Developing an Effective Vineyard Fungal Pest Management Program

Jim Kamas
Associate Professor & Extension Specialist
Texas A&M Agrilife Extension Viticulture & Fruit Lab
Fredericksburg, Texas

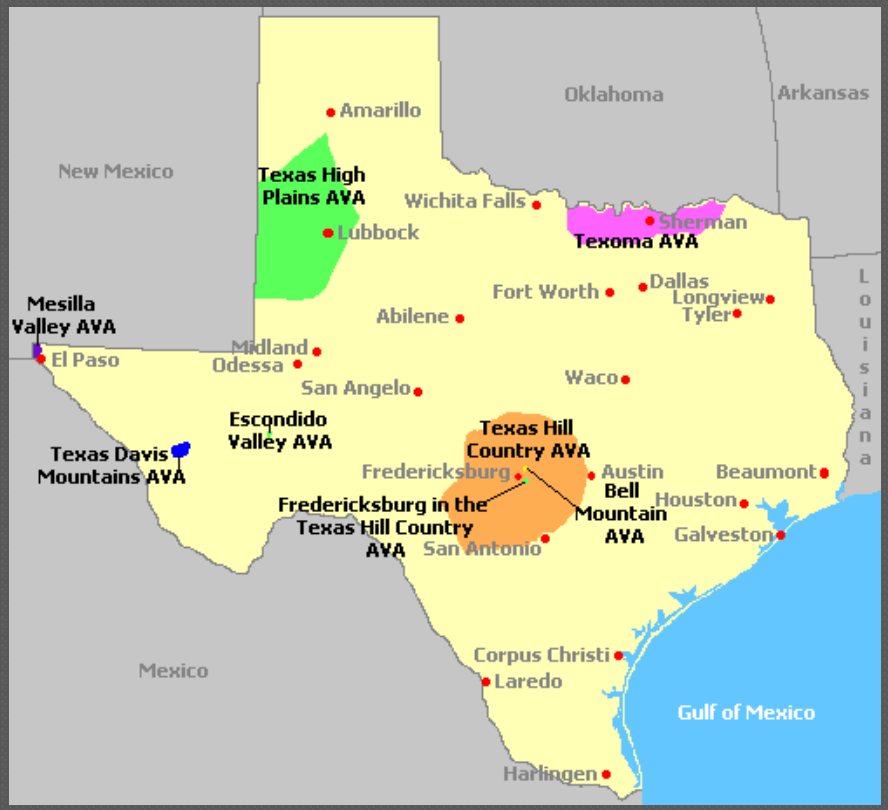
Texas A&M AgriLife Extension Viticulture and Fruit Lab

Axioms to Live By

- Great Wine is Only Made From Sound, Ripe Fruit
- Optimal Maturity Depends on Disease Free Clusters & Canopy
- Vine Health is Dependent on Effective Crop Control and a Healthy Canopy

Components of an Effective Management Program

- Relative Risk Assessment
- Timing
- Material Selection
- Effective Applications



Texas Grape Fungal Diseases Affecting Fruit & Foliage

- Powdery Mildew
- Black Rot
- Anthracnose
- Phomopsis Cane & Leaf Spot
- Downy Mildew
- Botrytis Bunch Rot
- Leaf Blight
- Summer Rot Complex

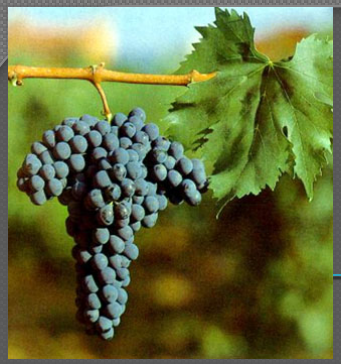
Managing the 4 Major Fungal &Fruit Diseases

Powdery Mildew

Downy Mildew

Black Rot

Phomopsis

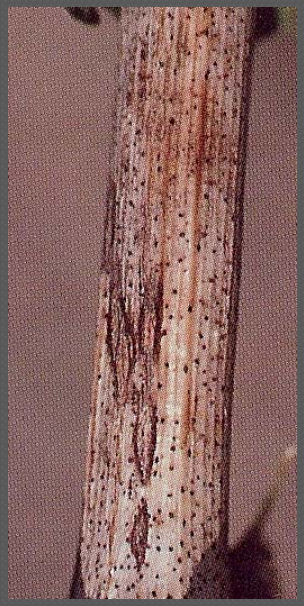


Critical Elements in Fungal Disease Management

- Understand the pathogen biology
  - Environmental effects
  - When active
  - Cultural practices that favor/ disrupt
- Understand host susceptibility
  - Relative degree (cultivar effect)
  - When not susceptible
  - Critical, peak period
- Understand fungicide characteristics
  - Surface-active or penetrant?
  - Protectant? Post-infection? Eradicant?
  - Spectrum of activity
  - Resistance concerns and management

Phomopsis viticoli

- Cool, Wet Season Disease
- Overwintering Structures
- Latent Rachis Infections
- Infections Become Systemic



Management of Phomopsis

- Start Spray Program at 1-3” Shoot Growth
- Must Maintain Coverage As Shoots & Cluster Tissue Expands
- Berries Susceptible to Direct Infection Until Pea-Sized
- Rachis Tissue is Usually Most Critical In Minimizing Crop Loss
- EBDC (Mancozeb and others), Captan, Strobilurins Effective in Control

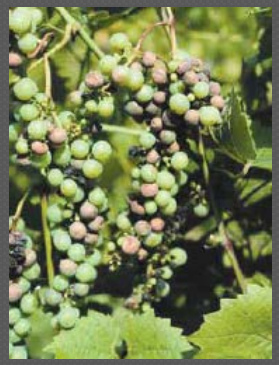
Black Rot

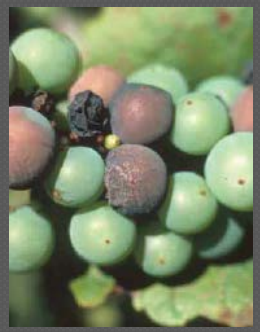
- Overwinters as Mummified Fruit or Cane Lesions
- Infection Periods are Temperature and Leaf Wetness Driven
- Key Periods of Susceptibility 2 Weeks Pre-bloom to 30 Days Post-bloom
- Achilles Heel of Organic Grape Production

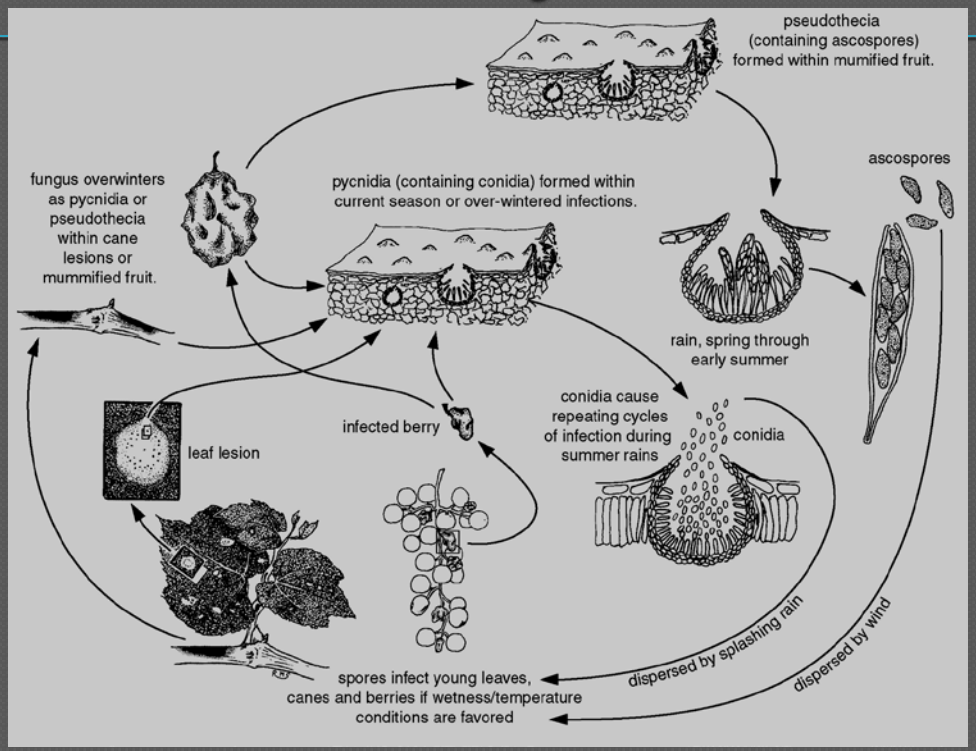
Black Rot Management Considerations

- Most commercial vineyards have low levels of inoculum
  - If so, makes it much easier to control with limited number of sprays
    - (Opposite is true, of course)
- Serious economic losses usually result from berry-to-berry spread within the vine (rain-splashed "secondary" spores)

Black Rot Life Cycle







BLACK ROT: IMPORTANCE OF SANITATION

(Removal of mummies from trellis)

- Mummies in trellis (versus on the ground)
  - Produce spores until +/- véraison *vs.* 1-2 wk postbloom
  - Produce 10-20x as many spores over the season
  - Produce spores right next to new fruit (splash dispersal)

Monitoring Black Rot Infection Periods

Leaf wetness duration and temperature necessary for infection by the black rot fungus.	
Temperature (degrees F)	Hours of leaf wetness required for infection
45	No infection
50	24
55	12
60	9
65	8
70	7
75	7
80	6
85	9
90	12

R. Spotts

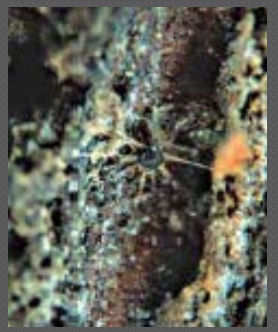
Black Rot Fungicide Options

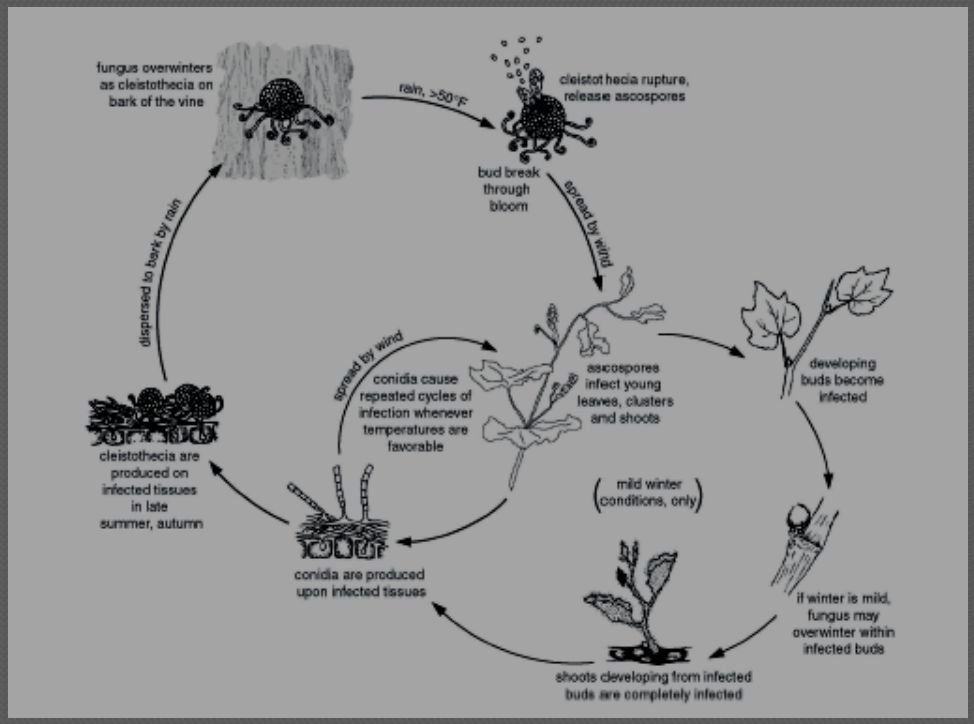
- Strobilurins- Abound, Flint, Pristine, Sovran
- DMI- Nova, Elite, etc.
- Mancozebs- Dithane, Penncozeb
- Carbamates- Ferbam

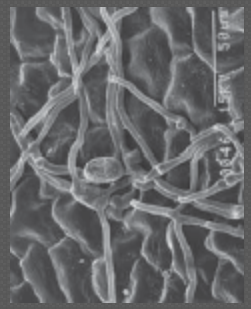
Powdery Mildew

- Problematic in All Parts of the State
- 0.1” Rain & 50°F Needed for Primary Infection
- No Rainfall Needed for Secondary Infection
- Key Period of Susceptibility is 2 Weeks Pre-bloom to 30 Days Post-bloom

Powdery Mildew Lifecycle







POWDERY MILDEW: EFFECT of TEMPERATURE on DISEASE SPREAD

Temp. (°F)	Generation time (days)
48	25
54	18
59	11
63	7
74	6
79	5
86	6
90	not active

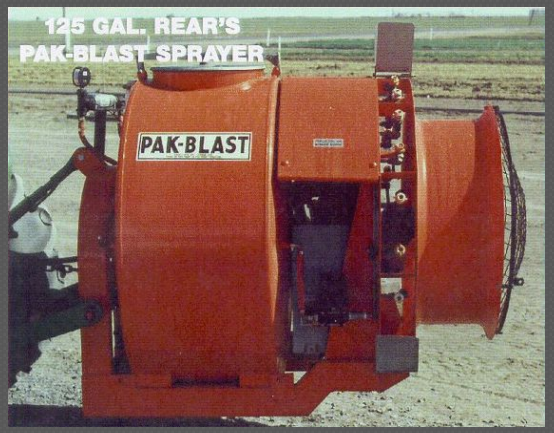
Potential Losses from PM

- **Direct Fruit Loss**
- **Loss of Fruit Quality**
- **Loss of Photosynthetic Area**

Powdery Mildew Fungicides Options

- Strobilurins- Flint, Abound, Pristine
- DMI- Nova, Elite
- Boscalids- Endura
- Other Unique Chemistries
- Sulfur
- Copper
- Other Contacts
  - Oils
  - Bicarbs
  - Peroxide Products

Resistance Management Is a Must!



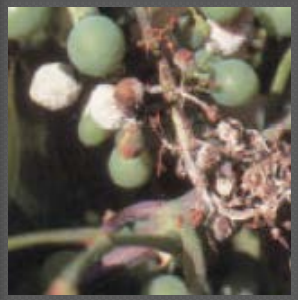
Powdery Mildew Rescue Treatments

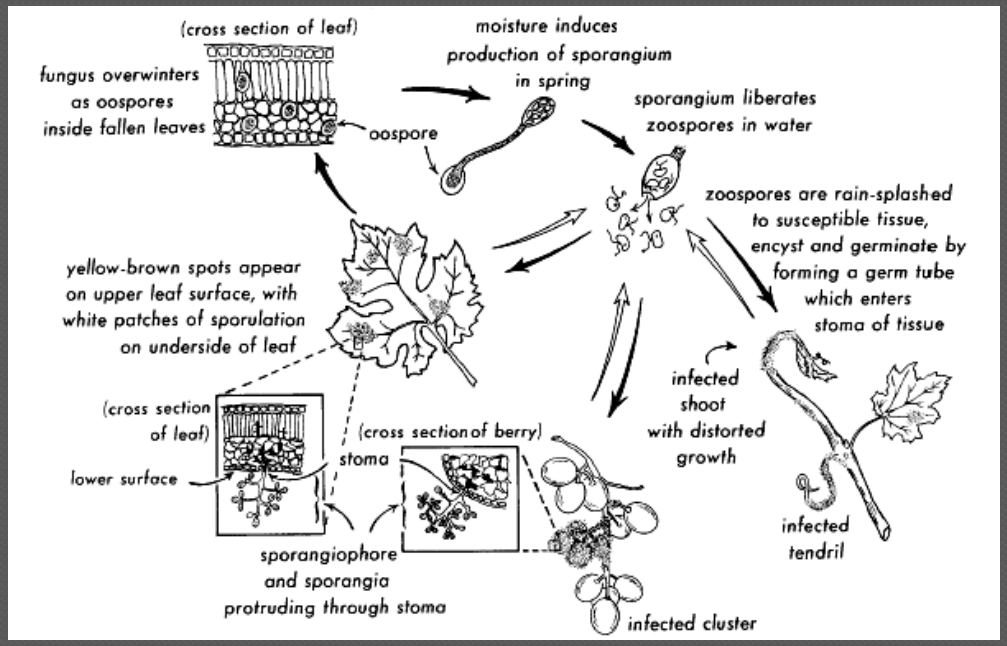
- Excellent Tank Mix Additions to Conventional Fungicides
- Important Products for Late Season (Post-harvest) Control of PM
- DO NOT WANT TO SOLELY RELY ON THEM WHEN SUSCEPTIBLE FRUIT ARE PRESENT

Downy Mildew

- Overwinters in Leaf Litter on Vineyard Floor
- Spores Disseminated by Splashing Rain
- Primary Infection Takes Place During Wet Nights
- Fruit/Rachis Infections Become Systemic

Downy Mildew Life Cycle





Potential Losses from Downy Mildew

- Direct Fruit Loss
- Loss of Photosynthetic Area (Foliage)
- Loss of Fruit Quality

Downy Mildew Management Considerations

- First primary infections occur about 2 - 3 weeks before bloom, to ~ 2 weeks post-bloom
  - ≥52°F, 0.1” rain
  - Critical time to prevent epidemic from starting
- Young Clusters Highly Susceptible

Chemicals Used to Manage Downy Mildew

- Mancozebs, Captan, Carbamates
- Strobilurins (some are much more effective than others)
- Copper Products
- Phos-Acids

Selecting Fungicides

- GENERAL PRINCIPLES
  - Understand fungicide characteristics
    - Surface-active or penetrant?
    - Protectant? Post-infection? Eradicant?
    - Spectrum of activity/ relative efficacy
    - Resistance concerns and management

Mancozeb Materials

- Trade Names- Dithane, Manzate & Penncozeb
- Excellent Protection Against Downy Mildew and Phomopsis
- Very Tenacious on Plant Material, Redistributes Well After Some Rain
- Need to Apply 3# to 4# Rate For Good Control
- 66 Day PHI, 24 Hour REI

Dow AgroSciences
Dithane®
Rainshield®
Specialty Fungicide
*Trademark of Dow AgroSciences LLC

Carbamate Fungicides

- Ferbam - (If You Can Find It) 7 Day PHI, 24 Hour REI, Rate is 4#/Acre, Only 3 Applications Per Season
- Ziram –(3-4#/acre, 21 Day PHI, 48 Hour REI
- Labeled For Black Rot, Downy Mildew, Phomopsis & “Ripe Rot”
- Up To 7 Ziram Applications Per Growing Cycle

Captan

- Old Class of Chemistry, Another Multi-site Toxin
- Very Active Preventative Against Downy Mildew & Phomopsis
- Black Rot is On the Label, but Don't Count On It!
- Very Helpful in Management of Sour Rot Complex
- "Cover Up" After Hail
- 3# to 4# Rates To Be Effective
- 1 Day PHI, 72 Hour REI

Locally Systemic Fungicides

- Some Have Great Protectant Activities While Others Are Stronger As Post-Infection Materials….(not post symptom)
- Advantage of Being Locally Systemic
  - Greater in Foliage Than Fruit
- Some Growers Get Lulled Into Complacency And Get Sloppy With Optimizing Coverage

Sterol Inhibitors

- Many Acronyms- SI's, DMI's, EBI's
  - 5 to 7 Day Protectant Activity
  - 7 to 10 Day Post-Infection Activity
- Initially Effective on 21 Day Intervals
  - Better Not Count on More Than 14 Days
- Resistance in Fungi is Multi-genic

SI Products

- Rally (40WSP)- Labeled at 2 to 5 ozs/Acre 14 Day PHI, 24 Hour REI. 48 oz/acre max.
  - 3-4 oz rate is Advisable, 5 oz Rate is Post-Infection Black Rot Rate
- Elite (45WP)- Labeled at 4 ozs per acre 14 Day PHI, 12 Hour REI. 32 oz/acre max.
- Procure (50WS)- Labeled at 4 to 8 ozs per acre 7 Day PHI, 12 Hour REI
- Rubigan (1E)- Label Prebloom 2-3 fl.oz/acre, Postbloom 4-5, Summer Sprays 5-6. Maximum 19 fl. oz/acre
- Package Mixes- Numerous Products Now Package-Mixed with SI products; Quadris Top, Inspire Super, Revus Top, Luna Experience

Strobilurin Fungicides

- Also Known As Qol Compounds
- Extremely Broad Spectrum Activity
- Excellent Protectant Activity
- Excellent Anti-sporulant Activity
- Little or No Kick-back Activity
- Also Locally Systemic
- Single Gene Resistance Mechanism for Powdery & Downy

Phosphorous Acid (Phosphonate) Materials

- Plant Nutrients Containing Phosphoric Acid are Not Effective
- Locally Systemic
- Excellent Post-Infection Control with Limited Eradicant & Protectant Activity
- Prone to Resistance

Other Chemistries

- Powdery Mildew Only
  - Vivando (U8)
  - Quintec (13)
  - Presidio (43)
  - Boscalids (7)

Good Old SULFUR

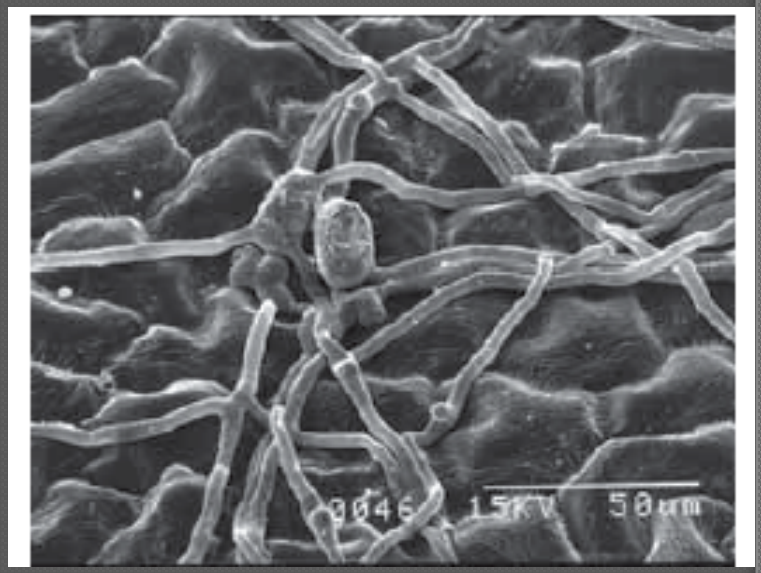
- DISADVANTAGES
  - Only Controls Powdery Mildew
  - Relatively short residual
    - Washes off easily
  - Temperature dependent
    - Ineffective <60-65°F (??)
    - Phytotoxic >90°F
- ADVANTAGES
  - CHEAP!

Good Ol' Sulfur

- New Research Shows No Reduced Efficacy (Protectant or Post-Infection) of Sulfur At Low Temperatures When Rates Were 5#/Acre or Higher.
- Sulfur provides consistent and extensive post-infection activity when applied up through the time that young colonies emerged after inoculation with fungal spores (about 1 week after the start of an infection under summer temperatures)

POWDERY MILDEW FUNGICIDES: "ALTERNATIVE" PRODUCTS

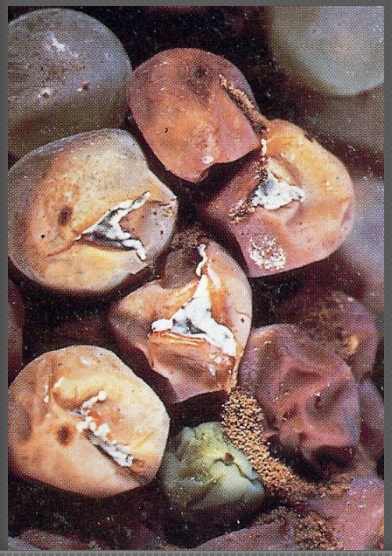
- Primarily <u>contact action</u>, "body" of PM fungus is on outside of plant
  - Oils
  - Potassium salts (Armicarb, Kaligreen, Nutrol)
  - Hydrogen peroxide (Oxidate)



POWDERY MILDEW FUNGICIDES: "ALTERNATIVE" PRODUCTS

- Short-term "knock-down", relatively little residual activity
- Complete coverage is imperative

Bunch Rot Organisms



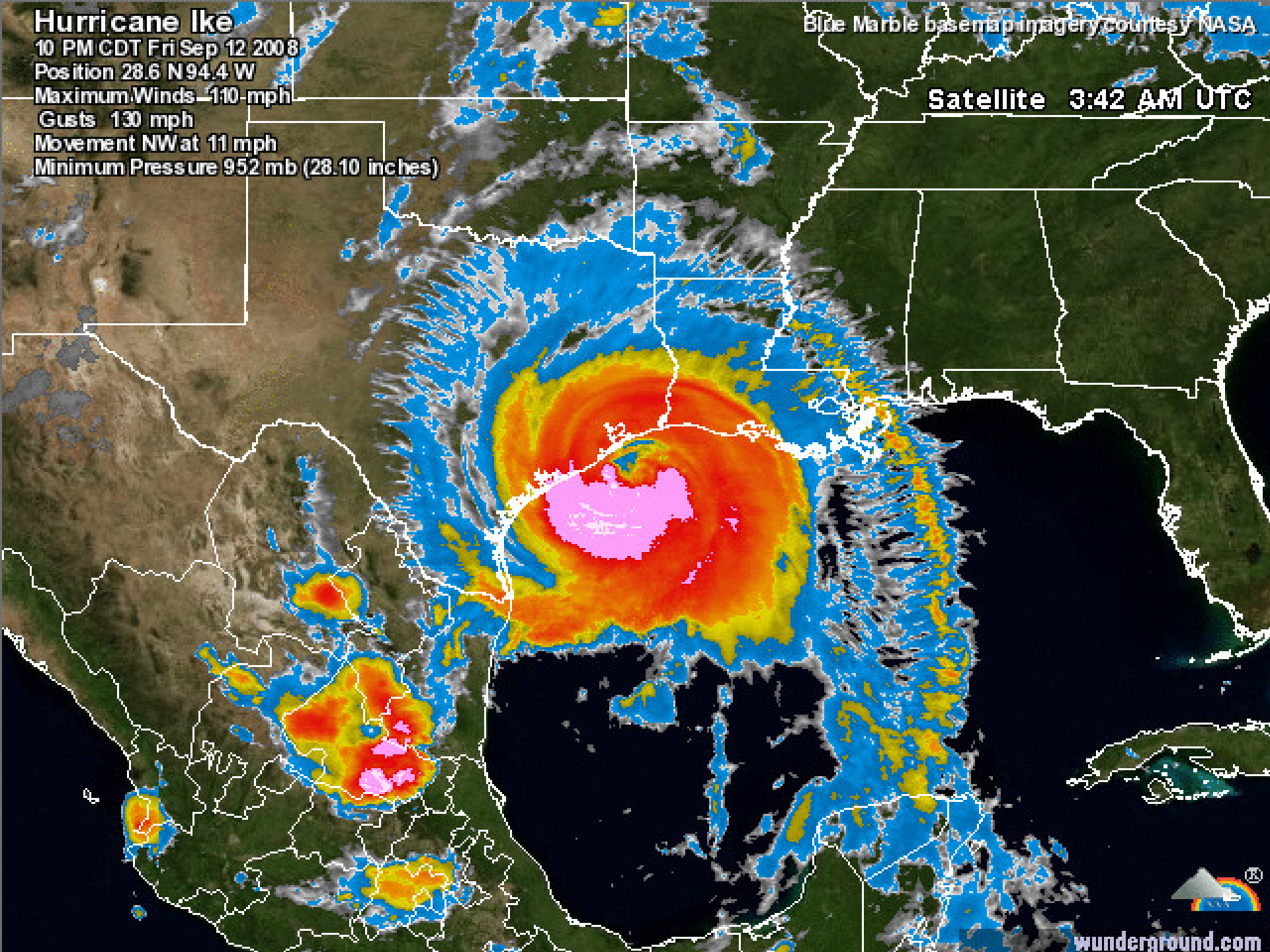
Botrytis cinerea

Although the fungus grows well only in berries that are ripening, young fruit also can become infected through attached blossom parts, and perhaps through scars left by the fallen caps. Such infections remaining latent (dormant) until some of them resume activity and rot the berries as they start to ripen.

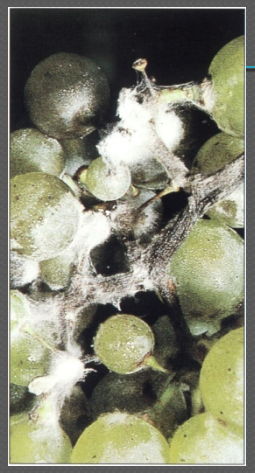
Botrytis Materials

- Vanguard- Locally Systemic, Some Post-Infection Activity, Prone to Resistance
- Scala- Similar Efficacy With Vanguard
- Switch - cyprodinil + fludioxonil
- Elevate- Protectant product with no “reach-back” activity
- Strobilurins- Some Effectiveness, good Anti-sporulation activity
  - ☺ Flint ☞ 😐 Sovran ☞ ☹ Abound


VIGNOBLES D'EUROPE
Bay of Biscay
Adriatic Sea
Ionian Sea
Tyrrhenian Sea
Balearic Sea
Mediterranean Sea
Alboran Sea


Hurricane Ike
10 PM CDT Fri Sep 12 2008
Position 28.6 N 94.4 W
Maximum Winds 110 mph
Gusts 130 mph
Movement NW at 11 mph
Minimum Pressure 952 mb (28.10 inches)
Blue Marble basemap imagery courtesy NASA
Satellite 3:42 AM UTC
wunderground.com

Characteristics of Other Bunch Rots & Molds



Alternaria alternata

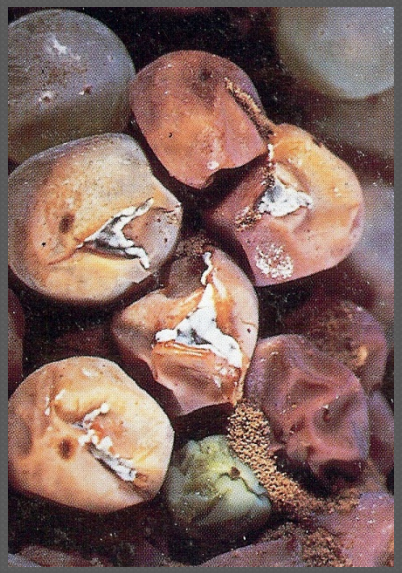
- Organisms are Ubiquitous
- Opportunistic Invaders
- Often Enter Through Mechanical Injury
  - GBM
  - Hail
  - Bird Pecks
  - PM Infections
  - Cracking Due to High Moisture Status

Aspergillis niger

Cladosporium spp.

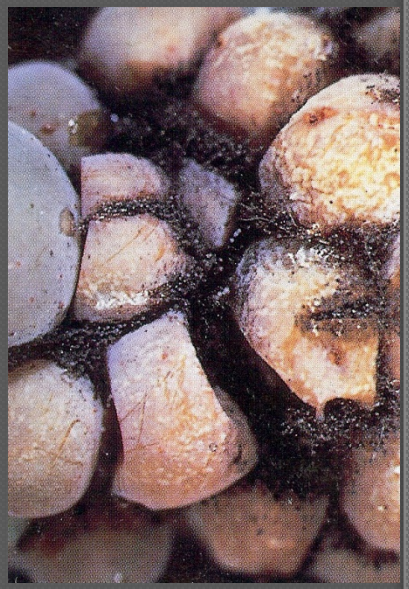
Other Organisms

- Variety Selection?
- Irrigation Strategy?
- Material Selection & Timing



Penicillium spp.

Greeneria uvicola
Bitter Rot



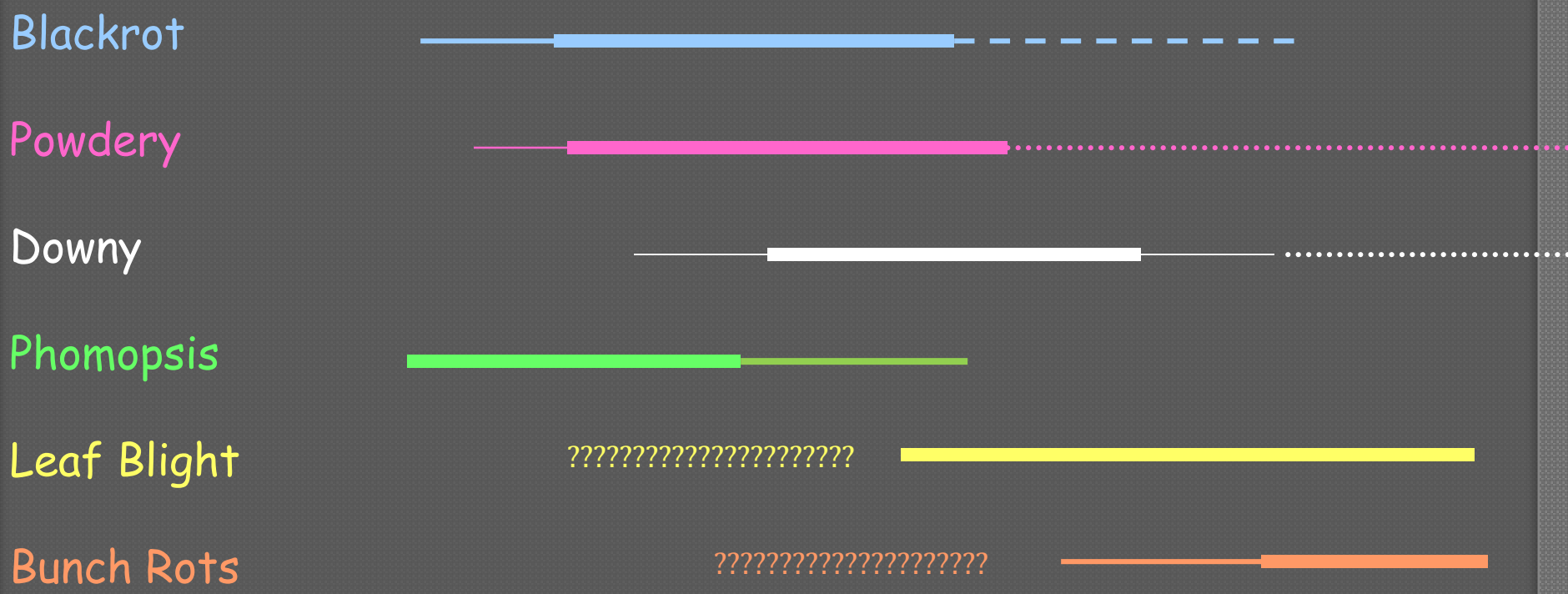
Rhizopus spp.

Cladisporium, Aspergillis , Alternaria, Botryosphaeria, Colletotricum

Conventional Wisdom is that Multi-site Toxin Fungicides are the Best Materials Available for Control

Mancozebs, Captan

Periods of Greatest Fruit/ Rachis Infection Potential



Fungicide- common name, trade name	Phomopsis cane and leaf spot	Anthracnose	Black rot	Downy mildew	Powdery mildew	Leaf Blight	Summer Rot Complex	Botrytis bunch rot	Fungicide Group	REI (hours)	PHI (days)
azoxystrobin (Abound)	++	+++	++++	++++	++++	++	+	+	11	4	14
azoxystrobin + difenoconazole (Quadris Top)	++	+++	++++	++++	++++	++	+	+	11, 3	12	14
boscalid (Endura)	0	?	0	0	++++	0	0	++/++++[a]	7	12	14
boscalid + pyraclostrobin (Pristine)	+++	++++	++++	++++	++++	++	++	++/++++[a]	7, 11	TVSL[b]	14
calcium polysulfide (limed sulfur)	?	++++	0	0	+	0	0	0	N/A	48	dormant only
captan (Captan, Captec)	++++	+	+	+++	0	0	++	+	M4	TVSL[b]	0
cyazofamil (Ranman)	0	0	0	+++	0	0	0	0	21	12	30
cyprodinil (Vangard)	0	0	0	0	+?	0	0	++++	9	12	7
cyprodinil + difenoconazole (Inspire Super)	0/+?	+	++++	0	++++	?	0	+++	9,3	12	14
cyprodinil + fludioxonil (Switch)	0	0	0	0	0	0	+++	+++	19,12	12	7
dihydrogen potassium phosphate (Nutrol)	0	0	0	0	++	0	0	0	N/A	4	0
fenamidone (Reason)	0	?	0	++++	0	0	?	0	11	12	30
fenarimol (Rubigan, Vintage)	0	0	++	0	+++	0	0	0	3	24	21
fenhexamid (Elevate)	0	?	0	0	+	0	0	++++	17	12	0
fixed copper (several formulations) and lime	+	0	+	+++	++	0	0	0	N/A	TVSL[b]	TVSL[b]
fluopicolide (Presidio)	0	0	0	++++	0	0	0	0	43	12	21
fluopyram + tebuconazole (Luna Experience)	+	?	+++	0	++++	?	?	++++	7, 3	TVSL[b]	14
iprodione (Rovral)	0	0	0	0	0	0	0	+++	2	48	7
kresoxim-methyl (Sovran)	++	++	++++	++	++++		++	++	11	12	14
mancozeb (Dithane, Manzate, Penncozeb)	++++	++	+++	+++	+	0	+++	0	N/A	24	66
mandipropamid (Revus)	0	0	0	++++	0	0	0	0	40	4	14
mandipropamid + difenoconazole (Revus Top)	0/+?	0	++++	++++	++++	?	0	0	40, 3	12	14
mefanoxam + mancozeb (Ridomil Gold MZ)	+	0	+	++++	0	0	0	0	4, M	48	66
mefanoxam + copper hydroxide (Ridomil Gold Copper)	+	0	0	++++	0	0	0	0	4, M1	48	42

One Inch Shoot Growth

Phomopsis cane and leaf spot

In older vineyards or those with a history of phomoposis cane and leaf spot, applying fungicides at one to three inch shoot growth is a critical component of a disease management program. Older wood serves as an important source of disease inoculum and can produce spores for several years. The disease is favored by cool, wet conditions and while active from budbreak to approximately two weeks after fruit set, most significant infections take place between budbreak and bloom. While leaves and shoots can and do become infected, rachis tissue is an extremely susceptible target and should be protected once clusters become visible until after bloom. Because tissue expands very rapidly during this period and effective, labeled fungicides are not locally systemic, spray frequency will depend on frequency and amount of precipitation.

	Captan 50WP	2-4 lb
OR	Captan 80WDG	1.25-2.5 lb
OR	Captec 4L	1-2 qt
OR	*[NY]Dithane DF *or* Dithane M45, *or* ^Manzate 75DF, Penncozeb 75DF	2-4 lb
OR	Dithane F-45	1.6-3.2 qt
OR	Ziram 76DF	3-4 lb

Powdery mildew

While most varieties in most locations in Texas do not require protection from powdery mildew at this growth stage, vineyard blocks with a history of high disease pressure may warrant treatment very early in the season.

	Liquid sulfur 6L	see label, rates vary
OR	Wettable Sulfur (several formulations)	see label, rates vary

Three to Five Inch Shoot Growth

Phomopsis cane and leaf spot

This is a critical spray for control of rachis infections on susceptible varieties in wet springs. On highly susceptible varieties, this can also be an important time to prevent the establishment of infections on young berry stems, which can move into the fruit and rot them later in the season. The maximum rates of the listed products should not be necessary at this growth stage IF sprays are thoroughly applied.

	Captan 50W	2-4 lb
OR	Captan 80WDG	1.25-2.5 lb
OR	Captec 4L	1-2 qt
OR	Dithane DF,	2-4 lb
	or Dithane M45,	
	or Manzate 75DF,	
	Penncozeb 75DF	
OR	Dithane F-45	1.6-3.2 qt

Black rot

Black rot sprays are rarely needed this early in the season unless serious disease occurred the previous year and warm, wet conditions are anticipated well before the next spray.

	Dithane DF,	2-4 lb	
	or Dithane M45,		
	or Manzate 75DF,		
	or Penncozeb 75DF		
OR	Dithane F-45	1.6-3.2 qt	
OR	Rally 40WSP	3-4 oz	Inspire Super, Orius, Revus Top, Tebuzol, and Rally have some protective activity but are most effective when applied after the start of an infection period . The duration of post-infection activity is incompletely characterized, but sprays applied up to 3-7 days after the start of an infection period
OR	Orius 45DF	3-4 oz	
	or Tebuzol 45DF		
OR	Revus Top 4SC	7 fl oz	

OR	Rally 40WSP	3-4 oz	CAUTION: To manage resistance to the sterol inhibiting fungicides, it is recommended that no more than three total sprays of any fungicides containing Mode of Action Group 3 materials.
OR	Vintage 1 SC	3 oz	
OR	Orius 45DF		
OR	Tebuzol 45DF		
OR	Revus Top 4SC	7 fl oz	
OR	Inspire Super	16-20 fl oz	
	Abound 2SC Adament 50WG Flint 50WG Sovran 50WG Pristine 38WG Quadris Top 2.7SC	not recommended at this timing	Although legal, use of the strobilurin-containing fungicides (Abound, Adament, Flint, Pristine, Quadris Top, Sovran) at this time is not recommended due to resistance-management considerations. Because product labels restrict the total number of sprays of this group of fungicides, these materials should be saved until the immediate prebloom growth stage or later, when they are likely to be most beneficial.

Ten to Twelve Inch Shoot Growth

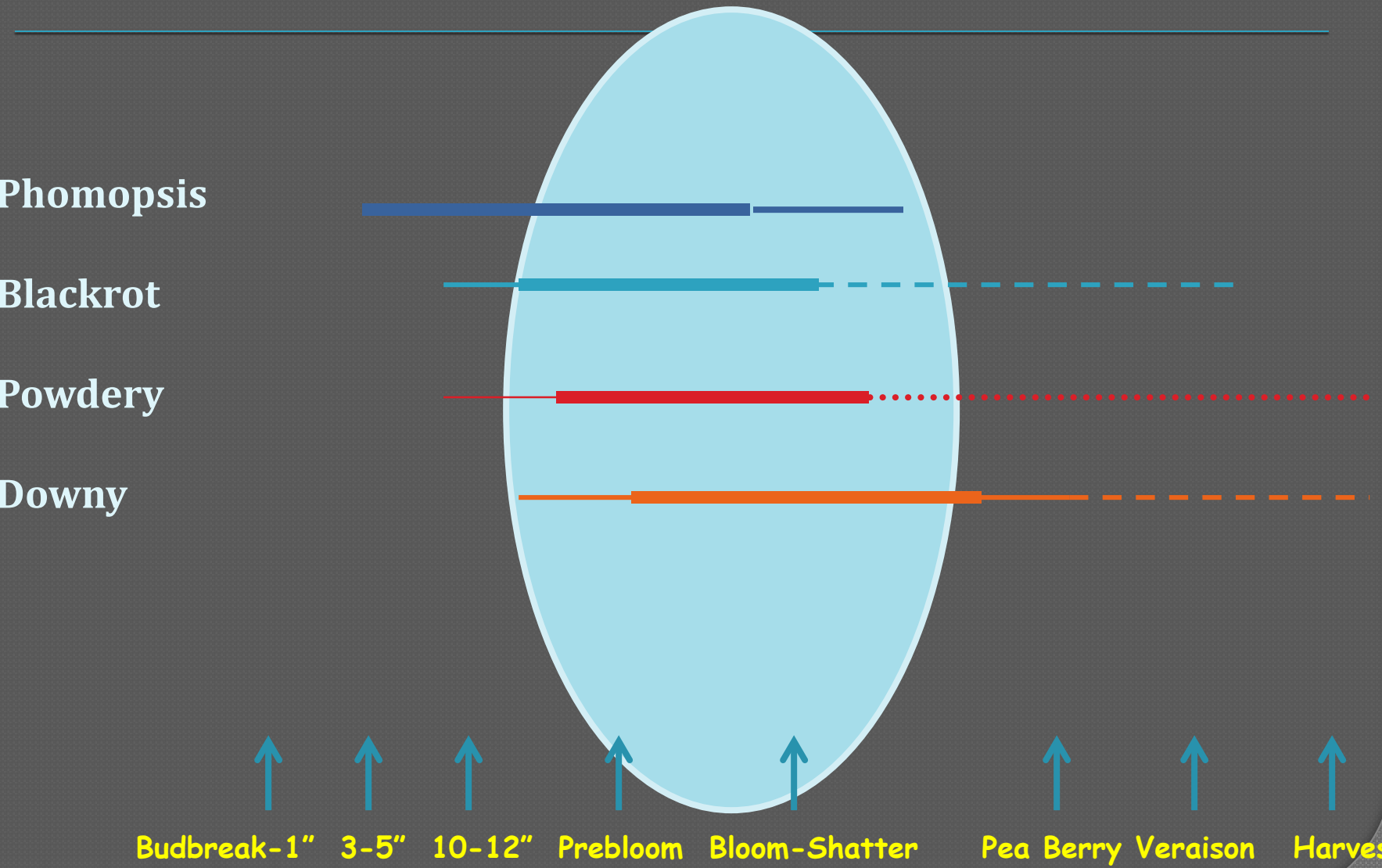
Phomopsis cane and leaf spot

Ten to twelve inch shoot growth is a critical timing for phomopsis control because expanding clusters are subject to rachis and pedicel infection. If infection occurs on these tissues, phomopsis infections become systemic, impossible to control and can lead to significant crop loss due to berry infection. Rapidly expanding grapevine tissue may require tightened spray intervals under very wet conditions

	Captec 4L	1.5-2.0 qt
OR	Captan 50WP	3-4 lb
OR	Captan 80WDG	1.75-2.5 lb

Management of the Primary 4 Fungal Pathogens

Focus the Use of Systemic, Highly Effective Materials During Periods of High Susceptibility



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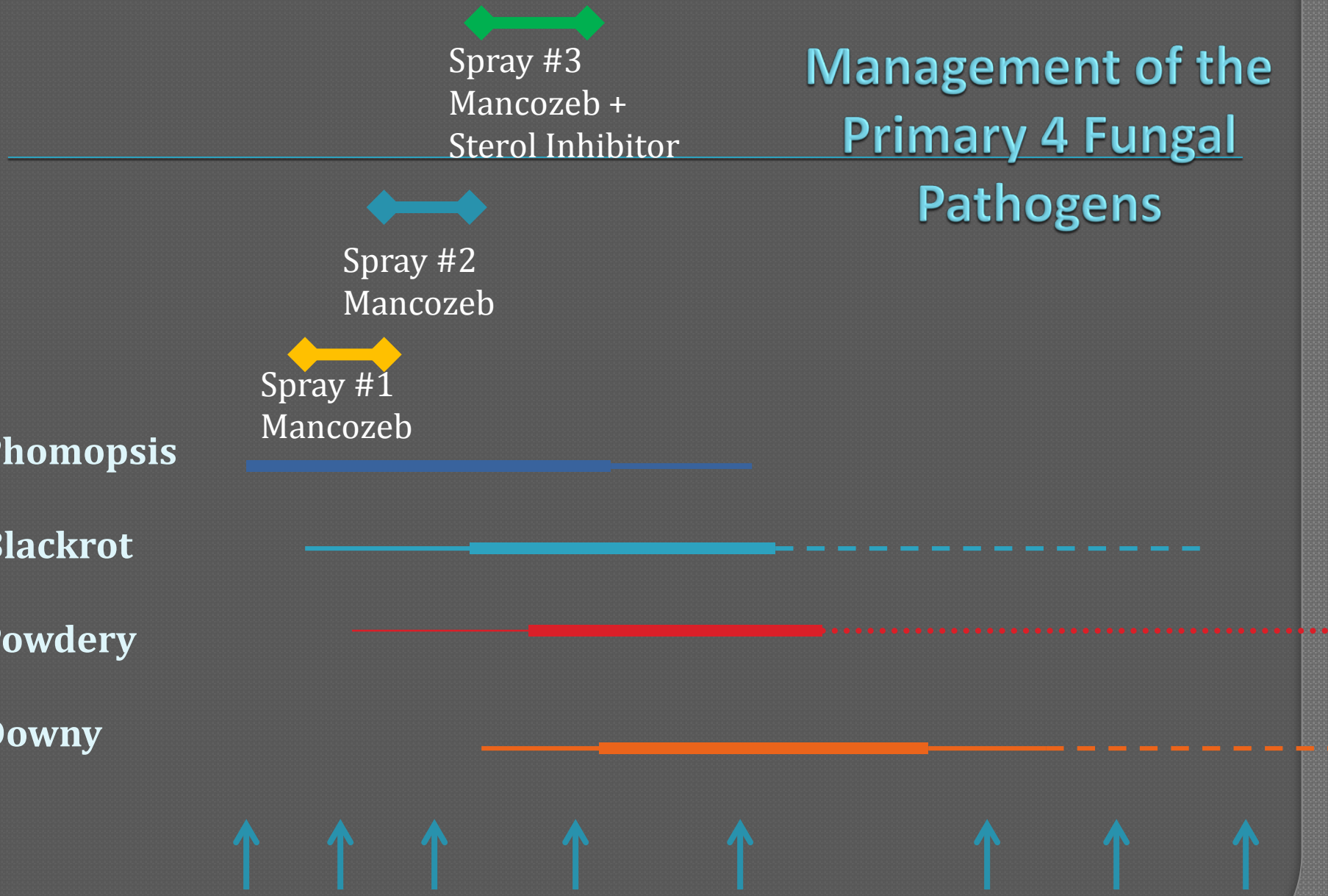

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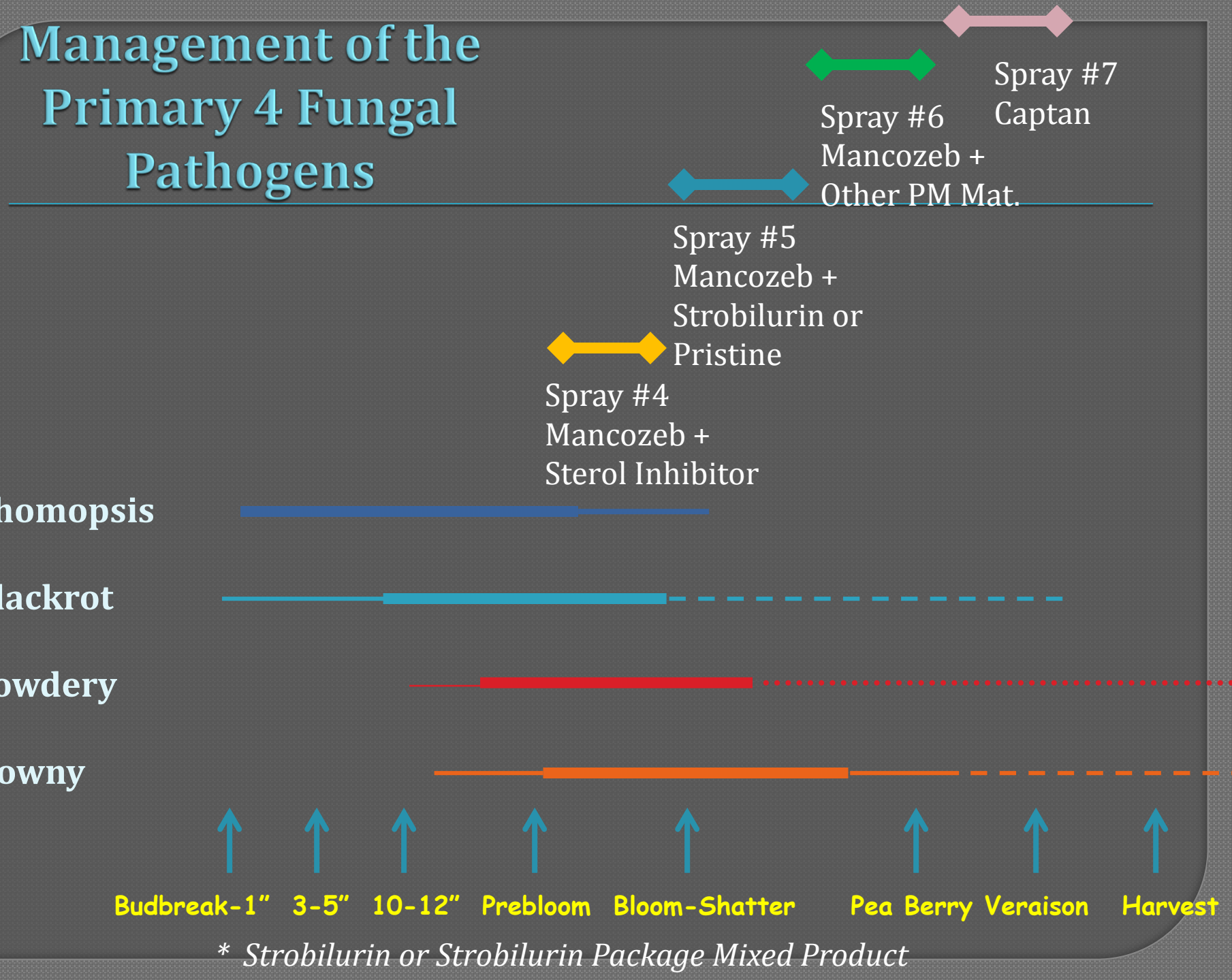


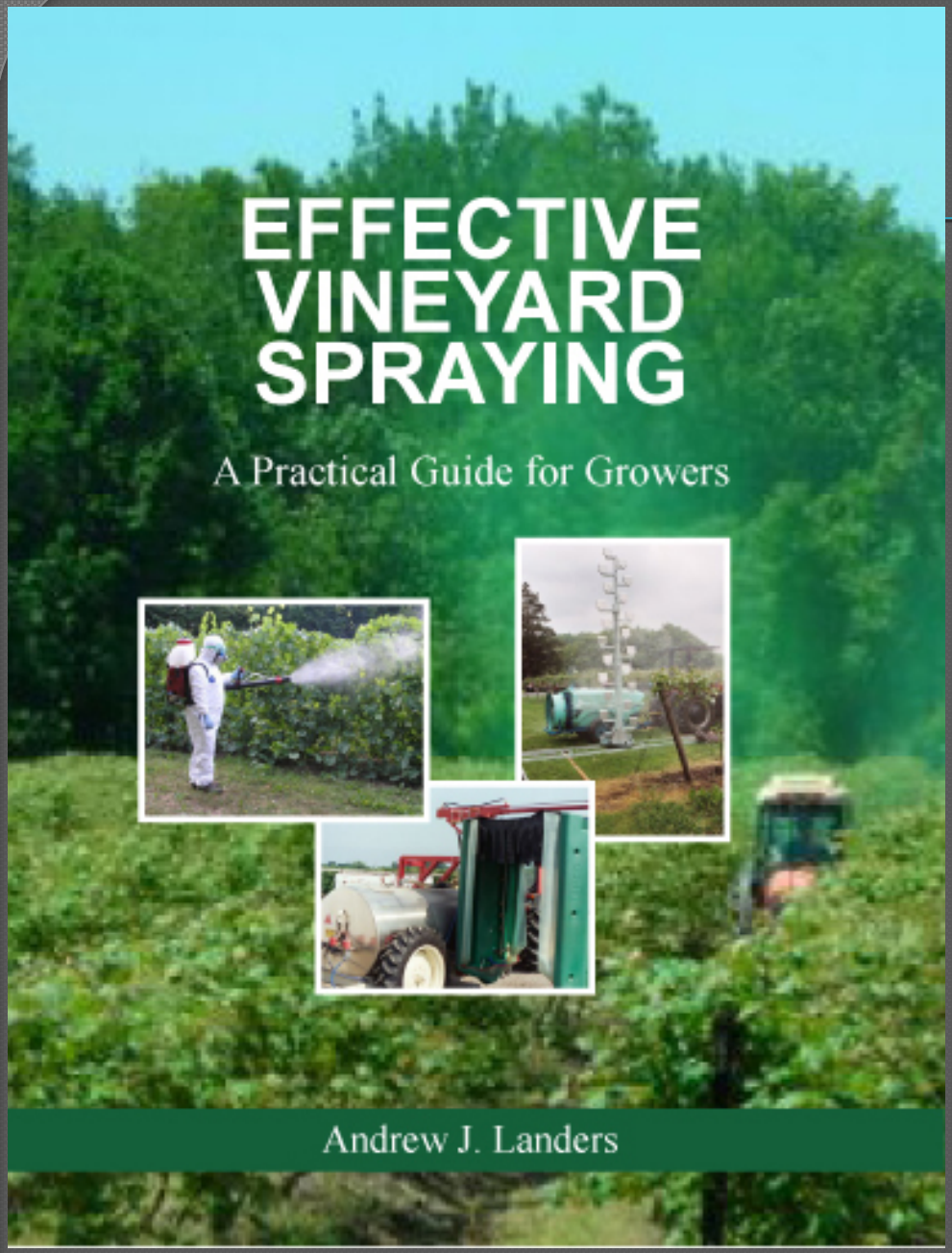
* *Strobilurin or Strobilurin Package Mixed Product*

Effectively Applying Fungicides

- #1 Leading Cause of Spray "Failure" is Poor Coverage
- Fungicide Efficacy Usually Tested With 100 gpa Water Rates

Coverage!

References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