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Research Article

Evaluation of botanicals and biopesticides against foliage feeding wheat aphid (*Rhopalosiphum padi* L.)

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Abstract

Field studies were conducted during *Rabi* **2008-09 to 2011-12 at Agricultural Research Station, Niphad, Maharashtra, India to determine the efficacy of promising entomopathogenic fungi and plant products (extract) for the management of wheat aphids.** *Metarhizium anisopliae* **1.15% WP @ 4g/l recorded minimum (4.99 and 20.67) number of aphids/shoot/plant at 7 and 15 days after spraying. It was at par with** *Verticillium lecanii* **1.15% WP @ 4 g/l at 7 days after spraying and** *V. lecanni* **1.15% WP @ 4g/l and** *Beauveria bassiana* **1.15% WP @ 5g/l.** *M. anisopliae* **1.15% WP @ 4g/l recorded highest yield of 45.06q/ha which was at par with** *V. lecanii* **1.15% WP @ 4g/l (44.87q/ha),** *B. bassiana* **1.15% WP @ 5g/l (44.78), Neem Seed Extract 5% (43.13q/ha) and** *Azadirachtin* **1500 ppm 3.0 ml/l (42.81q/ha). Lowest yield was observed from untreated control (35.53 q/ha). The additional yield and income over control was highest in** *M. anisopliae* **1.15% WP @ 4g/l (9.53 q/ha and ₹ 10,950q/ha). The monetary returns, net profit, benefit cost ratio and ICBR were maximum over control in** *M. anisopliae* **1.15% WP @ 4g/l (₹ 67,718, ₹ 41,606, 2.59 & 8.33). It was followed by** *V. lecanii* **1.15% WP @ 4g/l (₹ 67,453, ₹ 41,341, 2.58 & 8.14).**

Key words : Wheat, *Triticum aestivum, Rhopalosiphum padi (L)*

1. Introduction

Wheat (*Triticum aestivum*) is one of the most important cereal crop and the staple food throughout the world. It is extensively grown both in irrigated and rainfed areas around the world. In, Maharashtra, wheat is grown on an area of 10.97 lakh ha with a production and productivity of 16.69 lakh tons and 15.21 kg/ ha, respectively during *Rabi* 2013-14, (Anon., 2014a).

Among the wheat pests, aphids are the most widely distributed and are posing a serious threat to wheat crop throughout the world. (Yadev, 2003). They cause direct damage by sucking cell sap of leaves, young shoots, causing distortion, stunting, leaf curling, wilting and twisting. Indirect damage by depositing honey dew that reduce photosynthetic activity and induce sooty mould production and premature leaf senescence further pause serious losses (Ozder, 2002). Due to the introduction of new varieties and use of various newer insecticides, especially in cotton growing areas, several species of aphids have become serious pest in some areas. Among these wheat aphid (*Macrosiphum miscanthi*), bud cherry aphids (*Rhopalosiphum padi*) and English grain aphid (*Sitobion avenae*) are more common.(Said Mir Khan and Rashid Magbool, 2002). The damage is severe in cold and cloudy weather during winter. They appear mostly from December to January. Tradan and Milevoj (1999) has reported 10 to 50% reduction in crop yield due to aphid infestation. Management of aphids has been primarily done using chemical methods, resulting in serious environmental and health problems (Botto, 1999). Wide spread use of synthetic pesticides and demanding crop production causes several socio-economic problems throughout the world. More than 20 aphid species together with *Myzus persicae* (Foster *et al.*, 1997) have showed resistance to a number of carbamate, pyrethroid and

organophosphate insecticides. Entomopathogenic fungi provide an environmentally responsive alternative to chemical pesticides and are natural, easy to formulate, less toxic to mammals, with no residual activity (Copping,2004) and less chance to develop resistance (Zimmermann, 2007). *Beauveria bassiana* and *Metarhizium anisopliae* in particular have wide host range (Butt *et al.*,1994), distributed in all regions of the world and can be easily isolated from insects and soil (Freed *et al.*,2011).

Insect pathogenic fungi and botanicals are a component with in integrated pest management system and have a great capacity as a biological control agent against insect. Hyphomycete fungi are inexpensive for mass production, easy to store and efficient over an extensive range of temperature and humidity. These also offer a swift eradication at cost effective doses. Owing to the increasing threats of aphids in the region and indirect damage by the injudicious use of chemical pesticides, study was planned to test the efficacy of various biopesticides and botanicals.

2. Material and methods

A field experiment was conducted during *rabi* 2008-09, 2009-10, 2010-11 and 2011-12 on the research farm of Agricultural Research Station, Niphad, Dist-Nasik (M.S.), India. A field experiment was carried out in Randomized Block Design with ten treatments *viz.* Neem Seed Extract (NSE) 5 % , Neem leaves extract 5%, *Azadirachtin* 1500 ppm 3.0 ml/l, Vekhand powder (*Acorus calamus*) @ 5g/l, Green/Ripe chilli extract 2% , *V. lecanii* 1.15% WP @ 4g/l, *B. bassiana* 1.15% WP @ 5g/l, *M. anisopliae* 1.15% WP @ 4g/l, Oxy demeton methyl 25EC @ 1.0ml/l and untreated control and three replications on wheat variety Trimbak (NIAW-301) in plot size 6 x 1.35m (six rows of six meter row length).

The insecticidal sprays were applied at an interval of 15 days, initiating just after average infestation of 10 aphids/shoot/plant was realized. Five shoot from each plot were selected randomly for recording observations. Observations were recorded on the basis of average population of survival aphids. Pre-count was taken 24 hours before spray and post-count was taken on 1, 2, 7 and 15 days after spray. The average population of aphids survived per shoot was worked and the data were subjected to square root transformation. The experimental data were subjected to statistical analysis.

3. Results and discussion

3.1 Efficacy of Botanicals and bio-pesticide on aphids population : The pooled data for consecutive four years (2008-09 to 2011-12) pertaining to effect of various biological (entomopathogenic fungal biopesticides) and crude extract of plant products on aphids control in wheat is presented in Table 1 and 2. The pooled data revealed

Table 1. Efficacy of different botanicals and biopesticides against aphids in wheat at 1 and 2 day after spraying

SN	Treatments	Dose	Pre count (Av. no. of aphids/shoot/plant)					Post count 2 DAS (Av. no. of aphids/shoot/plant)				
			08-09	09-10	10-11	11-12	Pooled	08-09	09-10	10-11	11-12	Pooled
1	Neem Seed Extract (NSE)	5%	31.90 (5.73)	26.50 (5.24)	20.60 (4.65)	13.20 (3.76)	23.05 (4.90)	19.33 (4.50)	13.10 (3.75)	11.30 (3.51)	8.90 (3.15)	13.16 (3.76)
2	Neem leaves extract	5%	34.2 (5.93)	29.50 (5.52)	23.50 (4.95)	12.60 (3.68)	24.95 (5.09)	23.00 (4.89)	17.00 (4.24)	18.50 (4.42)	19.10 (4.48)	19.40 (4.52)
3	*Azadirachtin* 1500 ppm	3 ml/l	27.33 (5.32)	25.10 (5.11)	23.10 (4.91)	13.00 (3.74)	22.13 (4.81)	12.06 (3.60)	11.60 (3.55)	16.70 (4.21)	12.16 (3.63)	13.13 (3.76)
4	Vekhand powder (*Acorus calamus*)	5 g/l	26.33 (5.22)	26.70 (5.26)	23.30 (4.93)	13.30 (3.78)	22.41 (4.84)	38.33 (6.27)	26.10 (5.21)	26.60 (5.25)	20.70 (4.66)	27.93 (5.38)
5	Green/Ripe chilli extract	2%	27.73 (5.36)	26.70 (5.26)	25.00 (5.10)	12.60 (3.68)	23.01 (4.90)	33.93 (5.91)	24.30 (5.03)	26.20 (5.22)	19.86 (4.57)	26.07 (5.20)
6	*Verticillium lecanii* 1.15% WP	4 g/l	26.66 (5.25)	27.60 (5.35)	24.00 (5.00)	12.70 (3.70	22.74 (4.87)	21.06 (4.69)	15.20 (4.02)	16.60 (4.20)	9.56 (3.25)	15.61 (4.08)
7	*Beauveria bassiana* 1.15% WP	5 g/l	24.73 (5.07)	23.60 (4.96)	21.17 (4.76)	12.90 (3.72)	20.60 (4.65)	15.73 (4.09)	15.80 (4.10)	16.00 (4.12)	10.76 (3.43)	14.57 (3.95)
8	*Metarhizium anisopliae* 1.15% WP	4 g/l	24.93 (5.09)	25.80 (5.18)	24.90 (5.09)	12.90 (3.72)	22.13 (4.81)	16.26 (4.15)	17.40 (4.29)	14.30 (3.91)	8.53 (3.09)	14.12 (3.89)
9	Oxy demeton methyl 25 EC	1 ml/l	26.60 (5.25)	24.80 (5.08)	25.40 (5.14)	12.80 (3.71)	22.40 (4.84)	1.86 (1.69)	4.90 (2.43)	2.97 (1.99)	4.20 (2.28)	3.48 (2.12)
10	Untreated control	-	29.80 (5.55)	29.00 (5.48)	23.70 (4.97)	13.20 (3.76)	23.93 (4.99)	51.00 (7.21)	34.20 (5.93)	33.60 (5.88)	27.63 (5.35)	36.61 (6.13)
	SE ±		0.31	0.17	0.11	0.03	0.08	0.35	0.10	0.10	0.03	0.15
	CD at 5%		NS	NS	NS	NS	NS	1.04	0.30	0.29	0.09	0.46

Figures in parentheses are √ n+1 values

Table 2. Efficacy of different botanicals and biopesticides against aphids in wheat at 7 and 15 days after spraying

SN	Treatments	Dose	Post count 7 DAS (Av. no. of aphids/shoot/plant)					Post count 15 DAS (Av. no. of aphids/shoot/plant)					Av. No. of Natural enemies/m^2 (Pooled mean 2008-09 to 2011-12)	
			08-09	09-10	10-11	11-12	Pooled	08-09	09-10	10-11	11-12	Pooled	Precount	Postcount 10DAS
1	Neem Seed Extract (NSE)	5%	12.13 (3.62)	7.60 (2.93)	7.90 (2.98)	6.60 (2.76)	8.56 (3.09)	68.60 (8.34)	11.00 (3.46)	16.87 (4.23)	11.50 (3.54)	26.99 (5.29)	1.40 (1.55)	1.22 (1.49)
2	Neem leaves extract	5%	22.86 (4.88)	18.50 (4.42)	19.87 (4.57)	21.93 (4.79)	20.79 (4.67)	71.13 (8.49)	20.30 (4.62)	20.97 (4.69)	26.66 (5.26)	34.77 (5.98)	1.48 (1.57)	1.28 (1.51)
3	*Azadirachtin* 1500 ppm	3 ml/l	9.00 (3.16)	5.20 (2.49)	8.70 (3.11)	9.83 (3.29)	8.18 (3.03)	60.06 (7.81)	8.50 (3.08)	17.3.7 (4.29)	14.36 (3.92)	25.07 (5.11)	1.47 (1.57)	1.18 (1.48)
4	Vekhand powder (*Acorus calamus*)	5 g/l	34.66 (5.97)	22.00 (4.80)	25.87 (5.18)	22.30 (4.83)	26.21 (5.20)	69.93 (8.42)	26.20 (5.22)	26.16 (5.21)	27.93 (5.38)	37.56 (6.21)	1.55 (1.60)	1.34 (1.53)
5	Green/Ripe chilli extract	2%	37.26 (6.18)	23.00 (4.90)	25.93 (5.19)	22.70 (4.87)	27.22 (5.31)	63.93 (8.05)	22.80 (4.88)	24.87 (5.09)	27.26 (5.32)	34.72 (5.98)	1.46 (1.57)	1.42 (1.56)
6	*Verticillium lecanii* 1.15% WP	4 g/l	8.33 (3.05)	2.10 (1.76)	5.50 (2.55)	5.46 (2.54)	5.35 (2.52)	71.60 (8.52)	6.70 (2.77)	12.20 (3.63)	5.80 (2.61)	24.08 (5.01)	1.43 (1.57)	1.35 (1.53)
7	*Beauveria bassiana* 1.15% WP	5 g/l	7.93 (2.98)	3.20 (2.05)	11.67 (3.56)	7.13 (2.85)	7.48 (2.91)	64.93 (8.11)	10.70 (3.42)	13.90 (3.73)	8.10 (3.02)	24.41 (5.04)	1.42 (1.56)	0.94 (1.39)
8	*Metarhizium anisopliae* 1.15% WP	4 g/l	8.80 (3.13)	2.40 (1.84)	5.00 (2.45)	3.76 (2.18)	4.99 (2.45)	58.00 (7.68)	10.40 (3.38)	10.30 (3.36)	3.96 (2.23)	20.67 (4.66)	1.34 (1.53)	1.18 (1.48)
9	Oxy demeton methyl 25 EC	1 ml/l	0.83 (1.35)	1.20 (1.48)	2.40 (1.84)	3.13 (2.03)	1.89 (1.70)	49.66 (7.11)	14.40 (3.92)	12.83 (3.72)	13.93 (3.86)	22.70 (4.87)	1.22 (1.49)	0.63 (1.28)
10	Untreated control	-	70.53 (8.45)	35.00 (6.00)	36.26 (6.10)	33.40 (5.87)	43.80 (6.69)	93.33 (9.71)	32.40 (5.78)	32.77 (5.81)	36.36 (6.11)	48.72 (7.05)	1.42 (1.56)	1.47 (1.57)
	SE ±		0.18	0.12	0.13	0.04	0.10	0.43	0.09	0.16	0.04	0.18	0.04	0.03
	CD at 5%		0.54	0.36	0.39	0.13	0.28	1.27	0.27	0.48	0.13	0.53		

** Figures in parentheses are √ n+1 values*

that the treatment with *Azadirachtin* 1500 ppm @ 3ml/l recorded lowest aphid population /shoot/plant (13.13) at 2 DAS. However, it was at par with NSE @ 5% (13.16), *M. anisopliae* 1.15% WP @ 4g/l (14.12), *B. bassiana* 1.15% WP @ 5g/l (14.57) and *V. lecanii* 1.15% WP @ 4g/l (15.61). At 7 and 15 DAS, the treatment with *M. anisopliae* 1.15% WP @ 4g/l recorded minimum (4.99 and 20.67) number of aphids/shoot/plant which was at par with *V. lecanii* 1.15% WP @ 4 g/l at 7 DAS and *V. lecanni* 1.15% WP @ 4g/l and *B. bassiana* 1.15% WP @ 5g/l, NSE 5% and *Azadirachtin* 1500 ppm @ 3.0 ml/l at 15 DAS. In case of untreated control plot numbers of aphids/shoot/plant were 31.21, 36.61, 43.80 and 48.72 at 1, 2, 7 and 15 days after spray, respectively. The plots treated with Oxy demeton methyl @ 1.0 ml/l registered significantly minimum number of aphids as compared to rest of the treatments at 1, 2 and 7 days after spray. The data presented in Table 2 revealed that the population of natural enemies was non-significant at pre count. Lowest population of natural enemies (0.63) was recorded in oxy demeton methyl @ 1.0ml/l at 10 days after spraying.

3.2 Effect on yield : The data presented in- Table 3 revealed that yield differences due to spraying of botanicals and biological biopesticides were significant. Among the botanicals and biological *M. anisopliae* 1.15% WP @ 4g/l recorded highest yield of 45.06q/ha which was at par with *V. lecanii*1.15% WP @ 4g/l (44.87q/ha), *B. bassiana* 1.15% WP @ 5g/l (44.78), Neem Seed Extract (NSE) 5 % (43.13q/ha) and *Azadirachtin* 1500 ppm 3.0 ml/l

Table 3. Economics of the different treatments (Pooled data of consecutive four years (2008-09 to 2011-12)

SN	Treatments	Dose	Yield q/ha					Additional yield over control q/ ha	Additional income over control (₹)	Cost of cultivation + Cost of insecticide	Monetary returns (₹)	Net income (₹)	B:C ratio	ICBR
			08-09	09-10	10-11	11-12	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
1	Neem Seed Extract (NSE)	5%	43.62	34.07	48.72	46.11	43.13	7.60	8179	26219	64947	38728	2.48	5.67
2	Neem leaves extract	5%	40.74	31.93	44.20	41.58	39.61	4.08	2779	25807	59547	33740	2.31	2.61
3	*Azadirachtin* 1500 ppm	3 ml/l	46.97	32.59	45.23	44.46	42.81	7.28	6532	26412	63300	36888	2.40	4.17
4	Vekhand powder (*Acorus calamus*)	5 g/l	40.61	30.94	44.36	41.79	39.43	3.90	2522	26194	59290	33096	2.26	1.75
5	Green/Ripe chilli extract	2%	43.04	32.10	41.89	41.17	39.55	4.02	2435	26032	52203	26171	2.01	2.16
6	*Verticillium lecanii* 1.15% WP	**4 g/l**	46.50	36.54	47.45	48.99	44.87	9.34	10685	26112	67453	41341	2.58	8.14
7	*Beauveria bassiana* 1.15% WP	5 g/l	48.55	34.82	47.16	48.58	44.78	9.25	10365	26319	67133	40814	2.55	6.90
8	*Metarhizium anisopliae* 1.15% WP	**4 g/l**	47.32	35.35	47.73	49.82	45.06	9.53	10950	26112	67718	41606	2.59	8.33
9	Oxy demeton methyl 25 EC	1 ml/l	53.08	39.05	50.37	51.87	48.59	13.06	15992	25944	72761	46817	2.80	14.30
10	Untreated control	-	39.09	30.85	40.82	40.34	35.53	-	-	24807	56768	31961	2.28	-
	SE ±		0.98	1.52	1.65	2.22	0.86							
	CD at 5%		2.92	4.54	4.89	6.59	2.54							

Total cost of cultivation except insecticide control :₹ 22797/-, 23300/-, 25,630/-, 27500/- Price of wheat grains:₹ 1200/q,1500/-, 1600/-,1700/-

Cost of insecticides :

1. Neem Seed: ₹ *10/kg, 10/kg, 12/kg, 15/kg* *2. Neem leaves:* ₹ *3/kg, 3/kg, 4/kg, 4/kg*

3. Azadirachtin 1500ppm: ₹ *330/l, 330/l, 380/l, 380/l* *4. Vekhand Powder:* ₹ *100/kg, 100/kh, 125/kg, 125/kg*

5. Verticillium lecanii: ₹ *125/kg, 125/kg, 150/kg, 150/kg* *6. Beaveria bassiana:* ₹ *125/kg, 125/kg, 150/kg, 150/kg*

7. Metarhizium anisopliae: ₹ *25/kg, 125/kg, 150/kg, 150/kg* *8. Oxy-demeton methyl 25 EC:* ₹ *290/lit, ` 290/lit, ` 320/lit, 350/lit*

(42.81q/ha). However, maximum yield of 48.59 q/ha was obtained in plot treated with oxy demeton methyl @ 1.0 ml/l. Lowest yield was observed from untreated control (35.53 q/ha).

3.3 Economics of different treatments: The data in respect of economics of different treatments are presented in Table 3. Among the treatments with botanicals and biopesticides, the additional yield and income over control was highest in *M. anisopliae* 1.15% WP @ 4g/l (9.53 q/ha and ₹ 10,950q/ha) followed by *V. lecanii*1.15% WP @ 4g/l (9.34 q/ha and ₹ 10,685 q/ha), *B.bassiana*1.15% WP @ 5g/l (9.25 q/ha and ₹ 10,365q/ha) and NSE 5% (7.60 q/ha and ₹ 8,179 q/ha). The monetary returns and net profit over control was maximum in treatment with *M. anisopliae* 1.15% WP @ 4g/l (` 67,718 and ₹ 41,606) followed by *V. lecanii* 1.15% WP @ 4g/l (₹ 67,453 and 41,341), *B. bassiana* 1.15% WP @ 5g/l (₹ 67,133 and 40,814) and NSE 5% (₹ 64,947 and 38,728). The maximum benefit cost ratio and ICBR were found in treatment with *M. anisopliae* 1.15% WP @ 4g/l (2.59 & 8.33) follwed by *V. lecanii* 1.15% WP @ 4g/l (2.58 & 8.14), *B. bassiana* 1.15% WP @ 5g/l (2.55 & 6.90) and NSE 5% (2.48 & 5.67).

In present investigation, *M. anisopliae* 1.15% WP @ 4g/l, *V. lecanii* 1.15% WP @ 4g/l and *B. bassiana* 1.15% WP @ 5g/l was found to be the most effective in reducing the aphid population and registering the maximum yield. These findings are in supportive with reported by various researchers. All the biopesticides specially, entomopathogenic fungi showed significant control of aphid population as compare to untreated control. (Anon, 2014). Justin *et al.*,2004 reported the effectiveness of application of *B. bassiana* for the control of Russian wheat aphid {*Diuraphis noxia* (Kurdj)}. These results are also in agreement with the works of Vandenberg *et al.*,2001 and Khalil *et al.* 1985. The effectiveness of biopesticides against wheat aphid is supported by the findings of Jung *et al.,* 2006 and Kim, 2004 by *Lecanicillium sp*, Shia and Feng, 2004 and Wright *et al.*, 2004 by *M. anisopliae B. bassiana* (Quesada-Moraga *et al.*, 2006), and *Nomuraea rileyi* (Devi *et al.*, 2003) have been used for the management of aphids and many other pests.

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