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

Abstract

Artemisia pallens is an aromatic herb or shrubs, Xerophtic 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

Artemissia 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

Comment [HF1]: Aphid

Comment [HF2]: Shinji, 1933 (Hemiptera: Aphididae)

Comment [HF3]: (Asterales: :Asteraceae)

Comment [HF4]: An abstract in full paper contains: at last 250 words with 2 lines importance of subject, where and when research conducted, a summary of experiments and a summary of main results and then mention this result how can help the problem of the subject. So abstract needs completely to be reworded and revised.

Comment [HF5]: Please see some published papers and make some points for yourself.

Comment [HF6]: Introduction contains various texts of different scientists with names and years and more explanation. Please see some other papers.

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

Comment [HF7]: Which statistical software has been applied for analysis? There is no explanation. Also, you should clarify how you got the final results ? I mean this is the mean of 4 years or no?

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) evaluaed 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)

Comment [HF8]: Write a better title. What is DAT? You should explain this under the table. You should bring some nots of analysis . How many replication for each year you had? Finally you bring the mean of 4 years for each treatment clearly. You need to analyze your data using statistical software and provide mean comparisons along with the necessary statistical explanations. You have mentioned the first and second sprays; are these the averages over four years? Linear regression information should specify what results were obtained and how they were derived. These details must be included.

Sr. No.	Treatments	Pre treatment count (Pooled mean) aphids/tiller/ plant	Ist spray (Pooled mean) survival aphid population aphids/tiller/ plant			% reduction in pest population
			3 DAT	7 DAT	14 DAT	
1.	*Lecanicillium lecanii* @ 4 g/lit.	45.22 (6.68)	44.91 (6.66)	34.39 (5.86)	17.89 (4.17)	60.43
2.	*Lecanicillium lecanii* @ 8 g/lit.	45.17 (6.67)	44.54 (6.63)	30.77 (5.56)	13.13 (3.59)	70.82
3.	*Beauveria bassiana* @ 4 g/lit.	44.47 (6.61)	44.32 (6.60)	42.45 (6.46)	39.91 (6.26)	10.25
4.	*Beauveria bassiana* @ 8 g/lit.	46.13 (6.74)	45.78 (6.72)	41.49 (6.41)	35.73 (5.96)	22.53
5.	*Metarhizium anisopliae* @ 4 g/lit.	45.25 (6.67)	44.83 (6.64)	34.23 (5.84)	19.99 (4.44)	55.82
6.	*Metarhizium anisopliae* @ 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	IInd spray (Pooled	% reduction	Mean %	Fresh

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.	*Lecanicillium lecanii* @ 4 g/lit.	17.31 (4.11)	13.25 (3.65)	7.22 (2.66)	59.60	60.01	91.53
2.	*Lecanicillium lecanii* @ 8 g/lit.	12.73 (3.54)	8.86 (3.02)	4.05 (2.05)	69.14	69.98	104.54
3.	*Beauveria bassiana* @ 4 g/lit.	39.30 (6.22)	37.88 (6.11)	35.75 (5.93)	10.40	10.32	61.36
4.	*Beauveria bassiana* @ 8 g/lit.	35.07 (5.91)	32.02 (5.66)	27.54 (5.26)	22.92	22.72	65.57
5.	*Metarhizium anisopliae* @ 4 g/lit.	19.56 (4.39)	15.12 (3.90)	8.95 (3.01)	55.19	55.50	86.90
6.	*Metarhizium anisopliae* @ 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. ±	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.	*Lecanicillium lecanii* @ 4 g/lit.	9.15	3.08	46200	2800	43400	15.50	2.55
2.	*Lecanicillium lecanii* @ 8 g/lit.	10.45	4.38	65700	3600	62100	17.25	2.80
3.	*Beauveria bassiana* @ 4 g/lit.	6.13	0.06	900	2800	0	0.00	1.81
4.	*Beauveria bassiana* @ 8 g/lit.	6.55	0.48	7200	3600	3600	1.28	1.89
5.	*Metarhizium anisopliae* @ 4 g/lit.	8.69	2.61	39150	2800	36350	12.98	2.44
6.	*Metarhizium anisopliae* @ 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.

Comment [HF9]: After all corrections and analysis you can tell the conclusion at this stage you cannot.

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Comment [HF10]: 13 references seems not enough for four years research.. If there are more literature so should apply more and better ref.

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