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Management of whitefly, *Bemicia tabaci* in okra (*Abelmoschus esculents* L.) through new insecticide molecules

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Abstract
A field experiment was conducted to know the efficacy of new insecticides against whitefly, *Bemisia tabaci* Genn,) on okra under high pest pressure during summer 2015 at college of Agriculture, V.C. Farm, Mandya University of Agricultural Sciences, Bangalore. The results revealed that, foliar spray of Imidacloprid 17.8 SL @ 0.5 ml/l was found to be most effective against whiteflies with higher per cent reduction of pest population (84.54 per cent), followed by acetamiprid 20 SP @ 0.5 g/l, thiamethoxam 25 WG @ 0.3 g/l, acephate 95 SG @ 0.3 g/l, and clothianidin 50 WDG @ 0.25 g/l which recorded 84.36, 84.25, 76.38 and 73.53 per cent reduction in the pest population, respectively. The next best treatments were cyantraniliprole 10.26 OD @ 1 ml/l, oxydemeton methyl 25 EC @ 1.5 ml/l, imidacloprid 17.8 SL seed coating @ 4:20 ml/kg and thiamethoxam 25 WG seed coating @ 2:20 ml/kg which registered 59.98, 31.47, 25.16 and 19.25 per cent reduction, respectively.

Keywords: *Bemisia tabaci*, bio-efficacy, new insecticides, management

Introduction
Okra is cultivated throughout India over an area of 5.32 lakh hectares area with a total annual production of 63.46 lakh metric tonnes and a productivity of 11.9 t/ha (Anon., 2014) [1]. In karnataka bhendi providing a continuous and good source of income to the farmers. Okra growers frequently complain yield losses due to insect pests. The important pests affecting the yield of okra are jassid (*Amrasca biguttula biguttula* Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bemisia tabaci* Genn,), mite (*Tetranychus* spp.) and shoot and fruit borer (*Earias vittella* Fab) (Adetuyi *et al.*) [2]. Presently broad range of systemic and contact insecticides and biopesticides are recommended for the control of okra pests. However, short picking interval of okra fruits cause residue hazards to the consumers when conventional pesticides are used repeatedly, besides killing natural enemies and eventual development of resistance. For the management of whiteflies, farmers use several insecticides indiscriminately, which has lead to development of resistance, resurgence of pest and problem of residual toxicity. To overcome these problems, identification of safe molecules with better insecticidal properties with lower mammalian toxicity, safety to natural enemies and which fit well in the IPM concept is need of the hour. In view of these the present investigation was initiated at College of Agriculture, V. C. Farm, Mandya.

Materials and Methods
The experiment was conducted during summer 2015-16, in a Randomized Block Design (RCBD) at College of Agriculture, V. C. Farm, Mandya with 10 treatments including an untreated control and three replications, using Arka Anamika variety of okra in a plot size of 6 m x 6 m. The crop was raised with a spacing of 60X30 cm, between rows and plants, respectively. Eight new molecules were tested along with the standard check, oxydemeton methyl 25 EC and untreated check against whitefly of okra. Seeds were treated with two neonicotinoids *viz.*, imidacloprid 17.8 SL and thiamethoxam 25 WG and sown separately at the time of sowing. Other seven insecticides were sprayed at 30 and 45 days after sowing by using high volume knapsack sprayer with a spray volume of 500 l/ha. The observation on number of whiteflies was made a day before and after treatment imposition. In each treatment, the observations on population density of whitefly, *Bemicia tabaci* (Ishida) was recorded from three top, middle and bottom leaves of 10 designated plants.

Pre-count was taken a day before to spray and the post count observations on population density of leafhopper was recorded on 1, 7, and 14 days after spray. The data was subjected to square root transformation. Further, the data on leafhopper each treatment was subjected to ANOVA (Gomez and Gomez [3]; Hosmand [4]) and means were separated by Tukey's HSD (Tukey [5]) for interpretation.

Seed Coating

Two insecticides belonging to neonecotinoides group i.e. thiamethoxam 25 WG @ 2 ml was mixed in 20 ml of water meanwhile, imidacloprid 17.8 SL @ 4 ml was mixed in 20 ml of water separately, along with 2-3 ml of gum arabica and the slurry was mixed with one kilogram of okra seeds and carefully swirled well until all the seeds were uniformly coated with the insecticide. Further, the seeds coated with chemicals were shade dried for an hour and used for sowing. The observation on population density of whitefly, *Bemicia tabaci* (Ishida) was recorded on 30 and 45 days after sowing on three top, middle and bottom leaves of 10 designated plants.

The per cent reduction over untreated control was worked out using modified Abbot's formula given by Fleming and Ratnakaran [6].

$$P = \frac{100 \text{ X } 1 - (T_a \text{ X } C_b)}{(T_b \text{ X } C_a)}$$

Where,

P = Percentage population reduction over control; T_a = Population in treatment after spray

C_a = Population in control after spray; T_b = Population in treatment before spray

C_b = Population in control before spray

Results and Discussion

In the present investigations, eight new promising insecticide molecules were evaluated for their bioefficacy under field conditions along with standard check oxydemeton methyl 25 EC @ 1.5 ml/l and an untreated control. From the current study, it was observed that all the treatments proved their superiority over untreated control. Both the seed coating chemicals, *viz.*, imidacloprid 17.8 SL (4:20 ml/kg) and thiamethoxam 25 WG (2:20 ml/kg) recorded lowest per cent reduction (25.16 and 19.25, respectively) and their efficacy were below the standard check i.e. oxydemeton methyl 25 EC @ 1.5 ml/l.

The mean data of all seven observations regarding the efficacy of different treatments against leafhoppers revealed that, imidacloprid 17.8 SL @ 0.5 ml/l was recorded least aphid population (0.00/3 leaves) with higher per cent reduction (84.54 per cent). The next best treatments were acetamiprid 20 SP @ 0.5 g/l, thiamethoxam 25 WG @ 0.3 g/l, acephate 95 SG @ 0.3 g/l, clothianidin 50 WDG @ 0.25 g/l, cyantraniliprole 10.26 OD @ 1 ml/l, oxydemeton methyl 25 EC @ 1.5 ml/l, imidacloprid 17.8 SL seed coating @ 4:20 ml/kg and thiamethoxam 25 WG seed coating @ 2:20 ml/kg which registered 84.36, 84.25, 76.38, 73.53, 59.98, 31.47, 25.16 and 19.25 per cent reduction, respectively (Fig. 11; Fig. 12).

The present findings were in close agreement with findings made by Preetha *et al.* [7], who reported that imidacloprid 17.8 SL @ 25 g a,i./ha was found effective against whiteflies. Similarly, Ghosal and Chatterjee [8] reported decreasing order of treatments as imidacloprid 17.8 SL > thiamethoxam 25 WG > oxydemeton methyl 25 EC in brinjal and Begum and Patil [9] reported the efficacy of imidacloprid 17.8 SL @ 40 g a.i./ha and was most effective against whiteflies. Kadil *et al.* [10] who reported that imidacloprid, diafenthiuron, and carbosulfan against adults and immature of *B. tabaci* in cotton. Finally they revealed the percent reduction in pest intensity over untreated control in imidacloprid was 90.57 and found effective against whiteflies. Raghuraman and Gupta [11] reported that acetamiprid 40 g a.i/ha and imidacloprid 100 g a.i./ha were the most effective treatments against *B. tabaci* and also on sorghum shoot bug (Vijaykumar and Prabhuraj [12]). Rajveer *et al.* [13] also reported that foliar spray of Imidacloprid 17.8% SL @ 40 g a.i./ha was most effective insecticide against the population of *Bemisia tabaci.*

Table 2: Bio-efficacy of new insecticides against *B. tabaci*, summer 2015

S. No	Treatments	Dose (g or ml a.i. /ha)	No. of whiteflies/3 leaves								Per cent reduction over control
			I Spray				II Spray				
			DBS	1 DAS	7 DAS	14 DAS	DBS	1 DAS	7 DAS	14 DAS	
1	Cyantraniliprole 10.26 OD	102.7	6.03	3.21	4.10	4.25	4.25	4.01	4.05	4.04	59.98
			(2.56)	(1.93)^{cd}	(2.14)^{b}	(2.18)^{c}	(2.18)^{c}	(2.12)^{c}	(2.13)^{c}	(2.13)^{d}	
2	Clothianidin 50 WDG	125.0	6.13	2.35	2.26	2.75	2.75	2.01	1.25	1.59	73.53
			(2.57)	(1.69)^{ab}	(1.66)^{a}	(1.80)^{b}	(1.80)^{b}	(1.58)^{b}	(1.32)^{b}	(1.45)^{c}	
3	Acetamiprid 20 SP	100.0	5.82	1.17	1.01	1.03	1.03	0.20	0.00	0.00	84.36
			(2.51)	(1.29)^{a}	(1.23)^{a}	(1.24)^{a}	(1.24)^{a}	(0.84)^{a}	(0.71)^{a}	(0.71)^{a}	
4	Acephate 95 SG	285.7	5.83	2.12	2.01	2.46	2.46	1.32	1.02	1.00	76.38
			(2.52)	(1.62)^{ab}	(1.58)^{a}	(1.72)^{b}	(1.72)^{b}	(1.35)^{b}	(1.23)^{b}	(1.22)^{bc}	
5	Thiamethoxam 25 WG	75.0	6.13	1.27	1.06	1.20	1.20	0.22	0.00	0.29	84.25
			(2.57)	(1.33)^{a}	(1.25)^{a}	(1.30)^{a}	(1.30)^{a}	(0.85)^{a}	(0.71)^{a}	(0.89)^{ab}	
6	Thiamthoxam 25 WG (SC)	3.75	6.12	5.21	4.21	5.34	5.34	4.55	5.67	6.03	19.25
			(2.57)	(2.39)^{de}	(2.17)^{b}	(2.42)^{c}	(2.42)^{c}	(2.25)^{c}	(2.48)^{d}	(2.56)^{d}	
7	Imidacloprid 17.8 SL (SC)	5.34	6.21	5.12	4.13	5.32	5.32	4.53	5.65	6.01	25.16
			(2.59)	(2.37)^{de}	(2.15)^{b}	(2.41)^{c}	(2.41)^{c}	(2.24)^{c}	(2.48)^{d}	(2.55)^{d}	
8	Imidacloprid 17.8 SL	88.9	5.90	1.03	0.95	1.03	1.03	0.00	0.00	0.00	84.54
			(2.53)	(1.24)^{a}	(1.20)^{a}	(1.24)^{a}	(1.24)^{a}	(0.71)^{a}	(0.71)^{a}	(0.71)^{a}	
9	Oxydemeton methyl 25 EC	375.0	6.12	4.06	4.10	5.30	5.30	4.50	5.61	5.98	31.47
			(2.57)	(2.14)^{bc}	(2.14)^{b}	(2.41)^{c}	(2.41)^{c}	(2.24)^{c}	(2.47)^{d}	(2.55)^{d}	
10	Untreated control	-	6.12	6.25	7.56	8.09	8.09	9.68	10.28	11.05	--
			(2.57)	(2.60)^{e}	(2.84)^{c}	(2.93)^{d}	(2.93)^{d}	(3.19)^{d}	(3.28)^{e}	(3.40)^{e}	
SE m±			NS	0.11	0.09	0.10	0.10	0.08	0.10	0.12	--

CD @ p= 0.05		0.32	0.25	0.41	0.41	0.27	0.41	0.46	

* DBS: Day before spraying; DAS: Day after spraying; NS: Non significant; SC: Seed coating; Values in the column followed by common letters are non-significant at p = 0.05 as per Tuckey's HSD (Tukey, 1965) [5]. Figures in the parenthesis indicate √x+0.5 transformed values.

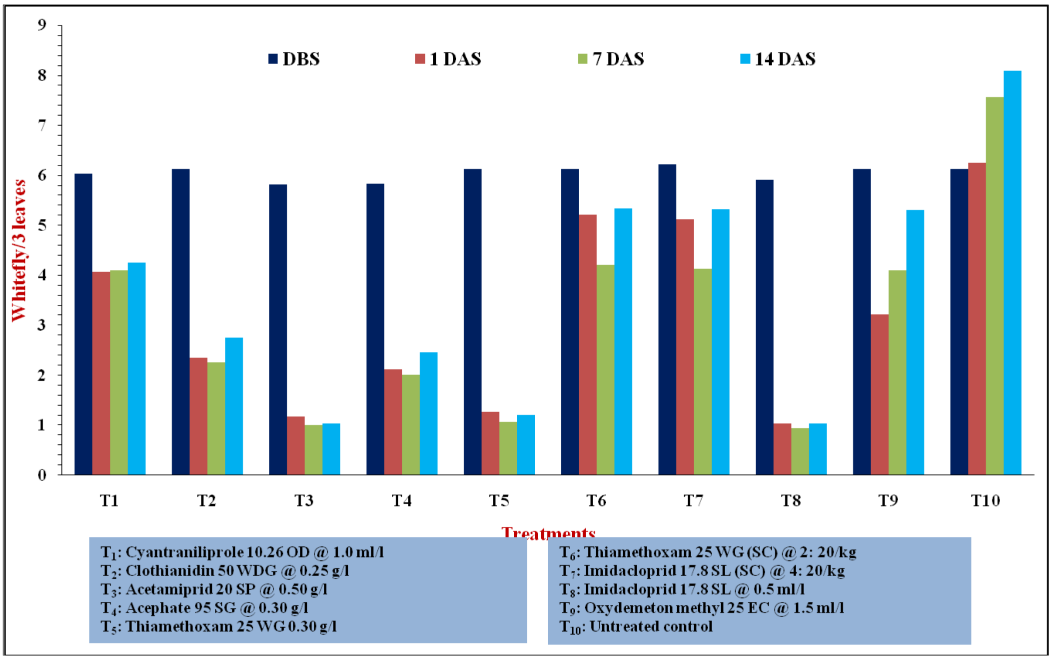

Fig 1: Bio Bio-efficacy of new insecticides against whitefly, *B. tabaci* on okra, summer 2015 (I Spray)

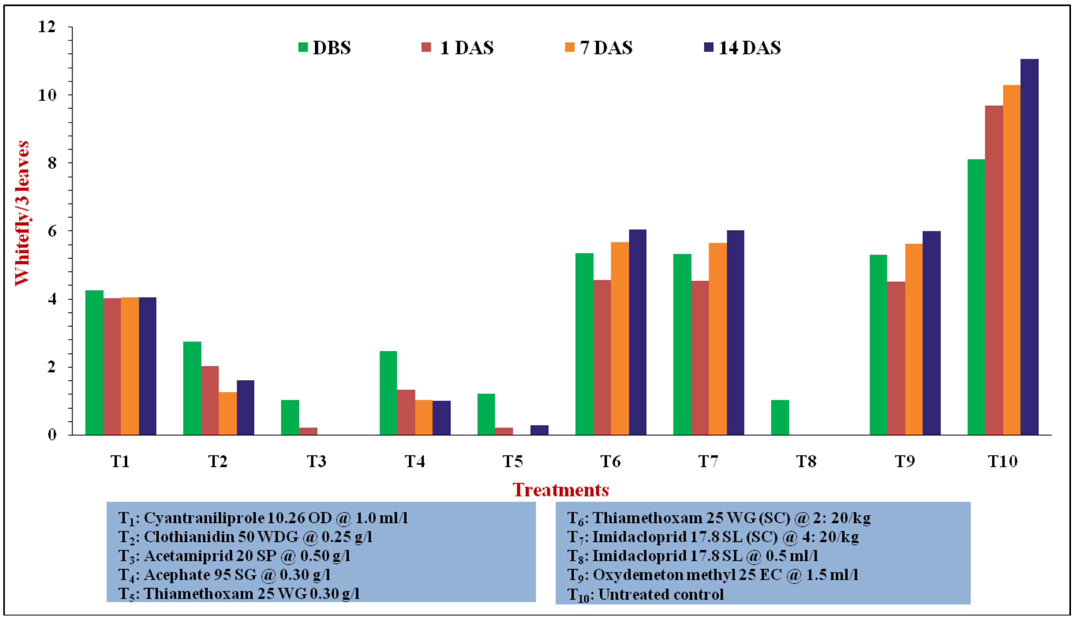

Fig 2: Bio-efficacy of new insecticides against whitefly, *B. tabaci*on okra, summer 2015 (II Spray)

Conclusion

Orka is growing round the year in Karnataka. Farmers are unaware of loss by whiteflies which causes both direct and indirect damage as a vector of leaf curl virus disease. To overcome the loss caused by the whiteflies, the foliar application of new molecules such as imidacloprid 17.8 SL @ 0.5 ml/l, or acetamiprid 20 SP @ 0.5 g/l or thiamethoxam 25 WG @ 0.3 g/l can be used in the management of leafhopper in okra.

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