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Evaluation of Emamectin Benzoate 5% SG for Control of Fruit and Shoot Borer in Brinjal in the Terai Region of West Bengal

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The bio-efficacy, phytotoxicity and residual field trials of Emamectin benzoate 5%SG against fruit and shoot borer in brinjal, was conducted at Regional Research Sub-station (T.Z) UBKV, Kharibari, West Bengal during June to November, 2018-2019 and October to March, 2019-2020 as per the

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recommended agricultural practices. The test chemical Emamectin Benzoate 5% SG was evaluated at different doses of 175, 200, 225 gm/ha and compared Indoxacarb 14.5% SC @ 400 ml/ha, Lambda Cyhalothrin 5% EC @ 300 ml/ha and Thiodicarb 75%WP @ 1000 g/ha as standard check and with an untreated check. Among these Emamectin Benzoate 5% SG @ 225 g/ha was found most effective.

Keywords: Bio-efficacy; fruit and shoot borer; brinjal; Emamectin benzoate.

1. INTRODUCTION

Brinjal, *Solanum melongena* Linnaeus is one of the most important vegetables grown in South and South-East Asia [1] where hot and wet climatic condition prevails [2]. It belongs to the plant family Solanacae and is the most commonly grown vegetable of this family [3]. The brinjal is believed to be domesticated in north-eastern India where wild forms are still grown. It was introduced to India by early traders from Arabia and Persia and to the countries of the eastern and southern shores of the Mediterranean, early in the Middle Ages. In 1806, it was introduced to American gardens primarily as an ornamental plant and was probably introduced into Europe during the Moorish invasion of Spain. It gained popularity in 1890s, as minor vegetable. There are several names by which the crop is known in India, of them brinjal is the most familiar. It is also called '*eggplan*t' or '*aubergine*'. It has been cultivated for many centuries in India, Bangladesh, Pakistan, China, Arabia and Philippines.

Brinjal is grown on nearly 727,000 hectares in India, making the country the second largest producer after China with a 22.97 % world production share [4]. It is an important cash crop for more than 1.4 million small, marginal and resource-poor farmers. Brinjal, being a hardy crop that yields well even under drought conditions, is grown in almost all parts of the country. Major Brinjal producing states in India viz. West Bengal (23.72% production share), Orissa (16.66%), Gujarat (12.01%), Bihar (9.43%) and Madhya Pradesh (8.74%) (National Horticulture Board).

In West Bengal, in spite of its popularity among small and resource-poor farmers, brinjal cultivation is often input intensive, especially for insecticide applications. Brinjal is prone to attack from insect pests and diseases and a number of insect pests attack brinjal starting from time of planting till its harvesting while the most serious and destructive of which is the shoot and fruit borer. Areas having a hot and humid climate are conducive for its distribution and incidence [5]. It causes severe damage in South Asia [1] where yield losses may reach up to 85 to 90 percent [6, 7]. BSFB has become a noxious insect pest in brinjal growing areas of West Bengal. In the state, twice a week applications of insecticides for BSFB control are a common practice of farmers. Extensive use of these conventional insecticides reduces their efficacy against BSFB and increases the cost of production. Since insecticide have several health hazardous effects, there is a need to use environmentally safe insecticides or less number of sprays and doses of insecticides. The present study was carried out to evaluate the efficacy of different insecticides to find out the best one for management of the borer if insecticides have to be considered only.

2. MATERIALS AND METHODS

The field experiment was conducted at the farm of Regional Research Sub-station (Terai one) Kharibari, UBKV, Darjeeling, West Bengal (26.55° N, 88.19° E and 2050 m above mean sea level).

The field experiment was carried out to evaluate the bio-efficacy of Emamectin Benzoate 5% SG at three different concentrations along with three standard checks like, Indoxacarb 14.5% SC, Lambda Cyhalothrin 5% EC and Thiodicarb 75 % WP against Shoot and Fruit borer infesting Brinjal during June to November, 2018-2019 and October to March, 2019-2020 as per the recommended agricultural practices. The experiment was laid out in a randomized block design (RBD) taking seven treatments including an untreated check. About four weeks old seedlings were transplanted to the main field with a spacing of 60 cm x 45 cm at a plot size of 5m x 10m maintaining three replications. The recommended dose of fertilizers was applied to maintain good plant stand throughout the crop period. The test chemical Emamectin Benzoate 5% SG was evaluated at different doses of 175, 200, 225 gm/ha and compared with Indoxacarb 14.5% SC @ 400 ml/ha, Lambda Cyhalothrin 5%

EC @ 300 ml/ha and Thiodicarb 75%WP @ 1000 g/ha as standard check and also with an untreated check where only water was sprayed.

All the treatments were imposed by high volume knapsack sprayer fitted with hollow cone nozzle. Spray schedule were initiated at the first appearance of insect incidence on brinjal plants. During the study period, two sprays were given. Observation on damaged fruits (%) and damaged shoots (%) for fruit and shoot borer (FSB) was taken day before the application and after 3, 7, and 10 days of each spray on five plants per treatment per replication.

The final fruit yield (qt/ha) was recorded after the harvest by consolidating the yield from all the picking. The data were subjected to ANOVA and treatment means were separated by the least significant difference test [8].

2.1 Insect Pest Assessment

The number of damaged shoots and damaged fruits per plant were calculated using the following formula

$$\% \text{ Shoot infestation} = \frac{\text{No. of shoot infested}}{\text{Total no. of shoot}} \times 100$$

$$\% \text{ Fruit infestation (by weight)} = \frac{\text{Weight of infested fruits}}{\text{Weight of total fruits}} \times 100$$

Percent population reduction over control was calculated by using the formula [9]:

> Per cent population reduction over control = (1 - Post treatment count in treatment × pre treatment count in control / pre treatment count in treatment × post treatment count in control * 100

3. RESULTS AND DISCUSSION

3.1 Shoot Damage

It was revealed from the experiment that there was no significant difference among the per cent reduction of shoot damage in all the treatments (Table 1) during *kharif* 2018 before spraying the insecticides having the damage percentage ranged from 6.66 to 6.98 percent. The data pertaining to percent reduction of shoot borer over control showed that in Emamectin Benzoate 5% SG @ 225 gm/ha (90.46) was most effective followed by Emamectin Benzoate 5% SG @ 200 g/ha (88.97) and were significantly superior when compared to the untreated control and standard checks. These were followed by Indoxacarb 14.5% SC @ 400 ml/ha (87.73), while it was (86.86%, 81.41% and 81.04%) in Lambda Cyhalothrin 5% EC @ 300 ml/ha, Thiodicarb 75 % WP @ 1000 ml/ha and Emamectin Benzoate 5% SG @ 175 g/ha whereas in untreated control the shoot damage increased from 6.98 to 16.14 per plant (Table 1).

During *Rabi* 2019 before spraying indicated the similar trend as found in first spraying and there was no significant difference among the percent reduction of shoot damage in all the treatments. Data recorded before the spray application ranged from 5.44 to 5.84 percent. After second spray, the highest percent reduction against shoot damage was noted in Emamectin Benzoate 5% SG @ 225 gm/ha (89.37) and Emamectin Benzoate 5% SG @ 200 gm-/ha (88.13) and showed significantly superiority over the untreated control and standard checks. These were followed Indoxacarb 14.5% SC @ 400 ml/ha (86.69) While it was (85.26, 83.82 and 83.56) in Lambda Cyhalothrin 5 % EC @ 300 ml/ha, Thiodicarb 75 % WP @ 1000 ml/ha and Emamectin Benzoate 5% SG @ 175 g/ha whereas in untreated control the shoot damage increased from 5.84 to 15.33 (Table 3).

3.2 Fruit Damage

Data recorded on damaged fruits before spraying indicated that there was no significant difference among the percent fruit damage in all the treatments having the damaged fruit ranged from 5.18 to 5.54 percent. After the second spray the highest percent reduction of fruit damage was observed in Emamectin Benzoate 5% SG @ 225 gm/ha (89.75) and Emamectin Benzoate 5% SG @ 200 gm/ha (87.94) and were significantly superior when compared to the standard checks and untreated control. Then Indoxacarb 14.5% SC @ 400 ml/ha revealed better performance (86.00) which was followed by Lambda Cyhalothrin 5% EC @ 300 ml/ha (84.63%), Thiodicarb 75 % WP @ 1000 ml/ha (83.25%) and Emamectin Benzoate 5% SG @ 175 g/ha (82.00) whereas in untreated control the shoot damage increased from 5.28 to 16.00 (Table 2).

Table 1. Evaluation of bio-efficacy of Emamectin Benzoate 5% SG against Fruit and Shoot borer (*Leucinodes orbonalis*) shoot damage in Brinjal during *Kharif* 2018-19

Treatment Dose (ml/ha)	% Damaged Shoots Borer /Plant									
	Days after First spray					Days after Second spray				
	Pre-Treatment	3	7	10	% Reduction	Pre-Treatment	3	7	10	% Reduction
T1- Emamectin Benzoate 5% SG @ 175 gm/ha	6.76 (15.07)	4.65 (12.46)	4.33 (12.02)	4.20 (11.83)	59.50	4.47 (12.20)	3.45 (10.7)	3.34 (10.53)	3.06 (10.07)	81.04
T2 - Emamectin Benzoate 5% SG @ 200 gm/ha	6.86 (15.18)	4.80 (12.66)	3.02 (10.00)	3.38 (10.58)	67.41	3.31 (10.49)	3.43 (10.67)	2.86 (9.71)	1.78 (7.66)	88.97
T3 - Emamectin Benzoate 5% SG @ 225 gm/ha	6.82 (15.13)	4.55 (12.32)	2.85 (9.72)	3.08 (10.11)	70.30	3.28 (10.43)	3.21 (10.31)	2.52 (9.11)	1.54 (7.12)	90.46
T4 – Indoxacarb 14.5% SC @ 400 ml/ha	6.76 (15.07)	4.96 (12.86)	4.29 (11.95)	3.64 (11.00)	64.90	4.66 (12.46)	3.52 (10.81)	2.94 (9.85)	1.98 (8.08)	87.73
T5 - Lambda – Cyhalothrin 5% EC @ 300 ml/ha	6.78 (15.09)	4.61 (12.39)	4.16 (11.76)	3.99 (11.52)	61.52	4.33 (12.01)	3.05 (10.06)	3.12 (10.17)	2.12 (8.36)	86.86
T6 - Thiodicarb 75%WP @ 1000 ml/ha	6.66 (14.96)	4.53 (12.29)	3.74 (11.16)	4.27 (11.92)	58.82	4.35 (12.04)	3.06 (10.08)	3.16 (10.24)	3.00 (9.94)	81.41
T7 - Untreated control	6.98 (15.32)	7.68 (16.09)	8.27 (16.71)	10.37 (18.78)	0.00	13.99 (21.97)	14.12 (22.07)	14.22 (22.15)	16.14 (23.69)	0.00
SEM	**0.14**	**0.11**	**0.07**	**0.12**		**0.07**	**0.09**	**0.16**	**0.11**	
CD (p=0.05)	**0.42**	**0.32**	**0.21**	**0.37**		**0.20**	**0.27**	**0.49**	**0.33**	

** Figures in the parentheses are arc sine transformed values*

Table 2. Evaluation of bio-efficacy of Emamectin Benzoate 5% SG against Fruit and Shoot borer (*Leucinodes orbonalis*) fruit damage in Brinjal *Kharif* 2018-19

Treatment Dose (ml/ha)	% Damaged Fruits Borer / Plant									
	Days After First Spray					Days After Second Spray				
	Pre-Treatment	3	7	10	% Reduction	Pre-Treatment	3	7	10	% Reduction
T1- Emamectin Benzoate 5% SG @ 175 gm/ha	5.18 (13.15)	4.58 (12.36)	3.16 (10.24)	4.08 (11.66)	65.16	4.17 (11.78)	3.92 (11.40)	3.12 (10.17)	2.88 (9.77)	82.00
T2 - Emamectin Benzoate 5% SG @ 200 gm/ha	5.48 (13.54)	4.16 (11.77)	3.01 (10.00)	3.33 (10.52)	71.56	3.62 (10.96)	3.47 (10.74)	2.64 (9.34)	1.93 (7.99)	87.94
T3 - Emamectin Benzoate 5% SG @ 225 gm/ha	5.42 (13.46)	4.08 (11.65)	2.87 (9.75)	3.12 (10.18)	73.36	3.47 (10.73)	3.16 (10.23)	2.38 (8.87)	1.64 (7.36)	89.75
T4 – Indoxacarb 14.5% SC @ 400 ml/ha	5.46 (13.51)	4.39 (12.09)	3.11 (10.16)	3.53 (10.82)	69.85	3.95 (11.46)	3.71 (11.11)	2.92 (9.82)	2.24 (8.61)	86.00
T5 - Lambda – Cyhalothrin 5% EC @ 300 ml/ha	5.28 (13.28)	4.76 (12.61)	3.38 (10.59)	3.76 (11.18)	67.89	4.43 (12.15)	4.25 (11.90)	2.86 (9.74)	2.46 (9.02)	84.63
T6 - Thiodicarb 75%WP @ 1000 ml/ha	5.54 (13.61)	4.74 (12.57)	3.43 (10.68)	3.89 (11.37)	66.78	4.46 (12.19)	4.01 (11.55)	3.08 (10.11)	2.68 (9.42)	83.25
T7 - Untreated control	5.28 (13.26)	8.27 (16.71)	6.12 (14.33)	11.71 (20.01)	-	11.16 (19.52)	13.39 (21.47)	14.28 (22.20)	16.00 (23.58)	-
SEm	**0.13**	**0.03**	**0.05**	**0.09**		**0.06**	**0.12**	**0.11**	**0.13**	
CD (p=0.05)	**0.41**	**0.11**	**0.17**	**0.27**		**0.18**	**0.38**	**0.33**	**0.40**	

** Figures in the parentheses are arc sine transformed values*

Table 3. Evaluation of bio-efficacy of Emamectin Benzoate 5% SG against Fruit and Shoot borer (*Leucinodes orbonalis*) shoot damage in Brinjal during *Rabi* 2019-2020

Treatment Dose (ml/ha)	% Damaged Shoots Borer/Plant									
	Days After First Spray					Days After Second Spray				
	Pre-Treatment	3	7	10	% Reduction	Pre-Treatment	3	7	10	% Reduction
T1- Emamectin Benzoate 5% SG @ 175 gm/ha	5.44 (13.48)	3.75 (11.16)	3.60 (10.93)	3.42 (10.65)	71.43	3.49 (10.76)	2.77 (9.59)	2.58 (9.24)	2.52 (9.13)	83.56
T2 - Emamectin Benzoate 5% SG @ 200 gm/ha	5.82 (13.94)	4.07 (11.64)	2.81 (9.65)	2.76 (9.57)	76.94	2.91 (9.82)	2.56 (9.20)	2.44 (8.98)	1.82 (7.75)	88.13
T3 - Emamectin Benzoate 5% SG @ 225 gm/ha	5.76 (13.89)	3.84 (11.30)	2.77 (9.58)	2.53 (9.15)	78.86	2.71 (9.46)	2.41 (8.93)	2.30 (8.71)	1.63 (7.34)	89.37
T4 – Indoxacarb 14.5% SC @ 400 ml/ha	5.68 (13.79)	4.16 (11.77)	3.91 (11.41)	3.17 (10.25)	73.52	3.60 (10.94)	2.95 (9.90)	2.67 (9.40)	2.04 (8.21)	86.69
T5 - Lambda – Cyhalothrin 5% EC @ 300 ml/ha	5.54 (13.61)	3.76 (11.18)	3.54 (10.84)	3.26 (10.4)	72.77	3.91 (11.41)	3.40 (10.62)	2.93 (9.86)	2.26 (8.65)	85.26
T6 - Thiodicarb 75%WP @ 1000 ml/ha	5.62 (13.71)	3.83 (11.28)	3.67 (11.05)	3.60 (10.94)	69.92	3.16 (10.24)	2.59 (9.25)	2.52 (9.13)	2.48 (9.06)	83.82
T7 - Untreated control	5.84 (13.97)	8.67 (17.12)	9.98 (18.41)	11.97 (20.24)	-	13.99 (21.97)	13.39 (21.47)	14.28 (22.20)	15.33 (23.05)	-
SEm	**0.15**	**0.09**	**0.03**	**0.09**		**0.06**	**0.08**	**0.08**	**0.10**	
CD (p=0.05)	**0.46**	**0.28**	**0.10**	**0.27**		**0.20**	**0.24**	**0.25**	**0.30**	

** Figures in the parentheses are arc sine transformed values.*

Table 4. Evaluation of bio-efficacy of Emamectin Benzoate 5% SG against Fruit and Shoot borer (*Leucinodes orbonalis*) fruit damage in Brinjal during *Rabi* 2019-2020

Treatment Dose (ml/ha)	% Damaged Fruits Borer /Plant									
	Days After First Spray					Days After Second Spray				
	Pre-Treatment	3	7	10	% Reduction	Pre-Treatment	3	7	10	% Reduction
T1- Emamectin Benzoate 5% SG @ 175 g/ha	4.68 (12.49)	4.14 (11.74)	3.77 (11.19)	3.36 (10.57)	71.93	3.54 (10.84)	2.85 (9.73)	2.76 (9.56)	2.68 (9.40)	82.89
T2 - Emamectin Benzoate 5% SG @ 200 g/ha	4.64 (12.44)	3.52 (10.82)	3.06 (10.08)	2.76 (9.57)	76.94	2.94 (9.87)	2.55 (9.19)	2.34 (8.80)	2.18 (8.49)	86.08
T3 - Emamectin Benzoate 5% SG @ 225 g/ha	4.62 (12.41)	3.48 (10.75)	2.96 (9.90)	2.55 (9.20)	78.70	2.69 (9.43)	2.45 (9.00)	2.22 (8.57)	1.74 (7.58)	88.89
T4 – Indoxacarb 14.5% SC @ 400 ml/ha	4.48 (12.22)	3.60 (10.94)	3.24 (10.37)	2.92 (9.85)	75.61	3.05 (10.05)	2.55 (9.19)	2.46 (9.02)	2.32 (8.76)	85.19
T5 - Lambda – Cyhalothrin 5% EC @ 300 ml/ha	4.54 (12.3)	4.10 (11.68)	3.81 (11.26)	3.51 (10.8)	70.68	3.66 (11.01)	2.91 (9.81)	2.66 (9.39)	2.48 (9.06)	84.16
T6 - Thiodicarb 75%WP @ 1000 ml/ha	4.68 (12.49)	4.00 (11.54)	3.76 (11.19)	3.29 (10.44)	72.51	3.39 (10.6)	2.90 (9.81)	2.70 (9.46)	2.60 (9.28)	83.40
T7 - Untreated control	4.72 (12.54)	7.39 (15.78)	9.98 (18.41)	11.97 (20.24)	0.00	13.39 (21.47)	13.99 (21.97)	14.24 (22.17)	15.66 (23.31)	0.00
SEM	**0.09**	**0.04**	**0.04**	**0.07**		**0.10**	**0.06**	**0.07**	**0.17**	
CD (p=0.05)	**0.28**	**0.12**	**0.13**	**0.23**		**0.30**	**0.18**	**0.23**	**0.53**	

** Figures in the parentheses are arc sine transformed values. DAS – Days after spraying*

Table 5. Effect of Emamectin Benzoate 5% SG on yield of brinjal

Treatment	Yield (tons/ha)	
	Season I	**Season II**
T1- Emamectin Benzoate 5% SG @ 175 g/ha	21.34 (27.51)	20.88 (27.19)
T2 - Emamectin Benzoate 5% SG @ 200 g/ha	22.86 (28.56)	22.16 (28.08)
T3 - Emamectin Benzoate 5% SG @ 225 g/ha	23.12 (28.74)	22.84 (28.55)
T4 – Indoxacarb 14.5% SC @ 400 ml/ha	22.38 (28.23)	21.86 (27.88)
T5 - Lambda – Cyhalothrin 5% EC @ 300 ml/ha	21.68 (27.75)	20.92 (27.22)
T6 - Thiodicarb 75%WP @ 1000 ml/ha	21.14 (27.37)	20.64 (27.02)
T7 - Untreated control	19.26 (26.03)	18.46 (25.45)
SEm	**0.19**	**0.24**
CD (p=0.05)	**0.59**	**0.73**

Figures in the parentheses are arc sine transformed values

During Rabi 2019 before spraying indicated similar trends as that of first spraying that fruit damage percent reduction did not show any significant difference among all the treatments. Data recorded before the spray application ranged from 4.48 to 4.72. After the second spray the highest reduction of fruit damage was recorded in Emamectin Benzoate 5% SG @ 225 gm/ha (88.89%) and Emamectin Benzoate 5% SG @ 200 gm/ha (86.08%) and were significantly superior over untreated control and standard checks. Then Indoxacarb 14.5% SC @ 400 ml/ha had shown higher fruit reduction per cent (85.19%) followed by Lambda Cyhalothrin 5 % EC @ 300 ml/ha, Thiodicarb 75 % WP @ 1000 ml/ha and Emamectin Benzoate 5% SG @ 175 gm/ha (84.16%, 83.40% and 83.40%), respectively (Table 4).

From overall observation, it was found that the test chemical Emamectin Benzoate 5% SG @ 225 gm/ha performed better than other doses of the same chemical, and standard checks like Indoxacarb 14.5% SC, Lambda Cyhalothrin 5% EC @ 300 ml/ha and Thiodicarb 75%WP @ 1000 g/ha. This finding is supported by Shivalingaswamy et al. [10] and Sujay et al. [11] they reported that Emamectin Benzoate was the most effective insecticides against brinjal fruit & shoot borer. Anwar et al. [12] also revealed that Emamectin Benzoate was most effective against brinjal fruit borer by evaluating six different insecticides viz,. spinosad, chloropyriphos, profenophos, fenvalerate and cypermethrin which is in conformity with the findings of present work. Pal [13] observed that Emamectin Benzoate 2.8EC @14g a.i./ha controlled the brinjal shoot and fruit borer most effectively followed by Indoxacarb, spinosad, deltamethrin, cypermethrin, carbofuran and azadirachtin which is confirmed our present findings again. This suggests its effectiveness as a pest control measure, leading to improved crop health and productivity [14] Emamectin benzoate 5 SG applied at 200 grams per hectare has been observed to result in comparatively lower fruit and shoot damage and higher fruit yield in brinjal (eggplant). Roy et al. [15] reported that applying emamectin benzoate 5 SG at a rate of 11 grams of active ingredient per hectare is effective in decreasing pod and grain damage in pigeon pea crops.

3.3 Yield

As regards to yield, the highest yield of 22.84 - 23.12 tone/ha recorded was found when Emamectin Benzoate 5% SG was used at 225 gm/ha, followed by Emamectin Benzoate 5% SG @ 200 g/ha (22.16 - 22.86), Indoxacarb 14.5% SC (21.86 - 22.38) at 200 gm/ha, Lambda Cyhalothrin 5 % EC (20.92 - 21.68) at 300 ml/ha and Thiodicarb 75 % WP (20.64 - 21.14) at 1000 ml/ha of water (Table 5). U. S. [16] also observed more or less similar type of results in term of yield (t/ha).

4. CONCLUSION

The results revealed that all the Emamectin Benzoate 5% SG treatments were highly effective in suppressing the damage caused by Fruit and Shoot borer in Brinjal crop. The treatments Emamectin Benzoate 5% SG @ 225 gm/ha and Emamectin Benzoate 5% SG @ 200 gm/ha were on par with each other. Hence it is suggested that Emamectin Benzoate 5% SG @ 225 gm/ha can be used for controlling Fruit and Shoot borer in Brinjal crop.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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