

**In vitro** screening of fungicides and tannins against fungal pathogens of jujube fruits

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**Abstract**

The aim of this study to identify the effective fungicides for controlling major leaf and fruit diseases of Jujube caused by different fungal pathogens. An in vitro experiment was undertaken to screen ten fungicides and two Tannins against six important fungal pathogens of Jujube fruits which were *Alternaria alternata*, *Colletotrichum gloeosporioides*, *Curvularia lunata*, *Lasiodiplodia theobromae*, *Fusarium semitectum* and *Pestalotiopsis palmarum*. Fungicides were Conza 5 EC (Hexaconazole), Folicur 250 EC (Tebuconazole) and Potent 250 EC (Propiconazole), Bavistin DF (Carbenzadim), Kasumin 2% liquid (Kasugamycin), Rovral 50 WP (Iprodine), Matco 72 WP (Mancozeb 64% + Metalaxyl 8%), Geneb 80 WP (Mancozeb), Emivit 50 WP (Copper oxychloride) and Evavit 80 WG (Sulphur 80 WG). And two tannins were Chestnut Tannin and Quabracho Tannin. Plain water was used as control. Poison food technique was followed to conduct the experiment. Both Tannins did not show satisfactory inhibition of mycelial growth of any of the six fungal pathogens. The effectiveness of fungicides varied greatly with fungal species. The most effective fungicides were Folicur 250 EC followed by Potent 250 EC, Rovral 50 WP, Conza 5 WP and Bavistin DF. Folicur 250 EC caused 89.52% inhibition of mycelium growth of *A. alternata* and 100% growth inhibition in other five fungi. In addition, Potent 250 EC inhibited growth of *L. theobromae*, *C. lunata*, *F. semitectum* and *P. palmarum* by 100% and that of *C. gloeosporioides* by 91.79%. Complete growth inhibition of *F. semitectum* and *P. palmarum* was achieved with Bavistin DF. Furthermore, Conza 5 EC caused 100% growth inhibition in *C. lunata* and more than 90% in *L. theobromae* and *F. semitectum*.

**Key words**: Screening, fungicides, tannins, fungal pathogens, jujube

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**Introduction**

Jujube (*Ziziphus mauritiana* Lam.) tree is subjected to attack by different fungal pathogens causing various diseases. In India, powdery mildew (*Oidium* sp.) causes defoliation and fruit-drop. Sooty mold (*Cladosporium zizyphi*) causes leaves to fall. Leaf spot results from infection by *Cercospora* spp. and *Isariopsis indica* var. *zizyphi*. Leaf rust, caused by *Phakopsora zizyphi-vulgaris*, ranges from mild to severe on all commercial cultivars in India. Fruits on the tree are attacked by *Alternaria chartarum*, *Aspergillus nanus*, *A. parasiticus*, *Helminthosporium atroolivaceum*, *Phoma hessavensis*, and *Stemphylium mavalparadisiacum*. Twigs and branches may be affected by *Entypella zizyphi*, *Hyposyphon hypomiltum*, and *Patellaria atrata*. In storage, the fruits may be spotted by the fungi *Alternaria brassicicola*, *Phoma* spp., *Curvularia lunata*, *Cladosporium herbarum*. Fruit rots are caused by *Fusarium* spp., *Nigrospora oryzae*, *Epicoccum nigrum*, and *Glomerella cingulata* (Morton, 1987).

Reports from different countries reveal that the crop is attacked by powdery mildew (*Oidium erysiphoides* f. sp. *ziziphi*), fruit spot and rot (*Colletotrichum gloeosporioides*, *Alternaria alternata*, *Fusarium* spp., *Pestalotiopsis palmarum*, *Curvularia lunata*, *Lasiodiplodia theobromae*, *Aspergillus* spp.), sooty mould, leaf rust, leaf spot etc. (Gupta and Madan 1977a; 1977b; 1977c; Rai et al., 1982; Singh and
Materials and methods

Ten different fungicides and two tannins were tested in the present experiment under in vitro condition against six major fungal fruit pathogens of Jujube namely *A. alternata*, *L. theobromae*, *C. gloeosporioides*, *C. lunata*, *F. semitectum* and *P. palmarum*. Fungicides Conza 5 EC (Hexaconazole), Folicur 250 EC (Tebuconazole) and Potent 250 EC (Propiconazole) were used at 0.05%. Bavistin DF (Carbendazim), Kasumin 2% liquid (Kasugamycin), Rovral 50 WP (Iprodine), Matco 72 WP (Mancozeb 64% + Metalaxyl 8%) and Geneb 80 WP (Mancozeb) were applied at 0.2%. Emivit 50 WP (Copper oxychloride), Evavit 80 WG (Sulphur 80 WG), Chestnut Tannin and Quabracho Tannin were used at 0.3%. For comparison, a control treatment was maintained in each experiment.

Separate experiment was conducted for each fungus. Each of the experiments was conducted following a completely randomized design with four replications (Petri dishes). At 1, 2, 5, 8 and 12 days after incubation (DAI), data on radial diameter of mycelium growth were measured. Final colony growth data were collected at 12 DAI for all tested fungi except *L. theobromae* and *P. palmarum*. Data of *L. theobromae* and *P. palmarum* were collected at 2 and 12 DAI, respectively. For measurement, two lines were drawn at right angle on the back side of the plates with a marker pen so that their intersection sets on the central point of the fungal disc. The radial growth rate, per cent radial growth inhibition and change of mycelial colour as compared to control were observed and recorded. Per cent radial growth inhibition over control was calculated by using the formula suggested by Vincent (1947).

\[
\text{Percent Inhibition} = \left( \frac{\text{Radial growth in control plate} - \text{Radial growth on amended PDA}}{\text{Radial growth in control plate}} \right) \times 100
\]

Finally data were analyzed statistically using MSTAT-C and means were compared following Turkey’s Test.
Results and Discussion

Radial growth of colony

*Alternaria alternata:* Except Q Tannin, amendment of PDA with eight fungicides and C Tannin reduced radial colony diameter of *A. alternata* significantly compared to control (Table 1). The reduction under different treatments ranged 6.07-89.52%. The highest reduction was achieved with Folicur 250 EC followed by Potent 250 EC. Their efficacy was statistically similar but significantly higher compared to other treatments. Conza 5 EC, Rovral 50 WP and Emivit 50 WP gave 76.83, 72.38 and 65.20% reduction in colony growth of *A. alternata* in-vitro. Other treatments caused only 6.07-29.09% reduction in its growth. The reduction under C Tannin, Q Tannin and Evavit 80 WG was significantly lower compared to all other treatments (Table 2 and Figure 1).

*Lasiodiplodia theobromae:* In-vitro colony growth of *L. theobromae* was reduced significantly over control due to amendment of PDA with all fungicides except Kasumin 2% liquid, and two Tannins (Table 1). The growth inhibition was 100% over control under Rovral 50 WP, Folicur and Potent 250 EC. Its growth inhibition over control was 94.44, 94.05, 97.26 and 99.21% due to amendment of PDA with Conza 5 EC, Bavistin DF, Matco 70 WP and Emivit 50 WP, respectively. Less than 40% growth inhibition was found under Geneb 80 WP and Evavit 80 WG and Kasumin 2% liquid showed only 1.31% growth inhibition of the fungus (Table 2 and Figure 1).

*Colletotrichum gloeosporioides:* Except Kasumin 2% liquid, Evavit 80 WG, C Tannin and Q Tannin, other treatments caused significant reduction of in-vitro radial colony diameter of *C. gloeosporioides* compared to control (Table 1). Total growth (100%) inhibition was achieved with only Folicur 250 EC, which statistically similar to Potent 250 EC. Conza 5 EC, Bavistin DF and Rovral 50 WP gave 77.62, 76.71 and 74.57% inhibition over control, respectively (Table 2 and Figure 1).

*Cuvularia lunata:* In-vitro colony growth of *C. lunata* was reduced significantly over control due to amendment of PDA all fungicides tested in the present experiment. The colony diameter under two Tannins and control was not significantly different (Table 1). Growth of the fungus was completely (100%) inhibited by Conza 5 EC, Rovral 50 WP, Folicur 250 EC and Potent 250 EC. Its growth inhibition was only 2.78-34.52% under other fungicides and two Tannins (Table 2 and Figure 1).

*Fusarium semitectum:* Radial colony diameter of *F. semitectum* was significantly reduced over control due to amendment of PDA with Conza 5 EC, Bavistin DF, Rovral 50 WP, Folicur 250 EC, Matco 70 WP, Potent 250 EC, Geneb 80 WP and Emivit 50 WP (Table 1). The reduction was 100% under Bavistin DF, Folicur 250 EC and Potent 250 EC.Conza 5 EC, Emivit 50 WP and Geneb 80 WP caused 99.21, 98.41 and 65.20% reduction of radial growth, respectively. Other fungicides and C Tannin gave 1.98-33.89% inhibition of the fungus over control. Q Tannin had not any inhibitory effect on *F. semitectum* (Table 2 and Figure 1).

*Pestalotiopsis palmarum:* Except two Tannins and Emivit 50 WP, amendment of PDA with other fungicides inhibited colony growth of *P. palmarum* significantly over control (Table 1). Complete growth inhibition of the fungus was achieved with Bavistin DF, Folicur 250 EC and Potent 250 EC. The growth inhibition of the fungus was 95.83, 94.45 and 80.16% over control under the treatments with Matco 70 WP, Geneb 80 WP and Conza 5 EC, respectively. Other materials showed only 2.78-34.40% growth inhibition (Table 2 and Figure 1).

Findings of the present experiment revealed that both C Tannin and Q Tannin did not show satisfactory inhibition of mycelial growth of any of the six fungal pathogens. The fungicides caused variable degree of growth inhibition of the fungal pathogens tested on amended PDA. Their effectiveness varied greatly with fungal species. Folicur 250 EC caused 89.52% inhibition of mycelium growth of *A. alternata* and 100% growth inhibition in other five fungi. Potent 250 EC inhibited growth of *L. theobromae*, *C. lunata*, *F. semitectum* and *P. palmarum* by 100% and that of *C. gloeosporioides* by 91.79%. Complete growth inhibition of *F. semitectum* and *P. palmarum* was achieved with Bavistin DF. Conza 5 EC caused 100% inhibition in *C. lunata* and more than 90% in
L. theobromae and F. semitectum. The results indicate that the most effective fungicides were Folicur 250 EC followed by Potent 250 EC, Rovral 50 WP, Conza 5 WP and Bavistin DF. They have potentiality to use against the fungal pathogens like L. theobromae, C. gloeosporioides, C. lunata, F. semitectum, P. palmarum and A. alternata causing fruit rot of Jujube. The findings are in agreement with the findings of other researchers (Anon. 1990, 1997, Talukder et al., 2004, Bakr 2007). However, they worked with other crops.

Table 1. Effect of ten fungicides and two tannins on inhibition of radial colony growth of six fungi causing fruit rot of Jujube

<table>
<thead>
<tr>
<th>Fungicides</th>
<th>Alternaria theobromae</th>
<th>Lasiodiplodia gloeosporioides</th>
<th>Colletotrichum lunata</th>
<th>Fusarium semitectum</th>
<th>Pestalotiopsis palmarum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.47f</td>
<td>2.78f</td>
<td>6.07f</td>
<td>10.71f</td>
<td>6.69f</td>
</tr>
<tr>
<td>Kasumin 2% liquid</td>
<td>6.72c</td>
<td>0.50d</td>
<td>1.96cd</td>
<td>7.28b</td>
<td>0.00f</td>
</tr>
<tr>
<td>Bavistin DF</td>
<td>2.32f</td>
<td>0.00e</td>
<td>2.14c</td>
<td>0.00f</td>
<td>6.69b</td>
</tr>
<tr>
<td>Folicur 250 EC</td>
<td>0.88g</td>
<td>0.00e</td>
<td>0.00e</td>
<td>0.00f</td>
<td>0.00f</td>
</tr>
<tr>
<td>Matco 70 WP</td>
<td>5.96d</td>
<td>0.23de</td>
<td>5.09b</td>
<td>7.20b</td>
<td>5.55c</td>
</tr>
<tr>
<td>Potent 250 EC</td>
<td>1.14g</td>
<td>0.00e</td>
<td>0.69de</td>
<td>0.00f</td>
<td>0.00f</td>
</tr>
<tr>
<td>Geneb 80 WP</td>
<td>6.11d</td>
<td>5.73b</td>
<td>6.30b</td>
<td>7.41b</td>
<td>2.92d</td>
</tr>
<tr>
<td>Emivit 50 WP</td>
<td>2.92e</td>
<td>0.07e</td>
<td>5.23b</td>
<td>2.22e</td>
<td>0.13e</td>
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<tr>
<td>Evavit 80 WG</td>
<td>7.55b</td>
<td>5.19c</td>
<td>7.76a</td>
<td>6.23c</td>
<td>8.23a</td>
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<tr>
<td>C Tannin</td>
<td>7.50b</td>
<td>8.40a</td>
<td>8.29a</td>
<td>8.17a</td>
<td>7.91a</td>
</tr>
<tr>
<td>Q Tannin</td>
<td>7.89ab</td>
<td>8.40a</td>
<td>8.28a</td>
<td>8.08a</td>
<td>8.40a</td>
</tr>
<tr>
<td>Control</td>
<td>8.4a</td>
<td>8.40a</td>
<td>8.40a</td>
<td>8.40a</td>
<td>8.40a</td>
</tr>
</tbody>
</table>

CV (%) 3.60 3.63 8.91 4.20 8.11 5.02

Means within the same column having a common letter(s) do not differ significantly (P=0.05). DAI means days after incubation.

Table 2. Effect of ten fungicides and two Tannins on inhibition of radial colony growth of six fungi causing fruit rot of Jujube

<table>
<thead>
<tr>
<th>Fungicides</th>
<th>Alternaria theobromae</th>
<th>Lasiodiplodia gloeosporioides</th>
<th>Colletotrichum lunata</th>
<th>Fusarium semitectum</th>
<th>Pestalotiopsis palmarum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>76.83b</td>
<td>94.44bc</td>
<td>77.62bc</td>
<td>100.00a</td>
<td>99.21a</td>
</tr>
<tr>
<td>Kasumin 2% liquid</td>
<td>18.8e</td>
<td>1.31f</td>
<td>6.91e</td>
<td>34.52c</td>
<td>5.95e</td>
</tr>
<tr>
<td>Bavistin DF</td>
<td>20.00e</td>
<td>94.05c</td>
<td>76.71bc</td>
<td>13.38e</td>
<td>100.00a</td>
</tr>
<tr>
<td>Folicur 250 EC</td>
<td>72.38b</td>
<td>100.00a</td>
<td>74.57c</td>
<td>100.00a</td>
<td>20.36d</td>
</tr>
<tr>
<td>Matco 70 WP</td>
<td>89.52a</td>
<td>100.00a</td>
<td>91.79ab</td>
<td>100.00a</td>
<td>95.83ab</td>
</tr>
<tr>
<td>Potent 250 EC</td>
<td>86.39a</td>
<td>100.00a</td>
<td>100.00a</td>
<td>100.00a</td>
<td>90.08b</td>
</tr>
<tr>
<td>Geneb 80 WP</td>
<td>72.26d</td>
<td>31.75e</td>
<td>25.00d</td>
<td>11.79e</td>
<td>65.20b</td>
</tr>
<tr>
<td>Emivit 50 WP</td>
<td>65.20e</td>
<td>99.21ab</td>
<td>37.18d</td>
<td>73.53b</td>
<td>98.41a</td>
</tr>
<tr>
<td>Evavit 80 WG</td>
<td>10.16f</td>
<td>38.26d</td>
<td>7.66e</td>
<td>25.91d</td>
<td>1.98e</td>
</tr>
<tr>
<td>C Tannin</td>
<td>10.71f</td>
<td>0.00f</td>
<td>1.35e</td>
<td>2.78f</td>
<td>5.83e</td>
</tr>
<tr>
<td>Q Tannin</td>
<td>6.07f</td>
<td>0.00f</td>
<td>1.47e</td>
<td>3.85f</td>
<td>0.00e</td>
</tr>
</tbody>
</table>

Means within the same column having a common letter(s) do not differ significantly (P=0.05)
a. Conza

b. Folicur

c. Potent

d. Rovral

e. Bavistin

f. Matco
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- g. Geneb
- h. Kasumin
- i. Emivit
- j. Evavit
- k. C Tanin
- l. Q Tannin
m. Control

Figure 1. In vitro control of six major fungi causing fruit spot and rot of Indian jujube using different fungicides and two Tannins

References


