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BIO-EFFICACY OF BIO-RATIONAL INSECTICIDES AND *B.T.* BASED BIO-INSECTICIDES AGAINST SHOOT AND FRUIT BORER, *EARIAS VITTELLA* F. IN OKRA

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Summary

An investigation was laid out during summer season of 2008 and 2009 with F1 okra hybrid Sonal to find out the comparative efficacy of newly introduced insecticidal molecules and Bt formulations against shoot and fruit borer, *Earias vittella* F. in okra crop. The studies revealed that indoxacarb 14.5% SC proved to be the most effective treatment against the pest and it was at par with spinosad, imidacloropid and diafenthiuron and significantly superior over all other treatments. Amongst various *Bacillus thuringiensis* based bio-insecticides, halt exhibited maximum mortality i.e. 67.23 per cent at 7 days after spraying and was at par with biolap and dipel during 2008 and 2009. The maximum fruit yield was observed in indoxacarb treated plots i.e. 179.85 and 184.68 q/ha respectively durind 2008 and 2009 which was at par with all the insecticidal molecules during both the years. Fruit yield from Bt formulations treated plots was also recorded in which halt received higher fruit yield *i.e.*, 136.20 q/ha during 2008 and 139.80 q/ha in 2009 followed by dipel and biolap.

सारांश

भिण्डी में लगने वाले मुख्यकीट तना एवं फली भेदक (इरियास विटेला) के नियंत्रण के लिये कुछ नयी संश्लेषित रसायनों एवं बी.टी. (बैसिलस थूरिन्जियेन्सिस) आधारित विभिन्न सुक्ष्म जीवी कीटनाशियों का गृष्म ऋतु के 2008 एवं 2009 के दौरान पन्तनगर कृषि विश्वविद्यालय के कृषि विज्ञान केन्द्र देहरादून पर अध्ययन किया गया। संश्लेसित रसायनों में इन्डाक्साकार्व एवं बी.टी. आधरित हाल्ट का प्रभाव कीटनियंत्रा एवं अधिक उत्पादन के लिये अच्छा पाया गया।

Introduction

Okra, *Abelmoschus esculentus* (L.). Moench is one of important vegetable crops cultivated throughout India and other parts of the world. It is extensively grown during summer and *Kharif* seasons and occupies 0.40 million hectares area with the total production of 4.19 million tonnes and average productivity is 10.30 metric tonnes/ha which is low as compare to potential yields obtained upto 18.22 tonnes/ha in the field demonstrations conducted at Dehradun (Uttarakhand) under Horticulture Technology Mission Project of Govt. of India. The low average productivity in okra 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. Incidence of pests is one of the major constraints in production of okra affecting quality and productivity both. Amongst various insect-pests attack okra crop, shoot and fruit borer, *Earias vittella* F. (Lepidoptera: Noctuidae) is considered as the limiting factor for production of marketable fruit yield.

The losses due to this pest have been estimated to range from 13.08 to 41.26 per cent (Mote and Pokharkar, 1974, Semuthiravelu and David, 1991, Tomar, 1998, Das *et al*., 2001, Rai *et al*., 2010). The studies conducted by the authors at Dehradun revealed that incidence of shoot and fruit borer is more in summer season okra crop i.e. upto 37.86 per cent as compared to *Kharif* crop in which maximum infestation was recorded upto 19.96 per cent. To overcome the menace of this pest, farmers apply 8 to 10 round sprays of insecticides indiscriminately which not only posed the residue problem in the fresh fruits, but also caused secondary pest outbreaks like white fly, mites and jassids. Although several insecticides have been recommended for the control of shoot and fruit borer in okra, yet the changing agro-environmental conditions needed to investigate and assess some newly introduced insecticidal molecules for its

effective control. This has an added relevance in view of the insecticides recommended earlier becoming either less effective or banned due to environmental hazards. On the other hand, there are some *Bacillus thuringiensis* (*Bt*) based bio insecticides introduced in the recent years and are available in the market which need to be evaluated against this pest in Dehradun (Uttarakhand) conditions as they are preferred over insecticides owing to their eco-friendly nature and lack of harmful residue and also due to slower development of resistance compared to insecticides (Basu, 2000, Mahesh and Men, 2007; Rai *et al.,* 2010) 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 okra shoot and fruit borer, *Earias vittella* F. under field conditions.

Materials and Methods

The experiments were carried out at Aasanbagh near G. B. Pant University of Agrculture and Technology, Krishi Vigyan Kendra, Dhakrani, Dehradun (Uttarakhand) for two consecutive years of 2008 and 2009 to find out the efficacy of some newly introduced insecticidal molecules and few *Bacillus thuringiensis* (Bt) based bio-insecticides. The trails were laid out in randomized block design with three replications, each in 2m x 2m plots keeping 45 cm row to row and 30 cm plat to plant distance. Okra hybrids "Sonal" was sown in first week of March during both the years of 2008 and 2009. All the agronomical practices recommended in the state package of practices were followed to raise the good crop. Nine treatments comprising 6 insecticides *viz;* indoxacarb 14.5% SC, imidacloprid 17.8% SL, spinosad 45% SC, novaluron 10% EC, endosulfal 35% EC, diafenthiuron 50% WP and three formulations of *Bacillus thuringiensis* (Bt) based bio-insecticides namely halt, biolap and dipel were evaluated against the pest. Thus, there were 10 treatments including control. Each treatment comprised three sprays. First spray was given 40 days after sowing and thereafter at 15 days intervals. The pre treatment count of shoot and fruit borer was recorded 24 hr prior to first and second spray subsequently post treatment counts were done after 3, 7 and 14 days, the last count of first spray served as pre treatment count for the second spray. From the observations at all the pre and post treatment counts,

Table 1. Effect of certain bio-rational insecticides and *Bt* based bioinsecticides on shoot and fruit borer in okra during 2008 and 2009

Treatment	Concentration (%)	% fruit damage	Per cent reduction in infestation*			Mean after treatment	% fruit damage	Per cent reduction in infestation*			Mean after treatment
		1 DBS	3 DAS	7 DAS	14 DAS		1 DBS	3 DAS	7 DAS	14 DAS	
Indoxacarb 14.5% SC	0.02	16.08 (4.07)	89.06 (9.46)	92.86 (9.66)	68.27 (8.29)	83.39 (9.15)	24.81 (5.03)	91.61 (9.59)	94.60 (9.75)	71.89 (8.50)	86.03 (9.30)
Imidacloprid 17.8% SL	0.02	15.01 (3.93)	86.79 (9.34)	89.02 (9.46)	59.62 (7.75)	78.47 (8.88)	23.45 (4.89)	87.54 (9.38)	91.80 (9.60)	63.60 (8.00)	80.98 (9.02)
Spinosad 45% SC	0.01	17.26 (4.21)	87.84 (9.39)	89.98 (9.51)	62.06 (7.90)	79.96 (8.96)	26.89 (5.23)	89.06 (9.46)	92.36 (9.63)	68.29 (8.29)	83.23 (9.15)
Novaluron 10% EC	0.02	17.95 (4.29)	70.62 (8.43)	78.14 (8.86)	49.82 (7.09)	66.19 (8.16)	27.08 (5.25)	74.01 (8.63)	81.62 (9.06)	56.82 (7.57)	70.81 (8.44)
Endosulfal 35% EC,	0.07	21.04 (4.64)	62.87 (7.96)	74.08 (8.63)	45.96 (6.81)	60.97 (7.84)	29.24 (5.45)	68.72 (8.31)	77.29 (8.81)	50.09 (7.11)	65.36 (8.11)
Diafenthiuron 50% WP	0.005	20.23 (4.55)	78.04 (8.86)	83.72 (9.17)	52.84 (7.30)	71.53 (8.48)	25.86 (5.13)	82.91 (9.13)	86.26 (9.31)	54.84 (7.43)	74.67 (8.67)
Halt (Bt)	0.20	16.29 (4.09)	58.01 (7.64)	67.23 (8.22)	40.08 (6.37)	55.10 (7.45)	25.06 (5.05)	57.01 (7.58)	70.24 (8.41)	44.00 (6.67)	57.08 (7.58)
Biolap (Bt)	0.20	19.06 (4.42)	82.04 (7.24)	54.16 (7.39)	34.12 (5.88	46.77 (6.87)	27.82 (5.32)	54.24 (7.39)	59.08 (7.71)	38.72 (6.26)	50.68 (7.15)
Dipel (Bt)	0.20	21.56 (4.69)	53.87 (7.37)	84.92 (7.44)	35.62 (6.00)	48.13 (6.97)	23.93 (4.94)	54.86 (7.44)	61.20 (7.85)	39.96 (6.36)	52.00 (7.24)
Control (water)	-	18.97 (4.41)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	28.69 (5.40)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)	0.00 (0.70)
SEm ±	-	0.679	0.473	0.479	0.480	0.580	0.364	0.475	0.495	0.478	0.590
CD at 5%	-	NS	0.994	1.006	1.010	1.220	NS	0.998	1.040	1.005	1.245

*Mean of three replications, DBS- days before spray, DAS- days after spray, Figures in parentheses are square root transformation

mean per cent reduction in borer incidence was computed. The fruits infested with shoot and fruit borer were recorded at each picking and their weight was noted. The weight of healthy and infested fruits was taken separately and level of per cent infestation due to fruit borer was worked out. Two years data were pooled and per cent infestation and its reduction due to various treatments were transformed to square root values before subjected to analyses of variance. The yield data in various treatments were also recorded during both years and pooled. Finally the crop was harvested in the last week of July during both the years.

Results and Discussion

The per cent fruit damage, per cent reduction in infestation of shoot and fruit borer, *Earias Vittella* F. and fruit yield amongst various treatments during 2008 and 2009 are presented in Table 1 and 2, respectively. The per cent fruit damage in okra due to shoot and fruit borer varies from 15.01 to 21.56 per cent during 2008 in which significant difference was not found. However, during 2009 fruit damage was higher and it was varies from 23.45 to 29.24 per cent which were also non-significantly different from each other. The shoot and fruit borer 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 data recorded in per cent reduction in infestation of shoot and fruit borer in various treatments revealed that maximum reduction was observed in the plots treated with indoxacarb i.e. 92.86 per cent at 7 days after spaying. It was at par with imidacloprid, spinosad and diafenthiuron and significantly superior over all other treatments including control in all the three observations recorded 3, 7 and 14 days after spraying during 2008. Almost same trend was found during 2009 also except novaluron which was also at par with indoxacarb in all the three observations during 2009. The investigation also indicated that all the treatments showed their maximum mortality/ reduction in borer infestation 7 days after spraying during both the years of study. Amongst various insecticides, endosulfan exhibited poor reduction rate as compared to other insecticidal molecules against shoot and fruit borer during both the years followed by novaluron. The maximum per cent mean reduction was 83.39 per cent in indoxacarb treated plots closely followed by 79.96 and 78.47 per cent in spinosad

Table 2. Effect of certain bio-rational insecticides and *Bt* formulations on fruit yield of okra during 2008 and 2009

Treatment	Concentration (%)	Mean fruit yield (q/ha)		Mean fruit yield (q/ha)	% yield increase over control		% yield increase over control two years pooled mean
		2008	2009		2008	2009	
Indoxacarb 14.5% SC	0.02	179.85	184.68	182.26	73.03	90.74	80.02
		(13.42)	(13.60)	(13.51)	(8.57)	(9.55)	(8.96)
Imidacloprid 17.8% SL	0.02	168.92	173.08	171.00	59.85	78.76	68.90
		(13.01)	(13.17)	(13.09)	(7.76)	(8.90)	(8.33)
Spinosad 45% SC	0.01	172.86	176.09	174.47	63.58	81.87	72.33
		(13.16)	(13.28)	(13.22)	(8.00)	(9.07)	(8.53)
Novaluron 10% EC	0.02	154.72	158.68	156.70	46.41	63.89	54.78
		(12.45)	(12.61)	(12.53)	(6.84)	(8.02)	(7.43)
Endosulfal 35% EC,	0.07	150.69	156.69	153.69	42.60	61.83	51.80
		(12.29)	(12.53)	(12.41)	(6.56)	(7.89)	(7.23)
Diafenthiuron 50% WP	0.005	158.07	161.98	160.02	49.58	67.30	58.06
		(12.59)	(12.74)	(12.66)	(7.07)	(8.23)	(7.65)
Halt (Bt)	0.20	136.20	139.80	138.00	28.89	44.39	36.30
		(11.69)	(11.84)	(11.76)	(5.42)	(6.70)	(6.06)
Biolap (Bt)	0.20	131.89	133.64	132.76	24.81	38.02	31.13
		(11.50)	(11.58)	(11.54)	(5.03)	(6.22)	(5.62)
Dipel (Bt)	0.20	134.60	136.84	135.45	26.86	41.33	33.79
		(11.60)	(11.71)	(11.65)	(5.23)	(6.46)	(5.85)
Control (water)	-	105.67	96.82	101.24	0.00	0.00	0.00
		(10.30)	(9.86)	(10.08)	(0.70)	(0.70)	(0.70)
SEm ±	-	0.795	0.805	0.950	1.228	1.368	0.408
CD at 5%	-	1.670	1.795	2.067	2.580	1.875	0.858

Figures in parentheses are square root transformation

and imidacloprid treated plots, respectively during 2008. However during 2009 indoxacarb was again recorded maximum per cent mean reduction i.e. 86.03 per cent followed by spinosad and imidacloprid. Amongst various *Bacillus thuringiensis* based bio-insecticides, halt exhibited maximum mortality i.e. 67.23 per cent at 7 days after spraying and was at par with biolap and dipel during 2008. Almost same trend was noticed in 2009 also in which halt caused maximum reduction in incidence of shoot and fruit borer. The per cent mean reduction in halt treated plots was 55.10 per cent during 2008 and 57.08 per cent during 2009.

The observations on fruit yield recorded during study showed that maximum fruit yield was observed in indoxacarb i.e. 179.85 and 184.68 q/ha, respectively during 2008 and 2009. It was at par with all the insecticidal molecules during both the years. Amongst different insecticides, endosulfan treated plots received less fruit yield i.e. 150.69 and 156.69 q/ha. respectively during 2008 and 2009 followed by novaluron in which 154.72 q/ha fruit yield during 2008 and 158.68 q/ha in 2009 was recorded. Amongst various *Bt* formulations halt received higher fruit yield i.e. 136.20 q/ha during 2008 and 139.80 q/ha in 2009 followed by dipel and biolap.

The present investigation revealed that very meagre studies has been carried out on newly introduced molecules and *Bt* formulations in different parts of the country against shoot and fruit borer in okra. Moreover, the studies conducted by Patel *et al*., during 1997 at Amnand (Gujrat) indicated that endosulfan sprayed plots exhibited maximum reduction and received higher fruit yield followed by chlorpyriphos. In the present study, endosulfan showed least reduction of shoot and fruit borer incidence and recorded low fruit yield amongst the various insecticidal molecules. Another study conducted by Singh *et al*., during 2008 at Jaipur (Rajasthan) revealed that imidacloprid and indoxacarb treated okra crop showed maximum reduction in incidence of shoot and fruit borer and received higher yield as compared to other insecticides like quinalphos, endosulfan which are in conformity with the present investigation in which indoxacarb and imidacloprid have been found most promising molecules. The findings of the present study shows that indoxacarb, spinosad and imidacloprid have been found most effective insecticides in keeping the infestation of shoot and fruit borer in okra. Hence, these potential molecules can be used commercially for the effective management of this serious pest. In order to avoid the pest resistance and residue problems in the fruits, it is better to use above insecticides in alternation, which will also help in conservation and multiplication of non target organisms.

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