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Bioefficacy of newer insecticides against brinjal whitefly and their natural enemies

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Abstract
The experiment was conducted at All India Coordinator Research Project on Water Management, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani, during the year 2014 and 2015 to study bioefficacy of newer insecticides against brinjal whitefly (*Bemicia tabaci* G.) and their natural enemies. The test insecticides evaluated for the management of brinjal whitefly, were also studied for their safety to natural enemies. Out of these acetamiprid, thiamethoxam and imidacloprid were most toxic to the lady bird beetle. Whereas buprofezin was comparitively safer insecticides to the lady bird beetle.

Keywords: Brinjal, acetamiprid, thiamethoxam, imidacloprid

Introduction

Vegetable farming has an important place in Indian agriculture due to their nutritional, medicinal and commercial value (Choudhary, 1977) [5]. It occupies 2-5 per cent of the total cropped area in the country. Amongst the vegetables, brinjal or egg plant (*Solanum melongena* Linn.) is normally self-fertilized, solanaceous crop native to India. Brinjal is worldwide known as aubergine or guinea squash which is the most popular and principle vegetable crop hence regarded as “King of vegetables”. After China, India is the second largest producer of vegetables in the world. In India, area under brinjal cultivation is estimated at 722.95 million ha with a production of 13888.42 million metric tons in 2013-14. The average yield of brinjal in India is reported to be around 200 to 350 quintals per hectare (Anon 2015). The main growing areas are in the states of Andhra Pradesh, Bihar, Karnataka, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal. As it is grown in all seasons which provides cumulative and continuous source of income to the farmers, it is most widely cultivated.

Materials and Methods

The field experiment was conducted in a Randomized Block Design with twelve treatments including untreated control. The brinjal crop using variety *Pune kateri* in *Summer* 2014 and *Summer* 2015 was conducted at All India Coordinator Research Project on Water Management, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The row to row distance of 3 ft. and plant to plant distance of 2 ft. was maintained. The crop was grown under drip irrigation. All the treatments were replicated four times. The insecticides were applied at 15 days interval starting from 30th day after transplanting. Four observation plants were selected randomly from the net plot of each treatment in each replication. They were properly labelled. The observations on total number of nymphs of whiteflies and ladybird beetle were recorded on leaf; each from top, middle and bottom canopy of the observation plants at one day before and 3, 5, 7, 10 and 14 days after first, second, third and fourth application of insecticides. The data on number of nymphs of whitefly recorded at different intervals were transformed into square root transformation in a Randomized Block Design before statistical analysis.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads:

A. Overall efficacy of brinjal whitefly based on pooled data of two years- *Summer* 2014 and 2015

Pooled data on incidence of whitefly (No./plant) of two years *viz.*, *Summer* 2014 and 2015 are presented in Table 1 and graphically depicted in fig 1. The pre-treatment count of whitefly before initiation of the spray treatments was in the range of 15.50 to 18.87 whitefly/plant. Based on the mean of four sprays of both the years, the post-treatment counts of whitefly population on untreated control plants were 19.31, 19.78, 19.56, 19.40, 19.75 and 19.66 whitefly/ plant on 1, 3, 5, 7, 10 and 14 days after spray (DAS), respectively. The whitefly incidence in all insecticide treatments was significantly low indicating that all the insecticides were significantly effective against whitefly. The treatments comprised of thiamethoxam 25 WG @ 25 g a.i. ha^{-1} was the most effective treatment (6.31 whitefly/plant) at 14 DAS followed by clothianidin @ 25 g a.i. ha^{-1} (6.85 whitefly/plant) and flonicamid @ 75 g a.i. ha^{-1} (7.14 whitefly/plant) and were at par with each other. The other insecticides evaluated for their efficacy against whitefly also minimized the incidence and the order of effectiveness was acetamiprid @ 20 g a.i. ha^{-1} (7.92 whitefly/plant) > diafenthuron @ 300 g a.i. ha^{-1} (8.16 whitefly/plant) > chlorfenapyr @ 100 g a.i. ha^{-1} (8.68 whitefly/plant) > buprofezin @ 250 g a.i. ha^{-1} (8.92 whitefly/plant) > imidacloprid @ 25 g a.i. ha^{-1} (8.95 whitefly/plant) > dinotefuron @ 40 g a.i. ha^{-1} (8.98 whitefly/plant) > fipronil @ 50 g a.i. ha^{-1} (9.03 whitefly/plant) > spiromesifen @ 76 g a.i. ha^{-1} (9.22 whitefly/plant) and there was no statistical difference indicating that these products can be used against whitefly on brinjal crop.

Table 1: Pooled data of whitefly population of two years- *Summer* 2014 and 2015

Tr. No.	Treatments	Dose (g a.i./ha)	Pre-count	Mean of two years 2014 and 2015					
				1DAS	3DAS	5DAS	7DAS	10DAS	14DAS
T_1	Buprofezin 25 EC	250	17.75	7.15	7.39	7.09	7.46	8.93	8.92
			(4.25)	(2.74)	(2.79)	(2.73)	(2.81)	(3.05)	(3.05)
T_2	Chlorfenapyr 10 SC	100	17.62	7.34	7.49	6.93	7.31	8.68	8.68
			(4.24)	(2.77)	(2.81)	(2.71)	(2.79)	(3.00)	(3.00)
T_3	Fipronil 5 SC	75	17.00	7.46	7.67	7.09	7.46	9.03	9.03
			(4.16)	(2.80)	(2.83)	(2.73)	(2.82)	(3.06)	(3.06)
T_4	Diafenthiuron 50 WP	300	17.62	6.59	6.96	6.18	6.37	8.15	8.16
			(4.24)	(2.62)	(2.70)	(2.54)	(2.62)	(2.87)	(2.87)
T_5	Acetamiprid 20 SP	20	16.50	6.46	6.79	6.37	6.65	7.90	7.92
			(4.11)	(2.60)	(2.67)	(2.62)	(2.67)	(2.88)	(2.88)
T_6	Imidacloprid 17.8 SL	25	18.87	7.25	7.48	7.03	7.43	8.96	8.95
			(4.39)	(2.75)	(2.80)	(2.72)	(2.81)	(3.05)	(3.05)
T_7	Flonicamid 50 WG	75	17.62	5.62	6.08	5.50	5.62	7.15	7.14
			(4.24)	(2.42)	(2.53)	(2.41)	(2.44)	(2.72)	(2.71)
T_8	Dinoteferon 20 SG	40	18.00	7.59	7.90	7.12	7.43	9.03	8.98
			(4.29)	(2.82)	(2.88)	(2.74)	(2.83)	(3.05)	(3.05)
T_9	Spiromesifen 22.9 SC	200	15.50	7.53	7.58	7.46	7.75	9.21	9.22
			(3.98)	(2.79)	(2.82)	(2.80)	(2.86)	(3.09)	(3.10)
T_{10}	Clothianidin 50 WDG	25	18.37	5.50	6.06	5.21	5.37	6.87	6.85
			(4.33)	(2.40)	(2.53)	(2.37)	(2.42)	(2.67)	(2.66)
T^{11}	Thiaomethoxam 25 WG	25	16.75	5.21	5.69	4.93	5.03	6.34	6.31
			(4.14)	(2.24)	(2.40)	(2.28)	(2.32)	(2.57)	(2.56)
T^{12}	Untreated control		17.75	19.31	19.78	19.56	19.40	19.75	19.66
			(4.26)	(4.44)	(4.49)	(4.47)	(4.47)	(4.49)	(4.48)
	SE $\pm$		0.13	0.08	0.07	0.08	0.07	0.07	0.07
	CD at 5%		NS	0.25	0.22	0.23	0.21	0.22	0.22

*Figures in parentheses are root transformation *DAS: Days After Spray * NS: Non-Significant

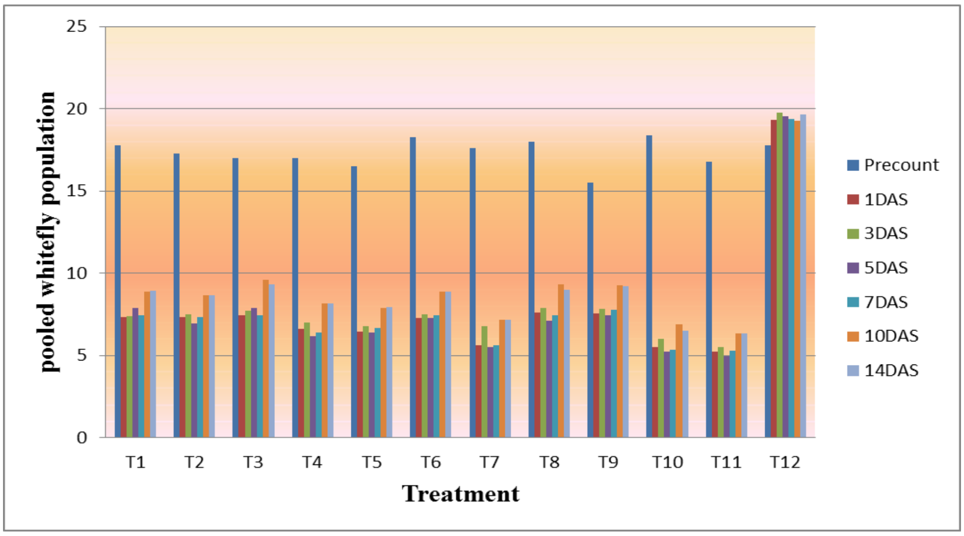

Fig 1: Effect of newer insecticides on of whitefly population based on pooled data of two years *Summer* 2014 and 2015

Considering the typical damage caused by whitefly on leaves of brinjal responsible for loss in the economic yield of the crop, spraying of these molecules *viz.*, thiamethoxam 25 WG @ 25 g a.i. ha^{-1}, clothianidin @ 25 g a.i. ha^{-1} and flonicamid @ 75 g a.i. ha^{-1}, acetamiprid @ 20 g a.i. ha^{-1}, diafenthuron @ 300 g a.i. ha^{-1}, chlorfenapyr @ 100 g a.i. ha^{-1}, buprofezin @ 250 g a.i. ha^{-1}, imidacloprid @ 25 g a.i. ha^{-1}, dinotefuron @ 40 g a.i. ha^{-1}, fipronil @ 50 g a.i. ha^{-1} and spiromesifen @ 76 g a.i. ha^{-1} (can be effectively advocated in spray schedule against brinjal ecosystem. However, the interval between two sprays should be reduced to 10 days, since, whitefly population in all the treatments raised at 14 DAS.

The reports of earlier researchers on chemical control of whitefly (*Bemisia tabaci*) infesting many field crops are discussed here. Spraying of thiamethoxam 25 WG @ 25 g a.i. ha^{-1} was reported to be effective against brinjal whitefly (Sharma and Lal, 2002). In the present study the new compounds thiamethoxam, clothianidin and flonicamid were found better and more consistent against whitefly. These compounds are basically claimed to be effective against whitefly on other crops as well (Arpita Chaterjee *et al.*, 2007 and Raghuraman *et al*., 2008) [2, 16]. In studies conducted by Biswas *et al.,* (2007) spraying of thiamethoxam 35 g a.i. ha^{-1} and acetamaprid 20 SP g a.i. ha^{-1} were found effective against whitefly infesting brinjal, recording 80.29 and 74.37 per cent reduction in whitefly population, respectively. Several other insecticides have shown better efficacy against whitefly, *Bemisia tabaci* (G.) infesting brinjal (Patel *et al*., 2006; Naik *et al*., 2009; Sinha *et al*., 2011) [15, 13, 18]. Otoidobiga, *et al*., (2003) [14] observed a fast increase in mortality of *Bemisia tabaci* within a short period from the plots treated with pyriproxifen, acetamiprid and diafenthuron. Muhammad Aslam *et al*., (2004) reported that acetamiprid 20 SP @ 150 g a.i. ha^{-1} and thiamethoxam 25 WG @ 24 g a.i. ha^{-1}were effective against cotton whitefly. The effectiveness of three doses of acetamiprid 20 SP @ 100, 150 and 200 g a.i. ha^{-1} against cotton whitefly was proved by Brar *et al*., (2005) [4] as compared to conventional insecticides oxydemeton methyl 25 EC @ 750 ml/ha, triazophos 1500 ml/ha and ethion 50 EC @ 2000 ml/ha. Gopal Das *et al*., (2014) [7] have found that buprofezin, imidacloprid and fipronil were significantly effective against cotton jassids and whitefly over control. Kandil *et al*., (2014) found that diafenthuron, carbosulfan, buprofezin and imidacloprid were the most effective compounds against cotton whitefly (*Bemisia tabaci*). Roditakis *et al*., (2014) [17] reported that flonicamid, as a novel systemic insecticide that caused 95% mortality of whiteflies up to 10 days after treatment and delayed population growth by one generation (32 days).

The insecticide molecules tested in the present investigation are designated as newer insecticides. Organophosphate insecticides are banned in many developed countries due to their greater risk to user, environment, non-targets, natural enemies and high levels of residues. The test insecticides are the compounds which are effective at low doses, have low impact on human health, environment and non-targets. They have low potential for development of pest resistance and are IPM compatible. These compounds belonging to different groups *viz.*, Neonecotenoid – acetamiprid, dinotefuron, clothianidin, thiamethoxam and difenthuron, pyridinecarboximide – flonicamid, chloronecotinyl neonicotinoid-imidacloprid, phenylpyrazole-fipronil, thiadiazine IGR – buprofezin, pyrroles – chlorfenapyr and acaricide- spiromesifen are systemic in their mode action against the target pest except buprofezin that affects the insect after ingestion. Whitefly, with their piercing and sucking type of mouth parts feed on the cell sap from the developing leaves of brinjal and also secrete honey dew on which the black sooty mould grows and adversely affect the photosynthesis of the crop.

The tested insecticides were found effective on this pest; particularly, thiamethoxam, clothianidin and flonicamid were highly effective. However, the rest of the molecules also proved their efficiency against this pest. These molecules are selective, environmentally safe due to low persistence, and showed less residues in brinjal fruits. Moreover, these test molecules can be advocated to the growers but the spray interval between two successive sprays should be reduced to 10 days because none of the molecule proved it’s persistence at 14 DAS. Three sprays at fortnightly interval can not protect the crop therefore four sprays should be taken against this pest.

B. Overall effect of newer insecticides on natural enemies of brinjal whitefly based on pooled data -*Summer* 2014 and 2015

Pooled data on effect of newer insecticides on lady bird beetle (No./plant) of two years *viz., Summer* 2014 and 2015 are presented in Table 2 and graphically depicted in fig 2. The pre-treatment count of lady bird beetle before initiation of the spray treatments was in the range of 1.50 to 2.50 lady bird beetle /plant. Based on the mean of four sprays of both the years, the post-treatment counts of lady bird beetle population on untreated control plants were 2.62, 2.25, 2.25, 2.12, 2.37 and 2.50 lady bird beetle on 1, 3, 5, 7, 10 and 14 days after spray (DAS), respectively. The lady bird beetle population in all insecticide treatments was low as compared to untreated control indicating that all the insecticides were toxic to the lady bird beetle. Buprofezin was least toxic to the lady bird beetle. The other treatments comprised of thiamethoxam 25 WG @ 25 g a.i. ha-1 and acetamiprid @ 20 g a.i. ha-1 were highly toxic to the lady bird beetle and showed the population in range of 1.37 to 1.87 lady bird beetle/plant over the 14 DAS, followed by clothianidin, spiromesifen, imidacloprid, diafenthuron, fipronil, flonicamid and dinotefuron. There was no statistical difference among these insecticides regarding their safety to lady bird beetle.

Table 2: Overall effect of newer insecticides on lady bird beetle based on pooled data of two years *Summer* 2014 and *Summer* 2015

Tr.No.	Treatments	Dose (ga.i./ha)	Pre-count	Mean of natural enemies of two Season 2014-15					
				1DAS	3DAS	5DAS	7DAS	10DAS	14DAS
T_1	Buprofezin 25 EC	250	2.12	2.00	2.00	1.87	1.87	2.00	2.12
			(1.59)	(1.56)	(1. 56)	(1.52)	(1.51)	(1.56)	(1.60)
T_2	Chlorfenapyr 10 SC	100	1.87	1.62	1.50	1.12	1.37	1.25	2.00
			(1.52)	(1.44)	(1.40)	(1.26)	(1.31)	(1.31)	(1.56)
T_3	Fipronil 5 C	75	1.75	1.50	1.25	1.37	1.75	1.75	1.75
			(1.47)	(1.40)	(1.31)	(1.35)	(1.48)	(1.49)	(1.48)

T_4	Diafenthiuron 50 WP	300	1.75	1.50	1.50	1.37	1.62	1.75	1.75
			(1.48)	(1.40)	(1.40)	(1.35)	(1.43)	(1.47)	(1.47)
T_5	Acetamiprid 20 SP	20	1.62	1.37	1.25	1.25	1.37	1.75	1.50
			(1.43)	(1.35)	(1.31)	(1.31)	(1.34)	(1.49)	(1.39)
T_6	Imidacloprid 17.8 SL	25	1.87	1.50	1.37	1.37	1.25	1.62	1.37
			(1.51)	(1.40)	(1.35)	(1.35)	(1.29)	(1.43)	(1.35)
T_7	Flonicamid 50 WG	75	1.62	1.75	1.37	1.50	1.50	2.00	1.75
			(1.43)	(1.47)	(1.34)	(1.40)	(1.39)	(1.55)	(1.47)
T_8	Dinoteferon 20 SG	40	1.62	1.87	1.62	1.62	1.50	2.12	1.87
			(1.43)	(1.51)	(1.44)	(1.44)	(1.39)	(1.59)	(1.51)
T_9	Spiromesifen 22.9 SC	200	1.50	1.50	1.50	1.37	1.62	1.37	1.50
			(1.40)	(1.40)	(1.39)	(1.35)	(1.43)	(1.34)	-1.39
T_{10}	Clothianidin 50 WDG	25	1.62	1.50	1.50	1.50	1.50	1.87	1.62
			(1.40)	(1.40)	(1.40)	(1.40)	(1.39)	(1.51)	(1.43)
T^{11}	Thiaomethoxam 25 WG	25	1.87	1.37	1.50	1.25	1.25	1.25	1.87
			(1.51)	(1.35)	(1.38)	(1.30)	(1.31)	(1.31)	(1.52)
T^{12}	Untreated control		2.50	2.62	2.25	2.25	2.12	2.37	2.50
			(1.71)	(1.75)	(1.64)	(1.64)	(1.60)	1.67)	(1.72)
	SE ±		0.13	0.10	0.11	0.09	0.12	0.12	0.12
	CD at 5%		NS	0.30	0.30	0.26	0.35	0.34	0.33

*Figures in parentheses are root transformation*DAS: Days After Spray *NS: Non

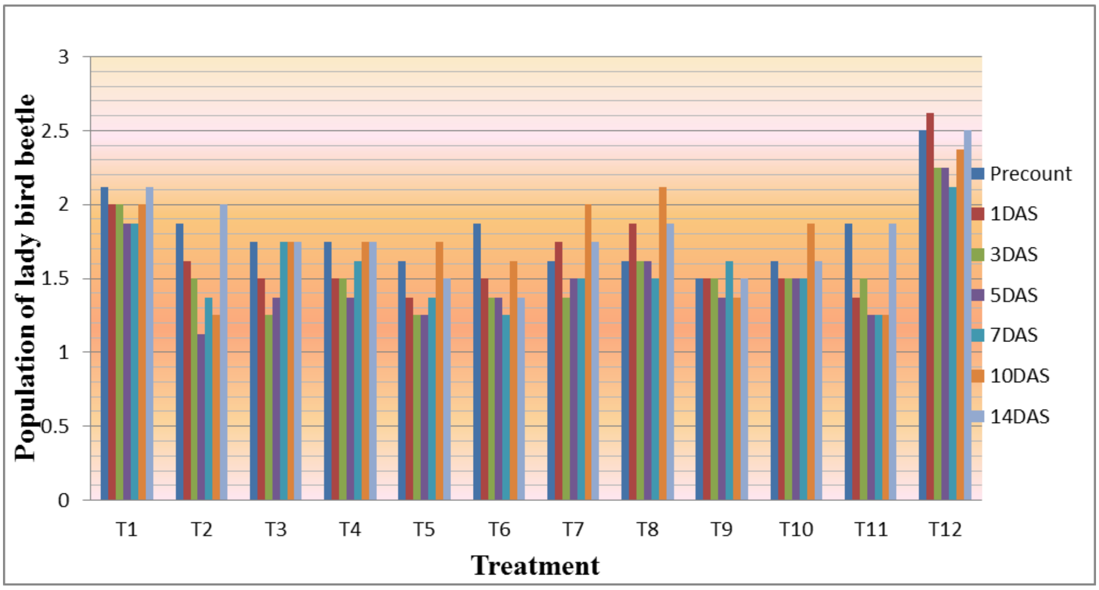

Fig 2: Overall effect of newer insecticides on population of lady bird beetle based on pooled data of two years *Summer* 2014 and 2015

The reports of earlier researchers on effect of newer insecticides on lady bird beetle on different crops under field condition are in conformity with the present study. Jerraya *et al* (1997) [8] showed the harmful effects of acetamiprid and imidacloprid on lady bird beetle. Mizeli and Sconyers (1992) [10] reported that the foliar spray of imidacloprid 0.004 per cent was harmful to many beneficial insects. Viggiani *et al.* (1998) [19] showed that the imidacloprid and acetamiprid were highly toxic to coccinellids upto 20 days under field conditions. Ghananand Tiwari *et al* (2011) [6] reported that imidacloprid caused maximum mortality of coccinellids (41.4, 45.3%). Aray *et al* (2006) [1] observed that imidacloprid (20.17% mortality) and acetamiprid (20.71% mortality) were the least toxic treatments. Effect of some commonly used insecticides like imidacloprid, acetamiprid, cypermethrin, deltamethrin and profenofos was tested by Munir Ahmad *et al* (2011) [12] and results revealed that mortality of adult *C. undecimpunctata* at 24, 48 and 72 hours ranged from 50-91% and 10-78%. Profenofos was the most toxic insecticide whereas imidacloprid caused the lowest mortality. Field sprayed leaves exposure proved imidacloprid as the least toxic insecticide.

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