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Efficacy and biosafety of new generation insecticides for the management of *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in brinjal and *Earias vitella* Fabricius (Lepidoptera: Noctuidae) in okra

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ABSTRACT: The field trials were conducted at the College of Agriculture, Vellayani to determine the efficacy of eight new generation insecticides *viz.,* emamectin benzoate 5SG @10 g a.i. ha^{-1}, spinosad 45 SC @ 75 g a.i. ha^{-1}, novaluron 10 EC @ 100 g a.i.ha^{-1}, chlorantraniliprole 18.5 SC @ 30 g a.i. ha^{-1}, indoxacarb 14.5 SC @ 60 g a.i. ha^{-1}, fipronil 80 WG @ 50 g a.i. ha^{-1}, thiodicarb 75 WP@ 750 g a.i. ha^{-1} and flubendiamide 480 SC@ 100 g a.i. ha^{-1} against fruit borers of brinjal and okra. Two conventional insecticides (carbaryl 50 WP @ 750 g a.i. ha^{-1} and malathion 50 EC @ 500 g a.i. ha^{-1}) and an untreated control were maintained as check. Damages to brinjal and okra fruits were reduced by 45.96 to 72.21 per cent and 44.34 to 83.26 per cent, respectively by these new generation insecticides. Chlorantraniliprole, indoxacarb, emamectin benzoate and flubendiamide recorded more than 60 per cent reduction in fruit damage in brinjal, and chlorantraniliprole, flubendiamide and indoxacarb with more than 70 per cent reduction in fruit damage in okra were superior. The yield was also significantly high in these treatments in the two crops. All the insecticides were compatible with *Beauveria bassiana* (Blas.) Vuill, and *Metarhizhium anisopliae* (Metsch). Flubendiamide and carbaryl inhibited the growth of *Lecanicillium* (*Verticillium) lecanii* Humber.

KEYWORDS: Fungal entomopathogens, brinjal borer, okra borer

INTRODUCTION

Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae) is the most destructive pest of brinjal, widely distributed in the Indian sub-continent. Yield losses of 85 to 90 per cent have been reported from various states of India by this pest (Patnaik, 2000; Jagginavar *et al.,* 2009). The fruit borer *Earias vitella* Fabricius (Lepidoptera: Noctuidae) is found throughout the year, attacking shoots and fruits of okra. It causes extensive damage resulting in 40 to 53 per cent reduction in yield (Rabindra, 2001).

After hatching, the neonate larvae bore into the shoots or fruits, thus becoming inaccessible to the action of the chemicals applied. This cryptic habit of the pest reduces the chances to kill the fruit borer larvae and has resulted in misuse of pesticides. It

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is not unusual for the vegetable growers to give 10 to 12 sprays in okra and five to six sprays in brinjal in a season. Thus, the fruits which are harvested at short intervals are likely to retain high level of pesticide residues which may be hazardous to the consumers (Sardana *et al*., 2006).

The old chemistries (especially organophosphates and carbamates) attack the nervous systems of insects. Since, insects and other animals have similar tissues, reproductive, hormonal and nervous systems; these compounds have potential for non target effects. This commonality has rendered old insecticides highly toxic to non-target organisms including human. Currently, numerous classes of insecticides with varied modes of action, target selectivity and benign ecological, ecotoxicological and environmental profiles are available which could be exploited for pest management. Fungal pathogens *viz*., *Beauveria bassiana* (Blas.) Vuill*, Lecanicillium* (*Verticillium) lecanii* Humber and *Metarhizhium anisopliae* (Metsch) are generally utilized in vegetable ecosystem on account of their wide host range. Hence, information on the compatibility of the new generation insecticides with these bio agents is a pre requisite for developing suitable IPM strategies for vegetable crops.

In fact, most of the vegetable growers consider these borers as the most serious pests and nearly all of them use only chemical insecticides to combat them. The present investigation was taken up to evaluate the efficacy of the relatively safer new generation insecticides recommended for these borer pests.

MATERIALS AND METHODS

The experiments for determining their efficacy against fruit borers were laid out in randomized block design (RBD) with three replications in the Instructional farm, College of Agriculture, Vellayani. One month old brinjal (variety Haritha) seedlings were transplanted to 3×3 m^2 plots at a spacing of 75 x 60 cm. Each plot had a density of 20 plants with one plant per pit. The seeds of okra variety Varsha Upahar were sown in plots of 3×2 m^2 with a spacing of 60 x 45 cm. The plants were maintained as per the recommended package of practices of Kerala Agricultural University (KAU, 2011). The insecticide sprays were given on need basis. The first spray was given one month after transplanting of brinjal when shoot damage was noticed. This was followed by a second spray 60 days after transplanting and a third spray 80 days after transplanting. The first insecticidal spray for okra was given when shoot damage was noticed 25 days after planting. This was followed by a second spray 45 days after planting and a third spray two weeks after the second spray.

The number of shoots damaged by the fruit borer was recorded three, five, seven, ten and 15 days after spraying from each brinjal plot and five, seven, ten and 15 days after spraying from okra. The damaged shoots were tagged and the count of freshly damaged shoots was taken during each observation. The total number of fruits and the number of damaged fruits were recorded at harvest five, ten and fifteen days after spraying for brinjal and three, five, seven, ten and fifteen days after spraying in the case of okra. The extent of damage was computed as

Percent shoot/fruit damage =

$$\frac{\text{Number of infested shoots / fruits}}{\text{Total number of shoots /fruits}} \times 100$$

The insecticide molecules evaluated against the fruit borers were tested for their safety to *B. bassiana*, *L. lecanii* and *M. anisopliae*, the entomopathogenic fungi commonly used for pest management in vegetable ecosystem following the poison food technique (Nene and Thapliyal, 1993).

Data relating to each aspect were analyzed statistically. Appropriate transformations were made wherever necessary. The F test was done by analysis of variance (Panse and Suhatme, 1985). Significant results were compared on the basis of critical differences. The overall efficacy of the insecticides against the fruit borers was worked out for which the insecticides were ranked based on their performance in each parameter (pest control, yield, waiting period and compatibility with entomopathogens) studied. The mean rank for each crop was worked out and overall efficacy was determined.

RESULTS AND DISCUSSION

The data on the shoot and fruit damages recorded at definite intervals subsequent to the insecticide sprays revealed that all the new generation insecticides *viz.,* emamectin benzoate 5SG @10 g a.i. ha^{-1}, spinosad 45 SC @ 75 g a.i. ha^{-1}, novaluron 10 EC@ 100 g a.i. ha^{-1}, chlorantraniliprole 18.5 SC @ 30 g a.i. ha^{-1}, indoxacarb 14.5 SC @ 60 g a.i. ha^{-1}, fipronil 80 WG @ 50 g a.i. ha^{-1}, thiodicarb 75 WP @ 750 g a.i. ha^{-1} and flubendiamide 480 SC @ 100 g a.i. ha^{-1} reduced the infestation of *L. orbonalis* on brinjal(Table 1,2 and 3) and *E. vitella* in okra (Table 4 and 5) significantly in the

Table 1. Damage of shoots by *Leucinodes orbonalis* in brinjal plots treated with new generation insecticides 30 days after transplanting

Treatments	Dosage(g a.i.ha^{-1})	5 DAS	10 DAS	15 DAS
Emamectin benzoate	10	0.25(1.12)	1.26(1.50)	2.77(1.94)
Spinosad	75	0.43(1.19)	1.14(1.46)	0.66(1.29)
Novaluron	100	0.69(1.30)	1.28(1.51)	1.58(1.61)
Chlorantraniliprole	30	0.12(1.06)	0.43(1.19)	0.43(1.19)
Indoxacarb	60	0.57(1.25)	0.73(1.31)	0.61(1.27)
Fipronil	50	0.22(1.10)	1.17(1.47)	1.57(1.60)
Thiodicarb	750	0.89(1.37)	0.68(1.30)	1.70(1.64)
Flubendiamide	100	0.29(1.14)	0.95(1.40)	0.73(1.32)
Carbaryl	750	0.73(1.31)	0.78(1.33)	1.37(1.54)
Malathion	500	0.67(1.29)	0.85(1.36)	1.08(1.44)
Untreated control		2.23(1.80)	3.20(2.04)	3.31(2.08)
CD(0.05)		(0.29)	(0.40)	(0.37)

Figures in parentheses are square root transformed values. DAS - Days after spraying

Table 2. Damage of shoots and fruits by *Leucinodes orbonalis* in brinjal plots treated with new generation insecticides 60 days after transplanting

Treatments	Dosage (g a.i.ha^{-1})	Shoot damage (%)			Fruit damage (%)		
		5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS
Emamectin benzoate	10	0.53(1.24)	1.03(1.43)	1.80(1.67)	6.27(2.70)	16.48	17.35
Spinosad	75	0.43(1.19)	1.02(1.42)	0.68(1.30)	14.03(3.88)	18.65	31.22
Novaluron	100	0.56(1.25)	1.00(1.41)	1.30(1.52)	19.53(4.53)	26.11	25.76
Chlorantraniliprole	30	0.24(1.11)	0.43(1.19)	0.57(1.25)	2.34(1.83)	15.99	18.33
Indoxacarb	60	0.57(1.25)	0.73(1.31)	0.62(1.27)	5.24(2.50)	13. 40	18.60
Fipronil	50	0.61(1.27)	1.17(1.47)	1.11(1.45)	13.08(3.75)	26.95	19.57
Thiodicarb	750	0.72(1.31)	0.86(1.36)	1.70(1.64)	17.37(4.29)	31.79	26.14
Flubendiamide	100	0.30(1.14)	0.95(1.40)	1.09(1.44)	6.82(2.80)	24.66	26.24
Carbaryl	750	0.73(1.31)	0.95(1.40)	1.34(1.53)	19.16(4.49)	37.35	41.11
Malathion	500	0.82(1.35)	1.04(1.43)	1.18(1.48)	18.13(4.37)	39.26	37.91
Untreated control		2.38(1.83)	3.20(2.05)	3.53(2.13)	33.04(5.83)	51.48	46.63
CD(0.05)		(0.33)	(0.40)	(0.26)	(2.06)	17.64	15.60

Figures in parentheses are square root transformed values. DAS - Days after spraying

Table 3. Damage of shoots and fruits by *Leucinodes orbonalis* in brinjal plots treated with new generation insecticides 80 days after transplanting

Treatments	Dosage (g a.i.ha^{-1})	Shoot damage (%)			Fruit damage (%)		
		5 DAS	10 DAS	15 DAS	5 DAS	10 DAS	15 DAS
Emamectin benzoate	10	0.40(1.18)	1.03(1.43)	1.37(1.54)	5.04 (2.46)	13.39	29.81
Spinosad	75	0.46(1.21)	0.57(1.25)	0.91(1.38)	11.26 (3.50)	21.37	31.30
Novaluron	100	0.68(1.30)	0.80(1.34)	1.19(1.48)	14.65 (3.96)	25.36	31.79
Chlorantraniliprole	30	0.24(1.11)	0.45(1.21)	0.70(1.30)	1.98 (1.73)	10.87	23.28
Indoxacarb	60	0.41(1.19)	0.73(1.31)	0.84(1.36)	5.04 (2.46)	13.03	23.54
Fipronil	50	0.73(1.32)	1.06(1.44)	1.11(1.45)	9.78 (3.28)	14.85	21.43
Thiodicarb	750	0.60(1.26)	0.68(1.30)	1.16(1.47)	8.65 (3.11)	22.79	30.53
Flubendiamide	100	0.29(1.14)	0.95(1.40)	1.09(1.44)	4.36 (2.32)	18.23	24.13
Carbaryl	750	0.73(1.31)	0.95(1.40)	1.10(1.45)	15.17 (4.02)	27.50	38.36
Malathion	500	0.63(1.28)	0.91(1.38)	0.95(1.40)	9.13 (3.18)	26.19	43.07
Untreated control		2.15(1.77)	2.79(1.95)	2.38(1.84)	31.09 (5.66)	50.46	46.14
CD(0.05)		(0.28)	(0.30)	(0.23)	(1.35)	13.68	20.80

Figures in parentheses are square root transformed values, DAS - Days after spraying

Table 4. Damage of shoots by *Earias vittella* in okra plots treated with new generation insecticides 25 days after planting

Treatments	Dosage (g a.i.ha^{-1})	3 DAS	5 DAS	7 DAS	10 DAS	15 DAS
Emamectin benzoate	10	0.93	1.25 (1.50)	2.18 (1.78)	4.08 (2.25)	4.01
Spinosad	75	1.91	2.46 (1.86)	2.97 (1.99)	3.42 (2.10)	5.09
Novaluron	100	1.98	1.63 (1.62)	2.59 (1.89)	4.18 (2.28)	4.15
Chlorantraniliprole	30	0.98	0.69 (1.30)	1.63 (1.62)	2.97 (1.99)	3.26
Indoxacarb	60	0.93	0.73 (1.31)	1.57 (1.60)	3.32 (2.08)	4.13
Fipronil	50	1.89	1.66 (1.63)	1.61 (1.62)	2.63 (1.91)	5.03
Thiodicarb	750	1.80	1.62 (1.62)	2.26 (1.81)	3.37 (2.09)	4.92
Flubendiamide	100	0.89	0.75 (1.32)	1.53 (1.59)	3.32 (2.08)	3.29
Carbaryl	750	0.98	1.61 (1.62)	3.42 (2.10)	4.16 (2.27)	5.78
Malathion	500	1.04	1.61 (1.62)	3.40 (2.10)	4.17 (2.27)	5.81
Untreated control	-	5.06	8.05 (3.01)	12.88 (3.73)	12.59 (3.69)	11.14
CD(0.05)	-	-	(1.00)	(0.98)	(0.68)	3.68

Figures in parentheses are square root transformed values, DAS - Days after spraying

field. Treatment of brinjal with the new generation insecticides reduced the damage of shoots by *L. orbonalis* by 62.53 to 84.00 per cent. The reduction in damage in carbaryl and malathion sprayed plots was only 64.72 and 66.36 per cent, respectively. Among the newer molecules, chlorantraniliprole (84.00 per cent), indoxacarb (76.28 per cent), spinosad (75.24 per cent) and flubendiamide (71.64 per cent) registered higher reduction in infestation of shoots. Infestation of fruits were also significantly lower, the reduction in damage ranging from 45.96 to 72.21 per cent in new generation

Table 5. Damage of fruits by *Earias vittella* in okra plots treated with new generation insecticides 45 and 60 days after planting

Treatments	Dosage (g a.i.ha^{-1})	45 DAP					60 DAP				
		3 DAS	5 DAS	7 DAS	10 DAS	15 DAS	3 DAS	5 DAS	7 DAS	10 DAS	15 DAS
Emamectin benzoate	10	2.56	14.60 (3.95)	12.51 (3.68)	14.52	18.66	0	7.66	13.06	23.89	24.81
Spinosad	75	3.03	10.44 (3.38)	19.03 (4.48)	13.68	22.22	4.17	14.98	19.52	16.98	22.91
Novaluron	100	6.67	18.92 (4.46)	12.59 (3.69)	19.07	41.67	5.56	11.36	13.61	22.84	27.30
Chlorantraniliprole	30	0.00	1.84 (1.69)	4.69 (2.39)	8.40	11.67	0.00	4.88	4.69	7.29	11.81
Indoxacarb	60	0.00	6.09 (2.66)	7.20 (2.86)	7.22	15.86	1.67	8.62	7.26	12.17	18.03
Fipronil	50	0.00	2.22 (2.63)	5.92 (4.44)	18.71 19.24	29.42	4.30	10.04	19.72	19.95	23.23
Thiodicarb	750	0.00	8.51 (3.08)	12.20 (3.63)	15.40	14.35	3.03	13.15	12.33	18.58	25.32
Flubendiamide	100	0.00	3.10 (2.24)	6.59 (2.75)	11.19	12.15	2.78	6.46	6.67	7.78	17.85
Carbary l	750	0.00	2.56 (4.50)	19.29 (4.39)	18.26 22.55	32.22	3.33	12.57	18.28	21.85	24.44
Malathion	500	0.00	16.87 (4.23)	27.65 (5.35)	20.32	24.21	0.95	17.60	27.78	25.45	24.17
Untreated control		11.96	34.32 (5.94)	35.71 (6.06)	37.37	47.78	9.14	34.72	35.83	35.15	44.81
CD(0.05)		-	(2.14)	(1.21)	8.06	15.61	-	9.80	10.17	10.37	13.72

Figures in parentheses are square root transformed values. DAP-Days after planting, DAS - Days after spraying

insecticide treated plots and 31.87 to 33.09 per cent in carbaryl and malathion treatments, respectively. Chlorantraniliprole (72.21 per cent), indoxacarb (70.51 per cent), emamectin benzoate (66.70 per cent) and flubendiamide (71.64 per cent) treated plots recorded higher reduction in the fruit damage. Commensurate with the reduced pest incidence, significantly higher yield was obtained from these plots, being 17.82 (flubendiamide), 17.63 (indoxacarb), 17.52 (chlorantraniliprole) and 16.51 (emamectin benzoate) kg per 9 sqm plot (Table 6). For every one rupee invested in plant protection, the returns from the treatments were Rs 5.55 (chlorantraniliprole), 5.33 (flubendiamide), 5.28 (indoxacarb) and 2.32 (emamectin benzoate). The effectiveness of novaluron 0.01 % against *L. orbonalis* recorded earlier (Chatterjee and Roy, 2004 ; Sawant *et al.,* 2004) , is contrary to the results of the present study. The efficacy of different formulations of flubendiamide against *L. orbonalis* was also documented earlier (Reshma and Behara, 2018; Jagginavar *et al.*, 2009). Similarly, emamectin benzoate 5 SG @ 20 g a.i. ha^{-1} was found effective in reducing fruit damage by *L. orbonalis* in brinjal (Kumar and Devappa, 2006; Anil and Sharma, 2010). The lowest shoot and fruit infestations (7.47 and 9.88 per cent) and highest marketable fruit yield of 143.50 q ha^{-1} were recorded in the plots treated with spinosad 2.5 SC (50 g a.i. ha^{-1}) followed by indoxacarb 14.5 SC 50 g a.i. ha^{-1} (8.89 and 13.13 per cent), emamectin benzoate 5 SG 15 g a.i. ha^{-1} (10.95 and 16.66 per cent), respectively (Patra *et al.,* 2009).

All the new generation insecticides were equally effective in reducing the shoot infestation by *E. vitella* in okra, the reduction in damage ranging from 68.09 to 80.82 per cent in the newer molecules and 67.89 and 67.73 in carbaryl and malathion treated plots respectively. Chlorantraniliprole (80.82 per cent), flubendiamide (80.34 per cent), indoxacarb (78.53 per cent) and emamectin benzoate (74.95 per cent) were comparatively more effective in preventing shoot damage. The reduction in damage of fruits ranged from 53.53 to 83.26 per cent in the novel insecticide treatments as against 45.82 and 43.97 per cent in carbaryl and malathion treatments, respectively. Among the insecticides, chlorantraniliprole, flubendiamide and indoxacarb with 83.26, 77.39 and 76.59 per cent reduction in fruit damage, respectively were superior. The associative yield obtained from these plots were significantly higher, being 5.80 kg (chlorantraniliprole), 5.61 kg (flubendiamide) and 5.50 kg (indoxacarb)

Table 6. Yield of brinjal and benefit: cost ratio of insecticidal treatments

Treatments	Dosage (g a.i.ha^{-1})	Yield			Monetary benefits (Rs ha^{-1})	Expenses for insecticides (Rs ha^{-1})	B: C ratio
		(kg/9 m^2 plot)	(t/ha)	Increase over control(%)			
Emamectin benzoate	10	16.51	18.34	33.76	68833.27	2.32	2.32:1
Spinosad	75	15.34	17.04	23.91	168666.67	1.54	1.54:1
Novaluron	100	15.74	17.49	27.14	175333.33	1.63	1.63:1
Chlorantraniliprole	30	17.52	19.47	41.52	205000.00	5.55	5.55:1
Indoxacarb	60	17.63	19.59	42.41	206833.33	5.28	5.28:1
Fipronil	50	15.70	17.44	26.82	174666.67	1.63	1.63:1
Thiodicarb	750	15.24	16.94	23.10	167000.00	-	-
Flubendiamide	100	17.82	19.80	43.94	210000.00	5.35	5.35:1
Carbaryl	750	14.47	16.08	16.88	154166.67	2.27	2.27:1
Malathion	500	14.52	16.13	17.29	155000.00	1.97	1.97:1
Untreated control		12.38	13.76			-	-
CD(0.05)		1.43					

Table 7. Yield of okra and benefit: cost ratio of insecticidal treatments

Treatments	Dosage (g a.i.ha^{-1})	Yield			Monetary benefits (Rs ha^{-1})	Expenses for insecticides (Rs ha^{-1})	B: C ratio
		(kg/6 m^2 plot)	(t/ha)	Increase over control(%)			
Emamectin benzoate	10	4.48	4.97	27.64	33333.33	5874/-	4.95:1
Spinosad	75	4.13	4.59	17.66	21666.67	5184/-	3.67:1
Novaluron	100	4.26	4.74	21.37	26000.00	8010/-	3.65:1
Chlorantraniliprole	30	5.80	6.45	65.24	77333.33	5625/-	6.23:1
Indoxacarb	60	5.50	6.11	56.70	67333.33	3855/-	6.96:1
Fipronil	50	4.11	4.57	17.09	21000.00	3402/-	4.51:1
Thiodicarb	750	3.95	4.39	12.54	15666.67	7350/-	3.20:1
Flubendiamide	100	5.61	6.23	59.83	71000.00	4620/-	6.93:1
Carbaryl	750	4.31	4.79	22.79	27666.67	2625/-	2.96:1
Malathion	500	4.13	4.59	17.66	21666.67	1013/-	3.34:1
Untreated control		3.51	3.89				-
CD(0.05)		0.80					

Table 8. Growth of *Beauveria bassiana, Lecanicillium lecanii* and *Metarrhizium anisopliae* on PDA media poisoned with different insecticides

Treatment	Dosage (g a.i.ha^{-1})	Mean mycelial growth (cm)														
		Beauveria bassiana					*Lecanicillium lecanii*						*Metarrhizium anisopliae*			
		3 DAI	9 DAI	15 DAI	21 DAI	27 DAI	3 DAI	9 DAI	15 DAI	21 DAI	27 DAI	33DAI	3 DAI	9 DAI	15 DAI	21 DAI
Emamectin benzoate	10	1.20	3.08	4.43	6.03	6.23	1.1	1.90	2.67	3.27	5.43	5.63	1.90	3.70	5.53	6.80
Spinosad	75	1.50	3.17	3.70	3.85	3.33	1.17	1.80	2.77	3.97	5.17	5.37	1.95	3.67	8.80	9.00
Novaluron	100	1.13	2.13	2.73	3.53	3.60	1.13	1.73	2.73	4.10	6.30	6.73	2.23	6.25	7.20	7.73
Chlorantraniliprole	30	1.67	3.87	4.33	5.10	5.23	1.13	2.33	3.57	4.73	7.17	7.50	2.30	4.20	8.33	9.00
Indoxacarb	60	1.70	4.27	4.87	6.40	6.63	1.17	2.30	3.33	4.37	6.03	6.47	2.33	8.33	8.73	9.00
Fipronil	50	1.17	2.57	3.60	4.57	4.73	1.17	1.57	2.73	4.13	6.93	7.13	2.28	4.17	6.83	7.77
Thiodicarb	750	1.33	2.57	3.37	4.40	4.50	1.10	1.27	2.50	3.73	5.77	6.03	1.93	3.80	5.77	6.67
Flubendiamide	100	1.13	2.13	2.60	3.47	3.63	1.07	1.47	2.10	2.33	2.53	2.80	1.50	4.40	6.42	7.67
Carbaryl	750	1.13	2.20	2.80	3.93	4.00	1.13	1.23	1.53	1.80	2.13	2.30	1.97	4.35	6.60	9.00
Malathion	500	1.20	2.90	3.77	4.73	4.83	1.10	1.37	3.10	3.40	4.90	5.10	2.27	5.30	7.47	9.00
Control		1.13	2.10	3.07	4.00	4.07	1.17	1.40	2.57	3.87	6.60	7.23	2.50	3.97	6.87	9.00
CD(0.05)		0.23	0.93	1.22	0.856	0.67	0.144	0.36	0.56	0.55	0.22	0.29	0.42	1.32	1.84	1.38

DAI - Days after inoculation

per six sq. m plot compared to the untreated plot (3.51 kg) (Table 7). The benefit cost ratio indicated that Rs 6.96 (indoxacarb), Rs 6.93 (flubendiamide) and Rs 6.23 (chlorantraniliprole) could be incurred in return for every one rupee spent to control the pest. The results of the study conform to the reports of other workers. Superiority of flubendiamide 480 SC @ 60 g a.i. ha^{-1} and 48 g a.i. ha^{-1} against okra fruit and shoot borer, *E. vitella* was reported by Katti and Surpur (2015). Emamectin benzoate 5 SG @ 11 g a.i. ha^{-1} reduced the larval population of *E. vitella* in okra (Kuttalam *et al.,* 2008). Significantly low fruit infestation was noticed with the application of spinosad 45 SC @ 30 g a.i. ha^{-1} followed by abamectin 1.9 EC @30 g a.i. ha^{-1}. Indoxacarb 0.015 % and fipronil 0.005 % were highly effective in preventing borer damage (Sinha *et al.,* 2009; Gupta *et al.,* 2009). Rynaxypyr 20 SC @ 30 g a.i. ha^{-1} and @ 20 g a.i. ha^{-1} were superior in recording less larval populations, lower fruit damage and higher fruit yield in okra, followed by spinosad @ 56 g a.i. ha^{-1}, emamectin benzoate @ 15 g a.i. ha^{-1} and flubendiamide @ 45 g a.i ha^{-1} (Chowdhary *et al.,* 2010).

All the insecticides were compatible with the white muscardine fungus, *B. bassiana* and in particular profuse growth of the fungus was seen in indoxacarb, emamectin benzoate and chlorantraniliprole indicating a probable synergistic effect on the fungus. Similarly, the various insecticides were safe to *M. anisopliae*, though comparatively lower growth of the green muscardine was noted in media poisoned with emamectin benzoate (24 per cent) and thiodicarb (26 per cent). All the treatments were found compatible with *L. lecanii* except flubendiamide and carbaryl which recorded 61 and 68 per cent reduction in the growth of the fungus, respectively (Table 8).

Considering the efficacy of the insecticides against the pests, associated yield increase, benefit cost ratio of the insecticide treatments and compatibility with bio agents, chlorantraniliprole 18.5 SC @ 30 g a.i. ha^{-1}, indoxacarb 14.5 SC @ 60 g a.i. ha^{-1} and emamectin benzoate 5SG @10 g a.i. ha^{-1} were adjudged as the potential insecticides against the fruit borers of brinjal and okra.

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