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Emamectin Benzoate 5 SG: A safer insecticide to coccinellids predators in cotton ecosystem

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Two field experiments were conducted one at Vellan Koil in winter season cotton cultivar - MCU 5 during January to April 2008 and the other at Erangkattur on Cultivar -Surabhi during May to September 2008. Both the field experiments were conducted in erode districts of Tamil Nadu to evaluate the safety of new formulation emamectin benzoate 5 SG at different doses (emamectin benzoate 5 SG at 7, 11 and 15 g a.i. / ha) in comparison with standard check, Proclaim® at 11 g a.i. / ha (emamectin benzoate 5 SG) which is a registered product of Syngenta and spinosad 45 SC at 75 g a.i. / ha) to coccinellid predators in cotton ecosystem. Observation on the population of coccinellids were made prior to spraying and on 1, 3, 5, 7 and 10 days after spraying from ten randomly tagged plants per plot and the mean population was worked out. The results showed that emamectin benzoate 5 SG was found safer to coccinellids at all the tested concentrations. The highest population was recorded in plots treated with emamectin benzoate 5 SG at 7 g a.i. / ha followed by emamectin benzoate 5 SG at 11 g a.i. / ha.

Key words: Safety, emamectin benzoate 5 SG, coccinellids, cotton ecosystem.

INTRODUCTION

Cotton (*Gossypium* spp. L.) is a high valued commercial crop, cultivated for its fibre and oil. India ranks second in cotton production after China, with a productivity of 526 kg / ha Govindan et al. (2010). In India, cotton is cultivated over an area of 93.73 lakh ha with a production of 290 lakh bales. In Tamil Nadu, the average area, production and productivity are 1.19 lakh ha, 5.00 lakh bales and 714 kg / ha, respectively (Anonymous, 2007). The cotton ecosystem normally contains beneficial predators and parasitoids that frequently provide partial to satisfactory pest control. In order to conserve natural enemies, care should be taken in the selection of appropriate insecticides for pest management to reduce the harmful effects of insecticide caused by them. The cotton crop harbors nearly 1326 insects and mites are reported all over the world (Hargreaves, 1948) and about 200 in India (Anonymous, 1981). Sap sucking pests in cotton consists of jassid, *Amrasca biguttula biguttula* Ishida, aphid, *Aphis gossypii* Glover, thrips, *Thrips tabaci* Linn, white fly, *Bemisia tabaci Genn*., mealy bug, *Phenococcus solenopsis* Tinsley and *Paracoccus marginatus* Williams and Granara de willink. As many of the recommended insecticides are reported highly toxic to predators and parasitoids (Dhawan et al., 1992, 1994; Singh, 1994). The population of predators declined by 68.4% during the last decades and many parasitoids has been eliminated from cotton ecosystem (Dhawan and Simwat, 1996). In cotton ecosystem sap sucking pests were effectively controlled by coccinellid predators and universally known group of beneficial insects (Ali and Rizvi, 2007). They

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are almost found everywhere and feed on aphids and variety of soft bodied insects (Indu and Chatterjee, 2006). Significance of biological control, the Coleoptera order ranks first. The family Coccinellidae of the order Coleoptera is exclusively predaceous except subfamily Epilachnae. Coccinellids, popularly known as ladybird beetles are the most successful group of beneficial l insects, which plays an essential role in checking the aphids and other soft bodied insects in the cotton ecosystem (Tank et al., 2007). About 90% of approximately 4,200 *Coccinellid* species are considered beneficial because of their predatory activity, mainly against homopterous insects and mites (Swaminathan et al., 2010). Emamectin benzoate, one of the newer compounds is synthesized from the naturally occurring insecticide/acaricide of avermectin family. This was discovered in 1984 as a broad spectrum lepidoptericide. Emamectin benzoate product is a mixture of emamectin benzoate B1a and emamectin benzoate B1b that are extracted from *Streptomyces avermitilis* Burg. It has been reported to possess excellent action against pests cotton and vegetables (Govindan et al., 2010) alternate to existing formulation and also ecologically sound for effective management of cotton bollworm complex. Hence the present investigation was undertaken to work out safety of emamectin benzoate 5 SG on coccinellid predators in cotton ecosystem.

MATERIALS AND METHODS

Safety of emamectin benzoate 5 SG was tested at different doses to evaluate safety against coccinellid predators in cotton ecosystem at two locations *viz*., first season at Vellan Koil in winter season (Cultivar - MCU 5) during January to April 2008 and second season experiment at Erangkattur on summer season (Cultivar -Surabhi) during May to September 2008 to evaluate the safety of new formulation emamectin benzoate 5 SG at different doses 7, 11 and 15 g a.i. / ha) along with standard check, Proclaim® at 11 g a.i. / ha (emamectin benzoate 5 SG) registered product of syngenta and spinosad 45 SC at 75 g a.i. / ha safety to coccinellid predators in cotton ecosystem. The two season field experiments were carried out in plots of 5 m □ 5 m size in a randomized block design (RBD) with seven treatments replicated thrice. The treatments were imposed two (Vellan Koil) and three (Erangkattur) times during January to August 2008, at 10 days interval commencing from 60th day after sowing and the spraying was given with pneumatic knapsack sprayer (Aspee sprayer) using 1000 L of spray fluid per hectare. In both the field trials, population of coccinellid grubs and adults was recorded on ten randomly selected plants per plot after 1, 3, 5, 7 and 10 days in treated plots. The data were obtained and analysed statistically (Gomez and Gomez, 1984). The mean values were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1951).

RESULTS AND DISCUSSION

The safety of emamectin benzoate 5 SG and other standard chemicals evaluated against in coccinellid predators based on two or three sprays and the results are presented in Tables 1 and 2. In the first season, field experiments the grubs and adult populations prior to first spraying were 7.70 to 9.00 per ten plants (Table 1). There was no reduction of coccinellids population at 1 and 3 days after treatment (DAT) due to emamectin benzoate 5 SG at 7, 11 and 15 g a.i. / ha which recorded 8.33, 8.00 and 7.66 coccinellids per ten plants when compared to other standard, and spinosad 45 SC at 75 g (7.66 / 10 plants). At three days after first application, the predatory coccinellid population was the highest (7.33 / 10 plants) in the plots treated with emamectin benzoate 5 SG at 7 g a.i. / ha followed by emamectin benzoate 5 SG at 11 g a.i. / ha (6.33 / 10 plants) and emamectin benzoate 5 SG at 15 g a.i. / ha (5.00/ 10 plants). The highest population of coccinellids was observed in untreated plots (10.33 / 10 plants).

Similar trend was observed in the treated plots at 5 and 7 days after initiation of treatments. At 10 DAT, the population was gradually increased in the lower dose of emamectin benzoate 5 SG at the lowest dose (7g a.i. / ha) recorded mean population of 8.26 coccinellids per 10 plants next to untreated check (10.66/10 plants) while emamectin benzoate 5 SG at 11 and 15 a.i. / ha recorded 7.26 and 6.48 coccinellids per ten plants followed by Proclaim® (7.03/10 plants) and spinosad (6.26/10 plants. Similar result were reported by Jasmine and Kuttalam (2011) who observed that plots treated with emamectin benzoate 5 SG at 7 and 11 g a.i. / ha recorded highest population of coccinellids in okra ecosystem. These present findings are in conformity with the results of Tilman and Mulrooney (2000) who reported that emamectin benzoate with novel mode of action is generally more selective and require lower rates than conventional insecticides and has low moderate impact on beneficial insects. Chizhov et al. (2000) stated that avermectins were safe to *Coccinella septempunctata.* After second round of application, at 3 DAT, emamectin benzoate 5 SG at 7 g a.i. / ha harbored 8.33 coccinellids which was on par with emamectin benzoate 5 SG at 11 g a.i. / ha (8.00 coccinellids / 10 plants), Proclaim® 11 g a.i. / ha (7.00 coccinellids / 10 plants) and spinosad 45 SC at 75 g a.i./ ha (6.00 / 10 plants) whereas higher dose of emamectin benzoate 5 SG at 15 g a.i./ ha and endosulfan harboured 7.00 and 4.66 coccinellids per ten plants respectively as against 11.66 coccinellids per ten plants in untreated check (Table 1). Present findings are in accordance with the observation of Jyoti and Goud (2008) who reported that emamectin benzoate 5 SG was safer to coccinellids in brinjal ecosystem and also Dunbar et al. (1998) observed that emamectin benzoate is a safe chemical to *Coccinellids* and *Chrysoperla carnea.* This might be due to rapid breakdown of the active ingredient by photo-oxidation to non-toxic level on the leaf surface, limiting contact activity to a very short period. Similar trend of population of coccinellids was observed at 5 and 7 DAT due to emamectin benzoate 5 SG treatments (6.00 to 7.66 / 10 plants) and 15 DAT (7.66 to 9.66 / 10 plants. At 10 DAT, the highest population of predatory coccinellids per

Table 1. Effect of emamectin benzoate 5 SG in coccinellids in cotton eco system after second application (Location: Vellankoil I season).

Treatments	Dose (g a.i./ha)	Number of grubs and adults per ten plants*													
		First application							Second application						
		PTC	1DAT	3DAT	5DAT	7DAT	10DAT	Mean	PTC	1 DAT	3DAT	5DAT	7DAT	10DAT	Mean
Emamectin benzoate 5 SG	7	9.00	8.33 (2.97)^{a}	7.33 (2.79)^{a}	6.33 (2.61)^{b}	8.66 (3.02)^{b}	10.66 (3.34)^{ab}	8.26	10.50	10.00 (3.23)^{a}	8.33 (2.97)^{b}	7.66 (2.84)^{b}	9.66 (3.18)^{b}	10.33 (3.29)^{ab}	9.29
Emamectin benzoate 5 SG	11	8.33	8.00 (2.91)^{a}	6.33 (2.60)^{b}	5.00 (2.33)^{bc}	7.66 (2.85)^{bc}	9.33 (3.13)^{c}	7.26	8.33	8.33 (2.97)^{b}	8.00 (2.91)^{b}	7.33 (2.79)^{b}	8.00 (2.91)^{bc}	8.33 (2.97)^{cd}	7.99
Emamectin benzoate 5 SG	15	8.00	7.66 (2.85)^{b}	5.00 (2.33)^{bc}	4.66 (2.26)^{c}	6.66 (2.67)^{cd}	8.33 (2.97)^{c}	6.46	8.00	7.66 (2.85)^{c}	7.00 (2.73)^{bc}	6.00 (2.54)^{bc}	7.66 (2.85)^{bc}	7.33 (2.79)^{de}	7.13
Endosulfan 35 EC	350	7.77	6.33 (2.61)^{d}	4.66 (2.70)^{c}	3.33 (1.94)^{d}	5.00 (2.33)^{e}	7.00 (2.73)^{d}	5.26	9.00	7.00 (2.73)^{c}	4.66 (2.27)^{d}	5.00 (2.33)^{c}	6.66 (2.67)^{c}	6.33 (2.60)^{e}	5.93
Emamectin benzoate 5 SG (Proclaim®)	11	9.00	8.00 (2.91)^{a}	6.00 (2.54)^{c}	5.33 (2.14)^{bc}	7.16 (2.76)^{c}	8.66 (3.02)^{c}	7.03	9.00	8.00 (2.91)^{b}	7.00 (2.73)^{bc}	6.00 (2.54)^{bc}	8.00 (2.91)^{bc}	9.00 (3.07)^{bc}	7.60
Spinosad 45 SC	75	9.00	7.66 (2.85)^{c}	4.66 (2.26)^{c}	4.66 (2.27)^{c}	5.66 (2.48)^{de}	8.66 (3.02)^{c}	6.26	10.00	7.00 (2.73)^{c}	6.00 (2.54)^{cd}	5.33 (2.41)^{c}	7.33 (2.78)^{c}	8.33 (2.97)^{cd}	6.79
Untreated check	-	8.33	9.00 (3.08)^{a}	10.33 (3.29)^{a}	10.33 (3.29)^{a}	11.66 (3.48)^{a}	12.00 (3.50)^{a}	10.66	10.50	10.00 (3.23)^{a}	11.66 (3.48)^{a}	12.00 (3.50)^{a}	12.50 (3.51)^{a}	13.50 (3.60)^{a}	11.93

PTC- Pre treatment count; DAT- Days after treatments, *****Mean of three replications, Values in parentheses are $\sqrt{x+0.5}$ transformed values, In a column means followed by a common letter(s) are not significantly different by DMRT (P=0.05).

ten plants was recorded in plots treated with emamectin benzoate 5 SG at 7 g a.i./ ha (10.33 / 10 plants) and untreated control recorded the highest coccinellids population of 13.50 per ten plants. Comparatively at all the days after treatment coccinellids population was low in endosulfan treated plot. Udikeri et al. (2004) reported that Proclaim® is safe to coccinellids in cotton ecosystem. Acharya et al. (2002) confirmed that abamectin was safer to lady bird beetles. Mean population coccinellids, emamectin benzoate 5 SG at 7 g a.i./ ha recorded 9.29 coccinellids per ten plants followed by emamectin benzoate 5 SG at 11 g a.i./ ha (7.99 / 10 plants), as compared to standard insecticide *viz.,* Proclaim® (7.60 / 10 plants). The population of coccinellids and lacewings were not significantly different between insecticide treated (emamectin benzoate, indoxacarb and spinosad) and untreated plots (Ruly, 2008). All the emamectin benzoate irrespective of the doses were found to have only a little impact on coccinellids. Population of coccinellids declined immediately after the spray and started increasing gradually.

The results of the second season field experiment carried out at Erangkattur on the toxicity of emamectin benzoate to coccinellids in cotton ecosystem are presented in Table 2. The pre treatment population of coccinellids ranged from 3.67 to 5.00 per ten plants. Significant differences among coccinellids population were observed among different treatments after spray. After the first round of spraying, At 3 DAT, the plots treated with emamectin benzoate 5 SG at 7 g a.i./ ha recorded 3.83 coccinellids per ten plants, which was on par with emamectin benzoate 5 SG at 11 g a.i./ ha (3.82 / 10 plants) whereas higher dose of emamectin benzoate 5 SG at 15 g a.i. / ha harboured 2.43 as against 6.10 coccinellids per ten plants in untreated check. Similar trend of coccinellids population was observed at 5 DAT (2.00 to 5.63 / 10 plants), 7 DAT (2.73 to 3.40 / 10 plants) and 10 DAT (3.10 to 3.73 / 10 plants) in emamectin benzoate treatments. The results reported by Balikai and Patil (2007) als o showed emamectin benzoate 5 SG (Proclaim®) at 8 g a.i / ha safe to coccenellids in grape vine. Emamectin benzoate had no effects on the ladybeetles *Hippodamia convergens* (Dunbar et al., 1998). Emamectin benzoate 5 SG at 7 and 11 g a.i. / ha recorded a mean coccinellids population of 3.19

Table 2. Effect of emamectin benzoate 5 SG in coccinellids in cotton eco system after second application (Location: Erangkattur - II season).

Treatments dose (g a.i.ha^{-1})	Number of grubs and adults per ten plants*										
	First application							Second application			
	PTC	1DAT	3DAT	5DAT	7DAT	10DAT	Mean	PTC	1DAT	3DAT	5DAT
Emamectin benzoate 5 SG 7 g a.i.ha^{-1}	4.00	3.50 (1.95)^{b}	2.83 (1.82)^{b}	2.60 (1.76)^{b}	3.30 (1.95)$_{bc}$	3.73 (2.06)^{b}	3.19	3.73	3.20 (2.10)^{b}	2.93 (1.92)^{b}	2.65 (1.80)^{b}
Emamectin benzoate 5 SG 11 g a.i.ha^{-1}	3.67	3.10 (1.90)^{b}	2.82 (1.81)^{b}	2.63 (1.77)^{b}	3.40 (1.97)$_{b}$	3.73 (2.06)^{b}	3.13	3.73	3.05 (1.90)^{b}	2.83 (1.89)^{b}	2.65 (1.81)^{b}
Emamectin benzoate 5 SG 15 g a.i.ha^{-1}	4.00	2.47 (1.72)^{bc}	2.43 (1.71)^{c}	2.00 (1.58)^{c}	2.73 (1.79)$_{bcd}$	3.10 (1.90)^{c}	2.54	3.10	2.50 (1.75)^{bc}	2.53 (1.81)^{c}	2.10 (1.68)^{c}
Endosulfan 35 EC 350 g a.i.ha^{-1}	3.67	2.30 (1.67)^{c}	1.93 (1.56)^{d}	1.70 (1.48)^{c}	2.10 (1.61)$_{d}$	2.43 (1.71)^{d}	2.09	2.43	2.35 (1.72)^{c}	1.95 (1.58)^{d}	1.80 (1.58)^{c}
Emamectin benzoate 5 SG (Proclaim®) 11g a.i.ha^{-1}	5.00	2.67 (1.78)^{bc}	2.30 (1.67)^{cd}	2.17 (1.63)^{bc}	2.83 (1.82)$_{bc}$	3.03 (1.88)^{c}	2.60	3.03	2.72 (1.83)^{bc}	2.35 (1.72)^{cd}	2.27 (1.70)^{bc}
Spinosad 45 SC 75 g a.i.ha^{-1}	4.00	2.40 (1.70)^{c}	2.30 (1.67)^{cd}	2.03 (1.59)^{c}	2.63 (1.77)$_{cd}$	2.90 (1.84)^{c}	2.45	2.90	2.45 (1.75)^{c}	2.40 (1.77)^{cd}	2.13 (1.69)^{c}
Untreated check	4.00	5.77 (2.50)^{a}	6.10 (2.57)^{a}	5.87 (2.52)^{a}	6.00 (2.55)$_{a}$	6.33 (2.61)^{a}	6.01	6.33	6.33 (2.61)^{a}	6.50 (2.97)^{a}	6.55 (2.52)^{a}

Treatments dose (g a.i.ha^{-1})	Number of grubs and adults per ten plants*									
	First application			Third application						
	7DAT	10DAT	Mean	PTC	1 DAT	3DAT	5DAT	7DAT	10DAT	Mean
Emamectin benzoate 5 SG 7 g a.i.ha^{-1}	3.43 (2.00)^{b}	3.75 (2.09)^{b}	3.19	3.75	3.67 (2.04)^{b}	3.17 (1.91)^{b}	2.93 (1.85)^{b}	3.00 (1.87)^{b}	3.63 (2.03)^{b}	3.28
Emamectin benzoate 5 SG 11 g a.i.ha^{-1}	3.30 (1.95)^{bc}	3.75 (2.09)^{b}	3.11	3.75	3.63 (2.03)^{b}	3.07 (1.89)^{b}	2.60 (1.76)^{bc}	2.83 (1.83)^{bc}	3.50 (2.00)^{b}	3.50
Emamectin benzoate 5 SG 15 g a.i.ha^{-1}	2.75 (1.84)^{bcd}	3.15 (1.95)^{c}	2.60	3.15	3.03 (1.88)^{c}	2.83 (1.83)^{b}	2.37 (1.69)^{c}	2.73 (1.80)^{c}	2.97 (1.86)^{cd}	2.78
Endosulfan 35 EC 350 g a.i.ha^{-1}	2.15 (1.66)^{d}	2.42 (1.73)^{d}	2.13	2.42	2.23 (1.65)^{d}	1.87 (1.54)^{c}	1.73 (1.49)^{d}	1.93 (1.56)^{d}	2.03 (1.59)^{e}	1.95
Emamectin benzoate 5 SG (Proclaim®) 11g a.i.ha^{-1}	2.85 (1.85)^{bc}	3.05 (1.91)^{c}	2.64	3.05	2.90 (1.84)^{c}	2.77 (1.81)^{b}	2.53 (1.74)^{bc}	2.80 (1.82)^{bc}	3.07 (1.89)^{c}	2.81
Spinosad 45 SC 75 g a.i.ha^{-1}	2.65 (1.79)^{cd}	2.95 (1.89)^{c}	2.51	2.95	2.80 (1.82)^{c}	2.63 (1.77)^{b}	2.33 (1.68)^{c}	2.77 (1.81)^{bc}	2.83 (1.83)^{d}	2.67
Untreated check	6.00 (2.55)^{a}	6.40 (2.87)^{a}	6.35	6.40	6.57 (2.66)^{a}	6.83 (2.71)^{a}	7.03 (2.74)^{a}	6.97 (2.73)^{a}	7.00 (2.74)^{a}	6.88

PTC- Pre treatment count; DAT- Days after treatments, *****Mean of three replications, Values in parentheses are $\sqrt{x+0.5}$ transformed values, In a column means followed by a common letter(s) are not significantly different by DMRT (P=0.05).

and 3.13 per ten plants, respectively and untreated plots recorded 6.01 per ten plants. The higher dose of emamectin benzoate 5 SG at 15 g a.i. / ha recorded 2.54 per ten plants, whereas Proclaim® and spinosad treated plots recorded 2.60 and 2.45 per ten plants, respectively. Dandale et al. (2001) also observed that spinosad had no harmful effect on coccinellid predators in cotton ecosystem.

Second spray data revealed that (Table 2) plots treated with lower dose of emamectin benzoate 5 SG at 7 g a.i./ ha recorded a coccinellids population of 2.93 per ten plants which was on par with emamectin benzoate 5 SG at 11 g a.i./ ha (2.83 / 10 plants) followed by emamectin benzoate 5 SG at 15 g a.i./ ha (2.83 / 10 plants), the standard, Proclaim®, (2.35/ 10 plants) was on par with spinosad. Patel et al. (2009) recorded minimum reduction in population of coccinellids over control in plots treated with emamectin benzoate at 8 g a.i./ ha followed by emamectin benzoate at 9. 8 g a.i./ ha, spinosad 45 SC at 100 g a.i./ ha, respectively. Among the insecticidal treatments lowest coccinellids population was registered in endosulfan treated plots (1.95 / 10 plants), untreated plots recorded the highest coccinellids population of 6.50 per ten plants at 3 DAT. These results are in line with Sechser et al. (2003) where they observed that foliar application of emamectin benzoate was relatively safe to all stages of the coccinellid predator species when applied as two applications at 13.5 g a.i / ha. Similar trend in coccinellids population was observed in at 5 and 7 DAT. At 10 DAT, emamectin benzoate 5 SG at 7, 11 and 15 g a.i./ ha treated plots, the predatory coccinellids population were 3.75, 3.75 and 3.15 per 10 plants. Sultana and Horowitz (2005) reported that emamectin benzoate a macrocyclic lactone insecticide had low toxicity to beneficial insects. The population of predatory coccinellids was the highest in untreated check during the period of study (6.40 / 10 plants). Thus there was slight reduction observed in the plots treated with endosulfan. Maximum mean population per 10 plants was observed in untreated check (6.35/ 10 plants) followed by emamectin benzoate 5 SG at 7 and 11 g a.i./ ha (3.19/ 10 plants and 3.11 / 10 plants, respectively). Results reported by Ishaaya and Ohsawa (2002) indicated that emamectin benzoate 5% SG was less toxic to beneficial insects. The population in Proclaim® and spinosad was more or less similar. The minimum population of 2.13 coccinellids per ten plants was observed in endosulfan treated plots.

The order of safety of different insecticidal treatments to predatory coccinellids was: Emamectin benzoate 5 SG at 7 g a.i. / ha > emamectin benzoate 5 SG at 11 g a.i. / ha > Proclaim® > emamectin benzoate 5 SG at 15 g a.i. / ha > spinosad > endosulfan after third round of application (Table 2). The activity of predatory insect population (*Coccinellids* and *Chrysoperla*) in emamectin benzoate 5 SG treated plots was found to be on par with untreated check indicating safety to these predominant natural enemies in cotton ecosystem (Udikeri et al., 2004). Emamectin benzoate 5 SG at 7 and 11 g a.i. / ha was found to be the least toxic recording a mean population of 3.28 and 3.50 coccinellids per ten plants, respectively after third application. Dunbar et al. (1998) observed that emamectin benzoate had no adverse effects on beneficial arthropod species. Among the emamectin benzoate doses, 15 g a.i. / ha recorded lowest mean of 2.78 coccinellid beetles per ten plants. All the emamectin benzoate treatments were found to have only a little impact on coccinellids. Fitt et al. (2004) and Horowitz and Ishaaya (2004) reported that bio-rational insecticides are less disruptive to beneficial populations. Population of coccinellids declined immediately after the spray and started increasing gradually. Untreated plots showed highest cocceinellids population throughout the period of studies. Emamectin benzoate had minimum negative impact on the predator population and may be considered as ideal chemical for use in integrated pest management programmes. Although emamectin reservoir with the mesophyll layer of leaf tissue is accessible to phytophagous insects, the parasitic and predatory arthropods continue to proliferate because of their short lived surface residues. Therefore, the application of emamectin benzoate is less harmful to the important natural enemies in cotton ecosystem.

Conclusion

The results concluded that emamectin benzoate 5 SG was found safer to coccinellids at all the tested concentrations. The highest population was recorded in plots treated with emamectin benzoate 5 SG at 7 g a.i. / ha followed by emamectin benzoate 5 SG at 11 g a.i. / ha.

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