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Field Evaluation of Emamectin Benzoate 5 SG against Okra Fruit Borers

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Two field experiments were conducted, the first season at Vandikaranoor during March 2008-June 2008 and the second season at Puttur during July 2008 – October 2008 to evaluate the bio efficacy of emamectin benzoate 5 SG at four doses *viz.,* 9, 11,13 and 15 g a.i. ha^{-1} for the control of okra fruit borers viz., *Earias vittella* Fabricius and *Helicoverpa armigera* Hubner. The new formulation of emamectin benzoate 5 SG at 11 and 13 g a.i. ha^{-1} was highly effective and reduced the fruit damage when compared to standard check, Proclaim® (emamectin benzoate 5 SG at 11g a.i. ha^{-1}) and endosulfan 35 EC @ 350 g a.i. ha^{-1}. The lowest fruit damage was recorded with the application of emamectin benzoate 5 SG at 11 g a.i. ha^{-1} and it was on par with 13 g a.i. ha^{-1} although the per cent fruit damage was less in all emamectin benzoate 5 SG doses which ultimately increased the fruit yield of okra.

Key words: Field efficacy, Emamectin benzoate 5 SG, Fruit borers, *Okra*,

Among several vegetable crops cultivated in India, *Okra*, *Abelmoschus esculentus* (L.) Moench is one of the important vegetables and the tender fruits are rich sources of vitamins (A, B and C), iron, calcium, magnesium and also certain other minerals. *Okra* is cultivated in almost all states of India and the major producers are Bihar, Orissa, Andra Pradesh, Karnataka and Tamil Nadu (Anonymous, 2006). Fruit borers *viz., Earias vittella* Fabricius. *Helicoverpa armigera* Hubner inflict direct losses in yield of marketable fruits and vitality of plant resulting in 54.04 per cent net yield loss (Sivakumar *et al.,* 2003). Insecticides have been used widely to control the pests on vegetables because of easy adoptability, effectiveness and immediate control. However, the indiscriminate use of organo phosphates, carbamates and synthetic pyrethroids has created a number of problems such as pests developing resistance to insecticides, pest resurgence and residues in soil (Mohapatra and Gupta, 1998) and increased cost of cultivation and has lead to some irreversible changes in our biosphere.

Emamectin benzoate, one of the newer compounds is synthesized from naturally occurring insecticides / acaricides of avermectin family. This was discovered in 1984 as a broad spectrum lepidoptericide. Patil and Rajanikantha (2004) explained its mode of action and efficacy. This product is a mixture of emamectin benzoate B_1 a and emamectin benzoate B_1 b that are extracted from soil actinomycete, *Streptomyces avermitilis* Burg. It is both a stomach and a contact insecticide (Lasota and Dybas, 1991).It interferes with neuro transmitters of target pests which results in disruption of nerve impulses. It is used primarily for the control of lepidopteran pests in foliage and fruity vegetables (Ishaaya and Ohsawa*,* 2002; Leibee *et al.,* 1995; Jansson *et al.,* 1996) and wide range of crops (Dunbar *et al.,* 1998). Present study was undertaken to evaluate the efficacy of emamectin benzoate 5 SG against fruit borers of *Okra*.

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Materials and Methods

Two field experiments were conducted in farmers' field one at Vandikaranoor (March 2008-June 2008) and another at Puttur (July 2008 – October, 2008) in Coimbatore district of Tamil Nadu. Emamectin benzoate 5 SG (9, 11, 13 and 15 g a.i. ha^{-1}) along with standard check, endosulfan 35 EC at 350 g a.i. ha^{-1} and Proclaim® at 11 g a.i. ha^{-1} (registered product of emamectin benzoate 5 SG) were evaluated against *Okra* fruit borers. The experiments were carried out in plots of 4 x 5 m_2 using the F_1 hybrid (Mahyco-10) in a randomized block design (RBD) with seven treatments replicated thrice. Treatments were imposed two (Vandikaranoor) or three (Puttur) times as and when fruit damage crossed the economic threshold level (ETL), which coincided with 30 DAP and a second spray was given 10 days after first application with pneumatic knapsack sprayer using 500 litres of spray fluid per hectare. Fruit damage was assessed based on the bore holes on the fruits before each spray application and at 3, 5, 7 and 10 days after treatment (DAT) . The total number of fruits and infested fruits in ten randomly selected plants per plot were counted and per cent fruit damage was worked out. During each picking, fruit yield was

recorded in all the treated plots and the cumulative yield of healthy fruits from each treatment was pooled to attain total yield and expressed as kg ha^{-1}.

Statistical analysis

The corrected per cent reduction of fruit borer damage over control was worked out as per Henderson and Tilton (1955). The data on percentage reduction were transformed into arc sine values before statistical analysis. The data from laboratory and pot culture experiments were analysed in completely randomized design, while the same from field experiments were analysed in randomized block design (RBD) (Gomez and Gomez, 1984). The mean values were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1951).

Results and Discussion

The results showed significant reduction in per cent fruit damage (Tables 1 and 2) . The damage before imposing treatments ranged from 17.30 to 20.0 per cent per ten plants (Table 1). There was a significant reduction in damage after first round of application, on 5 DAT. The lowest per cent fruit damage was recorded in emamectin benzoate 5 SG at 15 g a.i. ha^{-1} (9.3 % / 10 plants) followed by emamectin benzoate 5 SG at 13 g a.i. ha^{-1} (10.2%) which was on par with emamectin benzoate 5 SG at 11 g a.i. ha^{-1} (10.7%), followed by Proclaim® (11.3%), emamectin benzoate 5 SG at 9 g a.i. ha^{-1} (12.9%) and endosulfan (15.6%) while the untreated control recorded the highest fruit damage of 28.71 per cent. Govindan *et al.* (2011) found that foliar application of emamectin benzoate 5 SG @ 11 g a.i. ha^{-1} recorded lower boll damage, against cotton bollworms. This increase in per cent fruit damage at 10 DAT was due to the growth of new fruits that diluted the non-systemic insecticide deposits on the fruit surface and also that the new fruits acted as insecticide free refuges to the insects that decreased the mean efficacy of insecticides, as reported by (Wilson *et al.,* 1983). The per cent fruit damage in all the emamectin benzoate treatments was significantly low as compared to untreated control during the second spray. At 10 DAT, significantly the lowest percentage of fruit damage was recorded in emamectin benzoate 5 SG at 15 g a.i. ha^{-1} (6.5%) which was on par with emamectin benzoate 5 SG at 11 and 13 g a.i. ha^{-1} followed by emamectin benzoate 5 SG at 9g a.i. ha^{-1} which was on par with standard insecticide Proclaim® (9.5 %). These results are in line with Bheemanna *et al.* (2005) who found that foliar application of emamectin benzoate 5 SG 5 SG @ 11 g a.i. ha^{-1} recorded lower fruit damage, by *Okra* fruit borers. The highest per cent reduction of fruit damage was noticed in emamectin benzoate 5 SG at 15, 13 and 11 g a.i. ha^{-1} which recorded 70.0, 67.6 and 66.5 per cent reduction over untreated check, respectively after second spray of first season trial. It is in accordance with the findings of Kuttalam *et al.* (2008) who found emamectin benzoate 5 EC @ 13 and 15g a.i ha^{-1} as effective and reducing the *Okra* fruit damage.

Table 1. Effect of emamectin benzoate 5 SG against fruit borer damage in *okra* (Location: Vandikaranoor - I season)

Treatment / Dose (g a.i.ha^{-1})	Mean fruit damage per ten plants* (%)														Fruit yield kg ha^{-1}
	First application							Second application							
	PTD	3DAT	5DAT	7DAT	10DAT	Mean	ROC (%)	PTD	3DAT	5DAT	7DAT	10DAT	Mean	ROC (%)	
EB 5 SG @ 9.0 g	19.0	16.4 (23.9)$_{b}$	12.9 (21.1)$_{c}$	12.9 (21.0)$_{c}$	15.5 (23.1)$_{d}$	14.4	48.3	18.2 (23.6)$_{c}$	16.1 (21.4)$_{bc}$	13.3 (19.6)$_{b}$	11.3 (17.9)$_{b}$	9.5	12.5	61.8	8550b
EB 5 SG @ 11.0g	18.6	15.6 (22.5)$_{ab}$	10.7 (19.1)$_{ab}$	11.8 (20.1)$_{ab}$	11.4 (19.7)$_{ab}$	12.4	55.3	17.0 (22.5)$_{ab}$	14.7 (19.8)$_{a}$	11.5 (18.7)$_{ab}$	10.3 (15.9)$_{a}$	7.5	11.0	66.5	9065a
EB 5 SG @ 13.0g	18.3	15.0 (22.27$_{a}$	10.2 (18.6)$_{ab}$	11.3 (19.7)$_{ab}$	11.3 (19.7)$_{ab}$	12.0	56.9	17.3 (22.2)$_{ab}$	14.3 (19.6)$_{a}$	11.3 (17.9)$_{a}$	9.5 (15.8)$_{a}$	7.4	10.6	67.6	9095a
EB 5 SG @ 15.0g	19.5	14.5 (22.3)$_{a}$	9.1 (17.7)$_{a}$	10.2 (18.6)$_{a}$	10.7 (19.1)$_{a}$	11.2	59.7	19.0 (20.4)$_{a}$	12.2 (19.4)$_{a}$	11.2 (17.9)$_{a}$	9.4 (14.8)$_{a}$	6.5	9.8	70.0	9100a
EB 5 SG (Proclaim®) @ 11.0g	17.3	15.6 (22.5)$_{ab}$	11.3 (19.72$_{b}$	14.6 (22.5)$_{d}$	14.6 (22.5)$_{c}$	14.1	49.3	17.3 (23.3)$_{bc}$	15.7 (21.2)$_{bc}$	13.1 (18.7) $_{ab}$	10.2 (17.9)$_{b}$	9.5	12.1	63.1	8290c
Endosulfan 35 EC @350g	20.0	17.3 (24.6)$_{c}$	15.6 (22.5)$_{d}$	16.4 (23.9)$_{e}$	17.3 (24.5)$_{e}$	16.7	40.0	19.5 (25.0)$_{b}$	18.0 (24.5)$_{d}$	17.3 (23.0)$_{d}$	15.3 (21.4)$_{c}$	13.3	16.0	51.4	7750d
Untreated check	19.5	25.3 (30.2)$_{d}$	28.7 (32.4)$_{e}$	27.5 (31.6)$_{f}$	29.7 (33.0)$_{f}$	27.8	-	18.3 (33.7)$_{e}$	31.8 (34.7)$_{e}$	33.0 (34.7)$_{d}$	33.0 (35.7)$_{d}$	34.0	32.9	-	5150e

EB- Emamectin benzoate **,** PTD- Pretreatment damage; DAT- Days after treatments, ROC **-** Reduction over control, ***** Mean of three replications
Figures in parentheses are *arc sine* transformed values; In a column, means followed by a common letter(s) are not significantly different by DMRT(P=0.05).

Data of first spray of second season field experiment results revealed that per cent fruit damage before imposing treatments ranged from 18.3 to 20.0 (Table 2). At 7 DAT, emamectin benzoate 5 SG at 15 g a.i. ha^{-1} registered significantly the least damage to *Okra* fruits (9.50%) followed by emamectin benzoate 5 SG at 13 g a.i. ha^{-1} (11.3%) which were on par with emamectin benzoate 5 SG at 9 g a.i. ha^{-1} and 11 g a.i. ha^{-1} as against maximum damage 33.10 per cent in untreated control. Sontakke *et al.* (2007) observed that emamectin benzoate 5 SG @ 8.5 g a.i. ha^{-1} was effective in controlling the shoot and fruit borer and fruit damage in *Okra*. Similar trend could be observed after 10 DAT. Emamectin benzoate at 15, 13, and 11 g a.i. ha^{-1} reduced fruit damage of 63.2, 62.0 and 61.1 per cent mean over control, whereas untreated check registered 34.0 per cent damage. This may be due to the initial activity of the active ingredient on the target pest and its residual activity (persistence) as reported by Mulrooney and Elmore (2000). After second round of application, emamectin benzoate 5 SG at 15 g a.i. ha^{-1} registered a mean reduction of 68.06 per cent fruit damage over untreated check

followed by emamectin benzoate 5 SG at 13 g a.i. ha^{-1} (65.1%) and 11 g a.i. ha^{-1} (63.5%) and standard check Proclaim® (62.2%), while maximum mean fruit damage was noticed in the untreated plots (34.8%). Similar results were reported by Shobanadevi (2003) who found that foliar spray of Proclaim® at 11 g a.i ha^{-1} reduced the larval population and fruit damage caused by *H. armigera* in *Okra*.

Data after third spray (Table 2) showed significant differences in fruit borer damage between treatments. Emamectin benzoate 5 SG treatments were found significantly superior to untreated control in reducing fruit damage.However, lower fruit damage was recorded in emamectin benzoate 5 SG at 15 g a.i. ha^{-1} (8.7%) which was on par with emamectin benzoate 5 SG at 13, 11 and 9 g a.i. ha^{-1} (8.7 – 9.2 %) followed by standard check Proclaim® (10.1%) and endosulfan (13.7%) as against maximum damage of 35.75 per cent in untreated control. Similar results were reported by Kuttalam *et al.* (2008) where emamectin benzoate 5 SG @11 g a.i ha^{-1} reduced the larval population of *E. vittella* in *Okra*.

Fruit yields were significantly higher in all the insecticidal treatments than untreated check in field experiment I (Vandikaranoor). This revealed that emamectin benzoate 5 SG at 15 g a.i. ha^{-1}exhibited significantly higher yield (9100 kg ha^{-1}) over rest of the treatments which was on par with emamectin benzoate 5 SG at 13 g a.i. ha^{-1} (9095 kg ha^{-1}) emamectin benzoate 5 SG at 11 g a.i. ha^{-1} (9065 kg ha^{-1}) followed by emamectin benzoate 5 SG at 9 g a.i. ha^{-1} (8550 kg ha^{-1}) and Proclaim® at 11 g a.i. ha^{-1} (8290 kg ha^{-1}). The lowest yield was recorded in endosulfan treated plots with 7750 kg ha^{-1}, while in the untreated check the yield was 5150 kg ha^{-1}. Hence, the dose of emamectin benzoate 5 SG at 11 g a.i. ha^{-1}, which showed good efficacy against *Okra* fruit borer, *E. vittella* and also recorded higher yield could be considered appropriate and economical.The effectiveness of emamectin benzoate 5 SG on yield increase is in agreement with Shobanadevi (2003), Bheemanna *et al.* (2005) and Sontakke *et al.* (2007) on *Okra*. In the second field trial conducted at Puttur emamectin benzoate 5 SG at 15 g a.i. ha^{-1} treated plots recorded the highest yield of 9335 kg ha^{-1} with an increase of 87.07 per cent over untreated check, which was on par with emamectin benzoate 5 SG at 13 g a.i. ha^{-1} and 11 g a.i. ha^{-1} (9100 – 9290 kg ha^{-1}) while in the untreated check the fruit yield was 4990 kg ha^{-1}. The present findings are in tune with the earlier report of Kuttalam *et al*. (2008) who found that foliar application of emamectin benzoate 5 EC at 15, 13, 11 and 9 g a.i. ha^{-1} recorded 8100.90, 7590.67, 7215 and 6750 kg ha^{-1}, *okra* fruits respectively.

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Table 2. Effect of emamectin benzoate 5 SG against fruit borer damage in okra (Location: Puttur - II season)

Treatment/	Mean per cent fruit damage (%) per ten plants*																				
	First application							Second application							Third application						
	PTD	3DAT	5DAT	7DAT	10DAT	Mean	ROC(%)	PTD	3DAT	5DAT	7DAT	10DAT	Mean	ROC(%)	PTD	3DAT	5DAT	7DAT	10DAT	Mean	ROC(%)
EB 5 SG @ 9.0g	519.	715.	813.	311.	511.	013.	959.	116.	715.	714.	113.	511.	713.	561.	511.	410.	59.	59.	57.	29.	174.
		5)(22.ab	8)(21.c	7)(19.ab	8)(19.ab				5)(22.ab	5)(22.d	2)(21.c	9)(19.ab				82)(18.ab	9)(17.a	9)(17.a	9)(15.a		
EB 5 SG @ 11.0g	619.	715.	212.	411.	511.	712.	161.	714.	715.	212.	311.	411.	612.	563.	411.	310.	59.	59.	47.	29.	674.
		5)(22.ab	4)(20. ab	7)(19.ab	8)(19.ab				5)(22.ab	4)(20.ab	6)(19.ab	8)(19.ab				7)(18.ab	9)(17.a	9)(17.a	8)(15.a		
EB 5 SG @ 13.0 g	319.	515.	411.	311.	411.	412.	062.	411.	515.	411.	311.	410.	112.	165.	410.	49.	49.	49.	76.	78.	475.
		1)(23. ab	7)(19.ab	6)(19.ab	7)(19.ab				1)(23.ab	7)(19.ab	6)(19.ab	8)(18.a				8)(17.a	8)(17.a	8)(17.a	9)(14.a		
EB 5 SG @ 15.0 g	519.	416.	311.	59.	710.	012.	263.	710.	813.	311.	59.	810.	111.	068.	810.	49.	49.	49.	66.	78.	575.
		9)(23.a	7)(19.a	9)(17. a	1)(19.a				8)(21.a	7)(19.a	9)(17.a	2)(19.a				8)(17.a	8)(17.a	8)(17.a	8)(14.a		
EB 5 SG (Proclaim) @ 11.0 g®	318.	417.	714.	212.	212.	114.	756.	511.	416.	813.	212.	212.	113.	262.	212.	410.	210.	210.	59.	110.	670.
		5)(24.b	5)(22.d	4)(20.b	4)(20.b				9)(23.b	8)(21.c	4)(20.b	4)(20.b				8)(18.ab	7)(18.ab	7)(18.ab	9)(17.b		
Endosulfan 35 EC @350 g	020.	317.	615.	715.	317.	516.	545.	317.	317.	615.	715.	317.	516.	652.	317.	315.	813.	314.	212.	713.	461.
		6)(24.c	5)(22.e	5)(22.c	5)(24.c				6)(24.c	5)(22.e	5)(22.d	5)(24.e				0)(23.c	8)(21.c	2)(22.c	4)(20.c		
Untreated check	419.	730.	033.	133.	134.	732.	-	034.	534.	534.	834.	535.	834.	-	535.	635.	735.	835.	935.	735.	-
		0)(34.d	7)(34.f	8)(34.d	7)(35.d				1)(36.d	8)(34.f	1)(35.e	8)(36.f				9)(36.d	8)(36.d	1)(37.c	2)(37.d		

EB- Emamectin benzoate , PTD- Pretreatment damage; DAT- Days after treatments, ROC - Reduction over control, * Mean of three replications
Figures in parentheses are *arc sine* transformed values; In a column, means followed by a common letter(s) are not significantly different by DMRT(P=0.05).

References

Anonymous, 2006. Agricultural production data base. FAO, *http//:apps.fao.org./faostat*. 340p.

Bheemanna, M., Patil, B.V. Hanchinal ,S. G Hosamani, A C and Kengegowda, N 2005. Bioefficacy of emamectin benzoate (Proclaim®) 5% SG against *Okra* fruit borers. *Pestology,* **29**: 14-16.

Dunbar, D. M., Lawson, D. S. White, S and Ngo, N. 1998. Emamectin benzoate: control of the *Heliothis* complex and impact on beneficial arthropods**. In**: *Proc. Beltwide Cotton Conf.*, P. Dugger and D. Richter (eds.), San Diego, California, USA, 5-9 January, 1998, pp 1116-1118.

Duncan, D.B. 1951. A significance test for differences between ranked treatment means in an analysis of variance. *Va. J. Sci.,* **2**: 171-189.

Gomez, K.A and Gomez A. A. 1984. *Statistical Procedures for Agricultural Research*.John Wiley and Sons, New Delhi. 680p.

Govindan, K., Gunasekaran, K. Kuttalam. S and Aiswariya, K. K. 2011. Bio efficacy of Emamectin Benzoate 5 SG against *Helicoverpa armigera* (Hubner) in Cotton. *Annals Pl. Prot. Sci*, **19**: 364-368.

Henderson, C. F and Tilton E. W. 1955. Test with acaricides against the brown wheat mite. *J. Econ. Entomol*., **48**: 157-161.

Ishaaya, I and Ohsawa, K. 2002. Emamectin, a novel insecticide for controlling field crop pests. *Pest Manag. Sci.,* **58**: 1091-1095.

Jansson, R.K Peterson, R.F Halliday, W.R. Mookerjee, P.K and Dybas, R.A. 1996. Efficacy of solid formulation of emamectin benzoate controlling lepidopteran pests. *Florida Entomol.,* **79**: 434-449.

Kuttalam, S., Boomathi, N Vinothkumar, B Kumaran, N and Rajathi. D. S. 2008. Field efficacy emamectin benzoate 5 EC against *Okra* fruit borer, *Earias vittella* (Fab). *Pestology,* **32**: 32- 36.

Lasota, J. A and Dybas, R. A. 1991. Avermectins; A novel class of compounds: Implications for use in arthropod pest control. *Ann. Rev. Entomol.,* **36**: 91-117.

Leibee, G.L., Jansson, R.K. Nuessly, G and Taylor, J.L. 1995. Efficacy of emamectin benzoate and *Bacillus thruingiensis* for control of diamond back moth on cabbage in Florida. *Florida Entomol.,* **78**: 82-96.

Mohapatra, G.K. and Gupta, G. P. 1998. Pesticide induced resurgence. *Pestology,* **22** : 14-20.

Mulrooney, J.E. and Elmore, C.D. 2000. Rainfastening of bifenthrin to cotton leaves with selected adjuvants. *J. Environ. Qual.,* **29**:1863–1866.

Patil, B. V and Rajanikantha, R. 2004. New class of insecticides, mode of action and their bioefficacy international symposium on strategies for sustainable cotton production a global version, 3. *Crop Protect.*, 23 – 25 Nov., USA . Dharwad. 77 – 85.

Shobanadevi, R. 2003. Bioefficacy and selective toxicity of emamectin 5 SG (Proclaim) against *Helicoverpa armigera* (Hubner) on bhendi and chillies. M.Sc.(Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore -3, p 89.

Sivakumar, R., Nachiappan, R.M. and Selvanarayanan, V. 2003. Profenofos a potential insecticide against tomato fruit borer. *Pestology*, **27** : 13-16.

Sontakke, B.E., Das, N.Panda, P. K and Swain, L. K . 2007. Bio efficacy of emamectin benzoate 5% SG against fruit and shoot borer in *Okra*, *J. Plant Prot. Environ.,* **4**: 30-33.

Stanley, J., Chandrasekaran, S and Regupathy, A. 2007. Evaluation of emamectin benzoate against brinjal fruit borer *Leucinodes orbonalis* (Guen.). *Pestic. Res. J.,* **19**: 34-36.

Wilson, A.G.L., Desmarchelier, J. M. and Malafan, K. 1983. Persistence on cotton foliage of insecticide residues toxic to *Heliothis* larvae. *Pest. Sci.,* **14**: 623–633.

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