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FIELD EFFICACY OF ENTOMOPATHOGENIC FUNGI AGAINST MANGO HOPPERS, *IDIOSCOPUS NIVEOSPARSUS* (LETHIERRY)

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KEYWORDS

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ABSTRACT

For mango hopper management Thiame thoxam 25 WDG was found most superior treatment recorded lowest population per panicle, 0.97 and 1.69 at 14 days after second spray of year 2013-14 and 2014-15 respectively. The entomo pathogenic fungi viz., *V. lecanii, B. bassiana and M. anisopliae,* were observed equally effective however, its combination gave additive effect and more effective than alone. The combination of all three entomopathogenic fungi proved more superior over treatments of combination of two entomopathogenic fungi and recorded 8.11 and 3.77 hoppers per panicle at 14 days after first and second spray of 2013-14 and 11.75 and 5.99 hoppers per panicle at 14 days after first and second spray of 2014-15, respectively. Among sole effect, the EPF *V. lecanii* was found most effective pathogen recorded 10.09 and 11.89 hoppers per panicle at 14 days after second spray of year 2013-14 and 2014-15 respectively.

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INTRODUCTION

The Mango (*Mangifera indica* L.) is one of the world's most important and reputable fruits. The productivity of mango is influenced by several factors of which damage by the pest is one of the major factors. Amongst important insect pests, the Cicadellids (Jassids) popularly known as 'Mango hoppers' is the most noxious insect pest causing damage almost every year throughout the country. Almost 22 species reported (Dalvi *et al.,* 1992), *Amritodus atkinsoni* (Lethierry), *Idioscopus niveosparsus* Lethierry, *I. nagpurensis, I. clypealis* (Lethierry) (Homopetera: Cicadellidae) are prevalent in different mango growing belts of India (Joshi and Kumar, 2012). The warm and humid climate of the Konkan region of Maharashtra is very much conducive for the development of mango hoppers and hence the problem of mango hopper is prevented in this region.

To tackle the pest menace, a number of conventional insecticides are liberally sprayed on this crop. These insecticides have inherent toxicities that cause danger to the health of the applicators, consumers and the environment (Bagde *et al.* 2014). To overcome these problems application of mycoinsecticides would be better option and thus forms integral part of IPM. For a successful integrated pest management programme, the agents like the entomopathogenic fungi should be amenable to easy and cheap mass multiplication (Bhadauria *et al.*2012).

Several entomopathogenic fungal pathogens of whiteflies such as *Beauveria bassiana, Lecanicillium spp.* and *Metarhizium anisopliae* with good potential for control had been isolated from a variety of insects (Wraight *et al.* 1998; 2000, Faria and Wraight, 2007).

Appropriate co-application of two or more fungi or fungal strains with different host ranges and climatic tolerances can be considered a strategy to achieve a reasonable control. It has been shown that there is a need for coformulation studies to examine whether fungi will act synergistically (Wang *et al.* 2002). Very few previous studies had evaluated the efficacy of combined application of two entomopathogenic fungi. Malekan *et al.* (2013) assessed combination treatment with two entomopathogenic fungi *Beauveria bassiana* and *Lecanicillium muscarium* in laboratory on nymphal stages of *Trialeurodes vaporariorum.* The objective of our study was to investigate the compatibility effect of the entomopathogenic fungi, *M. anisopliae, B. bassiana* and *Verticillium lecanii* against mango hoppers, *I. niveosparsus* in field conditions.

MATERIALS AND METHODS

The statistically designed field experiment was conducted on the mango orchard of Centre of Excellence for Mango, Department of Horticulture, College of Agriculture, Dapoli in randomized block design with nine treatments during 2013-14 and 2014-15. Each treatment was replicated three times. A uniform size and uniformly flowered 27 trees of variety Alphanso were selected for experiment purpose.

The desired quantity of respective entomopathogenic fungi and their combinations were measured. For preparation of spray solution surfactant and sunflower oil each at the rate 2 ml per litre of water were added in spray solution. The spray solution was thoroughly stirred with the help of wooden stick before application.

Total two sprays were taken first at peak flowering period in each year and subsequently sprayed at 15 days of interval with the help of Gature spray pump. The treatments were applied on the selected trees randomly.

For recording observations, 25 panicles were selected randomly at four sides (N, S, E and W) on the trees under observations and labeled individually for each treatment. The observations on the population count of mango hoppers per panicle were recorded 24 hours before application of treatment and post treatment observation were recorded at 3rd, 7th and 14th days after application of the treatments.

The data recorded on hopper population per panicle was transformed to " x+1 (where, x is the mean value of hoppers/panicle) and statistically analysed by using randomized block design at 5 per cent level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

First spray 2013-14

The presented in Table 1 revealed that the pre count observations recorded 24 hrs prior to application were non-significant results indicating that the hopper population was uniform in all the treatments. The post treatment observations recorded, 3 DAS revealed the lowest hopper population (5.07 / panicle) was observed in thiamethoxam 25 WDG. Amongst EPF, the treatment combination of three fungi, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) was found most promising with 10.92 hoppers per panicle however. The rest of the treatments of EPF significantly showed less hopper population as compared to control.

Seven days after spray, among the treatments of entomopathogenic fungi treatment combination of three fungi, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) recorded lowest hopper population (7.80 hoppers / panicle) but was at par with treatment combination of *V. lecanii* + *M. anisopliae* (T_4) which recorded 9.75 hoppers per panicle. The sole treatment of *V. lecanii* (12.29 hoppers / panicle) and *M. anisopliae* (12.31 hoppers / panicle) found equal in effectiveness and were at par with the treatment combinations of *V. lecanii* + *B. bassiana* and *M. anisopliae* + *B. bassiana*.

The significantly lowest hopper population (3.24 hoppers / panicle) was noticed in the treatment of thiamethoxam 25 WDG at 14 days after first spray. However, among the treatments of EPF, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) recorded significantly less hopper population (8.11 / panicle) and found statistically superior over rest of the treatments.

Second spray 2013-14

The lowest hopper population (1.03 hoppers per panicle)

Table 1: Efficacy of entomopathogenic fungi against mango hoppers in field condition (2013-14)

Tr. No.	Treatments	Dose(g/l)	Number of mango hoppers / panicle						
			Pre count	After first spray			After second spray		
				3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
T_1	*Verticillium lecanii* (1 x 10^8cfu/g)	5	15.60 (4.07)*	13.40 (3.79)c	12.29 (3.64)de	12.84 (3.72)d	10.75 (3.43)*d	9.81 (3.28) d	10.09 (3.32) d
T_2	*Metarhizium anisopliae* (1 x 10^8cfu/g)	5	15.33 (4.04)	13.23 (3.77)c	12.31 3.64)de	12.57 (3.68)d	10.44 (3.37)d	9.80 (3.28)d	10.05 (3.31) d
T_3	*Beauveria bassiana* (1 x 10^8cfu/g)	5	15.23 (4.03)	13.32 (3.78)c	12.71 (3.70)e	12.87 (3.72)d	10.80 (3.43)d	10.36 (3.37)d	10.88 (3.44) d
T_4	*V. lecanii* (1 x 10^8cfu/g) + *M. anisopliae* (1 x 10^8cfu/g)	5+5	15.25 (4.03)	12.15 .62)bc	9.75 (3.27)bc	9.97 (3.31)c	7.67 (2.94) c	6.13 (2.66)c	6.33 (2.70) c
T_5	*V. lecanii* (1 x 10^8cfu/g) + *B. bassiana* (1 x 10^8cfu/g)	5+5	15.29 (4.04)	12.48 (3.67)bc	10.21 (3.34)cd	10.28 (3.36) c	8.11 (3.01)c	6.60 (2.75)c	6.77 (2.79) c
T_6	*M. anisopliae* (1 x 10^8cfu/g) + *B. bassiana* (1 x 10^8cfu/g)	5+5	14.91 (3.99)	12.39 (3.66)bc	10.25 (3.35)cd	10.40 (3.37) c	8.41 (3.07)c	6.99 (2.81)c	7.24 (2.87) c
T_7	*V. lecanii* (1 x 10^8cfu/g) + *M. anisopliae* (1 x 10^8cfu/g) + *B. bassiana* (1 x 10^8cfu/g)	5+5+5	15.43 (4.05)	10.92 (3.45)b	7.80 (2.96)b	8.11 (3.01) b	5.56 (2.56)b	3.67 (2.16)b	3.77 (2.18) b
T_8	Thiamethoxam 25 WDG	0.1	15.60 (4.07)	5.07 (2.45)a	4.21 (2.27)a	3.24 (2.04) a	1.03 (1.42)a	0.77 (1.33)a	0.97 (1.40) a
T_9	Control	-	15.53 (4.07)	16.15 (4.14)e	16.87 (4.23)f	17.12 (4.26) e	17.48 (4.30) e	17.72 (4.33)e	18.08 (4.37) e
S.E. m ±			0.06	0.09	0.11	0.09	0.09	0.13	0.12
CD (p=0.05)			NS	0.26	0.33	0.27	0.27	0.38	0.36

DAS = Days after spray, cfu = Colony forming units; *Figures in parenthesis are "x + 1 transformed values.

Table 2: Efficacy of entomopathogenic fungi against mango hoppers in field condition (2014-15)

Tr. No.	Treatments	Dose(g/l)	Number of mango hoppers / panicle						
			Pre count	After first spray			After second spray		
				3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS
T_1	*Verticillium lecanii* (1 x 10 ^{8}cfu/g)	5	20.36 (4.62)	16.43 4.17)*c	15.11 (4.01)c	15.53 (4.06)cd	13.29 (3.77)*cd	11.41 (3.52)cd	11.89 (3.59)d
T_2	*Metarhizium anisopliae* (1 x 10 ^{8}cfu/g)	5	19.80 (4.56)	17.64 (4.32)d	16.41 (4.17)cd	16.96 (4.23)d	14.09 (3.88)d	13.36 (3.79)de	13.81 (3.85)e
T_3	*Beauveria bassiana* (1 x 10 ^{8}cfu/g)	5	20.35 (4.62)	19.68 (4.55)d	18.24 (4.38)d	18.39 (4.40)de	16.93 (4.23)e	16.08 (4.13)e	16.32 (4.16)f
T_4	*V. lecanii* (1 x 10 ^{8}cfu/g) + *M. anisopliae* (1 x 10 ^{8}cfu/g)	5 + 5	20.28 (4.61)	16.49 (4.18)c	14.29 (3.91)c	14.43 (3.92)c	11.83 (3.58)c	10.14 (3.33)c	9.72 (3.27)c
T_5	*V. lecanii* (1 x 10 ^{8}cfu/g) + *B. bassiana* (1 x 10 ^{8}cfu/g)	5 + 5	19.71 (4.55)	16.41 (4.17)c	13.97 (3.86)bc	14.16 (3.89)c	11.37 (3.52)c	9.88 (3.29)c	10.10 (3.33)c
T_6	*M. anisopliae* (1 x 10 ^{8}cfu/g) + *B. bassiana* (1 x 10 ^{8}cfu/g)	5 + 5	20.71 (4.66)	16.69 (4.21)c	15.04 (4.00)c	14.05 (3.88)c	13.07 (3.75)cd	10.94 (3.45)cd	11.12 (3.48)cd
T_7	*V. lecanii* (1 x 10 ^{8}cfu/g) + *M. anisopliae* (1 x 10 ^{8}cfu/g) + *B. bassiana* (1 x 10 ^{8}cfu/g)	5 + 5 + 5	19.87 (4.57)	14.79 (3.97)b	11.24 (3.50)b	11.75 (3.57)b	8.69 (3.11)b	6.28 (2.68)b	5.99 (2.64)b
T_8	Thiamethoxam 25 WDG	0.1	20.51 (4.64)	7.07 (2.84)a	6.24 (2.69)a	6.37 (2.71)a	2.03 (1.74)a	1.13 (1.44)a	1.69 (1.64)a
T_9	Control	-	20.37 (4.62)	20.81 (4.67)e	21.57 (4.75)e	22.41 (4.84)f	22.84 (4.88)f	23.39 (4.94)f	24.39 (5.04)g
S.E. m ±			0.10	0.10	0.12	0.09	0.10	0.14	0.08
CD (p=0.05)			NS	0.29	0.36	0.27	0.29	0.42	0.24

DAS = Days after spray, cfu = Colony forming units; *Figures in parenthesis are "x + 1 transformed values.

was observed in thiamethoxam 25 WDG after 3 DAS. The treatment combination of three fungi, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) was found most superior among the EPF and recorded 5.56 hoppers per panicle. The treatment combinations of *V. lecanii* + *M. anisopliae* (T_4), *V. lecanii* + *B. bassiana* (T_5) and *M. anisopliae* + *B. bassiana* (T_6) were found at par with each other.

Observations recorded 7 days after application the treatment combination of three fungi, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) was found significantly superior among the treatments of EPF and recorded 3.67 hoppers per panicle. The treatment of *V. lecanii* (9.81 hoppers / panicle), *M. anisopliae* (9.80 hoppers / panicle) and *B. bassiana* (10.36 hoppers / panicle) found at par with each other and superior over control. The similar trend was observed after 14 days of second application. The lowest hopper population (0.97 hoppers / panicle) was observed in the treatment of thiamethoxam 25 WDG. The treatment combination of *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) recorded less hopper population (3.77 / panicle) and was found significantly superior over rest of the treatments of EPF.

First spray 2014-15

The pre-count of hopper population recorded 24 hrs before application showed non-significant results indicating population was uniform. The data regarding the efficacy of entomopathogenic fungi against mango hoppers recorded during the year 2014-15 is presented in the Table-2. The results revealed that, the treatment of thiamethoxam 25 WDG recorded lowest hopper population (7.07 / panicle) at 3 days after spray and found most superior over rest of the treatments. The combination treatment of three EPF (*V. lecanii* + *M. anisopliae* + *B. bassiana*) found second most superior treatment and recorded 14.79 hoppers per panicle. The sole treatment of *M. anisopliae* and *B. bassiana* significantly recorded less hopper population (17.64 and 19.68 / panicle, respectively) than control (20.81 / panicle) and found equal in effectiveness.

Seven days after application, the lowest hopper population was recorded in the treatment of thiamethoxam 25 WDP (6.24 hoppers/ panicle) followed by treatment combination of three EPF T_7 (*V. lecanii* + *M. anisopliae* + *B. bassiana*) recorded 11.24 hoppers per panicle. The significantly lowest hopper population (6.37 / panicle) was noticed in the treatment of thiamethoxam 25 WDG at 14 days after first spray. The treatment combination of *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) recorded significantly less hopper population (11.75/panicle) and found statistically superior over rest of the treatments of EPF. The sole treatments of *V. lecanii* and *M. anisopliae* recorded significantly less hopper population (15.53 and 16.96/ panicle, respectively) as compared to control and found at par with each other. The treatment of *B. bassiana* recorded highest hopper population among EPF treatments and found at par with T_1 and T_2.

Second spray 2014-15

The data pertaining to the efficacy of entomopathogenic fungi against mango hoppers after second spray is presented in Table 2. The lowest hopper population (2.03/panicle) was observed in thiamethoxam 25 WDG on 3 DAS. The treatment combination of three EPF, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) was found most superior among the pathogens and recorded 8.69 hoppers per panicle. The sole treatment of *M. anisopliae* recorded significantly less hopper population (14.09 / panicle) and found at par with T_6 and T_1.

Observations recorded seven days after of application revealed that, the treatment combination of three EPF, *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) was found significantly superior among the treatments of EPF, recorded 6.28 hoppers per panicle. Treatment combinations of *V. lecanii* + *B. bassiana* (T_5) and *V. lecanii* + *M. anisopliae* (T_4) were found significantly equal in effectiveness.

The treatment combination of *V. lecanii* + *M. anisopliae* + *B. bassiana* (T_7) recorded less hopper population after 14 days of spray (5.99 / panicle) and found statistically superior over rest of the treatments of EPF. The sole treatments of *M. anisopliae* and *B. bassiana* recorded significantly less hopper population (13.81 and 16.32 /panicle, respectively) as compared to control (24.39 / panicle).

There are several reports on the effectiveness of EPF on homopteran pests of various crops. The EPF namely *V. lecanii, M. anisopliae* and *B. bassiana* commonly tested in field and in-vitro and found promising. Patil *et al.* (2012) and Karkar *et al.* (2014) evaluated efficacy against aphids and leaf hoppers, respectively of cotton and brinjal in field condition and Kadam *et al.* (2008) evaluated against whiteflies and aphids, Saranya *et al.* (2010) against aphids, whereas, Vijay and Suresh (2013) against scales and mealy bugs under laboratory condition.

Among the EPF, *V. lecanii* observed to be more effective against mango hoppers at both laboratory as well as field condition. Earlier, Kadam *et al.* (2008), Saranya *et al.* (2010), Patil *et al.* (2012) and Karkar *et al.* (2014) reported its effectiveness against sucking homopterous pest *viz*. Whiteflies, Aphids, leaf hoppers which were in accordance with present findings.

All these three EPF showed some extend effect on host pests, therefore, to study whether the combination of these EPF are able to give additive effects on mortality of mango hoppers these fungus were tested in combination and results are encouraging. During present studies combination of three EPF were found comparatively more effective. The similar types of result were also reported by Malekan *et al.* (2013) against greenhouse whitefly, *Trialeurodes vaporariorum*.

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