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Research Note

Evaluation of fungal pathogens for the management of mealybugs in Bt cotton

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ABSTRACT: Three entomopathogenic fungi (*Verticillium lecanii, Beauveria bassiana* and *Metarhizium anisopliae*) along with two standard insecticides (acephate and chlorpyriphos) were evaluated for their effectiveness in the field on Bunny Bt (Cry 1AC) cotton neem oil + detergent (Nirma) powder and detergent powder alone during 2007–08 & 2008-09 against two mealybugs *viz*., *Phenococcus solenopsis* and *Paracoccus marginatus*. The results revealed that *B. bassiana*, *V. lecanii* and *M. anisopliae* brought out a reduction of 39.1, 30.9 and 28.2 per cent incidence and 69.0, 59.0 and 23.1 per cent population of mealybugs respectively, while, the insecticides acephate and chlorpyriphos brought out a reduction of 93.8 and 87.1 per cent incidence and 97.8 and 95.3 per cent population, respectively. Detergent powder brought out a reduction of 51.7 per cent incidence and 82.4 per cent population, while detergent powder + neem oil brought out a reduction of 20.9 and 36.1 per cent, respectively. Observation on the activity of predators revealed that *B. bassiana, V. lecanii* and *M. anisopliae* brought out a reduction of 61.3, 51.6, and 6.5 % coccinellids and 33.7, 15.2 & 22.8 % spiders as against 54.8 and 42.4 % respectively in the standard insecticide acephate. Treatments with neem oil+ detergent powder and detergent powder alone did not reduce coccinellid population, however, reduced spider population by 22.6 & 13.0 per cent respectively. All the treatments recorded significantly higher yield over control during 2008 – 09 and the increase in yield over control ranged from 18.0 to 43.0 %.

KEY WORDS: Mealybug, *Phenococcus solenopsis*, *Paracoccus marginatus*, pathogenicity, *Beauveria bassiana, Verticillium lecanii* and *Metarhizium anisopliae*

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INTRODUCTION

In the recent years mealybugs, *Phenococcus solenopsis* Tinsley, *Paracoccus marginatus* Williams and Granara de Willink and *Maconellicoccus hirsutus* Green have become serious threat to cotton cultivation in India (Monga *et al*., 2009 ; Nagrare *et al*., 2009; Tanwar *et al*., 2010). Severe damage by mealybugs lead to major crop loss in Bt cotton. Mealybug feeds on phloem and excretes honey dew, which encourages the development of sooty mould affecting the photosynthetic activities of the plant and the mealybug infested cotton plants exhibit bunchy appearance and stunted growth. Management of mealybug is difficult because of its crypticl habitat in plant parts and soil crevices and their morphological characteristics of waxy coating and mealy growth on the surface of their body, which resists penetration of insecticides. In order to find out a viable alternative to the chemical insecticides, an attempt was made to evaluate biopesticides *viz*., *Verticillium lecanii* (Zimmermann) Viegas, *Beauveria bassiana* (Balsamo) Vuillemin and *Metarhizium anisopliae* (Metchnikoff) Sorokin along with washing detergent powder in combination with neem oil and compared with two insecticides (acephate and chlorpyriphos).

MATERIALS AND METHODS

Two field experiments were conducted during 2007 - 09 seasons in Randomized Block Design (RBD) with eight treatments and three replications using Bunny Bt cotton treated with imidacloprid seed treatment. All the recommended agronomic practices including spacing and fertilizer application were followed. Observations were recorded on the incidence of mealybug (% of plants infested) and population from randomly five plants selected per plot at 121 ,130 ,135 and 138 days after sowing (DAS) during 2007-08. Due to late appearance of mealy bug in 2008–09, only one observations were recorded at 147 DAS. Incidence of predators (coccinellids and spiders) were also observed from five plants per plot. The yield data were recorded at harvest and all the data were subjected to single factor ANOVA.

Table 1. Evaluation of biopesticides and insecticides against the incidence of mealybug, at CICR, Coimbatore during 2007 – 08 & 2008 – 09

Treatments	Mealybug incidence (%)					Mean of two years	Reduction (%)
	2007-08				2008–09		
	121 DAS	130 DAS	135 DAS	138 DAS	147 DAS		
1. Acephate 700 g a.i./ha	0.00 (0.46)	0.00 (0.46)	0.00 (0.46)	1.04 (3.70)	11.11 (11.95)	2.43	93.8
2. Chlorpyriphos 500 g a.i./ha	1.04 (3.70)	1.04 (3.70)	1.04 (3.70)	4.16 (11.61)	18.05 (23.77)	5.06	87.1
3. Neem oil (2.5l/ha) + Detergent powder (0.1%)	11.91 (19.23)	15.63 (21.63)	21.75 (19.68)	36.45 (36.95)	69.77 (61.69)	31.10	20.9
4. Detergent Powder (0.1%)	11.46 (15.66)	8.33 (12.84)	4.12 (9.49)	7.28 (14.54)	63.89 (58.31)	19.01	51.7
5. *Verticillium lecanii* 5 gm/lit (2x108 cfu / gm)	20.24 (25.81)	18.75 (24.32)	14.58 (18.88)	36.45 (36.28)	45.83 (42.45)	27.17	30.9
6. *Beauveria bassiana* 5 gm/lit (2x108 cfu / gm)	17.71 (23.92)	16.67 (24.01)	17.7 (24.87)	29.16 (32.47)	38.41 (37.90)	23.93	39.1
7. *Metarhizium anisopliae* 5gm/lit (2x108 cfu / gm)	19.67 (22.36)	22.92 (27.86)	17.70 (24.87)	28.12 (31.63)	52.78 (46.60)	28.23	28.2
8. Control	19.67 (29.27)	32.29 (34.46)	31.25 (33.55)	34.37 (35.79)	78.93 (67.49)	39.32	-
SEd	6.01	5.78	5.52	5.74	11.80	-	-
CD (*P*=0.05)	12.41	11.93	11.39	11.84	24.46	-	-

2007 – 08 treatments were sprayed on 63, 76, 90, 104 and 124 DAS; 2008 – 09 Treatments were sprayed on 89, 117 and 132 DAS; DAS – Days After Sowing; * Figures in parentheses represent arcsine transformed values.

Table 2. Evaluation of biopesticides and insecticides against the population of mealybug at CICR, Coimbatore during 2007 – 08 & 2008 – 09

Treatments	Mealybug population / plant						Mean of two years	Reduction (%)
	2007 - 08				2008 - 09			
	121 DAS	130 DAS	135 DAS	138 DAS	122 DAS	130 DAS		
1. Acephate 700 g a.i./ha	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.08 (0.17)	1.13 (1.06)	0.27 (0.51)	0.24	97.8
2. Chlorpyriphos 500 g a.i./ha	0.58 (0.46)	0.50 (0.41)	0.25 (0.28)	0.91 (0.87)	0.33 (0.33)	0.47 (0.54)	0.50	95.3
3. Neem oil (2.5l/ha) + Detergent powder (0.1%)	2.30 (1.40)	3.63 (1.69)	9.62 (3.09)	8.82 (2.92)	7.80 (2.79)	8.87 (2.97)	6.84	36.1
4. Detergent Powder (0.1%)	1.64 (0.94)	1.96 (1.08)	0.62 (0.60)	1.70 (1.17)	0.93 (0.94)	4.47 (2.09)	1.88	82.4
5. *Verticillium lecanii* 5 gm/lit (2x108 cfu / gm)	4.52 (2.05)	4.91 (2.21)	5.14 (2.12)	9.62 (2.77)	0.60 (1.01)	1.60 (1.03)	4.39	59.0
6. *Beauveria bassiana* 5 gm/lit (2x108 cfu / gm)	3.54 (1.81)	3.60 (1.81)	2.95 (1.40)	5.58 (2.32)	1.07 (0.33)	3.20 (1.76)	3.32	69.0
7. *Metarhizium anisopliae* 5gm/lit (2x108 cfu / gm)	5.92 (2.13)	5.86 (2.38)	10.49 (3.13)	8.27 (1.81)	4.40 (2.08)	14.53 (3.80)	8.24	23.1
8. Control	7.21 (2.53)	6.66 (2.48)	7.64 (2.76)	8.32 (2.80)	7.73 (2.78)	26.73 (5.17)	10.71	-
SEd	0.70	0.51	0.59	0.70	-	-	-	-
CD (*P*=0.05)	1.45	1.05	1.22	1.46	0.53	0.64	-	-

2007 – 08 treatments were sprayed on 63, 76, 90, 104 and 124 DAS; 2008 – 09 Treatments were sprayed on 89, 117 and 132 DAS; DAS – Days After Sowing Figures in parentheses represent square root transformed values.

Table 3. Effect of biopesticides on predators (coccinellids and spiders) and seed cotton yield during 2007 – 08 & 2008 – 09

Treatments	Predators / plant						Seed cotton yield (Kg/ha)			
	Coccinellids			Spiders						
	2007 - 08	2008 - 09	Mean of 2 yrs	2007 - 08	2008 - 09	Mean of 2 yrs	2007 - 08	2008 -09	Mean of 2 yrs	% Increase
1. Acephate 700 g a.i./ha	0.22	0.07	0.14	0.30	0.77	0.53	3296	2252	2774	43.0
2. Chlorpyriphos 500 g a.i./ha	0.35	0.14	0.24	0.38	0.87	0.62	2499	2147	2323	19.7
3. Neem oil (2.5l/ha) + Detergent powder (0.1%)	0.33	0.37	0.35	0.46	0.97	0.71	2772	1817	2294.5	18.2
4. Detergent Powder (0.1%)	0.50	0.23	0.36	0.50	1.10	0.80	2392	2186	2289	18.0
5. *Verticillium lecanii* 5 gm/lit (2x108 cfu / gm)	0.11	0.20	0.15	0.43	1.13	0.78	2801	1995	2398	23.6
6. *Beauveria bassiana* 5 gm/lit (2x108 cfu / gm)	0.17	0.08	0.12	0.32	0.90	0.61	2765	1877	2321	19.6
7. *Metarhizium anisopliae* 5gm/lit (2x108 cfu / gm)	0.41	0.17	0.29	0.49	0.93	0.71	2797	1969	2383	22.8
8. Control	0.43	0.20	0.31	0.41	1.44	0.92	2458	1422	1940	-
SEd	-	-	-	-	-	-	276.69	116.35	-	-
CD (*P*=0.05)	N.S	N.S	-	N.S	N.S	-	N.S	241.29	-	-

2007 – 08 treatments were sprayed on 63, 76, 90, 104 and 124 DAS; 2008 – 09 Treatments were sprayed on 89, 117 and 132 DAS; DAS – Days After Sowing

RESULTS AND DISCUSSION

The mean per cent incidence of mealybug in the various treatments ranged from 2.40 to 39.3. The treatments with acephate and chlorpyriphos recorded a reduction of incidence by 87.1 to 93.8 % followed by treatments with detergent powder (51.7 %). The *B. bassiana*, *V. lecanii* and *M. anisopliae* were moderately effective and brought down the incidence by 39.1, 30.9 and 28.2 %, respectively (Table 1).

The mean population of mealybug per plant observed at periodical intervals revealed that it ranged from 0.2 to 8.2 in the various treatments as against 10.7 in control. Acephate, chlorpyriphos, detergent powder, *B. bassiana* and *V. lecanii* were effective and brought out a reduction of 97.8, 95.3, 82.4, 69.0 and 59.0 %, respectively. The treatments with neem oil + detergent powder and *M. anisopliae* were less effective (Table 2).

There were no significant differences in the abundance of predators among different treatments in both the years. The reduction of coccinellid predator ranged from 0.00 in neem oil + detergent powder and detergent powder to 54.8 % in acephate, while the reduction of spider population ranged from 18.0 % in detergent powder to 42.4% in acephate (Table 3).

All the treatments recorded significantly higher yield over control during 2008 – 09. The increase in yield over control ranged from 18.0 to 43.0 %, acephate recorded an increase of 43.0% followed by *V. lecanii* (23.6%), *M. anisopliae* (22.8%), chlorpyriphos (19.7 %), *B. bassiana* (19.6 %), neem oil + detergent powder (18.2 %) and detergent powder (18.0 %) (Table 3).

The present results are in conformity with earlier work of Lacey *et al*. (2001) and Lemawork (2008) who reported that the *B. bassiana* (PPRC - 56) caused highest mortality (54 %) and *M. anisopliae*)isolate Mm) was least effective in controlling mealybugs. Foliar spray of *V. lecanii* or *B. bassiana* (2 x 10^8 cfu/ml) @ 5 g / ml per liter of water is effective during high humid months in reducing the population of mealybugs (Tanwar *et al.,* 2007). The present findings are also inline with the observations made by Suresh *et al*. (2010) who reported that under field conditions, *B. bassiana* @ 5g / lit reduced infestation of *P. marginatus* from 90 % to 57.78% at 5 days after treatment Washing detergents have been reported (Curkovic *et al*., 2007) to remove the surface wax of mealybugs which make them more susceptible to dehydration leading to death. In the present study also washing detergent powder at 0.1% was found to be effective and brought out a reduction of 51.7 %. Banu *et al*. (2010) also recorded more than 50 % mortality of nymphs of mealybugs 48 hr after treatment with neem oil + detergent powder, detergent powder alone and *V. lecanii* under laboratory condition.

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