2015 Pesticide Safety: Fruit rot management

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Fruit rot management

Erika Saalau Rojas
Extension Plant Pathologist
UMass Cranberry Station
East Wareham, MA
# Bravo – Chlorothalonil

(F. Caruso 2010 Results)

<table>
<thead>
<tr>
<th>LOC</th>
<th>PHI</th>
<th>PPM</th>
<th># Apps</th>
<th>LAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td>77</td>
<td>0.026</td>
<td>3</td>
<td>06/29/10</td>
</tr>
<tr>
<td>MA</td>
<td>77</td>
<td>0.042</td>
<td>3</td>
<td>06/29/10</td>
</tr>
<tr>
<td>MA</td>
<td>77</td>
<td>&lt;0.01 ppm</td>
<td>3</td>
<td>06/29/10</td>
</tr>
<tr>
<td>MA</td>
<td>77</td>
<td>0.016</td>
<td>3</td>
<td>06/29/10</td>
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<tr>
<td>MA</td>
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<td>0.02</td>
<td>2</td>
<td>06/29/10</td>
</tr>
<tr>
<td>MA</td>
<td>77</td>
<td>&lt;0.01 ND</td>
<td>2</td>
<td>06/29/10</td>
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<tr>
<td>MA</td>
<td>77</td>
<td>0.008</td>
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<td>06/29/10</td>
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<tr>
<td>MA</td>
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<td>06/29/10</td>
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<tr>
<td>MA</td>
<td>88</td>
<td>&lt;0.01 ppm</td>
<td>2</td>
<td>06/18/10</td>
</tr>
<tr>
<td>MA</td>
<td>88</td>
<td>0.014</td>
<td>2</td>
<td>06/18/10</td>
</tr>
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</tr>
<tr>
<td>MA</td>
<td>97</td>
<td>&lt;0.01 ppm</td>
<td>1</td>
<td>06/09/10</td>
</tr>
<tr>
<td>MA</td>
<td>97</td>
<td>0.034</td>
<td>1</td>
<td>06/09/10</td>
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</table>

50% of detections >0.01 ppm
The new MRL essentially eliminates Bravo for fruit rot control.

50% of detections >0.01 ppm
**Efficacy** – the overall effect of a fungicide on the level of disease

In order of efficacy (best to worst):

- Chlorothalonil - Bravo, Equus, Echo
- EBDC’s – Manzate, Dithane, Roper
- Prothioconazole – Proline
- Fenbuconazole - Indar
- Azoxystrobin - Abound
- Ferbam
- Coppers – Champ, Kocide
# Fungicides available for fruit rot

<table>
<thead>
<tr>
<th>DMI</th>
<th>FRAC Code 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indar</td>
<td></td>
</tr>
<tr>
<td>Proline</td>
<td></td>
</tr>
<tr>
<td>QoI</td>
<td>FRAC Code 11</td>
</tr>
<tr>
<td>Abound</td>
<td></td>
</tr>
<tr>
<td>Evito</td>
<td></td>
</tr>
<tr>
<td>polyoxins</td>
<td>FRAC Code 19</td>
</tr>
<tr>
<td>Tavano</td>
<td></td>
</tr>
</tbody>
</table>

- **High risk**
  - chloronitriles
  - FRAC Code M5
- **Medium risk**
  - Bravo (and many others)
- **Low risk**
  - dithiocarbamates
  - FRAC Code M3
  - Mancozeb
  - Ferbam
## Fungicides available for fruit rot

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<td>Tavano/Oso</td>
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<table>
<thead>
<tr>
<th>chloroacetamides</th>
<th>FRAC Code M5</th>
</tr>
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<tr>
<td>Bravo (and many others)</td>
<td></td>
</tr>
<tr>
<td>dithiocarbamates</td>
<td></td>
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<tr>
<td>Mancozeb</td>
<td>Ferbam</td>
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Efficacy unknown $$$
Fungicides available for fruit rot

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Only 4 effective fungicides against fruit rot

- Abound
- Evito
- polyoxins FRAC Code 19
- Tavano/Oso

Efficacy unknown $$$
Why do fungicide applications fail?

• Fungicide ineffective against pathogen

• Improper timing

• Poor coverage / application method

• Fungicide resistance
Fungicide resistance

Fungal pathogen = less sensitive to fungicides

Heritable trait = resistant population builds up

Single-site fungicides pose a higher risk

Indar
Abound
Proline
Risk factors

- Pathogen diversity
- Single-site fungicides

**Storage Rot**
- Allantophomopsis lycopodina
- Allantophomopsis cytispora
- Coleophoma empetri
- Fusicoccum putrefaciens
- Phyllosticta elongata
- Phyllosticta vaccinii
- Physalospora vaccinii
- Strasseria geniculata

**Field Rot**
- Coleophoma empetri
- Colletotrichum accutatum
- Colletotrichum gloeosporioides
- Fusicoccum putrefaciens
- Phomopsis vaccinii
- Phyllosticta vaccinii
- Physalospora vaccinii
Efficacy – the overall effect of a fungicide on the level of disease

In order of efficacy (best to worst):

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– Coppers – Champ, Kocide
Chlorothalonil and mancozeb
FRAC codes M5 and M3

Multi-site: multiple targets (enzymes, metabolic pathways, spore germination, toxic to cell membranes)
FRAC code

Fungicide Resistance Action Committee
Classifies fungicides by mode of action
Different FRAC codes represent different modes of action.
QoI (Strobilurins)
FRAC code 11

**Single-site:** target the mitochondrion

**Fungal cell**
Different trade names, same mode of action
DMI fungicides
FRAC code 3

Single-site: target the cell membrane
FOR control of specified diseases on listed crops.

ACTIVE INGREDIENT:
Prothioconazole, 2-{2-(1-Chlorocyclopenty1)-3-(2-chlorophenyl)-2-hydroxypropyl}-1,
2-dihydro-3H-1,2,4-triazole-3-thione ........... 41.0%
INERT INGREDIENTS: .......................... 59.0%
........................................ 100.0%

Contains 4 pounds Prothioconazole per gallon.

KEEP OUT OF REACH OF CHILDREN
CAUTION
FOR ADDITIONAL PRECAUTIONARY
STATEMENTS: See Inside Booklet.
FRAC code
GROUP 3

For control of specified diseases on listed crops.

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KEEP OUT OF REACH OF CHILDREN
CAUTION
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STATEMENTS: See Inside Booklet.
# Standard fungicide approach

## Applications

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<tr>
<th>Early bloom 1</th>
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<th>Early/mid bloom 1</th>
<th>Mid/out bloom 2</th>
<th>Mid/out bloom 3</th>
</tr>
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5 applications
## Standard fungicide approach

### Applications

<table>
<thead>
<tr>
<th></th>
<th>Early bloom 1</th>
<th>Early bloom 2</th>
<th>Early/mid bloom 1</th>
<th>Mid/out bloom 2</th>
<th>Mid/out bloom 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 applications</td>
<td>Indar/Abound</td>
<td>Indar/Abound</td>
<td>Bravo</td>
<td>Bravo</td>
<td>Bravo</td>
</tr>
<tr>
<td>4 applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Areas with **moderate** to **high** fruit rot

The # of out-of-bloom applications may depend on cultivar

More resistant:
- Early Black
- Howes
- Mullica Queen
# Standard fungicide approach

## Applications

<table>
<thead>
<tr>
<th></th>
<th>Early bloom 1</th>
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<td><strong>Indar/Abound</strong></td>
<td><strong>Indar/Abound</strong></td>
<td><strong>Bravo</strong></td>
<td><strong>Bravo</strong></td>
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<td><strong>Bravo</strong></td>
</tr>
<tr>
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<td><strong>Indar/Abound</strong></td>
<td><strong>Bravo</strong></td>
<td><strong>Bravo</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Indar/Abound</strong></td>
<td><strong>Indar/Abound</strong></td>
<td><strong>Bravo</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Single-site fungicides
- Medium-high risk of resistance

### Multi-site fungicides
- Low risk of resistance
  - ‘cleanup application’
Single-site fungicides (Indar, Abound, Proline)

Medium-high risk of resistance
Single-site fungicides (Indar, Abound, Proline)

Medium-high risk of resistance
Single-site fungicides (Indar, Abound, Proline)

Medium-high risk of resistance

Indar (FRAC 3) + Abound (FRAC 11)
or
Proline (FRAC 3) + Abound (FRAC 11)
Single-site fungicides (Indar, Abound, Proline)

Medium-high risk of resistance

Indar (FRAC 3) + Abound (FRAC 11) or Proline (FRAC 3) + Abound (FRAC 11)
Single-site fungicides (Indar, Abound, Proline)
Medium-high risk of resistance

Indar (FRAC 3) + Abound (FRAC 11) or
Proline (FRAC 3) + Abound (FRAC 11)

Combine or alternate modes of action
Use FRAC codes for guidance

Multi-site fungicides
Low risk of resistance
‘cleanup application’

Use FRAC codes for guidance
Single-site fungicides (Indar, Abound, Proline)

Medium-high risk of resistance

Indar (FRAC 3) + Abound (FRAC 11) or Proline (FRAC 3) + Abound (FRAC 11)

Combine or alternate modes of action
Use FRAC codes for guidance

Multi-site fungicides

Low risk of resistance
‘cleanup application’

No carryover of resistant pathogens to next growing season
Single-site fungicides (Indar, Abound, Proline) are at medium-high risk of resistance.

Indar (FRAC 3) + Abound (FRAC 11)
or
Proline (FRAC 3) + Abound (FRAC 11) are recommended.

Multi-site fungicides have a low risk of resistance.

A 'cleanup application' of a multi-site fungicide, such as Bravo or Mancozeb, should be applied as the last application of the growing season.

Combine or alternate modes of action. Use FRAC codes for guidance.

No carryover of resistant pathogens to the next growing season is expected.
# Standard approach - No Bravo

<table>
<thead>
<tr>
<th>Early bloom 1</th>
<th>Early bloom 2</th>
<th>Early/mid bloom 1</th>
<th>Mid/out bloom 2</th>
<th>Mid/out bloom 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Proline/Abound</td>
<td>Proline/Abound</td>
</tr>
</tbody>
</table>

5 applications

FRAC 3 and FRAC 11
## Standard approach- No Bravo

<table>
<thead>
<tr>
<th>Early bloom 1</th>
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<th>Mid/out bloom 2</th>
<th>Mid/out bloom 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indar/Abound</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Areas with **moderate** to **high** fruit rot

Mancozeb (e.g., Dithane and Manzate) can affect fruit color and fruit size (long-term)
### Standard approach - No Bravo

<table>
<thead>
<tr>
<th>Early bloom 1</th>
<th>Early bloom 2</th>
<th>Early/mid bloom 1</th>
<th>Mid/out bloom 2</th>
<th>Mid/out bloom 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mancozeb</strong></td>
<td>Indar/Abound</td>
<td>Indar/Abound</td>
<td><strong>Mancozeb</strong></td>
<td><strong>Mancozeb</strong></td>
</tr>
<tr>
<td>**Indar/Abound</td>
<td><strong>Mancozeb</strong></td>
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</tr>
<tr>
<td>**Indar/Abound</td>
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<td><strong>Mancozeb</strong></td>
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</tr>
</tbody>
</table>

If spraying 2 mancozeb~ first application can be **In bloom**
Table 2: The potential impact of the new regulation on fungicides as assessed by the UK CRD.

<table>
<thead>
<tr>
<th>Most likely to be eliminated by hazard criteria</th>
<th>Additional fungicides that may be eliminated depending on definition of cut-off criteria for endocrine disruption</th>
<th>Fungicides likely to be identified as Candidates for Substitution (assuming not already eliminated, and depending on endocrine disruptor definition)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitertanol</td>
<td>Difenoconazole</td>
<td>Chloropicrin</td>
</tr>
<tr>
<td>Carbendazim</td>
<td>Folpet</td>
<td>Chlorothalonil</td>
</tr>
<tr>
<td>Cyproconazole</td>
<td>Fluquinconazole</td>
<td>Cyproconazole</td>
</tr>
<tr>
<td>Dinocap</td>
<td>Fuberidazole</td>
<td>Cyprodinil</td>
</tr>
<tr>
<td>Epoxiconazole</td>
<td>Metiram</td>
<td>Dimoxystrobin</td>
</tr>
<tr>
<td><strong>Fenbuconazole</strong></td>
<td>Prothioconazole</td>
<td>Fenbuconazole</td>
</tr>
<tr>
<td>Flusilazole</td>
<td>Penconazole</td>
<td>Famoxadone</td>
</tr>
<tr>
<td>Iprodione</td>
<td>Prochloraz</td>
<td>Fenbuconazole</td>
</tr>
<tr>
<td>Maneb</td>
<td>Propiconazole</td>
<td>Fluquinconazole</td>
</tr>
<tr>
<td><strong>Mancozeb</strong></td>
<td><strong>Prothioconazole</strong></td>
<td><strong>Fluquinconazole</strong></td>
</tr>
<tr>
<td><strong>EBDCs</strong></td>
<td><strong>Tetraconazole</strong></td>
<td><strong>Fluquinconazole</strong></td>
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<td>Thiram</td>
<td><strong>Fluquinconazole</strong></td>
</tr>
<tr>
<td></td>
<td>Triadimenol</td>
<td><strong>Silthiofam</strong></td>
</tr>
<tr>
<td></td>
<td>Triticonazole</td>
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</tr>
<tr>
<td></td>
<td></td>
<td><strong>Triazoxide</strong></td>
</tr>
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</table>
Opportunities

- Focus on proper timing and coverage of fungicide apps
- Cultural practices
  - Monitor weather conditions (e.g., KQF & scald)
  - Avoid pathogen buildup (e.g., trash flood)
  - Late water (?)
- Plant health and IPM (Integrated Pest Management)
  - Drainage
  - Nutrition
  - Weed/insect control
Summary

• Newer fungicides = higher risk of resistance
• Resistance management = fungicide durability
• Alternate/mix modes of action (use FRAC codes)
• End of season = multi-site fungicide application
• Integrated Pest and Disease Management