

Pomegranate Anthracnose Caused by *Colletotrichum gloeosporioides*: A Menace in Quality Fruit Production

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Pomegranate (*Punica granatum* L.), an ancient and commercially important fruit of both tropical and subtropical countries, is extensively cultivated around the Mediterranean and other parts of world including India. Regarded as a fruit of paradise, is one among the major fruit crops of arid zone. In India, it is regarded as a “vital cash crop”, grown in an area of 1.5 lakh ha with a production of 11.0 lakh tons. The fruits are immensely important as they are delicious, have high food value and rich in carbohydrates, calcium, iron, sulphur and vitamin-c and citric acid. Pomegranate fruits are known to possess pharmaceutical and therapeutic properties. It is a symbol of health, fertility, eternal life and also being valued as medicinal plant to treat diabetes, cancer, hypertension, gastric inflammation and heart and kidney diseases. Hence, they are consumed by many people of the world. The crop is becoming more popular among the growers and attained a status of commercial crop. The diseases are also spreading faster and becoming a major limiting factor in attaining high yield. Pomegranate is suffering from several economically important diseases like anthracnose, caused by *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc. which has become a potentially destructive disease both under orchard and post-harvest storage conditions. In severely affected orchards, defoliation, dropping of flowers and fruit resulting in drastic reduction of fruit yield and quality while, after harvest it reduces the market value of fruits. Propagules of pathogen cause spots and decay the fruit. Management study under field conditions revealed that the treatments with foliar sprays of carbendazim + mancozeb(0.3 %) and propiconazole (0.1 %) reduced the disease drastically with high yield and good quality fruits. With an aim to search for resistance genotypes against anthracnose, 19 genotypes were evaluated under in vitro conditions using detached leaf technique. Among them Ganesh, Araktha and Kesar found to be susceptible and none of them were resistant. Thus the present study revealed that, for better quality of fruits it is necessary to manage the anthracnose effectively both in orchards and also after harvest.

Key words: Anthracnose, AUDPC, fungicides, bioagents, botanicals, Genotypes.

Pomegranate (*Punica granatum*L.) regarded as “Fruit of Paradise” is one of the most adaptable subtropical minor fruit crops. In India, it

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is regarded as a “vital cash crop”, grown in an area of 1.5 lakh ha with a production of 11.0 lakh tons. Among the different states growing pomegranate, Maharashtra is the largest producer occupying 2/3rd of total area in the country followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan. Karnataka state has the distribution of cultivating

pomegranate under tropical condition in an area of 12,042 ha with a production of 1,29,547 tons. The crop is prone to many fungal diseases. Among various fungal diseases, anthracnose caused by *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc. is one of the most serious diseases of pomegranate. Anthracnose affects both quality and marketability of fruits.

In the present investigation various aspects on anthracnose of pomegranate (*Punica granatum* L.) was undertaken to manage the disease by evaluating fungicides, bioagents, botanicals. Furthermore, the botanicals, bioagents and fungicides are easily available and control measure can be implemented without much more professional expertise. Fruit rot /anthracnose of pomegranate management by fungicides is very prominent but in recent years, growing countries are demanding for chemical-free fresh produce. Exploring new methods to reduce dependency on use of agrochemicals is a worldwide trend. There is the need to develop alternate postharvest treatments that are safe and acceptable to consumers. Therefore, in present study evaluated bioagents and botanicals along with agrochemicals for the pomegranate sector. The screening for disease resistance is essential to identify resistant variety/source. Resistant variety is one of the best ways in reducing loss due to disease. However there is need to screen the genotypes against anthracnose. Hence, screening of the genotypes has been studied.

MATERIAL AND METHODS

The efficacy of six non systemic (one combi) and six systemic fungicides were tested against *C. gloeosporioides* under *in vitro* condition at 0.1, 0.2 and 0.3 per cent concentration, whereas systemic fungicides were tried at 0.05, 0.1, 0.15 per cent concentrations. Antifungal mechanism of seven plant extracts were tried at 10, 20, and 30 per cent concentration by poisoned food technique. Four bioagents *Bacillus subtilis*, *Pseudomonas fluorescens*, *Trichoderma viride* and *T. harzianum* were evaluated for their efficacy through dual culture technique.

By utilizing the *in vitro* information a field experiment was planned and executed during *ambiabaha* 2010 (Jan - May). Eight different

fungicides (five non-systemic, one combi product and two systemic) one bioagent (*Trichoderma viride*) with untreated control were evaluated with three replication for their efficacy on management of anthracnose of pomegranate fruits in an orchard at Bandi village, Taluk Yalburga, Koppal district, during 2010 *Ambiabaha*. The variety, Kesar was used. The per cent disease index (PDI) using 0-5 scale and per cent disease reduction over control (PDC) was calculated and angular transformed data were analyzed statistically and also AUDPC values for fruits was calculated using formula. Further recorded the fruit yield / tree, later it was calculated per hectare by taking the count of 643 trees / ha (4.25 m × 3.65 m).

$$A = \sum_{i=1}^k \frac{1}{2} (S_i + S_{i-1}) t$$

A = Area under disease progression curve (AUDPC)

S_i = Disease incidence at i^{th} day of evaluation

k = Number of successive evaluation

t = Interval between i and i-1 evaluation of disease

PDIC-PDIT

$$\text{PDC} = \frac{\text{PDIC-PDIT}}{\text{PDIC}} \times 100$$

PDIC

PDC = Per cent disease index over control

PDIC = PDI in control

PDIT = PDI in treatment

Screening of pomegranate genotypes

Nineteen pomegranate cultivars (Araktha, Alandi, Ganesh, GUT-C-Shah rose pink, G-137, Jalore seedless, Jodhpur red, Jural anar, Jyothi, Kabuli, Kaladgi local, Kandaar, Kesar, Mridula, Muskot, RCR, Ruby, Spen dahedar, Yeronad) were selected from glass house of Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences Dharwad and detached leaf inoculation technique was used for screening under artificial inoculation (Tuite, 1969).

Five young leaves from each genotype were selected and detached from the plant, washed thoroughly with distilled sterile water, swabbed with 1 per cent sodium hypochlorite and washed with sterile water and inoculated with inoculum 5mm disc of 12 days old culture. Control was maintained by spraying sterile water only. Moist cotton swab was placed at the base of petiole. The

leaves were kept in Petri plates lined with moist blotting paper to maintain humidity.

Further, these plates were placed in humid chamber and incubated at 27±1°C for 12 days. After 12 days of incubation the genotypes were evaluated for their reaction on 0-5 scale (NRCP, SOLapur). The varieties were classified as Grade 0-No disease (Immune), Grade 1- 0.0 to 5.0 (Resistant), Grade 2- 5.1 to 10.0 (Moderately Resistant), Grade 3-10.1 to 25.0 (Moderately Susceptible), Grade 4- 25.1 to 50.0 (Susceptible) and Grade 5- >50 per cent (Highly Susceptible)

RESULTS AND DISCUSSION

Evaluation of systemic and non-systemic fungicides

The systemic, non systemic fungicides, botanicals and bioagents have been tested at different concentrations and effective concentrations are presented in Table 1. Among non-systemic (one combi) fungicides, carbendazim + mancozeb at 0.3 per cent concentration showed 75.10 per cent inhibition of mycelial growth of fungus followed by captan with 60.77 per cent and least inhibition of mycelial growth was recorded in copper oxychloride with 0.9 per cent. Systemic fungicides, iprobenfos showed 87.99 per cent

inhibition of mycelial growth of fungus and was followed by propiconazole (87.10%) at 0.15 per cent concentration while, least per cent inhibition of mycelial growth was recorded in carbendazim (62.09). The effectiveness of the triazole fungicides like propiconazole may be attributed to their interference with the biosynthesis of fungal sterols and inhibit the ergosterol biosynthesis. These results are conformity with findings of other workers[4] showed 100 ppm of azoxystrobin inhibited mycelial growth of *C. gloeosporioides*.

Evaluation of bio-agents

Bioagents viz., *Bacillus subtilis*, *Pseudomonas fluorescens*, *Trichoderma viride* and *T. harzianum* were tested against *C. gloeosporioides* and results are presented in Table 1. Among the all bioagent tried, *Trichoderma viride* was found to be best in inhibiting mycelial growth of *Colletotrichum gloeosporioides* (86.82%) followed by *Trichoderma harzianum* (72.47%) and *Pseudomonas fluorescens* (67.00%) and least per cent inhibition of mycelial growth was observed in *Bacillus subtilis* (53.88). Present studies recorded significant mycoparasitism of *Trichoderma viride* and *Trichoderma harzianum* on anthracnose fungus that caused lysis of the hyphae and the spores *in vitro*. Similar finding were observed by several scientists⁵ use of

Table 1. *In vitro* evaluation of systemic-non systemic fungicides, botanicals and bioagents against *Colletotrichum gloeosporioides*

Systemic fungicides	Per cent Inhibition/Effective Conc.(%)						
	0.15%	Non-systemic fungicides	0.3%	Botanicals	30%	Bioagents	Dual Plate
Azoxystrobin	62.77 (52.43)*	Captan	73.88 (59.49)	Datura leaf	61.70 (51.72)	<i>B.subtilis</i>	53.88 (46.63)
Carbendazim	62.09 (51.98)	Carbendazim + mancozeb	81.88 (64.79)	Eucalyptus leaf	5.27 (13.17)	<i>P.fluorescens</i>	67.0 (54.64)
Difenconazole	67.21 (55.05)	Copper Oxychloride	1.55 (7.26)	Garlic bulb	50.00 (44.98)	<i>T.harzianum</i>	72.47 (57.67)
Hexaconazole	64.55 (53.42)	Chlorothalonil	20.32 (26.33)	Ginger rhizome	33.33 (35.23)	<i>T. viride</i>	86.82 (67.85)
Iprobenfos	87.99 (69.67)	Mancozeb	22.99 (28.63)	Neem leaf	10.83 (19.19)	CD at 1 %	1.04
Propiconazole	87.10 (69.47)	Propineb	29.10 (32.35)	Onion bulb	43.32 (41.14)		
C.D at 1%	0.59	C.D at 1%	0.84 C.D at 1%	<i>Tulsi leaf</i>	0.70 (4.78)		

*Arcsine transformed values

antagonistic micro-organisms and induction of resistance in harvested fruits have shown promise.

Several antagonistic micro-organisms have been found effective against post-harvest

pathogens e.g. *Trichoderma* spp. reduce severity of a number of fruit rot [4]. Biological control of fruit rot and dieback of chillies using antagonistic micro-organisms and plant products has been attempted several workers[2].

Table 3. Area under disease progress curve, efficacy of fungicides and bioagents on management of anthracnose of pomegranate

Treatments	Conc.	PDI on fruits	PDC fruits	Fruit yield (t/ha)	AUDPC values for fruits
Carbendazim	0.2%	4.00 (11.53)*	82.30	5.89	299.92
Difenconazole	0.1%	4.00 (11.53)	82.30	5.85	382.49
Hexaconazole	0.1%	6.50 (14.70)	71.23	5.37	388.64
Iprobenfos	0.2%	2.41 (8.89)	89.23	5.97	333.14
Propiconzole	0.1%	1.20 (6.31)	94.58	6.28	221.47
Captan	0.3%	4.83 (12.69)	78.54	5.67	361.19
Mancozeb	0.3%	6.33 (14.56)	71.91	5.33	407.24
Carbendazim + mancozeb	0.3%	0.83 (5.18)	96.22	6.35	186.22
<i>Trichoderma viride</i>	10g/lit	17.00 (24.33)	24.97	4.63	722.25
Control	-	22.66 (28.41)	-	2.57	839.54
S. Em. ±	0.72		0.12		
CD at 5%	1.53		0.27		

*Arcsine values

Table 3. Screening of pomegranate genotypes against *Colletotrichum gloeosporioides* by detached leaf technique

Sl. No.	Genotypes	Disease reaction
1	Araktha	S
2	Alandi	MS
3	Ganesh	S
6	GUT-C-Shah rose pink	MS
5	G-137	MS
6	Jalore seedless	MS
7	Jodhpur red	MS
8	Jural anar	MS
9	Jyoti	MS
10	Kabuli	MS
11	Kaladgi local	MS
12	Kandar	MS
13	Kesar	S
14	Mridula	MS
15	Muskot	MS
16	RRCR	MS
17	Ruby	MS
18	Speen dahedar	MS
19	Yeronad	MS

S=Susceptible;

MS=Moderately Susceptible

Evaluation plant extracts

Among seven plant extracts, most of the plant extracts showed fungistatic nature at higher concentration (30%). Two plant extracts viz. Datura leaf extract (61.70%), garlic extract (50.00%) showed e⁵⁰ per cent inhibition of mycelial growth, while least inhibition of mycelial growth was noticed in tulasi leaf extract (0.70%). At 20 per cent concentration, three plant extracts namely garlic leaf extract, onion bulb extract and garlic bulb extract showed more than 30 per cent inhibition of mycelial growth. The extracts of datura leaf shown maximum inhibition of mycelial growth of *Colletotrichum gloeosporioides* even at 10 per cent concentration (Table 1).

Evaluation of chemical fungicides and bioagents under *in-vivo* condition

The results after seven sprays revealed that, lowest disease severity of 0.83 PDI was observed in carbendazim + mancozeb at 0.3 per cent which was significantly superior over other treatments followed by propiconazole with a PDI of 1.20 at 0.1 per cent. The other fungicides viz., iprobenfos (0.2%), carbendazim (0.2%), difenconazole (0.1%), captan (0.3%) were found effective (Table 2). The bioagent like *T. viride* was

found to be less effective than fungicides. Maximum disease severity i.e., 22.60 PDI was recorded in untreated control. Further percent disease reduction over control (PDC) was calculated for all treatments. Among nine treatments highest PDC of 96.22 on fruits was calculated in carbendazim + mancozeb at 0.3 per cent and 94.58 propiconazole at 0.1 per cent. Finally concluded as propiconazole at 0.1 per cent concentration was significantly superior over other fungicides, where as iprobenfos (0.2%), carbendazim (0.2%) and difenconazole (0.1%) remained statistically on par with each other. Among non-systemic and combi fungicides, combi product like carbendazim + mancozeb at 0.3 percent concentration was significantly superior where as captan and mancozeb were less effective. The results are in agreement with findings Prashanth *et al.*⁵. Further highest and significant yield of 6.35 tonns per ha was recorded in carbendazim + mancozeb at 0.3 per cent concentration treated plot followed by propiconazole (0.1%) with a yield of 6.28 tonns/ha. AUDPC value gives an idea of disease progression over a period of time, which in turn indicates the effectiveness of the treatment. Least AUDPC value on fruit was recorded in Carbendazim+ mancozeb (186.22), which was followed by propiconazole (221.47) and carbendazim (299.92). Among the tested treatments, maximum AUDPC value was noticed in *Trichoderma viride*, indicating ineffectiveness of bioagent as foliar spray in the management of anthracnose of pomegranate.

Screening of Genotypes

The management of disease through host plant resistance has been an important choice in all crop improvement programme. Utilization of resistance is most simple, effective and economical method in the management of biotic stress. Besides, the resistant cultivars conserve natural resources and reduce the cost, time and energy when compared to other methods of disease management. Increase in use of fungicides to

control the anthracnose has led to consciousness of their persistence and development of new strains of pathogen. To avoid this situation, identifying the resistant cultivars against anthracnose is most significant one.

Nineteen pomegranate cultivars were screened for their reaction under artificial condition (Table 3). None of them were resistant to anthracnose fungus. Three cultivars *viz.*, Ganesh, Araktha and Kesar showed susceptible reaction where as sixteen cultivars showed moderately susceptible reaction⁶.

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