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Research Article

Bioefficacy of *Beauveria bassiana* (Balsamo) Vuillemin against *Hyadaphis coriandri* (Das) on coriander and *Aphis craccivora* Koch on fenugreek

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ABSTRACT: The field efficacy of *Beauveria bassiana* in comparison with the commercial formulation of *B. bassiana* (Daman) and standard check malathion 50 EC against *Hydaphis coriandri* and *Aphis craccivora* showed significant variations among pre-treatment and post-treatment counts. *H coriandri,* one day after treatment (DAT) a significant reduction (70.22%) in the aphid population was observed in malathion 50 EC (0.05%) followed by Daman (15.22%). At 7 DAT, the highest population reduction was 92.81% in malathion 50 EC followed by Daman (83.41%) was recorded, whereas in *A.craccivora* one-DAT, a significant reduction (68.42%) in the aphid population was observed in malathion 50 EC (0.05%) followed by Daman (10.70%). At 7 DAT, the highest population reduction was 90.0% in malathion 50 EC followed by Daman 81.34% were observed. Daman showed significantly high percent of reduction (54.60%) and (47.35%) in *H coriandri and A.craccivora*, respectively. However, the standard check, malathion 50 EC were highly toxic and showed significantly high percentage reduction (84.85%) and (82.55%) in the both the aphids population.

KEY WORDS: *Beauveria bassiana, Hyadaphis coriandri, Aphis craccivora*, malathion

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INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an annual aromatic herb native to the Mediterranean region. It is grown both for green vegetable as well as seed purposes. The seeds and leaves contain essential oil, which accounts for aromatic character of the plant (Sankracharya and Sankaranarayana, 1989). Fenugreek (*Trigonella foenum-graecum* L.) is an important seed spice crop. The fresh tender leaves and stems of this crop are consumed as curried vegetable and seeds are mainly used as spice for flavouring almost all vegetable dishes and pickles (Kumar *et al.*, 1993). Coriander is attacked by a number of insects pests, *viz.*, coriander aphid, chalcid fly, whitefly, semilooper, etc. (Mittal and Butani, 1994) and fenugreek is mainly attacked by aphid, alfalfa weevil, leaf miner (Sharma and Kalra, 2002). Among these, *Hyadaphis coriandri* (Das) on coriander and *Aphis craccivora* (Koch) on fenugreek are the most important insect pests and quite often proved as the yield limiting factors in the successful seed production of these crops. *Hyadaphis coriandri* causes yield losses up to 530 kg ha^{-1} in coriander (Mittal and Butani, 1989). During the flowering stage, a population of 55-70 aphids /5 plants could reduce yield by 50 per cent (Jain, and Yadav, 1989). Losses caused by *A. craccivora* on fenugreek were up to 68.8 per cent (Sharma and Kalra, 2002).

Management of this pest becomes increasingly difficult and health risks associated with indiscriminate use of pesticides to control of insect pests of crops. This has initiated the use of biological control agents as an important and alternate control practice. For sucking insects, entomopathogenic fungi are one of the most appropriate microbial bioagents as they infect the insect cuticle directly through contact and do not require to be ingested for infection to set in.

Fungi are the only insect pathogens currently used for control of aphids (Latge and Papierok, 1988) and several fungal species like, *Beauveria bassiana* (Balsamo) Vuillemin and *Metarhizium anisopliae* (Metschnikoff) Sorokin (Liu *et al.*, 1999; Ekesi *et al.*, 2000), *Fusarium pallidoroseum* (Sunitha and Mathai, 1999) and *Paecilomyces fumosoroseus* (Wize) Brown and Smith have been reported pathogenic to aphids (Chen and Feng, 1999).

Currently, the most widely used fungal insecticide is *Beauveria bassiana* and found effective against *A. craccivora, A. gossypii, Rhopalosiphum maidis, Ceratovacuna lanigera, Bemisia tabaci* and *Thrips tabaci*.

However, full potential of entomopathogenic fungi has not been exploited. A key aim of recent work has been to evaluate bioefficacy of *B. bassiana* against *H. coriandri* on coriander and *A. craccivora* on fenugreek under field conditions were undertaken as limited reports are available in literature on the use of entomophagous fungus.

MATERIALS AND METHODS

A field experiment was conducted during October 2007 – March, 2008 to evaluate the bioefficacy of *B. bassiana* against *H. coriandri* on coriander variety Hisar Anand *and A. craccivora* on fenugreek variety Hisar Sonali with plot size of 3 x 2.5 m and spacing is 30 x 10 cm. Malathion 50EC (0.05%) was considered as standard check. The experiment was carried out in a randomized block design with 10 treatments, each replicated four times.

Beauveria bassiana *culture and suspension preparation*

The culture of HaBa (Hyderabad) strain was raised on Potato Dextrose Agar (PDA) slants in 250 ml conical flasks following the standard method (Vimala Devi, 2003). Regular passing is done for further multiplication and maintenance which was done at 25 ± 2°C, >90% relative humidity and 16: 8h light: dark. Aqueous conidial suspension was made from conidia harvested from the slants preferred in conical flasks after 14 days of inoculation. Tween 80 (0.02%) was used to disperse the conidia. The conidial suspension was filtered through muslin cloth. A suspension of 1×10^{10} conidia ml^{-1} concentration was made using haemocytometer counts. The lower conidial concentrations were obtained from the serial dilutions. Daman is a commercial formulation of *Beauveria bassiana* sprayed at recommended rate (2×10^{6}) conidia ml^{-1} concentration was made using haemocytometer counts.

Procedure

The incidence was first recorded in the first week of February and last week of January, *H. coriandri* and *A. craccicora*, respectively. The infested umbels / twigs were tagged randomly ten plants/plot to count the number of aphids (only top 5 cm umbels / twigs) one day before spray and subsequent observations (mortality) were made 1, 2, 3, 4, 5, 6 and 7 day after treatment on same plant. Spraying was done during evening hour. Similar treatments were applied on fenugreek also. The data was subjected to analysis of variance. One-way analysis of variance (ANOVA) was conducted on the mortality data to test the level of significance of the difference in response between treatments. The data obtained in percentage were transformed to corresponding angles (arc sine / percentage). The mean values of treatments were then separated using Duncan's multiple range test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSION

Efficacy of B. bassiana *against* H. coriandri *on coriander*

The data on the field efficacy of *B. bassiana* in comparison with Daman and standard check malathion against *H. coriandri* showed significant variations among pre-treatment and post-treatment counts presented in Table 1. No information is available in the literature on the use of *B. bassiana* against *H. coriandri* under field conditions. However, Poprawski *et al.* (1999) conducted a field trials of *B. bassiana* based mycoinsecticide Mycotrol ES against brown citrus aphid, *Toxoptera citricida,* and they revealed that mycotrol provided relatively rapid kill of 79.8 and 94.4 per cent with 2.5×10^{13} and 5×10^{13} conidia per hectare, respectively. In the present study, *B. bassiana* was found to be effective against *H. coriandri* to an extent of 81.87 per cent at highest concentration seven days after treatment. However, Daman showed highest mortality (83.41%) then laboratory mass multiplied *B. bassiana* strains, however, Malathion (0.05%) caused highest aphid population reduction (92.81%). The mean per cent reduction in the aphid population was observed in highest concentration of *B. bassiana* (1×10^{11} spores ml^{-1}) treatment (50.01%) whereas, Daman showed highest mean per cent reduction in the aphid population (54.60%). However, the standard check malathion 50EC recorded significantly more aphid reduction (84.85%). While, Lingappa *et al.* (2003) evaluated some entomopathogenic fungi against sugarcane woolly aphid, *Ceratovacana langera* and found *M. anisopliae* to be effective in preliminary studies.

The present finding are in close agreement with that of Justin *et al.* (2004) who reported that commercial formulation based on *B. bassiana,* Mycotrol was highly effective against Russian wheat aphid, *Diuraphis noxia.* At 2.4 litre (5×10^{13} conidia ml^{-1}) per hectare + 0.1% organosilicone surfactant, 65% aphid population reduction was observed.

Efficacy of B. bassiana *against* A. craccivora *on fenugreek*

The data on the field efficacy of fungal pathogen, *B. bassiana* in comparison with Daman and the standard check malathion (0.05%) against *Aphis craccivora* showed significant variation among pre-treatment and post treatment counts presented in Table 2. Very little information is available in the literature on the use of *B. bassiana* against *A. craccivora* under field conditions. Saranya *et al.* (2009) the preliminary studies were carried out and reported that *V. lacanii, H. thomsonii and B. bassiana* were found to be the promising virulent isolates under field conditions.

By testing their field efficacy, they can be used as potential biocontrol agent for the management of cowpea aphid. However, earlier studies conducted by Dorschner *et al.* (1991) reported 100 per cent mortality in hop aphids

Table 1. Efficacy of *Beauveria bassiana* (spores ml^{-1}) against *Hyadaphis coriandri* on coriander under field conditions

Treatments (spores ml^{-1})	Aphid population per cent reduction at				
	PTC	**1 DAT**	**2 DAT**	**3 DAT**	**4 DAT**
1 x 10^{10} (ME-GH)	90.90	5.94(18.89)^{b}	21.59(27.87)^{c}	31.38(36.55)^{e}	41.14(42.28)^{c}
1 x 10^{10} (ME-LB)	98.55	6.12(18.81)^{b}	18.26(25.75)^{c}	32.54(34.30)^{de}	42.98(40.84)^{c}
1 x 10^{9} (LME-LB)	95.70	4.85(17.26)^{b}	16.61(24.70)^{c}	30.58(36.95)^{cde}	35.26(41.73)^{c}
1 x 10^{11} (HME-LB)	107.65	9.52(21.51)^{b}	24.41(33.63)^{bc}	41.14(45.51)^{bc}	46.11(52.40)^{b}
1 x 10^{9} (LME-GH)	110.65	7.13(19.65)^{b}	20.36(28.01) ^{c}	37.16(40.09)^{cde}	37.39(44.03)^{c}
1 x 10^{11} (HME-GH)	93.25	8.58(21.25)^{b}	25.02(28.73)^{bc}	44.61(43.09)^{bcd}	51.53(53.91)^{b}
Daman (2 x 10^{6})	100.40	15.22(22.09)^{b}	33.88(36.61)^{b}	47.54(48.79)^{b}	56.77(52.54)^{b}
Malathion 50EC (0.05%)	110.10	70.22(57.31)^{a}	79.54(65.83)^{a}	84.37(72.75)^{a}	87.28(78.00)^{a}
Tween 80 (0.02%)	109.20	0.01(11.24)	2.67(19.23)^{d}	2.94(29.41)^{b}	3.50(29.45)^{d}
Control (No spray)	122.20	–	–	–	–
SEM±	–	(6.04)	(3.75)	(4.73)	(4.19)
CD (P = 0.05)		(16.99)	(10.54)	(13.29)	(11.80)

Treatments (spores ml^{-1})	Aphid population per cent reduction at			
	5 DAT	6 DAT	7 DAT	Mean
1 x 10^{10} (ME-GH)	57.93(50.03)^{c}	60.96(56.97)^{c}	77.71(63.87)^{c}	42.37(42.67)^{c}
1 x 10^{10} (ME-LB)	55.27(48.43)^{c}	61.89(54.92)^{c}	76.42(62.13)^{c}	41.93(40.91)^{c}
1 x 10^{9} (LME-LB)	54.13(48.55)^{c}	59.31(54.59)^{c}	71.46(59.33)^{c}	38.89(40.71)^{c}
1 x 10^{11} (HME-LB)	70.99(58.81)^{b}	76.25(67.06)^{c}	81.71(74.02)^{b}	50..01(50.75)^{b}
1 x 10^{9} (LME-GH)	52.94(49.26)^{c}	63.12(56.29)^{c}	75.74(61.85)^{c}	41.69(43.15)^{c}
1 x 10^{11} (HME-GH)	62.06(58.40)^{b}	75.97(70.01)^{b}	81.87(77.00)^{ab}	49.53(50.55)^{b}
Daman (2 x 10^{6})	64.90(62.62)^{b}	80.52(72.14)^{b}	83.41(80.82)^{ab}	54.60(54.48)^{b}
Malathion 50EC (0.05%)	89.57(81.68)^{a}	90.21(86.49)^{a}	92.81(68.90)^{a}	84.85(75.85)^{a}
Tween 80 (0.02%)	4.74(30.06)^{b}	5.68(31.57)^{d}	6.48(30.62)^{d}	4.55(27.57)^{d}
Control (No spray)	–	–	–	–
SEM±	(4.19)	(3.84)	(3.08)	(1.68)
CD (P = 0.05)	(11.79)	(10.80)	(8.68)	(4.166)

(*Phorodon humuli*) exposed to *B. bassiana* under field conditions. In the present studies *B. bassiana* was found to be effective against *A. craccivora* to an extent of 79.11% at highest concentration seven days after treatment, whereas Daman showed higher mortality (81.34%) as compared to laboratory mass multiplied *B. bassiana* strains. However, malathion showed highest aphid population reduction (90.00%).

The mean per cent reduction in the aphid population was observed in highest concentration of treatment (44.60%), whereas Daman showed highest mean per cent reduction in the aphid population (47.35%). However, laboratory mass multiplied strains showed 34.15-44.60 per cent reduction. The standard check malathion recorded significantly more reduction (82.55%). Rosalind *et al.* (1995) reported that aphid derived strain of *B. bassiana* (1x10^{15} spores ml^{-1}) reduced pea aphids population up to 97.9 per cent under field conditions while during present studies, *B. bassiana* was found effective against *A. craccivora* on fenugreek to an extent of 44.60 per cent

Table 2. Efficacy of *Beauveria bassiana* (spores ml^{-1}) against *Aphis craccivora* on fenugreek under field conditions

Treatments (spores ml^{-1})	Aphid population per cent reduction at				
	PTC	**1 DAT**	**2 DAT**	**3 DAT**	**4 DAT**
1 x 1010 (ME-GH)	21.30	0.01(9.58)bc	5.62(16.71)bc	23.91(29.47)b	40.62(39.34)b
1 x 1010 (ME-LB)	24.95	0.01 (10.05)b	8.60(21.25)bc	24.46(33.00)b	44.25(42.74)b
1 x 109 (LME-LB)	25.95	0.01(12.08)bc	4.18(16.07)c	20.27(31.38)b	36.47(42.90)b
1 x 1011 (HME-LB)	21.85	0.01(7.20)bc	10.61(20.08)bc	30.73(32.87)b	49.86(45.90)b
1 x 109 (LME-GH)	26.25	0.01(6.02)bc	5.36(16.01)bc	24.25(29.58)b	35.35(42.11)b
1 x 1011 (HME-GH)	21.15	0.01(9.29)bc	5.64(17.84)bc	28.46(30.04)b	42.70(40.72)b
Daman (2 x 106)	27.90	10.70(9.86)b	11.97(20.76)b	32.20(32.98)b	53.06(47.74)b
Malathion 50EC (0.05%)	23.45	68.42(61.76)a	75.66(69.59)a	81.76(73.52)a	86.04(80.15)a
Tween 80 (0.02%)	24.25	0.01(12.34)	0.01(12.34)	2.00(22.41)c	2.72(26.94)c
Control (No spray)	26.30	–	–	–	–
SEM±		(3.07)	(3.60)	(4.35)	(4.58)
CD (P = 0.05)		(8.65)	(10.14)	(12.23)	(12.87)

Treatments (spores ml^{-1})	Aphid population per cent reduction at			
	5 DAT	6 DAT	7 DAT	Mean
1 x 1010 (ME-GH)	56.89(49.82)c	71.49(59.42)b	73.27(68.15)bc	38.08(41.30)d
1 x 1010 (ME-LB)	53.45(56.38)bc	63.83(67.49)b	71.33(75.37)abc	37.99(45.18)bc
1 x 109 (LME-LB)	51.81(55.28)bc	59.10(65.64)b	67.26(71.93)abc	34.15(45.25)cd
1 x 1011 (HME-LB)	65.85(56.03)bc	76.03(66.42)b	79.11(75.73)abc	44.60(45.92)bc
1 x 109 (LME-GH)	55.02(53.88)bc	61.27(68.01)b	68.43(73.90)abc	35.67(43.59)cd
1 x 1011 (HME-GH)	67.86(49.71)c	75.06(59.89)b	77.54(67.47)c	42.51(42.11)d
Daman (2 x 106)	62.98(62.38)b	79.24(71.22)b	81.34(83.17)ab	47.35(49.55)b
Malathion 50EC 0.05%	87.01(86.61)a	89.00(89.96)a	90.00(89.96)a	82.55(78.79)a
Tween 80 (0.02%)	2.80(28.96)d	2.81(25.14)c	3.32(32.07)d	1.95(22.29)e
Control (No spray)	–	–	–	–
SEM±	(4.66)	(4.61)	(4.25)	(1.59)
CD (P = 0.05)	(13.10)	(12.97)	(11.97)	(4.47)

ME-GH – most effect under greenhouse; ME-LB – most effect under laboratory; LME-LB – Lower than most effect; under laboratory; HME-LB – Higher than most effect under laboratory; LME-GH – Lower than most effect under greenhouse; HME-GH – Higher than most effect under greenhouse; PTC = pre-treatment count; DAT = days after treatment; in columns, means followed by a common letter are not statistically different by DMRT (P = 0.05); values in parentheses are arc sine transformations

under field conditions. Standard checks malathion showed highest per cent reduction followed by Daman.

The field studies at Arabhari, Karanataka with oil in water emulsion formulation of *M. anisopliae* caused 42.26 per cent mycosis in sugarcane woolly aphid, *C. lanigera* (Nirmala, 2003), while Aruna Jothi (2006) reported that *M. anisopliae* alone showed reduction (14.21%) in *C. lanigera* under field conditions. The standard checks, endosulfan and malathion recorded highest per cent reduction (78.93 and 71.76%, respectively) in aphid population. The mean aphid population reduction from 1.95 – 82.55 per cent was observed. Among all the treatments malathion showed highest population reduction (82.55%) followed by Daman (47.35%) than all other treatments in the experiments. *H. coriandri* showed highest population reduction throughout the experimental period than the *A. craccivora,* which indicated that *B. bassiana* and malathion (0.05%) were highly effective against *H. coriandri* than *A. craccivora*.

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