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Assessment of various fungicides and bio-agents against the powdery mildew of mango (*In vitro*)

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Abstract
Among all diseases, Powdery mildew (*Oidium mangiferae* Berthet) of mango is emerging as one of the most common, wide spread and serious disease throughout the world and causes significant yield losses. The most serious losses occur when flowering and growth flushes are infected during cool and dry conditions. *In vitro* evaluation of seven fungicides and two bio agent against *O. mangiferae* showed hexaconazole @ 0.01% and Wettable sulphur @ 0.3% were highly effective and inhibited the conidial germination. The next best in order of merit was *Pseudomonas fluorescence* @ 5% inhibited comparatively least growth of the pathogen.

Keywords: fungicides, powdery mildew

Introduction
Mango (*Mangifera indica* L.) is commonly referred as the 'King of fruits.' Due to its wider climatic adaptability it is cultivated in both tropical and subtropical regions of the world. One of the major constraint in the commercial cultivation of mango is it's proneness to large number of diseases. Among fungal diseases, powdery mildew (*Oidium mangiferae*) is the most destructive malady affecting almost all the commercial cultivars. During the recent years, in India incidence of the powdery mildew has assumed a devastating proportion and has emerged as a single limiting factor in expansion of the mango crop cultivation.
Among these diseases, Powdery mildew (*Oidium mangiferae* Berthet) of mango is emerging as one of the most common, wide spread and serious disease throughout the world and causes significant yield losses. The most serious losses occur when flowering and growth flushes are infected during cool and dry conditions. A minimum temperature range of 11-14 °C and maximum of 27-31 °C along with 64-72% RH are the most conducive for disease development (Nasir *et al*., 2014) [2]. The fungus produces the symptoms of white superficial powdery masses on inflorescence, leaves and young fruits. The disease mainly attack on inflorescence resulting in premature shedding of flowers and young fruits, thus causing heavy monetary losses to the mango growers (Prakash, 1996; Misra, 2002) [4, 1]. Application of dinocap and sulphur are the widely adopted practices but it becomes difficult to manage the disease particularly when the disease pressure is high at the time of flowering (Sharma, 1992; Verma and Deepraj, 1998; Prakash and Raoof, 1985) [5, 6, 3].

Materials and Methods
To find out the most effective fungicide against the test pathogen seven fungicides and two bio agents were evaluated under *in vitro* condition by spore germination inhibition method.
Double strength solution of each fungicide was prepared in the sterilized distilled water. Simultaneously, spore suspension was also prepared by dislodging the conidia from the infected inflorescence. One drop of each (*i.e*. fungicide solution and spore suspension) was separately put in the cavity of cavity slide. This was placed in flask with different fungicides and kept for incubation. The readings on germination of conidia were recorded after 24,36 and 48 hrs by placing cavity slides under light microscope and per cent inhibition in germination of each fungicide was calculated by adopting the formula,

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Per cent inhibition
C = Germination in control
T = Germination in treatment

Treatment details

Treatment	Technical name	Trade name	Per cent Concentration
T_1	Wettable sulfur	Sulfex 80 wp	0.3
T_2	Tridemefon	Bayleton 25wp	0.01
T_3	Myclobutanil	Nova	0.1
T_4	Carbendazim	Bavistin 50 WP	0.1
T_5	Azoxystrobin	Amister 25SC	0.1
T_6	Hexaconazole	Contaf 5EC	0.01
T_7	Penconazole	Topaz 10EC	0.05
T_8	*Pseudomonas fluorescence*	Navsari isolate	5
T_9	*Bacillus subtilis*	Navsari isolate	5
T_{10}	Control		

Results and discussion

In vitro evaluation of fungicides provides useful and preliminary information regarding efficacy of fungicides against pathogens within a shortest period of time and therefore, serve as a guide for field testing.

Seven fungicides and two bio agents from were evaluated at mentioned concentrations in *in vitro* condition for their efficacy against *Oidium mangiferae*. The results presented in Table-1 and depicted graphically indicated that fungicides were varied efficacy against *Oidium mangiferae*.

All the fungicides screened at different concentrations were found significantly superior in inhibiting the spore germination in *Oidium mangiferae*. Out of this, hexaconazole @ 0.01% significantly inhibited spore germination of pathogen and proved strongly fungi toxic at the given concentrations. Wettable sulphur @ 0.3% significantly inhibited growth of the pathogen and at par with the best one. The next best in order of merit was *Pseudomonas fluorescence* @ 5% inhibited comparatively least growth of the pathogen. Higher spore germination was recorded with rest of the fungicides. The spore germination was maximum inhibited by hexaconazole @ 0.01% at all mentioned concentrations.

2014-15

It is evident from this result that, the inhibition of spore germination increases with the use of chemicals. hexaconazole equally (2.11%) inhibition at 0.01% concentrations. And wettable sulphur equally (2.42%) inhibition at 0.3% concentrations which was at par with *Pseudomonas fluorescence* inhibition at 5%. over rest of the fungicides tested. The rest of all like penconazole @ 0.05%, *Bacillus subtilis* @ 5%, myclobutanil @ 0.1%, azoxystrobin @ 0.1%, carbendazim @ 0.1% and tridemefon @ 0.01% gave least inhibition. This suggests further testing of these chemicals as field spraying for more confirmation of their efficacy and feasibility of the pathogen.

2015-16

In the next year hexaconazole equally (2.07%) inhibition at 0.01% concentrations. And wettable sulphur equally (2.43%) inhibition at 0.3% concentrations which was at par with *Pseudomonas fluorescence* inhibition at 5% (2.52), over rest of the fungicides tested. Whereas the other treatment penconazole @ 0.05%, *Bacillus subtilis* @ 5%, myclobutanil @ 0.1%, azoxystrobin @ 0.1%, carbendazim @ 0.1% and tridemefon @ 0.01% least inhibition. This suggests further testing of these chemicals as field spraying for more confirmation of their efficacy and feasibility of the pathogen.

Pooled

It is very clear from the study that, the growth inhibition increases with the use of chemicals. Maximum inhibition was noticed in hexaconazole with 0.01% concentrations (2.09%). The wettable sulphur also gave the good result at 0.3% concentrations (2.43%) which was at par with *Pseudomonas fluorescence* inhibition at 5%. over rest of the fungicides tested. penconazole @ 0.05%, *Bacillus subtilis* @ 5%, myclobutanil @ 0.1%, azoxystrobin @ 0.1%, carbendazim @ 0.1% and tridemefon @ 0.01% least inhibition. This suggests further testing of these chemicals as field spraying for more confirmation of their efficacy and feasibility of the pathogen.

Table 1: Evaluation of fungicides and bio agent against powdery mildew of mango cv. Kesar in navsari (*In vitro*)

Per cent spore germination			
Treatment	**2014-15**	**2015-16**	**Pooled**
T_1 Wettable sulphur	10.65 (2.42)*	10.67(2.43)	10.66 (2.43)
T_2 Tridemefon	12.36 (3.6)	12.29 (3.54)	12.33 (3.57)
T_3 Myclobutanil	11.21 (2.79)	11.35 (2.89)	11.28 (2.84)
T_4 Carbendazim	11.93 (3.28)	12.05 (3.38)	11.99 (3.33)
T_5 Azoxystrobin	11.24 (2.86)	11.28 (2.93)	11.26 (2.89)
T_6 Hexaconazole	10.09 (2.11)	10.05 (2.07)	10.07 (2.09)
T_7 Penconazole	11.54 (3.04)	11.45 (2.97)	11.5 (3.01)
T_8 *Pseudomonas fluorescence*	10.74 (2.48)	10.78 (2.52)	10.76 (2.5)
T_9 *Bacillus subtilis*	10.92 (2.62)	11.23 (2.83)	11.08 (2.73)
T_{10} Control	22.3 (13.4)	22.85 (14.08)	22.58 (13.74)
S. Em	0.55	0.66	0.60
CD	1.63	1.95	1.77
CV %	7.70	9.16	8.36

*****Figure in the paranthesis are original value.
Those outside are arcsine transformed value.

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