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Lipsa Dash
MSSSoA, Centurion University of Technology and Management, Odisha, India

V Ramalakshmi
MSSSoA, Centurion University of Technology and Management, Odisha, India

Deepayan Padhy
MSSSoA, Centurion University of Technology and Management, Odisha, India

Corresponding Author:
Lipsa Dash
MSSSoA, Centurion University of Technology and Management, Odisha, India

Bio-efficacy of emamectin benzoate 5% SG against shoot and fruit borer *Earias vitella* (Fabricius) on okra

Lipsa Dash, V Ramalakshmi and Deepayan Padhy

Abstract
Field experiment was conducted to evaluate and validate the efficacy of some novel insecticides against shoot and fruit borer on okra. Effect of five different doses of Emamectin benzoate 5%SG along with Lambda cyhalothrin 5% EC, Deltamethrin 2.5%EC and Chlorantaniliprole18.5%EC were evaluated**.** The shoot and fruit borer infestation was recorded. Before each spray as well as 2, 4, 8 and 10 days after each spray. The results clearly indicated that Emamectin benzoate 5%SG at 17.0g a.i/ha were found most effective against shoot and fruit borer with an average reduction of 90.72% in population after three sprays. All treatments gave significantly higher fruits yield of okra over untreated control (3.3t/ha). However, highest yield of okra fruits (8.29t/ha) was obtained from Emamectin benzoate 5%SG at17.0ga.i/ha followed by the treatment Emamectin benzoate 5% SG at 10.25 ga.i/ha yields (8.04t/ha).

Keywords: Shoot and fruit borer, okra, emamectin benzoate 5% SG and *Eariasvitella*

Introduction
Okra (*Abelmoschus esculentus*) or ladies finger is important vegetable of the tropical countries and most popular in India, Nigeria, Pakistan, Cameroon, Iraq and Ghana. Though, it is virtually not grown in Europe and North America, yet, lot of people in these countries have started liking this vegetable because of good amount of vitamin A and folic acid, besides carbohydrates, phosphorus, magnesium and potassium. Okra crop suffers damage by a number of insect pest viz., the jassids, *Amrasca biguttula biguttula* Ishida; the aphid, *Aphis gossypii* Glover; the fruit borers, *Earias insulana* Boisduval and *Earias vittella* Fab.; *Helicoverpa armigera* Hub.; whitefly, *Bemisia tabaci* Genn.; and red spider mite, *Tetranychus cinnabarinus* that appears occasionally (Dadheech *et al.*, 1977) [1]. Among all pests, shoot and fruit borer, *Earias vitella* (Fabricius) is the most damaging pest of okra as young larva borers into tender shoots in early vegetative growth of plants. (Dhaker *et al.*, 2017) [2]. This is an oligophagous pest of malvaceous crops like okra and cotton. It is widely distributed throughout India. Initial stage caterpillars bore into tender shoots and tunnel downwards. Affected shoots wilted and drooped down. During reproductive stage, they bore the fruits and feed inside it. The infested fruits become unsuitable for consumption and marketing. Grown up larva damages many fruits results in in 54.04% yield loss and also reduces the vitality of the plant (Sivakumar *et al.*, 2003) [3]. The average fruit damage had been estimated to be (35-76%) (Narke and Suryawanshi, 1987) [4]. Indiscriminate use of organo phosphates, carbamates and synthetic pyrethroids had created number of problems such as insect resistance to insecticides (McCaffery *et al.*, 1989) [5], pest resurgence (Hardin *et al.*, 1995) [6] and pesticide residued in consumable produce at harvest (Rolando *et al.*, 1982). So it was important to adopt or use some newer insecticide molecules with high toxicity even at lower doses and should also be safer to the natural enemies present in the agro eco-system. One such insecticide was emamectin benzoate a semi synthetic derivative of avermectin produced as fermentation metabolites of soil actinomycetes, Streptomyces avermitilis Burg (Lasoata and Dybas, 1991) [7]. Hence the present investigation aimed as under taken to evaluate the efficacy of emamectin benzoate 5%SG against shoot and fruit borer in okra ecosystem.

Material and methods
Location
The investigation was carried out at "Adisaptagram Block Seed Farm", Department of Agriculture, Govt. of West Bengal, Moogra, Hooghly, West Bengal during, 2013-14. The geographical details of the site are 23° N latitude, 89° E longitude and 9.75 meter above mean sea level (MSL).

Details of the experiment

Crop and Variety	**:**	Okra, PusaSawani
Design	**:**	Randomized Block Design
Replications	**:**	Three
Plot Size	**:**	3m X 3m = 9 m^2
Spacing	**:**	60 cm X 40 cm

Methodology

Method of application: The required quantity of insecticides was diluted in water (500 lit/ha) and was sprayed by using a knapsack sprayer fitted with hollow cone nozzle.

Method of observation

The data of fruit borer (*Earias vittella*) recorded before each spray as well as 2, 4, 8 and 10 days after each spray. The number of damaged and undamaged fruits and also the number of caterpillars in each plot was recorded. From the data percent reduction in population over control was worked out. The yield data was also recorded during each plucking and also at the final harvest. The data on pest incidence and yield were subjected to analysis of variance after making necessary transformation, whenever necessary.

Table 1: Treatment details as follows:

S. No.	Treatments	Dosage (g.a.i/ha)	Formulations (g/ha)	Diluted in water (lit/ha)
T_1	Emamectin Benzoate 5% SG	5.0	100	500
T_2	Emamectin Benzoate 5% SG	6.75	135	500
T_3	Emamectin Benzoate 5% SG	8.50	170	500
T_4	Emamectin Benzoate 5% SG	10.25	205	500
T_5	Lambda cyhalothrin 5% EC	15.0	300	400
T_6	Deltamethrin 2.8% EC	10.0-15.0	400-600	500
T_7	Chlorantraniliprole 18.5% EC	25.0	125	500
T_8	Untreated Control	-	-	500
T_9	Emamectin Benzoate 5% SG	17.0	340	500

Results and discussion

Efficacy of different doses of insecticides against shoot and fruit borer of okra

The pooled data (table -2) on mean reduction in the control of shoot and fruit borer at 2, 4, 8 and 10 days after each spray days after first, second and third spray showed that all treatments were found significantly superior over untreated control. The results clearly indicated that Emamectin benzoate 5% SG at 17.0 g a.i/ha was found most effective against shoot and fruit borer. The average reduction in shoot and fruit borer population was 90.72% after three sprays. Next effective treatment was Emamectin benzoate 5% SG at 10.25 g a.i/ha with a population reduction of 89.43 % followed by Emamectin benzoate 5% SG at 8.50 g a.i/ha (86.00%), Emamectin benzoate 5% SG at 6.75 g a.i/ha (83.29%), chlorantaniliprole 18.5% EC at 25.0 g a.i/ha (82.43%), Emamectin Benzoate 5% SG at 5.0 g a.i/ha(80.29%), Lambda cyhalothrin 5% EC at 15.0 g a.i/ha (72.43%), Deltamethrin 2.5 % EC at 10.0 g a.i/ha (71.86%), respectively over control. Results were in accordance with findings of Sontakke *et al*., (2007) [8] observed that emamectin benzoate 5 SG @8.5 g a.i. ha-1was effective in controlling the fruit borer in okra. Yadav *et al* (2017) [9] observed the minimum percent infestation of shoot and fruit borer at emamectin benzoate 5 SG @15 g a. i. ha-1 treated bhendi crop The results are in accordance with the findings of Govindan *et al*., (2012) [10]. Ememctin benzoate 5 SG @ 200gm per ha recorded comparatively lower fruit and shoot damage and gave higher fruit yield in brinjal (Roy *et al*., 2016) [11]. Meena *et al.,* (2006) [12] found that emamectin benzoate 5 SG @ 11 g a.i. ha-1 was effective in reducing pod and grain damage in pigeon pea. The reduced efficacy of insecticide after 10 DAT and the subsequent increase in the larval population might be due to the influence of environmental factors like sun light and temperature which were responsible for the decay of insecticides, as reported by Wilson *et al.,* (1986) [13]. Chowdary *et al,* (2010) [15] evaluated that the efficacy of some new insecticides like rynaxypyr 20 SC @ 20 g a.i. ha-1, spinosad @ 56 g a.i. ha-1, emamectin benzoate @ 15 g a.i. ha-1, flubendiamide @ 45 g a.i. ha-1 against okra fruit borer, H. armigera and found that, rynaxypyr 20 SC @ 20 g a.i.ha-1 was superior recording less larval population, lower fruit damage and higher fruit yield, followed by spinosad @ 56 g a.i. ha-1, emamectin benzoate @ 15 g a.i. ha-1 and flubendiamide @ 45 g a.i. ha-1. Muralibaskaran *et al.,* (2010). Raghuraman *et al.,* (2008) [14] reported that EC formulation of emamectin benzoate at the dose of 11 g a.i. ha-1 as effective in reducing the incidence of bollworm complex (*H. armigera*, *E. vittella* and *P. gossypiella*) and increasing the yield of cotton.

Table 2: Effect of different treatments of Emmamectin Benzoate 5% SG against fruit borer population in okra

S. No.	Treatments	Dose g a.i./ha	Mean fruit borer population at different dates of observation after each spray															Mean	%DOC
			First spray					Second spray					Third spray						
			PT	2	4	8	10	PT	2	4	8	10	PT	2	4	8	10		
T1	Emmamectin benzoate 5% SG	5.00	10.33 (3.29)	6.00 (2.55)	3.00 (1.87)	2.67 (1.78)	2.33 (1.68)	5.33 (2.42)	2.00 (1.58)	2.00 (1.58)	1.67 (1.47)	1.00 (1.22)	3.67 (2.04)	2.33 (1.68)	1.67 (1.47)	1.33 (1.35)	0.67 (1.08)	3.07	80.29
T2	Emmamectin benzoate 5% SG	6.75	10.33 (3.29)	5.33 (2.41)	2.00 (1.58)	2.00 (1.58)	1.33 (1.35)	5.00 (2.35)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	0.67 (1.08)	3.00 (1.87)	2.00 (1.58)	1.67 (1.47)	1.33 (1.35)	0.33 (0.91)	2.60	83.29
T3	Emmamectin benzoate 5% SG	8.50	10.67 (3.34)	4.33 (2.20)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	4.00 (2.12)	1.33 (1.35)	1.33 (1.35)	1.00 (1.22)	0.33 (0.91)	3.33 (1.96)	1.00 (1.22)	0.67 (1.08)	0.33 (0.91)	0.33 (0.91)	2.18	86.00
T4	Emmamectin benzoate 5% SG	10.25	10.00 (3.24)	2.67 (1.78)	1.00 (1.22)	0.67 (1.08)	0.67 (1.08)	4.33 (2.20)	1.00 (1.22)	0.67 (1.08)	0.33 (0.91)	0.00 (0.71)	2.33 (1.68)	0.67 (1.08)	0.33 (0.91)	0.00 (0.71)	0.00 (0.71)	1.64	89.43
T5	Lambdacyhalothrin 5% EC	15.00	9.33 (3.14)	6.00 (2.55)	5.67 (2.48)	5.33 (2.42)	3.33 (1.96)	6.00 (2.55)	3.67 (2.04)	3.67 (2.04)	3.00 (1.87)	1.67 (1.47)	6.33 (2.61)	3.67 (2.04)	2.67 (1.78)	2.67 (1.78)	1.33 (1.35)	4.29	72.43

T6	Deltamethrin 2.5% EC	10.00	9.00	5.67	5.33	5.00	3.00	6.33	3.33	3.00	4.00	2.00	7.33	4.00	3.33	2.67	1.67	4.38	71.86
			(3.08)	(2.48)	(2.42)	(2.35)	(1.87)	(2.61)	(1.96)	(1.87)	(2.12)	(1.58)	(2.80)	(2.12)	(1.96)	(1.78)	(1.47)		
T7	Chlorantaniliprole 18.5% EC	25.00	10.33	4.33	3.00	2.67	2.00	4.00	2.00	1.67	1.67	0.67	2.67	2.67	1.67	1.33	0.33	2.73	82.43
			(3.29)	(2.20)	(1.87)	(1.78)	(1.58)	(2.12)	(1.58)	(1.47)	(1.47)	(1.08)	(1.78)	(1.78)	(1.47)	(1.35)	(0.91)		
T8	Untreated control	-	9.67	10.00	11.33	12.67	13.33	14.33	16.00	16.67	17.00	17.33	18.33	18.67	19.00	19.33	19.67	15.56	
			(3.19)	(3.24)	(3.44)	(3.63)	(3.72)	(3.85)	(4.06)	(4.14)	(4.18)	(4.22)	(4.34)	(4.38)	(4.42)	(4.45)	(4.49)		
T9	Emmamectin benzoate 5% SG	17.00	10.33	3.33	0.67	0.33	0.33	3.00	1.00	0.67	0.00	0.00	1.67	0.33	0.00	0.00	0.00	1.44	90.72
			(3.29)	(1.96)	(1.08)	(0.91)	(0.91)	(1.87)	(1.22)	(1.08)	(0.71)	(0.71)	(1.47)	(0.91)	(0.71)	(0.71)	(0.71)		
SE.m ±			-	0.06	0.09	0.12	0.10	0.03	0.07	0.13	0.10	0.11	0.09	0.10	0.13	0.10	0.13		
CD @ 5%			NS	0.19	0.26	0.36	0.30	0.10	0.22	0.38	0.31	0.33	0.28	0.31	0.40	(0.29	0.38		

Figures in parenthesis are square root transformed values
NS: Not significant, PT= Pre-treatment data

Table 3: Number of Healthy and damaged fruits of okra at each picking in different treatments

Mean number of damage and healthy fruits																			
Tr.	**Dose gm a.i./ha**		**Picking 1**		**Picking 2**		**Picking 3**		**Picking 4**		**Picking 5**		**Picking 6**		**Picking 7**		**Picking 8**		**yield of healthy fruits t/ha**
			HF	**DF**	**HF**	**DF**	**HF**	**DF**	**HF**	**DF**	**HF**	**DF**	**HF**	**DF**	**HF**	**DF**	**HF**	**DF**	
T_1	Emmamectin benzoate 5% SG	5.00	35.33	9.33	65.33	6.00	65.00	8.00	46.00	3.00	59.67	5.00	96.33	6.33	88.33	3.33	60.33	2.00	5.74
T_2	Emmamectin benzoate 5% SG	6.75	42.33	7.33	67.67	3.33	67.33	7.00	65.00	2.00	72.33	4.33	126.00	5.33	90.67	3.00	64.33	1.33	6.62
T_3	Emmamectin benzoate 5% SG	8.50	48.67	4.33	70.33	2.67	72.33	5.00	82.00	1.33	79.67	4.00	142.00	3.67	92.33	2.33	69.67	1.00	7.30
T_4	Emmamectin benzoate 5% SG	10.25	55.33	2.67	78.67	1.33	82.67	3.00	94.00	1.00	85.33	2.67	160.00	2.00	95.00	1.33	72.33	0.33	8.04
T_5	Lambdacyhalothrin 5% EC	15.0	45.00	10.00	49.67	9.00	50.67	13.00	45.00	7.00	60.33	9.67	93.67	12.33	85.33	10.33	58.33	7.33	5.42
T_6	Deltamethrin 2.5% EC	15.0	42.00	9.67	56.00	7.33	54.33	10.00	55.00	4.00	62.33	8.33	92.33	11.33	82.67	11.33	59.00	6.67	5.60
T_7	Chlorantaniliprole 18.5% EC	25.0	40.00	7.00	60.33	4.00	67.33	6.00	61.00	3.00	74.33	4.67	122.00	5.67	87.00	2.67	63.33	1.00	6.39
T_8	Untreated control	-	28.33	19.67	32.67	35.00	29.33	32.67	43.00	20.00	38.33	39.67	59.67	69.67	40.33	56.33	26.00	42.33	3.31
T_9	Emmamectin benzoate 5% SG	17.0	58.00	2.00	81.67	1.33	84.00	2.00	94.00	0.67	90.67	2.33	167.00	2.33	96.33	0.00	74.33	0.00	8.29

HF= healthy fruits, DF= damage fruits

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