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EVALUATION OF PLANT-BASED AND MICROBIAL TREATMENTS FOR APHID CONTROL IN CHRYSANTHEMUM

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ABSTRACT

The efficacy of plant- and microbial-origin pesticides against chrysanthemum aphid, *Macrosiphoniella sanborni*, was evaluated during *Kharif* 2023 and 2024. Seven treatments comprising microbial pesticides (*Metarhizium rileyi*, *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii*) and botanicals (Azadirachtin, Karanjin and Annonin) were compared with an untreated control. Aphid population was recorded at 3, 7 and 14 days after spraying (DAS). During *Kharif* 2023, *L. lecanii* 1.15% WP was consistently the most effective treatment, recording the lowest mean aphid population of 7.34 aphids/3 cm twig after the first spray and 4.76 aphids/3 cm twig after the second spray. *B. bassiana* 1.15% WP was the next most effective treatment. During *Kharif* 2024, *L. lecanii* again showed superior performance, particularly at 7 and 14 DAS. The results indicate that *L. lecanii* 1.15% WP and *B. bassiana* 1.15% WP have good potential for managing chrysanthemum aphid under field conditions.

***Key words*:** Chrysanthemum, *Macrosiphoniella sanborni*, aphid, biopesticides, botanicals, *Lecanicillium lecanii*.

Introduction

Chrysanthemum morifolium, commonly known as chrysanthemum, mums, or shevanti, is one of the most commercially important ornamental and flowering plants belonging to the family Asteraceae. In India, chrysanthemum is cultivated over an area of about 35.35 thousand hectares, producing nearly 521.42 thousand metric tonnes annually, while Maharashtra contributes approximately 0.85 thousand hectares with a production of 4.54 thousand metric tonnes (Government of India, Ministry of Agriculture and Farmers Welfare, 2024). Chrysanthemum is a herbaceous plant characterized by shallow, fibrous root systems, lobed leaves and large, attractive flower heads that may occur singly or in clusters. Beyond its ornamental value, chrysanthemum has been used for centuries in traditional medicine to treat ailments such as hypertension, hyperthyroidism, respiratory disorders, inflammation, headaches, colds, bronchitis, and swellings (Khan and Ullah 2025). It also serves as a source of pyrethrum, a natural insecticide of considerable commercial importance.

Despite its significance in floriculture and cut flower production, chrysanthemum productivity and market value are adversely affected by insect pest infestations, particularly aphids, resulting in substantial economic losses to growers. Several insect pests, including leaf miners, aphids, caterpillars, whiteflies and thrips pose serious constraints to profitable.

Chrysanthemum cultivation (Saicharan *et al*., 2019). Among these, the chrysanthemum aphid, *Macrosiphoniella sanborni*, causes both direct damage through sap feeding and indirect damage by promoting sooty mould development (Agrios, 1988). Aphids primarily infest young shoots and leaves by extracting phloem sap,

Table 1: Treatment Details.

Tr. No.	Treatments	DL	DH
1.	*Metarhizium rileyi* 1.15 % WP	5.0	2500
2.	*Beauveria bassiana* 1.15 % WP	5.0	2500
3.	*Metarhizium anisopliae* 1.15 % WP	5.0	2500
4.	*Lecanicilium lecanii* 1.15 % WP	5.0	2500
5.	Azadirachtin 3000 ppm	2.0	1000
6.	Karanjin 1 % EC	2.0	1000
7.	Annonin 1 % EC	2.0	1000
8.	Untreated control	-	-
DL: Doseg or ml /lit.; DH: Doseg or ml / ha			

leading to weakened plant growth. The population dynamics of aphids are strongly influenced by abiotic factors such as temperature, humidity and rainfall, which affect their survival, development and reproductive potential (Ajij *et al.*, 2009). Temperature plays a critical role by regulating aphid reproduction and population buildup (Cammell and Knight, 1992).

Material and Methods

In order to study the experiment was conducted at PG Instructional farm, Department of Entomology, PGI, MPKV, Rahuri to study the efficacy of plant and microbial origin pesticides against chrysanthemum aphids which was laid out in Randomized Block Design (RBD) with Eight treatments replicated three times using chrysanthemum variety "Poornima white". The five plants were randomly selected and tagged for recording observation from each plot.

Aphid population was recorded from 3 cm /twigs before spraying and at 3, 7 and 14 days after spraying (DAS). Two sprays were evaluated during *Kharif* 2023, while observations following the first spray were recorded during *Kharif* 2024. The data were statistically analysed, and treatment means were compared using the critical difference (CD) at 5% probability level. Values were transformed before statistical analysis where required.

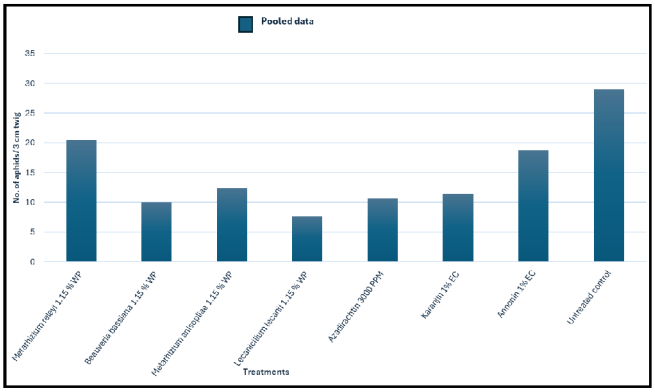


Fig. 1: Efficacy of plant and microbial origin pesticides against chrysanthemum aphids (Pooled data of *Kharif* 2023-2024).

Results and Discussion

Efficacy after first spray during *Kharif* 2023

Before spraying, aphid populations ranged from 15.80 to 19.00 aphids/3 cm twig and did not differ significantly among treatments, indicating uniform infestation. At 3 DAS, azadirachtin 3000 ppm recorded the lowest aphid population (7.00 aphids/3 cm twig), followed by *L. lecanii* 1.15% WP (10.87) and *B. bassiana* 1.15% WP (11.07).

At 7 DAS, *L. lecanii* became the most effective treatment, recording only 6.33 aphids/3 cm twig, followed by *B. bassiana* (7.93) and azadirachtin (11.27). The same trend continued at 14 DAS, when *L. lecanii* recorded 7.80 aphids/3 cm twig. Based on the overall mean, *L. lecanii* was the most effective treatment (7.34 aphids/3 cm twig), followed by *B. bassiana* (9.96) and azadirachtin (11.06). The untreated control recorded the highest mean population (30.29 aphids/3 cm twig).

Efficacy after second spray during *Kharif* 2023

The second spray further reduced aphid populations

Table 2: Efficacy after 1st spray during *Kharif* 2023.

Tr. No.	Treatments	Number of aphids/3 cm twig					
		Dg	Pre-count	3 DAS**	7 DAS	14 DAS	Mean
T_1	*Metarhizium releyi* 1.15 % WP	5	15.80(4.04)*	14.27(3.81)	13.47(3.73)	15.67(4.02)	14.47(3.86)
T_2	*Beauveria bassiana* 1.15 % WP	5	16.67(4.13)	11.07(3.40)	7.93(2.90)	10.87(3.37)	9.96(3.23)
T_3	*Metarhizium anisopliae* 1.15 % WP	5	19.00(4.41)	12.13(3.55)	10.50(3.32)	13.33(3.72)	11.98(3.53)
T_4	*Lecanicilium lecanii* 1.15 % WP	5	18.33(4.32)	10.87(3.36)	6.33(2.61)	7.80(2.86)	7.34(2.94)
T_5	Azadirachtin 3000 ppm	2	19.00(4.41)	7.00(2.72)	11.27(3.43)	14.93(3.43)	11.06(3.21)
T_6	Karanjin 1 % EC	2	18.67(4.38)	9.07(3.09)	11.93(3.52)	14.93(3.92)	11.97(3.51)
T_7	Annonin 1 % EC	2	18.67(4.38)	13.60(3.73)	13.27(3.66)	15.00(3.92)	13.95(3.77)
T_8	Untreated control	-	18.33(4.34)	24.93(5.03)	29.93(5.47)	36.00(6.04)	30.29(5.51)
	SE (m) ±		0.23	0.19	0.22	0.21	0.17
	CD 5 %		NS	0.60	0.69	0.66	0.52
	CV (%)		9.31	9.82	11.35	9.76	8.33
Dg: Dose (g or ml/lit.); * Figures in parenthesis indicates $\sqrt{x+0.5}$ transformed value; ** DAS- Days After Spray							

Table 3: Efficacy after 2nd spray during *Kharif* 2023.

Tr. No.	Treatments	Number of aphids/3 cm twig				
		Dose (g or ml/lit.)	3 DAS**	7 DAS	14 DAS	Mean
T_1	*Metarhizium releyi* 1.15 % WP	5	12.67(3.62)*	12.40(3.58)	13.40(3.71)	12.82(3.63)
T_2	*Beauveria bassiana* 1.15 % WP	5	9.73(3.20)	3.73(2.06)	6.07(2.55)	6.51(2.60)
T_3	*Metarhizium anisopliae* 1.15 % WP	5	11.23(3.38)	5.90(2.52)	7.33(2.79)	8.16(2.91)
T_4	*Lecanicilium lecanii* 1.15 % WP	5	7.67(2.83)	3.13(1.89)	3.47(1.97)	4.76(2.23)
T_5	Azadirachtin 3000 ppm	2	14.93(3.92)	3.60(2.02)	7.93(2.87)	8.13(2.93)
T_6	Karanjin 1 % EC	2	6.07(2.56)	8.87(3.06)	8.93(3.07)	7.95(2.89)
T_7	Annonin 1 % EC	2	12.13(3.55)	11.80(3.50)	12.47(3.59)	12.14(3.55)
T_8	Untreated control	-	36.73(6.05)	43.47(6.62)	48.20(6.98)	42.08(6.55)
	SE (m) ±	-	0.20	0.16	0.15	0.17
	CD 5 %	-	0.62	0.51	0.45	0.52
	CV (%)	-	10.94	9.55	7.87	9.30
* Figures in parenthesis indicates $\sqrt{x+0.5}$ transformed value; ** DAS- Days After Spray						

in all treated plots compared with the untreated control. At 3 DAS, *L. lecanii* recorded the lowest population (7.67 aphids/3 cm twig), followed by karanjin (6.07), *B. bassiana* (9.73) and *M. anisopliae* (11.23). At 7 DAS, *L. lecanii* showed the highest efficacy with only 3.13 aphids/3 cm twig, followed by *B. bassiana* (3.73) and azadirachtin (3.60).

At 14 DAS, *L. lecanii* maintained its superiority with 3.47 aphids/3 cm twig, followed by *B. bassiana* (6.07), *M. anisopliae* (7.33) and azadirachtin (7.93). The overall mean aphid population was lowest with *L. lecanii* (4.76), followed by *B. bassiana* (6.51) and azadirachtin (8.13), whereas the untreated control recorded 42.08 aphids/3 cm twig.

Efficacy after first spray during *Kharif* 2024

A similar trend was observed during *Kharif* 2024. After the first spray, *L. lecanii* recorded the lowest mean aphid population (12.95 aphids/3 cm twig), followed by *B. bassiana* (15.65), azadirachtin (16.34) and karanjin (16.65). At 7 DAS, *L. lecanii* recorded only 6.80 aphids/3 cm twig, indicating strong and sustained activity. The untreated control recorded the highest mean population of 40.16 aphids/3 cm twig.

The mean data of first spray revealed that, *Lecanicillium lecanii* 1.15 % WP was found to be superior among all the tested treatments which recorded least population of aphids (12.95 aphids/3 cm twig) followed by *Beauveria bassiana* 1.15 % WP (15.65 aphids/3 cm twig) and azadirachtin 3000 ppm (16.34 aphids/3 cm twig), which were statistically at par. The treatment karanjin 1 % EC (16.65 aphids/3 cm twig) was statistically at par with azadirachtin 3000 ppm. The order of effectiveness of remaining treatments was *Metarhizium anisopliae* 1.15 % WP (18.67 aphids/3 cm twig) > *Metarhizium rileyi* 1.15 % WP (28.40 aphids/3 cm twig) > annonin 1 % EC (27.67 aphids/3 cm twig). The highest aphid population was recorded in untreated control (40.16 aphids/3 cm twig).

Efficacy after first second during *Kharif* 2024

After the second spray in 2024, *L. lecanii* again

Table 4: Efficacy of plant and microbial origin pesticides against aphids after 1st spray *Kharif* 2024.

Tr. No.	Treatments	Number of aphids/3 cm twig					
		Dg	Pre-count	3 DAS**	7 DAS	14 DAS	Mean
T_1	*Metarhizium releyi* 1.15 % WP	5	31.00(5.58)*	28.13(5.35)	28.00(5.34)	29.07(5.41)	28.40(5.37)
T_2	*Beauveria bassiana* 1.15 % WP	5	33.27(5.81)	23.87(4.91)	11.13(3.41)	11.93(3.52)	15.65(3.95)
T_3	*Metarhizium anisopliae* 1.15 % WP	5	31.13(5.58)	24.20(4.97)	14.73(3.90)	17.07(4.19)	18.67(4.36)
T_4	*Lecanicilium lecanii* 1.15 % WP	5	33.13(5.79)	23.80(4.92)	6.80(2.69)	8.27(2.95)	12.95(3.50)
T_5	Azadirachtin 3000 ppm	2	31.93(5.66)	16.07(4.06)	15.53(3.99)	17.40(4.22)	16.34(4.09)
T_6	Karanjin 1 % EC	2	36.43(6.07)	18.07(4.23)	14.80(3.89)	17.07(4.19)	16.65(4.11)
T_7	Annonin 1 % EC	2	33.07(5.79)	27.93(5.33)	27.20(5.26)	27.87(5.32)	27.67(5.31)
T_8	Untreated control	-	29.87(5.51)	34.07(5.87)	41.73(6.47)	44.67(6.72)	40.16(6.35)
	SE (m) ±	-	0.29	0.20	0.21	0.21	0.20
	CD 5 %	-	NS	0.60	0.64	0.65	0.60
	CV (%)	-	8.95	7.01	8.43	8.27	7.90
Dg: Dose (g or ml/lit.); * Figures in parenthesis indicates $\sqrt{x+0.5}$ transformed value; ** DAS- Days After Spray							

Table 5: Efficacy of plant and microbial origin pesticides against aphids after 2nd spray *Kharif* 2024.

Tr. No.	Treatments	Number of aphids/3 cm twig				
		Dose (g or ml/lit.)	3 DAS**	7 DAS	14 DAS	Mean
T_1	*Metarhizium releyi* 1.15 % WP	5	24.33(4.98)*	26.80(5.22)	28.00(5.33)	26.37(5.17)
T_2	*Beauveria bassiana* 1.15 % WP	5	10.73(3.35)	5.40(2.42)	7.60(2.82)	7.91(2.86)
T_3	*Metarhizium anisopliae* 1.15 % WP	5	12.20(3.56)	7.87(2.89)	8.93(3.07)	9.67(3.18)
T_4	*Lecanicilium lecanii* 1.15 % WP	5	6.30(2.53)	4.13(2.13)	4.73(2.26)	5.48(2.40)
T_5	Azadirachtin 3000 ppm	2	7.06(2.82)	8.27(2.94)	11.00(3.37)	8.52(2.94)
T_6	Karanjin 1 % EC	2	7.47(2.80)	8.67(3.01)	11.53(3.46)	9.22(3.09)
T_7	Annonin 1 % EC	2	21.60(4.69)	19.67(4.49)	22.13(4.75)	21.14(4.65)
T_8	Untreated control	-	47.27(6.91)	51.60(7.22)	57.40(7.60)	54.05(7.24)
	SE (m) ±	-	0.20	0.19	0.19	0.19
	CD 5 %	-	0.61	0.57	0.59	0.59
	CV (%)	-	8.98	9.03	8.82	8.94

* Figures in parenthesis indicates $\sqrt{x+0.5}$ transformed value; ** DAS- Days After Spray

proved to be the most effective treatment, recording 6.30, 4.13 and 4.73 aphids/3 cm twig at 3, 7 and 14 DAS, respectively. It was followed by *B. bassiana* and *Metarhizium anisopliae*. The mean aphid population was lowest with *L. lecanii* (5.48), followed by *B. bassiana* (7.91), azadirachtin (8.52), karanjin (9.22) and *M. anisopliae* (9.67). In contrast, the untreated control recorded 54.05 aphids/3 cm twig.

Efficacy of plant and microbial origin pesticides against aphids (Pooled data of *Kharif* 2023- 2024)

The pooled analysis over *Kharif* 2023 and 2024

Table 6: Efficacy of plant and microbial origin pesticides against aphids (Pooled data of *Kharif* 2023- 2024).

Tr. No.	Treatments	No. of aphids/ 3 cm twig		
		2023	2024	PM
T_1	*Metarhizium releyi* 1.15 % WP	13.65 (3.75)*	27.39 (5.27)	20.52 (4.51)
T_2	*Beauveria bassiana* 1.15 % WP	8.24 (2.92)	11.78 (3.41)	10.01 (3.17)
T_3	*Metarhizium anisopliae* 1.15 % WP	10.07 (3.22)	14.77 (3.77)	12.42 (3.50)
T_4	*Lecanicilium lecanii* 1.15 % WP	6.05 (2.59)	9.22 (2.96)	7.63 (2.77)
T_5	Azadirachtin 3000 ppm	8.81 (2.91)	12.43 (3.52)	10.62 (3.21)
T_6	Karanjin 1 % EC	9.96 (3.20)	12.94 (3.57)	11.45 (3.38)
T_7	Annonin 1 % EC	13.05 (3.66)	24.41 (4.98)	18.73 (4.32)
T_8	Untreated control	45.37 (6.02)	41.12 (6.45)	43.24 (6.23)
	SE (m) ±	0.17	0.20	0.18
	CD 5 %	0.52	0.60	0.56
	CV (%)	8.82	8.42	8.62

PM: Pooled Mean;
*Figures in the parenthesis are $\sqrt{x+0.5}$ transformed value

confirmed the consistent superiority of *L. lecanii* 1.15% WP, which recorded the lowest aphid population (7.63 aphids/3 cm twig), followed by *B. bassiana* 1.15% WP (10.01), azadirachtin 3000 ppm (10.62), karanjin 1% EC (11.45) and *M. anisopliae* 1.15% WP (12.42). Annonin 1% EC and *M. rileyi* 1.15% WP were comparatively less effective, recording 18.73 and 20.52 aphids/3 cm twig, respectively. The untreated control recorded the highest pooled aphid population (43.24 aphids/3 cm twig)

Overall, *L. lecanii* 1.15% WP was the most effective and consistent treatment against *M. sanborni* across both seasons and sprays. The superior performance of *L. lecanii* was followed by *B. bassiana* and azadirachtin, indicating the potential of microbial and botanical pesticides as effective components of an eco-friendly aphid management strategy in chrysanthemum.

Our results align with previous studies showing high efficacy of *Lecanicillium lecanii* against aphids. Saicharan *et al*., (2017) reported 67–69% mortality when *L. lecanii* was combined with botanicals (azadirachtin, karanj oil), indicating synergism with plant insecticides. Chavan *et al*., (2008) found 68–89% mortality with liquid *L. lecanii* formulations. Varun *et al*., (2022) observed >81% to 100% aphid control under field conditions, with maximum reduction by day 7. Bhaskar *et al*., (2022) reported up to a 25% reduction in aphid population density on cabbage following *L. lecanii* application.

Conclusion

Lecanicillium lecanii 1.15% WP was the most effective treatment against *Macrosiphoniella sanborni*, followed by *Beauveria bassiana* 1.15% WP and azadirachtin 3000 ppm. With the lowest pooled aphid population (7.63 aphids/3 cm twig), *L. lecanii* showed strong and consistent efficacy and may be a promising component of integrated aphid management in chrysanthemum.

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