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EVALUATION OF ENTOMOPATHOGENIC FUNGI AGAINST *BEMISIA TABACI* (GENNADIUS) IN CAPSICUM UNDER PROTECTED CULTIVATION

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ABSTRACT

Effect of indigenous isolates of *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillum lecanii* were tested for two years during 2012 and 2013 on *Bemisia tabaci* infesting capsicum under protected cultivation. Among the ten isolates tested, NBAIR-Vl8 isolate of *L. lecanii*, NBAIR-Bb5a and NBAIR-Bb9 isolates of *B. bassiana* showed significant suppression of *Bemisia tabaci* (Genn.) with reduction of 73.15, 71.84 and 63.10% respectively. The yields were also superior in these treatments.

Key words: *Bemisia tabaci*, entomopathogenic fungi, Capsicum, protected cultivation, *Beauveria bassiana*, *Metarhizium anisopliae, Lecanicillum lecanii*, indigenous isolates, NBAIR- V18, NBAIR- Bb5a, NBAIR- Bb9

Bell pepper (*Capsicum annuum* L) is one of the most popular and highly remunerative vegetable and is intensively cultivated in Karnataka, Tamil Nadu, Maharashtra, Himachal Pradesh and hilly areas of Uttar Pradesh. Capsicum cultivation under protected conditions is gaining popularity in periurban production system because of easy access to urban markets. Various biotic, abiotic and physiological factors are encountered by the farmers which resulted in low productivity and poor quality produce. Sucking pests, especially whitefly *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) is considered a serious problem on capsicum crop in polyhouse cultivation, as they multiply in large numbers and cause significant crop loss under controlled conditions of temperature and humidity. It is a serious threat to crop production not only by direct damage but also by transmitting several plant viruses (Oliveira et al., 2001; Jones, 2003). *B. tabaci* is among the most devastating and widespread pest of a broad range of greenhouse and field crops worldwide. *B. tabaci* attacks more than 500 species of plants (Greathead, 1986) from 63 plant families (Mound and Halsey, 1978). Now-a-days whiteflies show resistance to insecticides due to indiscriminate use, and this causes many non-target effects (Sharma, 2009). Among biocontrol agents, entomopathogenic fungi possess the unique ability to infect their host directly through the integument. Moreover, they play a role in their natural mortality (Lacey et al., 1996). These can be easily mass multiplied, formulated and applied in the field using simple spraying techniques. Since favourable conditions of moderate temperature and humidity are maintained in polyhouse, the applied entomopathogenic fungi can multiply rapidly and give better control. The present study was taken up to develop a safe and environmental friendly control measure for capsicum whitefly under protected cultivation using entomopathogenic fungi.

MATERIALS AND METHODS

Four isolates of *Beauveria bassiana* (NBAIR Bb-5a, Bb-36, Bb-68 and Bb-9), three isolates of *Metarhizium anisopliae* (NBAIR Ma-42, Ma-41 and Ma-6) and three isolates of *Lecanicillium* spp (NBAIR Vl-8, Vl-12 and Vl-32) from ICAR-NBAIR culture repository were used for this experiment. Fungal isolates were grown on sterilized broken rice grains (100 grams) taken in polypropylene bags for 15days at 26± 1°C after inoculation with 4day-old shaker cultures grown on Sabouraud's Dextrose Yeast extract broth (SDYB) medium. Sporulated rice grains were dried aseptically at room temperature of 26-30°C for two days and the spores were harvested using 300µm sieve. Oil formulations were prepared using harvested spore dust, sterilized liquid paraffin oil, glycerol and Tween 80 with spore load of 1x 10^8 spores/ml. The trials were conducted under polyhouse conditions at ICAR-NBAIR, Yelahanka Farm, Bengaluru, India during July-October in 2012 and 2013 using capsicum variety Indira. The experiment was laid out in randomized block design (RBD) with three replications with a plot size of 1.2x 2 m and spacing of 60x 30 cm containing 30 plants. All agronomic practices were followed as per the package of practices of University of Horticultural Sciences

Table 1. Effect of entomopathogenic fungi on incidence of whitefly *B. tabaci* and yield in capsicum

Sl. No.	Isolate	2012				2013				Pooled				
		No. of whiteflies/ plant	% reduction over control	Yield (kg)/ Plant	Yield t/ ha	No. of whiteflies/ plant	% reduction over control	Yield (kg)/ Plant	Yield t/ ha	No. of whiteflies/ plant	% reduction over control	Yield (kg)/ Plant	Yield t/ ha	C:B ratio
1	Bb-5a	7.12^{a} (2.76)	66.67	2.18^{ab} (1.64)	104.9	6.98^{a} (2.73)	75.12	2.42^{a} (1.71)	118.1	7.05^{a} (2.66)	71.84	2.30^{ab} (1.67)	111.5	3.25
2	Bb-36	16.96^{bc} (4.18)	20.60	1.82^{cde} (1.52)	85.1	20.18^{b} (4.55)	30.24	1.94^{de} (1.56)	91.7	18.57^{bc} (4.37)	25.42	1.88^{de} (1.54)	88.4	2.46
3	Bb-68	14.11^{ab} (3.82)	34.09	1.98^{bc} (1.57)	93.9	17.36^{b} (4.23)	38.27	1.78^{ef} (1.51)	82.9	15.73^{b} (4.03)	36.18	1.88^{de} (1.54)	88.4	2.46
4	Bb-9	8.39^{ab} (2.98)	60.73	2.12^{ab} (1.62)	101.6	9.71^{ab} (3.20)	65.47	2.38^{ab} (1.70)	115.9	9.05^{ab} (3.09)	63.10	2.25^{ab} (1.66)	108.8	3.14
5	Ma-42	19.41^{bc} (4.46)	9.13	2.01^{bc} (1.58)	95.6	19.98^{b} (4.53)	28.95	1.86^{ef} (1.54)	87.3	19.70^{bc} (4.49)	19.04	1.94^{cd} (1.56)	91.4	2.56
6	Ma-41	15.84^{bc} (4.04)	25.85	1.62^{de} (1.46)	74.1	12.53^{ab} (3.61)	55.45	2.19^{bc} (1.64)	105.5	14.78^{b} (3.91)	40.65	1.91^{cd} (1.55)	89.8	2.51
7	Ma-6	17.19^{bc} (4.21)	19.53	1.52^{def} (1.42)	68.6	16.23^{b} (4.09)	42.29	1.92^{de} (1.56)	90.6	16.71^{b} (4.15)	30.91	1.72^{ef} (1.49)	79.6	2.16
8	Vl-8	6.18^{a} (2.58)	71.17	2.36^{a} (1.69)	114.8	6.47^{a} (2.64)	77.00	2.56^{a} (1.75)	125.8	6.33^{a} (2.50)	73.15	2.46^{a} (1.72)	120.3	3.53
9	Vl-12	16.78^{bc} (4.16)	21.45	1.48^{f} (1.41)	66.4	15.16^{b} (3.96)	46.09	2.09^{cd} (1.61)	100.0	15.97^{b} (4.06)	33.77	1.79^{def} (1.51)	83.2	2.29
10	Vl-32	16.42^{bc} (4.11)	23.17	1.86^{cd} (1.54)	87.3	13.19^{ab} (3.70)	53.10	2.37^{ab} (1.69)	115.4	14.81^{b} (3.91)	38.14	2.12^{bc} (1.62)	101.3	2.89
11	Control	21.36^{c} (4.68)	-	1.58^{def} (1.44)	71.9	28.12^{c} (5.35)	-	1.68^{f} (1.48)	77.4	24.74^{c} (5.02)	--	1.63^{f} (1.46)	74.7	2.00
CD (p=0.05%)		6.96	-	-	-	7.66	-	-	-	7.87	--	--	--	

Note: Means followed by the similar letters in the columns are not significantly different at (p=0.05) by DMRT; C:B - Cost Benefit ratio

(UHS), Bagalkot, Karnataka, India (Horticultural crops-package of practices, 2012). The foliar sprays of oil formulations of entomopathogenic fungi @ the dose 1x 10^8 cfu/ ml were imposed thrice at 15 days intervals as soon as *B. tabaci* incidence was noticed and the experiment was repeated for two consecutive years. The pre and post count observations on *B. tabaci* incidence were recorded on three leaves/ plant (lower, medium and upper part) at each spray. The data were statistically analysed using SPSS v16 software. The treatment-wise yield of capsicum/ plant were also recorded separately and converted to / ha basis. The cost benefit ratio was calculated for the pooled data based on the formula- BC Ratio =NR/CC where NR- net returns, and CC- cost of cultivation.

RESULTS AND DISCUSSION

The incidence of *B. tabaci* got significantly reduced in all the treatments with entomopathogenic fungi (EPF) during both years as shown in Table 1. During 2012, the incidence ranged from 6.18 to 19.41/ plant in all EPF treated plots as compared to 21.36 whiteflies /plant in the untreated control. Among the ten isolates tested, Vl-8 isolate of *L. muscarium*, Bb-5a and Bb-9 isolates of *B. bassiana* showed the least whitefly incidence (6.18, 7.12 and 8.39 whiteflies/ plant) with reduction of 71.17, 66.67 and 60.73%, respectively over control and were on par with each other. Similarly, during 2013, the least incidence was in the plots treated with Vl-8 isolate of *L. muscarium*, Bb-5a and Bb-9 isolates of *B. bassiana* (6.47, 6.98 and 9.71 whiteflies/ plant) with reduction of 77.0, 75.12 and 65.47%, respectively and at par with each other. The pooled data indicated that Vl-8 isolate of *L. muscarium*, Bb-5a and Bb-9 isolates of *B. bassiana* were superior with reduction of 73.15, 71.84 and 63.1%, respectively which were at par with each other. Singh and Joshi (2020) reported that three foliar applications of *L. lecanii* bioformulation @ 10 and 12 g/ l at 10 days interval showed 60-61% reduction of whitefly in capsicum. Cuthbertson and Walters (2005) demonstrated that the application of *L. muscarium* (Mycotal, Koppert Biological Systems Ltd., UK) resulted in a significant increase in the mortality of sweet potato whitefly *B. tabaci* under glasshouse cultivation. Flores et al., 2015 reported 51.5, 43.5 and 34.6% mortality of *B. tabaci* adults in beans with *B. bassiana*, *M. anisopliae* and *I. fumosorosea* respectively. *L. lecanii* was found most virulent among the fungal isolates tested against *B. tabaci* in tomato crop under greenhouse conditions (Abdel-Raheem and Lamya, 2016). In the present study, *L. muscarium* (Vl-8 isolate) and *B. bassiana* isolates (Bb-5a and Bb-9) showed 63-73% reduction in incidence.

Pooled data of yield revealed significantly higher yields of 120.3, 111.5 and 108.8 t/ ha in the treatments with Vl-8 isolate of *L. muscarium*, Bb-5a and Bb-9 isolates of *B. bassiana*, respectively and were on par with each other. The cost benefit ratio was found highest (3.53) in *L. muscarium* (ICAR-NBAIR-Vl-8) treatment, followed by *B. bassiana* (ICAR-NBAIR-Bb5a) treatment (3.25) and (ICAR-NBAIR-Bb9) treatment (3.14) and the rest of the treatments showed C:B ratio in the range of 2.0-2.56 (Table 1). Sreedhara et al. (2013) reported C:B ratio of 3.92 with chemical insecticide treatment for capsicum pest management under protected conditions, while Rath and Ghosal (2015) observed C:B ratio of 2.98 and 0.80 in chemical insecticide treatment in capsicum under greenhouse and open field conditions, respectively. In the present study, the cost benefit ratio was found 3.14-3.53 in the treatments with *L. muscarium* (Vl-8) and *B. bassiana* (Bb-5a and Bb-9 isolates). *Bemisia tabaci* infestation has been observed regularly in capsicum under protected cultivation in Karnataka, Tamil Nadu, Maharashtra, and Himachal Pradesh in spite of repeated use of insecticides. The results of the present study provide a safe and cost-effective control strategy for capsicum whitefly management. Three rounds of foliar sprays of oil formulations of *L. muscarium* (Vl-8)/*B. bassiana* (Bb-5a/Bb-9) at 15 days intervals @ the dose 1x10^8 cfu/ ml at the initial incidence was found effective.

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