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Comparative efficacy of certain bio-rational insecticides and *Bacillus thuringiensis* based bio-insecticides against *Leucinodes orbonalis* Guen. in brinjal

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ABSTRACT

Field trails were laid out during two *rabi* seasons 2007-08 and 2008-09 with F_1 brinjal hybrid Anamika to investigate the comparative efficacy of new introduced insecticidal molecules and *Bt* formulations against shoot and fruit borer, *Leucinodes orbonalis* Guen. in brinjal under *terai* conditions. The studies revealed that indoxacarb 14.5% SC to be the most effective treatment against the pest and it was at par with spinosad, emamectin benzoate, diafenthiuron, endosulfan and halt during both the years. The maximum shoot and fruit damage was found in delfin treated plots, i.e. 11.09 and 13.17 per cent, respectively while in the control was 25.78 and 33.43 per cent respectively. The fruit yield recorded during the study revealed that indoxacarb received higher fruit yield, i.e. 232.51 q/ha and per cent increase over control (57.94%), which was superior over all other treatments. Amongst *Bt* formulations, halt treated plots obtained maximum fruit yield (207.52 q/ha) while delfin treatment recorded minimum fruit yield (192.54 q/ha), but it was significantly higher to untreated control during both the years of study. The investigation revealed that there was consistency in effectiveness and yield increase potential of various insecticidal and *Bt* formulation treatments during both the experimental years.

INTRODUCTION

Brinjal is one of the extensively grown vegetable crop occupies 0.60 m. ha area with the total production of 10.37 million tonnes and the average productivity is 17.3 tonnes/ha which is low as compare to potential yields obtained up to 24.68 tonnes/ha in the field demonstrations conducted at Dehradun (Uttarakhand). The low average productivity in brinjal is mainly due to poor availability and adoption of high yielding varieties/ hybrids, production and protection technologies coupled with encountering the vagaries of seasonal weather pattern. Amongst various insect-pests attack brinjal crop, shoot and fruit borer, *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae) has become a major limiting factor in commercial cultivation of the crop in Uttarakhand causing an extensive shoot and fruit damage. The losses due to this pest have been estimated to range from 39.2 to 70.00 per cent (Singh and Sidhu, 6; Tripathi and Senapati, 8). Excessive and indiscriminate use of insecticides to control this devastating pest not only posed the residue problem in the fresh vegetable, but also caused secondary pest outbreaks like white fly and mites. Although several insecticides have been recommended for the control of shoot and fruit borer in brinjal, yet the changing agro-environmental conditions needed to investigate and assess some newly introduced insecticidal molecules for the effective control. On the other hand, there are also several *Bacillus thuringiensis* (*Bt*) based bio-insecticides introduced in the recent past and available in the market which need to be evaluated against this pest as they are preferred over insecticides owing to their eco-friendly nature and lack of harmful residues and also resulting in slower development of resistance compared to chemical insecticides (Basu, 1; Mahesh and Men, 2). Keeping these points in view, present investigations were undertaken to find out the relative efficacy of some newly introduced insecticidal molecules and to explore the feasibility of utilizing *Bt*-based bio-insecticides for the effective and eco-friendly management of brinjal shoot and fruit borer under field conditions.

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MATERIALS AND METHODS

The investigation was carried out at Aasanbagh near G.B. Pant University of Agriculture and Technology, Krishi Vigyan Kendra, Dhakrani, Dehradun for two consecutive years (2007-08 and 2008-09) to find out the efficacy of some newly introduced insecticidal molecules and few *Bacillus thuringiensis* based bio-insecticides. The insecticidal molecules *viz.*, spinosad, indoxacarb, emamecin benzoate, diafenthiuron and four *Bt*-based bio-insecticides namely Halt, Biolep, Defin, Dipel, with one conventional insecticide (endosulfan) were used in the experiment against brinjal shoot

and fruit borer, *Leucinodes orbonalis* Guen. The F_1 hybrid 'Anamika' was raised at 60 cm × 50 cm spacing adopting recommended agronomic practices in a randomized block design (RBD) with 10 treatments including one untreated control, each replicated thrice. The size of each plot was 20 m^2 (5 m x 4 m) and separated from the other neighbouring plots by 1 m. Four-week-old seedlings were uprooted and then transplanted in all the plots of insecticidal treatments in third week of September during 2008 and 2009. All the insecticidal molecules and *Bt*-based formulations were applied as foliar spray thrice at 15 days interval commencing from the 30 days after transplanting. In all treatments, dhanuvit @1 ml per litre of insecticidal solution was used as sticker. Spraying of insecticides and *Bt* formulations was done with knapsack sprayer using 500 l of spray fluid/ha. Observations on per cent shoot infestation were recorded at 5, 10 and 15 days of each spray from ten randomly selected plants of each plot. For per cent fruit damage, the numbers of infested and healthy as well as weight of healthy and infested fruits from ten observational plants were recorded at each picking. The total weight of healthy and infested fruits for all pickings was pooled and total yield per plot was computed and converted in to quintals per hectare.

RESULTS AND DISCUSSION

The per cent incidence of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen and yield of healthy marketable fruits amongst various treatments during 2007-2008 and 2008-09 are presented in Table 1 and 2, respectively. The shoot and fruit infestation data in different newly introduced insecticidal molecule treatments and *Bacillus thuringiensis* based bio-insecticides resulted in significant reduction of the borer and demonstrated their superiority over untreated control significantly during both the experimental years on the basis of mean of three replications. The results based on two year pooled mean on shoot and fruit damage by *L. orbonalis* revealed that a variation of 2.26 to 11.09 per cent shoot damage and 3.78 to 13.17 per cent fruit damage in the plots treated with bio-rational insecticides including endosulfan and *Bt*-formulations were recorded during the investigation. Based on two years pooled mean, shoot damage was significantly less in plots treated with indoxacarb (2.26%) followed by spinosad (2.51%), emamectin benzoate (2.40%),

Table 1. Effect of certain bio-rational insecticides and *Bt*-based bio-insecticides on shoot and fruit damage in brinjal by shoot and fruit borer.

Treatment	Conc. (%)	Mean shoot damage (%)		Pooled mean	Mean fruit damage		Pooled mean
		2007-08	2008-09		07-08	08-09	
Indoxacarb 14.5% SC	0.02	2.68 (1.78)*	1.84 (1.52)*	2.26 (1.66)*	4.09 (2.14)*	3.47 (1.99)*	3.78 (2.06)*
Spinosad 45% SC	0.01	3.04 (1.88)	1.98 (1.57)	2.51 (1.73)	5.14 (2.37)	4.07 (2.13)	4.60 (2.25)
Emamectinbenzoate	0.01	5.21 (2.38)	5.35 (2.41)	5.28 (2.40)	5.96 (2.54)	6.01 (2.55)	5.98 (2.54)
Diafenthiuron 50% WP	0.005	7.80 (2.88)	6.81 (2.70)	7.30 (2.79)	8.47 (2.99)	7.31 (2.79)	7.89 (2.89)
Endosulfan 35% EC	0.07	6.76 (2.69)	7.06 (2.74)	6.91 (2.72)	8.02 (2.91)	7.96 (2.90)	7.99 (2.86)
Halt (*Bt*)	0.20	7.92 (2.90)	6.96 (2.73)	7.44 (2.81)	8.48 (2.99)	7.99 (2.91)	8.23 (2.95)
Biolap (*Bt*)	0.20	10.74 (3.35)	10.40 (3.30)	10.57 (3.32)	11.92 (3.52)	12.08 (3.54)	12.00 (3.53)
Delfin (*Bt*)	0.20	11.93 (3.52)	10.25 (3.27)	11.09 (3.40)	13.46 (3.73)	12.89 (3.65)	13.17 (3.69)
Dipel (*Bt*)	0.20	11.08 (3.40)	10.69 (3.34)	10.88 (3.37)	13.10 (3.68)	12.98 (3.67)	13.04 (3.69)
Control (water spray)		28.51 (5.38)	23.06 (4.85)	25.78 (5.12)	36.15 (6.05)	30.72 (5.58)	33.43 (5.82)
CD at 5%		1.735	1.237	1.593	1.872	1.233	1.439

*Transformed data

Table 2. Effect of certain bio-rational insecticide and *Bt* formulations on fruit yield of brinjal.

Treatment	Conc. (%)	Mean fruit yield (q/ha)		Pooled mean fruit yield (q/ha)	Per cent yield increase over control based on two years pooled mean
		2007-08	2008-09		
Indoxacarb 14.5% SC	0.02	234.67 (15.33)*	230.36 (15.19)*	232.51 (15.26)*	57.94 (7.64)*
Spinosad 45% SC	0.01	222.54 (14.93)	232.56 (15.27)	227.56 (15.1)	54.54 (7.41)
Emamectin benzoate	0.01	218.86 (14.81)	220.88 (14.88)	219.67 (14.84)	49.34 (7.05)
Diafenthiuron 50% WP	0.005	212.58 (14.59)	220.5 (14.87)	216.54 (14.73)	47.07 (6.69)
Endosulfan 35% EC	0.07	212.02 (14.57)	218.86 (14.81)	215.44 (14.69)	46.32 (6.84)
Halt (*Bt*)	0.20	205.55 (14.35)	210.1 (14.51)	207.52 (14.43)	41.15 (6.45)
Biolap (*Bt*)	0.20	201.89 (14.22)	199.55 (14.14)	200.72 (14.18)	36.34 (6.06)
Delfin (*Bt*)	0.20	190.98 (13.83)	195.58 (14.0)	193.26 (13.92)	31.27 (5.63)
Dipel (*Bt*)	0.20	190.58 (13.82)	194.5 (13.96)	192.54 (13.89)	30.77 (5.59)
Control (water spray)	-	146.58 (12.12)	147.87 (12.18)	147.22 (12.15)	0.00 (0.70)
CD at 5%		2.31	2.11	2.08	1.43

*Transformed data

diafenthiuron (2.79%), endosulfan (2.72%) and halt (2.81%), which were at par with each other. The maximum shoot damage was recorded in delfin treated plots, i.e. 11.09% followed by dipel (10.88%) and biolap (10.57%) and they were significantly inferior to indoxacarb. Amongst various *Bt* formulations, the shoot damage was minimum in halt treated plots i.e. 2.81% which was at par with indoxacarb. Almost same trend was observed in case of fruit damage. Indoxacarb treated plots recorded less fruit damage (2.06%) followed by spinosad (2.25%), emamectin benzoate (2.54%), diafenthiuron (2.89%), endosulfan (2.86%) and halt (2.95%) which were at par with each other on the basis of two years pooled mean data. In fruit damage also, halt received less incidence of the pest among all the *Bt*-formulations.

The computation of two years pooled fruit yield data presented in Table 2 indicated that in comparison to untreated plots, 30.77 to 57.94 per cent higher yields were obtained in the insecticidal and *Bt* formulations treated plots. However, indoxacarb recorded significantly higher yield of 232.51q/ha over control, which account for 57.94 per cent higher yield as compared to the untreated control. The minimum fruit yield increase over control of 30.77 per cent was observed in the plots treated with dipel (*Bt* formulation). Among various *Bt* formulations, halt treated plots received maximum fruit yield, i.e. 207.52 q/ha in which increase over control was 41.15 per cent. However, all the newly introduced insecticidal molecules were higher in fruit yield as compared to endosulfan which is extensively used for the control of this devastating pest throughout the country. The investigation shows that there was consistency in effectiveness and yield increase potential of various insecticidal and *Bt*-formulation treatments during both the experimental years. Thus, the yield increase observed from different treatments was mainly attributed to the effective control of the shoot and fruit borer. Besides, indoxacarb and spinosad were found more effective against *L. orbonalis* and also obtained higher fruit yield as compared to other bio-rational products.

The present investigation revealed that very meager studies has been carried out on newly introduced insecticidal molecules in different parts of the country against shoot and fruit borer in brinjal. Moreover, the studies conducted by Rai *et al.* (4) indicated that the

application of emamectin benzoate and diafenthiuron was much effective in lowering the incidence of shoot and fruit borer in brinjal and increasing the yield of healthy fruits. They have further reported that indoxacarb and spinosad are very promising against Lepidopterous borers including shoot and fruit borer larvae. Endosulfan is the most widely used insecticide against this pest which has been reported by many workers (Sharma *et al.* 5; Singh and Nath, 7). In the present study also endosulfan was found effective against the pest. As far as performance of *Bt* based bio-insecticides was concerned, present findings are in conformity with the findings of Purnik *et al.* (3), and Mahesh and Men (2) who had earlier reported that *Bt* formulations were effective against shoot and fruit borer in brinjal, hence can be rotated with selective and safer insecticides to achieve expected outcome under an IPM programme. In can be concluded that indoxacarb and spinosad can be used in combinations of halt to keep the pest population below the economic damage level of shoot and fruit borer in brinjal crop as these molecules are comparatively safer and selective in nature hence their use in brinjal crop will not cause any harmful residue in the produce which is one of the main thrust area of IPM programme in vegetable crops.

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