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Bio-efficacy of insecticides against Okra whitefly (*Bemicia tabaci*) in Malwa region of Madhya Pradesh

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Abstract
The experiment was carried out to assess the bioefficacy of insecticides against Okra whitefly at experimental farm, College of Agriculture, Indore (M.P.) on Okra (*Abelmascus esculentus*). The six treatments consist of Four doses of carboxamide 300 SC @ 6.50, 12.50, 18.50 and 37 g.a.i. ha1, Chlorantraniliprole 18.5% SC @ 25 g.a.i. ha-1 and Cypermethrin 10% EC @ 70 g.a.i. ha-1 including untreated control were sprayed thrice at 10 days interval. The overall reduction in whitefly population after three applications of treatments over pre treatment population of first application to the last count of third spray was calculated. The result revealed that the maximum reduction in population was observed in treatment carboxamide 300 SC @ 37 g.a.i. ha-1 (93.45%) followed by chlorantraniliprole 18.5% SC @ 25 g.a.i. ha-1 (91.04%) and carboxamide 300 SC @ 18.5 g.a.i ha-1 (87.94%), The minimum percentage of reduction in whitefly population was recorded in the carboxamide 300 SC @ 6.50 g.a.i. ha-1 (75.82%). The marketable Okra fruit yield and cost benefit ratio was recorded higher in higher dose of carboxamide 300 SC @ 37 g.a.i. ha^{-1} at par with Chlorantraniliprole 18.5% SC @ 25 g.a.i. ha-1 followed by carboxamide 300 SC @ 18.50 g.a.i. ha-1 as compared to untreated control.

Keywords: *Abelmascus esculentus*, carboxamide, chlorantraniliprole, cypermethrin, whitefly

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench) belongs to family malvaceae is an important vegetable crop grown in India. It is choicest fruit vegetable grown extensively in the tropical, subtropical and warm areas of the world like India, Africa, Turkey and its neighbouring countries. In India, it is one of the most important vegetable crop grown for its tender green fruits throughout the year.

The okra plants are used for controlling diseases like stone in kidney, leucorrhoea, backache and goitre in human beings. Mucilage extract of stem and roots of okra are used for clarifying sugarcane juice for making jiggery (Gur). The fully ripened fruits and stems containing crude fibers are used in the paper industry. The fruits of okra contain carbohydrate (6.4%), protein (1.9%), fat (0.2%), fibre (1.2%), minerals (0.7%) and moisture (89.6%). The fruit is also rich source of β-carotene (53 µg), thiamine (0.07 mg), riboflavin (0.1 mg), vitamin C (13 mg), calcium (66mg), magnesium (53 mg), oxalic acid (8 mg), phosphorus (56 mg), iron (0.35 mg), sodium (6.9 mg), potassium (103 mg), copper (0.11 mg) and Sulphur (30 mg) per 100 g of edible portion. The dry seed contains 13-22 per cent good edible oil and van as 20-40 per cent protein. The oil is used in soap, cosmetic industry and as vanaspati. The crushed seed is fed to cattle for more milk production and the fiber is utilized in jute, textile and paper industry [2].

A number of insect pests causes damage on okra namely Jassid (*Amrasca biguttula biguttula*), Okra fruit and shoot borer (*Earias vettella*), Aphids (*Aphis gossypii*), White fly (*Bemisia tabaci*), Studies on occurrence and succession of pests of okra at Gwalior [4].

One of the major constraints for the low productivity of okra in India is that the crop is more vulnerable to the attack of insect pest intensity of damage. In Malwa region of Madhya Pradesh, shoot and fruit borer (*Earias vitella* Fab.), jassid and whitefly are the most destructive pest and causing considerable damage to okra crop in all stages of its growth. The sucking pests viz. *A. biguttula biguttula*, *A. gossypii* and *B. tabaci* were the first to appear on okra crop [3]. The whitefly *B. tabaci* is also a serious pest of okra. The nymph on emergence soon fixes their mouth parts into the plant’s tissues. They caused damage into two ways (a) the loss of cell sap and (b) normal photosynthesis is interfered with due to the growth or a sooty mould on the honeydew excreted by the insect. The attacked crop gives a sickly, black appearance.

Crop is affected due to susceptibility to yellow vein mosaic virus. The proposed study was aimed with following objectives; To study the efficacy of treatments against okra pest and To observe phytotoxic symptoms on Okra.

Materials and Methods

The experiment was carried out in randomized block design with seven treatments and 3 replications in rabi season of 2016 at experimental farm, College of Agriculture, Indore (M.P.). Okra Hybrid 01 was transplanted on 18th November, 2016 with 60 x 30 cm spacing. Insecticidal spray was started at the ETL of insects @ 500 litre water/ hectare with knapsack sprayer fitted with a flood jet nozzle. The six treatments i.e. T1-Carboxamide 300 SC, T2-Carboxamide 300 SC, T3-Carboxamide 300 SC, T4-Carboxamide 300 SC, T5Chlorantraniliprole 18.5% SC, T6Cypermetrhin 10% EC consist of Four doses of carboxamide 300 SC @ 6.50, 12.50, 18.50 and 37 g.a.i. ha-1, Chlorantraniliprole 18.5% SC @ 25 g.a.i. ha-1 and Cypermethrin 10% EC @ 70 g.a.i. ha-1 including untreated control were sprayed thrice at 10 days interval. Whitefly population was counted one day before and 1st, 3rd, 5th, 7th and 10 days after each spray from five randomly selected plants of each plot and population was counted on five leaves per plant with two top, two middle and one lower leaf using hand lens. Per cent population reduction was calculated for each spray, averaged for three sprays and finally overall population reduction was calculated. Thus, data obtained from the observations for each character were tabulated and analyzed statistically suggested by Fisher and Yates, 1963.

Results and Discussion

It was revealed that the whitefly population showed non-significant difference among different plots before the application of treatments. The pest population ranged from 20.61 to 22.32 whitefly/leaf. After first spray the per cent reduction in whitefly population was calculated from last observation of first spray over pre treatment count. It was revealed that the maximum reduction in population was recorded in T_4 -carboxamide 300 SC @ 37 g.a.i. ha^{-1} (71.19%) followed by T_5 -chlorantraniliprole 18.5% SC @ 25 g.a.i. ha^{-1} (65.53%). After second spray again maximum efficacy was recorded in highest dose of T_4 -carboxamide 300 SC @ 37 g.a.i. ha^{-1} (55.52%) followed by T_5 -chlorantraniliprole 18.5% SC @ 25 g.a.i. ha^{-1} (51.96%). The similar trend was also recorded after third spray repeatedly in the highest dose of T_4 - carboxamide 300 SC (48.95%) which was followed by T_5 -chlorantraniliprole 18.5% SC (45.95%) for whitefly population. Further, the mean and overall insect population reduction was noted maximum again in higher dose of T_4 -carboxamide 300 SC @ 37 g.a.i. ha^{-1} (93.45%) followed by T_5 -chlorantraniliprole 18.5% SC @ 25 g.a.i. ha^{-1} (91.04%). carboxamide, it is revealed that the product is being tested first time hence the references in this regard are not available. Further it may be stated that as a new product it may be free from insect resistance to the insecticides hence the efficacy of highest dose is justified. The lower doses of the product exhibited almost similar effect to chlorantraniliprole as it is not much old insecticide and having novel mode of action. Similarly [1] exhibited that the chlorantraniliprole recorded least reduction of *Bemisia tabaci* in cotton. In [5] showed that cypermethrin was found most effective against whitefly on okra and exhibited satisfactory control (>60% population suppression). Accordance with [6] noted significant reduction in whitefly population (72.32%) with the application of chlorantraniliprole 20% SC@ 40 g a.i. ha^{-1} in cotton. According to [7] reported that cypermethrin and supported chemical insecticides reduced the population of whitefly (4.8 $plant^{-1}$) on okra. With respect to [8] assessed that cypermethrin 25 EC @ 62.50 g a.i. ha^{-1} (1.60-2.36) and chlorantraniliprole 18.5 SC @ 30 g a.i. ha^{-1} (1.80-2.60) were effective treatments to reduce the whitefly population in tomato.

Table 1: Efficacy of insecticides against Whitefly Figures in parentheses are square root transformed values, DAS: Days After Spray

Treatment	Dose g.*a.i.*/ha	Pre-treatment	Whitefly population / leaf					Population reduction %	Overall population reduction%
			1 DAS	3 DAS	5 DAS	7 DAS	10 DAS		
T_1-Carboxamide 300 SC	6.50	7.61 (2.81)	3.80 (2.06)	3.91 (2.06)	4.14 (2.12)	4.51 (2.16)	5.03 (2.32)	33.39	75.82
T_2-Carboxamide 300 SC	12.50	6.37 (2.61)	2.86 (1.83)	2.95 (1.86)	3.16 (1.91)	3.48 (1.99)	3.95 (2.11)	37.99	80.83
T_3-Carboxamide 300 SC	18.50	4.50 (2.24)	1.57 (1.41)	1.64 (1.46)	1.82 (1.52)	2.09 (1.61)	2.53 (1.74)	43.77	87.94
T_4-Carboxamide 300 SC	37	2.86 (1.83)	0.71 (1.10)	0.73 (1.11)	0.86 (1.17)	1.10 (1.26)	1.46 (1.40)	48.95	93.45
T_5Chlorantranili prole 18.5% SC	25	3.55 (2.01)	1.06 (1.25)	1.11 (1.27)	1.26 (1.33)	1.52 (1.42)	1.92 (1.56)	45.91	91.04
T_6-Cypermetrhin 10% EC	70	5.35 (2.42)	2.14 (1.62)	2.23 (1.65)	2.43 (1.71)	2.72 (1.79)	3.17 (1.92)	40.74	85.07
T_7-Untreated check	---	23.06 (4.85)	23.15 (4.86)	23.57 (4.91)	23.89 (4.94)	24.12 (4.96)	24.36 (4.99)	---	---
S Em±		-	0.10	0.11	0.10	0.11	0.09		
CD at 5%		NS	0.31	0.33	0.32	0.34	0.29		
CV		-	8.72	9.07	8.59	8.88	7.15		

Yield and Economics

The findings revealed that obtained marketable fruit yield was noted highest in T4-carboxamide 300 SC @ 37 g.a.i. ha-1 (12.7 t ha-1) which was at par with T5-chlorantraniliprole 18.5% SC @ 25 g.a.i. ha-1 (12.3 t ha-1) followed by T3-carboxamide 300 SC @ 18.5 g.a.i ha-1 (11.8t ha-1), T6-cypermetrhin 10% EC @ 70 g.a.i. ha-1 (11.4 t ha-1), T2-carboxamide 300 SC @ 12.5 g.a.i. ha-1 (11.0 t ha-1), T1-carboxamide 300 SC @ 6.5 g.a.i. ha-1 (10.6 t ha-1) and T7-untreated check (6.7 t ha-1.). The maximum net return and

cost-benefit was obtained in T_4-carboxamide 300 SC @ 37 g.*a.i*. ha^{-1} (Rs.187972 ha^{-1} and 2.84) followed by T_5-chlorantraniliprole 18.5% SC @ 25 g.*a.i*. ha^{-1} (Rs 179917 ha^{-1} and 2.72), T_3-carboxamide 300 SC @ 18.5 g.*a.i* ha^{-1} (Rs. 172238 ha^{-1} and 2.70), T_6-cypermetrhin 10% EC @ 70 g.*a.i*. ha^{-1} (Rs.165588 ha^{-1} and 2.65), T_2-carboxamide 300 SC @ 12.5 g.*a.i*. ha^{-1} (Rs. 156971 ha^{-1} and 2.49), T_1-carboxamide 300 SC @ 6.5 g.*a.i*. ha^{-1}
(Rs.149705 ha^{-1} and 2.40) and The T_7- untreated check gave relatively lower net return of (Rs.74000 ha^{-1} and 1.23), respectively.

Table 2: Yield and Economics of Okra crop under different treatments.

Sr. No	Treatments	Dose g.a.i/ha	Dose gm or ml/ha	Fruit Yield t/ha	Cost benefit ratio
1	T_1-Carboxamide 300 SC	6.5	21.7	10.6	2.40
2	T_2-Carboxamide 300 SC	12.5	41.7	11.0	2.49
3	T_3-Carboxamide 300 SC	18.5	61.7	11.8	2.70
4	T_4-Carboxamide 300 SC	37	123.5	12.7	2.84
5	T_5-Chlorantraniliprole 18.5% SC	25	125	12.3	2.72
6	T_6-Cypermetrhin 10% EC	70	760	11.4	2.65
7	T_7-Untreated check	---	---	6.7	1.23
	S.Em. ± C.D. at 5%			0.72	
				2.23	

Conclusion
The present study concluded that maximum reduction in population was observed in treatment carboxamide 300 SC @ 37 g.a.i. ha^{-1}. Under untreated control minimum population reduction was found. The marketable Okra fruit yield and cost benefit ratio was recorded higher in higher dose of carboxamide 300 SC @ 37 g.a.i. ha^{-1} at par with Chlorantraniliprole 18.5% SC @ 25 g.a.i. ha^{-1} followed by carboxamide 300 SC @ 18.50 g.a.i. ha^{-1} as compared to untreated control.

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