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UCCE Sonoma
2015 Grape Day
18 Feb 2015

STRATEGIES IN PM MANAGEMENT: KNOW YOUR ENEMY

Michelle M. Moyer, Ph.D.
Assistant Professor
Statewide Viticulture Extension Specialist
WSU-IAREC
Prosser, WA

wine.wsu.edu





DISEASE MANAGEMENT MEANS PLANNING



“Chemical industry and plant breeders forge fine tactical weapons; but only epidemiology sets the strategy.”

- van der Plank



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GRAPEVINE POWDERY MILDEW

Erysiphe necator

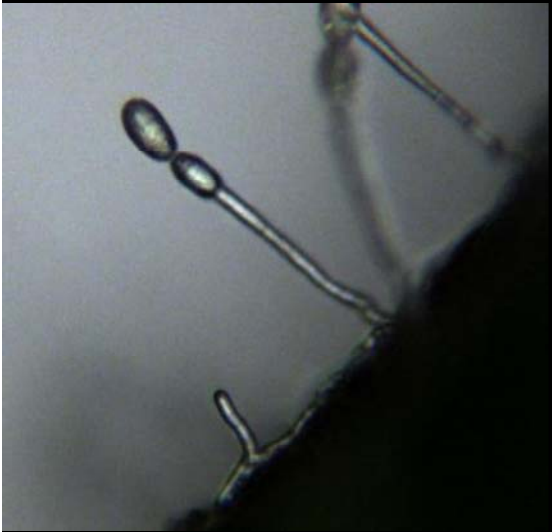


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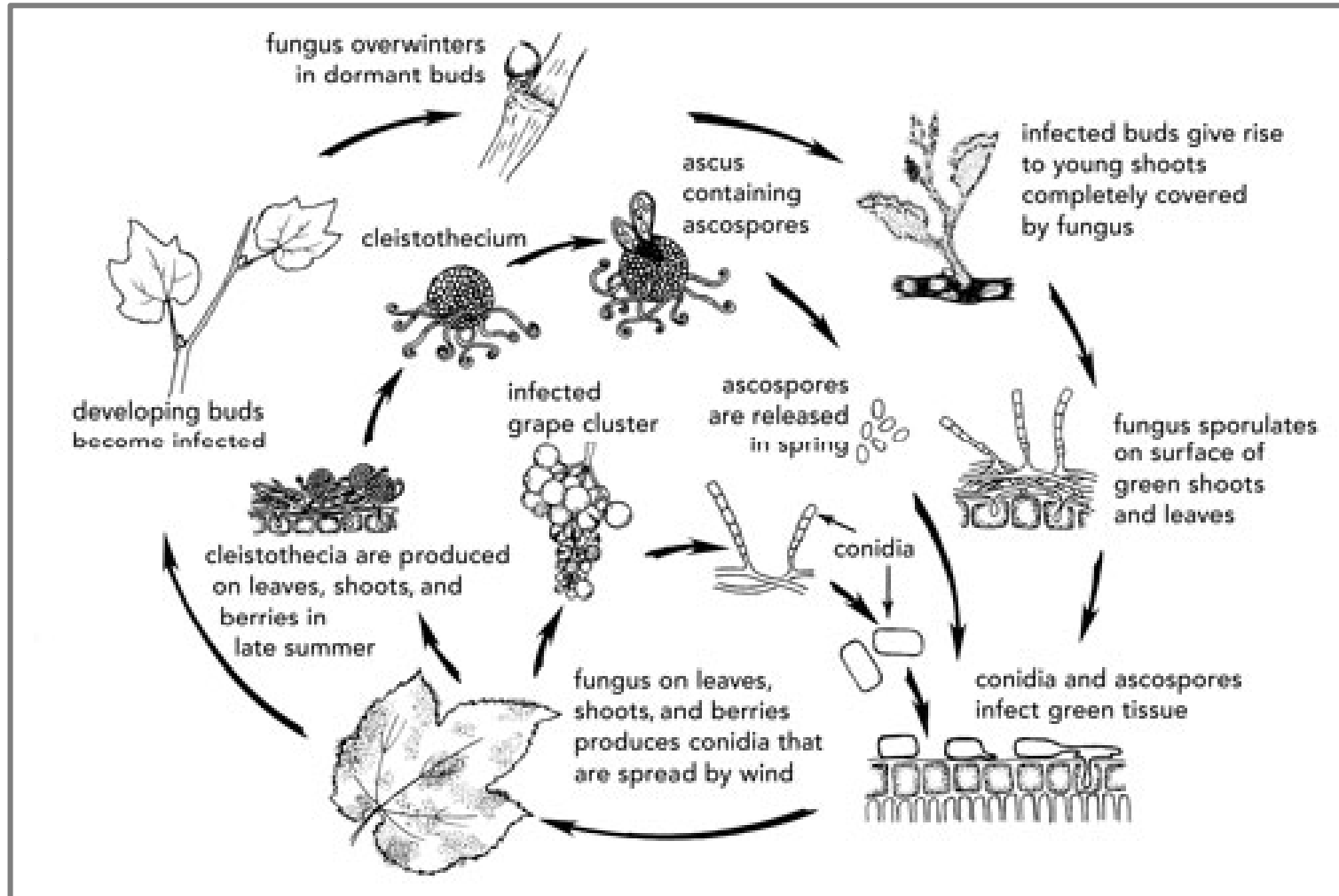


A DISEASE WITH A MISSION





BIOLOGY





BIOLOGY – OVERWINTERING

- Flag shoots
- Associated with cane pruning / previous years of early, severe disease





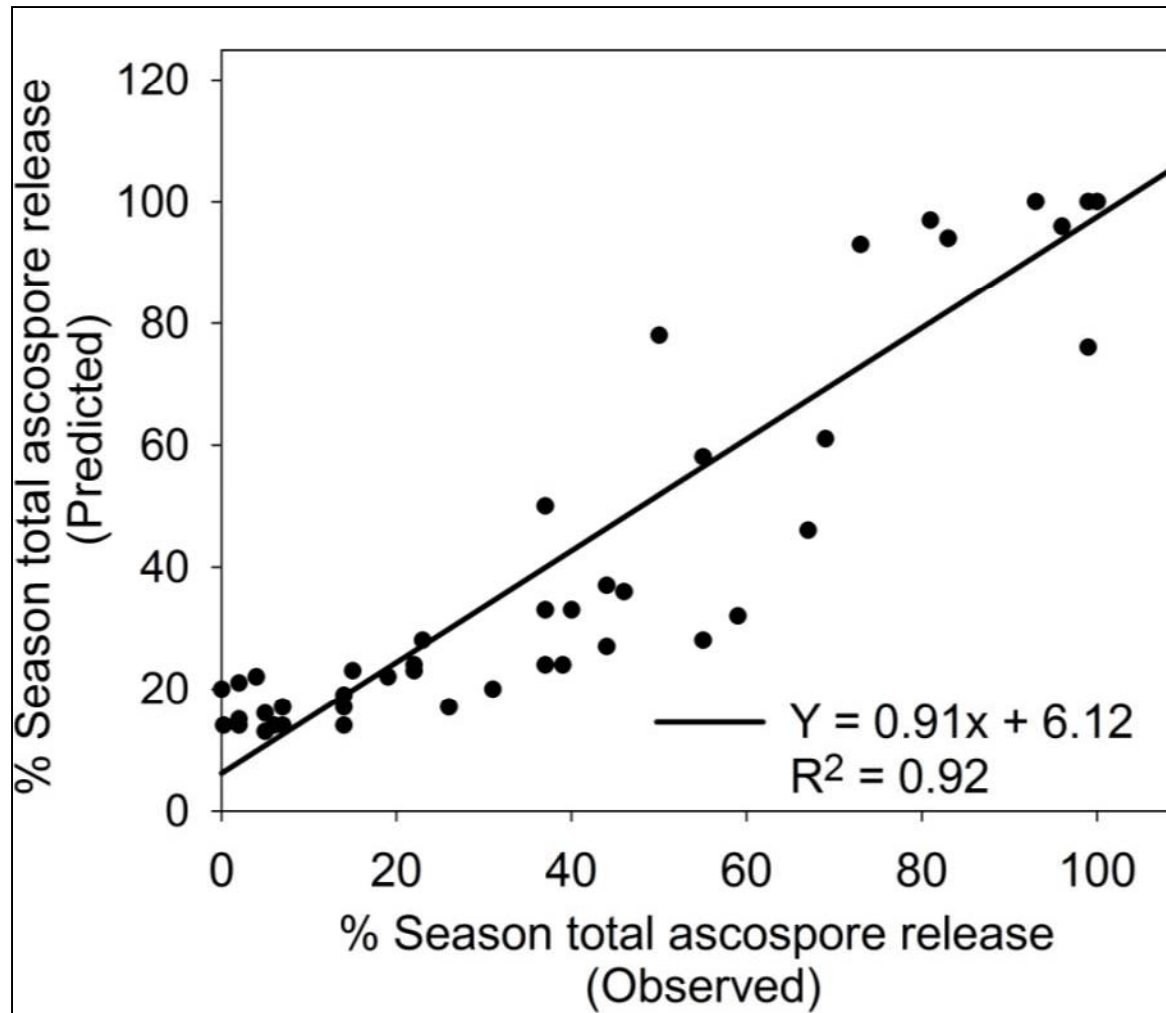
BIOLOGY – OVERWINTERING

- Major form of overwintering: cleistothecia / chasmothecia
 - Confirmed in 1980s
 - Sexual stage of fungus
 - Typically forms in late summer to fall
 - Washes off leaves during fall rains; lodges in bark crevices
 - Resilient to sunlight, cold temperatures





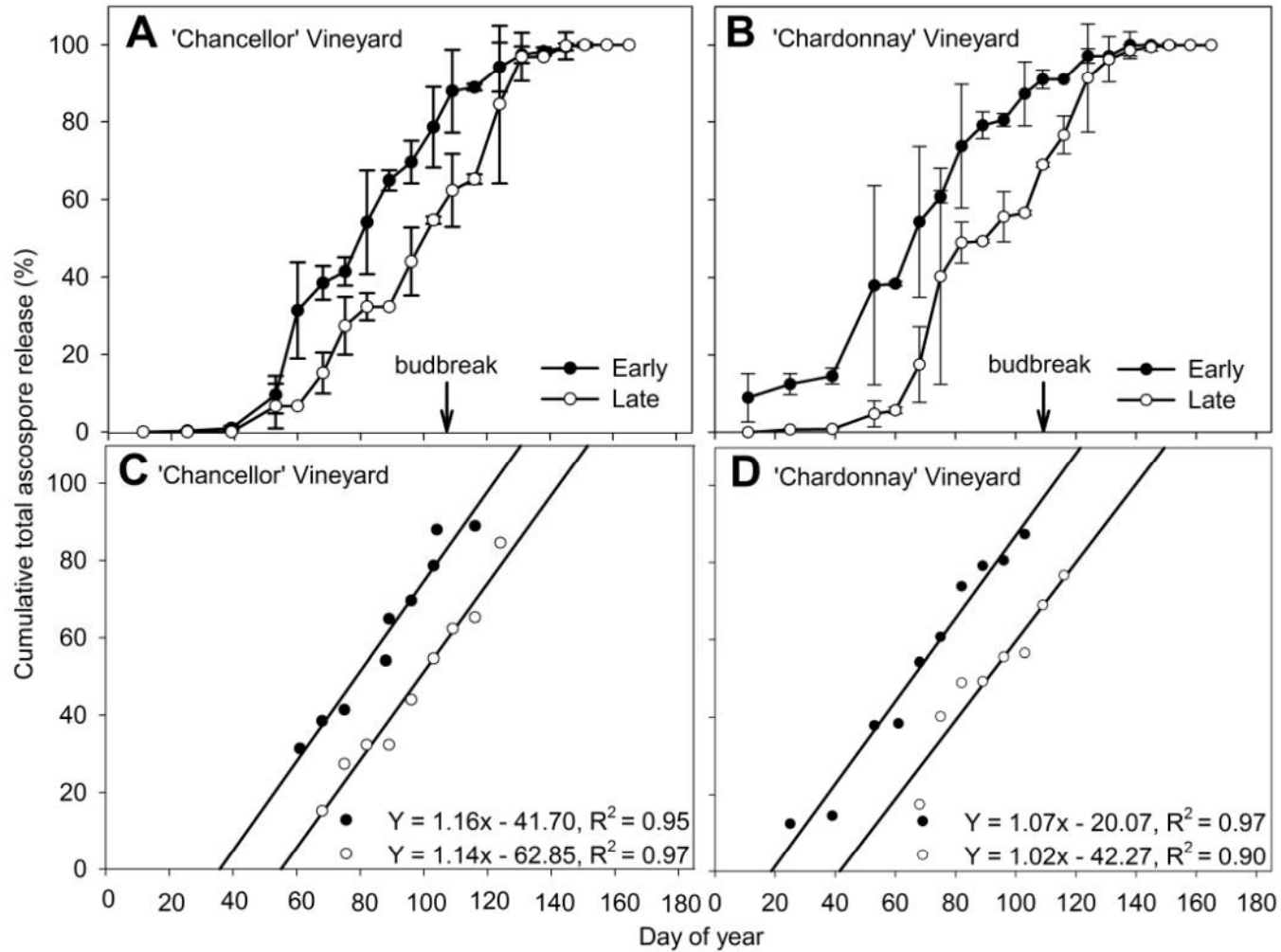
ENVIRONMENTAL IMPACT ON ASCOSPORE RELEASE



- Ascospore release is related to temperature and precipitation
- Timing of release is tied to that; and changes with locations and years



TIMING IS EVERYTHING



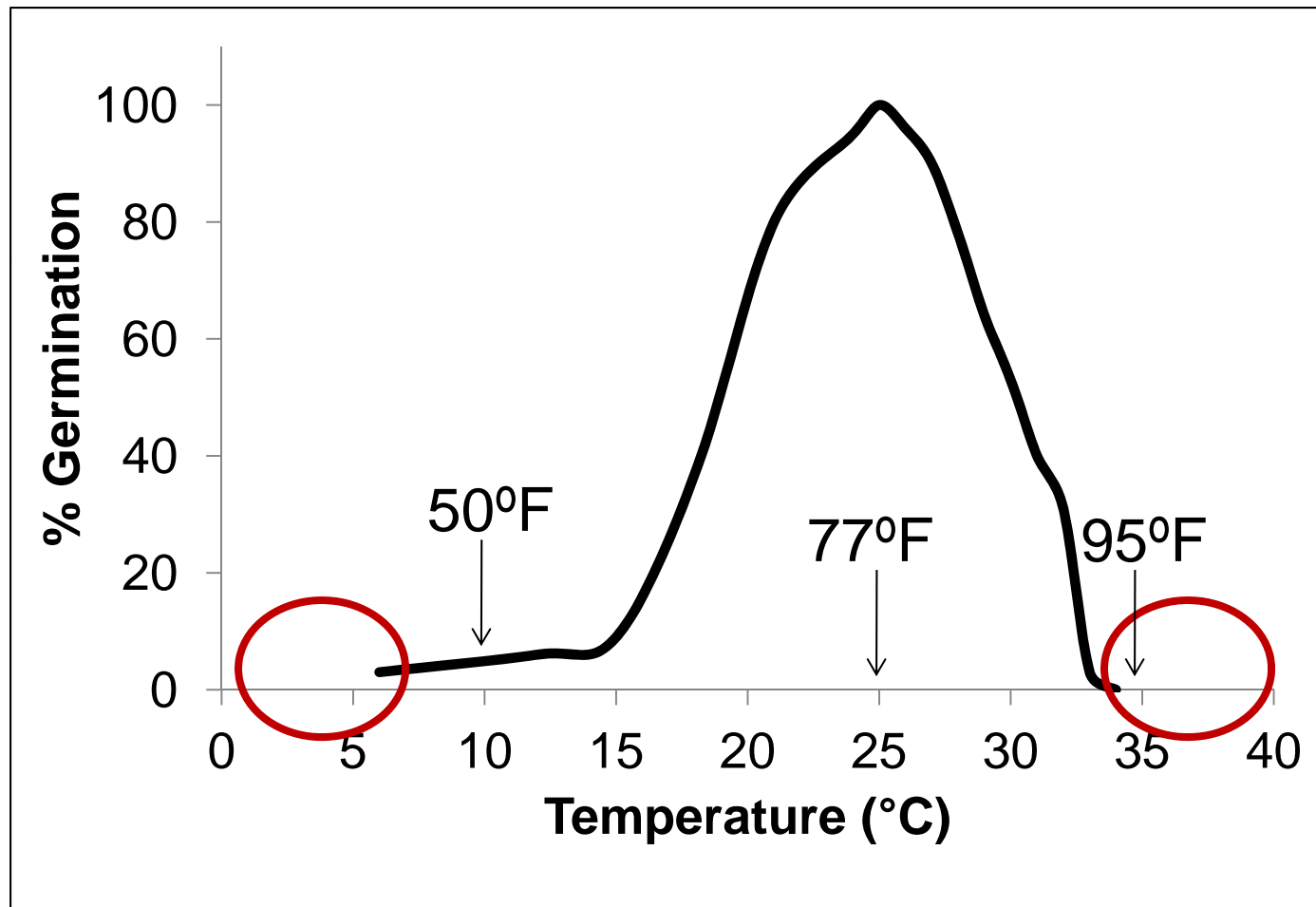


BIOLOGY – SEASONAL START

- Cleistothecia release ascospores
 - Starting in late winter to early spring
 - Infection occurs after bud break, with 0.1” rain and temperature $>50^{\circ}\text{F}$
- Infection occurs, colonies develop, and polycyclic lifecycle is set in motion
 - Development influenced by temperature, relative humidity, rain, and solar radiation
 - These factors work together to either enhance or detract from the rate of the fungus development and spread



BIOLOGY – TEMPERATURE RESPONSE





PM DOESN'T LIKE IT TOO HOT

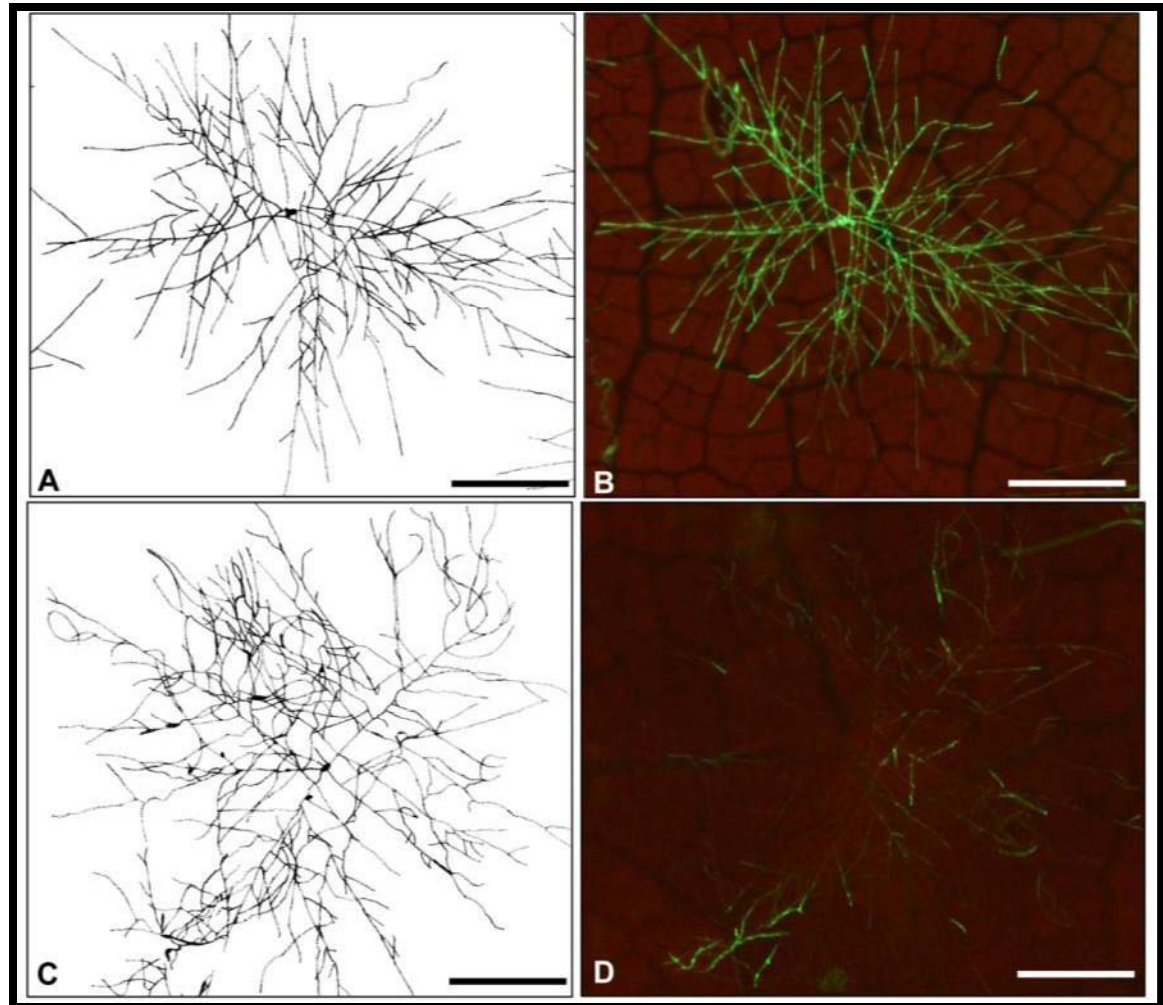
- Single heat events (89-95°F) can debilitate or kill PM colonies
 - Consecutive heating events do not add to damage; one event does it all
- Multiple, high-heat (99-102°F) events can have accumulating effects on colony growth
- Heat exposure events can delay sporulation



PM DOESN'T LIKE IT TOO COLD

Four-day-old colony grown at 75°F:

- A) Line sketch of colony footprint, and
- B) Same colony visualized with a vital stain



Four-day-old colony exposed to 36°F for 8 h at 3 days old:

- C) Line sketch of colony footprint, and
- D) Same colony visualized with a vital stain

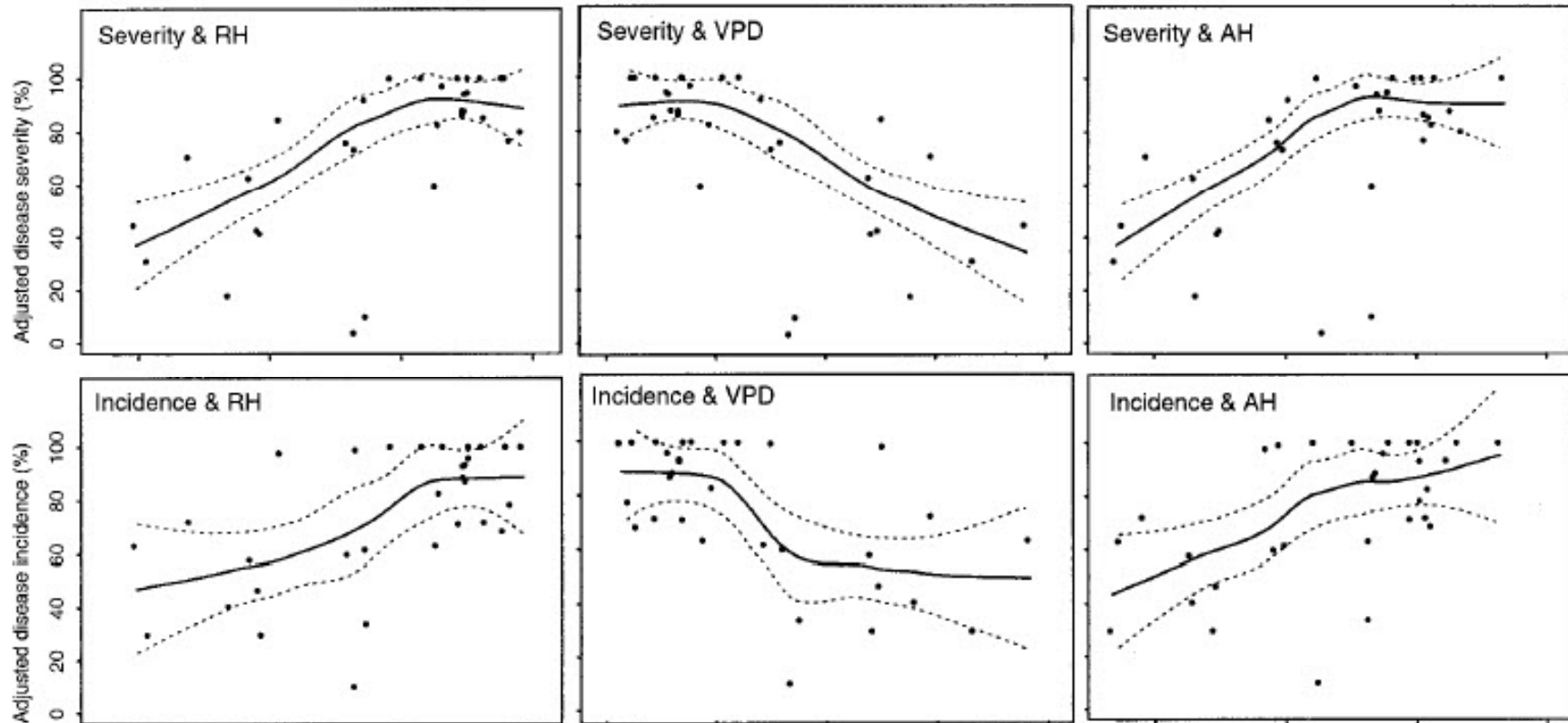


PM DOESN'T LIKE IT TOO SUNNY





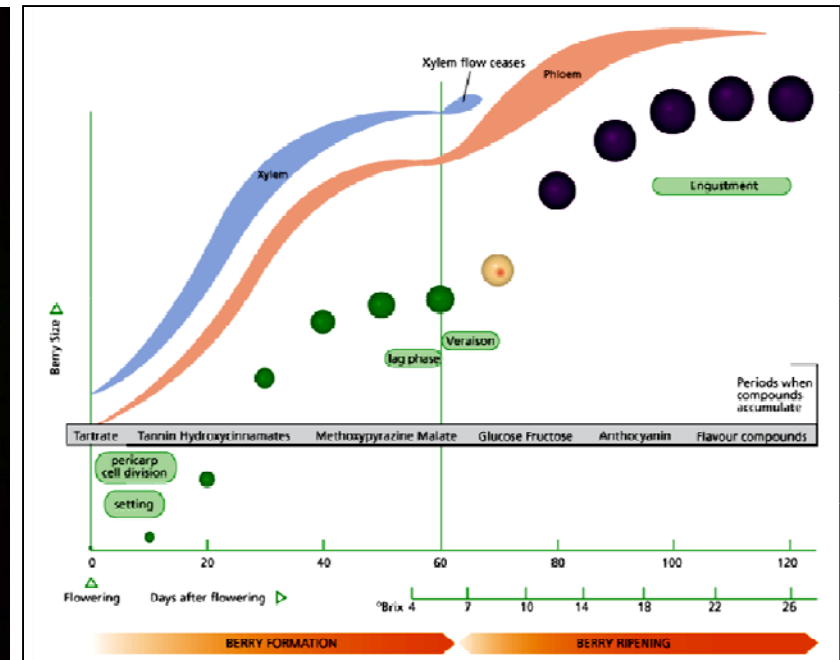
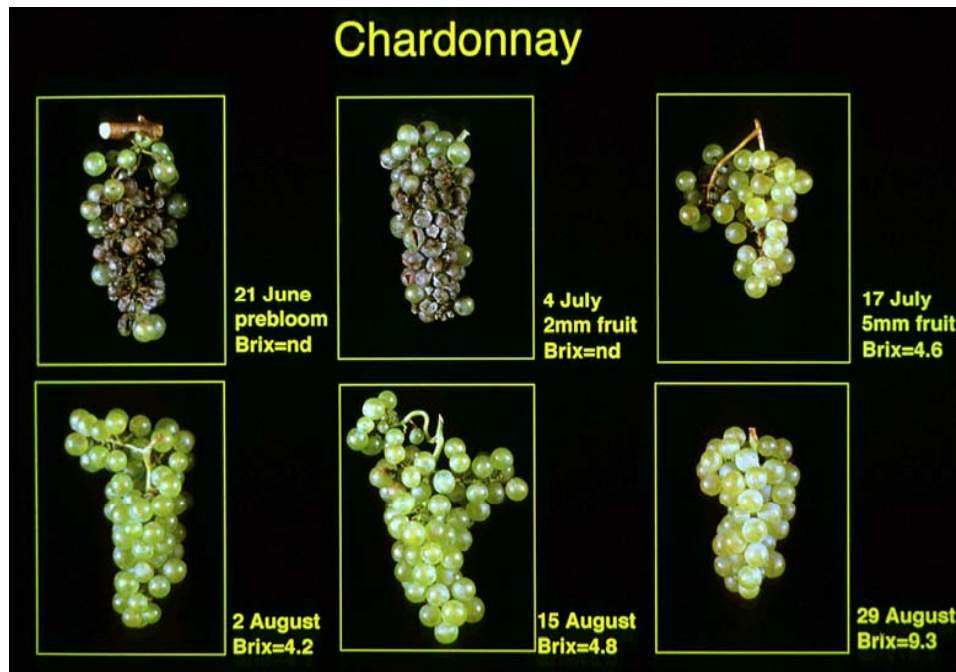
PM DOESN'T LIKE IT TOO DRY





BIOLOGY – SEASONAL DEVELOPMENT

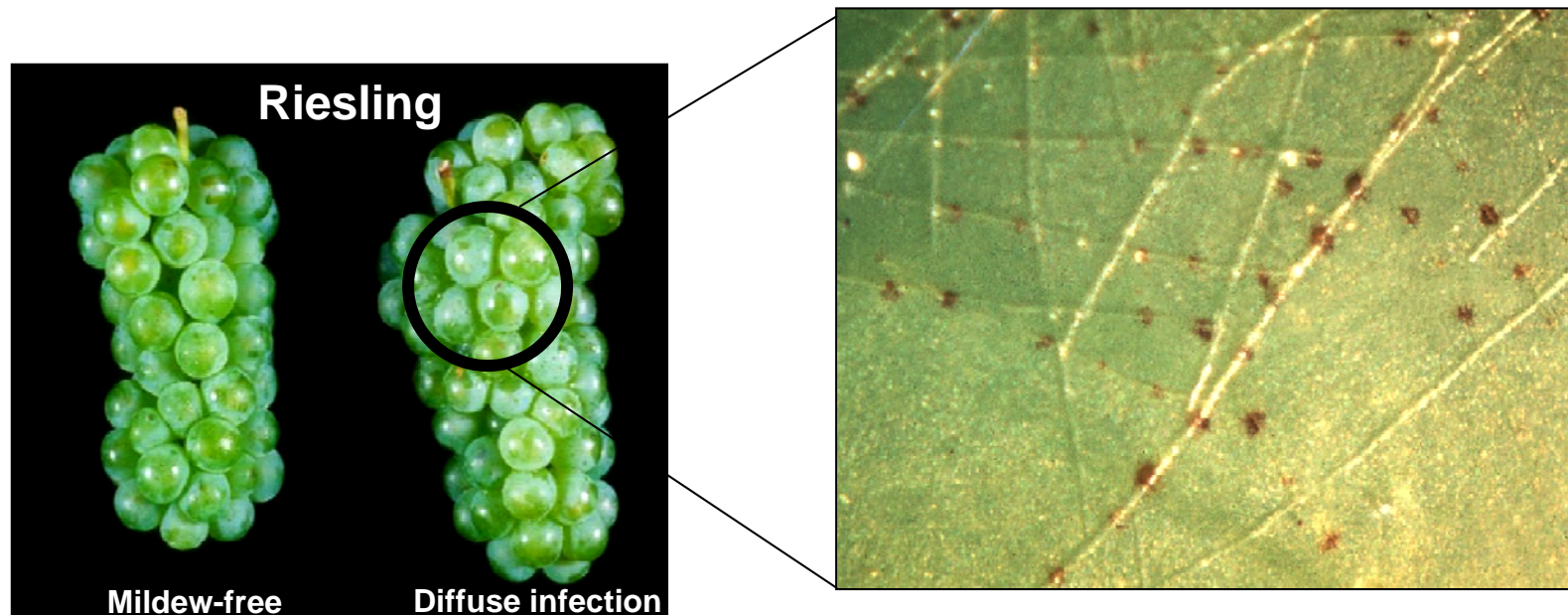
- Ontogenic Resistance
 - Age-related resistance in tissues
 - Seen in powdery mildew, downy mildew and black rot (to various degrees)





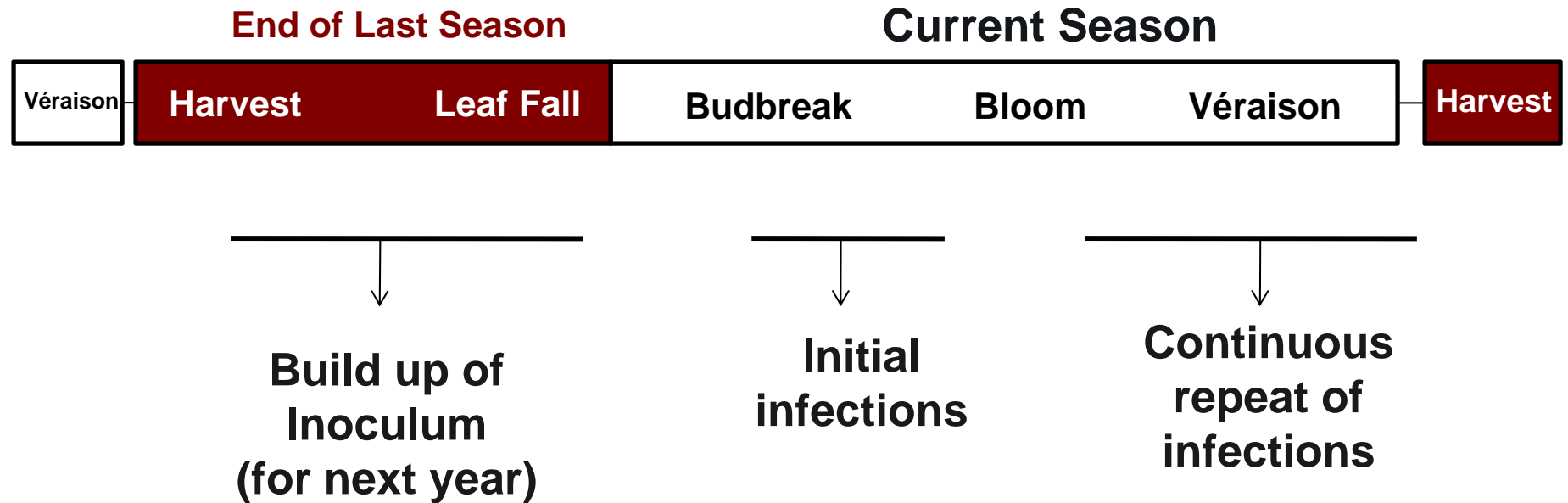
EFFECTS ON WINE

- Diffuse (light) infections can produce off flavors in wine
- Can enhance Botrytis bunch rot





BIOLOGY – YEAR TO YEAR INFLUENCES



Last year affects this year, which affects next year.



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MANAGEMENT

When to spray.



DECISION SUPPORT SYSTEMS

- Decision support systems help time sprays or provide information on pathogen biology
- What is driving the DSS?
 - You have to know *how* they work to understand *why* they work
- In some climates, they help reduce the total sprays
- In other climates, a DSS may actually **INCREASE** the number of sprays



UC-DAVIS PM INDEX

Table 2. Treatment timing guidelines based on risk index and spray material.

Powdery Mildew Risk Index	Spray Material	Spray Interval
0 to 30	sulfur dust	14 days**
	micronized sulfur	18 days**
	DMI fungicides*	21 days**
40 to 50	sulfur dust	10 days
	micronized sulfur	14 days
	DMI fungicides*	17 days
60 to 100	sulfur dust	7 days
	micronized sulfur	10 days
	DMI fungicides*	14 days
* Demethylation inhibitors such as Bayleton, Rally, Rubigan.		
** Or label maximum.		

- Model has 1 infection table (leaf wetness)
- Main-season model ('conidial') driven on high temperatures
 - Poor PM development at high temps
 - Aimed to reduce total sprays



WHAT DRIVES EPIDEMICS IN PLACES LIKE NY?

TABLE 1. *Erysiphe necator* cluster severity ratings and related grapevine phenology for the *Vitis* interspecific hybrid 'Rosette' in Geneva, New York, USA used for New York model development.

Year	Cluster disease severity (%) ^{x,y}	Budbreak ^z	Bloom ^z	Cultivar
1986	48.2	118	162	Rosette
1987	8.2	124	102	Rosette
1988	0.2	130	161	Rosette
1989	47.7	129	170	Rosette
1990	6.4	118	167	Rosette
1991	2.9	121	156	Rosette
1992	50.1	131	177	Rosette
1993	3.4	121 ⁺	172	Rosette
1994	36.8	121 ⁺	168	Rosette
1995	7.3	121 ⁺	172	Rosette
1996	31.0	121 ⁺	174	Rosette
1997	25.8	121 ⁺	176	Rosette
1998	9.4	121 ⁺	161	Rosette
1999	4.0	121 ⁺	166	Rosette
2000	6.2	121 ⁺	175	Rosette
2001	2.5	121 ⁺	174	Rosette
2002	4.0	121 ⁺	176	Rosette
2003	46.7	121 ⁺	179	Rosette
2004	9.0	121 ⁺	172	Rosette
2005	11.4	121 ⁺	167	Rosette
2006	24.6	127	167	Rosette
2007	8.9	130	164	Rosette

^x Cluster severity as % surface area of cluster diseased. Ratings denoted with an '*' were converted from a 0-3 scale (0 = healthy, 3=severely diseased).

^z Listed as Day of year If phenological data were not available, assumption was set as: budbreak 1 May (121) and bloom 21 June (172), denoted by a '+'.



EVAPOTRANSPIRATION



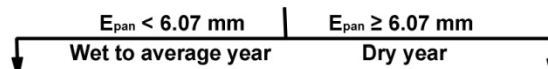


PUTTING IT TOGETHER...

Powdery Mildew Decision Support

In-season weather: How “wet” or “dry”, based on E_{pan} , has the weather been? What is the upcoming forecast?

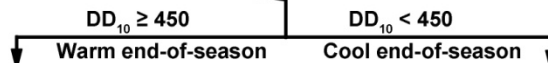
Time: 2 weeks prebloom to 4 weeks postbloom



In-season weather is conducive. What was the inoculum potential, determined by previous season late-summer/fall heat accumulation? Temperature aids in cleistothecia development.

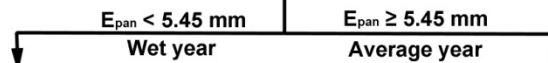
In-season weather is not conducive. 100% chance of a ‘mild’ year. Use of longer spray intervals or lower spray rates indicated on pesticide labels is appropriate.

Time: Berry touch to 100 % veraison



Inoculum potential is high. Combined with highly conducive in-season weather, this inoculum potential could be realized. Chance of a ‘severe’ year is 100%. Use the shorter spray intervals and higher spray rates indicated on pesticide labels.

Moderate to low inoculum potential. How conducive is the in-season weather to maximize the impact of this inoculum load?



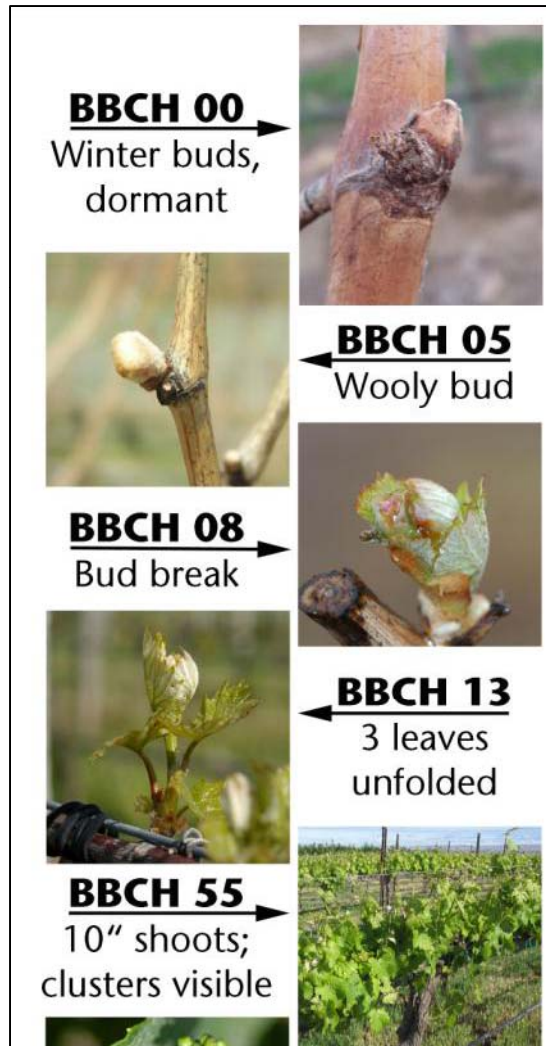
Low inoculum potential, but in-season weather is favorable. Inoculum potential could be realized. 60% chance of a ‘severe’ year. Use the shorter spray intervals and higher spray rates indicated on pesticide labels.

Low inoculum potential with average weather conditions. Inoculum potential not fully realized. 80% chance of a ‘mild’ year. Use of longer spray intervals or lower spray rates indicated on pesticide labels is appropriate.

- In NY, PM epidemics aren’t “controlled” by heat
- Dryness (E_{pan} / E_{to}) is a better modifier
- Why?
 - Plant stress?
 - Pathogen stress?



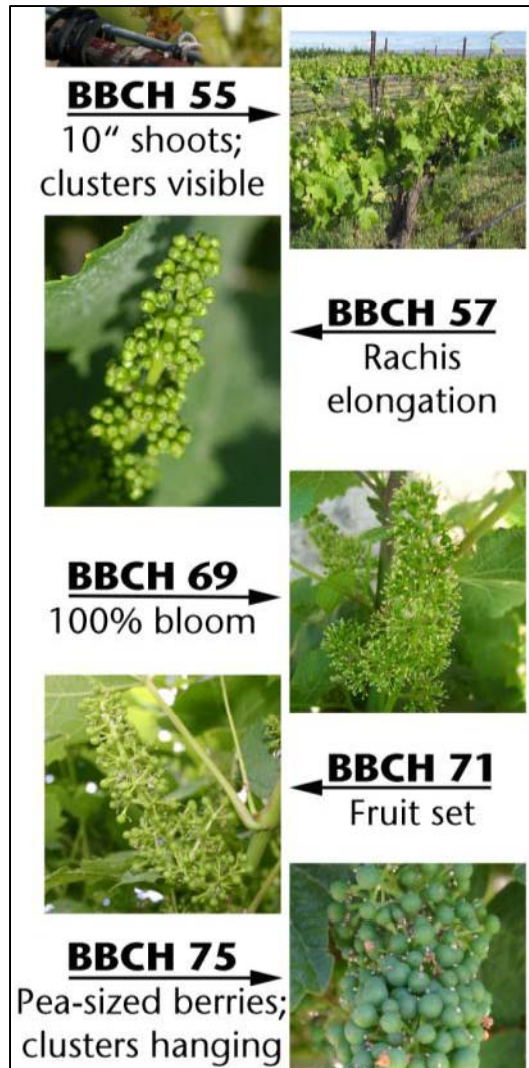
DISEASE MANAGEMENT – GENERAL PROGRAM



- **What to do:**
 - Watch temperatures
 - Watch rate of shoot growth
 - Consider contact products with eradicant activity (e.g., oils, sulfur)
 - Consider systemic products once clusters are visible
- **What to avoid**
 - Spraying too early (i.e., 3" shoot growth) typically unnecessary
 - Don't rely on "dormant" products for early-season control
 - Don't reduce rates if reducing volume



DISEASE MANAGEMENT – GENERAL PROGRAM



- **What to do:**

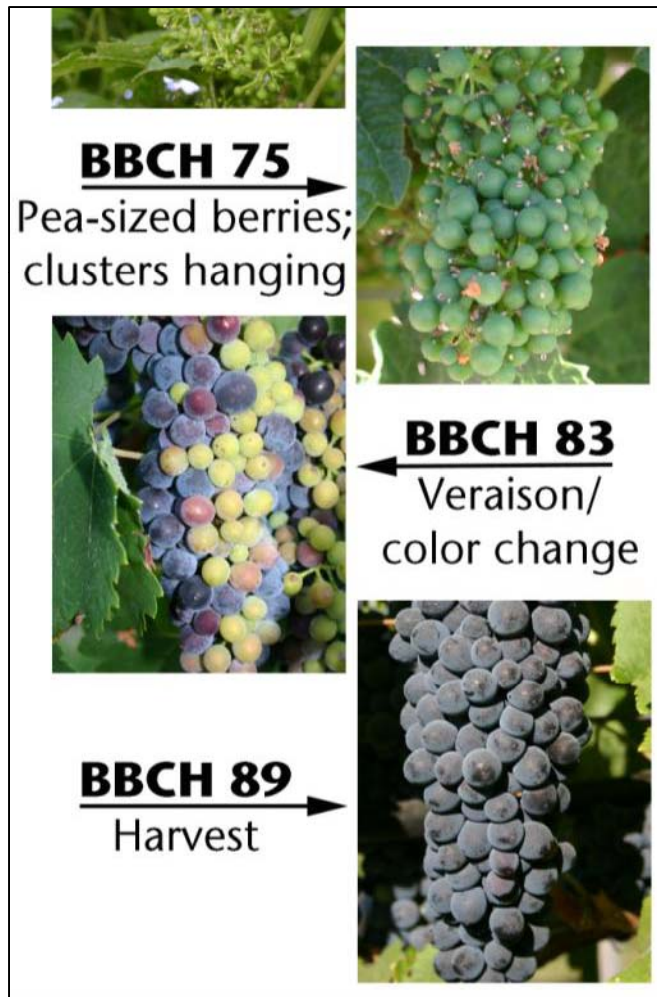
- Use your best available products
- Rotate FRAC codes
- Use dual-action products during bloom to pea-size berries (PM and BBR control)
- Use higher rates, shorter intervals
- Canopy management

- **What to avoid:**

- Repeated use of the same product
- Extended spray intervals
- Low water volumes if canopies are larger
- Products with “suppression” activity



DISEASE MANAGEMENT – GENERAL PROGRAM



- **What to do:**

- Watch temperatures
- Watch canopy development
- If disease pressure is low, “suppression” products are ok

- **What to avoid**

- Spraying high-risk compounds on a vineyard with lost disease control
- Tight spray intervals after bunch closure
- Low-volume sprays



DISEASE MANAGEMENT – GENERAL PROGRAM



- **What to do:**
 - Go on vacation! 😊
 - Watch for first frost – additional management may be necessary if delayed
 - Contact eradicator products work best to reduce cleistothecia load
- **What to avoid**
 - High resistance risk products
 - Not managing new outbreaks if canopy continues to grow



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MANAGEMENT

What to spray.



CONTACT PESTICIDES



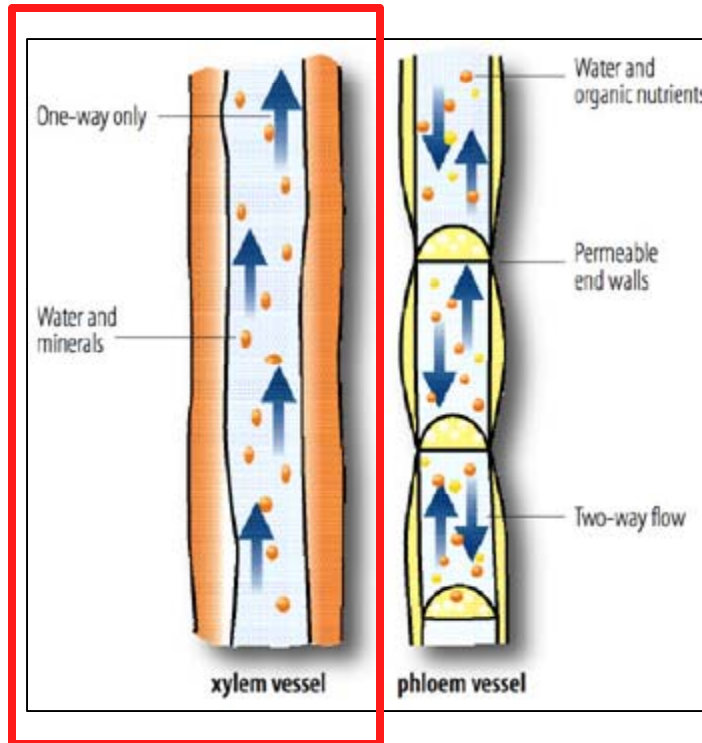
Common Contact Products:

- *Chromobacterium subtsugae* (Grandevo)
- Sulfur
- Potassium bicarbonate (Kaligreen / Armicarb)
- Hydrogen peroxide (Oxidate)
- Copper
- Oils (Neem, JMS stilet oil, etc)
- (Pyrethroids) Zeta-cypermethrin (Mustang Max)

- Preventative applications
 - Must go on before or IMMEDIATELY after pest arrival
- New plant growth not protected
 - Repeated applications necessary
- Typically do not move on / in the plant
 - Some may volatilize, redistribute



XYLEM-MOBILE SYSTEMIC PESTICIDES



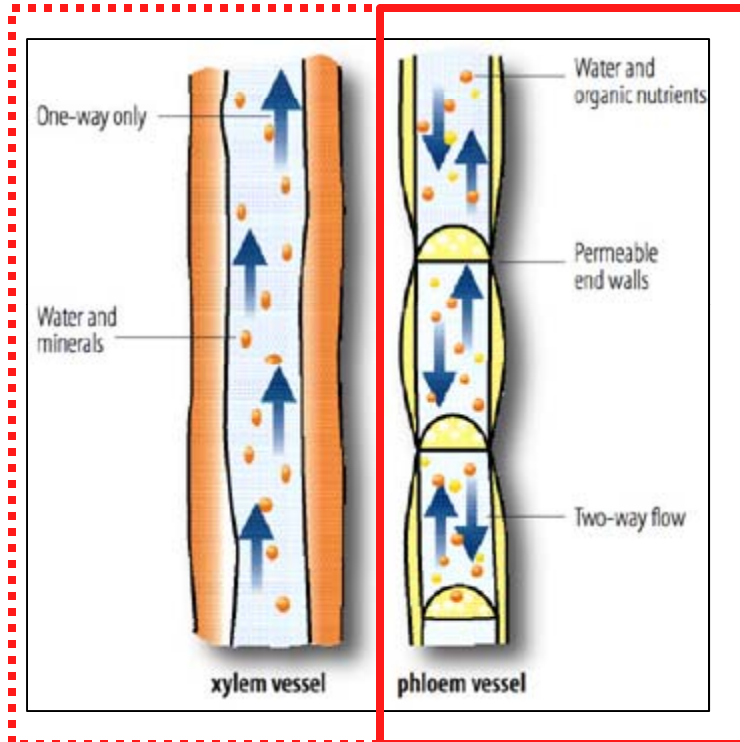
Common Xylem-Mobile Products:

- Imidacloprid
- Myclobutanil (Rally)
- Triflumizole (Procure)
- Azoxystrobin (Abound / Quadris)

- Xylem-mobile systems are absorbed by the plant and translocated upwards to other tissue
- In grapes, older tissue (below the point of contact) remain unprotected
- New tissue developing after application gets protected (to a point)



AMPHIMOBILE SYSTEMIC PESTICIDES



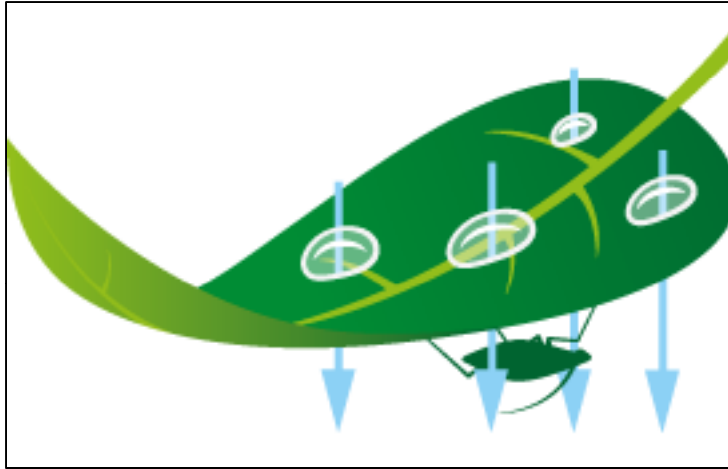
Common Amphimobile Products:

- Spirotetramat (Movento)
- Dinotefuran (Venom) – Soil applied
- Phosphorous acid (ProPhyt)
- Acibenzolar-S-Methyl (Actigard)

- Absorbed by the plant and translocated throughout (xylem + phloem)
- All tissue present at the time of application gets protection
- New tissue can get protection (to a point)



TRANSLAMINAR PESTICIDES



Common Translaminal Products:

- (Neo-nics) Dinotefuran (Venom) – Foliar applied
- Spinosad (Success)
- Cyprodinil (Vanguard)
- Trifloxystrobin (Flint)
- Fenhexamid (Elevate)

- Combine contact efficacy with limited systemic activity
- Sometimes referred to as “limited systemic activity”
- Product applied to top of leaf with also have activity to the bottom of leaf
- New tissue not protected
- Works well when “coverage” is limiting



PRODUCT TIMING CONSIDERATION

- Where a product works on the plant, and how it works on the target, influences when it is the most effective
- Systemic products work well during periods of active growth
 - Active movement in the plant = active movement of the product
- Contact and translaminar products work well during less-than-active growth
 - Contacts can hit the target when in abundance, translaminar help overcome reduced coverage



EXAMPLES – FUNGICIDES EARLY SEASON

- Contact fungicides
 - Work great if an infection period was missed
 - Do not provide coverage for active growth
- Systemic fungicides
 - Will move to protect new growth
 - BUT... if not a lot of tissue is available during application you aren't getting as much absorbed
- Translaminar fungicides
 - Can help with coverage, but coverage is generally not an early-season issue



EXAMPLES – FUNGICIDES LATE SEASON

- **Contact**
 - Depending on MOA, might help “clean up” existing infections
 - Can be problematic in dense canopies
- **Systemic**
 - Can overcome coverage problems
 - Poor plant growth may reduce translocation
- **Translaminar**
 - May help overcome coverage issues



FUNGICIDE RESISTANCE OR BAD APPLICATION?

- Stretched spray intervals
 - Not enough time to cover ground
 - Intervals based on “historical calendar”
- Inappropriate rates
 - Using lower-rates during key sprays/high pressure times
- Too-fast tractor speed
 - ...and poor calibration / nozzle maintenance / agitation, etc.



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DISEASE MANAGEMENT

How to spray.



MICHELLE'S 3 E'S OF SUSTAINABLE SPRAYING

Economical:

Spray application
must fit your budget

Efficient:

You should be
able to get
through your
vineyard

Effective:

Your spray
choices should
work against your
target



ECONOMICAL SPRAYING

- If you can't afford spraying, you aren't charging enough for your grapes
- The cost of spraying: the product, the equipment, the time
 - Consider the price relative to the amount and number of times you have to spray

Product	Rate / 3 App total	Price	Total Cost	Days Covered	Price per Day
Regalia	4 qts / 3 gal	\$80.00 / gal	\$240.00	42 days	\$5.71
Sulfur	10 lbs / 30 lbs	\$1.75 / lb	\$52.50	42 days	\$1.25
Quintec	6.6 oz / 19.8 oz	\$3.50 / oz	\$69.30	63 days	\$1.10
Pristine	12.5 oz / 37.5 oz	\$3.55 / oz	\$133.13	63 days	\$2.11



EFFICIENT SPRAYING

- Equipment choice (actual machine)
 - Does your sprayer fit your operation / vineyard?
 - i.e., if you are commercial and larger than 2 acres, you shouldn't use a hand sprayer
 - Is drift mitigation technology appropriate for your site?
Or are you frequently halted in sprays due to wind?
- Equipment number (size of operation)
 - Can you effectively cover your vineyard within the spray interval required?
 - Can you do so without speeding?



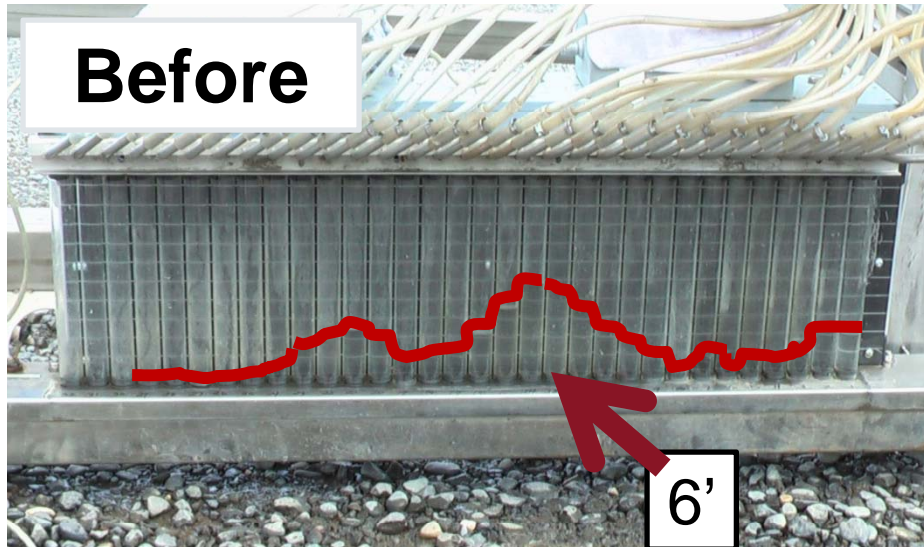
EFFECTIVE SPRAYING

- Are you actually getting control?
 - Are you reaching your desired quality with the spray program you are using?
 - Are you reaching your desired quality with as few sprays as possible?
- Canopy management
 - Is the spray getting to your target?
- Proper spray technique
 - Are you hitting your target, or is the spray drifting?
 - Do your nozzles provide good spray coverage?

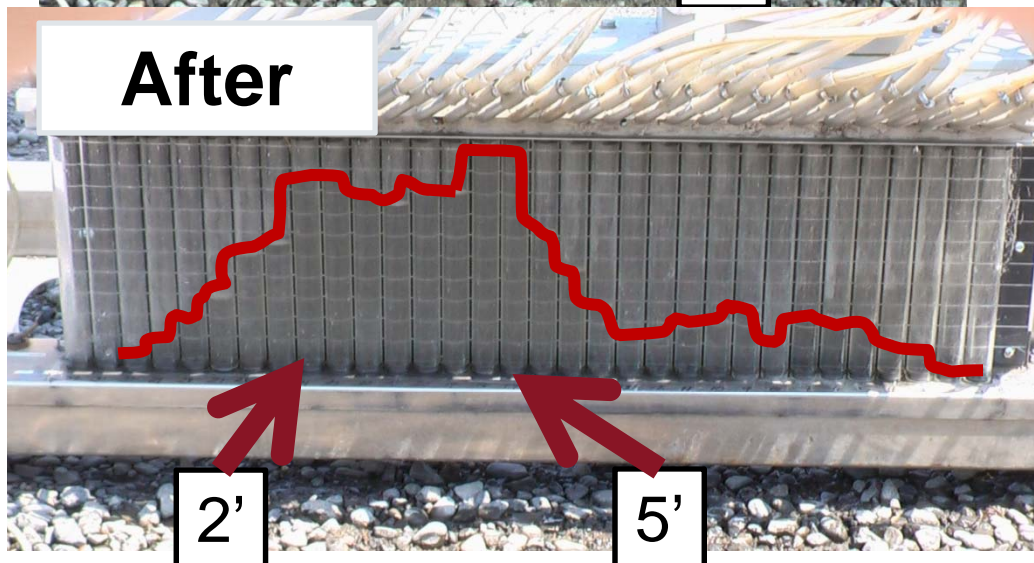


SPRAY PATTERN AND CANOPY SHAPE

Before



After





THE 3 E'S AND POOR SPRAYER CALIBRATION...

Economical:

Spray application
must fit your budget

Efficient:

You should be
able to get
through your
vineyard

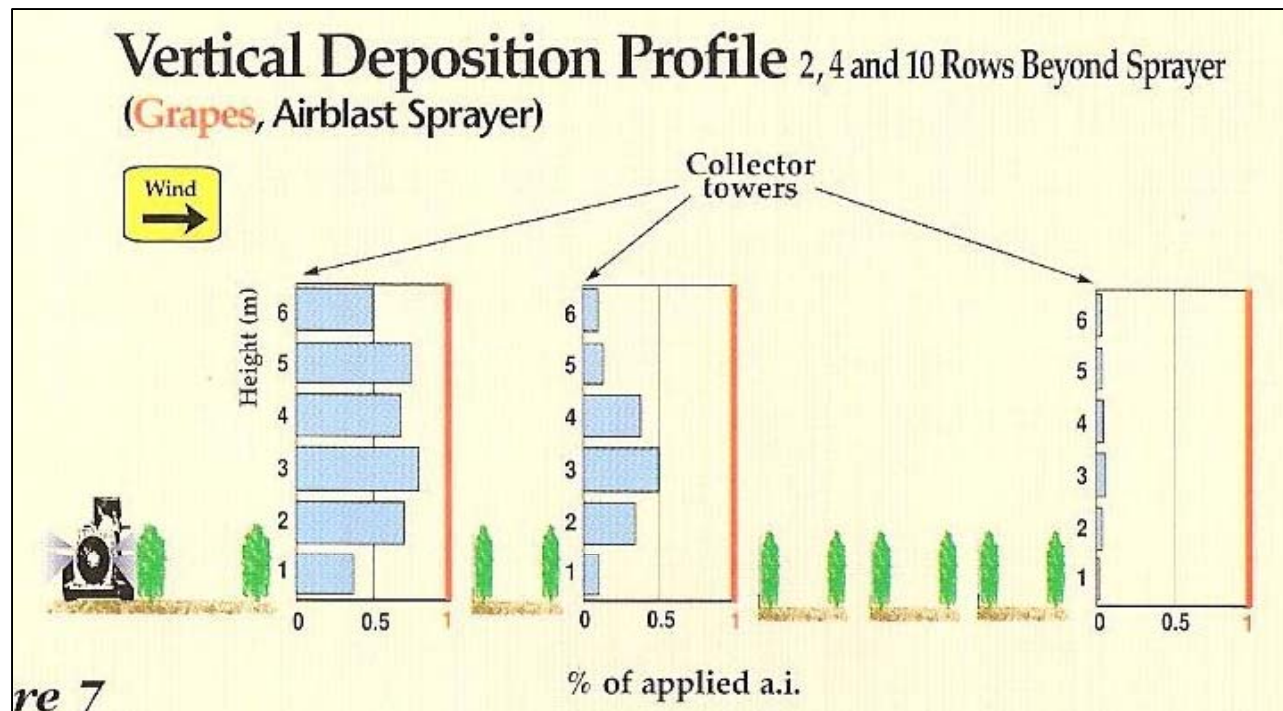
Effective:

Your spray
choices should
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target



THREE E SPRAYING – ECONOMICS

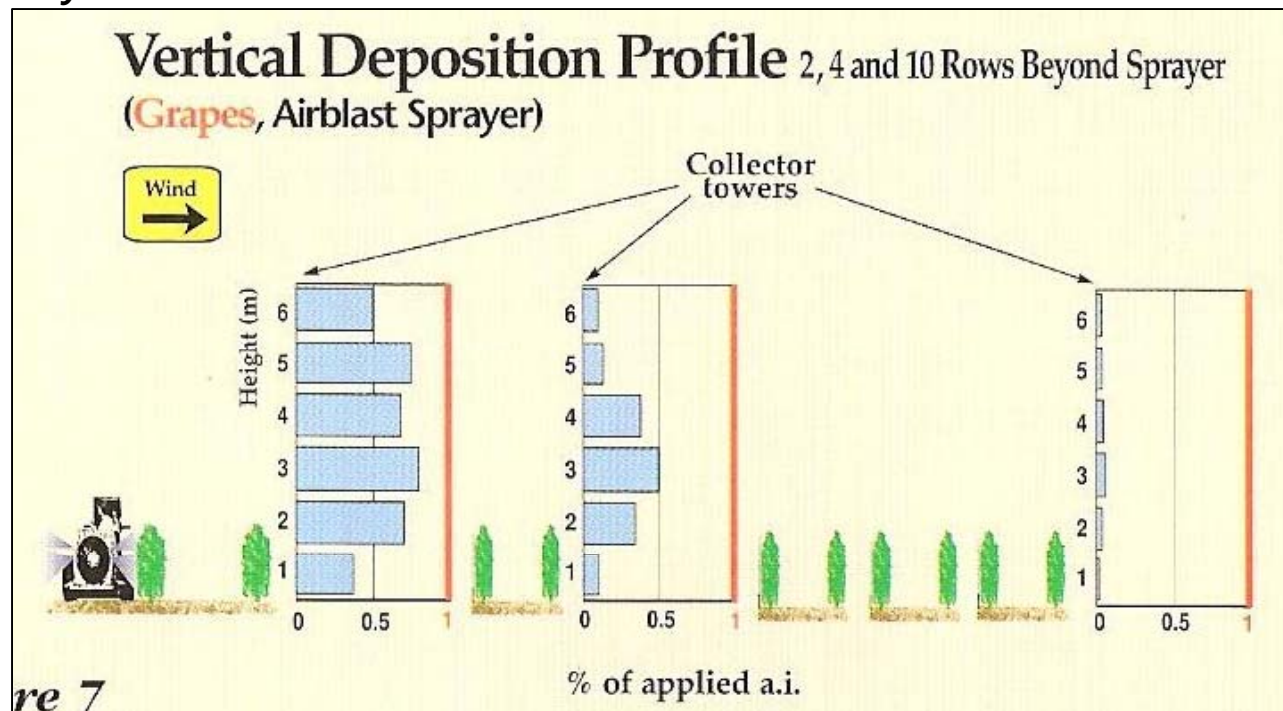
- **If 40-60% of your spray is lost to the ground or air**
 - *Gone = \$36 of material for a \$60/acre chemical*





THREE E SPRAYING – EFFICIENCY

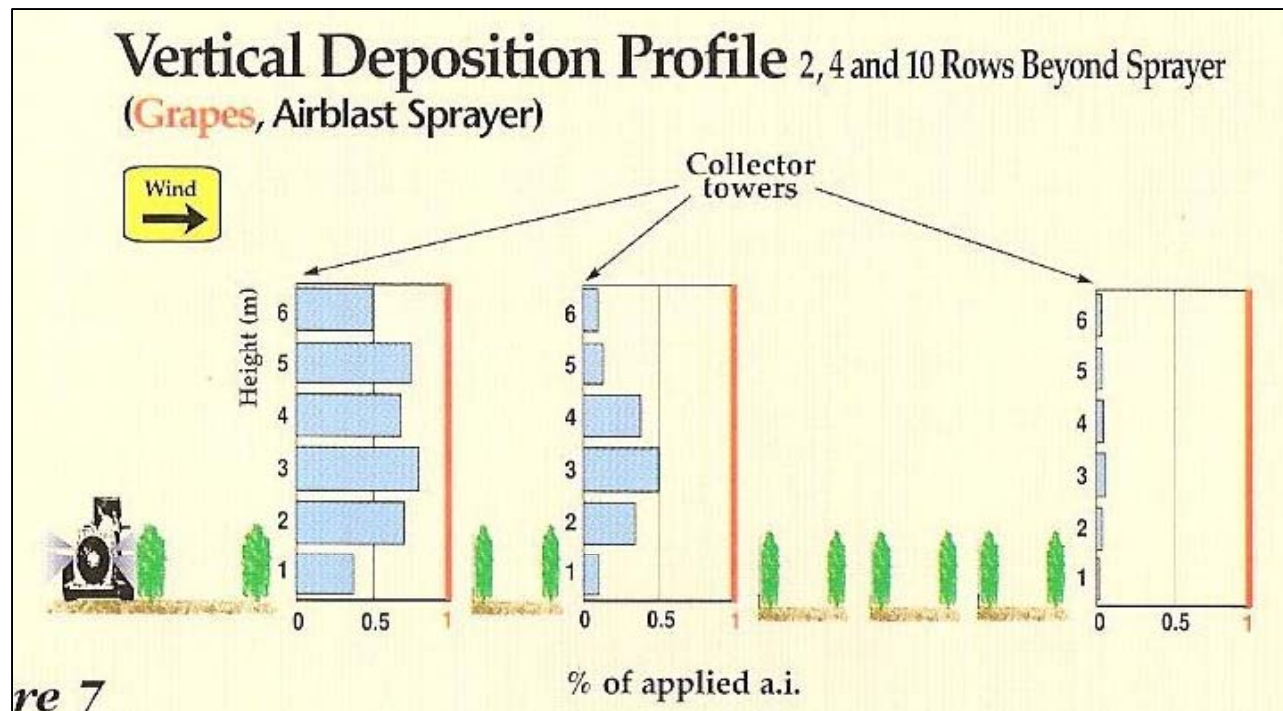
- **If 40-60%** of your spray is lost to the ground or air
 - *Gone = You didn't cover as much of the canopy as you thought you did*





THREE E SPRAYING – EFFECTIVENESS

- **If 40-60%** of your spray is lost to the ground or air
 - *Gone = You are applying a lower rate of chemical than intended*





THE SECRET TO A WELL-DESIGNED PROGRAM

- Planning...
 - Review what / when you sprayed last year
 - Did it work?
- Planning...
 - Design your spray program before the season starts, understanding that you will likely have to adjust
- ... and more Planning.
 - Order pesticides early
 - Calibrate machines frequently; make sure they work BEFORE the season starts



SMART PEST MANAGEMENT ... MY PERSPECTIVE

- **S**ustainability is always considered (social, economical, environmental)
- **M**anage, don't react
- **A**lways know the target's biology
- **R**esistance management should be top priority
- **T**hink, plan, evaluate, revise



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QUESTIONS?

VITICULTURE EXTENSION

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michelle.moyer@wsu.edu; Office: 509-786-9234
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