Evaluation of the Efficacy of Different Fungicides against *Fusarium musae*, a Fruit Rot Disease of Banana

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Authors' contributions

This work was carried out in collaboration between both authors. Author TTB designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author KBR managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Fruit rot disease caused by *Fusarium musae* is one of the post-harvest disease of banana and is adversely affecting the fruit quality and the market value. *In vitro* evaluation of different fungicides, against *F. musae*. Amongst, fungicides viz., mancozeb 75 WP at 2500 ppm, azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm and propiconazole (25 EC) at 500 ppm and 1000 ppm were found cent per cent inhibition of mycelial growth of *F. musae*. Whereas, *in vivo* evaluation were lowest fusarium fruit rot severity was observed in propiconazole (25 EC) at 1000 ppm in pre (6.61%) and post- inoculation (6.70%) treatments at 8 days after inoculation.

Keywords: *Banana; fungicide, Fusarium musae; in vitro; in vivo; post-harvest.*

1. INTRODUCTION

Banana (*Musa paradisiacal* L.) is one of the most important commercial fruit crop grown all over

the world in the tropical and subtropical areas. It is the second largest fruit crop, belongs to family *Musaceae* in order *Zingiberales*. It is indigenous to indo-Malayan region [1].

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Cultivated banana is susceptible to many diseases, mostly fungal pathogen which attacks various part of the plant from root to fruit. Bananas are highly perishable commodities with post-harvest losses estimated to the tune of 25-30 per cent [2]. Banana fruit suffers from many serious diseases such as fruit rot, crown rot, finger rot, cigar-end rot and pitting disease. The current postharvest problems for bananas are mainly concerned with storage and marketing. Crown rot due to, *Fusarium pallidoseum* (Cooke) Sacc, *Colletotrichum musae* (Berk. and Curt.), *Verticillium theobromae* (Turc.) Mason and Hughes, *Thielaviopsis paradoxa* (Desseynes) Sacc., *Lasiodiplodia theobromae* (Pat.) Griffith and Maubl, *Fusarium musae* (Syd.) M. B. Ellis and *Fusarium roseum* (Link) Snyder and Hansen pathogens causes losses of bananas in grown for local consumption and export of bananas [3]. Banana fruit majorly infected by *Alternaria alternata* (Fr.) Keissier, *Colletotrichum musae*, *Fusarium moniliforme* (Cooke) Sacc and *F. oxysporum* (Schlecht. Emend. Snyder and Hansen) pathogens. *Aspergillus flavus* Link., *A. fumigatus* Fresenius., *A. niger* Van. Teigh., *A. terreus* Thom., *Penicillium* spp. Link were dominant pathogens, same as *Curvularia lunata* (Wakker) Boedijn, *Cochliobolus lunatus* (Nelson and Haasis) and *Colletotrichum musae*. *Nigrospora oryzae* (Berk and Ba.) Petch. and *Khushkia oryzae* Hudson were active during the winter while, *Botryodiplodia theobromae* were sporadic whereas, *Deightonella torulosa* and *Cunninghamella echinulata* (Thaxter) were detected occasionally. *Rhizoctonia solani* (Kuhn) and *Macrophomina phaseolina* (Tassi) Goid. also caused considerable damage to fruits [4].

The banana fruit infecting fungus *Fusarium musae* was originally known as a distinct population within *Fusarium verticillioides*. However, [5] recently, showed, by multilocus phylogeny and mating experiments that this population represents a unique lineage in the *Fusarium fujikuroi* species complex (FFSC) and consequently they installed the new species *Fusarium musae* being closely related to (i.e. sister species) but distinct from *Fusarium verticillioides*. The first cases of human infection associated with *Fusarium musae* caused through contact with *Fusarium musae* contaminated banana fruits, either being imported or after traveling of the patient to a banana producing country. An alternative hypothesis is that *Fusarium musae* is not only present on banana fruits, but also on other plant

hosts or environmental sources. In a more recent survey performed laboratory testing the feasibility of an in house developed MALDITOF MS identification assay and there by using 390 fungal isolates collected between July 2012 and July 2013 from 2 hospitals located in Brussels, one *Fusarium musae* strain was found among the 20 *Fusarium* isolates identified. This *Fusarium musae* strain was isolated from a blood sample of an immune-suppressed patient, whereas majority of the other fusarioses [6].

As very meagre research work has been carried out on fruit rots of banana and their management in India, with a view to extend the shelf life of banana fruits and to reduce the losses caused by post-harvest diseases; it is felt worthwhile to carry out the investigations on fusarium fruit rot of banana and its management under south Gujarat conditions.

2. MATERIALS AND METHODS

2.1 *In vitro* Evaluation of Fungicides against *Fusarium musae*

Bio-efficacy of different fungicides were studied *in vitro* by following Poisoned Food Technique method [7] against *Fusarium musae* with different concentrations i.e., 250, 500, 1000, 1500, 2000 and 2500 ppm.

The list of fungicides are given in the Table 1 along with their technical name. Required quantity of each fungicide under study was mixed thoroughly in sterilized 100 ml PDA media filled in 250 ml flask separately under aseptic condition. The medium was supplemented with streptomycin sulphate at 100 ppm to prevent bacterial contamination. The poisoned 20 ml medium was poured in sterilized Petri plates and allowed it to solidify. The plates were then inoculated with 5mm diameter disc of seven days old culture of test pathogen by placing in the centre of the plate. Control was maintained for each set where fungal disc was placed on PDA medium without fungicide. Each treatment was replicated three times. The inoculated plates were then incubated at 27±2°C in BOD incubator. The observations on mycelial growth (mm) and per cent growth inhibition of *Fusarium musae* recorded after 8 days of incubation. The percent growth inhibition (PGI) of pathogen in each treatment was calculated by following formula [8].

Table 1. List of fungicides against *Fusarium musae* in vitro

Sr. No.	Technical Name	Trade Name	Concentration (ppm)		
1	Carbendazim 12% + Mancozeb 63%	Saaf	250	500	1000
2	Mancozeb 75 WP	Indofil M45	1500	2000	2500
3	Copper oxychloride 50 WP	Blitox-50	1500	2000	2500
4	Cymoxanil 8% + Mancozeb 64%	Curzet	250	500	1000
5	Thiophanate methyl 70 WP	Topsin-M	250	500	1000
6	Carbendazim 50 WP	Bavistin	250	500	1000
7	Azoxystrobin 20% + Difenconazole 12.5%	Amistar Top	250	500	1000
8	Propiconazole 25 EC	Tilt	250	500	1000
9	Chlorothalonil 75 WP	Kavach	1500	2000	2500

$$I = (C - T / C) \times 100$$

Where, I = Inhibition per cent

C = Colony diameter (mm) in control plate

T = Colony diameter (mm) in treated plate

Experimental details:

- I. Design: Completely Randomized Design (CRD)
- II. Treatments: 10 (Ten) (including control)
- III. Replications: 3 (Three)
- IV. Method: Poisoned food technique

2.2 In vivo Evaluation of Fungicides against *Fusarium* Fruit Rot

The fungicides found effective *in vitro* were further tested to study their efficacy in controlling *Fusarium* fruit rot diseases of banana *in vivo*.

Experimental details:

- I. Design: Completely Randomized Design (CRD)
- II. Treatments: 13 (Thirteen) (including control)
- III. Replications: 3 (Three)

2.3 Pre- inoculation of Fungicides on Banana Fruit

The healthy, matured, semi-ripe uniform size banana fruits of 'Grande Naine' cultivar were surface sterilized by dipping in 0.1 per cent sodium hypochlorite solution for one min. followed by three washings with distilled sterile water and inoculated separately with the pathogen by the stylar- end pricking method. The fruits were first dipped in the fungicidal solution for 5 min., air dried and after 12 hours treated fruits were inoculated with test pathogen

(10^6 cfu/ml) then bagged in sterilized polythene bags with sterilized moist absorbent cotton swab. The mouth of the bag was loosely tied and incubated at $27 \pm 2^\circ\text{C}$. The severity of *Fusarium* fruit rot was recorded on 4th and 8th day after inoculation with the help of assessment key.

2.4 Post- inoculation of Fungicides on Banana Fruit

The procedure detailed in above was followed except that the fruits were first inoculated with test pathogen and then treated with fungicides.

Disease severity was recorded after 4th and 8th days of inoculation following standard key.

$$\text{Severity (\%)} = (\text{Area of infected fruits} / \text{Total area of fruit tissue}) \times 100$$

Chart 1. Assessment key used for severity of *Fusarium* fruit rot disease of banana

Scale	Per cent infection
0	0%
1	1-10%
2	11-20%
3	21-40%
4	41-50%
5	> 60%

3. RESULTS AND DISCUSSION

3.1 Evaluation of Fungicides Against *Fusarium musae* under *In Vitro*

All fungicides under the investigation inhibited the mycelial growth of *F. musae* but their concentrations significantly differ within themselves. Among all concentration, the higher concentration of each fungicide gave maximum growth inhibition of *F. musae* under *in vitro*

condition. Total nine fungicides viz., carbendazim (12%) + mancozeb (63 %), mancozeb (75 WP), copper oxychloride (50 WP), cymoxanil (8%) + mancozeb (64%), thiophanate methyl (70 WP), carbendazim (50 WP), azoxystrobin (20%) + difenoconazole (12.5%), propiconazole (25 EC) and chlorothalonil (75 WP) were evaluated against *F. musae* using poison food technique on PDA medium at 250, 500, 1000, 1500, 2000 and 2500 ppm concentrations. The mycelial growth and per cent growth inhibition of *F. musae* were recorded at 8 days after incubation. The results presented in Table 2 indicated that all fungicides evaluated significantly reduced the growth of *F. musae* as compare to the control but all the fungicides and their concentrations significantly differ within themselves. The result indicated that, mycelial growth of *F. musae* ranged from 0.0 to 31.00 mm and inhibition of mycelial growth of *F. musae* varied from 52.29 to 100.0 per cent.

3.2 Effect of Fungicides on Colony Diameter of *F. Musae*

Nine fungicides at three different concentrations evaluated against *F. musae* *in vitro*. Among them, mancozeb (75 WP) at 2500 ppm, azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm and propiconazole (25 EC) at 500 ppm and 1000 ppm were found cent mycelial growth of *F. musae*. The next best fungicides in order of merit were carbendazim (12%) + mancozeb (63%) at 1000 ppm (5.33 mm), mancozeb (75 WP) at 2000 ppm (6.00 mm), carbendazim (12%) + mancozeb (63%) at 500 ppm (8.00 mm), mancozeb (75 WP) at 1500 ppm (9.33 mm), chlorothalonil (75 WP) at 2500 ppm (10.00 mm), azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm (11.00 mm), propiconazole (25 EC) at 250 ppm (11.00 mm) and copper oxychloride (50 WP) at 2500 ppm (11.33 mm) recorded lower mycelial growth of pathogen. Whereas, carbendazim (12%) + mancozeb (63%) at 250 ppm; copper oxychloride (50 WP) at 1500 ppm and 2000 ppm; cymoxanil (8%) + mancozeb (64%) at 250 ppm, 500 ppm and 1000 ppm; thiophanate methyl (70 WP) at 250 ppm, 500 ppm and 1000 ppm; carbendazim (50 WP) at 250 ppm, 500 ppm and 1000 ppm; azoxystrobin (20%) + difenoconazole (12.5%) at 250 ppm and chlorothalonil (75 WP) at 1500 ppm and 2000 ppm were found less effective and recorded comparatively higher mycelial growth of *F. musae* i.e., 26.00mm; 27.67 and 18.00 mm; 28.00, 17.00 and 15.00mm; 31.33, 19.00 and

16.00mm; 28.67, 14.00 and 12.00mm; 22.00 mm; 14.00 and 13.00 mm, respectively. All fungicides were found superior as compared to control (65.67 mm).

3.3 Effect of Fungicides on Growth Inhibition of *F. Musae*

Nine fungicides at three different concentrations evaluated against *F. musae* *in vitro*. Among them, mancozeb (75 WP) at 2500 ppm, azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm and propiconazole (25 EC) at 500 and 1000 ppm found cent per cent mycelium growth inhibition of *Fusarium musae*. The next best fungicides in order of merit in per cent mycelium growth inhibition were carbendazim (12%) + mancozeb (63%) at 1000 ppm (91.88%), mancozeb (75 WP) at 2000 ppm (90.86 %), carbendazim (12%) + mancozeb (63%) at 500 ppm (87.82%), mancozeb (75 WP) at 1500 ppm (85.79%), chlorothalonil (75 WP) at 2500 ppm (84.77%), azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm (83.25%), propiconazole (25 EC) at 250 ppm (83.25%) and copper oxychloride (50 WP) at 2500 ppm (82.74 %). Whereas, carbendazim (12%) + mancozeb (63%) at 250 ppm; copper oxychloride (50 WP) at 1500 ppm and 2000 ppm; cymoxanil (8%) + mancozeb (64%) at 250 ppm, 500ppm and 1000 ppm; thiophanate methyl (70 WP) at 250 ppm, 500 ppm and 1000 ppm; carbendazim (50 WP) at 250 ppm, 500 ppm and 1000 ppm; azoxystrobin (20%) + difenoconazole (12.5%) at 250 ppm and chlorothalonil (75 WP) at 1500 ppm and 2000 ppm were found less effective and recorded comparatively lower mycelium growth inhibition of *F. musae* i.e., 60.41; 57.87 and 72.59%; 57.36, 74.11 and 77.16%; 52.29, 71.07 and 75.64%; 56.35, 78.68 and 81.73%; 66.50%; 78.68 and 80.20%, respectively. All fungicides were found superior as compared to control.

These findings are conformities with Charpe et al. [9] studied different combinations of fungicides, waxes and bioagent against colletotrichum rot of Nagpur mandarins and observed that application at 0.1% propiconazole + 6% citrashine wax was the most effective with 11.90 per cent disease control followed by 0.1% propiconazole + 6% vegetable wax with 7.14 per cent disease control. Ingole et al. [10] reported that carbendazim at 0.1 per cent was found superior and recorded highest conidial inhibition of *Colletotrichum gloeosporioides*, *Fusarium moniliforme* and *Fusarium semitectum* of banana fruit.

3.4 Evaluation of Fungicides against *Fusarium musae* under *In Vivo*

Study *in vitro* experiment, the effective treatments viz., carbendazim (12%) + mancozeb (63%) at 500 and 1000 ppm; mancozeb (75 WP) at 1500, 2000 and 2500 ppm; copper oxychloride (50 WP) at 2500 ppm; azoxystrobin (20%) + difenoconazole (12.5%) at 500 and 1000 ppm; propiconazole (25 EC) at 250, 500 and 1000 ppm and chlorothalonil (75 WP) at 2500 ppm were further tested *in vivo*. All the fungicides found significantly superior in reducing the fusarium fruit rot severity after 4th and 8th day of inoculation in pre-and post-inoculation treatments (Table 3).

3.5 Pre-inoculation of Fungicides on Banana Fruit

After 4th day of inoculation, significantly lowest fusarium fruit rot severity was recorded in fruits treated with propiconazole (25 EC) at 1000 ppm (4.69%) and it was at par with carbendazim (12%) + mancozeb (63%) at 1000 ppm (4.95%). The next best fungicide in order of merit was carbendazim (12%) + mancozeb (63%) at 500 ppm (6.33%), propiconazole (25 EC) at 500 ppm (6.67%), mancozeb (75 WP) at 2500 ppm (6.67%), mancozeb (75 WP) at 2000 ppm (7.34%), mancozeb (75 WP) at 1500 ppm (7.91%), propiconazole (25 EC) at 250 ppm (8.06%), azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm (8.36%) and copper oxychloride (50 WP) at 2500 ppm (8.44%). Whereas, azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm (11.47%) and chlorothalonil (75 WP) at 2500 ppm (10.38%) were found least effective in controlling the fusarium fruit rot severity.

On 8th day of inoculation, significantly lowest fusarium fruit rot severity was recorded in fruits treated with propiconazole (25 EC) at 1000 ppm (6.61%) and it was at par with carbendazim (12%) + mancozeb (63%) at 1000 ppm (7.21%) and 500 ppm (7.76%). The next best fungicide in order of merit was propiconazole (25 EC) at 500 ppm (8.73%), mancozeb (75 WP) at 2500 ppm (8.89%), mancozeb (75 WP) at 2000 ppm (9.56%), mancozeb (75 WP) at 1500 ppm (11.07%), azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm (12.15 %), copper oxychloride (50 WP) at 2500 ppm (13.09%) and propiconazole (25 EC) at 250 ppm (13.18 %). Whereas, azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm (14.68%) and chlorothalonil

(75 WP) at 2500 ppm (14.24%) were found least effective in controlling the fusarium fruit rot severity.

3.6 Post-inoculation of Fungicides on Banana Fruit

After 4th day of inoculation, significantly lowest fusarium fruit rot severity was recorded in fruits treated with propiconazole (25 EC) at 1000 ppm (5.51%) and it was at par with carbendazim (12%) + mancozeb (63%) at 1000 ppm (5.58%), propiconazole (25 EC) at 500 ppm (6.35%) and carbendazim (12%) + mancozeb (63%) at 500 ppm (6.57%). The next best fungicide in order of merit was mancozeb (75 WP) at 1500 ppm (7.47%), 2500 ppm (7.61%), 2000 ppm (7.66%), propiconazole (25 EC) at 250 ppm (8.98%), azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm (9.03%) and copper oxychloride (50 WP) at 2500 ppm (9.20%). Whereas, azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm (11.41 %) and chlorothalonil (75 WP) at 2500 ppm (10.11%) were found least effective in controlling the fusarium fruit rot severity.

On 8th day of inoculation, significantly lowest fusarium fruit rot severity was recorded in fruits treated with propiconazole (25 EC) at 1000 ppm (6.72%) and it was at par with carbendazim (12%) + mancozeb (63%) at 1000 ppm (7.48%), propiconazole (25 EC) at 500 ppm (8.27%), carbendazim (12%) + mancozeb (63%) at 500 ppm (8.34%) and mancozeb (75 WP) at 2000 ppm (9.02%). The next best fungicide in order of merit was mancozeb (75 WP) at 2500 ppm (9.88%), azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm (10.52%) and copper oxychloride (50 WP) at 2500 ppm (11.06%), mancozeb (75 WP) at 1500 ppm (12.71%) and propiconazole (25 EC) at 500 ppm (15.15%). Whereas, azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm (15.43%) and chlorothalonil (75 WP) at 2500 ppm (15.39%) were found least effective in controlling the fusarium fruit rot severity.

The result was support with many workers. Kone et al. [11] tested trifloxystrobin, spiroxamine, propiconazole and tebuconazole at 0.01, 0.05, 0.1, 0.5 and 1 ppm against *Mycosphaerella fijiensis*, *Mycosphaerella musicola*, *Cladosporium musae* and *Fusarium musae* associated with banana. They observed that trifloxystrobin, propiconazole and tebuconazole reduced the mycelium growth of *Mycosphaerella fijiensis* and *Cladosporium musae* 75 to 90 per cent whereas, *F. musae* 50 to 75 per cent radial the mycelium

growth with application of tebuconazole, banana fruits rot caused by *Fusarium* trifloxystrobin and spiroxamine. Benomyl and *moniliforme* and *F. roseum* pre- and post- aretan at 100 ppm were completely checked the inoculation treatment up to 8 days [12].

Table 2. Testing of fungicides against fusarium fruit rot *in vivo*

Sr. No.	Technical Name	Concentration (ppm)
1	Carbendazim 12% + Mancozeb 63%	500
2	Carbendazim 12% + Mancozeb 63%	1000
3	Mancozeb 75 WP	1500
4	Mancozeb 75 WP	2000
5	Mancozeb 75 WP	2500
6	Copper oxychloride 50 WP	2500
7	Azoxystrobin 20% + Difenoconazole 12.5%	500
8	Azoxystrobin 20% + Difenoconazole 12.5%	1000
9	Propiconazole 25 EC	250
10	Propiconazole 25 EC	500
11	Propiconazole 25 EC	1000
12	Chlorothalonil 75 WP	2500

Table 3. Efficacy of fungicides on the *Fusarium musae* causing fusarium fruit rot of banana *in vitro*

Sr. No.	Treatment	Concentration (ppm)	Colony diameter (mm) 8 DAI	Per cent growth inhibition
1	Carbendazim 12% + Mancozeb 63%	250	5.15** (26.00)*	60.41
		500	2.91 (08.00)	87.82
		1000	2.41 (05.33)	91.88
2	Mancozeb 75 WP	1500	3.13 (09.33)	85.79
		2000	2.54 (06.00)	90.86
		2500	0.71 (0.00)	100.00
3	Copper oxychloride 50 WP	1500	5.31 (27.67)	57.87
		2000	4.30 (18.00)	72.59
		2500	3.44 (11.33)	82.74
4	Cymoxanil 8% + Mancozeb 64%	250	5.34 (28.00)	57.36
		500	4.18 (17.00)	74.11
		1000	3.94 (15.00)	77.16
5	Thiophanate methyl 70 WP	250	5.64 (31.33)	52.29
		500	4.41 (19.00)	71.07
		1000	4.06 (16.00)	75.64
6	Carbendazim 50 WP	250	5.40 (28.67)	56.35
		500	3.81 (14.00)	78.68
		1000	3.53 (12.00)	81.73
7	Azoxystrobin 20% + Difenoconazole 12.5%	250	4.74 (22.00)	66.50
		500	3.39 (11.00)	83.25
		1000	0.71 (0.00)	100.00
8	Propiconazole 25 EC	250	3.39 (11.00)	83.25
		500	0.71 (0.00)	100.00
		1000	0.71 (0.00)	100.00
9	Chlorothalonil 75 WP	1500	3.81 (14.00)	78.68
		2000	3.67 (13.00)	80.20
		2500	3.24 (10.00)	84.77
10	Control	-	8.13 (65.67)	-
SEm ±		0.07		
CD at 5 %		0.21		
CV %		3.48		

Table 4. Efficacy of fungicides on the severity of fusarium fruit rot of banana *in vivo*

Sr. No.	Fungicides	Con. (ppm)	Fusarium fruit rot severity (%)			
			Pre-inoculation		Post-inoculation	
			4 th day	8 th day	4 th day	8 th day
1	Carbendazim 12% + Mancozeb 63%	500	14.55** (06.33)*	16.15 (07.76)	14.83 (06.57)	16.77 (08.34)
2	Carbendazim 12% + Mancozeb 63%	1000	12.82 (04.95)	15.54 (07.21)	13.65 (05.58)	15.83 (07.48)
3	Mancozeb 75 WP	1500	16.31 (07.91)	19.38 (11.07)	15.84 (07.47)	20.85 (12.71)
4	Mancozeb 75 WP	2000	15.72 (07.34)	18.01 (09.56)	16.03 (07.66)	17.47 (09.02)
5	Mancozeb 75 WP	2500	14.93 (06.67)	17.30 (08.89)	16.00 (07.61)	18.29 (09.88)
6	Copper oxychloride 50 WP	2500	16.87 (08.44)	21.20 (13.09)	17.66 (09.20)	19.42 (11.06)
7	Azoxystrobin 20% + Difenoconazole 12.5%	500	19.77 (11.47)	22.51 (14.68)	19.74 (11.41)	23.13 (15.43)
8	Azoxystrobin 20% + Difenoconazole 12.5%	1000	16.80 (08.36)	20.38 (12.15)	17.47 (09.03)	19.00 (10.62)
9	Propiconazole 25 EC	250	16.48 (08.06)	21.29 (13.18)	17.43 (08.98)	22.90 (15.15)
10	Propiconazole 25 EC	500	14.97 (06.67)	17.18 (08.73)	14.59 (06.35)	16.70 (08.27)
11	Propiconazole 25 EC	1000	12.42 (04.69)	14.86 (06.61)	13.57 (05.51)	15.03 (06.72)
12	Chlorothalonil 75 WP	2500	18.79 (10.38)	22.15 (14.24)	18.49 (10.11)	23.09 (15.39)
13	Absolute control	-	24.49 (17.21)	28.81 (23.22)	25.82 (19.00)	30.91 (26.47)
SEm ±			0.61	0.65	0.60	0.69
CDat 5 %			1.76	1.89	1.74	2.02
CV %			6.35	5.74	6.11	6.02

*Figure in parenthesis is original value, **outside is arcsine transform value & DAI: Day after incubation

4. CONCLUSIONS

Various fungicides screened were found superior in inhibiting the mycelial growth of *F. musae* *in vitro*. Among them mancozeb 75 WP at 2500 ppm, azoxystrobin (20%) + difenoconazole (12.5%) at 1000 ppm and propiconazole (25 EC) at 500 ppm and 1000 ppm were found to be the most superior because of 100 per cent inhibition of mycelial growth of *F. musae*. Whereas, *in vivo* evaluation lowest fusarium fruit rot severity was observed with propiconazole (25 EC) at 1000ppm in pre (6.61%) and post- inoculation (6.7%) treatments at 8 days after inoculation. While azoxystrobin (20%) + difenoconazole (12.5%) at 500 ppm and chlorothalonil (75 WP) at 2500 ppm were found least effective.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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