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Bio – efficacy of some newer insecticides against brinjal shoot and fruit borer *Leucinodesorbonalis* (Guen.)

Surya Prakash Gupta and SP Singh

Abstract
Bio-efficacy of six newer insecticides – emamectin benzoate (15 g a.i. ha^{-1}), imidacloprid (20 g a.i. ha^{-1}), indoxacarb (50 g a.i. ha^{-1}), lambda – cyhalothrin (15 g a.i. ha^{-1}) and spinosad (50 g a.i. ha^{-1}) along with quinalphos (250 g a.i. ha^{-1}) was evaluated against shoot and fruit borer (*Leucinodesorbonalis* Guen.) in brinjal (*Solanummelongena* Linn) at Rajendra Agricultural University, Pusa, Bihar during *Rabi* 2012-13. Spinosad treatment was significantly superior to others and at par with emamectin benzoate in reducing the shoot and fruit borer damage. Spinosad at 50 g a.i. ha^{-1} recorded the maximum fruit yield (280.42 q ha^{-1}). It was followed by emamectin benzoate at15 g a.i. ha^{-1} (267.74 q ha^{-1}) and indoxacarb at 50 g a.i. ha^{-1} (262.58 q ha^{-1}). Lambda - cyhalothrin 15 g a.i. ha^{-1} treatment recorded maximum cost: benefit ratio of 1: 4.23 closely followed by imidacloprid 20 g and quinalphos 250 g a.i. ha^{-1} with ICBR of 1: 3.71 and 1: 3.43, respectively.

Keywords: Bio-efficacy, Emamectin benzoate, Imidacloprid, Indoxacarb, lambda-cyhalohrin, qinalphos, Spinosad, Brinjal

Introduction

Brinjal or egg plant, *Solanummelongena*, is one of the important vegetable crops grown as commercial and kitchen garden in India. Brinjal like many other vegetable crops is vulnerable to attack by a number of insect and non – insect pests which directly or indirectly inflict serious damage right from nursery and continue till the crop remains in the field and thus cause appreciable loss in fruit yield. No less than 140 species of insect pests have been reported to cause damage to brinjal in India (Frempong and Buahin 1978) [2]. Among all these insect pests, the most serious and destructive one is the shoot and fruit borer, *Leucinodesorbonalis* Guen. (Ghosh *et al*., 2003) [3]. It is a regular and most serious pest and a single caterpillar may infest 4 – 6 fruits. The attacked tender shoot dry up while the flowers and developing fruit fall prematurely and the damaged fruit become unfit for human consumption. Several insecticides have been evaluated and reported to be effective for the control of this pest but frequent and enormous use of insecticides possessed the problem of resistance to the pest. Therefore, there is a need to replace these insecticides with newer chemicals with lesser dose of few grams per hectare maintaining high toxicity to insect pests. The present studies were conducted to evaluate the efficacy of some newer insecticides against shoot and fruit borer, *L.orbonalis* (Guen.) on brinjal to replace the old ones in order to combat the resistance problem.

Materials and methods

A field experiment was laid out in a randomized block design with 7 treatments and 3 replications at the University farm of Rajendra Agricultural University, Pusa during *Rabi* 2012 - 13. Brinjal cv. RajendraBaigan -2 was grown according to the recommended package of practices for this region. The size of each plot was 3.75 x 3.60 m^2. The distance from row to row and plant to plant was 75 and 60 cm, respectively. The treatments were emamectin benzoate @ 15 g a.i. ha^{-1} (T_1), imidacloprid @ 20 g a.i. ha^{-1} (T_2), indoxacarb @ 50 g a.i. ha^{-1} (T_3), lambda – cyhalothrin @ 15 g a.i. ha^{-1} (T_4), spinosad @ 50 g a.i. ha^{-1} (T_5), quinalphos @ 250 g a.i. ha^{-1} (T_6) and a control (T_7). The insecticides were sprayed thrice, first just after the appearance of insect pests and the second and third thereafter at 15 days interval with a Knapsack sprayer. For evaluating the effectiveness of insecticides against shoot and fruit borer, damaged shoots were counted in each plot after 7 and 14 days after each spray and the per cent shoot damage was computed on the basis of number of infested shoots out of total number of shoots per plot in each observation. Fruit damage was recorded at each picking from each plot. Per cent fruit damage was worked out on the basis of weight of infested fruits out of total weight of harvested fruits. Average of all the pickings after each spray was worked out. The data so obtained were transformed to angular values and analyzed statistically.

Weight of healthy fruits was recorded after each picking per plot. The cumulative yield data of each treatment was worked out and analyzed statistically. Economics of the insecticidal applications was calculated in context of the applicability and suitability of individual insecticidal treatment. The net income was deduced by taking the difference between the gross income obtained by selling the produce at the market price and cost of insecticidal application. The benefit - cost ratio was calculated by dividing the additional income over control to the additional cost incurred for pest control.

Results and discussion

Effect on shoot damage: The results (Table 1) indicated that all the insecticides recorded reasonably less shoot and fruit damage due to *L.orbonalis* in brinjal in comparison to untreated control and the treatment differences were significant. Before the application of insecticides the mean shoot infestation varied from6.72 to 8.10 per cent in the plots. The minimum shoot damage was found in spinosad treatment @ 50 g a.i. ha^{-1}. It was followed by emamectin benzoate treatment at 15 g which was at par with indoxacarb at 50 g a.i. $ha^{-1}$and significantly superior to rest of the treatments.

Effect on fruit damage: The results on the effect of insecticidal treatments on per cent fruit damage by *L.orbonalis* in brinjal are presented in Table 2. The data showed that all the insecticidal treatments were significantly superior to untreated control in reducing the fruit damage which ranged from as minimum in spinosad 50 g a.i. ha^{-1} treatment and 22.86 – 36.94% as maximum in untreated control in all the sprays. Imidacloprid at 20 g a.i. ha^{-1} treatment was relatively less effective in reducing the fruit borer damage in brinjal.

The results of the effectiveness of insecticides and their doses on shoot and fruit damage by *L.orbonalis* in brinjal suggested that all the insecticides recorded reasonably less damage in comparison to untreated control and treatment differences were significant. Spinosad at 50 g a.i. ha^{-1} recorded lowest infestation and was at par with emamectin benzoate at 15 g a.i. ha^{-1}. The next best treatments were indoxacarb 50 g and quinalphos 250 g a.i. ha^{-1}. Lambda - cyhalothrin 15 g and imidacloprid 20 g a.i. ha^{-1} treatments were relatively less effective. Thus, it is evident from the present investigation that spinosad treatment at 50 g a.i. ha^{-1} was most effective against shoot and fruit borer. Emamectin benzoate and indoxacarb treatments also provided good protection against this insect pest. The present findings are in agreement to the report of Patra *et al*. (2009) [5] who evaluated the bio-efficacy of emamectin benzoate, spinosad, and indoxacarbalongwith other insecticides against *L.orbonalis* in brinjal and found lowest shoot as well as fruit infestation in the plots treated with spinosad (50 g a.i. ha^{-1}) followed by indoxacarb (50 g a.i. ha^{-1}) and emamectin benzoate (15 g a.i. ha^{-1}), respectively. Shah *et al*. (2012) [7] also reported emamectin benzoate, indoxacarb and spinosad as the effective treatments for controlling brinjal shoot and fruit borer damage. Anil and Sharma (2010) [1] reported emamectin benzoate and spinosad as the most effective treatments against brinjal shoot and fruit borer. Sinha *et al*. (2010) [8] reported indoxacarb as the effective treatment for controlling brinjal shoot and fruit borer. In addition, the reports of Stanely *et al*. (2007) [9] and Mathirajan *et al*. (2000) [4] are in conformity to the results of present investigation.

Effect on yield: Spinosad treatment at 50 g a.i. ha^{-1} recorded the maximum fruit yield (280.42 q ha^{-1}) in brinjal. It was followed by emamectin benzoate treatment (267.74 q ha^{-1}) which was at par with indoxacarb 50 g a.i. ha^{-1}. Imidacloprid @ 20 g a.i. ha^{-1} recorded minimum yield (228.21 q ha^{-1}). The increase in yield varied from a maximum of 84.52 q ha^{-1} in spinosad (50 g a.i. ha^{-1}) to a minimum of 32.31 q ha^{-1} in imidacloprid (20 g a.i. ha^{-1}) showing a corresponding increase of 43.14 and 16.49 per cent.

Economics: Maximum net benefit was obtained with spinosad (Rs 16220) followed by indoxacarb (Rs. 12633) and emamectin benzoate (Rs 10595). In terms of incremental cost – benefit ratio (ICBR), lambda – cyhalothrin treatment at 15 g a.i. ha^{-1} recorded maximum cost – benefit ratio of 1: 4.23 as compared to other treatments. It was closely followed by imidacloprid 20 g and quinalphos at 250 g a.i. ha^{-1} treatments with ICBR of 1: 3.71 and 1: 3.03, respectively.

Table 1: Effect of insecticides on percent shoot damage in brinjal after first spray

Insecticide	Dose ($g.i.ha^{-1}$)	Per cent shoot damage											
		Pre - spray				7th Day after I spray				14th Day after I spray			
		R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean
Emamectin benzoate	15	7.66	6.85	6.92	7.14 (15.49)	5.56	4.68	6.04	5.43 (13.44)	4.10	3.72	5.20	4.34 (11.98)
Imidacloprid	20	7.26	6.45	7.43	7.05 (15.38)	6.61	5.44	6.38	6.14 14.33)	4.83	5.10	5.85	5.26 (13.24)
Indoxacarb	50	8.27	6.63	7.18	7.36 (15.71)	6.70	5.27	5.63	5.87 (13.99)	5.00	4.26	4.80	4.69 (12.49)
Lambda - cyhalothrin	15	9.30	8.04	7.67	8.34 (16.76)	6.83	7.45	6.90	7.06 (15.39)	5.47	6.12	5.93	5.84 (13.97)
Spinosad	50	7.20	6.98	5.99	6.72 (15.01)	5.10	4.47	3.96	4.51 (12.24)	3.78	3.05	2.92	3.25 (10.36)
Quinalphos	250	6.50	7.78	8.07	7.45 (15.81)	5.97	7.01	7.14	6.71 (14.97)	5.27	5.58	6.25	5.70 (13.79)
Control		8.13	7.50	8.68	8.10 (15.80)	8.74	8.22	9.76	8.91 (17.34)	7.96	8.22	7.88	8.02 (16.44)
S.Em. (±) CD (P=0.05)					0.38 1.19 (1.30)				0.36 1.13 (1.34)				0.26 0.83 (1.13)

Figures in parenthesis are angular transformed values.

Table 2: Effect of insecticides on percent shoot damage in brinjal after second spray.

Insecticide	Dose (g a.i.ha⁻¹)	Per cent shoot damage							
		7th Day after II spray				14th Day after II spray			
		R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean
Emamectin benzoate	15	3.29	2.81	3.50	3.20 (10.29)	2.31	2.25	2.70	2.42 (8.93)
Imidacloprid	20	3.97	4.45	4.10	4.17 (11.77)	3.14	3.23	3.95	3.44 (10.67)
Indoxacarb	50	3.98	3.15	3.46	3.53 (10.81)	2.86	2.98	2.50	2.78 (9.58)
Lambda - cyhalothrin	15	4.18	5.04	4.34	4.52 (12.26)	3.96	3.71	4.64	4.10 (11.66)
Spinosad	50	2.43	2.26	1.85	2.18 (8.47)	1.30	0.86	0.98	1.05 (5.84)
Quinalphos	250	4.56	3.82	4.70	4.36 (12.03)	3.83	3.28	3.60	3.57 (10.88)
Control		6.90	7.84	7.28	7.34 (15.70)	5.63	6.25	6.57	6.15 (14.34)
S.Em. (±) CD (P=0.05)					0.24 0.76 (1.10)				0.19 0.59 (0.96)

Figures in parenthesis are angular transformed values.

Table 3: Effect of insecticides on percent shoot damage in brinjal after third spray

Insecticide	Dose (g a.i.ha⁻¹)	Per cent shoot damage							
		7th Day after III spray				14th Day after III spray			
		R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean
Emamectin benzoate	15	1.28	1.67	1.35	1.43 (6.86)	0.85	0.72	0.66	0.74 (4.93)
Imidacloprid	20	2.40	2.25	2.73	2.46 (9.01)	1.40	1.26	1.48	1.38 (6.73)
Indoxacarb	50	1.52	2.02	1.92	1.82 (7.73)	0.86	1.10	1.04	1.00 (5.72)
Lambda - cyhalothrin	15	2.24	1.95	2.15	2.11 (8.35)	1.30	1.08	1.22	1.20 (6.28)
Spinosad	50	0.60	0.47	0.86	0.64 (4.56)	0.18	0.21	0.36	0.25 (2.83)
Quinalphos	250	2.15	1.80	1.90	1.95 (8.01)	1.16	0.95	1.24	1.12 (6.05)
Control		5.00	4.58	4.41	4.66 (12.46)	4.48	4.26	3.95	4.23 (11.86)
S.Em. (±) CD (P=0.05)					0.139 0.43 (0.90)				0.087 0.27 (0.68)

Figures in parenthesis are angular transformed values.

Table 4: Effect of insecticides on percent fruit damage in brinjal

Insecticide	Dose (ga.i.ha⁻¹)	Per cent fruit damage after											
		I spray				II spray				III spray			
		R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean	R_1	R_2	R_3	Mean
Emamectin benzoate	15	15.60	14.82	12.71	14.38 (22.25)	12.41	14.10	11.60	12.70 (20.85)	16.78	18.26	14.48	16.51 (23.93)
Imidacloprid	20	17.17	18.60	20.19	18.65 (25.56)	15.78	17.64	19.16	17.53 (24.72)	25.45	26.24	22.30	24.66 (29.75)
Indoxacarb	50	15.49	13.16	12.08	13.58 (21.58)	13.12	11.86	14.65	13.21 (21.28)	19.63	17.18	16.70	17.84 (24.95)
Lambda - cyhalothrin	15	15.58	16.54	17.48	16.53 (23.97)	13.65	14.78	17.91	15.45 (23.10)	24.65	24.06	26.22	24.98 (29.96)
Spinosad	50	10.74	9.68	11.86	10.76 (19.13)	7.83	7.17	6.12	7.04 (15.36)	14.60	13.98	12.96	13.85 (21.83)
Quinalphos	250	14.61	17.34	15.35	15.77 (23.37)	17.76	16.12	18.49	17.46 24.67)	21.45	20.59	24.38	22.14 (28.04)
Control		22.48	21.27	24.82	22.86 (28.63)	25.9	26.98	28.57	27.15 (31.38)	38.24	37.28	35.30	36.94 (37.41)
S.Em. (±) CD (P=0.05)					0.87 2.70 (2.14)				0.79 2.45 (2.04)				0.94 2.90 (2.02)

Figures in parenthesis are angular transformed values.

Table 5: Effect of insecticides on the yield of brinjal fruits

Insecticide	Dose (g a.i.ha⁻¹)	Yield (q ha⁻¹)			
		R_1	R_2	R_3	Mean ± SD
Emamectin benzoate	15	279.70	270.67	252.56	267.74 ± 13.82
Imidacloprid	20	226.52	239.34	218.78	228.21 ± 10.38
Indoxacarb	50	271.87	265.36	250.52	262.58 ± 10.94
Lambda - cyhalothrin	15	249.60	221.14	226.35	232.36 ± 15.15
Spinosad	50	285.33	264.24	291.70	280.42 ± 14.37
Quinalphos	250	250.90	238.75	230.81	240.15 ± 10.12
Control		197.22	188.18	202.30	195.90 ± 7.15
S.Em. (±)					6.19
CD (P=0.05)					19.07

Table 6: Economics of insecticidal applications in brinjal

Insecticide	Dose (g a.i.ha⁻¹)	Mean yield (q ha⁻¹)	Increased yield over control (q ha⁻¹)	Increased yield over control (%)	Added benefit Over control* (Rs. ha⁻¹)	Cost of i nsecticide + labour (Rs. ha⁻¹)	Net profit (Rs. ha⁻¹)	Incremental cost-benefit ratio (ICBR)
Emamectin benzoate	15	267.74	71.84	36.67	18335	7290	10595	1 : 1.52
Imidacloprid	20	228.21	32.31	16.49	8245	1754	6500	1 : 3.71
Indoxacarb	50	262.58	66.68	34.04	17020	4387	12633	1 : 2.88
Lambda - cyhalothrin	15	232.36	36.46	18.61	9305	1778	7527	1 : 4.23
Spinosad	50	280.42	84.52	43.14	21570	5350	16220	1 : 3.03
Quinalphos	250	240.15	44.25	22.59	11295	2550	8745	1 : 3.43
Control		195.90						

* Selling price of brinjal fruits: Rs. 500/q

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