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SK Rohit
Department of Entomology
IGKV, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

KL Painkra
Department of Entomology
IGKV, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

GP Painkra
Department of Entomology
IGKV, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

PK Bhagat
Department of Entomology
IGKV, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

Corresponding Author:
SK Rohit
Department of Entomology
IGKV, Raj Mohini Devi College of Agriculture and Research Station, Ambikapur, Chhattisgarh, India

Evaluation of new promising pesticides for the management of sucking pests in winter okra crop

SK Rohit, KL Painkra, GP Painkra and PK Bhagat

Abstract
The field experiment on evaluation of new promising pesticides result showed that all the treatments observed significantly lower population of sucking pest viz., jassid, aphid, thrips and whitefly as compared to untreated control. In all the two sprayings, Thiamethoxam 25% WG proved the best treatment as reducing the populations of the major sucking pests of winter okra. The next effective treatment was of Chlorantraniliprole 18.5% SC. However, the treatments of Flubendiamide 20% WG, Emamectin benzoate 5% SG, Buprofezin 22% + Fipronil 3% SC and Spinosad 45% SC were also observed to be moderately effective treatments in most of the observations. The maximum population of sucking pests were encountered from the untreated control plot.

Keywords: Aphid, jassid, whitefly, thrips, okra, insecticides and treatments

Introduction

Okra (*Abelmoschus esculentus* Linn.) is one of the major economically important vegetable crops commercially cultivated in many parts of the world and throughout India. The crop is suitable for cultivation as a kitchen garden as well as on large high-tech commercial crop. In India okra is cultivated with a major share in state of Maharashtra, West Bengal, Uttar Pradesh, Karnataka, Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh and Chhattisgarh (Shinde *et al*. 2007) [12]. Okra plays a prominent role in human nutrition by providing minerals, vitamins, protein, carbohydrate and fat that are generally lacking in basic foods needed for a proper balanced diet. The fruit contains minerals especially magnesium, iron, calcium, phosphorus, proteins, vitamin A, B and C including riboflavin (Ndaeyo *et al.* 2005) [10]. The okra seeds are good sources of protein and oil (Oyelade *et al.* 2003) [11] and it has been known to be very important in nutritional quality.

Major limiting factor in productivity and crop growth of okra is its susceptibility to a large number of insect-pests. As many as 72 species of insect-pests have been recorded on okra (Srinivas Rao and Rajendra, 2002) [14] of which sucking pests comprising of leafhopper (*Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius) and mite, *Tetranychus urticae* (Boisduval) cause significant loss to the crop. Leafhopper has been a serious pest of okra causing huge loss during the crop growth period. Both the stage of the adults and nymphs suck the cell sap from the underside of leaves (Singh *et al.* 2008) [13]. Similarly, whitefly nymphs and adults remove significantly amount of cell sap from the leaves reducing the plant vigour. They are also responsible for transmitting yellow vein mosaic virus. Severe infestation of aphid results in curling of leaves, stunted growth and gradual drying and death of young plants. Red spider mites lap the oozing out sap scratched from the lower leaf tissues. The sucking insect-pest complex comprising of aphids, leafhoppers, thrips, whiteflies and mites cause 17.46% damage in yield and if failing to manage them in early stages were reported to cause 54.04% yield loss (Chaudhary and Daderch, 1989; Anitha and Nandihalli, 2008) [7, 1]. These sucking pests are most serious and transmit certain viral diseases causes reduced quality and quantity of fruits (Atwal, 1994) [2].

For the management of sucking insect-pests, 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, lower mammalian toxicity, safety to natural enemies etc., is the need of the hour. Seeing the seriousness of the sucking pests and to mitigate the losses caused due to them, there is need to evaluate the most promising as well as economical viable insecticides for the effective management of sucking pests to getting higher yield and harvest of good crop.

Materials and Methods

The experiment was laid out in randomized block design replicated thrice with seven treatments including untreated control, which are depicted in Table 1. The crop variety VNR-Deepika was sown with a spacing of 45x15 cm and plot size of 3x4 m^2 with all package of agronomic practices. The required quantity of spray solution was calibrated and spraying done by knapsack sprayer at morning hours. The first spray of insecticides was done at the initiation of pest infestation and second spray was done at 15 days after first spray.

Pre-treatment observations were recorded from randomly selected 5 plants at each plot and the number of sucking pests population were counted by visual observations. Post treatment observations were recorded at 1^{th}, 3^{rd}, 5^{th}, 7^{th} and 10^{th} days after each spray. The data obtained from the individual plant observations from RBD experiment was analyzed statistically as per the standard procedure.

Table 1: Treatment details

S. No.	Treatments	Formulations	Dose/ha
T_1	Spinosad	45%SC	150 ml
T_2	Flubendiamide	20%WG	250gm
T_3	Buprofezin+ Fipronil	22% + 3%SC	750ml
T_4	Emamectin benzoate	5%SG	200gm
T_5	Chlorantraniliprole	18.5%SC	150ml
T_6	Thiomethoxam	25%WG	200gm
T_7	Control	-	-

Results and Discussion

The current findings of the study on the evaluation of new promising pesticides against sucking pests are presented in Table 2, Table 3, Table 4 and Table 5, respectively.

Jassid or Plant leafhopper, *Amrasca biguttula biguttula* (Ishida)

Among the different sucking pests, jassids were observed as important and predominant sucking pest during the crop season (Table 2). The data indicated that the populations of jassids did not show differ significantly before spray in all the treatments. However the jassid populations were noticed significant reduction at 1, 3, 5, 7 and 10 days after application of insecticides except untreated control. The result clearly showed that all the treatments were significantly superior over untreated control. Thiamethoxam 25% WG (1.36 jassids/plant) was recorded significantly lowest average population of jassids that proved the best treatment. The next effective treatment in reducing jassid population was Chlorantraniliprole 18.5% SC (1.91 jassids/plant), followed by Buprofezin + Fipronil 22% + 3% SC (2.17 jassids/plant), Emamectin benzoate 5% SG (2.33 jassids/plant), Flubendiamide 20% WG (2.46 jassids/plant) and Spinosad 45% SC (2.59 jassids/plant). The highest population (10.98 jassids/plants) was noticed in untreated control plot.

The present findings are similar with the findings of Kumar *et al.* (2017) [9] who reported that the Thiamethoxam 25% WG and Imidacloprid 17.8% SL were the best suitable insecticides for reducing of sucking pests like jassid and whitefly. Bisht *et al*. (2017) [4] also revealed that Thiamethoxam 25% WG @ 25g a.i/ha was recorded with maximum jassid mortality on okra crop.

Aphid, *Aphis gossypii* (Glover)

The results represented in Table 3 revealed that the aphid population at 1 day before and after spraying of insecticides did not differ significantly in all the treatments. As compared to control there was significant reduction in aphid population in days after spraying in both the sprays. The average population of aphids were observed significant lower and superior (1.61 to 3.29aphid/plant) in all treated plots than untreated control plot (10.19 aphid/plant) on okra. Among all the treatments, Thiomethoxam 25% WG recorded lowest population (1.61 aphid/plant) and it was statistically followed by the treatment Chlorantraniliprole 18.5% SC (1.83 aphid/plant). The other treatments viz., Emamectin benzoate 5% SG (2.43 aphid/plant), Flubendiamide 20% WG (2.71 aphid/plant), Buprofezin+ Fipronil 22% + 3% SC (2.88 aphid/plant) and Spinosad 45% SC (3.29 aphid/plant) were found effective in reducing the aphid populations significantly over control and were at par with each other. Untreated control plot recorded significantly maximum populations of (10.19 aphid/plant).

These findings are in accordance with the findings of Ghosh *et al*. (2016) [8] reported that maximum reduction in aphids population by 92.95% and 99.47% were obtained in first and second spray with Thiamethoxam 25% WG @ 75g a.i./ha. While Venkateshalu and Math (2017) [15] also reported the thiamethoxam 25% WG was as moderately effective against aphid population in okra.

Whitefly, *Bemisia tabaci* (Gennadius)

The whitefly population (Table 4) was recorded 1 day before spraying of insecticides did not differ significantly in all the treatments. However significant reduction in whitefly population was observed in various days after spraying as compared to untreated control. The mean population of whitefly per plant in all treated plots were significantly lower than untreated control plot. Results (Table 4) showed that the mean population of whitefly was recorded minimum of (1.16 whitefly/plant) in the treatment of Thiomethoxam 25% WG. The next effective treatment was Chlorantraniliprole 18.5% SC (1.62 whitefly/plant) followed by Flubendiamide 20% WG (1.95 whitefly/plant), Emamectin benzoate 5% SG (2.03 whitefly/plant), Buprofezin + Fipronil 22% + 3% SC (2.09 whitefly/plant) and Spinosad 45% SC (2.36 whitefly/plant) which were at par with each other. The maximum mean population 6.13 whitefly/plant was recorded from untreated control plot.

The current finding revealed that the new promising molecule of Thiamethoxam 25% SC was noticed with maximum reduction of whitefly population, while Chaitanya and Kumar (2018) [6] reported that Imidacloprid 17.8% SL was the most effective treatment indicated lowest population of whitefly followed by Thiamethoxam 25% WG, Acetamiprid 20% SP, Dimethote 30% EC, Lambda cyhalothrin 5% EC, Neem oil 5% and NSKE 5%.

Thrips, *Thrips tabaci* (Lindeman)

The result in Table 5 showed that all the treatments were significantly reduced the thrips overall mean population after each spraying of insecticides except untreated control plot. The treatment of Thiomethoxam 25% WG proved to be best effective treatment among other treatments because it was recorded overall mean lowest population of 0.66 thrips/plants. The next best treatment was Chlorantraniliprole 18.5% SC (0.79 thrips/plant) followed by Flubendiamide 20% WG (0.85 thrips/plant), Buprofezin+Fipronil 22%+3% SC (0.87 thrips/plant), Emamectin benzoate 5% SG (1.05 thrips/plant) and Spinosad 45% SC (1.18 thrips/plant) respectively. There was maximum population (2.66 thrips/plant) observed in untreated control plot.

The present findings are supported by the work of the Boda and Ilyas (2017) [5] who revealed that the treatments Fipronil 5% SC and Spiromesifen 240 SC were found superior in lowering population of thrips on 3rd, 7th and 14th days after 1st and 2nd spray. Similarly, Begum and Patil (2016) [3] also recorded that the Imidacloprid 17.8 SL @40g.a.i./ha proved to be effective and superior over other treatments and control and recorded lowest population of thrips (1.41 thrips/plants).

Plate 1: Infested leaf with aphids

Plate 2: Infested leaf with jassid

Plate 3: Whitefly

Table 2: Evaluation of new promising pesticides against jassid in okra crop during winter 2018-19

S. No.	Treatments	Dose/ha	Average population of jassid/plant											
			Pre treatment	1st Spray					2nd Spray					Over all mean
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T_1	Spinosad 45% SC	150 ml	9.60 (3.25)*	3.33 (2.06)	2.33 (1.82)	2.13 (1.76)	2.47 (1.85)	2.27 (1.80)	3.67 (2.12)	2.37 (1.83)	2.10 (1.76)	2.53 (1.86)	2.73 (1.9)	2.59
T_2	Flubendiamide 20% WG	250gm	11.27 (3.48)	3.20 (2.02)	2.20 (1.78)	2.00 (1.72)	2.13 (1.76)	2.53 (1.86)	3.53 (2.09)	2.22 (1.78)	1.90 (1.70)	2.19 (1.78)	2.67 (1.9)	2.46
T_3	Buprofezin+ Fipronil 22% + 3% SC	750ml	10.93 (3.40)	2.60 (1.88)	1.93 (1.71)	1.53 (1.58)	2.20 (1.78)	2.27 (1.80)	2.93 (1.95)	1.90 (1.70)	1.53 (1.58)	2.23 (1.79)	2.59 (1.89)	2.17
T_4	Emamectin benzoate 5% SG	200gm	10.47 (3.38)	3.07 (2.00)	2.00 (1.72)	1.87 (1.66)	2.13 (1.75)	2.20 (1.78)	3.40 (2.07)	1.97 (1.70)	1.93 (1.68)	2.27 (1.80)	2.42 (1.84)	2.33
T_5	Chlorantraniliprole 18.5% SC	150ml	11.87 (3.56)	2.20 (1.78)	1.80 (1.67)	1.40 (1.54)	1.87 (1.69)	1.93 (1.71)	2.53 (1.87)	1.87 (1.69)	1.36 (1.52)	1.97 (1.72)	2.13 (1.76)	1.91
T_6	Thiomethoxam 25% WG	200gm	9.60 (3.25)	1.80 (1.67)	1.07 (1.43)	0.73 (1.31)	1.13 (1.45)	1.40 (1.54)	2.13 (1.76)	1.20 (1.47)	1.03 (1.42)	1.27 (1.50)	1.80 (1.67)	1.36
T_7	Control	-	8.27 (3.02)	9.33 (3.20)	10.40 (3.37)	11.73 (3.55)	11.80 (3.57)	12.13 (3.62)	10.73 (3.40)	10.87 (3.41)	11.13 (3.46)	10.93 (3.42)	10.70 (3.39)	10.98
SEm±			0.241	0.143	0.092	0.101	0.095	0.105	0.186	0.151	0.11	0.147	0.162	
CD at 5%			N/A	0.446	0.285	0.315	0.295	0.327	0.578	0.469	0.343	0.457	0.504	

Note: * Figures in the parenthesis are $\sqrt{x + 0.5}$ transformed value

Table 3: Evaluation of new promising pesticides against aphid on okra crop during winter 2018-19

S. No.	Treatments	Dose/ha	Average population of aphid/ plant											
				1st Spray					2nd Spray					
			Pre treatment	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	Over all mean
T_1	Spinosad 45% SC	150 ml	7.13 (2.78)*	4.13 (2.15)	3.47 (2.01)	2.53 (1.82)	3.73 (2.17)	4.00 (2.20)	3.80 (2.09)	2.73 (1.87)	2.53 (1.82)	3.40 (2.09)	2.60 (1.88)	3.29
T_2	Flubendiamide 20% WG	250gm	6.87 (2.79)	2.87 (1.95)	3.33 (2.07)	2.00 (1.72)	3.20 (2.04)	2.60 (1.89)	2.80 (1.94)	3.20 (2.04)	1.93 (1.70)	3.07 (2.00)	2.07 (1.73)	2.71
T_3	Buprofezin+ Fipronil 22% + 3% SC	750ml	7.20 (2.73)	4.00 (2.20)	2.20 (1.78)	1.73 (1.64)	3.67 (2.09)	3.47 (2.11)	3.87 (2.17)	2.00 (1.73)	1.67 (1.63)	3.40 (2.03)	2.80 (1.91)	2.88
T_4	Emamectin benzoate 5% SG	200gm	7.67 (2.94)	3.27 (2.06)	2.60 (1.89)	1.47 (1.56)	2.67 (1.91)	2.93 (1.98)	2.93 (1.98)	2.33 (1.80)	1.40 (1.54)	2.40 (1.84)	2.33 (1.80)	2.43
T_5	Chlorantraniliprole 18.5% SC	150ml	7.40 (2.83)	2.47 (1.83)	1.73 (1.62)	1.27 (1.50)	1.87 (1.67)	2.27 (1.80)	2.40 (1.82)	1.43 (1.50)	1.20 (1.48)	1.73 (1.62)	1.93 (1.69)	1.83
T_6	Thiomethoxam 25% WG	200gm	6.70 (2.75)	2.33 (1.81)	1.67 (1.61)	1.00 (1.41)	1.73 (1.63)	2.13 (1.76)	2.27 (1.79)	1.40 (1.54)	0.93 (1.39)	1.13 (1.46)	1.47 (1.56)	1.61
T_7	Control	-	7.43 (2.89)	6.47 (2.72)	8.13 (3.01)	9.73 (3.27)	9.87 (3.29)	10.67 (3.39)	10.60 (3.38)	11.07 (3.45)	11.23 (3.47)	11.93 (3.58)	12.20 (3.61)	10.19
SEm±			0.331	0.264	0.202	0.156	0.183	0.124	0.254	0.168	0.716	0.186	0.178	-
CD at 5%			N/A	N/A	0.629	0.486	0.569	0.387	0.791	0.522	0.548	0.581	0.555	-

Note: * Figures in the parenthesis are $\sqrt{x+0.5}$ transformed value

Table 4: Evaluation of new promising pesticides against whitefly on okra crop during winter 2018-19

S. No.	Treatments	Dose/ha	Average population of whitefly/ plant											
				1st Spray					2nd Spray					
			Pre treatment	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	Over all mean
T_1	Spinosad 45% SC	150 ml	3.67 (2.15)*	3.13 (2.03)	1.93 (1.7)	1.73 (1.63)	2.67 (1.89)	2.47 (1.86)	3.07 (2.01)	1.87 (1.68)	1.67 (1.61)	2.67 (1.89)	2.40 (1.84)	2.36
T_2	Flubendiamide 20% WG	250gm	3.47 (2.11)	2.73 (1.90)	1.73 (1.64)	1.47 (1.56)	1.93 (1.68)	2.07 (1.73)	2.60 (1.87)	1.67 (1.62)	1.40 (1.54)	1.87 (1.66)	2.00 (1.71)	1.95
T_3	Buprofezin+ Fipronil 22% + 3% SC	750ml	4.87 (2.37)	3.00 (1.99)	1.87 (1.67)	1.67 (1.60)	2.00 (1.69)	2.13 (1.72)	2.93 (1.97)	1.73 (1.61)	1.57 (1.57)	1.93 (1.67)	2.07 (1.71)	2.09
T_4	Emamectin benzoate 5% SG	200gm	4.60 (2.34)	2.67 (1.90)	1.80 (1.66)	1.60 (1.60)	2.07 (1.74)	2.20 (1.78)	2.60 (1.88)	1.73 (1.61)	1.53 (1.58)	2.00 (1.72)	2.13 (1.76)	2.03
T_5	Chlorantraniliprole 18.5% SC	150ml	5.13 (2.45)	1.87 (1.67)	1.47 (1.54)	1.13 (1.44)	1.80 (1.66)	2.00 (1.71)	1.80 (1.65)	1.40 (1.54)	1.07 (1.41)	1.73 (1.64)	1.93 (1.7)	1.62
T_6	Thiomethoxam 25% WG	200gm	5.60 (2.56)	1.73 (1.64)	0.87 (1.36)	0.60 (1.24)	1.00 (1.39)	1.53 (1.58)	1.67 (1.62)	1.03 (1.40)	0.80 (1.30)	1.20 (1.45)	1.13 (1.46)	1.16
T_7	Control	-	4.47 (2.32)	5.93 (2.62)	6.07 (2.65)	5.90 (2.58)	6.47 (2.69)	6.13 (2.64)	6.33 (2.66)	6.40 (2.68)	6.37 (2.62)	6.30 (2.68)	5.37 (2.49)	6.13
SEm±			0.217	0.157	0.145	0.207	0.222	0.195	0.193	0.211	0.249	0.201	0.179	-
CD at 5%			N/A	0.488	0.452	0.646	0.69	0.608	0.603	0.657	0.777	0.627	0.559	-

Note: * Figures in the parenthesis are $\sqrt{x+0.5}$ transformed value

Table 5: Evaluation of new promising pesticides against thrips on okra crop during winter 2018-19

S. No.	Treatments	Dose/ha	Average population of thrips / plant											
				1st Spray					2nd Spray					
			Pre treatment	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	Over all mean
T_1	Spinosad 45%SC	150 ml	1.27 (1.49)*	1.27 (1.50)	1.13 (1.45)	1.00 (1.41)	1.33 (1.52)	1.33 (1.52)	1.20 (1.48)	1.07 (1.43)	0.93 (1.39)	1.27 (1.49)	1.27 (1.49)	1.18
T_2	Flubendiamide 20%WG	250gm	1.00 (1.39)	0.93 (1.38)	0.87 (1.36)	0.73 (1.31)	0.87 (1.36)	1.00 (1.41)	0.87 (1.36)	0.80 (1.33)	0.67 (1.28)	0.80 (1.34)	0.93 (1.39)	0.85
T_3	Buprofezin+ Fipronil 22% + 3%SC	750ml	1.40 (1.54)	0.93 (1.38)	0.80 (1.33)	0.67 (1.28)	1.00 (1.40)	1.13 (1.45)	0.87 (1.36)	0.73 (1.31)	0.60 (1.25)	0.93 (1.38)	1.07 (1.43)	0.87
T_4	Emamectin benzoate 5%SG	200gm	1.60 (1.61)	1.07 (1.43)	1.00 (1.40)	0.87 (1.35)	1.20 (1.48)	1.27 (1.50)	1.00 (1.41)	0.93 (1.37)	0.80 (1.34)	1.13 (1.45)	1.20 (1.48)	1.05
T_5	Chlorantraniliprole 18.5%SC	150ml	1.13 (1.44)	0.80 (1.33)	0.73 (1.30)	0.60 (1.25)	0.93 (1.39)	1.07 (1.43)	0.73 (1.30)	0.67 (1.28)	0.53 (1.23)	0.87 (1.36)	1.00 (1.41)	0.79
T_6	Thiomethoxam 25%WG	200gm	1.13 (1.44)	0.73 (1.30)	0.67 (1.28)	0.53 (1.23)	0.67 (1.28)	0.87 (1.36)	0.67 (1.28)	0.60 (1.26)	0.47 (1.21)	0.60 (1.26)	0.80 (1.34)	0.66
T_7	Control	-	1.20 (1.48)	1.60 (1.61)	1.87 (1.69)	2.07 (1.75)	2.60 (1.89)	2.73 (1.93)	2.93 (1.98)	3.00 (1.99)	3.33 (2.07)	3.73 (2.17)	2.73 (1.93)	2.66
SEm±			0.142	0.102	0.086	0.058	0.051	0.042	0.09	0.091	0.06	0.059	0.046	-

CD at 5%	N/A	N/A	N/A	0.18	0.158	0.13	0.28	0.285	0.186	0.184	0.144	-

Note: * Figures in the parenthesis are $\sqrt{x+0.5}$ transformed value

Conclusion

It is clear from the data that all the treatments registered significantly minimized the population of major sucking pests in each application of pesticides except untreated control. In all the two sprays of Thiamethoxam 25% WG proved the best effective treatment for the reduction of sucking insect-pests population. The next better effective treatment was Chlorantraniliprole 18.5% SC however, treatments viz., Flubendiamide 20% WG, Emamectin benzoate 5% SG, Buprofezin 22% + Fipronil 3% SC, Spinosad 45% SC were also observed to be effective treatments in bringing down the population of sucking insect-pests.

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