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Bio-efficacy of newer insecticides against the shoot and fruit borer (*L. orbonalis*) of brinjal (*Solanum melongena* Linn.) Cv. Kavya

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Abstract

The current investigation, which is, "Study on incidence of insect pest complex of brinjal, *Solanum melongena* L. and evaluation of insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee" was carried out in the experimental field Agriculture Research Farm, Faculty of Agriculture, Rabindranath Tagore University, Raisen (M.P.) during Rabi 2020-21 and 2021-22. In 2020-21, insecticide spinosad 45 SC @ was founded most superior insecticide and recorded least fruit infestation as 11.64, 11.64, 13.86 and 16.09% at 3rd, 5th, 7th and 10th DAS after first spray. In 2020-21, after second spray, spinosad 45 SC @ was founded again most superior insecticide and recorded least fruit infestation as 7.12, 9.90, 12.68 and 12.68% at 3rd, 5th, 7th and 10th DAS. The maximum fruit infestation reduction (80.10% & 85.65%) was recorded from spinosad 45 SC treated plots during respective years. In 2021-22, insecticide spinosad 45 SC @ was founded most superior insecticide and recorded least mean fruit infestation as 14.52 and 12.96% after first and second spray. In 2021-22, the maximum fruit infestation reduction (80.31 & 84.05%) was recorded from spinosad 45 SC treated plots during 2020-21 & 2021-2022. In 2020-21, the maximum increased yield (97.78 q/ha) and net profit values (Rs. 76565.65) were obtained from spinosad 45 SC @ 0.5 ml/l treated plots. In 2021-22, the maximum fruit yield, increased yield and net profit values over control was recorded from spinosad45 SC @ 0.5 ml/l treated plots with 215.3 q/ha, 99.5 q/ha and Rs. 67325.5. The maximum incremental cost benefit ratio was recorded from emamectin benzoate 5 SG during both the years.

Keywords: Shoot and fruit borer, cost –benefit ration and brinjal

Introduction

One of the widespread and popular vegetables growing over the world, including India, is the brinjal (*Solanum melongena*), often known as eggplant or aubergine. India is the second-largest producer of vegetables in the world, behind China. India produced 21390 metric tonnes of vegetables on 1475 million acres in 2020–21, according to the Ministry of Agriculture and Farmers Welfare. India generated 13154 metric tonnes of brinjal from 758 million hectares in 2020–21. In 2018, West Bengal has the largest brinjal production and area. However, Uttar Pradesh, the state with the biggest production of brinjal, is placed 13th in production and 15th in area. One of the most significant issues among the many reasons for the low yield of brinjal is the harm done by insect pests. It is subjected to attack by number of insect pests right from nursery stage till harvesting. The yield loss due to the pest is to the extent of 70-92%. The infested fruits become unfit for consumption due to loss of quality and hence, lost their market value. Although, insecticidal control is one of the common means against the fruit borer, many of the insecticides applied are not effective in the satisfactory control of this pest. Because brinjal is grown as a vegetable, using chemical insecticides will leave hazardous residues on the fruits. In addition, sole reliance on pesticides for the control of this pest has resulted in the pest developing insecticidal resistance. (Natekar *et al*., 1987 and Harish *et al.*, 2011) [10, 9]. Finding alternative and safer solutions is therefore urgently needed. Knowledge of the pest complex is a prerequisite for developing and designing pest control and management techniques based on good ecological foundations and commercially viable. Therefore, it is crucial to use effective and innovative insecticides against the main insect pest complex of brinjal in a given area.

Materials and Methods

The current investigation, which is, "Study on incidence of insect pest complex of brinjal, *Solanum melongena* L. and evaluation of insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee" was carried out in the experimental field Agriculture Research Farm, Faculty of Agriculture, Rabindranath Tagore University, Raisen (M.P.) during Rabi 2020-21 and 2021-22.

Table 1: Treatment details:

Treatment No.	Insecticides	Formulation	Dose (g or ml/ha)	Group of Insecticide
T_1	Emamectin benzoate	5 SG	200 g	Avermectin
T_2	*Bacillus thuringiensis*	SC	625 ml	Bio Pesticide
T_3	Neem oil	10,000 PPM	625 ml	Botanical Pesticide
T_4	Spinosad	45 SC	185 ml	Spinosyns
T_5	Chlorantraniliprole.	18.5 SC	200 ml	Diamide Group
T_6	Cypermethrin	25 EC	300 ml	Pyrethroids
T_7	Spinetoram	11.7 SC	450 ml	Spinosyns
T_8	Thiodicarb	75 WP	1000 g	Carbametes
T_9	Chlorpyriphos	20EC	1000 ml	Organophosohate
T_{10}	Control	-	-	

Observation

Pre-treatment observations on the brinjal pest complex was recorded 24 hours before spraying, while pest- treatment observations will be taken 3, 7, and 10 days after the application of the treatments. Observations on the shoot and fruit borer *L. Orbonalis* will be recorded on five randomly selected tagged plants/plot. Fruit infestation by shoot and fruit borer was observed by counting the total number of damaged and healthy shoots and fruits in each picking/plot.

Percent fruit & shoot borer infestation = (Total number of shoot & fruit)/ (Total number of healthy & damage shoot& fruit) x 100.

Pre-treatment observations of the brinjal pest complex were made 24 hours prior to spraying, and post-treatment observations of the pests were made 3, 7, and 10 days later. On five randomly chosen tagged plants/plots, *L. orbonalis* observations on the shoot and fruit borer were noted. Counting the total quantity of damaged and healthy shoots and fruits in each picking/plot will allow us to determine the extent of the shoot and fruit borer infestation.

Results

In 2020-21, the fruit borer infestation was observed as no significant differences among various treatments as pre-treatment. On third day after first spray, the plot treated with spinosad 45 SC @ 0.5 ml/l recorded least fruit infestation (11.64%) and it was significantly different to other treatments. On 5th DAS, chlorantraniliprole 18.5% SC (16.55%) was significantly different with spinosad 45 SC (11.64%) but there is no significant difference with rest of treatment. At on 7th DAS, the lowest fruit infestation (13.86%) was recorded with spinosad 45 SC but it was not differ significantly with chlorantraniliprole 18.5% SC, emamectin benzoate 5 SG, Spinetoram 12 SC, and cypermethrin 25 EC. The indicated that at 10th DAS, low fruit infestation was observed in plots sprayed with spinosad 45 SC (16.09%).

The decrease in fruit infection compared to the control *viz.*, 80.10, 70.99, 66.88, 54.73, 55.00, 47.76, 36.38, 37.50, and 33.45% from spinosad 45 SC, chlorantraniliprole 18.5% SC, emamectin benzoate 5 SG, Spinetoram 12 SC, cypermethrin 25 EC, dimethoate 30 EC, chlorpyriphos 20 EC, *Bacillus thuringiensis* 20 SC, and neem oil treated plots, respectively.

On 3rd day after second spray**,** spinosad 45 SC was founded superior and reduced maximum fruit infestation but there was no significant difference between with chlorantraniliprole 18.5% SC and emamectin benzoate 5 SG whereas fruit infestation was recorded as 8.87 and 13.42 percent. Spinosad 45 SC was found most effective.

In the second year, a non-significant difference was observed one day before first spray. The maximum fruit and shoot infestation was recorded from untreated plots while the minimum fruit infestation was recorded from spinosad treated plots after 3rd, 5th, 7th and 10th DAS. The efficacy of novel insecticides was recorded based on fruit infestation reduction in ascending order viz., 19.96, 20.07, 27.02, 29.11, 48.61, 53.80, 74.66, 78.68 and 80.31% from neem oil @ 5.0 ml/l, *Bacillus thuringiensis* 20 SC @ 3.0 ml/l, chlorpyriphos 20 EC @ 2.0 ml/l, dimethoate 30 EC @ 2.5 ml/l, cypermethrin 25 EC @ 0.5 ml/l, Spinetoram 12 SC @ 0.1 ml/l, emamectin benzoate 5 SG @ 0.5 ml/l, chlorantraniliprole 18.5% SC @ 20 ml/l, and spinosad 45 SC @ 0.5 ml/l treated plots, respectively.

After second spray, on third day, the fruit infestation was recorded in ascending order viz., $8.02 < 8.12 < 9.22 < 12.23 < 14.84 < 22.20 < 23.54 < 29.16 < 36.68 < 78.92\%$ from chlorantraniliprole 18.5% SC, spinosad 45 SC, emamectin benzoate 5 SG, Spinetoram 12 SC, cypermethrin 25 EC, dimethoate 30 EC, chlorpyriphos 20 EC, *Bacillus thuringiensis* 20 SC, neem oil and control plots, respectively. The treatments, spinosad 45 SC @ 0.5 ml/l, chlorantraniliprole 18.5% SC @ 20 ml/l, emamectin benzoate 5 SG @ 0.5 ml/l, Spinetoram 12 SC @ 0.1 ml/l, and cypermethrin 25 EC @ 0.5 ml/l were founded non significantly to each other. The insecticide performance were recorded at 5th, 7th and 10th DAS and minimum fruit infestation was recorded from spinosad 45 SC treated plots and fruit infestation was noticed 10.90, 15.01 and 16.76 percent, respectively. Fruit infestation reduction rang was recorded 41.41-84.05% after second spray in the second year 2020-21.

In 2021-22, the maximum fruit yield was recorded in the plots treated with spinosad 45 SC @ 0.5 ml/l with 210.3 q/ha followed by chlorantraniliprole18.5% SC (207.6 q/ha), emamectin benzoate 5 SG (202.5 q/ha), Spinetoram 12 SC (192.3 q/ha), cypermethrin 25 EC (186.4 q/ha), dimethoate 30 EC @ (175.6 q/ha), chlorpyriphos 20 EC (162.3 q/ha), *Bacillus thuringiensis* 20 SC (140.2 q/ha), neem oil (138.5 q/ha) and untreated control plot (112.5 q/ha). The maximum increased yield followed by untreated control plot yield was obtained from spinosad 45 SC @ 0.5 ml/l with 97.78 q/ha.

The net profit values were recorded Rs. 76565.65 from spinosad 45 SC treated plots.

The maximum incremental cost benefit ratio was recorded from emamectin benzoate 5 SG @ 0.5 ml/l (Rs. 4.14) followed by chlorantraniliprole 18.5% SC @ 20 ml/l, spinosad 45 SC @ 0.5 ml/l, Spinetoram 12 SC @ 0.1 ml/l, dimethoate 30 EC @ 2.5 ml/l, chlorpyriphos 20 EC @ 2.0 ml/l, cypermethrin 25 EC @ 0.5 ml/l, *Bacillus thuringiensis* 20 SC @ 3.0 ml/l, and neem oil @ 5.0 ml/l whereas value was recorded as Rs. 3.70, 3.61, 3.53, 3.02, 2.53, 1.34, 1.15 and 1.07, respectively. The maximum fruit yield and increased yield over control was recorded from spinosad 45 SC @ 0.5 ml/l treated plots with 215.3 q/ha and 99.5 q/ha followed by other treatments during second year.

The maximum net profit value Rs. 67325.5/ha was noticed from spinosad 45 SC treated plots. The maximum cost benefit ratio was recorded from emamectin benzoate 5 SG (3.50) followed by others.

Table 1: Efficacy of insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee of brinjal during *Rabi* season, 2020-21

Treatment's	Mean fruit infestation (%)													
	1st Spray							2nd spray						
	Before	3rd DAS	5th DAS	7th DAS	10th DAS	Mean	ROC (%)	Before	3rd DAS	5th DAS	7th DAS	10th DAS	Mean	ROC (%)
Spinosad 45 SC	66.49 (54.69)*	11.64 (19.89)	11.64 (19.89)	13.86 (21.61)	16.09 (23.11)	13.31	80.10	45.42 (42.32)	7.12 (15.44)	9.90 (17.88)	12.68 (19.84)	12.68 (19.84)	11.08	85.65
Chlorantraniliprole 18.5% SC	67.14 (55.37)	15.60 (23.16)	16.55 (23.14)	19.88 (25.14)	25.60 (29.30)	19.40	70.99	46.71 (43.10)	8.87 (17.22)	10.83 (18.81)	14.75 (21.48)	14.75 (21.48)	13.49	82.53
Emamectin benzoate 5 SG	70.83 (57.49)	17.50 (24.61)	16.39 (23.41)	21.94 (27.51)	32.78 (34.49)	22.15	66.88	49.39 (44.58)	13.42 (21.28)	17.34 (23.94)	21.27 (26.30)	21.27 (26.30)	19.51	74.72
Spinetoram 12 SC	64.31 (53.68)	18.21 (24.58)	22.38 (27.06)	31.90 (33.29)	48.62 (43.84)	30.28	54.73	52.07 (46.19)	20.35 (26.56)	25.80 (30.05)	30.93 (32.25)	30.93 (32.25)	28.37	63.25
Cypermethrin 25 EC	71.46 (57.75)	22.03 (27.78)	25.06 (29.86)	30.18 (32.98)	43.12 (40.92)	30.10	55.00	47.31 (43.44)	21.20 (26.67)	27.04 (30.35)	31.20 (32.76)	31.20 (32.76)	31.48	59.22
Dimethoate 30 EC	60.68 (51.39)	15.14 (22.80)	30.17 (32.92)	41.39 (39.97)	53.05 (46.79)	34.94	47.76	44.01 (41.41)	25.90 (30.31)	32.25 (34.28)	37.01 (37.01)	37.01 (37.01)	36.94	52.15
Chlorpyriphos 20 EC	66.21 (54.56)	15.95 (23.26)	40.11 (38.32)	53.98 (52.22)	60.15 (51.05)	42.55	36.38	49.21 (44.54)	28.48 (31.88)	36.99 (37.26)	42.25 (40.36)	42.25 (40.36)	40.45	47.60
Bacillus thuringiensis 20 SC	70.06 (56.83)	17.68 (24.81)	33.27 (35.18)	48.87 (44.36)	67.38 (55.30)	41.80	37.50	50.96 (45.55)	37.28 (37.61)	46.99 (43.27)	52.25 (46.37)	52.25 (46.37)	50.85	34.13
Neem oil	75.49 (60.40)	21.18 (27.39)	30.39 (33.23)	50.98 (45.56)	75.49 (60.40)	44.51	33.45	58.92 (50.20)	34.54 (35.83)	43.97 (41.35)	50.99 (46.00)	50.99 (46.00)	52.07	32.56
Control	62.22 (52.86)	65.56 (54.79)	65.28 (53.90)	66.67 (54.74)	70.00 (56.76)	66.88	-	71.52 (57.75)	73.60 (59.08)	75.69 (60.40)	77.91 (61.97)	81.97 (64.87)	77.20	-
CD	N/A	1.205	2.282	2.329	2.193	-	-	N/A	1.702	2.075	2.894	2.876	-	-
SE(m)	0.390	0.402	0.762	0.778	0.732	-	-	0.569	0.568	0.693	0.966	0.960		

Table 2: Efficacy of insecticides against shoot and fruit borer, *Leucinodes orbonalis* Guenee of brinjal during *Rabi* season, 2021-22

Treatment	Mean fruit infestation (%)													
	1st Spray							2nd spray						
	Before	3rd DAS	5th DAS	7th DAS	10th DAS	Mean	ROC (%)	Before	3rd DAS	5th DAS	7th DAS	10th DAS	Mean	ROC (%)
Spinosad 45 SC	73.25 (58.87)	9.76 (17.99)	14.52 (21.35)	14.52 (21.35)	19.29 (24.22)	14.52	80.31	24.68 (27.05)	8.12 (15.58)	10.90 (17.54)	15.01 (20.93)	17.79 (22.57)	12.96	84.05
Chlorantraniliprole 18.5% SC	68.29 (56.11)	11.24 (19.43)	13.80 (21.31)	16.37 (22.97)	21.50 (26.00)	15.73	78.68	27.24 (31.00)	8.02 (16.24)	11.20 (18.88)	16.04 (22.47)	17.63 (23.46)	13.22	83.72
Emamectin benzoate 5 SG	69.49 (57.78)	12.56 (20.37)	17.01 (23.26)	23.68 (28.19)	30.34 (32.07)	20.90	71.66	29.43 (32.66)	9.22 (17.17)	11.60 (18.96)	15.57 (21.95)	16.76 ()22.69	13.29	83.64
Spinetoram 12 SC	71.85 (59.45)	21.85 (27.27)	26.30 (29.88)	41.85 (39.13)	46.30 (41.84)	34.07	53.80	33.99 (35.58)	12.23 (19.97)	15.68 (22.51)	21.90 (26.65)	25.35 (28.71)	18.79	76.86
Cypermethrin 25 EC	79.37 (63.44)	25.00 (29.64)	32.14 (33.77)	44.84 (41.94)	49.60 (44.98)	37.90	48.61	35.41 (36.28)	14.84 (21.90)	20.10 (25.10)	28.40 (31.31)	33.18 (34.78)	24.13	70.29
Dimethoate 30 EC	62.80 (52.81)	29.56 (31.81)	48.81 (44.23)	65.28 (59.17)	65.48 (54.23)	52.28	29.11	38.30 (37.73)	22.20 (27.41)	30.54 (32.28)	48.44 (44.03)	39.96 (38.71)	35.29	56.56
Chlorpyriphos 20 EC	68.71 (56.20)	33.31 (34.07)	49.12 (44.07)	61.89 (52.66)	70.98 (58.37)	53.83	27.02	41.87 (39.85)	23.54 (28.16)	33.07 (33.75)	53.57 (47.75)	43.12 (40.74)	38.33	52.81
Bacillus thuringiensis 20 SC	70.08 (58.06)	37.94 (37.48)	52.14 (46.15)	67.70 (56.49)	78.02 (63.05)	58.95	20.07	44.88 (42.04)	29.16 (32.61)	34.16 (35.52)	61.33 (51.79)	50.61 (45.33)	43.82	46.05
Neem oil	68.33 (56.39)	37.78 (37.53)	48.33 (44.11)	69.44 (56.56)	70.56 (57.14)	56.52	17.22	45.39 (42.30)	36.68 (37.21)	39.71 (38.95)	60.92 (51.35)	53.03 (46.75)	47.59	41.41
Control	69.26 (56.77)	70.74 (58.15)	72.96 (59.65)	74.26 (60.09)	77.04 (61.74)	73.75	-	78.92 (62.95)	78.92 (62.95)	80.44 (64.14)	81.49 (64.61)	84.05 (66.49)	81.22	-
CD	N/A	2.534	2.911	3.138	3.078	-	-	N/A	1.804	2.857	2.909	2.863	-	-
SE(m)	0.645	0.846	0.972	1.048	1.028			0.873	0.603	0.954	0.972	0.956		

Conclusion

In 2020-21, insecticide spinosad 45 SC @ was founded most superior insecticide and recorded least fruit infestation as 11.64, 11.64, 13.86 and 16.09 percent at 3rd, 5th, 7th and 10th DAS after first spray. In 2020-21, after second spray, spinosad 45 SC @ was founded again most superior insecticide and recorded least fruit infestation as 7.12, 9.90, 12.68 and12.68 percent at 3rd, 5th, 7th and 10th DAS. The maximum fruit infestation reduction (80.10% & 85.65%) was recorded from spinosad 45 SC treated plots during respective years. In 2021-22, insecticide spinosad 45 SC @ was founded most superior insecticide and recorded least mean fruit infestation as 14.52 and 12.96 percent after first and second spray. In 2021-22, the maximum fruit infestation reduction (80.31 & 84.05 percent) was recorded from spinosad 45 SC treated plots during 2020-21 & 2021-2022. In 2020-21, the maximum increased yield (97.78 q/ha) and net profit values (Rs. 76565.65) were obtained from spinosad 45 SC @ 0.5ml/l treated plots.

Discussion

The investigated that the highest increased yield (97.78 & 99.5 q/ha) over control was recorded from spinosad treated plots followed by chlorantraniliprole 18.5% SC, emamectin benzoate 5 SG, Spinetoram 12 SC, cypermethrin 25 EC, dimethoate 30 EC, chlorpyriphos 20 EC, *Bacillus thuringiensis* 20 SC and neem oil during respective years. The highest yield was noticed in Spinosad 45% SC and the least with Neem oil. Fundings of Patra *et al*. (2009) [12] and Annem Siva Sankar and Ashwani Kumar (2022) [2] were support to this funding. The maximum cost benefit ratio was recorded from emamectin benzoate 5 SG treated plots followed by chlorantraniliprole 18.5% SC, spinosad 45 SC, spinetora 12 SC, cypermethrin 25 EC, dimethoate 30 Ec, chlorpyriphos 20 EC, *Bacillus thuringiensis* 20 SC and neem oil. This finding was supported by Stanley *et al.* (2007) [18] and Radhakrishnan *et al.* (2022) [17].

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