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In vitro Evaluation of Systemic, Non-Systemic and Combi Fungicides against *Colletotrichum gloeosporoides* Causing Fungal Fruit Rot in Pomegranate

K.A. Burgute* and S.J. Magar

Department of Plant Pathology, College of Agriculture, Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.) India

**Corresponding author*

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A B S T R A C T

In vitro evaluation of systemic, non-systemic and combi fungicides against *Colletotrichum gloeosporoides* causing fungal fruit rot in pomegranate were carried out in the Department of Plant Pathology, College of Agriculture, Latur during the year 2017-18. Among the systemic fungicides at 1000 ppm concentration Carbendazim 50 WP showed (87.23%) inhibition of mycelial growth of fungus followed by Difenconazole 25 EC with (85.74%) and least inhibition of mycelial growth was recorded in Propiconazole 25 EC (74.66%). The non-systemic and combi fungicides were evaluated against the pathogen at 2000 ppm concentration. Among the non-systemic and combi fungicides the maximum percent inhibition of growth of *Colletotrichum gloeosporoides* was observed in combi fungicides Carboxin 37.5 + Thirum 37.5 75 WP (95.62%) followed by Caebendazim 12% + Mancozeb 63% 75 WP (94.00%) and non-systemic fungicides Propineb 70 WP (51.48%) followed by Chlorothalonil 75 WP (48.14). The least per cent inhibition of fungus was recorded in combi fungicides Cymoxanil 8% + Mancozeb 64%72 WP (19.13%) and non-systemic fungicides Mancozeb 75 WP (42.77%).

Introduction

Pomegranate (L.) is an important fruit crop of arid and semiarid regions of the World. India is one of the leading producers of pomegranate in the World. Maharashtra is the leading producer of pomegranate in India followed by Karnataka, Gujarat and Andhra Pradesh (Anonymous, 2013). Pomegranate is regarded as the "Fruit of Paradise". The most popular varieties in India are Ganesh, Mridula, Arakta, Bhagwa (Kesar). Successful cultivation of pomegranate in recent years has met with different problems such as pests and diseases. Among the various fungal diseases, fruit rot disease majorly caused *Colletotrichum gloeosporoides* (Penz.) Penz. and Sacc., is one of the most serious disease of pomegranate, remaining latent in early stages of fruit development, internal rotting and

reducing fruit quality to a greater extent. The pathogen *C. gloeosporoides* responsible for fruit rot was first reported in India by Butler (1918). Fungal fruit rot of pomegranate caused by *Colletotrichum gloeosporoides* (Penz.) Penz. and Sacc. is one of the most destructive disease of pomegranate (*Punica granatum*) inflicting considerable quantitative and qualitative losses.

Mostly the disease occurred on leaves and fruits but causes more damages to fruit of pomegranate. Considering the economic importance of the fruit crop as well as disease, present investigation was undertaken for evaluation of systemic, non-systemic and combi fungicides *in vitro* against *C. gloeosporoides*. *In vitro* study was conducted in the laboratory of Department of Plant Pathology, College of Agriculture, Latur.

Materials and Methods

The efficacy of seven systemic, three non-systemic and four combi fungicides were tested against *C. Gloeosporoides* for radial growth inhibition on thepotato dextrose agar medium using poisoned food technique under *in vitro* condition.

The systemic fungicides were tried at 1000 ppm concentration, whereas, non-systemic and combi fungicides were tried at 2000 ppm concentrations. The list of fungicides used along with their chemical and trade names are given in Table 3.

The poisoned food technique (Nene and Thapliyal, 1993) was followed to evaluate the efficacy of systemic, non-systemic and combi fungicides in inhibiting the mycelial growth of *C. gloeosporoides.* The fungus was grown on PDA medium for 12 days prior to setting up the experiment. The PDA medium was prepared and melted. The fungicidal suspension was added to the melted mediumto obtain the required concentrations on commercial formulation basis of the fungicide. Twenty ml of fungicides poisoned medium was poured in each sterilized Petriplates. Suitable check was maintained without addition of fungicide. Mycelial disc of 5 mm was taken from the periphery of 12 days old colony was placed in the centre of Petriplates and incubated at 27 $\pm 1^0$C for 12 days andthree replications were maintained for each treatment.

The diameter of the colony was measured in two directions and average was recorded. Per cent inhibition mycelial growth of the fungus was calculated by usingthe formula by Vincent (1927):

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

Where,

I = Per cent inhibition (mm)
C = Radial growth in (mm) control
T = Radial growth (mm) in treatment.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Systemic, non-systemic and combi fungicides against *C. gloeosporoides*

All of the seven systemic fungicides and seven non-systemic and combi fungicides evaluated *in vitro* were found fungitoxic to *Colletotrichum gloeosporoides* causing major fungal fruit rot in pomegranate which numerically and significantly influenced mycelial growth and its corresponding inhibition, over untreated control (Table 1 and Plate 1; Table 2 and Plate 2).

In vitro evaluation of systemic, non-systemic and combi fungicides against *C. gloeosporoides*

Screening of fungicides was done against *C. gloeosporoides* under laboratory condition by following poisoned food technique as described in "Materials and Methods".

Seven systemic and seven non-systemic (three) and combi (four) fungicides were evaluated against *C. gloeosporoides* in laboratory at 1000 ppm (Systemic fungicides) and 2000 ppm (three Non-systemic and four combi fungicides) concentrations by poisoned food technique.

Data with respect to inhibition of mycelial growth of *C. gloeosporoides* at 1000 ppm concentrations of seven systemic fungicides were recorded and presented in Table 1.

Data from Table 1 revealed that, the efficacy of different systemic fungicides at 1000 ppm concentrations and their interaction on per cent inhibition of mycelial growth of *C. gloeosporoides* differed significantly.

Maximum per cent inhibition (87.23%) of *C. gloeosporoides* was recorded in systemic fungicides Carbendazim 50 WP which was significantly superior over all other systemic fungicides followed by Difenconazole 25 EC (85.74%), Benomyl 50 WP (85.66%), Tebuconazole 25.9 EC (83.08%), Thiophanate methyl 70 WP (83.03%), Hexaconazole 5 EC (81.81%) and Propiconazole 25 EC (74.66%).

Least per cent inhibition was noticed in Propiconazole 25 EC (74.66%).

Data with respect to inhibition of mycelial growth of *C. gloeosporoides* at 2000 ppm concentrations of seven non-systemic and combi fungicides were recorded and per cent inhibition were recorded and presented in Table 2. It was observed that, fungicides, concentrations and their interaction differed significantly with respect to inhibition of the mycelial growth of *C. gloeosporoides.* Among seven non-systemic and combi fungicides, maximum per cent inhibition of growth of *C. gloeosporoides* was observed in Carboxin 37.5 + Thirum 37.5 75 WP recorded highest per cent inhibition of mycelial growth (95.62%) of fungus *C. gloeosporoides* which was significantly superior over other non-systemic and combi fungicides followed by Carbendazim 12% + Mancozeb 63% 75 WP (94.00%), Propineb 70 WP (51.48%), Chlorothalonil 75 WP (48.14%), Mancozeb 75 WP (42.77%) Metalaxyl 8% + Mancozeb 64% 72 WP (33.07%) and Cymoxanil 8% + Mancozeb 64 % 72 WP (19.73%).The leastinhibition of fungus was recorded in combi fungicides Cymoxanil 8% + Mancozeb 64 % 72 WP (19.73%).

Thus, all of the systemic, non-systemic and combi fungicides tested were found fungistatic against *C. gloeosporoides* and numerically inhibited its mycelia growth, over untreated control.

However, the systemic fungicides found most effective in their order of merit were Carbendazim 50 WP (87.23%), Difenconazole 25 EC (85.74%), Benomyl 50 WP (85.66%), Tebuconazole 25.9 EC (83.08%), Thiophanate methyl 70 WP (83.03%), Hexaconazole 5 EC (81.81%) and Propiconazole 25 EC (74.66%).

Non- systemic and combi fungicides found most effective in their order of merit were Carboxin 37.5 + Thiram 37.5 75 WP (95.62%), followed by Carbendazim 12% + Mancozeb 63% 75 WP (94.00%), Propineb 70 WP (51.48%), Chlorothalonil 75 WP (48.14%), Mancozeb 75 WP (42.77%) Metalaxyl 8% + Mancozeb 64% 72 WP (33.07%) and Cymoxanil 8% + Mancozeb 64 % 72 WP (19.73%).

Plate.1 *In vitro* efficacy of systemic fungicides @1000 ppm against *C. gloeosporoides* causing fruit rot in Pomegranate. **Plate.2** *In vitro* efficacy of non-systemic and combi fungicides @2000 ppm against *C. gloeosporoides* causing fruit rot in Pomegranate

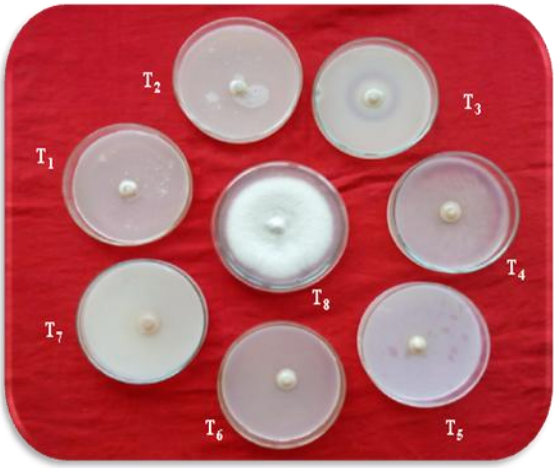

Plate.1

Plate.2

Table.1 *In vitro* efficacy of systemic fungicides @ 1000 ppm against *A. alternata*, causing fruit rot in pomegranate

Tr. No.	Treatments	Col. Dia. (mm)*	% Inhibition*
T_1	Carbendazim 50 WP	10.93	87.23
T_2	Propiconazole 25 EC	22.50	74.66
T_3	Hexaconazole 5 EC	16.00	81.81
T_4	Difenconazole 25 EC	12.50	85.74
T_5	Tebuconazole 25.9 EC	14.73	83.08
T_6	Benomyl 50 WP	12.60	85.66
T_7	Thiophanate methyl 70 WP	14.80	83.03
T_8	Control (untreated)	90.00	00.00
	S.E. ±	**0.39**	**0.60**
	C.D. at 1%	**1.13**	**1.76**

*: Mean of three replications, Col.: Colony, Dia.: Diameter, Figures in parentheses are arcsine transformed values

Table.2 *In vitro* efficacy of non-systemic and combi fungicides @ 2000 ppm against *A. alternata*, causing fruit rot in pomegranate

Tr. No.	Treatments	Col. Dia. (mm)*	% Inhibition*
T_1	Chlorothalonil 75WP	47.43	48.14
T_2	Mancozeb 75WP	51.60	42.77
T_3	Cymoxanil 8 % + Mancozeb 64%(72WP)	72.53	19.73
T_4	Carboxin 37.5 +Thiram 37.5 (75WP)	4.40	95.62
T_5	Metalaxyl 8% +Mancozeb 64% (72 WP)	62.00	33.07
T_6	Propineb 70 WP	44.51	51.48
T_7	Carbendazim 12% +Mancozeb 63% (75 WP)	6.53	94.00
T_8	Control (untreated)	90.00	00.00
	S.E. ±	**0.43**	**0.48**
	C.D. at 1%	**1.27**	**1.42**

*: Mean of three replications, Col.: Colony, Dia.: Diameter, Figures in parentheses are arcsine transformed values

Table.3 The list of fungicides used along with their chemical and trade names

Sr. No.	Common name	Trade name (A. I.*)	Chemical name
Systemic fungicides			
1.	Carbendazim	Bavistin50 WP	Methyl 1H-Benzimidazole-yl carbamate
2.	Propiconazole	Tilt 25 EC	1-(-2-(2,4-dichloropheny)-4-propyl-1,3-dioxolanyl methyl)- 1H-1-4 triazole
3.	Hexaconazole	Contaf5 EC	RS)-2-(2,6-dichlorophenyl-4prophyl,3-dioxolany 2-yl)methyl)-1H-1,2,6-
4.	Difenconazole	Score25 EC	Cis-trans-3-chloro-4-(4-methyl-2-(1H-1,2,4-trizol-1-yl methyl)1,3-dioxolan-2-yl) phenyl 4-chlorophenyl ether
5.	Tebuconazole	Folicur25.9 EC	(RS)-1-(4-Chlorophenyl)-4, 4-dimethyl-3-(1H,1,2,4-triazol-1-yl-methyl) pentan-3-0l
6.	Benlate	Benomyl50WP	Methyl1-(butyl carbamamoyl)-2Benzimidazolecarbaonate
7.	Thiophanate methyl	Topsin-M/Roko70WP	1-(biphenyl-4-yloxy)-3-3dimethy-1,2,4 trilzol-1-yl)
Non-systemic fungicides			
8.	Propineb	Antracol70WP	Zinc propylene-bis-dithiocarbamate
9.	Chlorothalonil	Kavach75 WP	Tetrachloroisophthalonitrile
10.	Mancozeb	Dithane M-4575 WP	Manganese ethylene bis (dithhiocarbamate) polymeric complex with zinc
Combi- fungicides			
11.	Cymoxanil 8% + Mancozeb 64 %	Curzet72 WP	1-(2-cyano-2 methoxyiminoacetyl)-3-acetamide + manganese ethylene bisdithhiocarbamate
12.	Carbendazim 12% + Mancozeb 63%	SAAF75 WP	Methyl 1-1-2 benzimidazole carbonate +zinc ion and manganese ethylene bis dithiocarbamate.
13.	Carboxin 37.5% + Thiram 37.5%	Vitavax Power 75 WP	3-(3-5-dichlorophenyl)-N-(1-methylethyl)-2-4-dioxo-1-lemadazolidine carboxamide + thetramethylthirum disulphide
14.	Metalaxyl 8% + Mancozeb 64%	Ridomil MZ 72 WP	[(1,2-ethanediybis [carbamadithiot)](2-)] manganese mixture with zinc+methyl N-(2,6-dimethylphenyl)-N-(methoxyacetyl)-Dl-alaninate

These results of the present study concedes with the reports of earlier workers who reported effectiveness of the systemic, non-systemic and combi fungicides such as Prashanth *et al.*, (2008) reported that among four systemic fungicides maximum %inhibition of growth of *C. gloeosporioides* was observed in Difenconazole (90.78 %) and Propiconazole (90.78 %), Gud and Raut (2008) reported that Thiophenate-methyl and Propiconazole were most effective against *C. gloeosporioides* followed by Hexaconazole and Carbendazim. Patel (2009) and Pandey *et al.*, (2012) studied that among the tested

fungicides Tricyclazoles were found to be superior for controlling *C. gloeosporioides* causes anthracnose of mango.

At higher concentration (2000 ppm) most of the fungicides viz. Hexaconazole, Propiconazole, Penconazole, Tebuconazole, Carbendazim, Azoxystrobin, Difenoconazole, Thifluzamide and Trifluoxystrobin inhibited maximum mycelial growth but decreased with reduced concentration (500 ppm and 1000 ppm). These results are in agreement with that of Sudhakar (2000); Prashanth (2007); Patel (2009); Devamma *et al.,* (2012) reported that among all the six fungicides evaluated against *C. gloeosporioides* the cause of mango anthracnose, the systemic fungicide Thiophanate-methyl (100 %) and the non-systemic fungicide Mancozeb (100 %) proved to be effective in inhibiting the mycelial growth of the highly virulent pathogen at 50 ppm and 500 ppm concentrations, respectively. Similarly, Pandey *et al.*, (2012) studied the effect of different fungicides on the control of *C. gloeosporioides* causes anthracnose of mango. Among the tested fungicides Tricyclazoles were found to be superior for controlling the incidence of pathogen and Saju *et al.*, (2012) reported the effectiveness of different fungicides against *C. gloeosporioides* infecting large cardamom, the *in vitro* tests showed that, the pathogen was highly sensitive to Copper oxychloride 50 WP (0.3 %) followed by Mancozeb 75 WP (0.3 %) and combined formulation of Carbendazim + Mancozeb (12 + 63) WP (0.3 %). Thus the results of earlier workers are also inline with the results obtained in the present investigation.

Thus from the present investigations, it was evident that, among the different systemic fungicides evaluated Carbendazim, Difenconazole, Benomyl, Tebuconazole, Thiophanate methyl, were most effective as well as non-systemic and combi fungicides Carboxin + Thiram, Carbendazim + Mancozeb, Metalaxyl + Mancozeb, Propineb, Chlorothalonil, Mancozeb were found highly efficient in the management of *Colletotrichum gloeosporioides* causing major fungal fruit rot disease in pomegranate.

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