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Comparative Efficacy of Some Bio-Rational and Chemical Insecticides against Whitefly *Bemisia tabaci* (Gennadius) on Okra *Abelmoschus esculentus* (L.) Moench

Sumit Kumar Singh* and Sasya Thakur

Department of Entomology, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad - 211 007, India

**Corresponding author*

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A B S T R A C T

In this study the field trial was conducted to determine the effect of bio-rational and chemical insecticides and benefit cost ratio at the Central field, Department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad during *kharif* 2016. Seven treatments were evaluated against whitefly *Bemisia tabaci* (Gennadius) viz., T_1-Neem oil 0.03%, T_2-*Verticillum lecanii*, T_3-*Metarhizium anisopliae*, T_4-*Beauveria bassiana*, T_5-Acetamiprid 20% SP,T_6-Imidacloprid 17.8% SL, T_7-Triazophos 40% EC. Studies revealed that the lowest infestation of whitefly and incremental benefit cost ratio were observed in Imidacloprid 17.8% SL (1.25 whiteflies/3leaves and 1:9.33)was statistically significant to remaining treatments, followed by Acetamiprid 20% SP (1.64 whiteflies/3leaves and 1:9.00), Triazophos 40% EC (2.31 whiteflies/3leaves and 1:8.48), Neem oil 0.03% (3.95 whiteflies/3leaves and 1:7.19), *Verticilium lecanii* (4.72 whiteflies/3leaves and 1:4.60), *Beauveria bassiana* (5.64 whiteflies/3leaves and 1:5.84) and *Metarhizium anisopliae* (6.04 whiteflies/3leaves and 1:5.60) respectively. The highest yield was recorded in Imidacloprid 17.8% SL (133.8q/ha) then followed by Acetamiprid 20% SP (121.4 q/ha), Triazophos 40% EC (116.12 q/ha), Neem oil (98.46 q/ha), *Verticillum lecanii* (81.43 q/ha), *Beauveria bassiana* (78.62 q/ha), *Metarhizium anisopliae* (77.82 q/ha), as compared to control (62.56q/h).

Introduction

Among the vegetable crops grown in India, Okra (*Abelmoschus esculentus* L. Moench), also known as lady's finger or bhendi, belongs to family Malvaceae and is an important crop grown throughout the year. Besides India, it is grown in many tropical and subtropical parts of the world. Tender fruits are used as vegetables or in culinary preparations as sliced and dried pieces. It is also used for thickening gravies and soups, because of its high mucilage content. The roots and stems of okra are used for cleaning cane juice Chauhan (1972). Matured fruits and stems containing crude fibre are used in paper industry. It has good nutritional value, particularly the high content of Vitamin C (30 mg/100 g), Calcium (90 mg/100 g), Iron (1.5 mg/100 g) and other minerals like magnesium and potassium, Vitamin A and B, fats and carbohydrates

Aykroud (1963). Among 72 species of insects infesting the crop, the sucking pest viz., Aphids (*Aphis gossypii* Glover), leafhopper (*Amrasca biguttula biguttula* Ishida) and whitefly (*Bemisia tabaci* Gennadius) are the most important which cause significant yield reduction. Aphids and leafhopper are important pests in the early stage of the crop which desap the plants, making them weak which results in reduced flowering and poor fruit set ultimately reduction in yield. The cultivation of okra in India received a setback due to yellow vein mosaic virus (YVMV) and enation leaf curl virus (ELCV), spread by the vector whitefly. The loss in marketable yield has been estimated at 50-94%, depending up on the stage of crop growth at which the infection occurs. Failure to control these pests in the initial stage causes a yield loss upto 54.04 per cent Chaudhary and Dadeech (1989). Thus in the present investigation an attempt has been made to evaluate the efficacy of some bio-rational and chemical insecticides against whitefly infesting okra along with benefit cost ratio.

Materials and Methods

The experiment was conducted during *kharif* season 2016 at the Central field of "Sam Higginbottom University of Agriculture, Technology and Sciences" Allahabad, Uttar Pradesh, India, laid in a Randomized Block Design (RBD) with three replications and eight treatments, using variety VNR-22 (Komal) in a plot size of (2m x 1m) at a spacing of (45x30cm) with recommended package of practices. The insecticidal treatments include viz., T_1-Neem oil 0.03%, T_2-*Verticillum lecanii*, T_3-*Metarhizium anisopliae*, T_4-*Beauveria bassiana*, T_5-Acetamiprid 20% SP, T_6-Imidacloprid 17.8% SL, T_7-Triazophos 40% EC along with untreated control. The spraying was done after the population reaching its ETL. Two insecticidal sprays were administrated at 38th (SMW) and 41st (SMW) starting from 42 days after sowing. The observations on the number of whitefly were made on the five randomly selected and tagged plants from each plot. The number of pest per leaf was calculated based on the number of insects on three leaves, each taken from top, middle and bottom of each plant. The observations are made 1 day before spray (DBS) followed by 3rd, 7th, 14th days after spray (DAS). Observations were recorded without disturbing the plants to minimize the observational errors. Population of whitefly was recorded from each net plot and the population was worked out per leaf. Fruit yield was also recorded. The total yield of the marketable fruits obtained from different treatments was calculated and converted by considering the additional cost (cost of insecticides and operational charges) and benefit (compared to untreated control) in the respective treatments.

Results and Discussion

The infestation of whitefly revealed that the lowest infestation of whitefly was recorded in T_6-Imidacloprid (1.25 whiteflies/3leaves) recorded lowest population of whitefly and was statistically significant to remaining treatments, followed by T_5-Acetamiprid (1.64 whiteflies/3leaves), T_7-Trizophos (2.31 whiteflies/3leaves), T_1-Neem oil (3.95 whiteflies/3leaves), T_2-*Verticilium lecanii* (4.72 whiteflies/3leaves), T_4-*Beauveria bassiana* (5.64 whiteflies/3leaves) and T_3-*Metarhizium anisopliae* (6.04 whiteflies/ 3leaves) showed least effect among all other treatments (Table.3).

Similar readings were found with Preetha *et al.,* (2009) showed among the newer insecticide molecules evaluated, efficacy of neonicotinoid, imidacloprid as foliar application against whitefly *Bemesia tabaci*. Imidacloprid 17.8 SL was found effective against whiteflies. The other neonicotinoid

also provide similar level of protection as that of imidacloprid. These findings can be supported with the study of Begum *et al.,* (2016) who reported that imidacloprid 17.8 SL was the most effective treatment indicating reduction in population of whiteflies. Over all best performance of insecticides against whitefly was recorded in imidacloprid treated plots with lowest population of whitefly (3.91 whitefly/15 leaves) by Sarkar *et al.,* (2016). Ghosh *et al.,* (2013) recorded satisfactory control >60 % population suppression with imidacloprid and neem oil.

Table.1 Effect of some bio-rational and chemical insecticides against whitefly, *Bemisia tabaci* (Gennadius) on okra *Abelmoschus esculentus* (L.) Moench (First spray)

Tr. No.	Treatments	Number of Whiteflies / 3 leaves				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
T_0	Untreated (Control)	7.40 **(2.72)**	8.60 **(2.93)**	9.46 **(3.07)**	10.80 **(3.28)**	9.62 **(3.10)**
T_1	Neem oil(0.03%)	7.53 **(2.74)**	4.46 **(2.11)**	4.13 **(2.03)**	5.60 **(2.36)**	4.73 **(2.17)**
T_2	*Verticillium lecanii*	7.46 **(2.73)**	5.40 **(2.32)**	4.86 **(2.20)**	5.93 **(2.43)**	5.40 **(2.32)**
T_3	*Metarhizium anisopliae*	7.20 **(2.68)**	6.06 **(2.46)**	5.73 **(2.39)**	6.80 **(2.60)**	6.20 **(2.49)**
T_4	*Beauveria bassiana*	7.26 **(2.69)**	5.73 **(2.39)**	5.46 **(2.33)**	6.66 **(2.58)**	5.95 **(2.44)**
T_5	Acetamiprid 20% SP	7.40 **(2.72)**	1.80 **(1.34)**	1.66 **(1.29)**	3.06 **(1.75)**	2.17 **(1.47)**
T_6	Imidacloprid 17.8% SL	7.46 **(2.73)**	1.40 **(1.18)**	1.13 **(1.06)**	2.26 **(1.50)**	1.60 **(1.26)**
T_7	Trizophos 40% EC	7.33 **(2.70)**	2.53 **(1.59)**	2.46 **(1.57)**	3.40 **(1.84)**	2.80 **(1.67)**
F- test		NS	S	S	S	S
S. Ed. (±)		0.020	0.038	0.032	0.035	0.017
C. D. (P = 0.05)		0.060	0.091	0.084	0.088	0.060

*Figures in parenthesis are square root transformed values.
DBS-Days before spray, DAS-Days after spray.

Table.2 Effect of some bio-rational and chemical insecticides against whitefly, *Bemisiata baci* (Gennadius) on okra *Abelmoschus esculentus* (L.) Moench (Second spray)

Tr. No.	Treatments	Number of Whiteflies / 3 leaves				
		1 DBS	3 DAS	7 DAS	14 DAS	Mean
T_0	Untreated (Control)	11.73 **(3.42)**	12.40 **(3.52)**	11.73 **(3.42)**	10.40 **(3.22)**	11.51 **(3.39)**
T_1	Neem oil (0.03%)	8.33 **(2.88)**	3.46 **(1.86)**	3.13 **(1.76)**	2.93 **(1.71)**	3.17 **(1.78)**
T_2	*Verticillium lecanii*	8.46 **(2.90)**	4.66 **(2.15)**	4.33 **(2.08)**	3.13 **(1.76)**	4.04 **(2.01)**
T_3	*Metarhizium anisopliae*	8.26 **(2.87)**	6.53 **(2.55)**	5.80 **(2.40)**	5.33 **(2.30)**	5.88 **(2.42)**
T_4	*Beauveria bassiana*	8.26 **(2.86)**	5.86 **(2.42)**	5.40 **(2.32)**	4.73 **(2.17)**	5.33 **(2.30)**
T_5	Acetamiprid 20% SP	5.20 **(2.28)**	1.33 **(1.15)**	1.16 **(1.07)**	0.85 **(0.92)**	1.11 **(1.05)**
T_6	Imidacloprid 17.8% SL	5.13 **(2.26)**	1.06 **(1.03)**	0.93 **(0.96)**	0.73 **(0.85)**	0.91 **(0.95)**
T_7	Trizophos 40% EC	6.00 **(2.44)**	2.20 **(1.48)**	1.80 **(1.34)**	1.46 **(1.21)**	1.82 **(1.35)**
F- test		NS	S	S	S	S
S. Ed. (±)		0.290	0.049	0.088	0.056	0.023
C. D. (P = 0.05)		0.870	0.103	0.139	0.111	0.071

*Figures in parenthesis are square root transformed values.
DBS-Days before spray, DAS-Days after spray.

Table.3 Effect of some bio-rational and chemical insecticides against whitefly, *Bemisia tabaci* (Gennadius) on okra *Abelmoschus esculentus* (L.) Moench (First and second spray pooled mean)

Tr. No.	Treatments	Number of Whiteflies / 3leaves		
		I-Spray	II-Spray	Overall Mean
T_0	Untreated (Control)	9.62 **(3.10)**	11.51 **(3.39)**	10.56 **(3.25)**
T_1	Neem oil(0.03%)	4.73 **(2.17)**	3.17 **(1.78)**	3.95 **(1.98)**
T_2	*Verticillium lecanii*	5.40 **(2.32)**	4.04 **(2.01)**	4.72 **(2.17)**
T_3	*Metarhizium anisopliae*	6.20 **(2.49)**	5.88 **(2.42)**	6.04 **(2.45)**
T_4	*Beauveria bassiana*	5.95 **(2.44)**	5.33 **(2.30)**	5.64 **(2.37)**
T_5	Acetamiprid 20% SP	2.17 **(1.47)**	1.11 **(1.05)**	1.64 **(1.28)**
T_6	Imidacloprid 17.8% SL	1.60 **(1.26)**	0.91 **(0.95)**	1.25 **(1.12)**
T_7	Trizophos 40% EC	2.80 **(1.67)**	1.82 **(1.35)**	2.31 **(1.52)**
F- test		S	S	S
S. Ed. (±)		0.017	0.023	0.012
C. D. (P = 0.05)		0.060	0.071	0.050

*Figures in parenthesis are square root transformed values.

Table.4 Economics of cultivation

Tr. No:	Treatment	Yield of q/ha	Cost of yield₹/q	Total cost of yield (₹)	Common cost (₹)	Treatment cost (₹)	Total cost (₹)	B :C ratio
T_0	**Control**	62.56	2000 ₹/q	**125120**	25728	-	**25728**	1:4.86
T_1	**Neem oil (0.03%)**	98.46	2000₹/q	**196920**	25728	1650	**27378**	1:7.19
T_2	***Verticillium lecanii***	81.43	2000₹/q	**162860**	25728	9650	**35378**	1:4.60
T_3	***Metarhizium anisopliae***	77.82	2000₹/q	**155640**	25728	2025	**27753**	1:5.60
T_4	***Beauveria bassiana***	78.62	2000₹/q	**157240**	25728	1170	**26898**	1:5.84
T_5	**Acetamiprid 20% SP**	121.40	2000₹/q	**242800**	25728	1248	**26976**	1:9.00
T_6	**Imidacloprid 17.8% SL**	133.80	2000₹/q	**267600**	25728	2940	**28668**	1:9.33
T_7	**Trizophos 40% EC**	116.12	2000₹/q	**232240**	25728	1650	**27378**	1:8.48

The yields among the treatment were significant. The highest yield was recorded (Table 4) in T_6- Imidacloprid 17.8% SL (133.8q/ha), followed by T_5- Acetamiprid 20% SP (121.4 q/ha), T_7- Triazophos 40% EC (116.12 q/ha), T_1- Neem oil (98.46 q/ha), T_2- *Verticillum lecanii* (81.43 q/ha), T_4- *Beauveria bassiana* (78.62 q/ha), T_3- *Metarhizium anisopliae* (77.82 q/ha), as compared to control T_0- (62.56q/h). When benefit cost ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T_6- Imidacloprid 17.8% SL (1:9.33), followed by T_5- Acetamiprid 20% SP (1:9.00), T_7- Triazophos 40% EC (1:8.48), T_1- Neem oil (1:7.19), T_2- *Verticillum lecanii* (1:4.60), T_4- *Beauveria bassiana* (1:5.84), T_3- *Metarhizium anisopliae* (1:5.60), as compared to control T_0- (1:4.86).

Simlar readings were found with, Naik and Shekarappa (2009) who reported that, the treatments *Metarhizium anisopliae* (38.80 q/ha) and *Verticillium lecanii* (38.50 q/ha) recorded with returns of 1:18.40 and 1:16.68 respectively. These findings can be supported with the study of Parmar *et al.*, (2013) who reported that from the experiment, the treatment Imidacloprid produced highest (105.22 q/ha) yield with (1:22.08) Benefit Cost Ratio.

From the critical analysis of the present findings it can be concluded that, Insecticides like Imidacloprid 17.8% SL and Acetamiprid 20%SP, Triazophos 40%EC can be suitably incorporated in pest management schedule against *Bemisia tabaci* (Gennadius) as an effective tool under chemical control, and treatments like Neem oil, *Verticillum lecanii*,

Beauveria bassiana and Metarhizium anisopliae are also to be incorporated in pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not much harmful to beneficial insects and in increasing cost effectiveness.

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