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BIOEFFICACY OF ENTOMOPATHOGENIC FUNGAL FORMULATION OF *METARHIZIUM ANISOPLIAE* (METCHNIKOFF) WITH ADJUVANTS IN THE MANAGEMENT OF MANGO HOPPERS IN MAHARASHTRA

A. S. DHANE[1], N. D. TAMBOLI[2], D. S. POKHARKAR[3], R. V. NAKAT[4] AND S. B. KHARBADE[5]

[1]Asstt. Prof. of Agril. Entomology, Dr. B.S.K.K.V., Dapoli, [2]Asstt. Prof. of Agril. Entomology, M.P.K.V., Rahuri, [3]Prof. of Agril. Entomology, M.P.K.V., Rahuri,[4]Assoc. Prof. of Agril. Entomology, M.P.K.V., Rahuri, [5]Asso. Dean, College of Agriculture, Karad, M.P.K.V., Rahuri, Email: ankurdhane@gmail.com

ABSTRACT

Mango (*Mangifera indica* Linn.) is a an important and popular fruit in the world. More than 300 insect pests have been recorded to infest mango crop in different regions of world. Mango hoppers have been recognized as the most noxious insect pest causing damage almost every year throughout the country to mango crop. Hopper may cause up to 50 per cent crop loss in cases of severe infestation. Keeping aforesaid facts in view, the experiment was carried out with an objective to evaluate *Metarhizium anisopliae* fungal formulation with adjuvant against mango hoppers under field conditions. The trial was laid out in the mango orchards at Regional Fruit Research Station, Ganeshkhind, Pune for three consecutive years during 2011 to 2014.The results indicated that *Metarhizium anisopliae* @ 1 x 10^9 spores/ml during off season in the month of December followed by four sprays of the pathogen mixed with adjuvant (sunflower oil 1 ml/lit + Triton-X 100 @ 0.1 ml/lit) at weekly interval during flowering were found significantly superior over other treatments in suppressing the hopper population and increased fruit setting. The mean surviving population was recorded as 10.98 hoppers and 11.82 fruit sets per inflorescence. The untreated control block recorded 54.39 hoppers and 6.01 fruits set of mango per inflorescence.

Keywords: Mango hopper, *Metarhizium anisopliae*, bioefficacy.

INTRODUCTION

Mango, *Mangifera indica* L., called as "King of Fruits" is enormously handicapped by ravages of insect pests resulting in low yields. Especially, the Cicadellids (Jassids) popularly known as "Mango hoppers" have been recognized as the most noxious insect pest causing damage almost every year throughout the country to mango crop (Adnan *et al.,* 2014). The various mango hopper species are serious pests at flowering and besides, honey dew excreting from hoppers causes sooty mould on the leaves. The affected panicles will not set fruits and yield loss could be heavy under such conditions (Butani, 1979).The farmers mainly rely on insecticides for the management of this pest. However, in recent times, interest in entomopathogenic fungi as potential substitute for chemical insecticides has greatly increased in agriculture (Ignoffo and Hadli 1975;Hajek and St Leger, 1994). The entomopathogenic fungi cause regular mortality of several pests in many parts of the world and constitute an efficient and extremely important natural control factor. In addition, entomopathogenic fungi have an essential role in IPM if they could be used in conjunction with other strategies for sustainable pest control and biological control. Keeping aforesaid facts in view, the experiment was carried out with an objective to evaluate *Metarhizium anisopliae* fungal formulation with adjuvant against mango hoppers under field conditions.

MATERIALS AND METHODS

The trial was laid out in the mango orchards at Regional Fruit Research Station, Ganeshkhind, Pune for three consecutive years during 2011 to 2014. Each treatment block had 40 trees, which were further divided into four sub-plots as replicates. The planting distance was 10m x 10m.

The hopper population was recorded before treatment and post counts a week after each spray from four inflorescences per tree and as such 10 trees per plot as well as number of fruits set per inflorescence. The off-season spray of *M. anisopliae* was given in the month of December and subsequent four sprays were given during flowering period. Data on surviving hopper population were transformed into $\sqrt{x+0.5}$ values before subjecting to analysis of variance.

RESULTS AND DISCUSSION

The results are shown in Table (1), during 2011-12**,** treatment T_1, *M. anisopliae* @ 1 x 10^9 spores/ml during off season in the month of December followed by four sprays of the fungal pathogen mixed with adjuvants (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering was found significantly superior over other treatments in suppressing the hopper population and increased fruit setting. The mean surviving population was recorded to the extent of 11.96 hoppers per inflorescence during flowering and 11.58 fruit set per inflorescence. It was followed by treatment T_2:*M. anisopliae* @ 1 x 10^9 spores/ml followed by four sprays of the fungal pathogen mixed with adjuvants (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering which recorded 19.02 hoppers and 10.41 fruit set per inflorescence. However, this treatment (T_2) was at par with T_3:*M. anisopliae* @ 1 x 10^7spores/ml with four sprays of the fungal pathogen mixed with adjuvants (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering which recorded 21.53 hoppers and 8.83 fruit set per inflorescences as against 57.90 hoppers and 6.33 fruit set per inflorescence in untreated control.

During 2012-13 and 2013-14, the results in Table (2) and Table (3) showed more or less similar trend of mean surviving population of mango hoppers in different treatments compared to untreated control.

The pooled data of three years presented in Table (4) indicate that T_1, *M. anisopliae* @ 1 x 10^9 spores/ml during off season in the month of December followed by four sprays of the pathogen mixed with adjuvant (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering was found significantly superior over other treatments in suppressing the hopper population and increased fruit setting. The mean surviving population was recorded as 10.98 hoppers and 11.82 fruit sets per inflorescence. It was followed by treatment with T_2, *M. anisopliae* @ 1 x 10^9 spores/ml followed by four sprays of the fungal pathogen mixed with adjuvants (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering which recorded 17.57 hoppers and 10.35 fruit set per inflorescence. The treatment T_2 was at par with T_3, which recorded 19.71 hoppers and 8.79 fruit set per inflorescence as against 54.39 hoppers and 6.01 fruits set of mango per inflorescence in untreated control block.

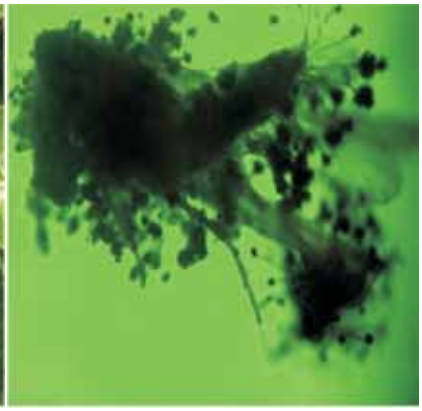
The present study results are similar to that of Varghese (1998), who reported that imidacloprid

Mango hopper on leaves

Poor fruit setting due to Mango hopper damage on inflorescence

Mango hopper affected shoot

M. anisopliae treated healthy shoot



Mango hopper infected with *M. anisopliae*

Table 1. Effect of *Metarhizium anisopliae* on hopper population and fruit set of mangoduring 2011-12

Treatment	Hopper population/ inflorescence, 7 days after spray						Fruit set/ inflorescence
	Pre-count	I spray	II spray	III spray	IV spray	Average	
T1: M. anisopliae@ 1 x 10^9 spores/ml with adjuvants - 1 spray in off-season + 4 sprays during flowering	32.54 (5.74)	21.40 (4.67)	11.40 (3.40)	8.35 (2.93)	4.08 (2.63)	11.96 (3.52)	11.58
T2: M. anisopliae@ 1 x 10^9 spores/ml with adjuvants - 4 sprays during flowering	35.75 (6.00)	26.79 (5.15)	21.22 (4.65)	16.40 (4.09)	8.64 (3.45)	19.02 (4.42)	10.41
T3: M. anisopliae@ 1 x 10^7 spores/ml with adjuvants - 4 sprays during flowering	34.39 (5.90)	28.40 (5.37)	22.61 (4.80)	18.79 (4.39)	12.38 (4.10)	21.53 (4.64)	8.83
T4: Imidacloprid @ 0.3 ml/l - 1 spray at pre-flowering	36.35 (6.05)	17.24 (4.20)	24.20 (4.96)	26.61 (5.91)	21.48 (5.47)	24.39 (5.00)	8.25
T5: Untreated control	34.62 (5.92)	47.82 (6.94)	52.29 (7.24)	61.60 (7.86)	54.04 (8.42)	57.90 (7.73)	6.33
S.Em ±	0.23	0.30	0.27	0.26	0.26	0.11	0.61
CD at 5%	NS	0.91	0.82	0.79	0.80	0.33	1.88

Figures in parentheses are √x+0.5 transformed values

Table 2. Effect of *Metarhizium anisopliae* on hopper population and fruit set of mangoduring 2012-13

Treatment	Hopper population/ inflorescence, 7 days after spray						Fruit set/ inflorescence
	Pre-count	I spray	II spray	III spray	IV spray	Average	
T1: M. anisopliae@ 1 x 10^9 spores/ml with adjuvants - 1 spray in off-season + 4 sprays in flowering	34.68 (5.88)	20.93 (4.60)	10.68 (3.31)	6.67 (2.67)	3.32 (1.95)	10.40 (3.30)	12.08
T2: M. anisopliae@ 1 x 10^9 spores/ml with adjuvants -4 sprays in flowering	36.33 (6.07)	25.33 (5.07)	18.33 (4.33)	15.33 (3.92)	7.67 (2.86)	16.66 (4.13)	10.25
T3: M. anisopliae@ 1 x 10^7 spores/ml with adjuvants - 4 sprays in flowering	38.13 (6.18)	26.68 (5.21)	19.43 (4.45)	16.83 (4.15)	11.33 (3.43)	18.56 (4.39)	8.58
T4: Imidacloprid @ 0.3 ml/l -1 spray at pre-flowering	34.65 (5.88)	14.33 (3.83)	16.83 (4.16)	22.43 (4.78)	26.68 (5.38)	20.06 (4.64)	8.08
T5: Untreated control	37.50 (6.15)	44.88 (6.69)	50.10 (7.09)	61.15 (7.78)	52.33 (7.18)	52.11 (7.16)	6.00
S.Em ±	0.22	0.24	0.24	0.27	0.23	0.16	0.60
CD at 5%	NS	0.75	0.75	0.83	0.71	0.50	1.86

Figures in parentheses are √x+0.5 transformed values

Table 3. Effect of *Metarhizium anisopliae* on hopper population and fruit set of mango during 2013-14

Treatment	Hopper population/ inflorescence, 7 days after spray						Fruit set/ inflorescence
	Pre-count	I spray	II spray	III spray	IV spray	Average	
T1: *M. anisopliae*@ 1 x 10^9 spores/ml with adjuvant - 1 spray in off-season + 4 sprays in flowering	37.22 (6.14)	21.31 (4.67)	10.82 (3.36)	7.21 (2.78)	2.91 (1.84)	10.60 (3.33)	11.80
T2: *M. anisopliae*@ 1 x 10^9 spores/ml with adjuvant -4 sprays in flowering	35.71 (6.02)	26.20 (5.17)	18.72 (4.38)	16.30 (4.10)	6.90 (2.72)	17.04 (4.19)	10.41
T3: *M. anisopliae*@ 1 x 10^7 spores/ml with adjuvant - 4 sprays in flowering	35.40 (5.99)	26.91 (5.23)	20.41 (4.57)	17.21 (4.21)	11.72 (3.49)	19.00 (4.42)	8.92
T4: Imidacloprid @ 0.3 ml/l -1 spray at pre-flowering	37.00 (6.12)	13.92 (3.79)	17.73 (4.27)	21.93 (4.73)	24.71 (5.02)	19.64 (4.49)	8.21
T5: Untreated control	37.01 (6.12)	43.90 (6.66)	52.21 (7.26)	63.20 (7.98)	53.42 (7.34)	53.20 (7.33)	5.70
S.Em ±	0.23	0.27	0.26	0.27	0.24	0.15	0.63
CD at 5%	NS	0.80	0.78	0.80	0.73	0.44	1.90

Figures in parentheses are √x+0.5 transformed values

Table 4. Effect of *Metarhizium anisopliae* on hopper population and fruit set of mango (Pooled data for 2011-12 to 2013-14)

Treatment	Hopper population/ inflorescence, 7 days after spray						Fruit set/ inflorescence
	Pre-count	I spray	II spray	III spray	IV spray	Average	
T1: *M. anisopliae*@ 1 x 10^9 spores/ml with adjuvant - 1 spray in off-season + 4 sprays in flowering	34.80 (5.92)	21.22 (4.65)	10.98 (3.38)	7.42 (2.80)	4.32 (2.12)	10.98 (3.38)	11.82
T2: *M. anisopliae*@ 1 x 10^9 spores/ml with adjuvant -4 sprays in flowering	35.93 (6.03)	26.10 (5.13)	19.41 (4.46)	16.02 (4.10)	8.75 (3.03)	17.57 (4.25)	10.35
T3: *M. anisopliae*@ 1 x 10^7 spores/ml with adjuvant - 4 sprays in flowering	35.97 (6.03)	27.32 (5.27)	20.81 (4.61)	17.60 (4.25)	13.11 (3.68)	19.71 (4.49)	8.79
T4: Imidacloprid @ 0.3 ml/l -1 spray at pre-flowering	35.99 (6.04)	15.15 (3.95)	19.59 (4.48)	23.64 (4.91)	26.99 (5.23)	21.34 (4.67)	8.17
T5: Untreated control	36.39 (6.06)	45.52 (6.76)	51.52 (7.21)	61.98 (7.88)	58.54 (7.68)	54.39 (7.40)	6.01
S.Em ±	0.17	0.23	0.10	0.19	0.13	0.10	0.48
CD at 5%	0.53	0.72	0.32	0.59	0.39	0.30	1.48

Figures in parentheses are √x+0.5 transformed values

(Confidor 200 SL) was effective in reducing the hopper population to almost zero at all the doses tested ranging from 0.2 ml per litre to 1.6 ml per litre. In Sri Lanka, Kudagmage *et al.* (2001) tested three insecticides against mango hoppers and reported that imidacloprid 1.0 ml per litre was the most effective insecticide.

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