Overview of fungicides for disease management and impacts of weather on efficacy

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Millardet and Bordeaux Mixture
Fungicide types

**Protectant**
- Remains on plant surface
- Can be washed off by rain

**Systemic**
- Absorbed by plant tissues
- More rainfast than protectants
Protectant/contact fungicides

- Sulfur
- Lime Sulfur
- Ziram
- Oils
- Mancozeb
- Bravo
- Copper
- Salts
Characteristics of protectants

• Broad-spectrum, contact materials
• Kill fungal spores and hyphae
• Need to be applied before infection
• Thorough coverage important
• Susceptible to wash-off by rain
• PHI = 0 days (captan) to 66 days (mancozeb)
• Resistance development rare
Biological control agents

Trichoderma spp.
# Modern fungicides (systemics)

<table>
<thead>
<tr>
<th>Fungicide class</th>
<th>Examples</th>
<th>Period</th>
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<tbody>
<tr>
<td>Benzimidazoles</td>
<td>Benlate, Topsin M</td>
<td>1960s</td>
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<tr>
<td>Sterol inhibitors</td>
<td>Bayleton, Rally, Elite</td>
<td>1970s</td>
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<tr>
<td>Phenylamides</td>
<td>Ridomil</td>
<td>1980s</td>
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<tr>
<td>Strobilurins</td>
<td>Abound, Sovran, Flint</td>
<td>1990s</td>
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<tr>
<td>Various new classes</td>
<td>Vangard, Endura, Quintec</td>
<td>2000s</td>
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Characteristics of systemics

• More specific to certain fungal groups
• Active at lower doses than protectants
• Lower mammalian toxicity than older products
• Absorbed by the plant; therefore may have curative (post-infection) and/or anti-sporulants activity
• More rainfast than protectant fungicides
• Tend to be more prone to resistance development
Systemic movement of sterol inhibitors (e.g., Elite)
Systemic movement of strobilurin fungicide (Flint)

http://www.apsnet.org/edcenter/advanced/topics/Pages/StrobilurinFungicides.aspx

- **Surface redistribution**: Trifloxystrobin is redistributed locally on the surface of the turfgrass plant.
- **Penetration of waxy cuticle**: Trifloxystrobin has a high affinity with the plant surface and is absorbed by the waxy layers of the plant.
- **Translaminar activity**: Trifloxystrobin penetrates plant tissue using translaminar activity but there is little or no transport within the vascular system of the plant.
- **Vapor phase redistribution**: Trifloxystrobin redistributes on the plant surface and adjacent blades by limited vapor movement and reabsorption.
Systemic movement of Ridomil

Systemic movement of phosphites
Fungicidal activity of a locally systemic fungicide
Impacts of weather on spray efficacy
How fungicides are lost from plant surfaces

- Wash-off by rain or overhead irrigation
- Breakdown by UV light
- Microbial degradation
- Rapid plant growth (dilution effect)
- Chemical breakdown inside plant
Systemic fungicides have to pass through plant cuticle.
Best conditions for fungicide application

• For protectant fungicides: sunny and dry
  - want quick drying

• For systemic fungicides: cloudy, moist soil
  - need plant cuticle to be swollen for rapid absorption
What is fungicide resistance?

• Reduced sensitivity to fungicides

• Starts with a natural mutation; resistant strains survive repeated sprays of a particular fungicide

• Resistance is may be rate-dependent (quantitative)
  or complete (qualitative)

• Resistance is more likely to develop to fungicides
  with a “single-site” mode of action (tend to be systemic fungicides)
Fungicide resistance management

- Limit the number of applications of "at-risk" fungicides per year
- Alternate classes of fungicides with different modes of action
- Do no apply fungicides below label rates
- If you suspect fungicide resistance, tank-mix with a protectant/contact fungicide
For fungicide labels and material safety data sheets check out: www.cdms.net