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Research Article

Field evaluation of entomopathogenic fungi against cabbage aphid, *Brevicoryne brassicae* (L.) and their effect on *coccinellid predator, Coccinella septempunctata* (Linnaeus)

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ABSTRACT: The present study was carried out to assess the field efficacy of three isolates of entomopathogenic fungi (EPF) for management of cabbage aphid, *Brevicoryne brassicae*. All the tested isolates showed suppressive effect on aphid. Two-year pooled data revealed lower incidence of 13.9–17.1 aphids/plant in the EPF treated plots compared to higher incidence of 107.5 aphids/plant in untreated control. Significantly higher yields were recorded in the plots treated with Bb-5a, Ma-4 and Vl-8 isolates (28.0, 27.4 and 27.4 t/ha, respectively) compared to untreated control (22.3 t/ha). The populations of predatory coccinellid and spiders in EPF treated and untreated control plots were found statistically non-significant indicating the safety of entomopathogenic fungi to these predators.

KEY WORDS: *Beauveria bassiana, Brevicoryne brassicae, Cabbage, Coccinella septempunctata,* Entomopathogenic fungi, *Lecanicillium lecanii, Metarhizium anisopliae*

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INTRODUCTION

Cabbage (*Brassica oleracea* var *capitata*) is an important vegetable crop in India and many countries of the world (Munthali *et al.,* 2004). In India, cabbage is cultivated in an area of 3.9 lakh ha with 85 lakh tonnes production and productivity of 22 t/ha. In Karnataka, it is grown in an area of 10400 ha with production of 2.2 lakh tonnes and productivity of 20 t/ha (Anon. 2015). Cabbage aphid, *Brevicoryne brassicae (L)* is an important pest of cabbage in all growing areas of the world (Bhatia and Verma, 1994; Dattu and Dattu, 1995). In India, cabbage aphid plays a prominent role in reducing the yield, ranging from 35 to 80% (Rohilla *et al.,* 1987; Ellis and Singh, 1993; .Shoaib, 2003). Cabbage aphid populations tend to build up quickly on infested plants because of its high reproductive capacity and results in stunted growth with deformation of plant (McKinley, 1992). Infestation reduces the quality of the produce through their presence and by contamination of the leaves with exuvae, wax, honeydew and sooty mould that grows on the honeydew (McKinley, 1992).

Major management strategy for cabbage aphid includes use of insecticides. But this is considered as environmentally hazardous as it increases residue problem and resistance development against insecticides. These factors have led to increased interest in finding alternative ways for managing pests. Biocontrol is considered as a safe and effective method. Aphids are attacked by many entomopathogens, predators and parasitoids (Skouras *et al.,* 2015). Many entomopathogenic fungi like *Beauveria bassiana* (Balsamo) Vuillemin, *Metarhizium anisopliae* (Metschnikoff) Sorokin, *Lecanicillium lecanii* (Zimm.) Zare & Gams, have been reported to be effective against aphids (Jouda *et al.,* 2010 and Ujjan *et al.,* 2012). Prevalent high humidity favours development of entomopathogens and this may be the leading cause of insect mortality and avoids the build up of resistance to insecticides and also conserves its natural enemies.

For the control of sucking pests, entomopathogenic fungi are the most appropriate microbial bioagents as they infect the insect cuticle directly by contact and do not require ingestion for infection. Mass production techniques of entomofungal pathogens are much simpler, easier and cheaper (Rabindra and Ramanujam, 2007). However, field efficacy of different isolates of entomofungal pathogens was not tested extensively for the management of cabbage aphid. Hence the present study was undertaken to evaluate the field efficacy of entomopathogenic fungi, *viz*., *Beuveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium leca-*

nii and their effect on natural enemies.

MATERIALS AND METHODS

The field trial on evaluation of entomopathogenic fungi on cabbage aphid, *Brevicoryne brassicae* and their effect on *Coccinella septempunctata* (Linnaeus) in cabbage eco-system was carried out at ICAR-NBAIR, Yalahanka Farm, Bengaluru, Karnataka, India during kharif season (June-September) in 2014 and 2015 by using Unnati hybrid with three entomopathogenic fungi , *B. bassiana* (ICAR-NBAIR-Bb-5a strain), *M. anisopliae* (ICAR-NBAIR-Ma-4 strain) and *L. lecanii* (ICAR-NBAIR-Vl-8 strain). The trial was laid out in RBD design with five replications for each treatment and with a plot size of 43 m^2 for each replication with 1 m apart. All the agronomic practices with recommended dose of fertilizers were followed till the harvest of crop as per the package of practices of University of Agricultural Sciences, Bengaluru, Karnataka, India. Four rounds of foliar sprays of oil formulations of entomopathogenic fungi at the spore dose of $1x10^8$cfu/ml were given at 10 days interval during July-August. Observations on population count of aphids (nymphs and adults) were recorded before and after each spray. Yield of cabbage was recorded at harvest. The population of *C. septempunctata* (larvae and adults) in each of the treatment was recorded before and after every spray and they were removed each time after recording throughout the experimental period to avoid their effect on pest population in the experimental plots. All the recorded observations were statistically analyzed by using SPSS v16 software and later analyzed data of all the sprays were averaged and separated by Duncan's Multiple Range Test (DMRT). The yield of cabbage was recorded for each treatment and converted to tonnes per hectare. The weather parameters during experimental period of June to September 2014 were T_{max} (28.28 °C), T_{min} (19.35 °C), RH-I (93%), RH-II (55%) and RF (754.8 mm) and in 2015 were T_{max} (29.1 °C), T_{min} (19.35 °C), RH-I (90.75%), RH-II (52.25%) and RF (472.8 mm). The meteorological data recorded was observed with meteorological observatory from the University of Agricultural Sciences, Bangalore, Karnataka, India for experimental purpose.

RESULTS AND DISCUSSION

Effect of oil formulations of entomopathogenic fungi on the population of *Brevicoryne brassicae* and cabbage yield

Among the three isolates tested during 2014, Bb-5a isolate of *B. bassiana* showed the least post aphid population of 2.33 aphids/plant followed by Vl-8 isolate of *L. lecanii* and Ma-4 isolate of *M. anisopliae* of 6.33 and 8.0 aphids/plant with percent reduction of 98.5, 96.1 and 95.1 respectively over control as presented in Table 1. Similarly during 2015, the minimum post aphid populations were recorded in the plots treated with Bb-5a isolate of *B. bassiana* and Ma-4 of *M. anisopliae* (25.45 and 26.73 aphids / plant) with 49.14 and 46.58 percent reduction respectively over control and were on par with each other (Table 1 and Fig 1). Pooled data analysis of two years indicated the least post aphid population of 13.9 aphids/plant in the plots treated with Bb-5a isolate of *B. bassiana* followed by Vl-8 isolate of *L. lecanii* and Ma-4 isolate of *M. anisopliae* of 17.1 and 17.4 aphids/plant with percent reduction of 87.1, 84.1 and 83.9 respectively over control (Table 1). Mandi *et al.,* (2016) reported the field efficacy of *B. bassiana* with 54.4% reduction of aphid population of *Myzus persicae* (Sulzer) in cabbage in Mohanpur, West Bengal. Similarly Meena *et al.,* (2013) reported that *B. bassiana, V. lecanii* and *M. anisopliae* @ 5g/l showed 78, 75 and 74% reduction of mustard aphid, *Lipaphis erysimi* population over control in Bharatpur, Rajasthan. Ahmed Al-Keridis, (2) reported

Fig. 1. A Mycosis of ICAR-NBAIR-Bb-5a on Brevicoryne *brassicaeon* cabbage leaf and B. untreated control leaf with healthy aphids.

the field efficacy of *V. lecanii* against *Brevicoryne brassicae* after 3rd spray with 97% reduction over control.

Table 1. Effect of oil formulations of entomofungal pathogens on cabbage aphid population, yield and natural enemy population

Isolates	2014				2015				Pooled data					
	Pre count aphids/ plant	Post count Aphids/Plant (Mean) *	% reduction over control	Yield (t/ha)	Pre count aphids/ plant	Post count Aphids/Plant (Mean) *	% reduction over control	Yield (t/ha)	Pre count of aphids /plant	Post count Aphids/ Plant (Mean) *	% reduction over control	Yield (t/ha)	Natural enemy population: Pre count	Natural enemy population: Post count
B. bassiana (NBAIR-Bb-5a)	253.33^{a} (15.63)	2.33^{a} (1.22)	98.5	19.0^{a} (4.42)	97.00^{a} (9.87)	25.45^{a} (5.09)	49.14	37.0^{a} (6.12)	175^{a} (13.23)	13.9^{a} (3.79)	87.1	28.0^{a} (5.34)	0.07^{a} (0.75)	0.26^{a} (0.87)
M. anisopliae (NBAIR-Ma-4)	264.33^{a} (16.20)	8.0^{c} (2.82)	95.1	18.5^{a} (4.36)	89.80^{a} (9.50)	26.73^{a} (5.22)	46.58	36.3^{a} (6.06)	177^{a} (13.33)	17.4^{b} (4.23)	83.9	27.4^{a} (5.28)	0.00^{a} (0.71)	0.08^{a} (0.76)
L. lecanii (NBAIR-Vl-8)	266.00^{a} (16.26)	6.33^{b} (2.05)	96.1	18.5^{a} (4.36)	98.53^{a} (9.95)	27.95^{b} (5.33)	44.15	36.2^{a} (6.06)	182^{a} (13.52)	17.1^{b} (4.20)	84.1	27.4^{a} (5.28)	0.07^{a} (0.75)	0.11^{a} (0.78)
Control	310.00^{a} (17.06)	165^{d} (12.59)	-	14.5^{b} (3.87)	95.00^{a} (9.77)	50.04^{c} (7.11)	-	30.0^{b} (5.52)	203^{a} (14.25)	107.5^{c} (10.39)	-	22.3^{b} (4.77)	0.20^{a} (0.84)	0.31^{a} (0.90)
CD@5%	NS	2.32	-	-	NS	1.44	-	-	NS	1.88	-	-	NS	NS
CV	-	13.60	-	-	-	7.83	-	-	-	10.71	-	-	-	-

* Mean of four observations recorded at ten days intervals during July-August

Pooled analysis of two years yield data revealed that significantly higher yields were noticed in Bb-5a isolate of *B. bassiana*, Vl-8 isolate of *L. lecanii* and Ma-4 isolate of *M. anisopliae* with 28.0, 27.4 and 27.4 t/ha respectively and were on par with each other compared to untreated control which recorded 22.3 t/ha as mentioned in Table 1. Suppression of aphid population by these isolates (Fig. 1) might have resulted in higher yields. Mandi *et al.,* (2016) reported 25.41% increase of cabbage yield (41.13 t/ha) in the *B. bassiana* treated plots (2x10^{7} spores/g) @ 1.0%.

Effect of oil formulations of entomopathogenic fungi on natural enemies

Pooled data analysis of both years on *C. septempunctata* population in the experimental plots revealed that the pre-count population were ranged 0-0.2/plant and post-count ranged 0.08-0.31/plant which were statistically on par with each other. This clearly indicates that the tested entomopathogenic fungal isolates have no detrimental on *C. septempunctata* and can be considered as safe. Meena *et al.,* (2014) reported the maximum population of coccinellid (*C. septempunctata*) in cabbage crop treated with *V. lecanii* @ 5g/L. Similarly Derakhshan *et al., (2007)* reported that the *V. lecanii* was not pathogenic to natural enemies *viz*., *Chrysoperia carnea* (Stephens), *Coccinella septempunctata* (Linnaeus), *Episyrphus baiteatus* (De Geer) and *Sumia cynthia ricini* (Boisduval).

CONCLUSION

Among the three isolates tested, *Beuveria bassiana* (Bb-5a) showed superior effect in suppression of cabbage aphid (*Brevicoryne brassicae* L.) under field conditions during Kharif seasons. It is eco-friendly and doesn't have any adverse affect on *C. septempunctata*, environment and human or animal health. It can be recommended to farmers against cabbage aphid control as an alternative to chemicals insecticides.

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