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Efficacy of certain bio-pesticides against sucking pests of okra, *Abelmoschus esculentus* (L.) Moench

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ABSTRACT: A field experiment was carried out at the Assam Agricultural University, Jorhat, Assam, India during 2018-2019 to evaluate the efficacy of different biopesticides against sucking pests of okra. The treatments *viz.* neem oil @ 5%, karanj oil @ 5%, *Melia azedarach* leaf extract @ 5%, garlic extract @ 5%, chilli fruit extract @ 5%, *Beauveria bassiana* @ 5ml/l, *Verticillium lecanii* @ 5ml/l, deltamethrin @ 10 g *a.i.*/ha were applied at 15 days interval starting from seedling stage when leafhopper and aphid infestation started. Results revealed that the overall best performance of insecticides against leafhoppers recorded in deltamethrin treated plots with the lowest mean population of leafhoppers (2.07 leaf hoppers/3 leaves) followed by neem oil (2.54 leaf hoppers/3 leaves), karanj oil (3.20 leaf hoppers/3 leaves) while the order of efficacy against aphids was deltamethrin (3.25 aphids/3 leaves), neem oil (5.87 aphids/3 leaves), karanj oil (6.82 aphids/3 leaves). Results revealed that deltamethrin, neem oil and karanj oil were very effective treatments against leafhoppers and aphids.

Keywords: Okra, leafhopper, aphid, neem oil, *karanj* oil

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) or bhendi or lady's finger (Malvaceae) is an important vegetable crop grown in India and it is an important warm-season vegetable crop cultivated comprehensively in tropical and subtropical regions of the world. Okra is native to Ethiopia. It is a short duration crop grown around the year. It is cultivated in an area of 5.28 lakh hectares with a production of 61.4 lakh tons in India. Whereas in Assam it is cultivated on an area of 12,110 hectares with a production of 191.70 thousand tones (Anon., 2017). The major okra growing states includes Assam, Uttar Pradesh, Bihar, Orissa, West Bengal, Maharashtra, Andhra Pradesh and Karnataka (Anon., 2017). In India, okra crop is cultivated in a very large area but 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. The intensity of damage caused by pests also varied from one region to other. About 13 insect pests are known to cause damage to okra (Mandal *et al*., 2006). Among the major pests of this crop, the leafhopper *Amrasca biguttula biguttula* (Ishida) and shoot and fruit borer, *Earias* spp. have been reported to cause about 69% loss in okra (Rawat and Sahu, 1973). As high as 72 species of insects have been reported on the crop (Rao and Rajendran, 2003) among which, the sucking pest complex consisting of aphids (*Aphis gossypii* Gloner), leaf hopper (*Amrasca biguttula biguttula* Ishida), whitefly *(Bemisia tabacii* Green) are a major problem and cause 17.46% yield loss in okra (Sarkar *et al.,* 1996).

At present, schedule based application of various insecticides is recommended for the management of different insect pests. But, the injudicious use of synthetic chemicals to manage these pests has resulted in resistance, resurgence, secondary pest outbreak, phyto-toxicity, toxicity to beneficial organisms, residues in food beyond the tolerance limits posing unwarranted health hazards to the consumers (Mandal *et al.,* 2006). Botanicals, microbials like *Bacillus thuringiensis*, *Beauveria bassiana, Metarrhizium anisopliae* and *Verticillium lecanii* and biological control agents should be integrated for economic management of insect pests of okra (Arora *et al*., 1996; Abro *et al.,* 2004; Memon *et al*., 2004). Botanical and biological agents have a vital role to control pest damage. The management system needs to be solving the pest problem by application of bio-pesticides which would be the better option. Therefore, the present study was undertaken to evaluate the efficacy of different bio-pesticides for eco-friendly management of sucking pests of okra.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at Experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam. The experiment was conducted with okra cv. Arka Unnathi in Randomized Block Design (RBD), with three replications of nine treatments including a control (Table 1) . The net area for the experiment was 230sq.m. The net area was divided into three blocks and each block was further divided into

nine equal plots (2.7m x 2.1m) each, respectively. Interspacing between blocks was 0.60 m and plots was 0.45 m.

Extraction of botanicals

Preparation of *Melia azedarach* L. leaf extract

The fresh leaves of naturally grown mature plants were collected and washed thoroughly and then were dried under shade. After drying, the plant material was grounded to a fine powder and sieved separately through 80 mesh nylon cloth and then soaked in distilled water at room temperature between 24 and 48 hours. The ratio of plant material to water was 1:20 (w: v), which was necessary to make 5% solution. After soaking, the plant materials were squeezed manually. The solution then filtered through a fine-mesh nylon cloth to obtain an extract, free of plant residue and detritus.

Preparation of garlic extract

The outer layers of the matured garlic were peeled off after that grounded to paste. 50 gm of paste was mixed with 1000 ml of distilled water at room temperature for 24 to 48 hours to give 5% solution. The solution was filtered through a fine-mesh nylon cloth to obtain an extract free of any residue and detritus.

Preparation of chilli fruit extract

The chilli fruits were collected and dried under shade and grounded to a fine powder. 50 gm of chilli powder was mixed with 1000 ml of water to make a 5% concentration. After that soaked in distilled water at room temperature between 24 to 48 hours. After soaking the solution was filtered through a fine-mesh nylon cloth to obtain an extract, free of residue and detritus.

Preparation of fungal bio-formulations

The fungal bio-agents *viz*., *Beauveria bassiana* and *Verticillum lecanii* were collected from the Department of Plant Pathology, Assam Agricultural University. Fine millilitre of the fungal formulation was mixed with 1000 ml of water.

At the time of the appearance of the pest, the crop was sprayed with these treatments as mentioned above. The treatments were imposed by using a knapsack sprayer @ 400-500 litres of spray solution/ha depending on the stage of the crop. The crop received a total of 3 sprays. The spray application was given at the time of incidence noticed and second, spray was given at an interval of 15 days thereafter.

Recording observations

For recording the number of leafhoppers and aphids, five plants were selected randomly in each plot and were tagged. Observations were recorded on three leaves; each at the top, middle and bottom of five tagged plants in each plot. The first observation was recorded 1 day before treatment as a pretreatment count and post-treatment observations were recorded at the 3rd, 7th, and 10th day after each spraying. Data thus obtained were analyzed statistically and presented.

RESULTS AND DISCUSSION

Efficacy of treatments against leafhopper:

Results revealed that there was no significant difference of the leafhopper population among the treatments before spraying. During the first spray (Table 1), the lowest mean population of leafhopper was observed in the deltamethrin treated plot (0.98 leafhoppers/3 leaves) followed by neem oil (1.10 leafhoppers/3 leaves) and the next best treatment was pongamia oil (1.52 leafhoppers/3leaves). The other treatments recorded the pest count in the range of 1.79 to 3.12 leafhoppers/3 leaves. The data showed that the treatment of deltamethrin @ 10 gm *a.i.*/ha recorded the highest percent reduction (85.71%) of leafhopper population followed by neem oil @ 5% (84.03%), karanj oil @ 5% (77.75%) and *M. azedarach* leaf extract @ 5% (73.89%). After the second spray (Table 2), results revealed that the deltamethrin recorded the minimum population of 2.03 leafhoppers/3 leaves followed by neem oil @ 5% (2.70 leafhoppers/3 leaves), karanj oil @ 5% and *M. azedarach* leaf extract @ 5% with 3.35, 4.82 leafhoppers/3 leaves respectively. *B. bassiana* and *V. lecanii* were found to be less effective in reducing the leafhopper population but were superior over control. Similar trend was observed in percent reduction of the leafhopper population over control as in the first spray. After the final spray (Table 3), the lowest mean population of leafhopper was observed in deltamethrin treated plots with 3.21 leafhoppers/3 leaves followed by neem oil @ 5% was found best with 3.81 leafhoppers/3 leaves and karanj oil @ 5% with 4.72 leafhoppers/3 leaves. The data showed that treatment of deltamethrin 10 gm *a.i.* /ha recorded the highest percent reduction (77.72%) of leafhopper population followed by neem oil @ 5% (73.85%) and karanj oil @ 5% (66.79%).

The mean data of three sprays imposed in okra, targeting leafhoppers indicated that (Table 7), among biopesticides, neem oil (5%) recorded the least count of leafhopper (2.54 leafhoppers/3leaves). The next best treatments were karanj oil (5%) with 3.20 leafhoppers/3 leaves, *Verticillium lecanii* (5ml/l) with 4.31 leafhoppers/3 leaves. The reduction in leafhopper population in different treatments was in order of deltamethrin > neem oil > karanj oil > *Verticillium lecanii* > *Melia azedarach* leaf extract > *Beauveria bassiana* > Garlic extract > chilli fruit extract. The higher efficacy of neem oil against

Table 1. Efficacy of biopesticides against leafhopper, *Amrasca biguttula biguttula* population on okra during 1st spray

Treatment	Dose	Number of leafhoppers/3 leaves					Per cent reduction in population
		I spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	6.89	1.01	0.90	1.41	1.10	84.03
Karanj oil	5%	6.83	1.50	1.31	1.75	1.52	77.75
Melia azedarach leaf extract	5%	6.97	2.28	1.37	1.82	1.82	73.89
Garlic extract	5%	6.92	2.80	2.50	2.40	2.57	62.86
Chilli fruit extract	5%	6.85	3.82	2.52	3.02	3.12	54.45
Beauveria bassiana	5ml/l	6.76	2.72	2.52	2.31	2.52	62.72
Verticillium lecanii	5ml/l	6.77	2.01	1.46	1.90	1.79	73.56
Deltamethrin	10g *a.i*/ha	6.86	0.92	0.86	1.16	0.98	85.71
Control	-	6.87	5.85	5.58	6.02	5.82	15.28
S.Ed±	-	0.40	0.43	0.53	0.69	-	-
CD(P=0.05)	-	NS	0.91	1.13	1.47	-	-

NS=Non significant, DBS=Day before spray, DAS=Days after spray, *Data are mean of 3 replications

Table 2. Efficacy of biopesticides against leafhopper, *Amrasca biguttula biguttula* population on okra during 2nd spray

Treatment	Dose	Number of leafhoppers/3 leaves					Per cent reduction in population
		II spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	10.43	3.60	2.01	2.50	2.70	74.11
Karanj oil	5%	11.37	4.21	2.45	3.38	3.35	70.54
Melia azedarach leaf extract	5%	10.39	5.24	4.13	5.10	4.82	53.61
Garlic extract	5%	10.21	7.12	5.20	6.32	6.21	39.18
Chilli fruit extract	5%	10.36	8.12	6.17	5.30	6.53	36.97
Beauveria bassiana	5ml/l	11.43	5.75	5.32	6.40	5.82	49.08
Verticillium lecanii	5ml/l	10.40	4.12	3.62	7.28	5.01	51.83
Deltamethrin	10g *a.i*/ha	10.30	2.09	1.28	2.72	2.03	80.29
Control	-	10.75	11.16	10.01	11.01	10.73	0.19
S.Ed±	-	0.68	1.18	1.02	0.59	-	-
CD(P=0.05)	-	1.44	2.51	2.17	1.25	-	-

DBS=Day before spray, DAS=Days after spray, *Data are mean of 3 replications

leafhopper may be due to feeding deterrence in addition to mortality. As back as 1962, the antifeedant property of neem has been discovered by Pradhan *et al.* The neem seeds contain azadirachtin which possesses antifeedant, repellents as well as insecticidal property. The higher efficacy of neem oil followed by karanj oil, against the leafhopper population as revealed in the present studies is in line with Rosaiah (2001a) who reported the neem oil @ 2% found significantly superior by recording least the leafhopper population (36.55 leafhoppers/5 plants) followed by pongamia oil. Anita and Nandihalli (2008) reported neem oil to be effective against the leafhopper population. The efficacy of mycopathogens is in accordance with Girish Kumar (2000) who reported that the *V. lecanii* and *B. bassiana* fungi infection of leaf hopper and field collected live leaf hoppers carried infection by entomopathogens viz., *V. lecanii* and *B. bassiana*. During the present investigation garlic bulb was also found effective against leafhopper. Similar to the present finding Nayeb and Rokib (2013) also reported garlic bulb extract to be effective against leafhoppers.

Efficacy of treatments against aphid:

The pretreatment counts made a day before spraying indicated that there was a nonsignificant difference among the treatments. However, the aphid population ranged from 9.14 to 9.20/3 leaves. After the first spray (Table 4), deltamethrin recorded the lowest mean population of 1.15 aphids/3 leaves followed by neem oil @ 5% with 2.59 aphids/3 leaves. The mean range of aphid population in other treatments was between 3.13 to 4.62 aphids/3 leaves. The data showed that the treatment of deltamethrin 10 gm *a.i.* /ha recorded the highest percent reduction (87.50%) of aphid population followed by neem oil @ 5% (71.66%), karanj oil @ 5% (65.94%) and *V. lecanii* @ 5ml/l (63.39%). After the second spray (Table 5), results revealed that deltamethrin recorded a minimum population of aphid (3.30 aphids/3 leaves) followed by neem oil @ 5% (6.51 aphids/3 leaves), karanj oil @ 5% with 7.42 aphids/3 leaves. Other treatments recorded the pest count in the range of 8.62 to 11.21 aphids/3 leaves. The data showed that the treatment of deltamethrin 10 gm *a.i.*/ha recorded the highest percent reduction (78.30%) of aphid population followed by neem oil @ 5% (67.64%), karanj oil @ 5% (61.37%) and *B. bassiana* @ 5ml/l (51.69%). After the final spray (Table 6), the lowest mean population of aphids (5.30 aphids/3 leaves) was recorded in deltamethrin treated plots followed by neem oil @ 5% (8.51 aphids/3 leaves), karanj oil @ 5% with 9.92 aphids/3 leaves. Other treatments recorded the pest count in the range of 10.62 to 12.10 aphids/3 leaves. The data showed that the treatment of deltamethrin 10 gm *a.i.* /ha recorded the highest percent reduction (73.53%) of aphid population followed by neem oil @ 5% (60.53%), karanj oil @ 5% (55.39%) and *V. lecanii* @ 5ml/l (52.97%).

Table 3. Efficacy of biopesticides against leafhopper, *Amrasca biguttula biguttula* population on okra during 3rd spray

Treatment	Dose	Number of leafhoppers/3 leaves					Percent reduction in population
		III spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	14.57	4.23	3.22	3.98	3.81	73.85
Karanj oil	5%	14.21	4.99	3.97	5.21	4.72	66.79
Melia azedarach leaf extract	5%	13.28	7.86	6.12	6.45	6.81	48.72
Garlic extract	5%	15.12	7.54	7.11	9.72	8.12	46.30
Chilli fruit extract	5%	13.07	8.14	7.26	8.15	7.85	39.94
Beauveria bassiana	5ml/l	14.32	7.99	6.58	7.09	7.22	49.58
Verticillium lecanii	5ml/l	13.80	6.24	5.96	6.15	6.12	55.65
Deltamethrin	10g *a.i*/ha	14.41	3.26	2.76	3.61	3.21	77.72
Control	-	13.23	12.14	11.13	12.27	11.85	10.43
S.Ed±	-	0.89	0.74	0.37	0.47	-	-
CD(P=0.05)	-	1.88	1.57	0.79	1.00	-	-

DBS=Day before spray, DAS=Days after spray, *Data are mean of 3 replications

Table 4. Efficacy of biopesticides against Aphid, *Aphis gossypii* population on okra during 1st spray

Treatment	Dose	Number of Aphids/3 leaves					Per cent reduction in population
		I spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	9.14	2.46	2.21	3.10	2.59	71.66
Karanj oil	5%	9.19	3.31	2.52	3.56	3.13	65.94
Melia azedarach leaf extract	5%	9.50	3.85	3.19	4.42	3.82	59.79
Garlic extract	5%	9.14	4.18	3.65	4.52	4.12	54.92
Chilli fruit extract	5%	9.26	4.97	3.85	5.03	4.62	50.11
Beauveria bassiana	5ml/l	9.20	3.65	2.86	4.19	3.57	61.20
Verticillium lecanii	5ml/l	9.15	3.42	2.78	3.85	3.35	63.39
Deltamethrin	10g *a.i*/ha	9.20	1.23	0.56	1.67	1.15	87.50
Control	-	9.15	7.76	8.34	7.11	7.74	15.41
S.Ed±	-	0.58	0.58	0.44	0.75	-	-
CD(P=0.05)	-	NS	1.24	0.93	1.59	-	-

NS=Non significant, DBS=Day before spray, DAS=Days after spray, *Data are mean of 3 replications

Table 5. Efficacy of biopesticides against Aphid, *Aphis gossypii* population on okra during 2nd spray

Treatment	Dose	Number of Aphids/3 leaves					Per cent reduction in population
		II spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	20.12	6.81	5.71	7.01	6.51	67.64
Karanj oil	5%	19.21	7.45	6.43	8.37	7.42	61.37
Melia azedarach leaf extract	5%	20.12	10.23	8.96	10.87	10.02	50.20
Garlic extract	5%	19.57	11.26	10.65	11.72	11.21	42.72
Chilli fruit extract	5%	20.42	11.24	10.74	11.05	11.01	46.08
Beauveria bassiana	5ml/l	20.12	9.91	8.92	10.34	9.72	51.69
Verticillium lecanii	5ml/l	17.21	8.56	8.29	9.01	8.62	49.91
Deltamethrin	10g *a.i*/ha	15.21	3.45	3.21	3.25	3.30	78.30
Control	-	20.12	16.95	16.28	17.01	16.75	16.75
S.Ed±	-	0.96	1.05	0.78	1.07	-	-
CD(P=0.05)	-	2.03	2.22	1.66	2.27	-	-

DBS=Day before spray, DAS=Days after spray, *Data are mean of 3 replications

Table 6. Efficacy of biopesticides against Aphid, *Aphis gossypii* population on okra during 3rd spray

Treatment	Dose	Number of Aphids/3 leaves					Perc ent reduction (-)/increase (+) in population (%)
		III spray					
		1 DBS	3 DAS	7 DAS	10 DAS	Mean	
Neem oil	5%	21.56	8.65	7.98	8.89	8.51	60.53
Karanj oil	5%	22.24	10.01	9.43	10.31	9.92	55.39
Melia azedarach leaf extract	5%	22.76	11.90	10.98	11.98	11.62	48.95
Garlic extract	5%	22.98	12.25	11.79	12.02	12.02	47.69
Chilli fruit extract	5%	24.36	12.35	11.46	12.48	12.10	48.57
Beauveria bassiana	5ml/l	23.18	11.35	10.95	11.32	11.21	51.64
Verticillium lecanii	5ml/l	22.58	10.13	10.11	11.62	10.62	52.97
Deltamethrin	10g *a.i*/ha	20.02	5.42	4.98	5.50	5.30	73.53
Control	-	23.51	22.92	20.95	21.86	21.91	6.81
S.Ed±	-	0.97	0.61	0.44	0.84	-	-
CD(P=0.05)	-	2.06	1.29	0.94	1.79	-	-

DBS=Day before spray, DAS=Days after spray, *Data are mean of 3 replications

Table 7. Overall performance of biopesticides against leafhopper and aphid (pooled of three sprays)

Treatment	Dose	Mean number of insects/3 leaves at days interval		reduction over control (%)		Yield (q/ha)	% increase yield over control
		Leaf hopper	Aphid	Leaf hopper	Aphid		
Neem oil	5%	2.54	5.87	73.18	62.05	41.21	86.89
Karanj oil	5%	3.20	6.82	66.21	55.91	40.10	81.86
Melia azedarach leaf extract	5%	4.48	8.49	52.69	45.12	39.25	78.00
Garlic extract	5%	5.63	9.12	40.55	41.05	32.15	45.80
Chilli fruit extract	5%	5.83	9.24	38.44	40.27	31.10	41.04
Beauveria bassiana	5ml/l	5.19	8.17	45.20	47.19	35.56	61.27
Verticillium lecanii	5ml/l	4.31	7.53	54.49	51.32	36.25	64.40
Deltamethrin	10g *a.i*/ha	2.07	3.25	78.14	78.99	43.55	97.51
Control	-	9.47	15.47	-	-	22.05	-
S.Ed±	-	0.25	1.01	-	-	-	-
CD(P=0.05)	-	0.53	2.15	-	-	-	-

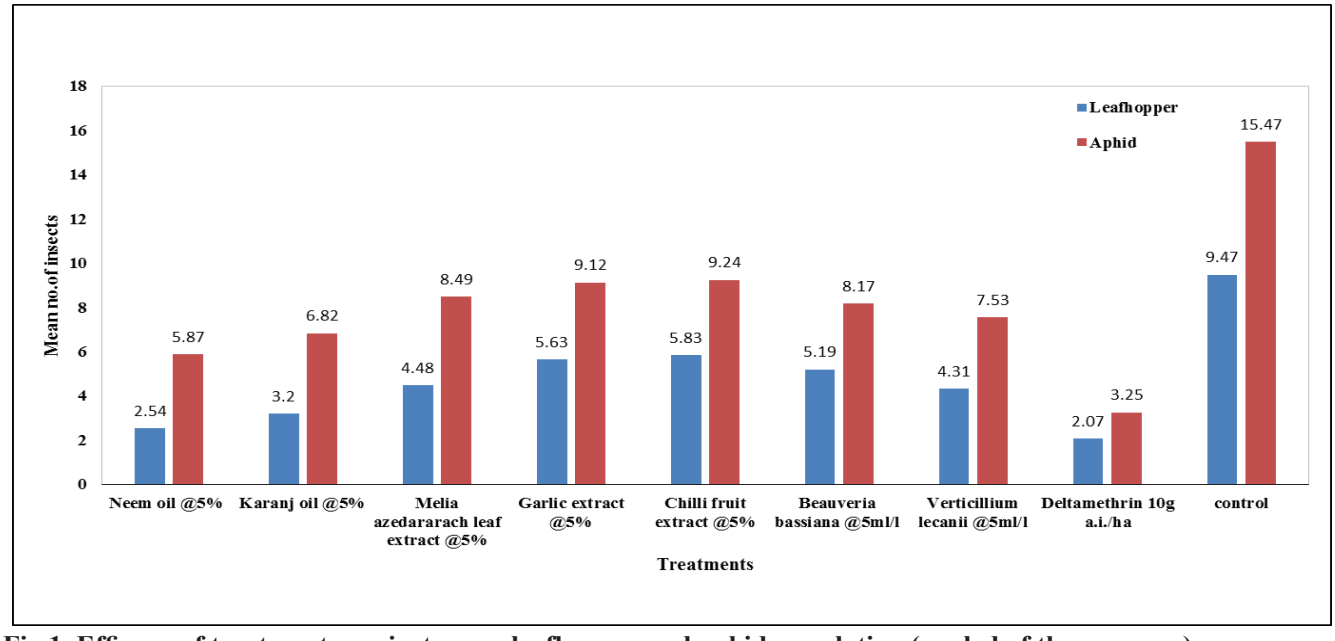

Fig 1. Efficacy of treatments against mean leafhopper and aphid population (pooled of three sprays)

Pooled data of three consecutive sprays revealed that (Table 7), deltamethrin (10 gm *a.i*. /ha) recorded the least aphid count (3.25 aphids/3 leaves). Among biopesticides, neem oil @ 5% was the most effective treatment (5.87 aphids/3 leaves). The next best treatments were karanj oil @ 5% (6.82 aphids/3 leaves), *Verticillium lecanii* @ 5ml/l (7.53 aphids/3 leaves), *Beauveria bassiana* @ 5ml/l (8.17 aphids/3 leaves), *Melia azedarach* leaf extract @ 5% (8.49 aphids/3 leaves). Among biopesticides, neem oil was effective against aphid. Similar to the present finding, Rao *et al*., (1991) also reported neem oil @ 1% showed 63 percent reduction in aphid population over untreated control and Pinto *et al*., (2013) and Dhaked *et al.,* (2016) also observed that neem oil @ 1% caused mortality of *Lipaphis erysimi* up to 68.01%. The effectiveness of karanj oil in controlling aphid was showed by Kulat *et al*., (1997) according to them, pongam leaf extract highly toxic to aphid, *A. gossypii*. The present findings are in agreement with those of Anita (2007) who reported the neem oil and *V. lecanii* recorded least number of aphids. Efficacy of mycopathogens against aphids is in accordance with Nirmala *et al*., (2006), who reported that *V. lecanii* recorded maximum mortality of *A. craccivora* and *A. gossypii* and Safavi *et al.,* (2002) showed that *V. lecanii* significantly increased aphid mortality due to mycosis.

Yield: The yield of okra were significantly different among treatments. The highest fruit yield of okra was recorded in deltamethrin treated plots followed by neem oil, karanj oil whereas, the yield obtained from untreated control plots was 22.05q/ha.

The present study on evaluation of different biopesticides for eco-friendly management of sucking pests of okra revealed that among the biopesticides used neem oil and karanj oil were found very effective against the target pests. Therefore, neem oil and karanj oil can be an alternative eco-friendly management option for the sucking pests of okra.

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