 17.8 SL @ 0.02% (64.65%) and *Bacillus thuringiensis* @ 0.75kg/ha is (30.45%) minimum was recorded in foliar sprays in standing crop. The second insecticidal spray was applied after 15 days of 1st spraying and data was presented in Table-2. A similar or decrease trends of efficacy of insecticide as in 1st application on reduction of shoot damage infestation was recorded. After 15 days of insecticide application all data were recorded and all the treatments were found significantly superior over control The minimum shoot damage (08.51 percent) was recorded in the plots treated with imidacloprid 17.8 SL @ 0.02% followed by imidacloprid 17.8 SL @ 0.015% (10.43 percent). The next in order of effectiveness of treatment were Nimbicidine 300 ppm 0.5%, Nimbicidine 300 ppm 0.25%, Nimbicidine 300 ppm 0.15%, Cypermethrin 10 EC @ 0.05%, Cypermethrin 10 EC @ 0.01% and *Bacillus thuringiensis* @ 1 kg/ha, *Bacillus thuringiensis* @ 0.75kg/ha in which 12.17, 13.75, 14.57, 14.76, 15.30, 16.03 and 16.76 percent shoot damage were recorded respectively. The maximum shoot damage (24.09 percent) was recorded in control plot. The maximum control treatment was Imidacloprid 17.8 SL @ 0.02% is 64.67% and *Bacillus thuringiensis* @ 0.75kg/ha minimum (30.42%) was recorded in foliar sprays in standing crop. Imidacloprid may be recommended for effective management of brinjal shoot and fruit borer *L. orbonalis* suggested by Singh *et al*, 2015 [7]**.** Third spray was applied for fruit borer infestation after 15 days of second spraying the related data presented in Table-3. The data was recorded after 15 days of spraying of insecticide and it indicated that all insecticide was found effective and significantly superior over control. Among all the treatment imidacloprid 17.8 SL @ 0.02%, followed by imidacloprid 17.8 SL @ 0.015% (09.50, 11.65 percent) and the efficacy was better than other treatments. The next in order of effectiveness of treatment were Nimbicidine 300 ppm 0.5%, Nimbicidine 300 ppm 0.25%, Nimbicidine 300 ppm 0.15%, Cypermethrin 10 EC @ 0.05%, Cypermethrin 10 EC @ 0.01% and *Bacillus thuringiensis* @ 1kg/ha, *Bacillus thuringiensis* @ 0.25kg/ha in which 13.58, 15.35, 16.26, 16.47, 17.07, 17.90 and 18.71 percent fruit damage were recorded respectively. The maximum fruit damage (26.89 percent) was recorded in control plot. The maximum control treatment was Imidacloprid 17.8 SL @ 0.02% is 64.67% and minimum *Bacillus thuringiensis* @ 0.75kg/ha (30.42%) was recorded in foliar sprays in standing crop. Fourth spray was applied after 15 days of third spray and data was recorded after 15 days of spraying of insecticide and it indicated that all insecticide was found effective and significantly superior over control. Among all the treatment imidacloprid 17.8 SL @ 0.02% followed by imidacloprid 17.8 SL @ 0.15% (8.08, 09.90 percent) and the efficacy was better than other treatments. The next in order of effectiveness of treatment were Nimbicidine 300 ppm 0.5%, Nimbicidine 300 ppm 0.25%, Nimbicidine 300 ppm 0.15%, Cypermethrin 10 EC @ 0.05% Cypermethrin 10 EC @ 0.01% and *Bacillus thuringiensis* @ 1kg/ha, *Bacillus thuringiensis* @ 0.75kg/ha in which 11.54, 13.04, 13.82, 14.00, 14.51, 15.26 and 15.90 percent fruit damage were recorded respectively. The maximum fruit damage (23.27 percent) was recorded in control plot. The maximum control treatment was Imidacloprid 17.8 SL @ 0.02% is 65.27% and minimum *Bacillus thuringiensis* @ 0.75kg/ha (31.67%) was recorded in foliar sprays in standing crop. The results obtained are in close agreement with Dwivedi *et al.*, 2014 [2] studied on brinjal shoot and fruit borer, *Leucinodes orbonalis*. During this investigation six insecticides were evaluated under field conditions. Regarding the efficacy of insecticides Imidacloprid 17.8 SL @ 250 g a.i./ha proved most effective which was closely followed by Indoxacarb 14.5 SC @ 50 g a.i./ha and Dimethoate 30 EC @ 1 lit/ha.

Table 1: Evaluation of Several Insecticides on shoot damage caused by *Leucinodes orbonalis* G. after 1st spraying

S.N	Common Name	Dose	% Shoot damage (V1)	% Shoot damage (V2)	Total mean	% shoot damage Over control
			Mean	Mean		
1.	Imidacloprid 17.8 SL	0.02%	9.15	11.25	10.20	64.65
2.	Imidacloprid 17.8 SL	0.015%	11.75	13.25	12.50	56.68
3.	Nimbicidine 300 ppm	0.5%	13.65	15.50	14.57	49.51
4.	Nimbicidine 300 ppm	0.25%	15.80	17.15	16.47	42.93
5.	Nimbicidine 300 ppm	0.15%	16.65	18.25	17.45	39.53
6.	Cypermethrin 10 EC	0.05%	16.90	18.45	17.67	38.77
7.	Cypermethrin 10 EC	0.01%	17.75	18.90	18.32	36.52
8.	*Bacillus thuringiensis*	1kg/ha	18.45	19.95	19.20	33.47
9.	*Bacillus thuringiensis*	0.75kg/ha	15.70	20.45	20.07	30.45
10.	Control	-	27.85	29.88	28.86	-
	C.D at 5%		1.076	2.406	N.S	
	S.E(d)		0.531	1.188	1.680	

Table 2: Evaluation of Several Insecticides on shoot damage caused by *Leucinodes orbonalis* G. after 2nd spraying

S.N	Common Name	Dose	% Shoot damage (V1)	% Shoot damage (V2)	Total mean	% shoot damage Over control
			Mean	Mean		
1.	Imidacloprid 17.8 SL	0.02%	7.64	9.39	8.51	64.67
2.	Imidacloprid 17.8 SL	0.015%	9.81	11.06	10.43	56.70
3.	Nimbicidine 300 ppm	0.5%	11.40	12.95	12.17	49.48
4.	Nimbicidine 300 ppm	0.25%	13.19	14.32	13.75	42.92
5.	Nimbicidine 300 ppm	0.15%	13.90	15.24	14.57	39.51
6.	Cypermethrin 10 EC	0.05%	14.11	15.41	14.76	38.72
7.	Cypermethrin 10 EC	0.01%	14.82	15.78	15.30	36.48
8.	*Bacillus thuringiensis*	1kg/ha	15.41	16.66	16.03	33.45
9.	*Bacillus thuringiensis*	0.75kg/ha	16.45	17.08	16.76	30.42
10.	Control	-	23.25	24.94	24.09	
	C.D at 5%		0.959	2.145	N.S	
	S.E(d)		0.474	1.060	1.460	

Table 3: Evaluation of Several Insecticides on fruit damage caused by *Leucinodes orbonalis* G. after 3rd spraying

S.N	Common Name	Dose	% fruit damage (V1)	%fruit Damage (V2)	Total Mean	% fruit damage Over control
			Mean	Mean		
1.	Imidacloprid 17.8 SL	0.02%	8.53	10.48	9.50	64.67
2.	Imidacloprid 17.8 SL	0.015%	10.95	12.35	11.65	56.67
3.	Nimbicidine 300 ppm	0.5%	12.75	14.45	13.58	49.49
4.	Nimbicidine 300 ppm	0.25%	14.72	15.98	15.35	42.91
5.	Nimbicidine 300 ppm	0.15%	15.52	17.01	16.26	39.53
6.	Cypermethrin 10 EC	0.05%	15.75	17.20	16.47	38.75
7.	Cypermethrin 10 EC	0.01%	16.54	17.61	17.07	36.51
8.	*Bacillus thuringiensis*	1kg/ha	17.20	18.60	17.90	33.43
9.	*Bacillus thuringiensis*	0.75kg/ha	18.36	19.06	18.71	30.42
10.	Control	-	25.95	27.84	26.89	----
	C.D at 5%		1.120	2.504	N.S	
	S.E(d)		0.553	1.237	1.749	

Table 4: Evaluation of Several Insecticides on fruit damage caused by *Leucinodes orbonalis* G. after 4th spraying

S.N	Common Name	Dose	% Fruit damage (V1)	% Fruit damage (V2)	Total Mean	% shoot damage Over control
			Mean	Mean		
1.	Imidacloprid 17.8 SL	0.02%	7.25	8.91	8.08	65.27
2.	Imidacloprid 17.8 SL	0.015%	9.31	10.50	9.90	57.45
3.	Nimbicidine 300 ppm	0.5%	10.81	12.28	11.54	50.79
4.	Nimbicidine 300 ppm	0.25%	12.51	13.58	13.04	43.96
5.	Nimbicidine 300 ppm	0.15%	13.19	14.46	13.82	40.61
6.	Cypermethrin 10 EC	0.05%	13.38	14.62	14.00	39.83
7.	Cypermethrin 10 EC	0.01%	14.06	14.97	14.51	37.64
8.	*Bacillus thuringiensis*	1kg/ha	14.72	15.81	15.26	34.42
9.	*Bacillus thuringiensis*	0.75kg/ha	15.60	16.20	15.90	31.67
10.	Control	-	22.05	24.50	23.27	
	C.D at 5%		0.887	1.983	N.S	
	S.E(d)		0.438	0.979	1.385	

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