

# Fungicides Demystified

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# What are Fungi?

- ◆ organisms that lack chlorophyll and obtain their food by living on other living or dead organisms
- ◆ reproduce by spores
- ◆ spread by wind, rain, insects, birds, soil, machinery and contaminated seed



# Fungicides

- ◆ fungicides are pesticides that specifically kill fungi or inhibit fungal development
- ◆ about 40 different classes of fungicides used for plant protection
- ◆ almost all must be present on the plant surface before infection
- ◆ classes are based on target site and biochemical mode of action
  - multi-site – PREVENTIVE only
  - site-specific – PREVENTIVE and CURATIVE

# Preventive vs Curative

## ◆ Preventive:

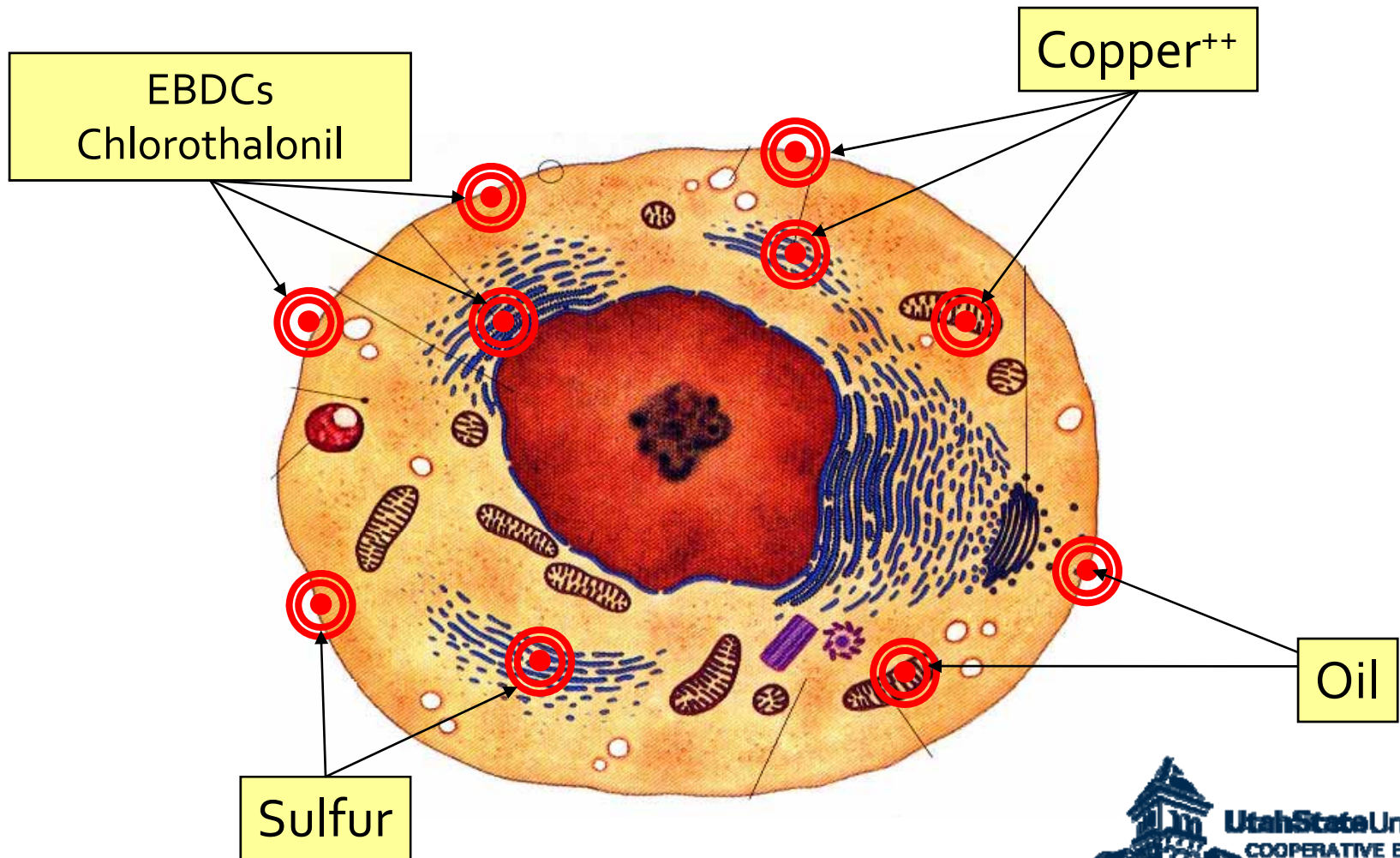
- AKA protectant, contact, broad spectrum
- suppresses growth of a pathogen before it infects and colonizes a plant
- most fungicides are applied as a preventive
- examples: Bravo, Ziram

## ◆ Curative:

- AKA systemic, penetrant
- suppresses growth of a pathogen after it infects and colonizes a plant
- examples: strobilurins and some sterol inhibitors

# Multi-site/Preventive fungicides

affect multiple metabolic processes; kill spores and inhibit germination



# Multi-site/Preventive fungicides

- ◆ Group “M” fungicides
- ◆ Risk of resistance is LOW
- ◆ Provide a chemical barrier to the fungus; uniform coverage essential
- ◆ Short protection interval; may wash off
- ◆ Most are protectant fungicides only and **non-systemic**
  - Chlorothalonil
  - Mancozeb
  - Copper Hydroxide, Hydrogen Dioxide
  - Captan
  - Ziram/Thiram

# Multi-site - Systemic fungicide

Group “M33” fungicides are phosphonates, and are the only true systemics, moving through entire plant from leaves to roots

- good protectant against phytophthora crown and collar rot
- mode of action is unknown
  - Aliette
  - Agri-fos, Phostrol, Fosphite

# Multi-site - Copper fungicides

- ◆ Broad spectrum; useful as fungicide and bactericide; protective (preventive) fungicides
- ◆ Copper ions mixed with water are toxic to all fungi, bacteria, and plant tissues;
  - copper is now “fixed” so that it is more insoluble in water and less toxic to plants
- ◆ Bordeaux mixture (copper sulfate and hydrated lime): long residual, dormant season
- ◆ Fixed coppers (tribasic copper sulfate, copper hydroxide): shorter residual



# Multi-site/Preventive fungicides

## Examples of efficacy

	Apple PM	Cherry PM	Peach PM	Shothole
Bravo	NL	0	0	3
captan	0	0	0	3
copper	0	0	0	3
lime sulfur	3	0	0	0
sulfur	3	3	3	3
ziram	0	0	0	3

# Single-site Fungicides

- ◆ Affect a specific metabolic process, for example:
  - amino acid and protein synthesis
  - sterol biosynthesis
  - respiration
  - nuclear division
- ◆ Many different classification groups
- ◆ Often, potential for resistant is high
- ◆ Most are **systemic**, can be **protective and/or curative**
- ◆ Longer application intervals
- ◆ Less prone to washing off

# Groups of Single-Site Fungicides

## Most common (pre-harvest) tree fruit fungicides

Group	Class	Example Names	Mobility
1	benzimidazoles (MBC)	Topsin	xylem mobile
2	affect cell division, DNA & RNA synthesis	Rovral	contact
3	demethylation inhibitor (DMI); AKA: sterol biosynthesis inhibitor (SBI, or SI)	Rubigan, Indar, Elite, Rally, Orbit, Bayleton, Procure, Inspire, Quash	xylem mobile
3 (+ 11)	DMI + strobilurin	Adament	xylem mobile
7 (+ 11)	oxathiin	Pristine	locally systemic
9	anilinopyrimidine	Scala, Vangard	locally systemic
11	quinone outside inhibitors (QOI), strobilurins	Sovran, Abound, Gem, Flint, Cabrio	locally systemic/ translaminar
13	quinoline	Quintec	contact

# Group 1 and 2

## Examples of efficacy

	Apple PM	Cherry PM	Peach PM	Brown Rot	Shothole
Rovral	NL	0	0	3	0
Topsin	2	3	3	4	0

# Single-site - Group 3 (Sterol Inhibitors)

- ◆ Affect a narrow site of action (enzyme production) so possibility for resistance is high
- ◆ Have curative effects
- ◆ To prevent resistance, should be used preventively, not curatively, and alternate with other groups
- ◆ Highly effective for control of mildew

# Group 3

## DMI's or sterol-biosynthesis inhibitors (SBI)

	Apple PM	Cherry PM	Peach PM	Brown Rot
Bayleton	3	NL	NL	NL
Elite (Orius, Tebuzole)	NL	2	3	4
Indar	4	1	1	4
Inspire	no data	NL	NL	NL
Orbit/Tilt (Bumper)	NL	3	3	4
Procure	4	3	NL	3 (cherry)
Quash	NL	3	no data	3
Rally	4	3	4	3
Rubigan	4	3	NL	3 (cherry)

# Single-site – Group 11 (Strobilurins)

- ◆ Block electron transport through mitochondria
- ◆ In nature, “strobilurin A” is produced by a fungus
- ◆ Designated as “reduced risk” by EPA
- ◆ A valuable group because they work against various groups of fungi
  - ascomycetes (powdery mildew), basidiomycetes (rusts), oomycetes (pythium)

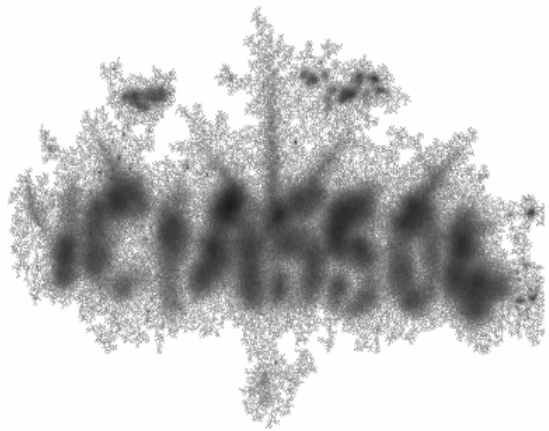
# Single-site – Group 11 (Strobilurins)

- ◆ Must be present on leaf surface before disease
  - kill germinating spores
- ◆ Long residual
- ◆ Resistance can occur, but is not known in powdery mildew; rotate with other classes
- ◆ Good mobility within plant tissues

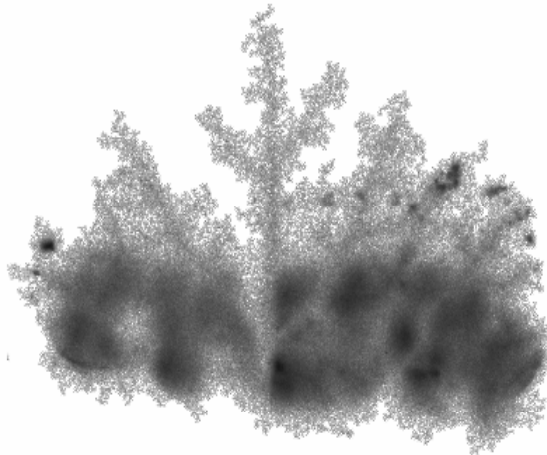


# Single-site – Strobilurins

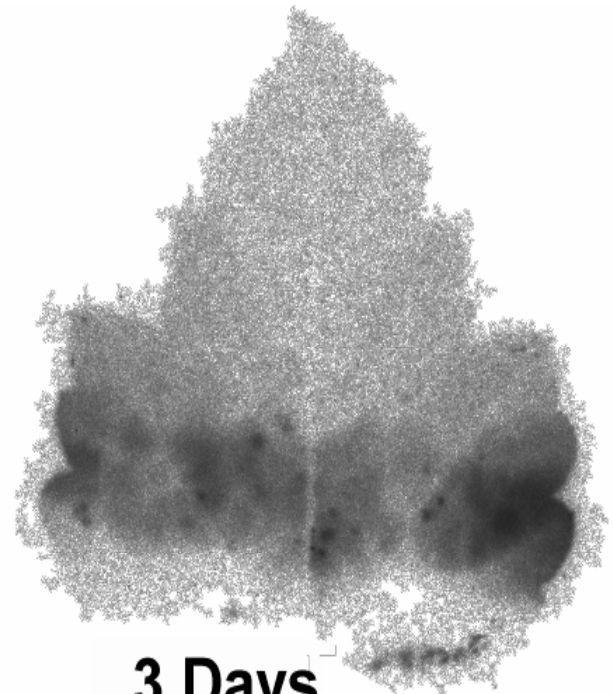
Distribution of azoxystrobin in a grape leaf



**6 Hours**



**1 Day**



**3 Days**

# Groups 7-13

## Examples of efficacy

	Group	Apple PM	Cherry PM	Peach PM	Brown Rot	Shot hole Peach/Nec
Adament	3+11	NL	3	3	4	no data
Pristine	7+11	4	3	3	4	4
Scala	9	1	NL	1	4	1
Vanguard	9	1	NL	no data	4	1
Abound	11	NL	3	2	2	2
Cabrio	11	NL	3	NL	no data	no data
Flint	11	4	2	2	3	NL
Sovran	11	3	NL	NL	NL	NL
Quintec	13	NL	4	NL	no data	no data

# Organic fungicides

- ◆ Bicarbonates (Kaligreen): poor to moderate control of powdery mildew
- ◆ Horticultural oil: good control of powdery mildew
- ◆ Copper
- ◆ Sulfur for powdery mildew
  - not rain-fast; must be applied before infection every 5 days
- ◆ Serenade (*Bacillus subtilis*) is labeled to prevent powdery mildew infections and fire blight
  - not as effective as oils or sulfur in an organic program
  - not effective on fire blight