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Bioefficacy of insecticides against *Leucinodes orbonalis* on brinjal

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Abstract: *Studies on bioefficacy of insecticides against brinjal shoot and fruit borer, Leucinodes orbonalis Guenee on brinjal were carried out during 2007 and 2008. The results on bioefficacy of insecticides showed that in terms of shoot infestation, emamectin benzoate (0.002%), endosulfan (0.05%), novaluron (0.01%) and lambda-cyhalothrin (0.004%) were found superior. The total number of drooping shoots was minimum (4.17) in emamectin benzoate followed by endosulfan (6.83) and novaluron (7.00), as compared to spinosad (9.17), deltamethrin (11.67) and Bacillus thuringiensis (13.17). In terms of reduction in fruit infestation, emamectin benzoate (0.002%) was highly effective followed by endosulfan (0.05%), agrospray oil T (0.2%) and spinosad (0.0024%). However, cost benefit ratio was highest in agrospray oil T (0.2%) followed by lambda-cyhalothrin (0.004%), endosulfan (0.05%) and deltamethrin (0.0028%).*

Key words: *Bioefficacy, Insecticides, Leucinodes orbonalis, Brinjal*
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Introduction

Brinjal (*Solanum melongena* L.) is one of the most popular and economically important vegetables among small-scale farmers and low-income consumers of South Asia and this region accounts for nearly 60 and 53% of world's area and production, respectively. It is grown in almost all states of India with an area of 5.10 lakh hectares under cultivation and production of 88.0 lakh tonnes (Singhal, 2003). In Himachal Pradesh, the crop is grown in an area of 903 hectares with a production of 17,564 metric tonnes (Anonymous, 2008).

Brinjal is attacked by plethora of insect and mite pests starting from seedling stage to senescence. A survey carried out by the Asian Vegetable Research and Development Centre (AVRDC, 1995) indicated that the shoot and fruit borer, *Leucinodes orbonalis* Guenee, cotton leaf hopper, *Amrasca biguttula biguttula* Ishida and epilachna beetle, *Henosepilachna* (*Epilachna*) *vigintioctopunctata* Fabricius are the destructive pests on brinjal in Asia. Independently, in the entire South Asian region the shoot and fruit borer was identified as the primary limiting factor in brinjal production. Occasionally, brinjal is severely infested by mites, *Tetranychus* sp., aphids, *Aphis gossypii* Glover and whiteflies including *Bemisia tabaci* Guenee and *Trialeurodes* sp. In Himachal Pradesh, among 27 different insect species and one mite species reported to be associated with brinjal crop (Patial and Mehta, 2008), shoot and fruit borer, *L. orbonalis* (Lepidoptera: Pyralidae) is the key pest throughout Asia (Purohit and Khatri, 1973; Kuppuswamy and Balasubramanian, 1980; Allam *et al.,* 1982). 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). The larvae bore into tender shoots in the early stage resulting in drooping shoots, which are readily visible in the infested fields. At the later stage, caterpillars bore into flower buds and fruits, rendering the fruits unfit for consumption and marketing, resulting in direct yield losses. The pest has been reported to inflict losses to the tune of 20.7-60.0% in Tamil Nadu (Raja *et al.,* 1999), 70% in Andhra Pradesh (Sasikala *et al.,* 1999), 80% in Gujarat (Jhala *et al.,* 2003) and 41% in Himachal Pradesh (Lal *et al.,* 1976).

The insecticides have been used extensively for the control of these insect-pests for want of natural enemy complex. At present, repeated applications of synthetic pyrethroids are made for the control of *L. orbonalis* and their indiscriminate use has led to the resurgence of whitefly, aphid and mite. For the control of shoot and fruit borer, endosulfan (0.05%) and fenvalerate (0.01%) have been recommended in the state of Himachal Pradesh (Anonymous, 2003). The present investigation was, therefore, planned to evaluate some alternate insecticides against shoot and fruit borer on brinjal under field conditions.

Materials and Methods

The present investigation was conducted at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India (latitude 32.6°N, longitude 76.3°E, altitude 1290.8 m a.s.l.). The average maximum and minimum temperatures during the course of investigation were 24.8 and 19.4°C, with relative humidity of 84% and a total rainfall of 425 mm.

The trials were laid out during the year 2007 and 2008 in a randomized block design having plot size of 6.75 m^2 at experimental farm of the department. The seedlings were transplanted on 30th April 2007 and on 5th May 2008. Brinjal variety, Arka Nidhi was raised as per recommended package of practices (Anonymous, 2003), except insect-pest management practices. Bioefficacy of eight insecticidal treatments comprising biopesticides- *Bacillus thuringiensis* var. *kurstaki* (Halt 5 WP), spinosad (Success 2.5 SC) and emamectin benzoate (Proclaim 5 SG), chitin synthesis inhibitor- novaluron

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(Rimon 10 EC), cyclodiene insecticide- endosulfan (Thiodan 35 EC), petroleum oil- Agrospray oil T (Agrospray oil T) and synthetic pyrethroids- deltamethrin (Decis 2.8 EC) and lambda-cyhalothrin (Xylo 5 EC) was determined during both the years and each treatment was replicated thrice. Two sprays of each insecticide were applied with the help of knapsack sprayer upto the point of runoff at fortnightly intervals starting from the fruit initiation. The application of insecticides was given on 6th and 21st July in 2007, while it was made on 8th and 23rd July in 2008. Observations on the total number of drooping shoots and larvae observed per plot, percent shoot infestation from five randomly selected plants and percent fruit infestation by *L. orbonalis* on weight basis per plot were recorded at one day before first spray and seven and 14 days after each spray. Cost of brinjal fruits = Rs 700/q; no. of labours required per spray/ha = 2; labour charges = Rs 100/day, Cost of insecticides: endosulfan @ Rs 137.00/500ml, deltamethrin @ Rs 244.80/500ml, lambda-cyhalothrin @ Rs 290.00/500ml, novaluron @ Rs 1875.00/500ml, spinosad @ Rs 725.00/500ml, agrospray oil T @ Rs 63.50/500ml, emamectin benzoate @ Rs 4875.00/500g, *B. thuringiensis* @ Rs 300.00/500g, #On the basis of cost of protection.

Data obtained were subjected to analysis of variance (ANOVA) after transformation of data through CPCS-I software and as per the procedure suggested by Gomez and Gomez (1984).

Results and Discussion

Data presented in Table 1 on shoot infestation revealed that percent mean shoot infestation in different treatments varied from 0.56 to 4.77. However, data on number of drooping shoots and larvae observed given in Table 2 revealed that the total number of drooping shoots and larvae observed in different treatments varied from 4.17 to 34.00 and 3.17 to 29.50, respectively. The percent mean shoot infestation, total number of drooping shoots and larvae observed were minimum (0.56, 4.17 and 3.17, respectively) in emamectin benzoate followed by endosulfan (0.87, 6.83 and 5.17, respectively) and novaluron (0.96, 7.00 and 5.83, respectively). All the insecticidal treatments were significantly superior over untreated check. The present observations on the effectiveness of emamectin benzoate are in conformity with those of Kumar and Devappa (2006) in brinjal against *L. orbonalis*, Kanna *et al.* (2005) in tomato against *H. armigera* and Bheemanna *et al.* (2005) in cotton against cotton bollworm complex. Singh *et al.* (1996), Sharma and Chhibber (1999) and Reddy and Srinivasa (2005) reported

Table - 1: Effect of different insecticides on shoot infestation by *Leucinodes orbonalis* (pooled data of two years)

Treatments	Concentration (%)	Percent shoot infestation days after spray					
		1 DBS	First spray		Second spray		Mean
			7 DAS	14 DAS	7 DAS	14 DAS	
Agrospray oil T	0.2	4.55	0.41 (1.14)	1.93 (1.65)	0.57 (1.18)	1.71 (1.59)	1.16 (1.39)
Bacillus thuringiensis	0.2	6.24	3.04 (2.01)	1.21 (1.38)	1.30 (1.45)	1.73 (1.60)	1.82 (1.61)
Deltamethrin	0.0028	4.59	2.47 (1.82)	1.81 (1.56)	0.98 (1.33)	1.20 (1.42)	1.62 (1.53)
Emamectin benzoate	0.002	6.48	0.42 (1.15)	0.96 (1.32)	0.00 (1.00)	0.86 (1.30)	0.56 (1.19)
Endosulfan	0.05	4.73	0.60 (1.19)	0.88 (1.30)	0.83 (1.29)	1.16 (1.41)	0.87 (1.30)
Lambda-cyhalothrin	0.004	3.74	1.48 (1.49)	1.32 (1.45)	1.38 (1.41)	0.34 (1.12)	1.13 (1.37)
Novaluron	0.01	2.60	0.94 (1.32)	0.39 (1.14)	1.72 (1.59)	0.79 (1.28)	0.96 (1.33)
Spinosad	0.0024	5.01	0.95 (1.32)	2.82 (1.95)	0.34 (1.12)	0.89 (1.30)	1.25 (1.42)
Untreated check	-	5.54	6.54 (2.73)	5.40 (2.49)	3.84 (2.19)	3.28 (2.05)	4.77 (2.36)
Mean		4.83	1.87 (1.63)	1.86 (1.65)	1.22 (1.45)	1.33 (1.51)	

Figures in the parentheses are transformed values, 1DBS = One day before spray; DAS = Days after spray, CD (p=0.05)
Treatments = 0.27, Spray application (first and second) = 0.13, Observation period (7 DAS and 14 DAS) = NS

Table - 2: Effect of different insecticides on extent of wilting by *Leucinodes orbonalis* and its larval density (pooled data of two years)

Treatments	Concentration (%)	No. of drooping shoots/plot	No. of larvae observed/plot
Agrospray oil T	0.2	7.83 (2.96)	6.33 (2.70)
Bacillus thuringiensis	0.2	13.17 (3.73)	11.33 (3.48)
Deltamethrin	0.0028	11.17 (3.39)	9.67 (3.15)
Emamectin benzoate	0.002	4.17 (2.21)	3.17 (1.99)
Endosulfan	0.05	6.83 (2.68)	5.17 (2.38)
Lambda-cyhalothrin	0.004	8.00 (2.90)	6.67 (2.69)
Novaluron	0.01	7.00 (2.68)	5.83 (2.48)
Spinosad	0.0024	9.17 (3.15)	7.50 (2.89)
Untreated check	-	34.00 (5.91)	29.50 (5.51)
CD (p=0.05)		(0.88)	(0.80)

*Mean of three replications, Figures in the parentheses are transformed values, CD (p=0.05)

Table - 1: Effect of different insecticides on fruit infestation (weight basis) by *Leucinodes orbonalis* (pooled data of two years)

Treatments	Concentration (%)	Percent shoot infestation days after spray					
		1 DBS	First spray		Second spray		Mean
			7 DAS	14 DAS	7 DAS	14 DAS	
Agrospray oil T	0.2	2.63	10.17 (18.27)	24.95 (29.56)	16.00 (23.03)	31.31 (33.73)	20.61 (26.15)
Bacillus thuringiensis	0.2	1.28	14.61 (22.36)	31.23 (33.81)	22.10 (27.70)	41.10 (39.80)	27.26 (30.91)
Deltamethrin	0.0028	0.00	15.35 (22.76)	35.33 (36.31)	32.16 (34.30)	42.22 (40.45)	31.26 (33.46)
Emamectin benzoate	0.002	10.42	7.83 (16.10)	20.50 (26.39)	10.94 (19.01)	27.04 (31.27)	16.58 (23.19)
Endosulfan	0.05	10.48	10.77 (18.88)	26.10 (30.27)	13.51 (21.53)	31.29 (33.81)	20.42 (26.12)
Lambda-cyhalothrin	0.004	1.96	13.60 (21.46)	31.60 (34.04)	22.63 (28.13)	44.94 (42.06)	28.19 (31.42)
Novaluron	0.01	0.00	9.60 (16.51)	26.48 (30.61)	22.56 (28.22)	35.22 (36.33)	23.46 (27.92)
Spinosad	0.0024	0.00	12.41 (20.25)	27.99 (31.78)	17.60 (24.43)	35.42 (36.49)	23.35 (28.24)
Untreated check	-	3.33	27.92 (31.63)	48.08 (43.87)	52.48 (46.41)	54.61 (47.67)	45.77 (42.39)
Mean		3.34	13.59 (21.30)	30.25 (32.22)	23.33 (28.33)	38.13 (38.03)	

Figures in the parentheses are transformed values, 1DBS = One day before spray; DAS = Days after spray, CD (p=0.05)
Treatments = 0.27, Spray application (first and second) = 0.13, Observation period (7 DAS and 14 DAS) = NS

Table - 4: Economics of different insecticides in brinjal (mean of two years)

Treatments	Concentration (%)	Total yield (q ha^{-1})	Marketable yield (q ha^{-1})	Increase in yield over untreated check (%)	Net profit (Rs)#	Cost benefit ratio (C:B)#
Agrospray oil T	0.2	81.98	69.26	56.68	47827.48	1:73.13
Bacillus thuringiensis	0.2	77.64	62.53	52.02	42171.60	1:26.36
Deltamethrin	0.0028	67.61	49.32	39.17	33635.09	1:37.81
Emamectin benzoate	0.002	63.13	51.54	41.80	31780.25	1:7.39
Endosulfan	0.05	65.60	50.80	40.95	34777.73	1:44.36
Lambda-cyhalothrin	0.004	72.01	56.05	46.48	38370.57	1:44.41
Novaluron	0.01	69.73	56.23	46.65	35214.20	1:8.49
Spinosad	0.0024	74.53	61.60	51.30	41273.46	1:22.31
Untreated check	-	53.43	30.00	-	21000.00	-

that endosulfan was found effective in reducing shoot infestation by *L. orbonalis*, which also corroborate the present results of endosulfan. The effectiveness of novaluron is also similar to those of Chatterjee and Roy (2004) and Sawant *et al.* (2004). However, Rajavel *et al.* (1989) reported that spray of lambda-cyhalothrin (31.5 to 50.0 ppm) and deltamethrin (20.0 ppm) provided complete control of *L. orbonalis,* which is contrary to the present findings. This could be due to different climatic conditions and timing and number of insecticidal applications.

Data pertaining to fruit infestation presented in Table 3 indicated that mean per cent fruit infestation varied from 16.58 to 45.77%. The mean fruit infestation was minimum (16.58%) in emamectin benzoate followed by endosulfan (20.42%) and agrospray oil T (20.61%). However, fruit infestation was maximum (31.26%) in deltamethrin followed by lambda-cyhalothrin (28.19%) and *B. thuringiensis* (27.26%). Spinosad and novaluron registered moderate (23.35 and 23.46%, respectively) mean fruit infestation. On the basis of mean fruit infestation, all the insecticidal treatments were significantly superior over untreated check, whereas emamectin benzoate was significantly superior.

The efficacy of emamectin benzoate in the present study is substantially supported by the findings of Kumar and Devappa (2006), who reported that application of Proclaim 5 SG @ 200 g a.i. ha^{-1} was found effective in reducing fruit damage by *L. orbonalis* in brinjal. Bharadiya and Patel (2005) and Reddy and Srinivasa (2005) observed endosulfan an effective insecticide against *L. orbonalis* in brinjal, which support the present findings on endosulfan in reducing fruit infestation. Agrospray oil T was found effective in the present investigations. This could be due to its desiccation effect on eggs and behaviour modifying properties. Similar effects of neem oil in reducing fruit borer damage in brinjal were observed by Raja *et al.* (1999). The present findings on the effectiveness of spinosad are in conformity with those of Sinha and Sharma (2008).

Economics of different insecticides: The data in terms of economics of different insecticides presented in Table 4 indicated that all the insecticidal treatments recorded increase in marketable yield over untreated check. Agrospray oil T recorded highest marketable yield (69.26 q ha^{-1}), increase in marketable yield (56.68%) and net profit (Rs. 47827.48). The cost benefit ratio calculated on the basis of cost of protection for different insecticidal treatments revealed that agrospray oil T was found superior as it recorded a profit of Rs. 73.13 per rupee invested followed by lambda-cyhalothrin (1:44.41) and endosulfan (1:44.36). Patnaik and Singh (1997) reported that spraying of endosulfan and fenvalerate resulted in highest cost benefit ratio of 1:40.3, which also corroborates the present observations on cost benefit ratio for endosulfan.

Thus, the present studies suggested that emamectin benzoate (0.002%), endosulfan (0.05%), agrospray oil T (0.2%) and spinosad (0.0024%) were superior in reducing the fruit infestation by *Leucinodes orbonalis*, however, on the basis of cost benefit ratio, agrospray oil T (0.2%), lambda-cyhalothrin (0.004%), endosulfan (0.05%) and deltamethrin (0.0028%) were superior.

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