Evaluation of fungicides and biological agents for the management of mango anthracnose

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Abstract— *Mango is an important fruit crop in area and production in Gujarat also, where it is cultivated over an area of about 130.1 thousand hectares with annual production of 911.3 thousand tones with productivity of 7.01 tones/ha. Its plantation has become quite popular in the districts of Valsad, Junagadh, Navsari, Kutch, Surat, Amreli and Bhavnagar because of favourable agro-climate condition. Mango is affected by number of diseases at all the stages of its development right from plant in nursery to the fruit in storage or transit. Mango is prone to many fungal diseases like Anthracnose, Rhizopus rot, Stem end rot, Penicillum rot, Black mould rot, Mucor rot, Phyllosticta rot, Pestalotiopsis rot, Macrophoma rot and powdery mildew, leading to heavy loss in yield. Among these diseases, anthracnose is the major disease of mango as it occurs at all the growing parts including leaves, twigs, flowers, fruits except root and trunk throughout the year. Anthracnose caused by Glomerella cingulata (Stoneman) Spauld and H Schrenk (anamorph: Colletotrichum gloeosporioides (Penz.)) appear to be more severe causing devastation of mango fruits during grading, packing, transportation, storage and marketing (Pathak, 1980).*

Keywords— Mango, Anthracnose, fungicides and botanicals.

I. MATERIAL AND METHOD

Considering the importance of the disease and variation in the recommendations of different fungicides/bioagents available in the market for the control of anthracnose disease of mango, a field experiment was laid out with the chemicals/bioagents which were found effective under laboratory condition in controlling Anthracnose disease of mango during 2011-12 and 2012-13. The experiment was laid out in randomized block design with six chemical fungicide and two bioagents keeping three replications. The efficacy of each fungicide was compared with control plant which was sprayed with water only.

TABLE: 1

LIST OF SYSTEMIC, NON SYSTEMIC, COMBINE FUNGICIDE AND BIOAGENTS TESTED UNDER FIELD CONDITION

Sr. No.	Technical Name of fungicides	Trade Name	Quantity of fungicides used in g or ml/lit water
1	Propiconazole	Tilt (25% E. C.)	1ml
2	Hexaconazole	Contaf (5% E. C.)	1 ml
3	Carbendazim	Bavistin (50 WP)	1gm
4	Flusilazole	Nustar(40% E.C)	0.5ml
5	Kresoxim methyl	Ergon (43% E. C.)	1ml
6	Pyraclostrobin + Metiram	Cabriotop (5+55%WP)	1gm
7	*Pseudomonas fluorescens*	Navsari native	6ml
8	*Bacillus subtilis*	Navsari native	6ml
9	Control spraying with water	_	

Three sprays of fungicides and bio agents were carried out with respect to location. For this, 27 plants were selected. First spray was given in November, second spray was given one month after first spraying and third spay was given one month after second spray. Normal agronomic practices were adopted. The Per cent Disease index (PDI) of each treatment was calculated after final spray in each year. Observations were recorded at 15 days interval. Per cent disease intensity and per cent disease control of anthracnose was recorded. The disease rating was done by using 0-5 scale and Per cent Disease Index was calculated by adopting the formula given in 3.1.

The disease control DC(%) was calculated by using formula of Das and Raj (1995)

$$DC\ \% = \frac{\text{Disease \% in control- Disease \% in treatment}}{\text{Disease\% in control}} \times 100$$

II. RESULTS AND DISCUSSION

The hazardous effects of chemicals used in plant disease management have diverted plant pathologists to find out an effective alternative method with little or no adverse effect on environment. Hence for considering the necessity, this present study tried to found out the effectiveness of chemicals against C.gloeosporioides causing anthracnose disease of mango. Six fungicides and two antagonistis were evaluated at mentioned concentrations under field condition for their efficacy against mango anthracnose in two different locations (Paria and Waghai) during 2011-12 and 2012-13. The results presented in Table- 4.11 [Plate-VI] depicted graphically in Fig-4 indicated that fungicides were varied efficacy against mango anthracnose

2.1 Pooled 2011-12 and 2012-13, location Paria

All the fungicides and antagonists were found significantly effective in reducing mango anthracnose disease incidence. Out of this, Pyraclostrobin + Metiram (0.1%) and Propiconazole (0.1%) recorded significantly minimum per cent disease intensity (7.56 and 9.83%) and highest per cent disease control (79.08 and 72.79%) of mango anthracnose. The next best in order of merit were Hexaconazole (0.1%), Carbendazim 0.1%), Flusilazole (0.05%) and Kresoxim methyl (0.1%) with 11.13, 13.9, 16.76 and 17.39 per cent disease intensity and 69.20, 61.53, 53.63 and 51.88 per cent disease control, respectively. While, Pseudomonas fluorescens and Bacillus subtilis reported less effective with with 20.31 and 21.9 per cent disease intensity and 43.79 and 39.40 per cent disease control, respectively of mango anthracnose (Table- 2).

TABLE: 2

EFFICACY OF FUNGICIDES AND BIO-AGENTS FOR THE MANAGEMENT OF MANGO ANTHRACNOSE UNDER FIELD CONDITION AT PARIA

Tre. No.	Common Name	Per cent disease intensity			Efficacy over control %
		2011-12	2012-13	Pooled	
T_1	Propiconazole 25% E. C.	1.86 (10.11)	1.82 (9.56)	1.84 (9.83)	72.79
T_2	Hexaconazole 5% E. C.	1.99 (11.63)	1.91 (10.63)	1.95 (11.13)	69.20
T_3	Carbendazim 50 WP	2.23 (14.71)	2.11 (13.1)	2.17 (13.9)	61.53
T_4	Flusilazole 40% E.C	2.43 (17.54)	2.32 (15.97)	2.38 (16.76)	53.63
T_5	Kresoxim methyl	2.47 (18.1)	2.37 (16.67)	2.42 (17.39)	51.88
T_6	Pyraclostrobin + Metiram 5+55%WP	1.68 (8.11)	1.57 (7.01)	1.62 (7.56)	79.08
T_7	*Pseudomonas fluorescens*	2.64 (20.72)	2.59 (19.9)	2.61 (20.31)	43.79
T_8	*Bacillus subtilis*	2.76 (22.74)	2.66 (21.06)	2.71 (21.9)	39.40
T_9	Control spraying with water	3.52 (37.17)	3.42 (35.10)	3.47 (36.14)	---
SEm ±		0.05	0.05	0.04	---
CD (P = 0.05)		0.15	0.15	0.12	---
CV %		3.56	3.73	2.98	---

***Figure in the parenthesis are original value and those outside are arc sin transformed value**

The results in terms of fruits yield (kg/plant) showed that Pyraclostrobin + Metiram (0.1%), Propiconazole (0.1%), Hexaconazole (0.1%) and Carbendazim (0.1%), recorded significantly highest fruits yield 88.06, 84.64, 82.57 and 79.38 kg, respectively of mango. While, Flusilazole (0.05%) and Kresoxim methyl (0.1%), Pseudomonas fluorescens and Bacillus subtilis recorded less fruit yield 68.39, 66.51, 66.36 and 64.16 kg, respectively of mango (Table- 3).

TABLE 3

EFFECT OF FUNGICIDES AND BIO-AGENTS ON FRUIT YIELD AGAINST ANTHRACNOSE DISEASE OF MANGO UNDER FIELD CONDITION AT PARIA

Sr. No.	Common Name	Fruit yield (kg/plant)		
		2011-12	2012-13	Pooled
T_1	Propiconazole 25% E. C.	82.47	86.80	84.64
T_2	Hexaconazole 5% E. C.	81.43	83.70	82.57
T_3	Carbendazim 50 WP	78.16	80.60	79.38
T_4	Flusilazole 40% E.C	65.48	71.30	68.39
T_5	Kresoxim methyl 43% E. C.	64.81	68.20	66.51
T_6	Pyraclostrobin + Metiram 5+55% WP	86.22	89.90	88.06
T_7	*Pseudomonas fluorescens*	65.22	67.50	66.36
T_8	*Bacillus subtilis*	63.22	65.10	64.16
T_9	Control spraying with water	39.36	42.10	40.73
SEm ±		4.69	4.72	4.70
CD (P = 0.05)		14.05	14.15	14.10
CV %		11.66	11.23	11.44

2.2 Pooled 2011-12 and 2012-13, location- waghai

All the fungicides and antagonists were found significantly effective in reducing mango anthracnose disease incidence. Out of this, Pyraclostrobin + Metiram (0.1%) and Propiconazole (0.1%) recorded significantly minimum per cent disease intensity (6.90 and 8.55%) and highest per cent disease control (74.68 and 68.62%) of mango anthracnose. The next best in order of merit were Hexaconazole (0.1%), Carbendazim (0.1%), Flusilazole (0.05%) and Kresoxim methyl (0.1%) with 9.47, 11.97, 13.89 and 14.70 per cent disease intensity and 65.25, 56.07, 49.03 and 46.07 per cent disease control, respectively. While, Pseudomonas fluorescens and Bacillus subtilis reported less effective with 16.21 and 19.20 per cent disease intensity and 40.53 and 29.54 per cent disease control, respectively of mango anthracnose (Table- 4).

The result in terms of fruits yield (kg/plant) showed that The result in terms of fruits yield (kg/plant) showed that Pyraclostrobin + Metiram (0.1%), Propiconazole (0.1%), Hexaconazole (0.1%) and Carbendazim (0.1%), recorded significantly highest fruits yield 93.9, 88.7, 87.4 and 82.4 kg, respectively of mango. While, Flusilazole (0.05%) and Kresoxim methyl (0.1%), Pseudomonas fluorescens and Bacillus subtilis recorded less fruit yield 71.4, 67.4, 64.9 and 62.8 kg, respectively of mango (Table- 5).

TABLE 4

EFFICACY OF FUNGICIDES AND BIO-AGENTS FOR THE MANAGEMENT OF MANGO ANTHRACNOSE UNDER FIELD CONDITION AT WAGHAI

Tre. No.	Common Name	Per cent disease intensity			Efficacy over control %
		2011-12	2012-13	Pooled	
T_1	Propiconazole 25% E. C.	1.77 (9.10)	1.67 (8.00)	1.72 (8.55)	68.62
T_2	Hexaconazole 5% E. C.	1.93 (10.83)	1.68 (8.11)	1.81 (9.47)	65.25
T_3	Carbendazim 50 WP	2.04 (12.17)	2.01 (11.77)	2.02 (11.97)	56.07
T_4	Flusilazole 40% E.C	2.23 (14.7)	2.11 (13.08)	2.17 (13.89)	49.03
T_5	Kresoxim methyl 43% E. C.	2.26 (15.06)	2.21 (14.33)	2.23 (14.70)	46.07
T_6	Pyraclostrobin + Metiram 5+55%WP	1.58 (7.10)	1.54 (6.70)	1.56 (6.90)	74.68
T_7	*Pseudomonas fluorescens*	2.40 (17.02)	2.28 (15.39)	2.34 (16.21)	40.53
T_8	*Bacillus subtilis*	2.62 (20.4)	2.46 (18.00)	2.54 (19.20)	29.54
T_9	Control spraying with water	3.09 (28.61)	2.94 (25.89)	3.02 (27.25)	---
SEm ±		0.06	0.05	0.06	---
CD (P = 0.05)		0.18	0.16	0.17	---
CV %		4.68	4.32	4.48	---

TABLE 5

EFFECT OF FUNGICIDES AND BIO-AGENTS ON FRUIT YIELD AGAINST ANTHRACNOSE DISEASE OF MANGO UNDER FIELD CONDITION AT WAGHAI.

Tre. No.	Common Name	Fruit yield (kg/plant)		
		2011-12	2012-13	Pooled
T_1	Propiconazole 25% E. C.	87.1	90.3	88.7
T_2	Hexaconazole 5% E. C.	86.2	88.6	87.4
T_3	Carbendazim 50 WP	81.9	83.0	82.4
T_4	Flusilazole 40% E.C	70.7	72.0	71.4
T_5	Kresoxim methyl	66.5	68.3	67.4
T_6	Pyraclostrobin + Metiram 5+55%WP	92.7	95.0	93.9
T_7	*Pseudomonas fluorescens*	63.5	66.3	64.9
T_8	*Bacillus subtilis*	61.5	64.0	62.8
T_9	Control spraying with water	42.2	46.1	44.2
SEm ±		5.71	5.57	5.64
CD (P = 0.05)		17.11	16.70	16.91
CV %		13.64	12.89	13.26

These results are in harmony with earlier workers *viz.*, Gud and Raut (2008) who reported that thiophanate methyl (0.2%), M.E.M.C. (Emisan 0.2%) and propiconazole 0.1% were the most effective fungicides totally inhibiting the mycelial growth of mango anthracnose. Joshi *et al*. (2010) revealed that Tricyclazole (0.1%) and Procbloraz (0.125%) were found most promising fungicides which recorded 50.38 and 48.78 per cent disease control over untreated control. These fungicides were proved to be promising as alternatives to the recommended fungicides viz. Carbcndazim (0.1%) and Mancozeb (0.25%). Sharma *et al* (2010) demonstrated that spraying of Saaf (carbendazim 12% + mancozeb 63%) @ 0.2% was the most promising fungicide in fields and this can be recommended for the control of mango anthracnose.

Haggag *et al.* (2011) found that spray application of bacterial filtrate (*Streptomyces aureofaciens*) on mango trees provided greater efficacy for controlling anthracnose disease suggested that the bacteria produce some antifungal enzymes for protecting the fruit against the pathogen.

The present findings are more or less in agreement with the findings of the above workers. New product Pyraclostrobin + Metiram 5+55% WP and Propiconazole 20% E. C. are found superior.

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