BIO EFFICACY OF EMAMECTIN BENZOATE 5 SG AND 1.9 EC AGAINST SHOOT AND FRUIT BORERS OF OKRA

ABSTRACT

Okra also known as Bhendi (*Abelomoschus esculentus* L) is heavily infested by a variety of insect pests causing considerable damage and yield reduction. Among the pests, borers are most dreaded pests of national importance. Emamectin benzoate is an avermectin effective against several pests in number of crops. Two field experiments were conducted to evaluate the bio efficacy of emamectin benzoate against borers of bhendi. Emamectin benzoate 5 SG and 1.9 EC @ 7,11 15 and 20 g a.i. ha^{-1} were tested in comparison with Proclaim 5 SG @ 11 g a.i. ha^{-1} , chlorpyrifos 20 EC 200 g a..i ha^{-1} and untreated check. Observations on larval population and fruit damage were made prior to spraying and on 3, 7, 10 and 14 days after spraying from 10 randomly tagged plants per plot and the mean worked out. The fruit damage was assessed based on bore holes found on the fruit. The total number of fruits and infested fruits in ten randomly selected plants per plot were counted and the per cent fruit damage was worked out and the yield of bhendi fruits was also recorded. Results clearly showed that emamectin benzoate 5 SG @ 20 g a.i.ha^{-1} followed by 1.9 EC @ 20 g a.i.ha^{-1} were found to be more effective in controlling bhendi borers. The order of efficacy was emamectin benzoate 5 SG at 20 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1} >emamectin benzoate 5 SG at 15 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 15 g a.i.ha^{-1}>emamectin benzoate 5 SG at 11 g a.i.ha^{-1} ≥ Proclaim 5 SG at 11 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 11g a.i.ha^{-1} >emamectin benzoate 5 SG at 7 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 7 g a.i.ha^{-1} > chlorpyrifos 20 EC 200 g a..i ha^{-1}

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KEY WORDS(do it in italics): Emamectin benzoate, Bioefficacy, Okra, *Helicoverpa armigera, Earias vittella* (*Arrange it in alphabetical order)*

INTRODUCTION

Okra (*Abelomoschus esculentus* L) is an important vegetable crop. The stem of the crop is used in paper industry and also for the extraction of fibre. The productivity of the crop is low because of insect pest damage at all the stages of crop growth. (Sharma *et al*., 1997; Jagtab *et al.*, 2007). Sucking pests in the early stage and the fruit borers, *Earias vittella* Fabricius, *Earias insulana* Boisdual and *Helicoverpa armigera* (Hübner) in the later stage causes extensive damage to fruits and results in 69 per cent yield loss (Atwal and Singh, 1990; Mani *et al*., 2005). Chemical insecticides are used as the frontline defense sources against pests, inspite of their drawbacks in India. However, their indiscriminate use has created a number of problems such as pests developing resistance to insecticides, pest resurgence, and bio concentrations of pesticide residues in consumable produce. To overcome the above said problems, identification of new chemical molecules with better insecticidal properties, lower mammalian toxicity and lower application rate with selective action fits very well in the Integrated Pest Management concept. One such molecule, emamectin benzoate belonging to avermectins group, has been reported to possess excellent performance against the pests of cotton and vegetables (Sinha *et al.*, 2007; Harish and Patil, 2008, Sharma and Kausik, 2010). It is one of the broad spectrum microbial insecticides derived from the soil actinomycetes *Streptomyces avermitilis*. With this above background, the present study was taken up to evaluate the efficacy of emamectin benzoate against bhendi borers.

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MATERIALS AND METHODS

Two field experiments were conducted one each at Allapalayam, Annur and Maampalli, Kinathukadavu to evaluate the bioefficacy of emamectin benzoate 5 SG and 1.9 EC against borers on bhendi. The experiments were carried out in a randomized block design with eleven treatments, each replicated three times. The treatments imposed were emamectin benzoate 5 SG and 1.9 EC @ 7,11 15 and 20 g a.i. ha^{-1}, Proclaim 5 SG @ 11 g a.i. ha^{-1} , chlorpyrifos 20 EC 200 g a..i ha^{-1} and untreated Check. The treatments were imposed three times at 14 days interval commencing from 30^{th} day after sowing with pneumatic Knapsack sprayer using 750 litres of spray fluid per hectare. The observations on larval population and fruit damage were taken prior to spraying and at 3, 7 10 and 14 days after spraying. Larval population was recorded in 10 randomly tagged plants from each plot. The fruit damage was assessed based on bore holes found on the fruit. The total number of fruits and infested fruits in ten randomly selected plants per plot were counted and the per cent fruit damage was worked out and the yield of bhendi fruits were also recorded. The statistical analysis was carried out using IRRISTAT ver 3.1.ANOVA. The data obtained in percentages were transformed to corresponding angles (arcsine √percentage). The mean values of treatments were separated using Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1994).

RESULTS AND DISCUSSION

The results of the field experiment conducted at Allapalayam to test the efficacy of emamectin benzoate 5 SG and 1.9 EC showed a significant reduction in the per cent damage caused by borers on bhendi and the results were presented in the Tables 1-3. The larval population prior to first spraying ranged from 19.67 to 21.00 per ten plants and the damage caused by fruit borer was 24.58 to 26.74 per cent (Table 1). Emamectin benzoate 5 SG at 20 g a.i.ha^{-1} recorded higher

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reduction in larval population of 73.18, 87.57, 76.08 and 60.62 per cent, on 3, 7, 10 and 14 days after treatment respectively followed by emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1} and which was on par with each other. Emamectin benzoate 5 SG @ 20 g a.i.ha^{-1} recorded lower levels of fruit damage *viz.*, 9.85, 8.70, 11.19 and 13.91 per cent on 3, 7, 10 and 14 days after treatment, respectively. (Table 1). Emamectin benzoate 5 SG at 11 g a.i.ha^{-1} recorded 55.12, 72.12, 56.12 and 47.36 per cent reduction in larval population on 3, 7, 10 and 14 DAT, respectively and recorded 49.95 per cent mean reduction in fruit damage after the first spray. The efficacy of chlorpyrifos (26.52%) was significantly lower than that of Proclaim (49.17%). The second application was given fourteen days after the first application. The trend of efficacy of different treatments regarding the per cent reduction in larval population and fruit damage was similar to that of first application. The maximum reduction in larval population (88.81%) was noticed in plots treated with emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1} and was followed by emamectin benzoate 5 SG at 20 g a.i.ha^{-1} (83.13%). The mean reduction in fruit damage at the end of second spray was 71.99 per cent and 70.83 per cent, in the above treatments, respectively (Table 2). After the third round of spray, emamectin benzoate 5 SG at 20 g a.i.ha^{-1} registered the highest larval population reduction of 66.05 per cent on 7 DAT followed by emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1}(65.71%) and the lowest per cent reduction was observed in chlorpyrifos 20 EC (39.57%). Likewise, the mean reduction in fruit damage at the end of third spray was 87.28 per cent and 87.49 per cent, in the above treatments, respectively. Emamectin benzoate 5 SG at 11 g a.i.ha^{-1} recorded a mean reduction in fruit damage of 78.36 per cent which was on par with Proclaim (78.18%) and emamectin benzoate 1.9 EC at 11 g a.i.ha^{-1} (78.62%) (Table 3).

The trend of efficacy of different treatments was similar in the second field experiment conducted at Maampalli also (Fig. 1-2). The larval population prior to first spraying ranged from

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18.3 to 19.3 per ten plants and the damage caused by fruit borer was 24.65 to 26.45 per cent. Emamectin benzoate 5 SG at 20 g a.i.ha^{-1} recorded higher reduction in larval population of 71.24, 84.93, 74.38 and 58.22 per cent on 3, 7, 10 and 14 days after treatment, respectively followed by emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1} and which was on par with each other. The fruit damage was 10.11, 8.61, 11.58 and 14.27 per cent on 3, 7, 10 and 14 days after treatment Emamectin benzoate 5 SG at 11 g a.i.ha^{-1} recorded 52.23, 67.69, 54.69 and 45.22 per cent reduction in larval population on 3, 7, 10 and 14 DAT, respectively which was on par with Proclaim and emamectin benzoate 1.9 EC at 11 g a.i.ha^{-1} and recorded 46.39 per cent mean reduction in fruit damage after the first spray. The efficacy of chlorpyrifos (16.30%) was significantly lower than that of Proclaim (45.91%) (Fig. 1-2). The yield was significantly higher in all the treatments compared to untreated check (4916.00 kg ha^{-1} and 4768.00 kg ha^{-1}) in first and second experiments, respectively. The highest yield of 8147.20 and 7902.00kg ha^{-1} was recorded in the plots treated with emamectin benzoate 5 SG at 20 g a.i.ha^{-1} followed by emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1} (8055.90 kg ha^{-1} and 7813.00). The yield in emamectin benzoate 5 SG at 11 g a.i.ha^{-1} (7278.33 and 7059.67 kg ha^{-1}) was comparable with Proclaim (7245.00 and 7027 kg ha^{-1}) and emamectin benzoate 1.9 EC at 11 g a.i.ha^{-1} (7208.00 and 6991.67 kg ha^{-1}) (Fig.3).

The order of efficacy was emamectin benzoate 5 SG at 20 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 20 g a.i.ha^{-1} >emamectin benzoate 5 SG at 15 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 15 g a.i.ha^{-1}>emamectin benzoate 5 SG at 11 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 11g a.i.ha^{-1} >emamectin benzoate 5 SG at 7 g a.i.ha^{-1} ≥ emamectin benzoate 1.9 EC at 7 g a.i.ha^{-1} > chlorpyrifos 20 EC 200 g a.i.ha^{-1}.

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Similar studies were conducted by Suganya Kanna *et al.* (2005), Murugaraj *et al.* (2006) and Kumar and Shivaraju (2009) against tomato fruit borer *Helicoverpa armigera* (Hubner), reporting the superiority of emamectin benzoate over lambda cyhalothrin and spinosad. The findings of present study corroborate with earlier workers in suppressing larval population, per cent fruit damage and higher yield in insecticidal treatments than untreated control. Further, tested newer insecticide molecule performed better than the traditional insecticide.

The efficacy of emamectin benzoate in the present study is substantially supported by the findings of Kumar and Devappa (2006 a and b) and Anil and Sharma (2010) who reported that application of Proclaim 5 SG @ 200 g a.i. ha-1 was found effective in reducing fruit damage by shoot and fruit borer in brinjal. Emamectin benzoate was very effective in controlling bollworm complex in cotton evidenced by lower square and boll damage (Sontakke *et al.,* 2007). Whereas Chowdary *et al.* (2010) reported that rynaxypyr 20 SC @ 30 g a.i. /ha was superior in recording less larval populations of *H. armigera*, lower fruit damage and higher fruit yield of bhendi than emamectin benzoate @15 g.a.i/ha.

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(Arrange it in alphabetical sequences)

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Fig.1. Effect of emamectin benzoate 5 SG and 1.9 EC on the larval population of borers - Maampalli

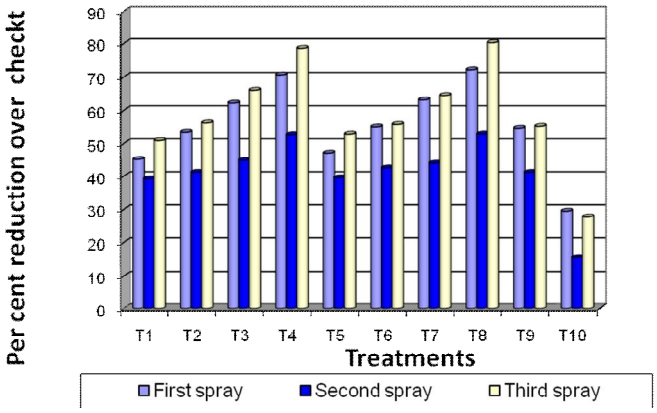

Fig. 2. Effect of emamectin benzoate 5 SG and 1.9 EC on fruit damage caused by borers - Maampalli

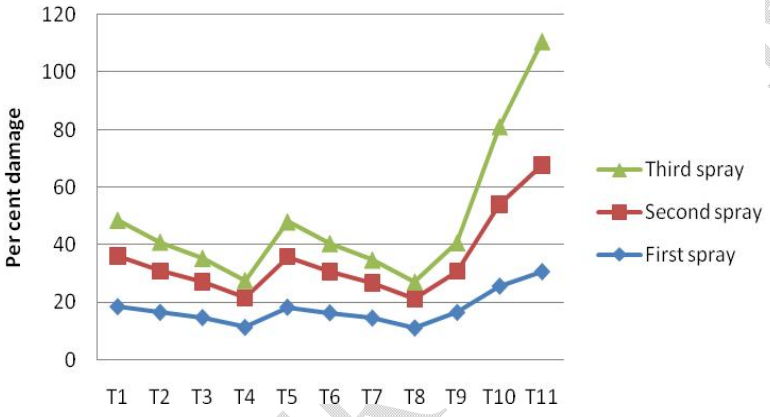

Fig.3. Effect of emamectin benzoate 5 SG and 1.9 EC on bhendi yield

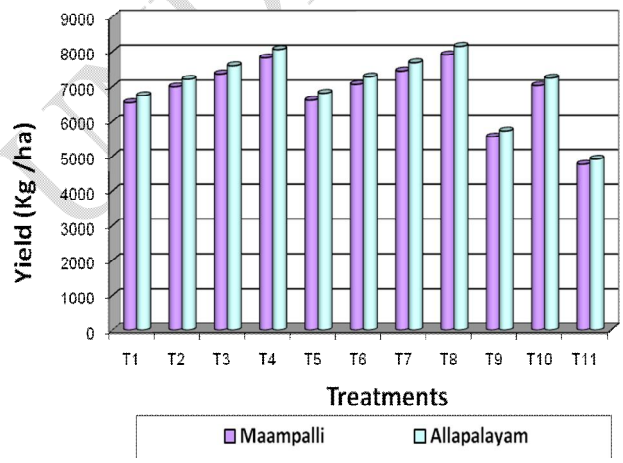

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Table 1. **Effect of Emamectin benzoate 5 SG and 1.9 EC on the larval population and fruit damage by borers on bhendi**

(Location - Allapalayam,) (Mean of three observations)

Treatments	Days after first treatment															
	PTC	No. of larvae/ 10 plants								Per cent fruit damage						
		3 DAT		7 DAT		10 DAT		14 DAT		PTC	3	7	10	14	Mean	Percent reduction over check
		No	% R	No	% R	No	% R	No	% R							
T1-Emamectin benzoate 1.9 EC @ 7.0 g a.i.ha^{-1}	20.33	12.67	46.44^{c} (42.96)	9.00	63.66^{d} (52.93)	14.00	46.08^{c} (42.75)	17.67	35.16^{bc} (36.36)	25.81	16.23^{bc} (23.76)	14.71^{c} (22.55)	18.83^{e} (25.72)	22.60^{d} (28.39)	18.09	42.89
T2-Emamectin benzoate 1.9 EC @ 11.0 g a.i.ha^{-1}	20.00	10.67	53.86^{bc} (47.22)	7.34	69.62^{cd} (56.55)	11.67	54.38^{bc} (47.51)	14.33	46.54^{ab} (43.02)	26.59	14.69^{b} (22.54)	13.39^{bc} (21.46)	16.59^{d} (24.04)	20.35^{c} (26.81)	16.26	48.69
T3-Emamectin benzoate 1.9 EC @ 15.0 g a.i.ha^{-1}	19.67	9.00	60.84^{ab} (51.26)	5.33	77.32^{bc} (61.56)	8.00	67.33^{ab} (55.14)	12.67	51.79^{ab} (46.02)	25.38	13.82^{b} (21.82)	11.79^{b} (20.09)	13.93^{b} (21.92)	17.09^{b} (24.42)	14.16	55.31
T4-Emamectin benzoate 1.9 EC @ 20.0 g a.i.ha^{-1}	19.67	6.67	71.37^{a} (57.65)	3.34	86.10^{ab} (68.11)	6.34	74.46^{a} (59.64)	10.34	59.46^{a} (50.45)	25.52	9.71^{a} (18.15)	8.40^{a} (16.84)	11.38^{a} (19.72)	13.80^{a} (21.81)	10.82	65.84
T5-Emamectin benzoate 5 SG @ 7.0 g a.i.ha^{-1}	20.67	12.67	47.39b^{c} (43.51)	8.67	65.83^{d} (54.23)	13.33	49.34^{c} (44.62)	17.33	37.05^{bc} (37.49)	25.72	16.74^{bc} (24.15)	14.52^{c} (22.40)	18.41^{e} (25.41)	22.74^{d} (28.48)	18.10	42.86
T6-Emamectin benzoate 5 SG @ 11.0 g a.i.ha^{-1}	20.33	10.67	55.12b^{c} (47.94)	6.67	72.12^{cd} (58.13)	11.33	56.12^{bc} (48.51)	14.00	47.36^{ab} (43.49)	25.57	14.76^{b} (22.59)	12.90^{bc} (21.05)	15.91^{c} (23.51)	19.86^{c} (26.47)	15.86	49.95
T7-Emamectin benzoate 5 SG @ 15.0 g a.i.ha^{-1}	20.00	9.00	61.15a^{b} (51.44)	5.34	78.18^{bc} (62.15)	8.00	68.49^{ab} (55.85)	12.00	54.90^{a} (47.81)	25.87	13.65^{b} (21.68)	12.39^{b} (20.61)	14.12^{b} (22.07)	17.18^{b} (24.48)	14.33	54.76
T8-Emamectin benzoate 5 SG @ 20.0 g a.i.ha^{-1}	19.67	6.00	73.18^{a} (58.81)	3.00	87.57^{a} (69.36)	6.00	76.08^{a} (60.72)	10.00	60.62^{a} (51.13)	24.58	9.85^{a} (18.29)	8.70^{a} (17.16)	11.19^{a} (19.55)	13.91^{a} (21.90)	10.92	65.55
T9-Emamectin 5 SG (Proclaim®) @ 11.0 g .i.ha^{-1}	20.33	10.33	55.28b^{c} (48.03)	7.33	70.16^{cd} (56.89)	11.00	56.46^{bc} (48.71)	14.00	47.83^{ab} (43.76)	26.74	14.95^{b} (22.75)	13.28^{bc} (21.37)	16.32^{cd} (23.82)	19.86^{c} (26.47)	16.10	49.17
T10-Chlorpyrifos 20 EC @ 200 g a.i.ha^{-1}	20.67	13.33	43.01^{c} (40.98)	13.67	44.50^{e} (41.84)	19.34	24.81^{d} (29.87)	20.67	23.73^{c} (29.15)	26.22	19.13^{c} (25.93)	20.45^{d} (26.89)	24.47^{f} (29.65)	29.07^{e} (32.62)	23.28	26.52
T11- Untreated Check	21.00	24.34	-	25.67	-	26.67	-	28.00	-	26.52	28.41^{d} (32.21)	32.92^{c} (35.01)	31.66^{g} (34.24)	33.74^{f} (35.51)	31.68	-

PTC – Pre treatment count; % R- Per cent reduction from control

Figures in parentheses are arcsine $\sqrt{\text{per cent}}$ transformed values ; In a column, means followed by a common letter(s) are not significantly different by DMRT(P=0.05)

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Table 2. **Effect of Emamectin benzoate 5 SG and 1.9 EC on the larval population and fruit damage by borers on bhendi**

(Location - Allapalayam,) (Mean of three observations)

Treatments	Days after second treatment														
	PTC	No. of larvae/ 10 plants								Per cent fruit damage						
		3 DAT		7 DAT		10 DAT		14 DAT		PTC	3	7	10	14	Mean	Percent reduction over check
		No	% R	No	% R	No	% R	No	% R							
T1-Emamectin benzoate 1.9 EC @ 7.0 g a.i.ha^{-1}	17.67	11.33	37.83^{a} (37.96)	7.00	63.31^{ab} (52.72)	13.00	33.49^{ab} (35.36)	15.67	24.78^{b} (29.85)	24.62	17.45^{e} (24.69)	14.64^{d} (22.50)	18.83^{d} (25.72)	22.60^{c} (28.39)	18.38	54.18
T2-Emamectin benzoate 1.9 EC @ 11.0 g a.i.ha^{-1}	14.33	9.33	36.29^{a} (37.04)	5.33	65.29^{ab} (53.91)	10.67	32.69^{ab} (34.88)	12.33	27.07^{ab} (31.35)	21.23	14.49^{cd} (22.37)	11.67^{c} (19.97)	15.16^{bc} (22.91)	18.68^{b} (25.61)	15.00	62.61
T3-Emamectin benzoate 1.9 EC @ 15.0 g a.i.ha^{-1}	12.67	7.67	40.80^{a} (39.70)	3.33	75.26^{ab} (60.17)	7.00	48.97^{ab} (44.41)	10.67	28.71^{ab} (32.40)	19.21	13.99^{bcd} (21.96)	9.54^{bc} (17.99)	14.93^{bc} (22.73)	17.09^{ab} (24.42)	13.89	65.38
T4-Emamectin benzoate 1.9 EC @ 20.0 g a.i.ha^{-1}	10.34	5.33	48.54^{a} (44.16)	1.33	86.81^{a} (68.71)	5.33	44.91^{ab} (42.08)	8.33	34.96^{a} (36.25)	16.09	11.71^{ab} (20.01)	7.59^{ab} (15.99)	11.38^{a} (19.72)	16.13^{ab} (23.68)	11.70	70.83
T5-Emamectin benzoate 5 SG @ 7.0 g a.i.ha^{-1}	17.33	11.33	36.97^{a} (37.44)	6.67	64.21^{ab} (53.25)	12.33	35.37^{ab} (36.49)	15.33	24.95^{b} (29.97)	24.00	17.25^{e} (24.54)	14.42^{d} (22.31)	18.74^{d} (25.65)	22.74^{c} (28.48)	18.29	54.41
T6-Emamectin benzoate 5 SG @ 11.0 g a.i.ha^{-1}	14.00	9.33	36.22^{a} (37.00)	4.67	68.81^{ab} (56.05)	10.33	33.41^{ab} (35.31)	12.00	27.31^{ab} (31.51)	21.20	15.08^{de} (22.85)	11.25^{c} (19.60)	15.91^{c} (23.51)	18.53^{b} (25.50)	15.19	62.13
T7-Emamectin benzoate 5 SG @ 15.0 g a.i.ha^{-1}	12.00	7.67	38.26^{a} (38.21)	3.33	74.24^{ab} (59.50)	7.00	47.15^{ab} (43.37)	10.00	29.33^{ab} (32.79)	18.55	12.38^{abc} (20.60)	9.61^{bc} (18.06)	13.12^{ab} (21.23)	15.84^{ab} (23.46)	12.74	68.25
T8-Emamectin benzoate 5 SG @ 20.0 g a.i.ha^{-1}	10.00	4.67	53.19^{a} (46.83)	1.67	83.13^{a} (65.75)	5.00	54.08^{a} (47.34)	8.00	32.88^{ab} (34.99)	15.80	11.37^{a} (19.70)	7.33^{a} (15.71)	11.71^{a} (20.01)	14.53^{a} (22.41)	11.24	71.99
T9-Emamectin 5 SG (Proclaim®) @ 11.0 g .i.ha^{-1}	14.00	9.00	36.74^{a} (37.31)	5.33	64.89^{ab} (53.66)	10.00	35.69^{ab} (36.69)	12.00	27.30^{ab} (31.50)	21.43	14.34^{cd} (22.25)	11.27^{c} (19.62)	15.95^{c} (23.54)	18.47^{b} (25.45)	15.01	62.59
T10-Chlorpyrifos 20 EC @ 200 g a.i.ha^{-1}	21.33	12.00	45.30^{a} (42.30)	11.67	49.29^{b} (44.60)	18.33	22.17^{b} (28.09)	19.33	23.10^{b} (28.73)	31.18	26.57^{f} (31.03)	27.20^{e} (31.43)	30.77^{e} (33.69)	33.12^{d} (35.13)	29.42	26.68
T11- Untreated Check	28.00	29.00	-	30.34	-	31.00	-	33.00	-	37.73	38.07^{g} (38.10)	40.33^{f} (39.42)	41.66^{f} (40.20)	40.41^{e} (39.47)	40.12	-

PTC – Pre treatment count; % R- Per cent reduction from control

Figures in parentheses are arcsine $\sqrt{\text{per cent}}$ transformed values ; In a column, means followed by a common letter(s) are not significantly different by DMRT(P=0.05)

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Table 3. Effect of Emamectin benzoate 5 SG and 1.9 EC on the larval population and fruit damage by borers on bhendi

(Location - Allapalayam,) (Mean of three observations)

Treatments	Days after third treatment														
	PTC	No. of larvae/ 10 plants								Per cent fruit damage					
		3 DAT		7 DAT		10 DAT		14 DAT		PTC	3	7	10	14	Mean	Percent reduction over check
		No	% R	No	% R	No	% R	No	% R							
T1-Emamectin benzoate 1.9 EC @ 7.0 g a.i.ha^{-1}	15.67	10.33	37.53^{a} (37.78)	8.00	53.05^{cd} (46.75)	12.00	32.75^{ab} (34.91)	13.67	24.29^{b} (29.53)	20.89	14.31^{d} (22.23)	9.65^{ef} (18.10)	10.82^{d} (19.21)	11.82^{d} (20.11)	11.65	73.24
T2-Emamectin benzoate 1.9 EC @ 11.0 g a.i.ha^{-1}	12.33	8.33	35.16^{a} (36.37)	6.33	52.43^{cd} (46.39)	9.67	31.28^{ab} (34.01)	10.33	27.38^{ab} (31.55)	17.75	11.59^{c} (19.91)	7.62^{d} (16.02)	8.44^{c} (16.89)	9.60^{c} (18.05)	9.31	78.62
T3-Emamectin benzoate 1.9 EC @ 15.0 g a.i.ha^{-1}	10.67	6.67	40.03^{a} (39.25)	4.33	62.14^{abc} (52.03)	6.00	49.53^{ab} (44.73)	8.67	29.68^{ab} (33.01)	15.25	9.65^{b} (18.10)	5.81^{c} (13.95)	6.37^{b} (14.62)	7.72^{b} (16.13)	7.39	83.03
T4-Emamectin benzoate 1.9 EC @ 20.0 g a.i.ha^{-1}	8.33	4.33	47.62^{a} (43.64)	2.33	65.71^{ab} (54.16)	4.00	46.84^{ab} (43.19)	6.33	43.04^{a} (41.00)	12.51	7.79^{a} (16.21)	3.98^{ab} (11.51)	4.27^{a} (11.93)	5.74^{a} (13.87)	5.45	87.49
T5-Emamectin benzoate 5 SG @ 7.0 g a.i.ha^{-1}	15.33	10.33	36.58^{a} (37.21)	7.67	53.66^{cd} (47.10)	11.33	34.87^{ab} (36.19)	13.33	24.56^{b} (29.71)	20.72	14.43^{d} (22.33)	9.82^{f} (18.27)	10.61^{d} (19.01)	11.73^{d} (20.02)	11.65	73.26
T6-Emamectin benzoate 5 SG @ 11.0 g a.i.ha^{-1}	12.00	8.33	35.30^{a} (36.45)	5.67	56.28^{bc} (48.61)	9.33	31.71^{ab} (34.27)	10.00	27.71^{ab} (31.76)	17.01	11.48^{c} (19.80)	7.86^{def} (16.28)	8.70^{c} (17.16)	9.66^{c} (18.11)	9.42	78.36
T7-Emamectin benzoate 5 SG @ 15.0 g a.i.ha^{-1}	10.00	6.67	37.05^{a} (37.49)	4.33	60.03^{abc} (50.78	6.00	47.16^{ab} (43.37)	8.00	30.65^{ab} (33.62)	15.19	9.53^{b} (17.98)	5.39^{bc} (13.42)	6.42^{b} (14.67)	7.39^{b} (15.77)	7.18	83.51
T8-Emamectin benzoate 5 SG @ 20.0 g a.i.ha^{-1}	8.00	3.67	54.15^{a} (47.38)	2.67	66.05^{a} (54.36)	4.00	54.70^{a} (47.70)	6.00	36.36^{a} (37.08)	12.51	7.84^{a} (16.27)	3.89^{a} (11.38)	4.89^{a} (12.77)	5.54^{a} (13.62)	5.54	87.28
T9-Emamectin 5 SG (Proclaim®) @ 11.0 g .i.ha^{-1}	12.00	8.00	35.57^{a} (36.61)	6.33	51.61^{cd} (45.92)	9.00	34.61^{ab} (36.04)	10.00	27.70^{ab} (31.76)	16.33	11.98^{c} (20.25)	7.76^{de} (16.18)	8.74^{c} (17.20)	9.52^{c} (17.97)	9.50	78.18
T10-Chlorpyrifos 20 EC @ 200 g a.i.ha^{-1}	19.33	11.00	45.88^{a} (42.64)	12.67	39.57^{d} (38.98)	17.33	21.09^{b} (27.34)	17.33	22.18^{b} (28.10)	31.73	25.24^{e} (30.16)	25.41^{g} (30.27)	26.19^{e} (30.78)	27.15^{e} (31.41)	26.00	40.30
T11- Untreated Check	33.00	35.00	-	36.00	-	37.67	-	38.00	-	40.50	41.59^{f} (40.16)	42.35^{h} (40.60)	44.82^{f} (42.03)	45.44^{f} (42.39)	43.55	-

PTC – Pre treatment count; % R- Per cent reduction from control

Figures in parentheses are arcsine $\sqrt{\text{per cent}}$ transformed values ; In a column, means followed by a common letter(s) are not significantly different by DMRT(P=0.05)

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