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EVALUATIO OF MICROBIAL AGENTS AND BIO-PRODUCTS FOR THE MANAGEMENT OF MUSTARD APHID, *LIPAPHIS ERYSIMI* (KALT.)

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ABSTRACT
Microbial agents (*Verticillium lecanii*, *Beauveria bassiana* and *Metarhizium anisopliae* @ 5 g per litre of water), plant products (Tobacco, onion and neem seed kernel extract @ 5%), cow urine @ 50 litre/ha and dimethoate 30EC @ 300 g a.i/ha were evaluated against mustard aphid, *Lipaphis erysimi* (Kalt.) and their safety to natural enemies and pollinators. Significantly higher aphid reduction was recorded under these treatments over the control without any phytotoxic effect and found safe to natural enemies of mustard aphid and honeybee. Most favourable cost-benefit ratio was obtained under the treatment *i.e.* dimethoate 30 EC @ 300 g a.i/ha (1:38) followed by neem seed kernel extract @ 5% (1:18), onion extract @ 5% (1:17), cow urine @ 50 litre/ha (1:11), *Beauveria bassiana* @ 5 g per litre of water (1:10), *Verticillium lecanii* @ 5 g per litre of water (1:10), *Metarhizium anisopliae* @ 5 g per litre of water (1:8), tobacco extract @ 5% (1:6) and water spray (1:2).

INTRODUCTION

Mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae) is the key pest of rapeseed-mustard crops in India. This pest is widely distributed throughout the world on all *Brassica* crops (Yue and Liu, 2000) and responsible to cause yield loss ranging from 9 to 96% (Singh and Sharma 2002) and 15% oil reduction (Verma and Singh 1987) in India. In the past many workers have evaluated a number of chemical insecticides against this dreaded insect and some of them have been found effective to control this insect (Mathur and Upadhyay, 1980; Prasad, 1978; Singh *et al*., 2007; Singh and Singh, 2009). These chemical insecticides have been found more or less toxic to a number of parasitoids and predators *i.e. Diaeretiella rapae*, *Chrysoperla carnea*, coccinellids and syrphid flies. Present in mustard fields as natural enemies of aphid (Singh *et al*., 2007). The use of chemical pesticides is also responsible for environmental pollution, health hazards to human beings, toxic to pollinators, pest resurgence, development of resistance in insect-pests and residue in oil and cake (Singh, 2001; Singh and Sharma, 2002). An eco and user friendly pest control approach against mustard aphid is the necessity of present time to safeguard the natural enemies and pollinators as well as human health. Keeping the above facts in mind the present investigation was undertaken to evaluate the eco-friendly bio-products.

MATERIALS AND METHODS

The present investigation was carried out at Directorate of Rapeseed-Mustard Research, Sewar (Bharatpur), Rajasthan during Rabi season of the year 2008-09. Experiment was conducted in a complete randomized block design with 3 replications having plot size of 4.2 x 3m and spacing between row to row and plant to plant as 30cm and 10cm respectively. The mustard cultivar used was Pusa Jai Kisan (BIO-902) sown on November 6th 2008 and all the standard agronomic practices were followed to raise the good crop. Ten treatments including control i.e. *Verticillium lecanii* @ 5 g per litre of water, *Beauveria bassiana* @ 5 g per litre of water, *Metarhizium anisopliae* @ 5 g per litre of water, cow urine @ 50 litre per ha, tobacco extract @ 5%, onion extract @ 5%, neem seed kernel extract (NSKE) @ 5%, dimethoate 30 EC @ 300 g a.i/ha and water spray were applied with the help of hand operated knapsack sprayer. Aphid population was counted on 10 randomly selected tagged plants per plot one day before and 3, 7 and 10 days after spray on 10cm top twig per plant and population of natural enemies and honeybees also recorded. Yield was recorded from net plot area and converted in to kilogram per ha and data were statistically analyzed. Observations on phytotoxicity was taken visually on crop injury using 0-10 scale considering the following symptoms *i.e.* leaf injury on the tips and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty. The incremental cost-benefit ratio was calculated by prevailing market price of mustard seed, cost of insecticides and labourers used with the following formulae.

Cost Benefit Ratio = Additional Profit over the control – Cost

of Treatment

RESULTS AND DISCUSSION

Bio-efficacy

Significantly low (10.55-30.03 aphid/plant) population of mustard aphid was recorded after 10 days of spray in the treatments viz., *V. lecanii* @ 5 g per litre of water, *B. bassiana* @ 5 g per litre of water, *M. anisopliae* @ 5 g per litre of water, cow urine @ 50 litre per ha, tobacco extract @ 5%, onion extract @ 5%, NSKE @ 5% and dimethoate 30 EC @ 300 g a.i/ha over control (170.75 aphid/plant) while among the treatments no significant difference was observed in aphid population at 3, 7 and 10 days after spray. The data clearly indicate that water spray alone did not provide any significant reduction of mustard aphid population at any stage. The per cent reduction of aphid population after 10 days of spray was maximum under dimethoate 30 EC @ 300 g a.i/ha (91.00%) followed by NSKE @ 5% (83.20%), *B. bassiana* @ 5 g per litre of water (78.00%), cow urine @ 50 litre per ha (76.33%), onion extract @ 5% (76.00%), tobacco extract @ 5% (75.40%), *V. lecanii* @ 5 g per litre of water (75.0%) and *M. anisopliae* @ 5 g per litre of water (74.0%). Significantly higher yield of mustard seed (2017-2460 kg/ha) was recorded in all treatments over the water spray (1633 kg/ha) and control treatment (1610 kg/ha). The highest yield was obtained in dimethoate 30 EC @ 300 g a.i/ha (2460 kg/ha) followed by NSKE @ 5% (2358 kg/ha), cow urine @ 50 litre per ha (2133 kg/ha), onion extract @ 5% (2125 kg/ha), *B. bassiana* @ 5 g per litre of water (2108 kg/ha), tobacco extract @ 5% (2092 kg/ha), *V. lecanii* @ 5 g per litre of water (2067 kg/ha) and *M. anisopliae* @ 5 g per litre of water (2017 kg/ha). Among the treatments significantly higher yield was recorded in dimethoate 30 EC @ 300 g a.i/ha (2460 kg/ha) over the *V. lecanii* @ 5 g per litre of water (2067 kg/ha) and *M. anisopliae* @ 5 g per litre of water (2017 kg/ha) (table 1). Singh and Singh (2009) observed a significantly higher yield of mustard seed under dimethoate 30 EC @ 300 g a.i./ha. Rahman and Saikia (2005) reported that the maximum reduction of *L. erysimi* population in the treatment of Econeem (0.1%) followed by *Acorus calamus* (3.5%), *Nicotiana tabacum* (3%), neem (3%) and *Polygonum hydropiper* (3.5%). Gupta (2005) recorded highest mean grain yield in phosphamidon @ 0.04% (1836 kg/ha) followed by neem oil @ 1% + dimethoate @ 0.03% (1541 kg/ha) and neem kernel extracts @ 3% (1508 kg/ha). Singh *et al*. (2008) evaluated *V. lecanii* @ 10^8 spores/ml of water against mustard aphid in the field and found some promising results provided sufficient relative humidity in the atmosphere. Singh and Lal (2009) found that neem seed kernel extract @ 5%, neem leaf extract @ 5% and neem oil @ 2% effective in reducing the mustard aphid population. Kumar and Singh (2009) reported

Table 1: Efficacy of microbial and bio-products against mustard aphid, *Lipaphis erysimi* (Kalt.)

Treatments	Mean aphid population on main shoot (top 10 cm/plant)				MustardAphid percent reduction(%)	Phytotoxicity rating	Seed yield (kg/ha)
	Pre-treatment	3 DAS	7 DAS	10 DAS			
Verticillium lecanii (5g/L.)	90.43	27.13	24.42	22.61	75.00	0	2067
Beauveria bassiana (5g/L.)	108.93	29.41	26.14	23.96	78.00	0	2108
Metarhizium anisopliae (5g/L.)	115.50	35.80	32.34	30.03	74.00	0	2017
Cow urine (50L/h)	118.38	33.94	30.39	28.02	76.33	0	2133
Tobacco extracts (5%)	108.56	32.13	28.88	26.71	75.40	0	2092
Onion extract (5%)	105.63	30.63	27.46	25.35	76.00	0	2125
Neem seed kernel extracts (5%)	115.26	25.13	21.67	19.36	83.20	0	2358
Dimethoate (300g.a.i/h)	117.28	16.42	12.90	10.55	91.00	0	2460
Water spray	98.33	117.12	130.18	158.55	-	0	1633
Control	112.13	190.20	211.30	170.75	-	0	1610
S.Em ±	12.14	14.28	16.23	15.47	-	-	120.34
C.D. (P = 0.05)	-	-	-	-	-	-	361

DAS = Days after spray

Table 2: Impact of microbial and bio-products on the beneficial insect fauna

Treatments	Beneficial insect fauna	Mean population of natural enemies of mustard aphid and honeybees (No./plant)			
		Pre-treatment	3 DAS	7 DAS	10 DAS
Verticillium lecanii (5g/l.)	CoccinellidsSyrphid flies Honeybees	0.360.231.28	0.290.180.69	0.420.201.54	0.700.360.50
Beauveria bassiana (5g/l.)	CoccinellidsSyrphid flies Honeybees	0.420.201.37	0.300.130.92	0.390.401.40	0.670.460.35
Metarhizium anisopliae (5g/l.)	Coccinellids Syrphid flies Honeybees	0.350.331.48	0.260.270.87	0.450.291.30	0.640.380.28
Cow urine (50 l/h)	Coccinellids Syrphid flies Honeybees	0.400.211.30	0.250.170.67	0.370.201.55	0.680.400.50
Tobacco extracts (5%)	Coccinellids Syrphid flies Honeybees	0.370.241.43	0.270.200.72	0.430.321.53	0.670.420.45
Onion extract (5%)	Coccinellids Syrphid flies Honeybees	0.340.221.27	0.230.160.73	0.390.401.48	0.630.480.46
Neem seed kernel extracts (5%)	Coccinellids Syrphid flies Honeybees	0.320.251.35	0.260.200.82	0.420.241.51	0.690.420.45
Dimethoate (300g.a.i/h)	Coccinellids Syrphid flies Honeybees	0.300.291.45	0.240.130.53	0.360.191.28	0.600.350.25
Water spray	Coccinellids Syrphid flies Honeybees	0.440.361.43	0.480.301.52	0.520.401.64	0.740.640.60
Control	Coccinellids Syrphid flies Honeybees	0.400.271.30	0.490.351.54	0.590.471.63	0.830.650.62
S.Em ±	Coccinellids Syrphid flies Honeybees	0.070.050.09	0.020.08o.18	0.080.100.12	0.090.110.13
C.D. (P = 0.05)	CoccinellidsSyrphid flies Honeybees	0.220.130.25	0.300.230.52	0.240.290.36	0.270.320.38

DAS = Days after spray

Table 3: Economics of microbial and bio-products against mustard aphid, *Lipaphis erysimi* (Kalt.)

Treatments (doses/concentration)	Unit price (Rs/kg)	Quantity of treatment required (lit/kg)	Cost of treatment (Rs/ha)(a)	Labour charge (R/has)(b)	Cost of treatment(A) + adjuvant + Labour(B) = C	Unite of mustard (Rs/q)(D)	Yield of mustard (kg/ ha)	Increased yield over control (kg/ha)(E)	Value of increased yield(Rs/ha) (D x E) = F	Net profit over control (Rs/ha)(C-F) = G	Cost Benefit Ratio (C.B.R) C:F
Verticillium lecanii (5g/l.)	75	11.34	850	242	1092	2200	2067	457	10054	8962	1: 9
Beauveria bassiana (5g/l.)	75	11.34	850	242	1092	2200	2108	498	10956	9864	1: 10
Metarhizium anisopliae (5g/l.)	75	11.34	850	242	1092	2200	2017	407	8954	7862	1: 8
Cow urine (50 l/h)	10	50.00	500	242	992	2200	2133	523	11506	10514	1: 11
Tobacco extracts (5%)	70	13.23	926	242	1418	2200	2092	482	10604	9186	1: 6
Onion extract (5%)	12	13.23	159	242	651	2200	2125	515	11330	10679	1: 17
Neem seed kernel extracts (5%)	30	13.23	397	242	889	2200	2358	748	16456	15567	1: 18
Dimethoate (300g.a.i/h)	240	1.00	240	242	482	2200	2460	850	18700	18212	1: 38
Water spray	-	-	-	242	242	2200	1633	23	506	264	1: 2
Control	-	-	-	-	-	-	1610	-	-	-	-

that use of *V. lecanii* alone provided good aphid control and also in combination with *C. carnea* and oxy-demeton methyl. These studies support the present investigation.

Phytotoxicity

No phytotoxic symptoms were observed in any treatment. The phytotoxicity rating recorded was zero under all the treatments and no abnormality was observed in the crop (Table 1).

Toxicity to natural enemies and honeybee

No significant difference in the coccinellids and syrphid fly population was observed under any treatment at 3, 7 and 10 days after spray as compared with control. Among the treatments no significant difference in the population of the predator was observed under any treatment at 3, 7 and 10 days after spraying. The population of coccinelids per plant at 10 days was found lowest dimethoate 30 EC @ 300 g a.i/ha (0.60 adult and grub/plant) in comparision to control (0.83 adult and grub/plant) and in case of syrphid fly 0.35 and 0.65 adult/plant respectively. Water spray did not provide any toxicity to the predators as population was more or less equal to control. Honey bees population was recorded low in all treatments at 3rd day of spray however no significant difference in population was found at 3, 7 and 10 days after spraying except in dimethoate 30 EC @ 300 g a.i/ha. Honeybee population was found low at 10th day after spray in all treatments due to pod formation in the crop (Table 2). Dhingra *et al*. (2006) found the maximum population of coccinellid (*C. septempunctata*) in the treatment of thermo and photostable tetrahydro azadirachtin-A (THA) followed by azadirachtin and lowest in oxy-demeton methyl, neem oil EC and Neemazal. Patel *et al*. (2009) observed rich activity of bio-agents *i.e.* syrphid fly, coccinellids and *D. rapae* in mustard when they used neem oil based formulation @ 0.3% and tobacco decoction @ 16.6 g/litre supporting the present investigation.

Incremental cost-benefit ratio

Cost benefit analysis of the crop indicated that maximum increase in the yield was obtained under the treatment i.e. dimethoate 30 EC @ 300 g a.i/ha (850 kg) followed by NSKE @ 5% (748 kg), cow urine @ 50 litre per ha (523 kg), onion extract @ 5% (515 kg), *B. bassiana* @ 5 g per litre of water (498 kg), tobacco extract @ 5% (482 kg), *V. lecanii* @ 5 g per litre of water (457 kg), *M. anisopliae* @ 5 g per litre of water (407 kg) and water spray (23 kg) while the expenditure on plant protection was Rs.482, Rs.889, Rs.651, Rs.1418, Rs.992, Rs.1092, Rs.1092, Rs.1092 and Rs. 242 respectively.. The price of mustard seed taken in to account was Rs.2200/- per quintal. Most favorable cost-benefit ratio was obtained under the treatment *i.e.* dimethoate 30 EC @ 300 g a.i/ha (1:38) followed by NSKE @ 5% (1:18), onion extract @ 5% (1:17), cow urine @ 50 litre per ha (1:11), *B. bassiana* @ 5 g per litre of water (1:10), *V. lecanii* @ 5 g per litre of water (1:9), *M. anisopliae* @ 5 g per litre of water (1:8), tobacco extract @ 5% (1:6) and water spray (1:2)(table 3). Akhauri and Singh (2009) reported the cost benefit ratio of some chemical insecticides and bio-products against mustard aphid and found that highest return (1:24.6) was obtained in NSKE @ 5% followed by dimethoate 30EC (22.7), imidacloprid 17.8 SL (19.4), beta-cyhalothrin (18.1), neem oil (15.9), endosulfan (14.4) and

diflubenzuron (9.0) and is in corroboration to the present study.

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