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Bioefficacy of Bifenthrin 10 EC against Sucking Insects, Bollworms and Natural Enemies in Cotton

N. Balakrishnan*, B. Vinoth Kumar and P. Sivasubramanian
Department of Agricultural Entomology,
Tamil Nadu Agricultural University, Coimbatore-641 003

Studies were conducted to evaluate bifenthrin 10 EC as foliar application for its bioefficacy against sucking insects, bollworms, phytotoxicity and effect on natural enemies on cotton in Tamil Nadu Agricultural University, Coimbatore. Field experiments on cotton revealed that the higher dose of bifenthrin 10 EC (1000 ml ha^{-1}) recorded 67.54, 79.76, 84.83 and 81.56 per cent reduction from control for leafhoppers, thrips, aphids and whiteflies, respectively and it was on par with bifenthrin 10 EC (800 ml ha^{-1}), that recorded 64.59, 76.32, 83.21 and 79.01 per cent reduction from control for leafhoppers, thrips, aphids and whiteflies, respectively. The effectiveness of bifenthrin 10 EC (1000 ml ha^{-1}) against bollworms was on par with bifenthrin 10 EC (800 and 600 ml ha^{-1}), standard check spinosad 45 SC (175 ml ha^{-1}) and indoxacarb 14.5 SC (500 ml ha^{-1}). Reduction in the population of coccinellids and spiders was observed immediately after the application of insecticides. Though there was a sudden decline in the population, it started increasing gradually in the bifenthrin 10 EC treated plots. However, the population was found to be less when compared to untreated check. Bifenthrin 10 EC did not produce any phytotoxic symptom up to 1600 ml ha^{-1} dose on cotton.

Key words: Bifenthrin, bioefficacy, phytotoxicity, safety, bollworms

Cotton (*Gossypium hirsutum* Linn.), plays a key role in national economy with an export worth of Rs.38,000 crores (Dhawan, 1998). In India, it is grown under varying climatic and soil conditions in an area of 85.6 lakh ha, with a production of 223 lakh bales. Tamil Nadu accounts for 1.60 lakh ha producing 5.50 lakh bales with a productivity of 584 kg lint ha^{-1} (Raveendran *et al*., 2002), as against the national average of 294 kg ha^{-1} (Dhawan, 2000). Nearly 1326 insects and mites all over the world (Hargreaves, 1948) and about 200 in India (Anonymous, 1981) have been recorded as pests of cotton. However, the major constraint in attaining high production of seed cotton is due to the damage inflicted by the bollworm complex consisting of american bollworm, *Helicoverpa armigera* (Hubner), spotted bollworm, *Earias* spp. and pink bollworm, *Pectinophora gossypiella* (Saunders). Krishnamoorthy and Paul (1973) and Patil (1998) reported that the bollworms are the most destructive among the pests of cotton causing heavy losses in yield and the losses were to the extent of 30 - 80 per cent.

Chemical insecticides are used as the frontline defense sources against these insect pests, in spite of their drawbacks and cotton growers in India depend heavily on synthetic pesticides to combat pests and consumed about 54 per cent of the total insecticides used in the country (Anonymous, 1997). The efforts in the past resulted in the development of less persistent chemicals with novel mode of action to overcome the ecological constraints like resurgence, resistance and residues. These newer molecules are selective, neuroactive and always have a higher stability and superiority over the conventional pesticides to control the pest population density in classical manner at field level. Keeping this in view, the present study was taken up to evaluate bifenthrin 10 EC a photo stable synthetic pyrethroid introduced by M/s. United Phosphorus Limited, Mumbai as foliar application for its bioefficacy against bollworms, phytotoxicity and effect on natural enemies on cotton.

*Corresponding email: balakrishnanento@yahoo.co.uk

Materials and Methods

Two field trials were conducted one at Mandapasalai (Experiment I) Aruppukottai and Erankattur (Experiment II) near Bhavanisagar of Tamil Nadu in randomized block design (RBD). The first trial was conducted using cotton variety Ankur WH 216 and the second with, MCU 5 to evaluate the bioefficacy, phytotoxicity and safety to natural enemies of bifenthrin 10 EC in cotton. The crop was maintained well by adopting standard agronomic practices as per the recommendations of Tamil Nadu Agricultural University. The treatments were imposed when the pests attained ETL at the concentrations and control plots were maintained with water spray with a pneumatic knapsack sprayer using 750 litres of spray fluid per hectare. All the treatments were replicated three times with the plot size of 20 m^2. Two sprays were given at 15 days interval starting from 100 and 82 days after spray (DAS) for the experiments I and II, respectively. The insecticides used in the investigation and their dosages were T1 – Untreated check, T2 – Imidacloprid 17.8 SL @112 ml ha^{-1}, T3 – Monocrotophos 36 SL @ 1500 ml ha^{-1}, T4 – Cypermethrin 25 EC @ 280 ml ha^{-1}, T5 – Indoxacarb 14.5 SC @ 500 ml ha^{-1}, T6 – Spinosad 45 SC @ 175 ml ha^{-1}, T7 – Bifenthrin 10 EC @ 600 ml ha^{-1}, T8 – Bifenthrin 10 EC @ 800 ml ha^{-1} and T9 - Bifenthrin 10 EC @ 1000 ml ha^{-1}. To assess the phytotoxicity of bifenthrin 10 EC two doses *viz*., 800 and 1600 ml ha^{-1} were used. The population of leaf hoppers, thrips, aphids and whiteflies were recorded on three leaves one each at top, middle and bottom portions from 10 randomly tagged plants per plot prior to spraying and on 1, 3, 5, 7, 10 and 14 days after spraying.

Observations on the larval population of *H. armigera* and *P. gossypiella* and on the infestation of bollworm complex in green fruiting bodies (square, flower and green bolls) on the day of each spray application and on 3, 7, 10 and 14 days after treatment (DAT) from ten randomly tagged plants per plot were made and the mean was worked out. Cotton yield per plot was recorded from each picking and pooled to arrive at the total yield. Finally, it was computed to quintals ha^{-1}. The numbers of spiders and coccinellids were recorded on ten randomly tagged plants per plot prior to application of insecticides and 3, 7, 10 and 14 DAT in order to assess the effect of insecticides.

The plants were observed on 1, 3, 5, 7, 10, 14, 21 and 28 DAT for the phytotoxic symptoms such as injury to the leaf tip, wilting, necrosis, vein clearing, epinasty and hyponasty on the plants. The extent of phytotoxicity was recorded based on the scale prescribed by Central Insecticide Board and Registration Committee (CIB and RC). The per cent leaf injury was calculated using the formula,

$$\text{Per cent leaf injury} = \frac{\text{Total grade points}}{\text{Maximum grade x Number of leaves observed}} \text{x100}$$

Leaf injury was assessed by visual rating in a 0-10 scale i.e., 0 - No phytotoxicity, 1 – 1 to 10 %, 2 – 11 to 20 %, 3 – 21 to 30 %, 4 – 31 to 40 %, 5 – 41 to 50 %, 6 – 51 to 60 %, 7 – 61 to 70 %, 8 – 71 to 80 %, 9 – 81 to 90 %, 10 – 91 to 100 % phytotoxicity.

Statistical analysis

The corrected per cent reduction of pest population over control in the field was worked out by using the formula given by Henderson and Tilton (1955).

$$\text{Corrected per cent reduction} = \left(1 - \left(\frac{T_a \times C_b}{T_b \times C_a}\right)\right) \text{x } 100$$

where, T_a - Number of insects in the treatment after spraying, T_b - Number of insects in the treatment before spraying, C_b - Number of insects in the untreated check before spraying and C_a - Number of insects in the untreated check after spraying

The data on percentage were transformed into arc sine values and the population number into $\sqrt{x + 0.5}$ before statistical analysis. The mean values were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1951).

Results and Discussion

The data on mean population of nymphs and adults of aphids are presented in Table 1. The results showed that bifenthrin 10 EC @ 600, 800 and 1000 ml/ha were significantly superior over all other treatments and were on par with each other at 1, 3, 7, 10 and 15 days after treatment. Imidacloprid 17.8 SL @ 112 ml/ha was found to be on par with above treatments of bifenthrin 10 EC at 7, 10 and 15 days after treatment. The least effective treatments were indoxacarb 14.5 SC, spinosad 45 SC and cypermethrin 25 EC @ 500, 175 and 280 ml/ha, respectively. The data indicated that all the treatments were significantly superior over untreated check in reducing the population of whiteflies.

The data on per cent damage of fruiting bodies (Table 2) showed bifenthrin @ 600, 800 and 1000 ml/ha and indoxacarb 14.5 SC @ 500 ml/ha and spinosad 45 SC @ 175 ml/ha were significantly superior over all other treatments at 7 and 15 days after treatment and were on par with each other. The least effective treatments were cypermethrin 25 EC, monocrotophos 36 SL and imidacloprid 17.8 SL @ 280, 1500, 112 ml/ha, respectively. The effect

Table 1. Bioefficacy of bifenthrin 10 EC against sucking pests of cotton

Treatment	Leaf hoppers			Thrips			Aphids			Whiteflies		
	PTC	PM	PRC	PTC	PM	PRC	PTC	PM	PRC	PTC	PM	PRC
Untreated check	210.0	253.0 (15.9)^{e}	-	170.0	224.2 (15.0)^{e}	-	750.0	857.7 (29.3)^{f}	-	390.0	414.2 (20.4)^{e}	-
Imidacloprid 17.8 SL@ 112 ml ha^{-1}	209.7	118.4 (10.9)^{b}	53.13	171.5	80.6 (9.0)^{b}	64.35	748.0	217.4 (14.8)^{b}	74.59	391.5	156.9 (12.5)^{b}	62.26
Monocrotophos 36 SL@ 1500 ml ha^{-1}	209.5	167.1 (12.9)^{c}	33.82	172.0	112.3 (10.6)^{c}	50.48	745.0	394.9 (19.9)^{c}	53.65	392.8	237.6 (15.4)^{c}	43.05
Cypermethrin 25 EC@ 280 ml ha^{-1}	208.3	202.1 (14.2)^{d}	19.49	173.0	167.2 (13.0)^{d}	26.70	747.5	528.8 (23.0)^{d}	38.14	391.0	238.4 (15.5)^{c}	42.59
Indoxacarb 14.5 SC@ 500 ml ha^{-1}	209.0	211.8 (14.6)^{d}	15.91	170.5	176.9 (13.3)^{d}	21.33	748.0	692.2 (26.3)^{e}	19.09	392.5	331.2 (18.2)^{d}	20.55
Spinosad 45 SC@ 175 ml ha^{-1}	208.8	213.2 (14.6)^{d}	15.28	171.0	175.9 (13.3)^{d}	22.00	750.0	636.4 (25.2)^{e}	25.80	391.7	343.5 (18.5)^{d}	17.42
Bifenthrin 10 EC@ 600 ml ha^{-1}	209.7	94.1 (9.7)^{ab}	62.75	171.0	58.3 (7.7)^{ab}	74.15	749.0	153.1 (12.4)^{a}	82.12	393.5	144.7 (12.1)^{b}	65.37
Bifenthrin 10 EC@ 800 ml ha^{-1}	208.5	89.0 (9.5)^{a}	64.59	170.3	53.2 (7.3)^{a}	76.32	749.0	143.8 (12.0)^{a}	83.21	392.0	87.4 (9.4)^{a}	79.01
Bifenthrin 10 EC@ 1000 ml ha^{-1}	209.0	81.7 (9.1)^{a}	67.54	172.8	46.1 (6.8)^{a}	79.76	747.0	129.6 (11.4)^{a}	84.83	393.5	77.181.56 (8.8)^{a}	
CD (P= 0.05)	NS	1.2		NS	1.3		NS	2.0		NS	1.4	

Number per 10 plants
Means in a column followed by same letter(s) are not significantly different (P=0.05) by DMRT
PTC – Pretreatment count, PM – pooled mean of 2 sprays, PRC – Percent reduction over control
Figures in parentheses are square root" transformed values

of bifenthrin 10 EC on coccinellids and spiders was presented in table 7 and 8. Among the insecticidal treatments, highest population was recorded in bifenthrin 10 EC @ 600 ml/ha and it was followed by bifenthrin 10 EC @ 800 and 1000 ml/ha, spinosad 45 SC @175 ml/ha and indoxacarb 14.5 SC @ 500 ml/ha and the treatments were on par with each other, followed by imidacloprid 17.8 SL @ 112 ml/ha, monocrotophos 36 SL @ 1500 ml/ha and cypermethrin 25 EC @ 280 ml/ha treated plots. High yields were obtained in bifenthrin 10 EC @ 1000, 800 and 600 ml/ha which were on par with each other, followed by spinosad 45 SC @ 175 ml/ha and indoxacarb 14.5 SC @ 500 ml/ha against the untreated check. Lowest yield was obtained in monocrotophos 36 SL @ 1500 ml/ha, imidacloprid 17.8 SL @ 112 ml/ha and cypermethrin 25 EC @ 280ml/ha (Table 2).

Table 2. Effect of bifenthrin 10 EC on bollworms, natural enemies and yield

Treatment	Bollworms			Coccinellids			Spiders			Kapas yield (Kg ha^{-1})
	PTC	PM	PRC	PTC	PM	PRC	PTC	PM	PRC	
Untreated check	20.7	51.6 (45.9)[d]	-	20.0	28.4 (5.4)[a]	-	16.3	12.8 (3.6)[a]	-	834.67[e]
Imidacloprid 17.8 SL@ 112 ml ha^{-1}	21.0	32.7 (34.9)[c]	37.67	21.5	12.4 (3.6)[c]	59.23	15.7	5.8 (2.5)[bc]	53.19	986.17[d]
Monocrotophos 36 SL@ 1500 ml ha^{-1}	20.5	37.0 (37.5)[c]	27.77	22.0	11.7 (3.5)[c]	62.61	15.0	6.5 (2.6)[bc]	44.72	975.33[d]
Cypermethrin 25 EC@ 280 ml ha^{-1}	20.8	18.8 (25.7)[b]	63.93	21.0	11.1 (3.4)[c]	62.62	16.5	5.5 (2.4)[c.]	57.74	970.00[c]
Indoxacarb 14.5 SC@ 500 ml ha^{-1}	20.5	11.8 (20.1)[a]	76.87	23.5	20.8 (4.6)[b]	37.49	14.0	9.6 (3.2)[ab]	12.84	1470.67[b]
Spinosad 45 SC@ 175 ml ha^{-1}	20.7	10.8 (19.2)[a]	79.16	21.5	21.9 (4.7)[b]	28.18	15.0	9.8 (3.2)[ab]	16.64	1481.67[b]
Bifenthrin 10 EC@ 600 ml ha^{-1}	21.0	12.3 (20.5)[a]	76.63	23.0	20.1 (4.5)[b]	38.49	16.5	9.0 (3.1)[ab]	30.42	1511.33[a]
Bifenthrin 10 EC@ 800 ml ha^{-1}	21.3	11.5 (19.8)[a]	78.40	21.0	17.9 (4.3)[b]	39.79	15.0	8.7 (3.0)[b]	25.73	1511.33[a]
Bifenthrin 10 EC@ 1000 ml ha^{-1}	22.5	11.0 (19.4)[a]	80.41	22.5	17.4 (4.2)[b]	45.58	14.5	8.3 (3.0)[b]	26.98	1525.00[a]
CD (P= 0.05)	NS	2.54		NS	0.5		NS	0.3		25.50

Number per 10 plants
Means in a column followed by same letter(s) are not significantly different (P=0.05) by DMRT
PTC – Pretreatment count, PM – pooled mean of 2 sprays, PRC – Percent reduction over control
Figures in parentheses are square root"x+0.5 transformed values

Table 3. Phytotoxic effect of bifenthrin 10 EC on cotton

Treatment	Dose g a.i.ha^{-1}	Phytotoxicity rating *					
		Leaf tip injury	Wilting	Vein clearing	Necrosis	Epinasty	Hyponasty
Bifenthrin 10 EC	800	0	0	0	0	0	0
Bifenthrin 10 EC	1600	0	0	0	0	0	0
Untreated check	-	0	0	0	0	0	0

* Observed on 1, 3, 5, 7, 10, 14, 21 and 28 days after treatment

Cotton plants sprayed with bifenthrin 10 EC at 800 (X) and 1600 (2X) ml/ha concentrations had not caused any phytotoxic effects like injury to leaf tip and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty. Present findings are in accordance with the findings of Udikeri *et al.,* (2006), who reported that significantly lowest *H.armigera* larval population (0.63 larvae per plant) was recorded in bifenthrin 10 EC 80 g ai / ha and was found on par with its lowest dosage (60 g a.i./ha) the damage due to bollworms to fruiting bodies and locules was the least in bifenthrin 10 EC at 80 g a.i./ha (13.4 %), which resulted in significantly high seed cotton yield.

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