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AR Andhale
Post Graduate Scholar, Department of Entomology, PGI, MPKV, Rahuri, Ahmednagar, Maharashtra, India

BY Pawar
Assistant Professor, Department of Entomology, AICRP on MAP & Betelvine, Department of Plant Pathology and Agril. Microbiology, MPKV, Rahuri, Ahmednagar, Maharashtra, India

SA Pawar
Junior Entomologist, AICRP on Vegetable Crops, Department of Horticulture, MPKV, Rahuri, Ahmednagar, Maharashtra, India

SA Landge
Scientist- I, Department of Entomology, AICRP on Forage crops, Department of Agril. Botany, MPKV, Rahuri, Ahmednagar, Maharashtra, India

RT Gaikwad
Associate Professor, Post Graduate Institute, Department of Plant Pathology and Agril. Microbiology, MPKV, Rahuri, Ahmednagar, Maharashtra, India

Corresponding Author:
AR Andhale
Post Graduate Scholar, Department of Entomology, PGI, MPKV, Rahuri, Ahmednagar, Maharashtra, India

Seasonal incidence, and eco-friendly management of aphids (*Aphis nerii* Boyer de Fonscolombe) on Bedki (*Gymnema sylvestre* R. Br)

AR Andhale, BY Pawar, SA Pawar, SA Landge and RT Gaikwad

Abstract
An experiment entitled "seasonal incidence and eco-friendly management of aphids" was conducted at the All India Co-ordinated Research Project on MAP and Betelvine, M.P.K.V, Rahuri, Dist. Ahmednagar (Maharashtra) during 2022-23. During the course of study, incidence of aphids (*A. nerii*) was initiated from 4th week of October, 2022 (43th SMW) and recorded up to 4th week of January, 2023 (4th SMW). The data revealed that average no of aphids per 10 cm twig ranged from 12.4 to 198.8 aphids per 10 cm twig during entire period. The incidence of aphids started in the month of October, 2022. The incidence increased up to the fourth week of November and reached its peak 198.8 aphids per 10 cm twig. Thereafter population declined gradually from 3rd November (48th SMW) and observed up to 20.5 aphids per 10 cm twig at 4th week of January, 2023 (4th SMW). As regard the eco-friendly management of aphids, among all treatment evaluated, treatment *Lecanicillium lecanii* @ 5 g/L showed to be the significantly superior treatment, which recorded 19.20 aphids per 10 cm twig found at par with Azadirachtin 10000 ppm @ 1 ml/L which recorded 33.27 aphid population per 10 cm.

Keywords: Bedki, aphid, twig

Introduction
Ayurveda is a major medicine system with historical background in the Indian subcontinent. *Ayurveda* is heavily practiced in India from ancient period and also at modern era with their harmless and eco-friendly medicines. Plants synthesize hundreds of chemical compounds for various functions, including defensive and protective against insects, fungi, diseases and other damaging agent. Bedki '*Gymnema sylvestre* R. Br*'* is one of the medicinal plant. *Gymnema sylvestre* R. Br. is a valuable herb belonging to the family Asclepiadaceae/ Apocynaceae, and widely distributed in India, Malaysia, Srilanka, Australia, Indonesia, Japan, Vietnam, Tropical Africa and the south western region of the People's Republic of China (Gupta *et al*. 2012) [1].
Bedki (*Gymnema sylvestre*) is slow growing, perennial woody climber found in central and southern India and Tropical Africa, in the ayurvedic system, it referred to as "*Meshshringa* or *Gurmar*" and has indicator for use in glucose balance. It is a very useful herb for patients who are facing Diabetes. The Latin name of this herb is '*Gymnema sylvestre'*. *Gymnema* has effective on blood sugar, to cure diabetic patients. Within the past two decades' researchers have determined that *Gymnema* extract also play a role in the treatment of Type 1 diabetics, which needs daily injections of insulin to control the disease. *Gymnema* taken orally minimize blood glucose levels and maintain blood fat and cholesterol profiles. Foliage of this plant have also been used to treat the patients suffering from the honey urine disorder, treatment of bronchial asthma, cough, leprosy, skin diseases, wounds *etc*. in the Indian Systems of Medicine (Thakur *et al.* 2012) [2].
Oleander aphid (*Aphis nerii* Boyer de Fonscolombe) has a wide range of hosts, but mostly feeds on plants belongs to, family Asclepiadaceae, mainly including milkweeds, oleander and periwinkle medicinal and ornamental plants. It is occasionally recorded feeding on plants in the spurge family, bindweed family, and daisy family also rarely being recorded on citrus. Its common names also included oleander aphid, nerium aphid, sweet pepper aphid and milkweed aphid. The oleander aphid is widespread in regions with tropical as well as mediterranean climate. Small populations of oleander aphid are present in gardens, ornamental and medicinal plants. The oleander aphid is an obligate parthenogenetic aphid the adult aphids are all female and males do not occur in the wild. Adult females may be winged or wingless. The oleander aphid, *A. nerii* Boyer de Fonscolombe (Hemiptera) is an important sucking pest of various

ornamental and also medicinal plants belonging to the family Asclepiadaceae. In addition to causing direct damage, the Aphids producing honeydew secretions, which producing the growth of black sooty mould on various plant parts like foliage, stem and fruits also indirectly affecting the plant photosynthetic activities (Shivakumara *et al*, 2022) [3]. They prefer mostly fresh parts, which leads to the weakening of the host and leaf curling. The amount of damage mostly depends on the number of aphids on the plant, where aphids suck, when they present in large numbers, it may lead to the death of whole vine (Rabeea, 2021) [4] also affecting the quality and quantity of the economical parts like foliage and fruits which leads to heavy economical loss.

Among the different insect pests infesting on Bedki, *Gymnema sylvestre* R. Br the aphids *Aphis nerii* is the major pest of Bedki, *Gymnema sylvestre*, which appears in winter season on the crop and cause heavy losses to the crop of Bedki vines, by accepting many control measure practices, we can reduce the yield loss caused by the aphids. Though the best option to control aphid is using chemical pesticides but Bedki, *Gymnema sylvestre* is medicinal plant and use as a raw product like foliage and powder, which is directly consumed so the another best option to control the pest is to use of biopesticides and plant products which are eco-friendly management practices and cheaper and effective to control aphids the application of biopesticides for control of pests on medicinal and aromatic plant are increasing day by day to a greater extent because of greater environmental awareness and food safety concerns.

Materials and Methods

Studies on seasonal incidence and eco-friendly management of aphids conducted at AICRP on MAP & Betelvine MPKV, Rahuri Dist- Ahmednagar (MH) during 2022-2023.

Seasonal incidence of aphids, *Aphis nerii* Boyer de Fonscolombe with weather parameter

The seasonal incidence of aphid was studied in relation to weather parameters. The observations of aphid, *A. nerii* was recorded at weekly intervals on randomly selected plants from 4 m x 2 m plot size. Aphid count was taken by observing 10 cm of randomly selected 5 twigs on randomly selected plot and tagged plant from experimental plot. The weekly aphid population data recorded and correlated with weather parameters. The whole plot was kept free from insecticidal application (unprotected). The data on weather parameters *viz*., maximum temperature, minimum temperature, morning and evening relative humidity, rainfall, were obtained from Department of Agronomy, MPKV, Rahuri Ahmednagar, (M.S.)

Management of aphids *Aphis nerii* Boyer de Fonscolombe infesting Bedki, *Gymnema sylvestre* R.Br.

The experiment was conducted on the farm of AICRP on MAP and Betel vine, MPKV Rahuri, Dist-Ahmednagar (M.S.) for eco-friendly management of aphids infesting Bedki bio-efficacy of biopesticide and plant products (spray formulations) experiment was laid out in Randomized Block Design (RBD) with 7 treatments replicated three times. The five twigs were randomly selected and tagged from each plot. The spray application was executed in the evening using a knapsack sprayer. All the plots within each replication were treated simultaneously to prevent spray fluid drift onto adjacent plots. Prior to the application of other biopesticides, meticulous care was taken to thoroughly clean the spray pump with water. The data on marketable yield of fresh and dry foliage yield expressed in kg/ plot form which the yield in q/ ha was calculated.

The data of surviving aphids (*A. nerii*) population recorded from 5 randomly selected twigs of vines per plot was transferred into square root transformation values and then data were subjected to statistical analysis as suggested by Panse and Sukhatme (1985) [5]. The standard error (S.E.) and critical difference (C.D.) at 5% level of probability were calculated to know the effective biopesticide and botanical treatment.

Observations on average number of aphids were recorded during 4th week of October 2022 to last week of January 2023 is given in Table.1.

Table 1: Seasonal incidence of aphids (*Aphis nerii*, Boyer de Fonscolombe) recorded during Oct 2022- Jan 2023 on Bedaki (*Gymnema Sylvestre* R. Br)

Std Met Week	Date of observation	Average population of aphids/10 cm twig.	Temperature (℃)		Humidity (%)		Rainfall (mm)
			Max	Min	Morn	Eve	
43	23.10.22	12.4	28.2	18.7	85	43	3.6
44	30.10.22	40.8	29.6	17.3	83	36	0
45	O6.11.22	57.4	31	17.2	77	27	0
46	13.11.22	151.6	30.1	15.6	85	34	0
47	20.11.22	188.3	28	14.7	78	32	0
48	27.11.22	198.8	30.5	16.2	81	36	0
49	04.12.22	197.2	30.1	16.3	88	39	0
50	11.12.22	193.2	28.9	17.3	87	47	0
51	18.12.22	191.8	30.3	16.2	83	34	0
52	24.12.22	179.6	31.7	16	81	31	0
1	02.01.23	141.8	28.1	15.1	83	48	0
2	09.01.23	108.2	28.6	11.6	86	25	0
3	16.01.23	76.2	30.1	13.5	83	30	0
4	23.01.23	20.5	29.3	15.3	78	40	0

Results and Discussion

The infestation of aphids (no per 10 cm twig) was noticed from of 4th week of October (43 SMW) to 4th week of January (4th SMW). The aphid population found in the range of 12.4 to 198.8 aphids per 10 cm twig. The first appearance of aphid was noticed on 4th week of October, 2022 (43th SMW) i.e 12.4 aphids per 10 cm of twig, during this period average maximum and minimum temperature, morning and evening

relative humidity and rainfall recorded were 28.2 ℃, 18.7 ℃, 85 per cent, 43 per cent, 3.6 mm. The aphid population were increasing upto 4th week of November, 2022 (48th SMW). The maximum population noticed on 4th week of November, 2022 (48th SMW) 198.8 aphids per 10 cm twig during this period average maximum and minimum temperature, morning and evening relative humidity and rainfall recorded were 30.5 ℃, 16.2 ℃, 81 per cent, 36 per cent, 3.6 mm respectively. There after gradual decrease of aphid population were observed from 4th week of November to 3rd week of December (48th to 51st SMW) i.e 198.8 to 191.8 aphids per 10 cm twig respectively. After that the population started to rapid decline and recorded minimum 20.5 aphids per 10 cm twig on 4th week of January, 2023 (4th SMW) With average maximum and minimum temperature, morning and evening relative humidity and rainfall recorded 29.3 ℃, 15.3 ℃ ,78 per cent, 40 per cent, 00 mm. Thereafter aphid population was not noticed upto the end of observation.

The present findings on seasonal incidence were coincide with the results of Bade and kadam (2001) [6] reported that aphid infestation observed during December and January under safflower field condition continue until January. Landge *et al*, (2021) [7] reported that seasonal incidence of aphids was observed from 4th week of November upto 1st week of February on potato crop are in support with above observations recorded

Fig 1: Aphid (*Aphis nerii)* infestation on twigs of Bedki (*Gymnema sylvestre* R. Br

Management of aphids *Aphis nerii* Boyer de Fonscolombe infesting Bedki, *Gymnema sylvestre* R. Br.

The results in respect to management of different biopesticides against aphids (*Aphis nerii* Boyer de Fonscolombe) at 3, 7, 14, days after spraying (DAS) on Bedki (*Gymnema Sylvestre* R. Br) in two sprays with 15 days interval between them are presented in Tables 2, 3, 4.

First spray

The pre count of average number of aphids/ 10 cm twig found statistically non- significant, while all the biopesticides and plant products were found superior over untreated control at 3, 7, 14, days after spraying for management of aphids (*A. nerii* Boyer de Fonscolombe) on Bedki vines (*G. sylvestre* R. Br). Untreated control treatment showed 157.40 survival aphids population/ 10 cm twig before treatment. Observation of first spray are presented in Table. 2

3 days after spraying

The observations recorded on three days after spraying showed that Azadirachtin 10000 ppm @ 1ml/L spay recorded minimum number of the survival aphid population recorded 94.66 aphids per 10 cm twig followed by the treatments Azadirachtin 3000 ppm @ 2 ml/L (112.76 aphids per 10 cm twig) which is at par with NSE 5% (124.86 aphids per 10 cm twig). However, all the biopesticides treatments did not show any remarkable effect on aphid population at 3 days after spraying. The maximum population was found under untreated control (161.19 aphids/ 10 cm twig).

7 days after spraying

The observations recorded on seven days after spraying showed that Azadirachtin 10000 ppm @ 1ml/L spay recorded the minimum number of the survival aphid population 46.38 aphids per 10 cm twig which was significantly superior over remaining treatment followed by Azadirachtin 3000 ppm @ 2 ml/L (61.68 aphids/ 10 cm twig) followed by NSE 5% (109.68 aphids/ 10 cm twig) was at par with Lecanicillium *lecanii* @ 5 g/L, (118.81 aphids/ 10 cm twig) and *Metarhizium anisopliae* @ 5g/L (119.63 aphids/ 10 cm twig) followed by *Beauveria bassiana* @ 5 g/L (126.38 aphids/ 10 cm twig). Whereas in untreated control recorded maximum 165.79 aphids per 10 cm twig.

14 days after spraying

The results in respect survival of aphids at 14 days after spraying revealed that the treatment *Lecanicillium lecanii* @ 5 g/L recorded the minimum number of survival aphids (45.44 aphids/ 10 cm twig), which proved to be significantly superior over other treatments tested. However, it was at par with Azadirachtin 10000 ppm @ 1 ml/L which recorded 50.38 aphid population per 10 cm twig. The next best treatment on their merit was *Metarhizium anisopliae* @ 5 g/L (64.59 aphids/ 10 cm twig) which was at par with *Beauveria bassiana* @ 5 g/L (70.88 aphids/ 10 cm twig) and Azadirachtin 3000 ppm @ 2 ml/L (71.88 aphids/ 10 cm twig) respectively followed by NSE 5% (118.48 aphids/ 10 cm twig). The maximum aphid population was observed in untreated control was 165.83 aphids per 10 cm twig.

The highest per cent reduction in aphid population was observed in the treatment of *Lecanicillium lecanii* @ 5 g/L recorded 69.98 per cent followed by Azadirachtin 10000 ppm @ 1 ml/L, Metarhizium *anisopliae* @ 5g/L, *Beauveria bassiana* @ 5 g/L, and Azadirachtin 3000 ppm, with 67.70, 57.99, 54.79, and 54.01 per cent respectively. The minimum reduction in aphid population was observed in the treatment of NSE 5% with 23.11 per cent. The aphid population was found increase in untreated control plot.

Table 2: Management of aphids (*A. nerii* Boyer de Fonscolombe) after first spray on Bedaki (*Gymnema sylvestre* R. Br.)

Sr. No	Treatments	Pre Treatment Count	Avg. No. surviving aphid population / 10 cm twig			Percent reduction in aphid population.
			3 DAS	7 DAS	14 DAS	
1.	*Lecanicillium lecani* @ 5g/L	151.48 (12.33)	144.04 (12.02)	118.81 (10.91)	45.44 (6.78)	69.98
2.	*Beauveria bassiana* @ 5 g/L	156.80 (12.54)	148.92 (12.22)	126.38 (11.26)	70.88 (8.45)	54.79
3.	*Metarhizium anisopliae* @ 5 g/L.	153.77 (12.42)	147.82 (12.18)	119.63 (10.93)	64.59 (8.07)	57.99
4.	NSE 5%	154.10 (12.43)	124.86 (11.19)	109.68 (10.50)	118.48 (10.91)	23.11
5.	Azadirachtin 3000 ppm @ 2 ml/L	156.30 (12.52)	112.76 (10.62)	61.68 (7.88)	71.88 (8.50	54.01
6.	Azadirachtin 10000 ppm @ 1ml/L	152.68 (12.38)	94.66 (9.75)	46.38 (6.85)	50.38 (7.10)	67.70
7	Untreated control	157.40 (12.56)	161.19 (12.71)	163.72 (12.81)	163.83 (12.81)	-
	S.E±	0.08	0.19	0.20	0.17	-
	C.D. @ 5%	N.S	0.58	0.62	0.54	-

DAS: Days after spraying.

Figures in the parentheses are transformed values of $\sqrt{x+0.5}$ where x is original value

Second spray

The second spay for control of aphid population was taken, on the pretreatment count of average number of the aphids per 10 cm twig was recorded statistically non-significant, while all other treatment were significantly superior over untreated control at 3, 7, 14, days after spraying, respectively. Observations of second spray are given in Table.3

3 days after spraying

The observations recorded three days after second spray showed that Azadirachtin 10000 ppm @ 1 ml/L recorded minimum number of survival aphid population (30.22 aphids per 10 cm twig) than other treatments tested. The next best treatment on their merit basis were *Lecanicillium lecanii*@ 5 g/L (43.17 aphids/ 10 cm twig) which was at par with Azadirachtin 3000 ppm @ 2 ml/L (51.39 aphids per 10 cm twig) followed by *Metarhizium anisopliae* @ 5 g/L (61.37 aphids/ 10 cm twig) was at par with *Beauveria bassiana* @ 5 g/L (67.34 aphids/ 10 cm twig) followed by NSE 5% (94.83 aphids/ 10 cm twig). The maximum aphid population was observed under untreated control with 167.02 aphids per 10 cm twig.

7 days after spraying

Observations recorded after seven days of second spraying showed that Azadirachtin 10000 ppm @ 1 ml/L spay recorded minimum number of the survival aphid population (13.66 aphids per 10 cm twig) significantly superior over treatment tested. The next performing treatment on their merit were Azadirachtin 3000 ppm @ 2 ml/L (27.12 aphids/ 10 cm twig) followed by *Lecanicillium lecanii* @ 5 g/L (36.36 aphids per 10 cm twig) followed by *Metarhizium anisopliae* @ 5 g/L (50.26 aphids/ 10 cm twig) was at par with *Beauveria bassiana* @ 5 g/L (56.83 aphids/ 10 cm twig) followed by NSE 5% (82.88 aphids/ 10 cm twig). The maximum aphid population was observed in untreated control with 167.87 aphids per 10 cm twig.

14 days after spraying

The result in respect of survival of aphids at 14 days after second spraying revealed that the treatment *Lecanicillium lecanii* @ 5 g/L recorded the minimum number of survival aphids (12.96 aphids per 10 cm twig), which proved to be significantly superior over treatment tested. However, it was at par with Azadirachtin 10000 ppm @ 1 ml/L which recorded 16.16 aphid population per10 cm twig. The next best treatment on their merit were *Metarhizium anisopliae* @ 5 g/L (25.85 aphids per 10 cm twig) which was at par with *Beauveria bassiana* @ 5 g/L (30.48 aphids per 10 cm twig) and *Azadirachtin* 3000 ppm @ 2 ml/L (31.66 aphids/ 10 cm twig) respectively also followed by NSE 5% (87.13 aphids/ 10 cm twig). The maximum aphid population was observed in untreated control with 167.90 aphids per 10 cm twig.

The highest per cent reduction in aphid population was observed in the treatment of *Lecanicillium lecanii* @ 5 g/L recorded 71.98 per cent followed by Azadirachtin 10000 ppm @ 1 ml/L, *Metarhizium anisopliae* @ 5 g/L, *Beauveria bassiana* @ 5 g/L, and Azadirachtin 3000 ppm, with 67.92, 59.97, 56.99, and 55.95 per cent respectively. The minimum percent reduction in aphid population were observed in the treatment of NSE 5% 26.46 per cent

Table 3: Management of aphids (*A. nerii* Boyer de Fonscolombe) after second spray on Bedaki, (*Gymnema sylvestre* R. Br.)

Sr. No	Treatments	Avg. no. surviving aphid population / 10 cm twig			Per cent reduction in aphid population.
		3 DAS	7 DAS	14 DAS	
1.	*Lecanicillium lecanii* @ 5 g/L.	43.17 (6.58)	36.36 (6.07)	12.96 (3.63)	71.98
2.	*Beauveria bassiana* @ 5 g/L	67.34 (8.24)	56.83 (7.55)	30.48 (5.55)	56.99
3.	*Metarhizium anisopliae* @ 5 g/L	61.37 (7.82)	50.26 (7.11)	25.85 (5.10)	59.97
4.	NSE 5 per cent	94.83 (9.76)	82.88 (9.13)	87.13 (9.36)	26.46
5.	Azadirachtin 3000 ppm @ 2 ml/L	51.39 (7.17)	27.12 (5.25)	31.66 (5.65)	55.95
6.	Azadirachtin 10000 ppm @ 1ml/L	30.22 (5.54)	13.66 (3.75)	16.16 (4.07)	67.92
7	Untreated control	167.02 (12.94)	167.87 (12.97)	167.90 (12.98)	
	S.E±	0.22	0.16	0.16	-
	C.D. @ 5%	0.67	0.49	0.50	-

DAS: Days after spraying.

Figures in the parentheses are transformed values of $\sqrt{x+0.5}$ where x is original value

Cumulative effect of two spray

The cumulative results of effect of above two sprays on aphids showed in Table. 4

3 days after spraying

The observations of cumulative effect of two sprays recorded at 3 day after spraying Azadirachtin 10000 ppm @ 1 ml/L recorded minimum number of surviving aphid population (62.44 aphids/ 10 cm twig) than other treatments and significantly superior to remaining all other treatment. The next best treatment on their merit basis was Azadirachtin 3000 ppm @ 2 ml/L (82.07 aphids/ 10 cm twig) with was at par with *Lecanicillium lecanii* @ 5 g /L (93.60 aphids/ 10 cm twig) followed by *Metarhizium anisopliae* @ 5 g/L (104.59 aphids/ 10 cm twig) was at par with *Beauveria bassiana* @ 5 g/L (108.13 aphids per 10 cm twig) and NSE 5% (109.84 aphids/ 10 cm twig). The maximum aphid population was observed in untreated control 164.10 aphids per 10 cm twig.

At 7 days after spraying

Observations recorded seven days after showed that Azadirachtin 10000 ppm @ 1ml/L recorded minimum number of the surviving aphid population 30.02 aphids per 10 cm twig significantly superior over treatment tested. The next performing treatments on their merit were Azadirachtin 3000 ppm @ 2 ml/L (44. 40 aphids/ 10 cm twig) followed by *Lecanicillium lecanii* @ 5 g/L (77.58 aphids/ 10 cm twig) was at par with *Metarhizium anisopliae* @ 5 g/L (84.94 aphids/ 10 cm twig) followed by *Beauveria bassiana* @ 5 g/L (91.60 aphids per 10 cm twig) at par with NSE 5% (96.37 aphids/ 10 cm twig). The maximum aphid population were observed in untreated control 165.79 aphids per 10 cm twig.

14 days after spraying

The result in respect of survival of aphid population at 14 days after second spraying revealed that the treatment *Lecanicillium lecanii* @ 5 g/L recorded the lower number of survival aphids 19.20 aphids per 10 cm twig, which proved to be significantly superior over treatment evaluated. However, it was at par with Azadirachtin 10000 ppm @ 1 ml/L which recorded 33.27 aphid population per 10 cm twig). The next best treatment on their merit was *Metarhizium anisopliae* @ 5 g/L (45.22 aphids/ 10 cm twig) which was at par with *Beauveria bassiana* @ 5 g/L (50.68 aphids/ 10 cm twig) and Azadirachtin 3000 ppm @ 2 ml/L (51.77 aphids/ 10 cm twig) respectively also followed by NSE 5 per cent (102.80 aphids/ 10 cm twig). The maximum aphid population were observed in untreated control 165.86 aphids per 10 cm twig.

The maximum per cent reduction in aphid population were observed in the treatment of *Lecanicillium lecanii* @ 5 g/L recorded 70.98 per cent followed by Azadirachtin 10000 ppm @ 1 ml/L, *Metarhizium anisopliae* @ 5 g/L, *Beauveria bassiana* @ 5 g/L, and Azadirachtin 3000 ppm, with 67.81, 58.98, 55.89, and 54.98 per cent, respectively. The minimum percent reduction in aphid population were observed in the treatment of NSE 5% (24.78 per cent).

Table 4: Cumulative effect of different treatments against aphids (*A. nerii* Boyer de Fonscolombe) on Bedaki (*Gymnema sylvestre* R. Br).

Sr. No	Treatments	Avg. No. surviving aphid population/10 cm twig			Per cent reduction in aphid population
		3 DAS	7 DAS	14 DAS	
1.	*Lecanicillium lecanii* @ 5 g/L.	93.60 (9.70)	77.58 (8.84)	29.20 (5.45)	70.98
2.	*Beauveria bassiana* @ 5 g/L	108.13 (10.42)	91.60 (9.60)	50.68 (7.15)	55.89
3.	*Metarhizium anisopliae* @ 5 g/L.	104.59 (10.25)	84.94 (9.24)	45.22 (6.76)	58.98
4.	NSE 5%	109.84 (10.50)	96.37 (9.84)	102.80 (10.16)	24.78
5.	Azadirachtin 3000 ppm @ 2 ml/L	82.07 (9.09)	44.40 (6.70)	51.77 (7.23)	54.98
6.	Azadirachtin 10000 ppm @ 1 ml/L	62.44 (7.93)	30.02 (5.52)	33.27 (5.81)	67.81
7	Untreated control	164.10 (12.83)	165.79 (12.90)	165.86 (12.90)	-
	S.E±	0.19	0.20	0.17	-
	C.D. @ 5%	0.58	0.62	0.54	-

DAS: Days after spraying.

Figures in the parentheses are transformed values of $\sqrt{x + 0.5}$ where x is original value

Results of entomopathogenic fungi and plant products indicates that, neem based insecticides proved to be moderate effective against upto 7 days after spray treatment during present investigation. Gour and Parekh (2003) [8] reported that NSE at least effective against mustard aphids on mustard. Salunke (2003) [9] reported moderate effect of eco neem and neem seed extract on cowpea aphids on cowpea. Verma and Chaman Lal (2006) [10] reported that *Azadirachta indica* was effective but provided only moderate level of control of mustard aphid. Yeo *et al.* (2003) [11] reported that *L. lecanii* is the most pathogenic to aphids. Karthikeyan and Selvanarayanam (2011) [12] conducted studies on bioefficacy of *Lecanicillium lecanii* against *Aphis gossypii* and recorded the highest mortality of *A. gossypii* (100 per cent) at 0.025 concentration. Gangawane (2017) [13] reported that among all entomopathogenic fungi *Lecanicillium lecanii* 1.15% @ 7.5 g/L provide excellent control on oat aphid on forage oat.

Incremental cost benefit ratio (ICBR) of different treatments against aphids, *Aphis nerii* Boyer de Fonscolombe.

The data generated on incremental cost benefit ratio of different treatments applied against aphids (*A. nerii*) is presented in Table 5. as regards the incremental cost benefit ratio among all treatments, the highest ICBR was recorded (1: 4.60) in *Lecanicillium lecanii* @ 5 g/L, it was followed by Azadirachtin (10000 ppm) @ 1ml/L (1:2.52), *Metarhizium anisopliae* @ 5 g/L (1:2.15), *Beauveria bassiana* @ 5 g/L (1:1.90), Azadirachtin 3000 ppm @ 2 ml/L (1:0.83), NSE 5% (1:0.36), respectively.

Table 5: Incremental cost benefit ratio (ICBR) of different treatments against aphids

Sr. No.	Treatment	Yield (q/ha)	Additional yield over control (q/ha)	Additional income (Rs/ha)	Additional cost (Rs/ha)	Net profit (Rs/ha)	ICBR
1.	*Lecanicillium lecanii* @ 5g/L.	4.52	1.12	16800	3000	13800	1:4.60
2.	*Beauveria bassiana* @ 5 g/L	3.98	0.58	8700	3000	5700	1:1.90
3.	*Metarhizium anisopliae* @ 5 g/L.	4.03	0.63	9450	3000	6450	1:2.15
4.	NSE 5%	3.11	0.11	1650	2600	950	1:0.36
5.	Azadirachtin 3000 ppm @ 2 ml/L	3.95	0.55	8250	4500	3750	1:0.83
6.	Azadirachtin 10000 ppm @ 1ml/L	4.42	1.01	15150	4300	10850	1:2.52
7	Untreated control	3.40	-	-	-	-	-
	S.E.±	0.15					
	C.D. @ 5%	0.46					
	C.V	6.57					

Conclusion

The incidence of aphids, *A. nerii* was initiated from 4th week of October, 2022 (43th SMW) and remained continuous up to 4th week of January, 2023 (4th SMW) and incidence of aphids was found maximum 198.3 aphids/10 cm twig in 4th week of November, 2022 (48th SMW). For The effective management of aphids, *A. nerii* treatment of *Lecanicillium lecanii* @ 5 g/L proved to be significantly superior over treatment tested and found at par with the treatment Azadirachtin 10000 ppm @ 1 ml/L. Among all the treatments evaluated, the highest incremental cost benefit ratio 1:4.60 was recorded in the treatment *Lecanicillium lecanii* @ 5 g/L and followed by the treatment Azadirachtin 10000 ppm @ 1ml/L observed 1:2.52 ICBR ratio.

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