Biology and Management of Downy Mildew

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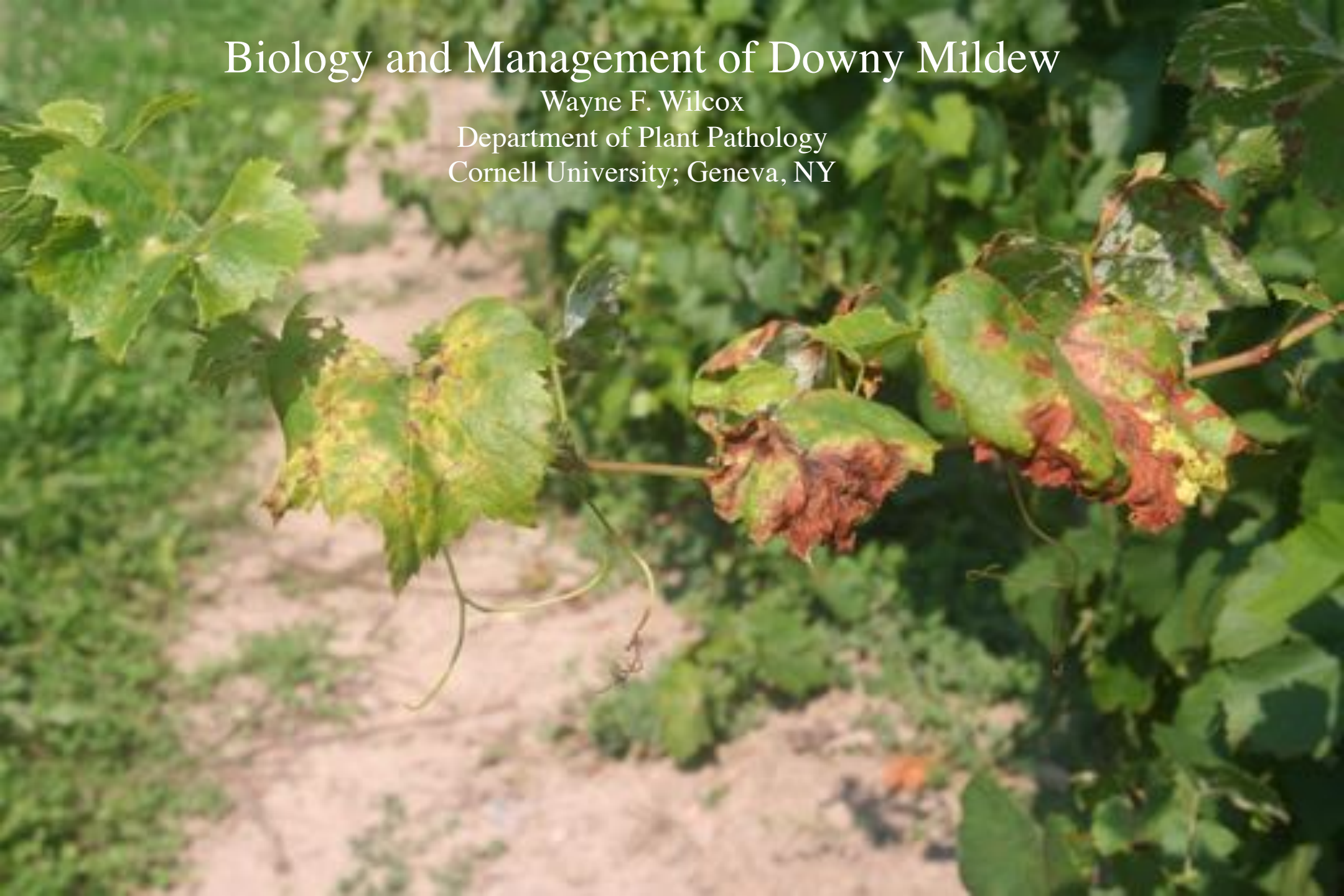


DOWNY MILDEW

- North American origin
  - Introduced into Europe (first noted in Bordeaux, 1878)
  - Hence, all *V. vinifera* are highly susceptible
    - No selection pressure for resistant individuals to survive preferentially as species evolved
    - (Converse true for North American species; hence, variable degrees of R among interspecific hybrids)

DOWNY MILDEW: BIOLOGY IN A NUTSHELL

- First infections originate from resting spores in soil, come from infected fallen leaves as they decompose
  - Resting spores viable for many years, but numbers decrease over time if not replenished
    - Degree of control last year matters, but most influential at start of the season (early pressure more intense if bad last year)

DOWNY MILDEW: BIOLOGY IN A NUTSHELL

- Primary infections can occur (if weather favorable) once new leaves and cluster stems develop breathing pores (stomates), through which infection occurs
  - Approximately 4 inch shoot growth in literature; in NY, first infections seldom before 10-in shoot growth (3 wk pre-bloom)

DOWNY MILDEW: CONDITIONS FOR PRIMARY INFECTION

- Wet soil
  - Resting spores germinate to release active "swimming spores"
- Rain (minimum 2-3 mm)
  - Swimming spores splash from soil onto young leaves
  - Growth near soil most likely to be infected

DOWNY MILDEW: CONDITIONS FOR FOR PRIMARY INFECTION

- Wet soil
  - Resting spores germinate to release active "swimming spores"
- Rain (minimum 2-3 mm)
  - Swimming spores splash from soil onto young leaves
- Leaves remain wet long enough
  - Once splashed onto leaves, spores swim (with "tails") to breathing pores, cause infection
  - 1.5-2 hr @ 60-75°F; 4 hr @50°

DOWNY MILDEW: BIOLOGY IN A NUTSHELL

- Once primary infections occur, disease can spread rapidly from new spores ("sporangia") produced on diseased leaves, clusters


00007930
30 µm
REM-Labor
Uni Basel

DOWNY MILDEW: DISEASE SPREAD

- Once established, disease can spread very rapidly if weather is favorable
  - Humid nights (>95% RH)
    - Necessary for sporangia to form
  - Rain that night or in the morning
    - Necessary for infection to occur

DOWNY MILDEW: DISEASE SPREAD

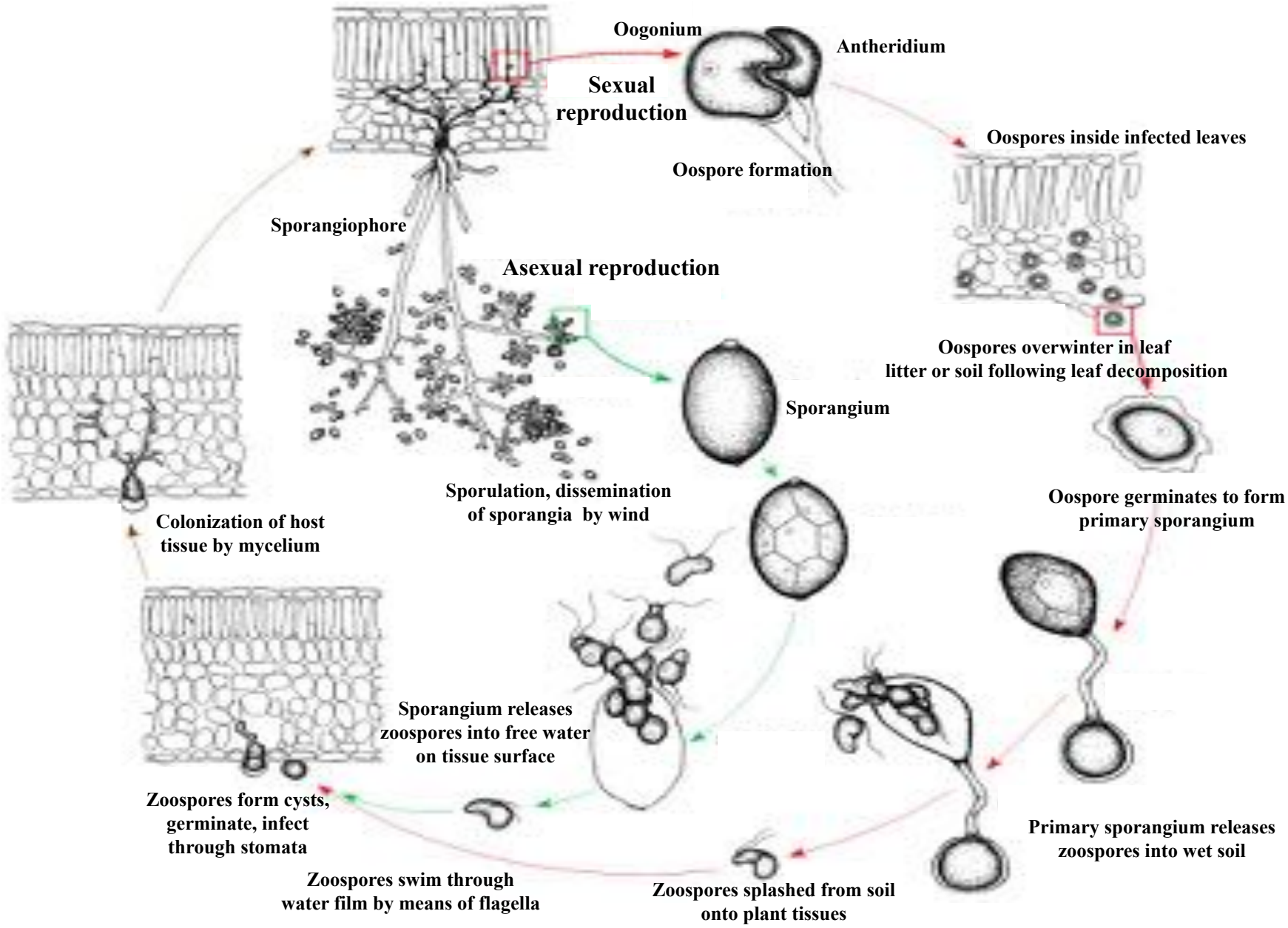
- Once established, disease can spread very rapidly if weather is favorable
  - Disease is active at 50 – 85°F, but spreads more slowly at low/high ends of range
    - Optimum night/morning temperature = 77°F
      - Bottom line: Muggy summer weather

DOWNY MILDEW: Consideration

- Sporangia that form at night to spread disease are killed by direct sunlight ("vampires") the next day if no rain occurs
  - But they survive (and wait for rain) for several days if cloudy

DOWNY MILDEW: DISEASE SPREAD

- Once primary infections occur, disease can spread rapidly (secondary infections) from sporangia produced on diseased leaves
  - New generation every 4-5 days when weather is favorable
    - Day 1 = 1 infection occurs
    - Day 6 = 1,000 new infections from these
    - Day 11 = 1,000,000 new infections from these


Oogonium
Antheridium
Sexual reproduction
Oospore formation
Oospores inside infected leaves
Sporangiophore
Asexual reproduction
Oospores overwinter in leaf litter or soil following leaf decomposition
Sporangium
Sporulation, dissemination of sporangia by wind
Oospore germinates to form primary sporangium
Colonization of host tissue by mycelium
Sporangium releases zoospores into free water on tissue surface
Zoospores form cysts, germinate, infect through stomata
Primary sporangium releases zoospores into wet soil
Zoospores swim through water film by means of flagella
Zoospores splashed from soil onto plant tissues

DOWNY MILDEW: BIOLOGY IN A NUTSHELL

- Period of susceptibility
  - Leaves: Most susceptible when young, but retain some susceptibility throughout
  - Berries: Become resistant to direct infection ≈3 wk post-bloom, but can become infected through berry stem for additional 2-3 wk

DOWNY MILDEW: BIOLOGICAL FACTOID

- DM organism and similar beasties no longer considered fungi, now classified in a class of their own (oomycetes)
- So what? If it looks, walks, and quacks like a duck, who cares what you call it?

DOWNY MILDEW: BIOLOGICAL FACTOID

- DM organism and similar beasties no longer considered fungi, now classified in a group of their own
- Significance:
  - DM organism and "true" fungi are so biologically different that many fungicides active against one group are not active against the other

SPECIFIC FUNGICIDES & GROUPS: COPPER

- Toxic component= Cu++ ion
  - Also toxic to plant cells
- Various formulations with low solubility ("fixed" coppers), slow release of Cu++
  - Same principle as original "Bordeaux mix" (bluestone + lime)

SPECIFIC FUNGICIDES & GROUPS: COPPER

- Potential phytotoxicity concerns
  - Some red interspecific hybrid cultivars
  - "Slow drying" conditions
    - Cool and/or humid
    - Presumably, promotes absorption
  - V. low pH in spray tank, on plant surface (increased solubility, higher dose of Cu++)

CURRENT DM FUNGICIDES: COPPER

- Protectant only
- Only fair to poor control of other diseases, but often the most effective of approved "organic" materials
- No resistance concerns
- Does not break down (element), accumulates in soil over long periods of use

CURRENT DM FUNGICIDES: MANCOZEB

- Multiple sites of activity
- Broad spectrum of target organisms
- No resistance
- Surface protective activity only

CURRENT DM FUNGICIDES: CAPTAN

- Many target sites in living cells
  - No resistance after nearly 60 yr of use on multiple crops, worldwide
  - Broad spectrum of activity (controls many diseases)
  - Causes plant injury if crosses cuticle (e.g., applied with oils, some other pesticides in liquid formulations [solvent])
  - Environmental/worker exposure concerns

CURRENT DM FUNGICIDES: QoI (STROBILURIN) (Grp. 11)

- VERY HIGH risk of resistance—We no longer recommend for use in NY unless tank-mixing with something effective

CURRENT DM FUNGICIDES: Ridomil Gold (Copper and MZ formulations)

- Best DM fungicide ever--the nuclear option
  - Highly systemic; protective, post-infection, and eradicative activities; also significant vapor activity
- HIGH risk of resistance, easy to burn out
- Expensive, DM only (Ridomil component)
- 42- and 66- day PHI (RG Copper, -MZ)

CURRENT DM FUNGICIDES: "Group 40" Materials--DM only

- Revus/Revus Top
  - Consistently one of 2 best DM fungs in my trials
- Zampro (one component)
  - Consistently one of 2 best DM fungs in my trials
  - Mixture of two active ingredients to combat resistance development
    - Resistance to Revus documented in VA in 2016

CURRENT DM FUNGICIDES: "Group 40" Materials--DM only

- Revus/(Revus Top), Zampro (one component)
- Strongest in protectant mode, some post-infection activity but poorly characterized
  - P-i probably stronger with penetrating surfactant
- 2nd Zampro component poorly characterized, probably good post-inf activity

DM CONTROL, 2014 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	72
Zampro	1,3,5,7,9	5	0.2
Revus Top	1,3,5,7,9	3	0.1
Bio (+ Phos)	(1),2,5,9		
Zampro	3,7	15	0.5
Phos/Zam	1/3,7	19	0.7

*14-d intervals beginning 2 wk pre-bloom

DM CONTROL, 2015 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	56
Zampro	1 – 7	18	2
Revus Top	1 – 7	13	1
Phos/ Zam	1/ 2,4,6	49	4

*14-d intervals beginning 2 wk pre-bloom

RANMAN RESULTS, 2014 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	72
Zampro	1,3,5,7,9	5	0.2
Revus Top	1,3,5,7,9	3	0.1
Ranman	1,3,5,7,9	50	7.1

*14-d intervals beginning 2 wk pre-bloom

REGALIA RESULTS, 2014 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	72
Zampro	1,3,5,7,9	5	0.2
Revus Top	1,3,5,7,9	3	0.1
Ranman	1,3,5,7,9	50	7.1
Regalia	1-10 (7-d)	94	35.8

*14-d intervals beginning 2 wk pre-bloom

CURRENT DM FUNGICIDES: LifeGard

- Bacterium that elicits defense response to (some) pathogens in the grapevine
- Consistent very good/excellent results vs. DM in 3 years of my trials
- Good/very good vs. PM, poor vs. Botrytis in 2017 (1st yr for those diseases)

LIFEGARD RESULTS, 2014 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	72
Zampro	1,3,5,7,9	5	0.2
Revus Top	1,3,5,7,9	3	0.1
Ranman	1,3,5,7,9	50	7.1
Regalia	1-10 (7-d)	94	35.8
LifeGard	1-10 (7-d)	14	1.0

*14-d intervals beginning 2 wk pre-bloom

LIFEGARD RESULTS, 2015 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	56
Zampro	1 – 7	18	2
Revus Top	1 – 7	13	1
Phos/ Zam	1/ 2,4,6	49	4
LifeGard	1 – 7	1	<1

*14-d intervals beginning 2 wk pre-bloom

LIFEGARD RESULTS, 2017 (cv. Chardonnay)

Material	Timing*	% Lvs	% Lf area
None	---	100	65
Zampro	1 – 7	9	0.1
Revus Top	1 – 7	11	1
LifeGard A	1 – 7	18	1
LifeGard B	1 – 7	58	9

*14-d intervals beginning 2 wk pre-bloom

CURRENT DM FUNGICIDES: Phosphonates (Group 33)—DM only

- Heavy use over past decade Effective, "reasonable" price, no cross-resistance issues, clean, no residue limits
- NOT miracle drugs, have their limits
- Some anecdotal reports of unsatisfactory performance in NY
  - "Partial" resistance (DMI type) is possible—DON'T BURN THESE OUT!

PHOSPHOROUS ACID (PHOSPHITE, PHOSPHONATE)

- NOT a fertilizer (phosphoric acid, phosphate)
  - In fact, plant cannot utilize phosphite as P-source
- Some products labeled for DM control

PHOSPHONATES: CONCLUSIONS

- Significant protective activity
  - ,≤1 week?
- At least 3-4 days “true” curative activity
  - Improves with rate, repeat application
- Significant anti-sporulant activity
  - Extends effective period of curative activity
- Do not eradicate existing lesions, but do reduce additional sporulation


Mancozeb, missed spray


Mancozeb, missed spray


Modern fungicide, missed spray


Modern fungicide, missed spray