Integrated disease management for tropical and subtropical fruits

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Fruit crops
Downy mildew
### Management of downy mildew

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Nature of chemical</th>
<th>Dose on formulation basis</th>
<th>EU MRL (mg/kg) updated as on 13.10.11</th>
<th>PHI (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low risk fungicides: non-systemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mancozeb 75WP</td>
<td>NS</td>
<td>1.5-2.0g/L</td>
<td>5.0</td>
<td>35*</td>
</tr>
<tr>
<td>Propineb 70WP</td>
<td>NS</td>
<td>3.0g/L</td>
<td>1.0</td>
<td>40*</td>
</tr>
<tr>
<td>COC 50WP</td>
<td>NS</td>
<td>2.5g/L, 2.4g/L</td>
<td>50.0</td>
<td>42*</td>
</tr>
<tr>
<td>Chlorothalonil 75WP</td>
<td>NS</td>
<td>2.0g/L</td>
<td>1.0</td>
<td>60</td>
</tr>
<tr>
<td><strong>Low risk fungicides: systemic/systemic+non-systemic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cymoxanil+Mancozeb 8+64WP</td>
<td>S+NS</td>
<td>2.0g/L</td>
<td>0.2+5.0</td>
<td>66</td>
</tr>
<tr>
<td>Dimethomorph 50 WP+ Mancozeb 75WP as tank mixture</td>
<td>S+NS</td>
<td>0.5 to 0.75g/L +2.0g/L</td>
<td>3.0+5.0</td>
<td>66</td>
</tr>
<tr>
<td>Iprovalicarb + Propineb 5.5+61.25WP</td>
<td>S+NS</td>
<td>2.25g/L</td>
<td>2.0+1.0</td>
<td>55</td>
</tr>
<tr>
<td>Mandipropanamid 23.4%SC</td>
<td>NS (but trans- laminar movement)</td>
<td>0.8ml/L</td>
<td>2.0</td>
<td>5</td>
</tr>
<tr>
<td>Fosetyl Al 80WP</td>
<td>S</td>
<td>1.4-2.0g/L</td>
<td>100.0</td>
<td>7</td>
</tr>
<tr>
<td><strong>High risk fungicides</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metalaxyl+Mancozeb 8+64WP**</td>
<td>S+NS</td>
<td>2.5g/L</td>
<td>2.0+5.0</td>
<td>66</td>
</tr>
<tr>
<td>Metalaxyl-M+Mancozeb (mefenoxam) 4+64 WP**</td>
<td>S+NS</td>
<td>2.5g/L</td>
<td>2.0+5.0</td>
<td>66</td>
</tr>
<tr>
<td>Fenamidone+Mancozeb 10+50WG</td>
<td>S+NS</td>
<td>2.5 to 3g/L</td>
<td>0.5+5.0</td>
<td>66</td>
</tr>
<tr>
<td>Azoxystrobin 23SC</td>
<td>S</td>
<td>494mL/ha</td>
<td>2.0</td>
<td>7</td>
</tr>
<tr>
<td>Famoxyadone 16.6%+Cymoxanil 22.1%SC</td>
<td>S+NS</td>
<td>500mL/ha</td>
<td>2.0+0.2</td>
<td>27</td>
</tr>
<tr>
<td>Kresoxim methyl 44.3SC</td>
<td>S</td>
<td>600-700mL/ha</td>
<td>1.0</td>
<td>30</td>
</tr>
<tr>
<td>Fenamidone 4.44%+Fosetyl Al 66.66% WDG</td>
<td>S</td>
<td>2 to 2.5kg/ha</td>
<td>0.5+100</td>
<td>27</td>
</tr>
<tr>
<td>Pyraclostrobin 5%+Metiram 55% 60WG</td>
<td>S+NS</td>
<td>1.5-1.75kg/ha</td>
<td>1+5</td>
<td>15</td>
</tr>
</tbody>
</table>

S= systemic ; NS = non-systemic ; * avoid using after fruit set; ** Though registered, these products are not effective in controlling the disease presently (probably due to presence of resistance in pathogen), as observed in multi-locational field trials conducted by this centre.

Source: NRC grapes, Pune
Powdery mildew
## Management of powdery mildew

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<td><strong>Risk known fungicide</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Difenoconazole 25EC</td>
<td>S</td>
<td>0.50mL/L</td>
<td>0.5</td>
<td>45</td>
</tr>
<tr>
<td>Dinocap 48EC</td>
<td>NS</td>
<td>0.30-0.35mL/L</td>
<td>0.05</td>
<td>50*</td>
</tr>
<tr>
<td><strong>Low risk fungicide</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sulfur 40SC, 55.16SC, 80WP, 80WDG, 85WP</td>
<td>NS</td>
<td>3.0mL, 3.0mL, 2.50g, 1.87-2.50g, 1.50-2.0g/L, resp.</td>
<td>50.0</td>
<td>15</td>
</tr>
<tr>
<td><strong>Medium risk fungicides</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Penconazole 10EC</td>
<td>S</td>
<td>0.50mL/L</td>
<td>0.2</td>
<td>50</td>
</tr>
<tr>
<td>Triadimefon 25WP</td>
<td>S</td>
<td>0.50-1.0g/L</td>
<td>2.0</td>
<td>45</td>
</tr>
<tr>
<td>Hexaconazole 5EC</td>
<td>S</td>
<td>1.0mL/L</td>
<td>0.1</td>
<td>38</td>
</tr>
<tr>
<td>Myclobutanil 10WP</td>
<td>S</td>
<td>0.40g/L</td>
<td>1.0</td>
<td>30</td>
</tr>
<tr>
<td>Flusilazole 40EC</td>
<td>S</td>
<td>25mL/200L</td>
<td>0.05</td>
<td>50</td>
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<tr>
<td>Fenarimol 10EC</td>
<td>S</td>
<td>0.40mL/L</td>
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S= systemic; NS= non-systemic; *avoid application when tender shoots are present in canopy.

Source: NRC grapes, Pune
Anthracnose
## Management of anthracnose

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<tr>
<td>Carbendazim 50WP, 46.27SC</td>
<td>S</td>
<td>1.0g/L, 1.0mL/L</td>
<td>0.30</td>
<td>50</td>
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S = systemic; NS = non-systemic; * avoid using after fruit set

**Source:** NRC grapes, Pune
1. June- October
2. Number of rainy days rather than total rainfall
3. Leaf wetness along with moderate temperature (20-28°C)
4. Secondary spread through wind borne urediospores

1. Select disease dogridge root stock
2. Crop regulation
3. Bordeaux mixture (1%) Bittertanol (1g/l), Tridemefon (1g/l), propiconazole (1ml/l) and chlorothalonil (2g/l)
Anthracnose
Spore germinates to form infection peg and remain dormant until fruit ripens.

Disease colonizes the cell.

Healthy fruit.

Spores spread by wind, rain splash.

Anthracnose on inflorescence and leaf.

Survives on tree trunk and bark.

Fruit anthracnose.

Acervulus.
Integrated management of anthracnose

Pre-harvest
Pre-harvest sprays of copper oxychloride (2g/l), thiophanate methyl (1g/l) or carbendazim (1g/l)

Post-harvest
Hot water treatment at 52 ± 1°C for 10 min either combined with carbendazim (1g/l) or Prochloraz (1g/l)

Source: IIHR, Bangalore and CISH, Lucknow
Powdery mildew

Wettable sulphur (2g/l), dinocap (0.5ml/l), carbendazim (1g/l), tridemorph (1ml/l), thiophanate methyl (1g/l) and flusilazole (0.15ml/l) at 15 day interval

Source: IIHR, Bangalore and CISH, Lucknow
Bacterial blight
Management

- Alternate application of bactericides (Bordeaux mixture 1% and Streptocycline 500ppm + COC 0.3%) at monthly interval during rest period (five months)

- Sequential application of Bordeaux mixture 1% → Streptocycline 500ppm + COC 0.3% → Bordeaux mixture 0.5% → Bactranol-100 + COC 0.3% → Streptocycline 500ppm + Kocide 0.2% → Zantholin 2ml/l (botanicals) → Streptocycline 500ppm + COC 0.3% → Zantholin 2ml/l at fortnightly interval right from pruning

- Clean cultivation and orchard sanitation during rest and cropping period significantly reduced the blight incidence (8.20%) and increased the pomegranate yield (12.0 t/ha) as compared to highest disease incidence (64.0%) and lowest yield (1.02 t/ha) in untreated control.

Source: OHM, IIHR, Bangalore and NRCOP, Solapur and UAS, Dharwar
Nematode  Wilt (*Ceratocystis fimbriata*)
Aleuro conidia

Peritheciurn with long tube shaped neck and fimbriated ostiole

Endo conidia

Ceratocystis fimbriata

Aleuro conidia

Xyleborus perforans – Pomegranate shot hole borer
Integrated management of wilt

Cultural practices
Avoid wilt infested sites for new planting
Eradicate wilt infected plants
Disinfect pruning tools with sodium hypochlorite (2.5%)

Biological control
Apply *Trichoderma harzianum* + *Paecilomyces lilacinus* @ 25g with 2kg well composted FYM and neem cake

Chemical control
Drench 5-8 liters solution of chlorpyriphos (3ml/l + carbendazim (2g/l) or propiconazole (2ml/l) – repeat at 3-4 times at 20 days interval.

Source: UHS, Bagalkot, IIHR, Bangalore and NRCOP, Solapur
Panama wilt/Fusarium wilt

**Cultural Practices**
- Soil solarisation
- Disease free planting material
- Removal and destruction of infected plant

**Crop rotation**
- Host resistance
  - Grand Nain, Dwarf Cavedish and Rousta

**Biological control**
- Application of *P. fluorescens*, *harzianum* and neem cake

**Chemical**
- Soil drenching carbendazim (1g/l) twice at monthly intervals up to 6 months after planting *(Source: NRC Banana, Trichy)*
Sigatoka leaf spot

**Cultural practices**
1. Deleafing at 7-10 days intervals during rainy season
2. Plantation should be weed free
3. Remove side suckers
4. Remove diseased leaves
5. Proper drainage system and avoid water logging

**Chemical**
- Mancozeb (2.5g/l)
- Tridemorph (2ml/l)
- Propiconazole (1ml/l)
- Hexaconazole (1ml/l)
- Mineral oil

(Source: NRC Banana, Trichy)
Erwinia rot

Bordeaux mixture (1%)
A. Severe streak symptom of BSD in cv. Grand Nain; B. virions of baciliform particle. C. Striped mealy bug (*Ferrisia virgata*) vector of *banana streak virus* (BSV) colonizing banana. D, Genome organization of BSV species infecting banana cv Poovan (Mysore)

(Source: NRC Banana, Trichy)
A. Banana bunchy top disease; B, virion of BBTV; C, Banana black aphid (*Pentalonia nigronervosa*) vector of BBTV. D, Genome organization of BBTV infecting hill banana isolate.

(Source: NRC Banana, Trichy)
A. Typical mosaic symptom of Banana bract mosaic disease in bract; B. *Aphis crassivora* - Vector of BBrMV. C. Virions of BBrMV. D. Presence of chlorotic mosaic, line pattern symptom of banana mosaic disease on the leaf of Grand Naine, Cavendish group. E. Virions of CMV

(Source: NRC Banana, Trichy)
Guava

Wilt

Canker

Anthracnose

Phytophthora fruit rot

Pestabotiopsis leaf spot

Damping off
Management of guava diseases

**Wilt**
An integrated approach using *Aspergillus niger* strain AN17 and resistant root stock (*P. molle* x *P. guajava*)
Intercropping with marigold or turmeric

**Anthracnose**
Carbendazim-mancozeb combination (2g/l)

**Canker and Phytophthora fruit rot**
Bordeaux mixture (1%)

**Damping off**
Raised beds
Drench copper oxychloride

*(Source: CISH, Lucknow)*
Phytophthora diseases of citrus

- Damping off
- Root rot
- Gummosis
- Collar/ Foot rot
- Crown rot & Root rot
- Decline
- LEAF BLIGHT
- BROWN ROT OF FRUIT
Management strategies

- Basic hygiene.
- Disease free root stock (*Phytophthora*-free nursery material).
- Optimum drainage and irrigation.
- Improving soil health.
- Use of disease-resistant germplasm.
- Biological and chemical control.
Nursery techniques for Management of Citrus *Phytophthora* diseases

- **Strict sanitary measure while extracting and cleaning the seeds**
- **Seed may be treated at 50°C for 10 min**
- **For storage seed should be treated with 8 hydroxyquinoline for 3 min in aerated mesh bags**
- **Field nursery/ seed bed**
  - should be well drained land away from citrus plantation
  - operational equipments should be separate
  - If used repeatedly, should be either solarized and/or fumigated
Disinfesting Planting Media

- **Soil solarization**
  - Soil temp. up to 100°C for 1 hr
  - Fungal spores, Bacteria, nematodes, weed seeds

- **Soil fumigation**
  - Dazomet granules
  - MITC gas
  - Kills Phytophthora
  - At 40g/m³ soil

- **Steam sterilization unit**
  - (Source: NRC Citrus, Nagpur)
Phytophthora-free production of containerized nursery stocks

(Source: NRC Citrus, Nagpur)
Planting material (Nagpur mandarin) - Ready to release

(Source: NRC Citrus, Nagpur)
Uniform performance in field
Management *Phytophthora* diseases

**Selection of proper site for adequate drainage**

Avoid excess irrigation and root injuries

**Follow high planting**—keeping bud union well above the soil surface.

**Provision of double ring for keeping the irrigation water away from the trunk.**

**Application of trunk paint with Bordeaux paste**

(Source: NRC Citrus, Nagpur)
Rejuvenation of elite old budlines by inarching
THANK YOU