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Evaluation of Pre-Mix Molecule, Emamectin Benzoate 5% + Lufenuron 40% Wg against Fruit and Shoot Borer in Brinjal

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ABSTRACT

The experiment was conducted to evaluate the bio-efficacy of ready-mix formulation of Emamectin Benzoate 5% + Lufenuron 40% WG against brinjal fruit and shoot borer, *Leucinodes orbonalis* (Guen.) at Agricultural Research Station- Banswara (Rajasthan) during the year 2019-20 and 2020-21. The experiment included nine treatments *viz.* emamectin benzoate 5% + lufenuron 40% WG @ 50, 60, 70 g ha^{-1}; Emamectin benzoate 5% SG @ 200g ha^{-1}; Lufenuron 5.4% EC @ 600 ml ha^{-1}; Chlorantraniliprole 18.5% SC @ 200 ml ha^{-1}; Betacyfluthrin 8.49% + Imidacloprid 19.81% OD @ 200 ml ha^{-1}; untreated check and one phytotoxicity treatment, which were replicated thrice. The results revealed that maximum percent control (85.90 & 86.25 % during the years 2019-20 and 2020-21, respectively) was recorded in Emamectin benzoate 5% w/w + Lufenuron 40% w/w WG @ 70 g ha^{-1} and was statistically at par with its lower dose of 60 g ha^{-1}. The same trend was followed in the case of fruit yield.

Keywords: Efficacy, ready mix molecule, Emamectin Benzoate 5% + Lufenuron 40% WG, fruit and shoot borer, brinjal.

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INTRODUCTION

Brinjal (*Solanum melongena* L.), also known as aubergine/ guinea squash/ eggplant/*King of vegetables*, is a highly consumed vegetable in Southern and Eastern parts of Asia, including India. Globally, India is the second largest brinjal producing country after China (Anonymous 2022). However, there are several limiting factors such as insect pests, diseases and weeds that are associated with the declined cultivation of brinjal. Brinjal is likely to be attacked by 140 species of insect pest (Sharma and Tayde 2017), the major ones being, shoot and fruit borer, *Leucinodes orbonalis* (Guen.); whitefly, *Bemisia tabaci* (Genn.); leaf hopper, *Amrasca biguttula biguttula* (Ishida); *Epilachna* beetle, *Henosepilachna vigintioctopunctata* (Fab.) and non-insect pest like red spider mite, *Tetranychus* species. Out of these pests, brinjal shoot and fruit borer (BSFB), Leucinodes orbonalis (Guen.) is one of the most serious pests and decisive constraints of successful brinjal production. It belongs to the family crambidae of order Lepidoptera.

In India, BSFB has a country wide distribution and has been categorized as the most destructive and serious pest causing huge losses in brinjal. It damages all life stages of eggplant thereby, decreases the production of the crop (Gautam *et al.* 2019) and is the limiting factor for impairing both qualitative and quantitative harvest of brinjal (Rahman *et al.* 2019). The infestation of this pest on brinjal can be as high as 75 to 92 per cent (Mane and Kumar, 2019), and starts after a few weeks of transplantation. The caterpillars bore into the stems or petioles of leaves and feed on internal tissues, as a result of which, affected stems get weakened and plants exhibit symptoms of drooping. After fruit formation, they enter through the calyx and then into the fruit, plugging the holes with excreta, leaving no visible sign of infestation. Large holes seen on the fruits are exit holes. Such fruits are rendered unfit for human consumption and get fewer prices in the market. Researches show a reduction in yield due to this pest as high as 70–92%. Infestation by this pest also results in reduced vitamin C content, up to 80 percent, in infested brinjal fruit.

Rigorous use of pesticides has led to the development of high level of insecticide resistance to a number of conventional insecticides in pests, along with, growing concerns about the harmful residues in food; effects on non-target organisms and development of insecticide resistance have developed the need of new and safer molecules. Hence, there is great demand and need for new green chemistry molecules with novel mode of action for the management of shoot and fruit borer.

MATERIAL AND METHODS

The field experiments were conducted at Agricultural Research Station, Borwat Farm, Banswara (Rajasthan) during 2019-20 and 2020-21 to evaluate the efficacy of different doses of Emamectin benzoate 5% w/w + Lufenuron 40% w/w WG as foliar spray against shoot and fruit borer of eggplant. The trial was laid out in randomized block design (RBD) with three replications and nine treatments including one phytotoxicity treatment, the details of which are given in Table 1. The seedlings of eggplant (variety Kavach) were transplanted at 90 × 60 cm spacing. The plot size was kept 5.40 m × 4.80 m. All recommended package of practices were followed to raise the crop, except plant protection measures. The knapsack sprayer fitted with hollow cone nozzle and 500-liter water ha^{-1} was used to impose the spray. First spray was applied when target pests population reached Economic Threshold Level and subsequent spray was given 15 days after 1stspray.

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Table 1: Treatment details

Treatments	Treatments details	Dose (g ai ha^{-1})	Product Dose (g or ml ha^{-1})
T_1	Untreated	-	-
T_2	Emamectin benzoate 5% + Lufenuron 40% WG	22.5 (2.5+20)	50
T_3	Emamectin benzoate 5% + Lufenuron 40% WG	27 (3+24)	60
T_4	Emamectin benzoate 5% + Lufenuron 40% WG	31.5 (3.5+28)	70
T_5	Emamectin benzoate 5% + Lufenuron 40% WG*	63 (7+56)	140
T_6	Emamectin benzoate 5% SG	10	200
T_7	Lufenuron 5.4% EC	30	600
T_8	Chlorantraniliprole 18.5% SC (w/w)	40	200
T_9	Beta-cyfluthrin 8.49% + Imidacloprid 19.81% OD	60 (18+42)	200

*For phytotoxicity test only

Observations on per cent fruit damage caused by *Leucinodes orbonalis* were recorded by counting total number of fruits and damaged fruits per plot prior to application and at 5, 10 and 15 days after each spray. Mean fruit damage percentage was calculated as below:

$$\text{Mean fruits damage (\%)} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

The visual observations on the phytotoxicity symptoms *viz.* leaf injury, wilting, stunting, vein clearing, necrosis, chlorosis, epinasty and hyponasty *etc.* if any, on the crop due to application of test molecules (Emamectin benzoate 5% w/w + Lufenuron 40% w/w WG @ 140g ha^{-1}) were recorded at 0, 1, 3, 5, 7 and 10 days after each spray using the scores in Table 2.

Table 2: Phytotoxicity rating on brinjal plant

Score	Percent crop affected	Score	Percent crop affected
0	No adverse effect	**6**	51-60
1	1-10	**7**	61-70
2	11-20	**8**	71-80
3	21-30	**9**	81-90
4	31-40	**10**	91-100
5	41-50		

RESULTS AND DISCUSSION

The efficacy of different doses of pre-mix emamectin benzoate 5% + lufenuron 40% WG @. 50, 60, 70 g ha^{-1} ; emamectin benzoate 5% SG @ 200g ha^{-1} ; Lufenuron 5.4% EC @ 600 ml ha^{-1} ; Chlorantraniliprole 18.5% SC @ 200 ml ha^{-1} and Betacy fluthrin 8.49% + Imidacloprid 19.81% OD @ 200 ml ha^{-1} were evaluated against brinjal shoot and fruit borer under field conditions and the results are summarized in Table 3 & 4.

During the year 2019-20, the fruit damage by shoot and fruit borer was uniform and no significant difference was observed among the treatments/plots (3.77 to 5.57) per cent before first spray. The observations recorded at different days after two sprays of insecticides depicted that the lowest per cent fruit damage 2.69 % was recorded in emamectin benzoate 5% w/w + lufenuron 40% w/w WG @ 70 g ha^{-1} with highest fruit yield of 15.25 t ha^{-1} and statistically at par with its lower dose *i.e.* emamectin benzoate 5% w/w + lufenuron 40% w/w WG @ 60 g ha^{-1}. Chlorantraniliprole 18.5% SC (w/w) @ 200 ml ha^{-1} and emamectin benzoate 5% SG @ 200 g ha^{-1} were found the next best treatments. Whereas, maximum fruit damage with mean of 19.09 per cent was recorded in untreated check (Table 3).

During the year 2020-21, the fruit damage of shoot and fruit borer did not vary significantly in all the plots before first spray (3.80 to 5.13 per cent fruit damage). The observations recorded at different days after two sprays of insecticides showed that the lowest per cent fruit damage 3.71 % was recorded in emamectin benzoate 5% w/w + lufenuron 40% w/w WG @ 70 g ha^{-1} with highest fruit yield 17.65 t ha^{-1} and statistically at par with its lower dose *i.e.* emamectin benzoate 5% w/w + lufenuron 40% w/w WG @ 60 g ha^{-1}. Chlorantraniliprole 18.5% SC (w/w) @ 200 ml ha^{-1} and emamectin benzoate 5% SG @ 200 g ha^{-1} were found next best treatments. Whereas, maximum fruit damage with mean of 17.46 per cent was recorded in untreated check (Table 4).

The visual observation on phytotoxicity symptoms revealed that emamectin benzoate 5% w/w + lufenuron 40% w/w WG did not cause phytotoxicity in any form (leaf injury, wilting, stunting, vein clearing, necrosis, chlorosis, epinasty and hyponasty) even spray up to 140 g ha^{-1}.

Effect on yield (t/ha)

The maximum fruit yield of 15.25 and 17.65 t ha^{-1} was recorded in emamectin benzoate 5% w/w + lufenuron 40% w/w WG @ 70 g ha^{-1} during the year 2019-20 and 2020-21, respectively. It was statistically at par with its lower doses *i.e.* emamectin benzoate 5% w/w + lufenuron 40% w/w WG @ 60 g ha^{-1}, during both the years. Whereas, minimum fruit yield of 11.78 and 13.19 t ha^{-1} was recorded in untreated check during 2019-20 and 2020-21, respectively (Table 5). In the present study, emamectin benzoate 5% + lufenuron 40% WG @ 70 and 60 g ha^{-1} provided good protection against shoot and fruit borer in brinjal with higher fruit yield.

These results are in accordance with the study conducted by Chundawat *et al.* (2020) as both the doses of Emamectin benzoate 5% + Lufenuron 40% WG were found very effective against ber fruit borer, *Meridarchis scyrodes* Meyrick. Various other studies also showed that the plots treated with Emamectin benzoate 5 SG and flubendiamide 20 WG had low fruit damage with high yield in brinjal (Kumar and Devappa 2006; Shah *et al.* 2012; Awal *et al.* 2014; Yousafi *et al.* 2015; Satyanarayana and Arunakumara 2017; Mane and Kumar 2019). In certain other experiments conducted, emamectin benzoate + abamectin, lufenuron 5EC (Rahman *et al.* 2019) and

Table 3: Effect of Emamectin benzoate 5% w/w + Lufenuron 40% w/w WG against shoot and fruit borer of brinjal during 2019-20

Treatments	Per cent Fruit damage due to *Leucinodes orbonalis*							Mean	% Reduction over control
	Pre count	Days after spraying							
		First spray*			Second spray*				
		5	10	15	5	10	15		
Untreated check	5.23 (13.19)	8.20 (16.59)	14.20 (22.06)	17.43 (24.65)	19.90 (26.47)	24.63 (29.74)	30.20 (33.31)	19.09 (25.89)	-
Emamectin benzoate 5% + Lufenuron 40% WG @ 50g ha^{-1}	4.60 (12.30)	3.10 (10.09)	4.43 (12.13)	5.60 (13.64)	5.23 (13.18)	7.07 (15.40)	7.97 (16.34)	5.57 (13.62)	70.82
Emamectin benzoate 5% + Lufenuron 40% WG @ 60g ha^{-1}	5.07 (12.97)	1.83 (7.77)	2.80 (9.63)	3.73 (11.13)	3.47 (10.69)	4.40 (12.06)	6.00 (14.16)	3.71 (11.08)	80.56
Emamectin benzoate 5% + Lufenuron 40% WG @ 70g ha^{-1}	4.53 (12.28)	1.33 (6.60)	1.87 (7.78)	2.87 (9.61)	2.37 (8.75)	3.23 (10.29)	4.50 (12.23)	2.69 (9.40)	85.90
Emamectin benzoate 5% SG @ 200 g ha^{-1}	5.57 (13.61)	2.97 (9.90)	4.07 (11.62)	5.50 (13.54)	4.87 (12.73)	6.47 (14.72)	7.93 (16.33)	5.30 (13.30)	72.24
Lufenuron 5.4% EC @ 600 ml ha^{-1}	4.70 (12.48)	3.40 (10.58)	6.33 (14.57)	9.53 (17.96)	8.23 (16.67)	9.37 (17.80)	12.60 (20.76)	8.24 (16.69)	56.83
Chlorantraniliprole 18.5% SC (w/w) @ 200 ml ha^{-1}	4.13 (11.70)	2.63 (9.26)	3.50 (10.74)	4.60 (12.35)	4.63 (12.41)	5.83 (13.97)	7.20 (15.55)	4.73 (12.56)	75.22
Betacyfluthrin 8.49% + Imidacloprid 19.81% OD @ 200 ml ha^{-1}	3.77 (11.16)	3.70 (11.08)	6.70 (14.97)	11.13 (19.47)	9.57 (18.01)	10.97 (19.32)	12.00 (20.21)	9.01 (17.45)	52.80
0.69	**0.60**	**0.73**	**0.85**	**0.71**	**0.67**	**0.81**	**0.56**	-	
NS	**1.82**	**2.21**	**2.57**	**2.14**	**2.02**	**2.45**	**1.70**	-	

*Mean of three replications, Figures in parentheses are arcsine transformed values

Table 4: Effect of Emamectin benzoate 5% w/w + Lufenuron 40% w/w WG against shoot and fruit borer of brinjal during 2020-21

Treatments	Per cent Fruit damage due to *Leucinodes orbonalis*							Mean	% Reduction over control
	Pre count	Days after spraying							
		First spray*			Second spray*				
		5	10	15	5	10	15		
Untreated check	4.93 (12.79)	8.63 (17.04)	12.03 (20.23)	15.27 (22.95)	18.43 (25.36)	22.83 (28.52)	27.53 (31.64)	17.46 (24.66)	-
Emamectin benzoate 5% + Lufenuron 40% WG @ 50g ha^{-1}	4.67 (12.42)	2.47 (8.96)	3.13 (10.16)	4.10 (11.64)	4.07 (11.60)	5.93 (14.04)	8.07 (16.40)	4.63 (12.37)	73.48
Emamectin benzoate 5% + Lufenuron 40% WG @ 60g ha^{-1}	5.13 (13.07)	1.80 (7.69)	2.13 (8.32)	2.97 (9.87)	2.87 (9.68)	4.57 (12.32)	5.77 (13.83)	3.35 (10.51)	80.81
Emamectin benzoate 5% + Lufenuron 40% WG @ 70g ha^{-1}	4.40 (12.07)	1.40 (6.75)	1.57 (7.09)	2.13 (8.30)	2.00 (8.03)	3.10 (10.07)	4.20 (11.78)	2.40 (8.85)	86.25
Emamectin benzoate 5% SG @ 200 g ha^{-1}	3.80 (11.15)	2.37 (8.82)	2.90 (9.70)	3.77 (11.15)	3.70 (11.06)	5.83 (13.92)	8.23 (16.61)	4.47 (12.20)	74.39
Lufenuron 5.4% EC @ 600 ml ha^{-1}	5.07 (12.95)	3.63 (10.96)	5.30 (13.29)	7.30 (15.66)	7.03 (15.33)	8.00 (16.40)	11.73 (19.96)	7.17 (15.52)	58.93
Chlorantraniliprole 18.5% SC (w/w) @ 200 ml ha^{-1}	4.43 (12.09)	2.20 (8.42)	2.80 (9.61)	3.40 (10.61)	3.30 (10.43)	4.97 (12.78)	6.63 (14.91)	3.88 (11.35)	77.77
Betacyfluthrin 8.49% + Imidacloprid 19.81% OD @ 200 ml ha^{-1}	3.97 (11.44)	4.13 (11.64)	6.23 (14.43)	7.60 (15.98)	8.37 (16.80)	10.30 (18.70)	13.80 (21.78)	8.41 (16.83)	51.83
0.81	**0.69**	**0.77**	**0.66**	**0.85**	**0.84**	**1.01**	**0.62**	-	
NS	**2.10**	**2.35**	**2.00**	**2.59**	**2.56**	**3.07**	**1.88**	-	

*Mean of three replications, Figures in parentheses are arcsine transformed values

Table 5: Effect of Emamectin benzoate 5% w/w + Lufenuron 40% w/w WG on yield of brinjal during 2019-20 and 2020-21

S. No.	Treatments & Doses	Yield (t/ha)	
		2019-20	2020-21
1	Untreated check	11.78	13.19
2	Emamectin benzoate 5% + Lufenuron 40% WG @ 50g ha^{-1}	13.56	15.48
3	Emamectin benzoate 5% + Lufenuron 40% WG @ 60g ha^{-1}	14.57	16.66
4	Emamectin benzoate 5% + Lufenuron 40% WG @ 70g ha^{-1}	15.25	17.65
5	Emamectin benzoate 5% SG @ 200 g ha^{-1}	13.62	15.35
6	Lufenuron 5.4% EC @ 600 ml ha^{-1}	12.76	14.57
7	Chlorantraniliprole 18.5% SC (w/w) @ 200 ml ha^{-1}	13.70	15.74
8	Betacyfluthrin 8.49% + Imidacloprid 19.81% OD @ 200 ml ha^{-1}	12.51	14.30
	SEm ±	**0.49**	**0.54**
	CD at 5 %	**1.50**	**1.63**

Emamectin benzoate 1% + Cartap hydrochloride 25% SG (Dey 2019) were found effective against brinjal fruit and shoot borer. A ready-mix formulation (triazophos 40% + cypermethrin 4%) also offered good protection against the borer and recorded lowest shoot and fruit damage (Chakraborti and Sarkar 2011). Kazi *et al*. (2021) also evaluated several combination products (spinosad + buprofezin, abamectin + buprofezin, emamectin benzoate + lufenuron) along with biorational based IPM package against tomato fruit borer and found reduction in percentage of fruit infestation.

CONCLUSION

It can be concluded that emamectin benzoate 5% + lufenuron 40% WG @ 70 g ha^{-1} and 60 g ha^{-1} proved to be most effective in terms of per cent reduction in shoot and fruit damage and also gave higher fruit yield of brinjal.

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