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Evaluation of insecticide and biopesticides against okra Aphid, *Aphis gossypii* Glover

Vinayak N Jalgaonkar, Manoj Mahla, AV Naik, Kumud Naik, Anil Vyas and Gopal Golvankar

Abstract
The field experiment was carried outto the evaluation of insecticides and biopesticides against okra aphid, *Aphis gossypii* Glover during *summer* 2016 and 2017 at RARS, Karjat. Regarding the efficacy of some insecticide and biopesticide against aphids, the average data from both of the year 2016 and 2017 indicated that all the treatments were significantly superior over control. Treatment T3 (1st spray T3Thiomethaxon 25% WG and 2nd spray Thiodicarb 75% WP) was recorded minimum aphids population (9.78) and it was at par with all other treatment except untreated check.

Keywords: Efficacy, aphids, okra, insecticides, *Aphis gossypii* Glover

Introduction
Okra, *Abelmoschus esculentus* (L.) Moench, is one of the major vegetable crops in the tropical and subtropical regions of the world and is cultivated commercially in West Africa, South East Asia, Southern United States, Brazil, Turkey, and Northern Australia. In India, it is widely cultivated in West Bengal, Bihar, Orissa, Gujarat, Andhra Pradesh, Jharkhand, Chhattisgarh, Haryana and Maharashtra; occupying an area of about 532.6 thousand hectares, with a production of nearly 6346.3 million tones and productivity of 11.9 MT/ ha (Anon., 2014) [2]. In Maharashtra okra occupies an area of 23 thousand hectares, with productivity of 441.5 metric tons and productivity of 10.5 MT/ ha (Anon., 2014) [2].
Okra is attacked by a number of insect pests, in this shoot and fruit borer, whitefly, jassids and yellow vein mosaic diseases are the major constraints. There are about 13 major insect and non-insect pests species, which attack this crop at various stages of growth (Dhamdhere *et al.*1984) [5]. The major insect pests being jassids (*Amrasca biguttula biguttula* Ishida), white flies (*Bemisia tabaci*), flea beetle (*Podagrica bowringi* Baly), shoot and fruit borer (*Earias vittella* Fabricius and *Earias insulana* Boisduval), aphids (*Aphis gossypii* Glover) and mite (*Tetranychus cinnabarinus* Boisduval) (Chand, 1995) [4].
There is a great acceptance for safer and more selective insecticides. The rapidly developing resistance to numberof pesticides, residue hazards and resurgence of secondary pests provided the impetus to study new alternative of more ecologically acceptable selective insecticides for pest control strategies as a part of IPM programmes. One of these approaches which has captured worldwide attention to the development of compounds with novel modes of action andaction selectively on certain groups of insect pests. Therefore, the present investigation was planned to effective management of okra aphids.

Materials and methods
Experimental site
The experiment was carried out at Regional Agriculture Research Station, Karjat (M.S).

Preparation of experimental plot
After harvest of previous crop, the field was ploughed twice followed by clod crushing and harrowing to bring soil to a fine tilth. The experimental plot was laid out with two replications and fourteen treatments for first objective and three replications and ten treatments for second objective, of gross plot size of 2.5 ×3.0 m for each treatment. The flat beds were prepared in each plot for growing okra.

Seeds
The seed of okra variety Varsha upahar was used.

Manures
Organic manure in the form of F.Y.M. @ 20 t/ha was applied in the soil before last harrowing so that it could be mixed well in the soil.

Fertilizers
The recommended dose of fertilizers, 100 Kg N_2O, 50 Kg P_2O_5 and 50 Kg K_2O/ha was applied in the form of straight fertilizers through urea (46.4 per cent N), single super phosphate (16 per cent P_2O_5) and muriate of potash (60 per cent K_2O) to each plot. Nitrogen was applied in 3 split doses, 1/3rd N at the time of sowing and 2/3rd dose of N at 30 and 60 days after sowing while phosphorus and potassium was applied as basal dose.

Variety	:	Varshaupahar
Plot size	:	2.5 m × 3.0 m
Sowing date	:	9th January, 2016 and 2017
Spacing	:	45 cm x 30 cm
Design	:	Randomised Block Design
No. of replications:		Three
Treatments	:	Seven

Treatments Details

Treatments	1st spray	2nd spray	3rd spray	4th spray
T1	Clothianidin 50%WG @ 60 g/ha	Flubendiamide 39.35% SC @ 125 ml / ha	Azadirachtin5% @ 500 ml / ha	*Beauveria bassiana* @ 1x10^8 spores/ g
T2	Flonicamid 50%WG @ 150 g/ha	Emamectin benzoate 5%SG @ 170g /ha	*B.t.*@ 1kg/ ha	*Beauveria bassiana* @ 1x10^8 spores/ g
T3	Thiamethoxam 25%WG @ 100 g/ha	Thiodicarb75%WP @1000 g / ha	*B.t.*@ 500 g/ ha	*Verticillium lecanii* @ 1x10^8 spores/ g
T4	Tolfenpyrad 15% EC @ 1000 ml/ha	Deltamethrin2.8% EC @ 400 ml / ha	*Beauveria bassiana* @ 1x10^8 spores/g	Spinosad @ 170 g / ha
T5	Spiromesifen 22.9% SC @ 500 ml/ha	Thiodicarb75%WP @1000 g / ha	Emamectinbenzoate 5%SG @ 170g /ha	Flubendiamide 39.35%SC @125 ml / ha
T6	Azadirachtin 5%@ 500 ml / ha	*Verticillium lecanii* @ 1x10^8 spores/ g	*B.t.*@ 500 g/ ha	*Beauveria bassiana* @ 1x10^8 spores/ g
T7	Untreated Check			

Method and time of insecticide application
Actual quantity of spray material required per plot was calibrated prior to each spray using water alone. The spraying was done with manually operated knapsack sprayer. The desired concentration of various insecticides were prepared on the basis of percentage of active ingredient present in respective trade product and applied in respective plots thoroughly in form of fine droplets using high volume spray. The sprayer was washed off thoroughly after completion of spraying in each treatment.
The first spray application of insecticides was given at the time of incidence noticed and second spray was given at an interval of 15 days thereafter.

Method of recording observations
Observations on incidence of aphids were recorded on three leaves; each at top, middle and bottom of five randomly selected plants in each plot. The first observation was recorded 1 day prior to treatment as a pre treatment count and post treatment observations were recorded at 3rd, 7th, and 14th days after each spraying Data thus obtained were analysed statistically and presented.

Results and Discussion
Efficacy of different treatments against aphid of okra during 2016
The data on the efficacy of various treatments in reducing the aphids population after first and second spraying are furnished in Table 1.

First spray
There was no significant difference in the aphids population at a day before imposition of different treatments and population was recorded in the range of 15.88 to 20.55 aphids/3 leaves. The aphids population was uniform in all the treatments before spray. All the insecticides were significantly superior over untreated check up to 14 DAS. At 3 DAS, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (10.05 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The chronological order of various treatments based on average number of aphids / 3 leaves was T4 (10.32) > T1 (10.60) > T6 (10.85) > T3 (11.32) > T2 (12.45) > T7 untreated check (22.60). After 7 DAS, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (3.42 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids / 3 leaves in other treatments was T1 (3.89) > T4 (4.18) > T6 (4.22) > T3 (5.02) > T2 (5.58) > T7 untreated check (24.38). At 14 DAS, the trend of aphids population was observed increasing, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (10.54 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids/ 3 leaves in other treatments was T4 (11.30) > T6 (12.03) > T3 (12.36) > T1 (12.45) > T2 (13.62) and T7 untreated check (27.38) respectively.

Second spray

The aphids population was uniform in all the treatments before spray. All the insecticides were significantly superior over untreated check up to 14 DAS. After 3 DAS, the treatment T5 Spiromesifen 22.9% SC was recorded least aphids (6.32 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The trend of effectiveness of various treatments based on average number of aphids / 3 leaves was T1 (6.94) > T6 (8.25) > T2 (8.36) > T3 (8.36) > T4 (8.56) > T7 untreated check (19.22). At 7 DAS, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (0.80 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids / 3 leaves in other treatments recorded was T1 (1.11) > T2 (1.66) > T3 (2.19) > T6 (2.30) > T4 (2.80) > T7 untreated check (20.68) respectively. After 14 DAS, the trend of aphids population was observed increasing, the least aphids population / 3 leaves was recorded in the treatment T2 Emamectin benzoate 5% SG (2.00 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids / 3 leaves in other treatments observed as T5 (2.90) > T1 (3.30) > T3 (3.60) > T6 (4.00) > T4 (4.40) > T7 untreated check (21.50).

Results obtained from average data of two years (Table 3) indicated that all the treatments were significantly superior over untreated check. Treatment T5 (1st spray T5 Spiromesifen 22.9% SC and 2nd spray Thiodicarb 75% WP) was recorded minimum aphids population (8.27) and it was at par with all other treatment except untreated check. The trend of treatments as per their effectiveness to untreated check aphids /3 leaves population was T2 (10.05) followed by T1, T4, T3, T6 and T7 (Untreated check) respectively.

Efficacy of different treatments against aphid of okra during 2017

The data on the efficacy of various treatments in reducing the aphids population after first and second spraying are furnished in Table 2.

First spray

There was no significant difference in the aphids population at a day before imposition of different treatments and population was recorded in the range of 17.38 to 26.98 aphids/3 leaves. The aphids population was uniform in all the treatments before spray as treatment difference was non-significant. All the insecticides were significantly superior to untreated check up to 14 DAS. At 3 DAS, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (5.07 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The chronological order of various treatments based on average number of aphids / 3 leaves was T3 (5.47) > T4 (5.68) > T1 (6.68) > T6 (7.22) > T2 (8.33) > T7 untreated check (33.52). After 7 DAS, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (3.18 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids / 3 leaves in other treatments was T4 (4.27) > T2 (4.68) > T6 (5.22) > T1 (5.28) > T3 (6.80) > T7 untreated check (37.18). At 14 DAS, the trend of aphids population was observed increasing, the minimum aphids population / 3 leaves was recorded in the treatment T5 Spiromesifen 22.9% SC (22.27 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids/ 3 leaves in other treatments was T3 (23.68) > T2 (24.27) > T6 (24.60) > T1 (25.87) > T4 (26.68) and T7 untreated check (45.98).

Second spray

The aphids population was uniform in all the treatments before spray as treatment difference was non-significant. All the insecticides were significantly superior to untreated check up to 14 DAS. After 3 DAS, the treatment T5 Thiodicarb 75% WP was recorded least aphids (4.32 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The trend of effectiveness of various treatments based on average number of aphids / 3 leaves was T1 (5.98) > T4 (6.18) > T3 (6.19) > T6 (6.68) > T2 (7.32) > T7 untreated check (28.32). After 7 DAS, the minimum aphids population / 3 leaves was recorded in the treatment T5 Thiodicarb 75% WP (0.18 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids / 3 leaves in other treatments recorded was T1 (0.32) > T3 (0.68) > T4 (0.89) > T6 (1.01) > T2 (1.28) > T7 untreated check (37.18) respectively. After 14 DAS, the trend of aphids population was observed increasing, the least aphids population / 3 leaves was recorded in the treatment T5 Thiodicarb 75% WP (2.00 aphids population / 3 leaves) among various treatments. However, it was at par with all other treatment except untreated check. The average number of aphids / 3 leaves in other treatments observed as T1 (3.18) > T2 (3.72) > T3 (4.68) > T6 (4.98) > T4 (5.18) > T7 untreated check (45.98).

Results obtained from average data of two years presented in the Table 3 and indicated that all the treatments were significantly superior over untreated check. Treatment T3 (1st spray T3 Thiomethaxon 25% WG and 2nd spray Thiodicarb 75% WP) was recorded minimum aphids population (9.74) and it was at par with all other treatment except untreated check. The trend of treatments as per their effectiveness to untreated check aphids /3 leaves population was T1 (11.64) followed by T6, T2, T5, T4 and T7 (Untreated check) respectively.

The finding of present investigation are in close agreement with the Bhalala *et al.* (2006) [3] evaluated the bio-efficacy of thiamethoxam 25 WG and endosulfan 35 EC and monocrotophos 36 SL against the sucking pest complex of okra. The treatment of thiamethoxam 25 WG at higher dosages (50 and 37.5 g a.i./ha) was found most effective aginst aphid, jassid, whitefly and mite, however, monocrotophos was found at par for controlling whiteflies and mites. The marketable fruit yield was higher in the treatment of thiamethoxam.

Anitha and Nandihalli (2009) [1] evaluate the efficacy of various insecticides against leafhopper (*Amrasca biguttula biguttula*) and aphid (*Aphis gossypii*) on okra in Dharwad, Karnataka, India, during the *kharif* of 2006-07. Imidacloprid 70 WS (5 g/kg seeds) and thiamethoxam 70 WS (5 g/kg seeds) were used for seed treatment at sowing, whereas acetamiprid 20 SP (0.2 g/litre), spinosad 45 SC (0.2 ml/litre), imidacloprid 200 SL (0.2 ml/litre) and thiamethoxam 25 WG (0.2 g/litre) were applied as foliar spray

at 19 and 39 days after sowing. At 25 days after sowing (DAS), imidacloprid 200 SL recorded the lowest aphid population, followed by thiamethoxam 25 WG. At 35 DAS (15 days after the first spray), there was an increase in aphid population for all foliar sprays, and both seed treatments recorded the lowest aphid population. At 45 and 55 DAS (5 and 15 days after the second spray, respectively), foliar spraying of imidacloprid 200SL resulted in the lowest aphid population, followed by thiamethoxam 25 WG and acetamiprid 20 SP.

Similarly, Patil *et al.* (2014) [7] reported that the foliar spray of Thiamethoxam 25 WG @ 0.006% was found the most effective against aphids, followed by lambda Cyhalothrin 5 EC @ 0.004%.

Ghosh *et al.* (2016) [6] conducted a field trial to assess the bio-efficacy of different doses of Thiamethoxam 25%WG and check, Wiloxam against sucking pests like Jassids, Aphids and White flies of okra. The crop protected by higher doses of Thiamethoxam 25%WG 25, 50 and 75gm a.i./ha proved its superiority over the lower dose (15gm a.i/ha) and standard check, Willoxam. The results indicate a reduction of 92.95% and 99.47% population of aphids in first and second spray with Thiamethoxam 25%WG @ 75g a.i./ha though it is at par with Thiamethoxam 25% WG @ 25g and 50g a.i,/ha.

Table 1: Efficacy of some insecticide and biopesticides against Aphids population recorded during 2016

Tr. No.	Treatment	Pre count	Mean reduction of Aphids population days after sprays					
			1st spray			2nd spray		
			3rd* DAS	7th DAS	14th DAS	3rd DAS	7th DAS	14th DAS
T_1	1st spray- Clothianidin 50% WG @ 60 g/ha 2nd spray- Flubendiamide39.35% SC @125 ml / ha	18.95 (4.46)	10.60 (3.40)	5.02 (2.45)	12.45 (3.67)	6.94 (2.81)	1.11 (1.45)	3.30 (2.07)
T_2	1st spray- Flonicamid 50% WG @ 150 g/ha 2nd spray- Emamectin benzoate5%SG @ 170g /ha	20.55 (4.53)	12.45 (3.66)	5.58 (2.56)	13.62 (3.82)	8.36 (3.05)	1.66 (1.63)	2.00 (1.73)
T_3	1st spray- Thiamethoxam 25%WG @ 100 g/ha 2nd spray- Thiodicarb75%WP @1000 g / ha	19.47 (4.52)	11.32 (3.50)	5.02 (2.45)	12.36 (3.65)	8.36 (3.05)	2.19 (1.78)	3.60 (2.14)
T_4	1st spray- Tolfenpyrad 15% EC @1000 ml/ha 2nd spray- Deltamethrin2.8% EC@ 400 ml / ha	17.93 (4.35)	10.32 (3.36)	4.18 (2.27)	11.30 (3.50)	8.56 (3.09)	2.80 (1.94)	4.40 (2.32)
T_5	1st spray- Spiromesifen 22.9% SC @ 500 ml/ha 2nd spray- Thiodicarb75%WP @1000 g / ha	15.88 (4.45)	10.05 (3.32)	3.42 (2.10)	10.54 (3.39)	6.32 (2.70)	0.80 (1.34)	2.90 (1.97)
T_6	1st spray- Azadirachtin5%@ 500 ml / ha 2nd spray- *Verticilliumlecani*@ $1x10^8$ spores/ g	18.85 (4.45)	10.85 (3.40)	4.22 (2.28)	12.03 (3.60)	8.25 (3.04)	2.30 (1.81)	4.00 (2.23)
T_7	1st spray- Untreated Check 2nd spray- Untreated Check	19.54 (4.53)	22.60 (4.85)	24.38 (5.03)	27.38 (5.32)	19.22 (4.49)	20.68 (4.65)	21.50 (4.74)
	S.Em.±	0.26	0.42	0.26	0.16	0.23	0.38	0.39
	CD (p=0.05)	0.79	1.31	0.79	0.51	0.71	1.17	1.21

Table 2: Efficacy of some insecticide and biopesticides against Aphids population recorded during 2017

Tr. No.	Treatment	Pre count	Mean reduction of Aphids population days after sprays					
			1st spray			2nd spray		
			3rd* DAS	7th DAS	14th DAS	3rd DAS	7th DAS	14th DAS
T_1	1st spray- Clothianidin 50% WG @ 60 g/ha 2nd spray- Flubendiamide39.35% SC @125 ml / ha	22.80 (4.87)	6.68 (2.77)	5.28 (2.52)	25.87 (5.18)	5.98 (2.64)	0.32 (1.14)	3.18 (2.04)
T_2	1st spray- Flonicamid 50% WG @ 150 g/ha 2nd spray- Emamectin benzoate5%SG @ 170g /ha	22.73 (4.87)	8.33 (3.05)	4.68 (2.38)	24.27 (5.02)	7.32 (2.88)	1.28 (1.50)	3.72 (2.17)
T_3	1st spray- Thiamethoxam 25%WG @ 100 g/ha 2nd spray- Thiodicarb75%WP @1000 g / ha	17.38 (4.28)	5.47 (2.54)	6.80 (2.79)	23.68 (4.96)	6.19 (2.68)	0.89 (1.37)	4.68 (2.38)
T_4	1st spray- Tolfenpyrad 15% EC @1000 ml/ha 2nd spray- Deltamethrin2.8% EC@ 400 ml / ha	20.20 (4.60)	5.68 (2.58)	4.27 (2.29)	26.68 (5.26)	6.18 (2.67)	0.18 (1.08)	5.18 (2.48)
T_5	1st spray- Spiromesifen 22.9% SC @ 500 ml/ha 2nd spray- Thiodicarb75%WP @1000 g / ha	21.93 (4.78)	5.07 (2.46)	3.18 (2.04)	22.27 (4.82)	4.32 (2.30)	0.68 (1.29)	2.00 (1.73)
T_6	1st spray- Azadirachtin5%@ 500 ml / ha 2nd spray- *Verticilliumlecani*@ $1x10^8$ spores/ g	19.73 (4.55)	7.22 (2.86)	5.22 (2.49)	24.60 (5.05)	6.68 (2.77)	1.01 (1.41)	4.98 (2.44)
T_7	1st spray- Untreated Check 2nd spray- Untreated Check	26.98 (4.74)	33.52 (6.06)	37.18 (6.57)	45.98 (8.45)	28.32 (5.87)	37.18 (6.17)	45.98 (6.85)
	S.Em.±	0.26	0.16	0.19	0.19	0.14	0.18	0.27
	CD (p=0.05)	0.81	0.50	0.58	0.60	0.43	0.56	0.85

Table 3: Efficacy of some insecticide and biopesticides against Aphids average population recorded at different intervals

Tr. No.	Treatment	2016			2017			2016-2017		
		Average Population of Aphids after		Over all mean Population	Average Population of Aphids after		Over all mean Population	Average Population of Aphids after		Over all mean Population
		1st spray	2nd spray		1st spray	2nd spray		1st spray	2nd spray	
T_1	1st spray- Clothianidin 50% WG @ 60 g/ha 2nd spray- Flubendiamide39.35% SC @125 ml / ha	11.47 (3.44)	7.19 (2.65)	9.33 (3.05)	15.16 (3.84)	8.11 (2.63)	11.64 (3.24)	13.32 (3.64)	7.65 (2.64)	10.49 (3.14)
T_2	1st spray- Flonicamid 50% WG @ 150 g/ha 2nd spray- Emamectin benzoate5%SG @ 170g /ha	13.05 (3.64)	7.04 (2.64)	10.05 (3.14)	14.19 (3.68)	8.75 (2.85)	11.47 (3.27)	13.62 (3.66)	7.90 (2.75)	10.76 (3.21)
T_3	1st spray- Thiamethoxam 25%WG @ 100 g/ha 2nd spray- Thiodicarb75%WP @1000 g / ha	12.04 (3.53)	7.35 (2.75)	9.70 (3.14)	12.08 (3.42)	7.47 (2.64)	9.78 (3.03)	12.06 (3.48)	7.41 (2.70)	9.74 (3.09)
T_4	1st spray- Tolfenpyrad 15% EC @1000 ml/ha 2nd spray- Deltamethrin2.8% EC@ 400 ml / ha	10.93 (3.37)	8.17 (2.90)	9.55 (3.14)	14.21 (3.68)	8.98 (2.82)	11.60 (3.25)	12.57 (3.53)	8.58 (2.86)	10.58 (3.20)
T_5	1st spray- Spiromesifen 22.9% SC @ 500 ml/ha 2nd spray- Thiodicarb75%WP @1000 g / ha	9.97 (3.32)	6.56 (2.54)	8.27 (2.93)	15.19 (3.90)	7.82 (2.70)	11.51 (3.30)	12.58 (3.61)	7.19 (2.62)	9.89 (3.12)
T_6	1st spray- Azadirachtin5%@ 500 ml / ha 2nd spray- *Verticilliumlecani*@ $1x10^8$ spores/ g	11.49 (3.43)	8.01 (2.85)	9.75 (3.14)	14.19 (3.74)	8.72 (2.86)	11.46 (3.30)	12.84 (3.59)	8.37 (2.86)	10.61 (3.23)
T_7	1st spray- Untreated Check 2nd spray- Untreated Check	23.48 (4.93)	19.71 (4.54)	21.60 (4.74)	35.92 (6.46)	34.62 (6.04)	35.27 (6.25)	29.70 (5.70)	27.17 (5.29)	28.44 (5.50)
	S.Em.±	0.38	0.36	0.37	0.38	0.45	0.42	0.38	0.41	0.40
	CD (p=0.05)	1.16	1.11	1.14	1.17	1.39	1.28	1.17	1.25	1.21

Conclusion

From the present study, it can be concluded that the efficacy of some insecticide and biopesticide against aphids. The average data from both of the year 2016 and 2017 indicated that all the treatments were significantly superior over control. Treatment T3 (1st spray T3Thiomethaxon 25% WG and 2nd spray Thiodicarb 75% WP) was recorded minimum aphids population (9.78) and it was at par with all other treatment except untreated check.

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