

Ecofriendly Management of Aphids, *Macrosiphoniella pseudoartemisiae* on Dawana, *Artemisia pallens*

Abstract

Artemisia pallens is an aromatic herb or shrubs, Xerophytic in nature. The flowers are racemose panicles it belongs to Asteraceae family. It is commercially cultivated for its fragrant leaves and flowers. It grows from seeds and cuttings and reaches maturity in four months. The plant is woody in the lower part of the stem. Dawana crop mostly grown in Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu states in India. The aphids *Macrosiphoniella pseudoartemisiae* is the major pest of dawana in Maharashtra.

The pooled results indicated that among the treatments tested the treatment *Lecanicillium lecanii* @ 8 g/lit was significantly superior over all other treatments found to be most effective by recording minimum survival of aphid population i.e. 13.13 aphids per tiller per plant after first spray and 4.05 aphids per tiller per plant after second spray with 70.04% pest control and found at par with the treatment *Metarhizium anisopliae* @ 8 g/lit. *Lecanicillium lecanii* @ 8 g/lit. recorded maximum fresh herbage yield i.e. 104.54 q/ha.

Introduction

Artemisia pallens, is an aromatic herb or shrubs, xerophytic in nature. The flowers are racemose panicles, bear numerous small yellow flower heads or capitula, but the silvery white silky covering of down gives the foliage a grey or white appearance. Dawana has alternate pinnasect leaves or palmatisect leaves belonging to the family Asteraceae.

It is commercially cultivated for its fragrant leaves and flowers. It has two distinct morphological types one in which the plants are short in stature and flowering sets in early and the other in which plants are tall and flowers sets in later. It grows from seeds and cuttings and reaches maturity in four months. The plant is woody in the lower part of the stem, but with yearly branches seen mostly grown in Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu states in India.

Davanone, divan ether, davana furan and linalool are the major constituents of dawana oil.

The leaves and flowers yield as essential oil known as oil of Davana. Davana blossoms are offered to Shiva the God of transformation. Davana has been widely

used in Indian folk medicine for the treatment of diabetes mellitus. This plant is accredited with antihelmintic, antipyretic and tonic properties and also considered as good fodder. The oil possesses antispasmodic, antibacterial, antifungal and stimulant properties. Among the pests, the aphids *Macrosiphoniella pseudoartemisiae* is the major pest of *Artemisia pallens* in Maharashtra, hence the efforts are made to study the management of aphids on Dawana.

Material and Methods

The field experiment was conducted for four years during 2015-16, 2016-17, 2017-18 and 2018-19 at AICRP on Medicinal, Aromatic Plants and Betelvine Project Research Farm, Central Campus, MPKV, Rahuri (M.S.) with nine treatments viz., *Lecanicillium lecanii* @ 4 g/lit, *Lecanicillium lecanii* @ 8 g/lit, *Beauveria bassiana* @ 4 g /lit, *Beauveria bassiana* @ 8 g /lit, *Metarhizium anisopliae* @ 4 g/lit, *Metarhizium anisopliae* @ 8 g/lit, Azadirachtin 10000 ppm @ 3 ml/lit, NSE @ 5% and the control treatments also maintained for comparison with RBD design. The pre treatment count survival of pest population was recorded before taking spraying at 3, 7 and 14 days after sprays. Two sprayings were given when conducting of the experiment during maximum aphid population level was in the field.

The sowing of seeds on raised beds was done and after one to one and half month, the seedlings were transplanted in the experimental field as per treatments at 3 x 4 m plot size and 45 x 10 cm spacing were maintained.

Result and Discussion

The pooled results of four years data i.e. 2015-16, 2016-17, 2017-18 and 2018-19 were presented in the table 1. Observations on pre treatment counts were recorded and pooled mean ranged from 42.89 aphids per tiller per plant to 46.13 aphids per tiller per plant. Subsequently the observations were recorded at 3, 7 and 14 days after sprayings.

The pooled results indicated that among the treatments tested the treatment *Lecanicillium lecanii* @ 8 g/lit was significantly superior over all other treatments and found to be most effective by recording minimum survival of aphids population i.e. 13.13 aphids per tiller per plant after first spray and 4.05 aphids per tiller per plant after second spray with 69.98% pest control and found at par with the treatment *Metarhizium anisopliae* @ 8 g/lit recording the aphid population i.e. 15.30 aphids per tiller per plant after first spray and 5.28 aphids per tiller per plant after second spray with 65.41% pest control.

As regards the fresh herbage yield of Dawana, statistically significant differences were recorded among the treatments. The treatment *Lecanicillium lecanii* @ 8 g/lit recorded significantly maximum fresh herbage yield i.e. 104.54 q/ha. However, the treatment *Metarhizium anisopliae* @ 8 g/ha was found at par recorded fresh herbage yield i.e. 95.51 q/ha. The treatment *Lecanicillium lecanii* @ 8 g/lit recorded highest B:C ratio i.e. 2.80 and ICBR 17.25 among the treatments tested. It was found that two sprayings of the treatment *Lecanicillium lecanii* @ 8 g/lit was most effective and found at par with the treatment *Metarhizium anisopliae* @ 8 g/lit.

Results of entomopathogenic fungi and neem based insecticides that proved to be moderate effective upto 7 days after spray treatment during present investigation. These results are more or less in agreement with Gour and Parekh (2003), they reported that NSE at least effective against mustard aphids on mustard. Salunke (2003) reported moderate effect of econeem and neem seed extract on cowpea aphids on cowpea. Verma and Chaman Lal (2006) reported that *Azadirachtin indica* was effective but provided only moderate level of control of mustard aphid. Shivakumara *et al.* (2022) revealed that the commercial bioinsecticide Azadirachtin 10000 ppm @ 5 ml/L was the most effective in protecting plants from aphid feeding and was comparable to synthetic insecticide in Bedki crop. Tambe (2009) reported that Azadirachtin 1% and NSE 5% were observed moderately effective against lucern aphids upto 5 days after spraying.

Among entomopathogenic fungi *Lecanicillium lecanii* 1.15% @ 5 g/L proved excellent control on aphids. Shivkumara *et al.* (2022) reported neem oil spray 10000 ppm @ 0.75% could effectively manage the aphid population in field conditions. Yeo *et al.* (2003) reported that *Lecanicillium lecanii* is the most effective and pathogenic to aphids. Karthikeyan and Selvanarayanan (2011) conducted studies on bioefficacy of *Lecanicillium lecanii* against *Aphis gossypii* and recorded the highest mortality of *Aphis gossypii* (100 per cent) at 0.025 concentration.

Gangawane (2017) reported that among all entomopathogenic fungi *Lecanicillium lecanii* 1.15% @ 7.5 g/L provide excellent control on oat aphid on forage oat. Sosamma and Philp (2017) revealed that high concentration (10^8 spores/ml) give best result with *Lecanicillium lecanii* followed by *Beauveria bassiana* as cowpea aphid mortality declined with decreasing concentration. Mishra *et al.* (2015) evaluated that in okra crop *Lecanicillium lecanii* which recorded 82.16 and 82.92 per cent reduction of aphid population. Janghel *et al.* (2015) evaluated different

biopesticides and bioagents against sucking pests of okra, results showed that for control of aphid, the most effective biopesticide being *Lecanicillium lecanii*. Rana and Singh (2002) studied field trials of *Lecanicillium lecanii* against mustard aphid *Lipaphis erysimi* at the concentration of 10^6 spores/ml at ETL 13-15 aphids per plant and reported the significant reduction was found at 10 days after spraying. Narwade *et al.* (2023) evaluated six sequential strategies against sucking pest complex of okra. The result showed that treatment with spraying *Lecanicillium lecanii* @ 5 g/L followed by Thiamethoxam 25 SG @ 0.25 g/L followed by Pongamia oil 1% @ 10 ml/L was found to be most effective and recorded least average survived population of aphids, leaf hoppers, whitefly and mites.

Table 1. Efficacy of different biopesticides against aphids on *Dawana Artemisia pallens* (Summary table 2015-16 to 2018-19)

Sr. No.	Treatments	Pre treatment count (Pooled mean) aphids/tiller/plant	I st spray (Pooled mean) survival aphid population aphids/tiller/plant			% reduction in pest population
			3 DAT	7 DAT	14 DAT	
1.	<i>Lecanicillium lecanii</i> @ 4 g/lit.	45.22 (6.68)	44.91 (6.66)	34.39 (5.86)	17.89 (4.17)	60.43
2.	<i>Lecanicillium lecanii</i> @ 8 g/lit.	45.17 (6.67)	44.54 (6.63)	30.77 (5.56)	13.13 (3.59)	70.82
3.	<i>Beauveria bassiana</i> @ 4 g/lit.	44.47 (6.61)	44.32 (6.60)	42.45 (6.46)	39.91 (6.26)	10.25
4.	<i>Beauveria bassiana</i> @ 8 g/lit.	46.13 (6.74)	45.78 (6.72)	41.49 (6.41)	35.73 (5.96)	22.53
5.	<i>Metarhizium anisopliae</i> @ 4 g/lit.	45.25 (6.67)	44.83 (6.64)	34.23 (5.84)	19.99 (4.44)	55.82
6.	<i>Metarhizium anisopliae</i> @ 8 g/lit.	44.22 (6.60)	43.90 (6.58)	30.88 (5.56)	15.30 (3.90)	65.38
7.	Azadirachtin 10,000 ppm @ 3 ml/lit.	42.89 (6.48)	33.87 (5.78)	21.17 (4.58)	23.72 (4.85)	44.67
8.	NSE 5%	45.89 (6.72)	39.97 (6.29)	27.53 (5.22)	31.97 (5.63)	30.32
9.	Control	45.72 (6.72)	47.05 (6.81)	48.38 (6.9)	47.86 (6.83)	--
	S.E. ±	0.01	0.01	0.11	0.12	
	C.D. @ 5%	N.S.	0.05	0.34	0.35	

Figures in parenthesis are $\sqrt{X + 0.5}$ transformed values

Table 1 contd...

Sr.	Treatments	II nd spray (Pooled	% reduction	Mean %	Fresh
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No.		mean) survival aphid population aphids/tiller/ plant			in pest population	pest control of two sprays	herbage yield (q/ha)
		3 DAT	7 DAT	14 DAT			
1.	<i>Lecanicillium lecanii</i> @ 4 g/lit.	17.31 (4.11)	13.25 (3.65)	7.22 (2.66)	59.60	60.01	91.53
2.	<i>Lecanicillium lecanii</i> @ 8 g/lit.	12.73 (3.54)	8.86 (3.02)	4.05 (2.05)	69.14	69.98	104.54
3.	<i>Beauveria bassiana</i> @ 4 g/lit.	39.30 (6.22)	37.88 (6.11)	35.75 (5.93)	10.40	10.32	61.36
4.	<i>Beauveria bassiana</i> @ 8 g/lit.	35.07 (5.91)	32.02 (5.66)	27.54 (5.26)	22.92	22.72	65.57
5.	<i>Metarhizium anisopliae</i> @ 4 g/lit.	19.56 (4.39)	15.12 (3.90)	8.95 (3.01)	55.19	55.50	86.90
6.	<i>Metarhizium anisopliae</i> @ 8 g/lit.	14.99 (3.86)	10.62 (3.30)	5.28 (2.35)	65.45	65.41	95.51
7.	Azadirachtin 10,000 ppm @ 3 ml/lit.	18.97 (4.49)	12.11 (3.48)	13.53 (3.69)	41.91	43.29	78.39
8.	NSE 5%	27.68 (5.25)	19.64 (4.41)	20.56 (4.72)	35.69	33.005	68.35
9.	Control	46.60 (6.75)	42.58 (6.42)	32.85 (5.75)	--		60.71
	S.E. \pm	0.13	0.17	0.12			2.18
	C.D. @ 5%	0.39	0.50	0.37			6.37

Table 2. Incremental cost benefit ratio and B:C ratio of different treatments against aphids on Dawana

Sr. No.	Treatments	Estimated oil yield (lit/ha)	Additional yield over control (lit./ha)	Additional income (Rs.)	Additional cost (Rs.)	Net profitable income (Rs.)	ICBR	B:C ratio
1.	<i>Lecanicillium lecanii</i> @ 4 g/lit.	9.15	3.08	46200	2800	43400	15.50	2.55
2.	<i>Lecanicillium lecanii</i> @ 8 g/lit.	10.45	4.38	65700	3600	62100	17.25	2.80
3.	<i>Beauveria bassiana</i> @ 4 g/lit.	6.13	0.06	900	2800	0	0.00	1.81
4.	<i>Beauveria bassiana</i> @ 8 g/lit.	6.55	0.48	7200	3600	3600	1.28	1.89
5.	<i>Metarhizium anisopliae</i> @ 4 g/lit.	8.69	2.61	39150	2800	36350	12.98	2.44
6.	<i>Metarhizium anisopliae</i> @ 8 g/lit.	9.55	3.48	52200	3600	48600	13.50	2.60
7.	Azadirachtin 10,000 ppm @ 3 ml/lit.	7.83	1.76	26400	5600	20800	3.71	2.12
8.	NSE 5%	6.83	0.76	11400	2300	9100	3.95	
9.	Control	6.07	--	--	--	--	--	

Conclusion

From the four years pooled data, it was concluded that among the treatment tested, the treatment *Lecanicillium lecanii* @ 8 g/lit was found most effective for the management of aphids on Dawana, *Artemisia pallens* with minimum survival of aphid population and maximum percentage of pest control and found at par with the treatment *Metarhizium anisopliae* @ 8 g/lit.

References

Gangawane, A.B. 2017. Seasonal abundance and biological control of oat aphids (*Rhopalosiphum padi* L.) on forage oat (*Avena sativa* L.). M.Sc. (Agri.) Thesis, Department of Agril. Entomology, submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, pp. 26-30.

- Gour, T.S. and Parekh, B.Z. (2003) Field evaluation of insecticide against mustard aphids *Lipophisery simi* under semi arid region of Rajasthan. Indian Journal of Plant Protection, pp: 153-158.
- Janghel, M., Mishra, I. and Mishra, B. 2015. Evaluation of different bio-pesticides against the aphid in okra at Bhubaneswar. Journal of Agricultural Environment Science, 15(4): 694-698.
- Karthikeyan, A. and Selvanarayan, V. 2011. *In vitro* efficacy of *B. bassiana* (Bals) vulli and *Lecanicillium lecanii* (Zimm) viegas against pest of cotton. Journal of Recent Research in Science and Technology, 3(2): 142-143.
- Mishra, B.K., Mishra, I. and Mohanisha, J. 2015. Evaluation of the different biopesticides against the aphids in okra at Bhubaneshwar. Middle-East Journal on Science and Research. 23(3): 421-425.
- Narwade, D.K., Pawar, S.A., Saindhane, Y.S., Datkhile, R.V. and Bhalekar, M.N. 2023. Management of sucking pest complex in okra by sequential strategy. The Pharma Innovation Journal, 12(11): 414-419.
- Rana, J.S. and Singh, D.S. 2002. Entomopathogenic fungi, *V. lecanii* (Zimm) as a potential biocontrol agent against mustard aphid, *Lipaphis erysimi* (Kalt) on rapeseed mustard, Cruciferae Newsletter, 24: 97-98.
- Salunke, J.S. 2003. Studies on population dynamics and management of major pests in cowpea (*Vigna unguiculata* L.) Wap. M.Sc. (Agri.) thesis Mahatma Phule Krishi Vidyapeeth, Rahuri.
- Shivakumara, K.T., Keerthi, M.C., Polaiah, V., Thondaiman, T. and Manivel, P. 2022. Seasonal abundance of oleander aphid, *Aphis nerii* Boyer de Fonscolombe and its predator on *Gymnema sylvestre* R. Br. in relation to weather parameters from India. Author: Satyajit Roy Source: International Journal of Tropical Insect Science 42(2), pp. 1925-1932.
- Sosamma, J. and Philip, B. 2017. Efficacy of different entomopathogenic fungi against cowpea aphid. *Aphis craccivora* (Koch). International Journal of Plant Protection, pp. 68-71.
- Tambe, A.B. 2009. Studies on management of pest infesting lucern, *Medicago sativa* (Linnaeus), Ph.D. Thesis Submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri.

- Verma, L.R. and Chamanlal 2006. Efficacy of different indigenous plant extracts and their combinations in comparison to monocrotophos against mustard aphids. *India Journal of Entomology*, 68(2): 132-138.
- Yeo, H., Pell, J.K., Alderson, P.G., Clark, S.J. and Pye, B.J. 2003. Laboratory evaluation of temperature effects on germination and growth of entomopathogenic fungi and their pathogenicity to aphid. *Pest Management Science*. 59(2) : 156-165.

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