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WSU-Wine Science Center
14 July 2016

ADVANCEMENTS IN POWDERY MILDEW

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"CONCERNING POWDERY MILDEW; WE KNOW WHAT IS NEEDED TO CONTROL THE DISEASE.

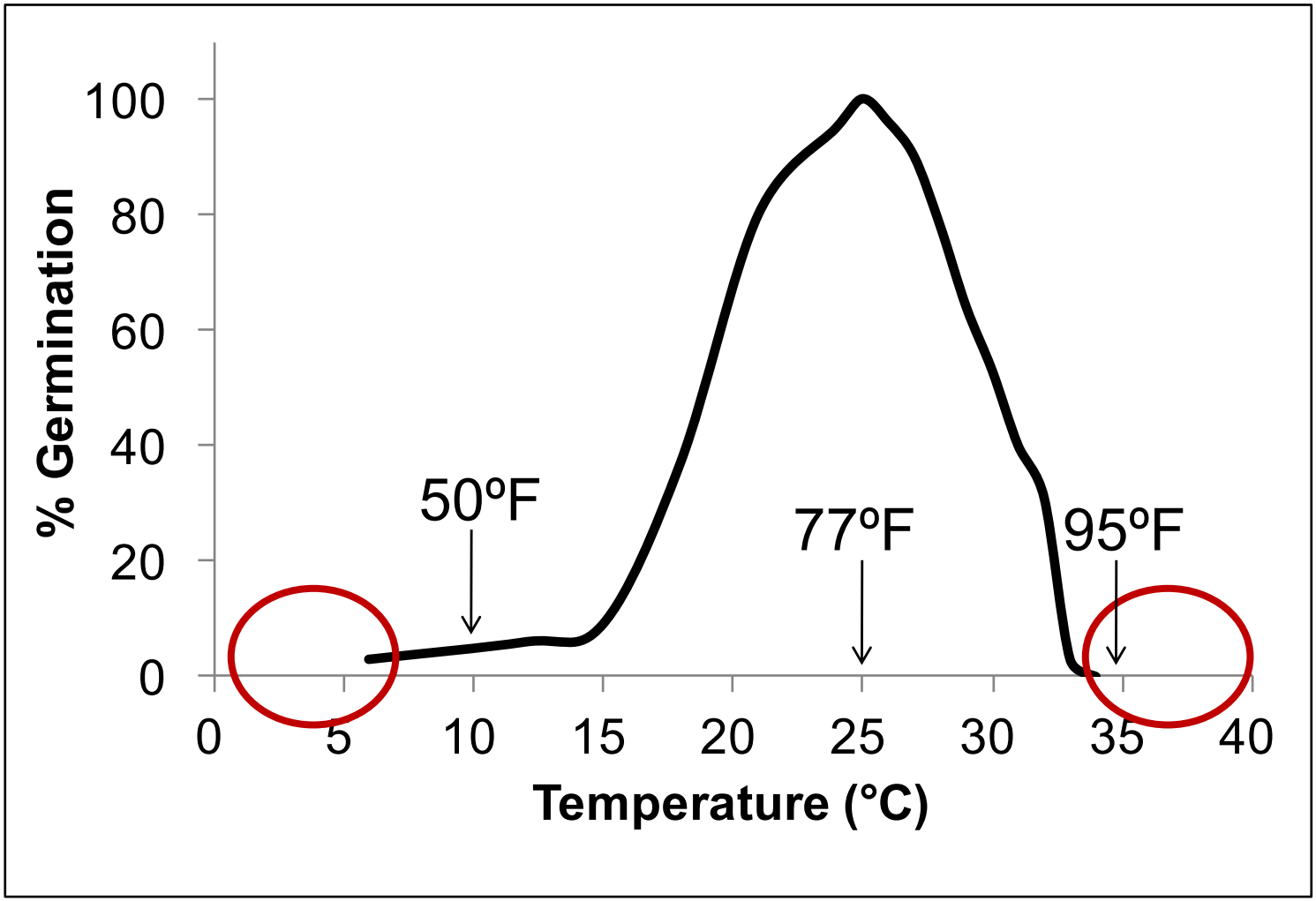
THERE ARE A FEW THINGS THAT ARE UNKNOWN, *BUT THEY ARE OF SECONDARY IMPORTANCE*."

P. Viala, Les Maladies de la Vigne. Paris. 1893.

WHAT WE KNOW

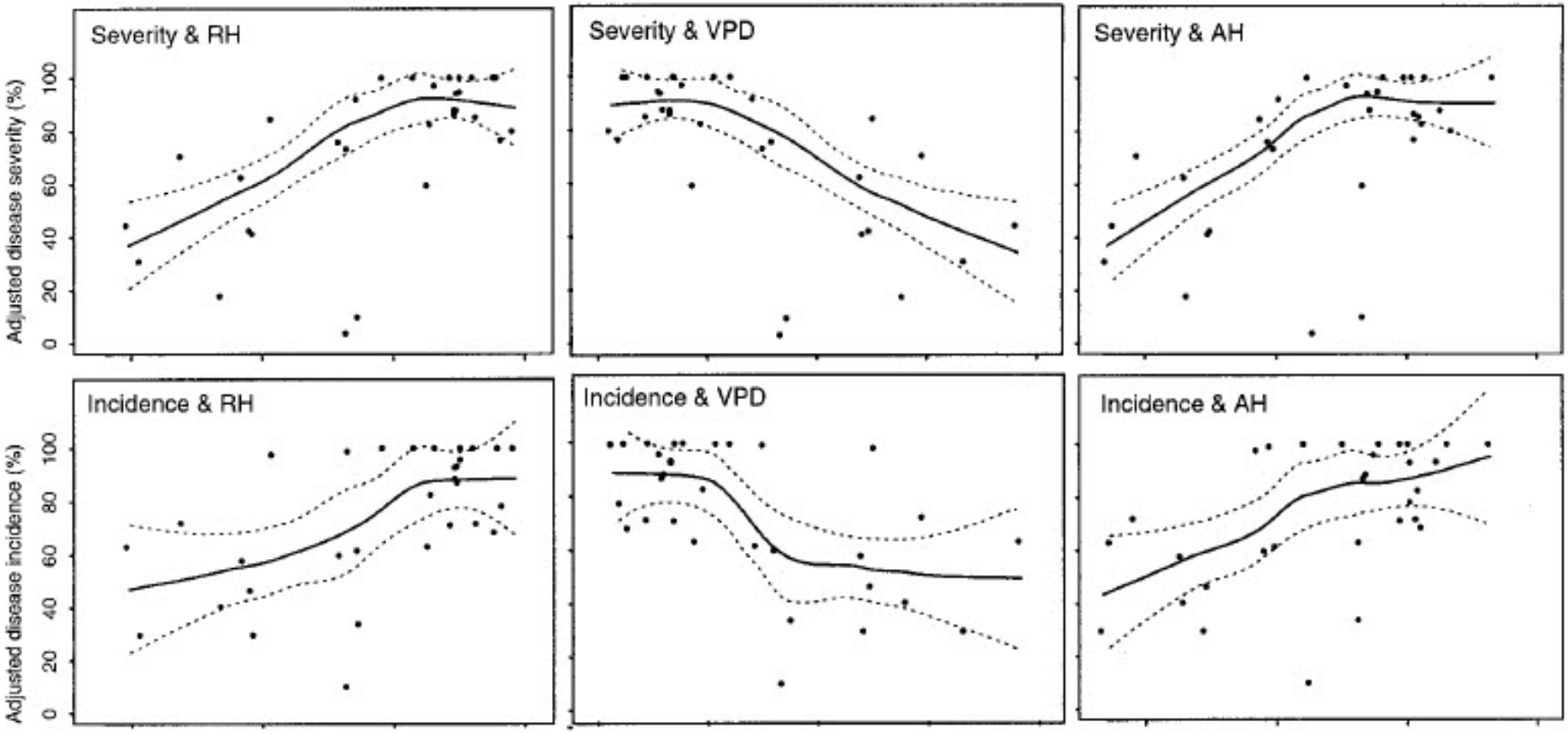
A look at past research…chronologically.

PM LIKES MODERATE TEMPERATURES



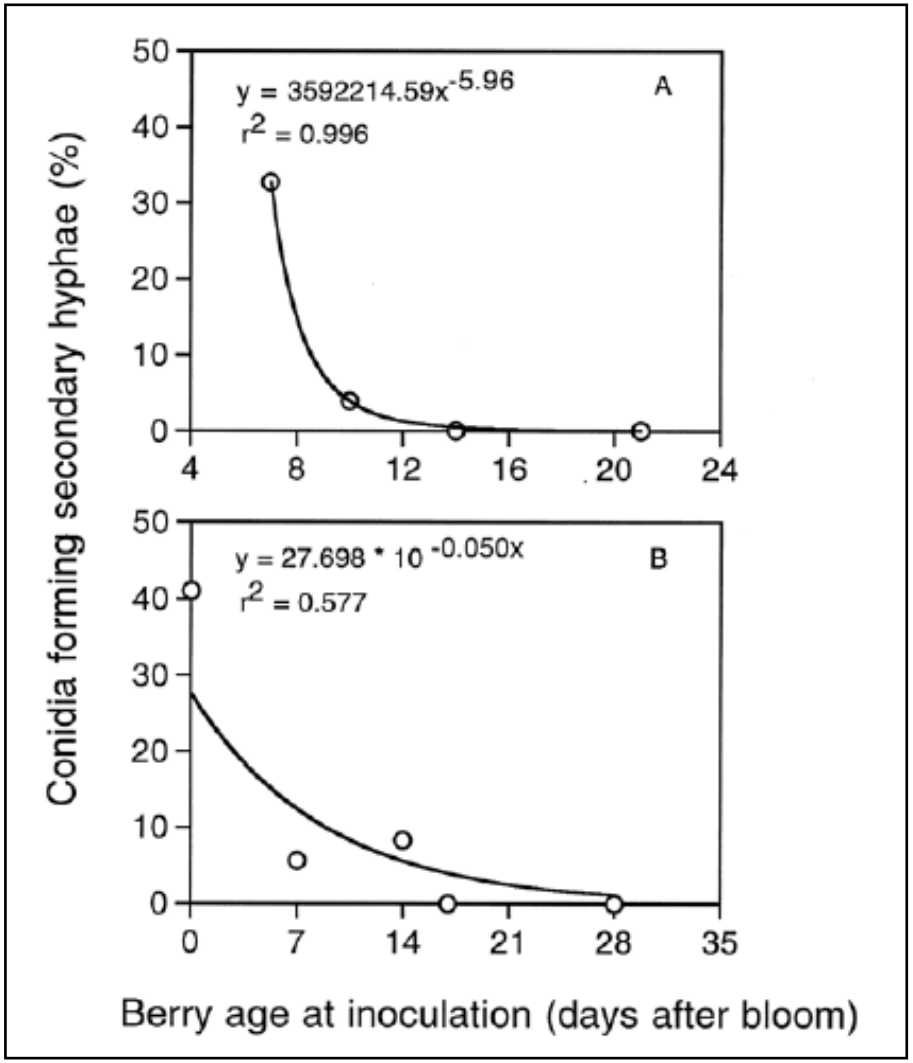
Delp, C.J. 1954. Phytopathology 44:615-626.

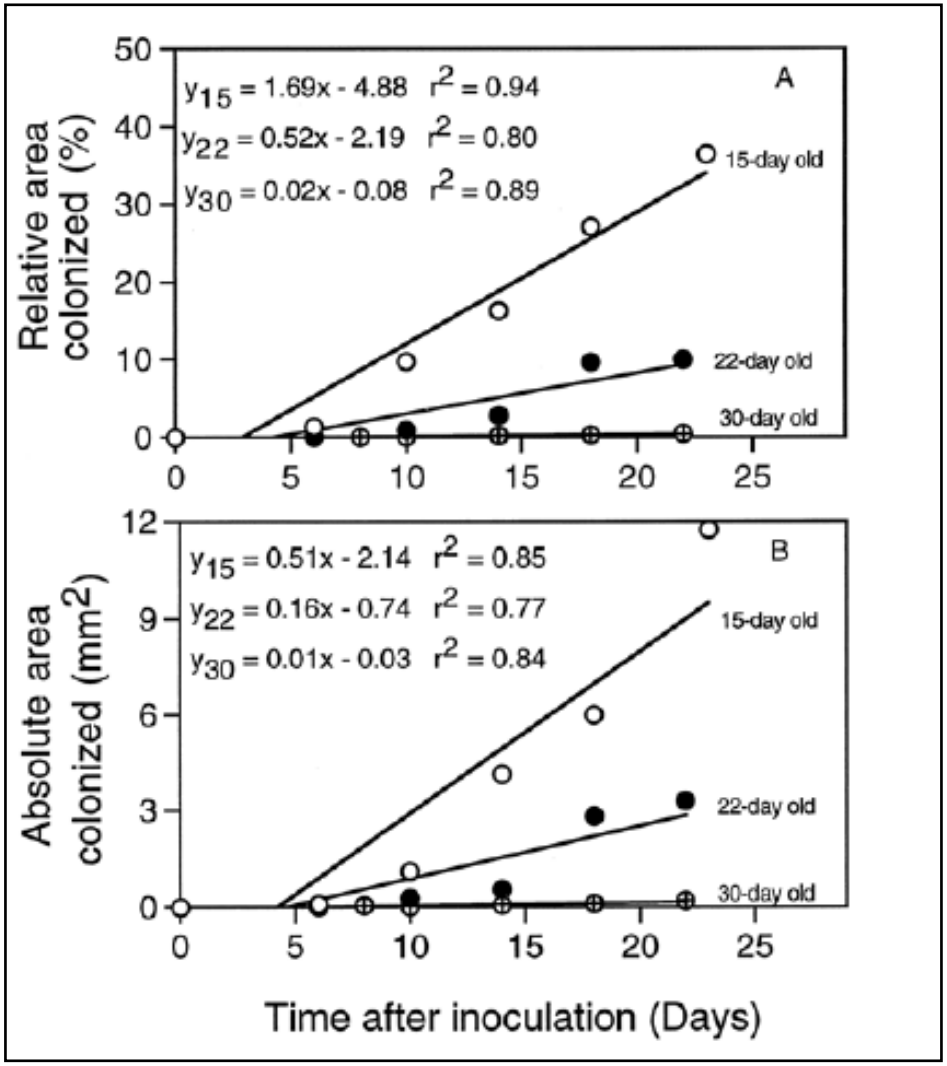
PM DOESN'T LIKE IT TOO DRY



Carroll, J. et. al. 2003. Phytopathology. 93: 1137-1144.

ONTOGENIC RESISTANCE – GRAPE BERRIES





Ficke, et. al. 2003. Phytopathology 93:556-563.

ONTOGENIC RESISTANCE

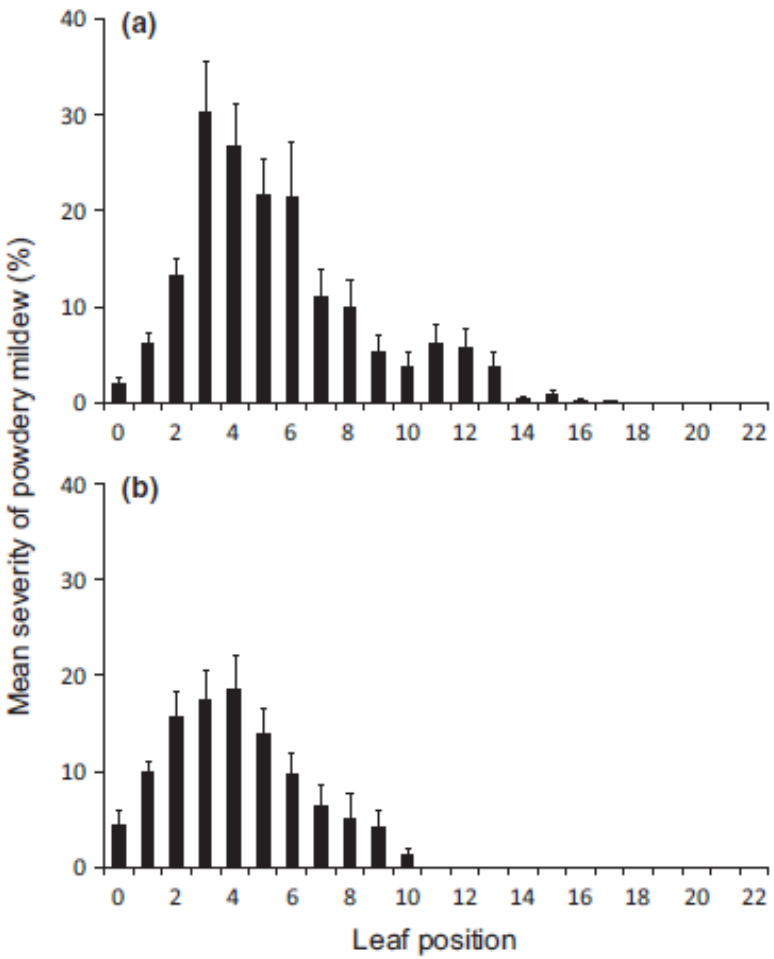
- Grape berries, and leaves display increasing levels of resistance
- Berries completely resistant within 1 month post-bloom
- Rachis remains susceptible all season
- Infection can start early (cluster emergence), but likelihood is a function of target size

THE CATCH – WHEN IS "BLOOM"?

Synchronous Bloom

Asynchronous Bloom

ONTOGENIC RESISTANCE – LEAVES



- Transitioning leaves are simultaneously sources and sinks – maximum assimilate in tissue

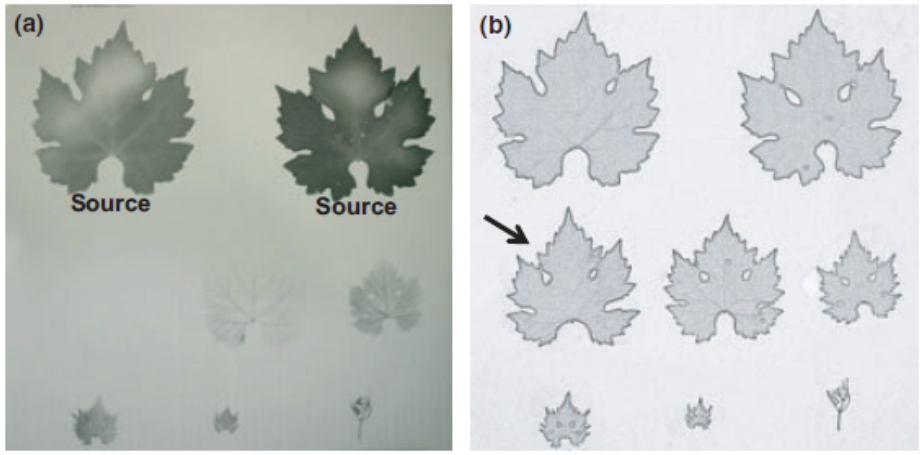


Image from: Merry, et. al.2013, Plant Pathology 62: 842-850.

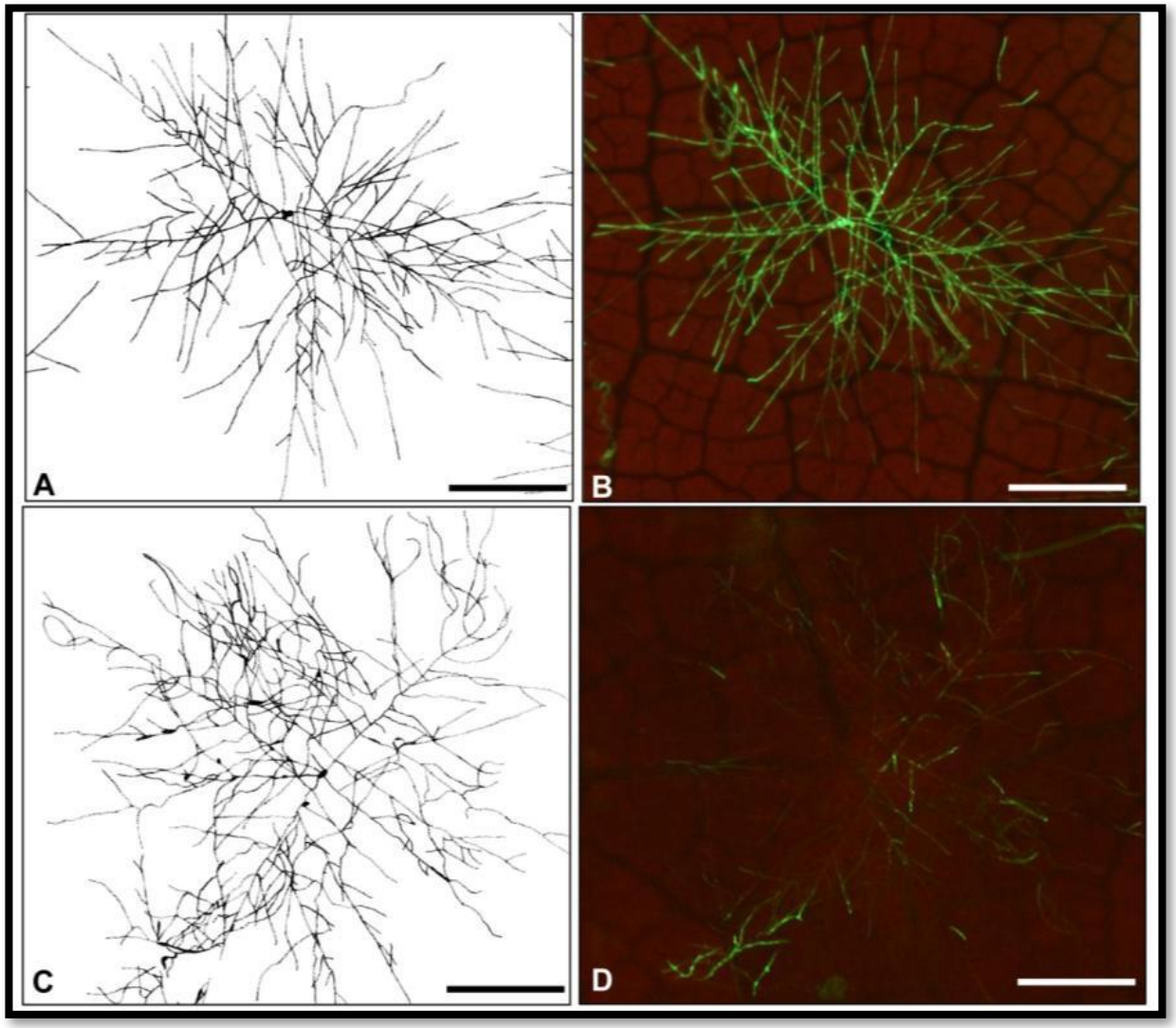
PM DOESN'T LIKE IT TOO COLD

Four-day-old colony grown at 75°F:

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

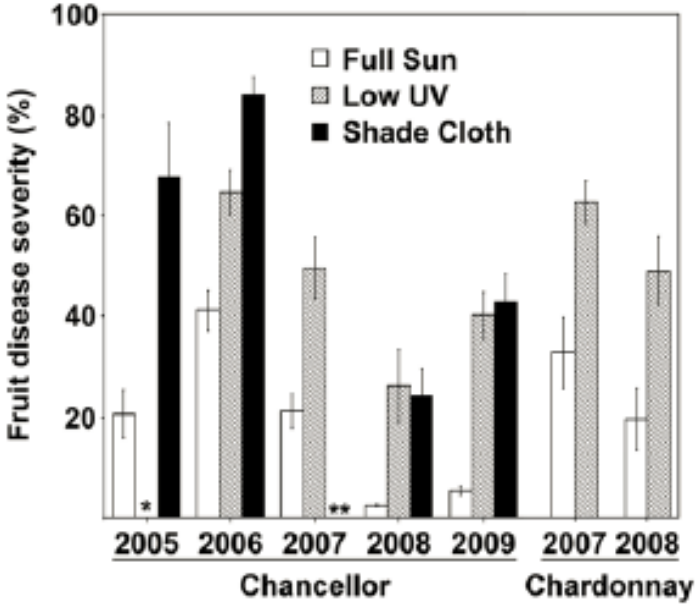
Four-day-old colony exposed to 36°F for 8 h at 3 days old:

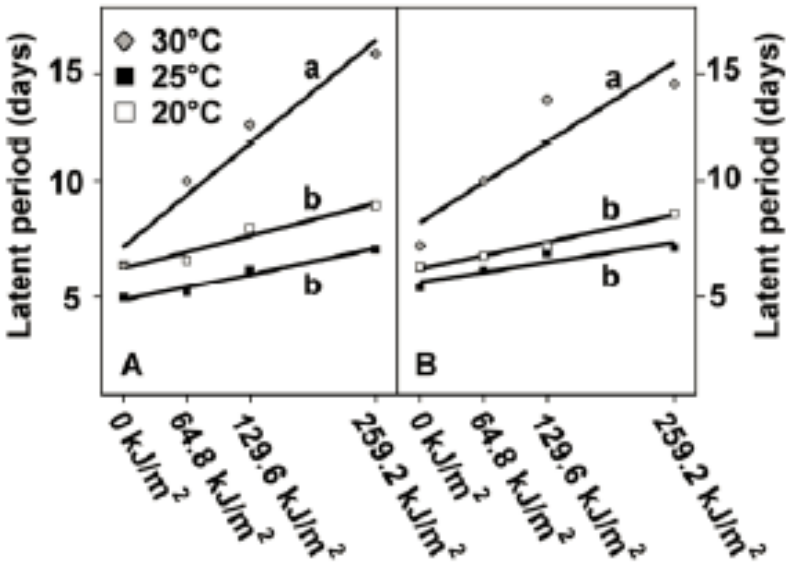
C) Line sketch of colony footprint, and
D) Same colony visualized with a vital stain



Moyer, M.M., et. al. 2010. Phytopathology 100:1240-1249

PM DOESN'T LIKE IT TOO SUNNY





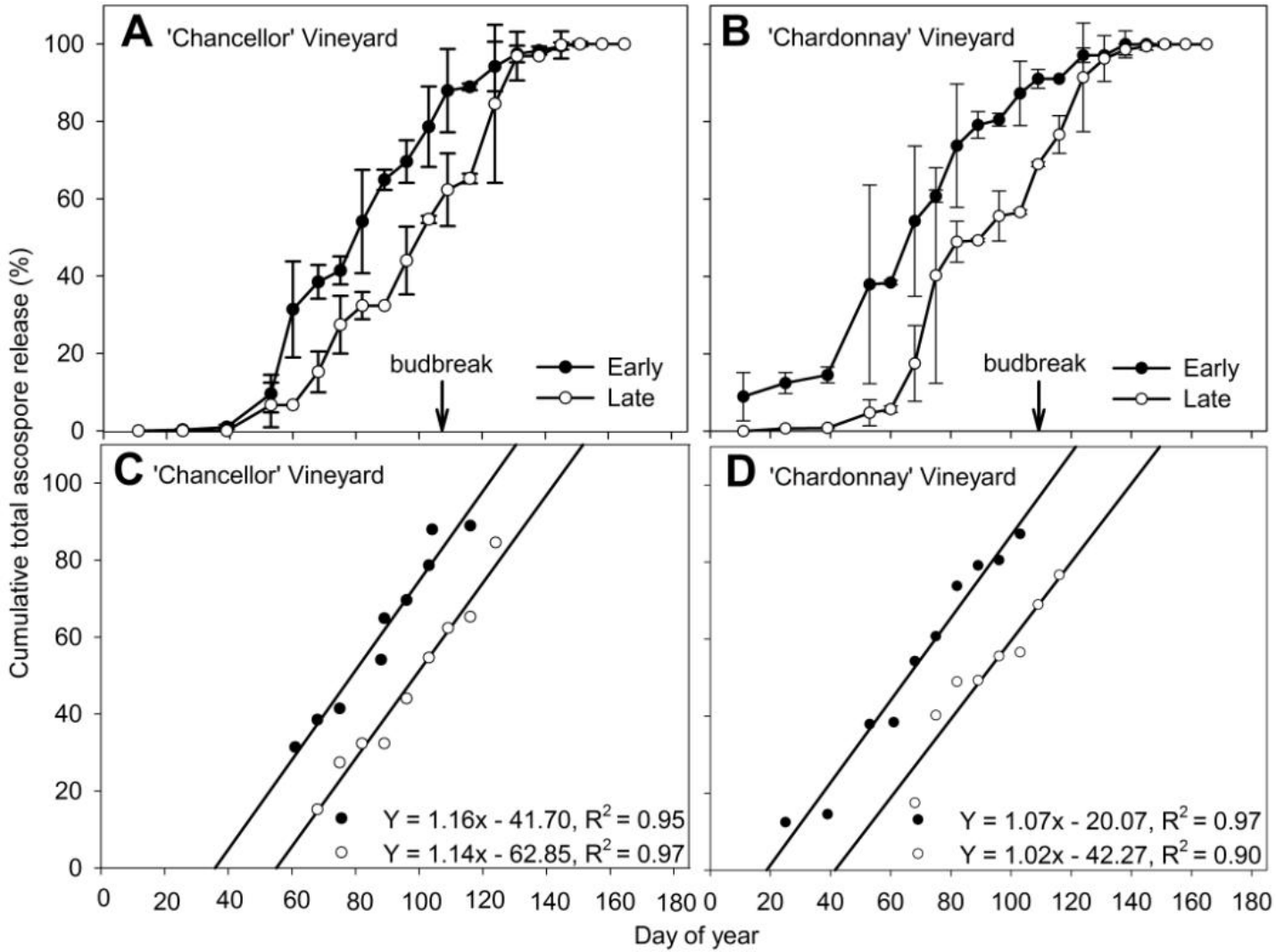
Austin, C.N. et al., 2012. Phytopathology 102:857-866

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

Choudhury, R. 2013. Thesis. Consecutive Heat Acclimation and Modeling Uncertainty for Grapevine Powdery Mildew. UC-Davis, USA

FALL DEVELOPMENT INFLUENCES SPRING RELEASE



Moyer, M.M., et. al. 2014. Am. J. Enol. Vitic. 63:315-324.

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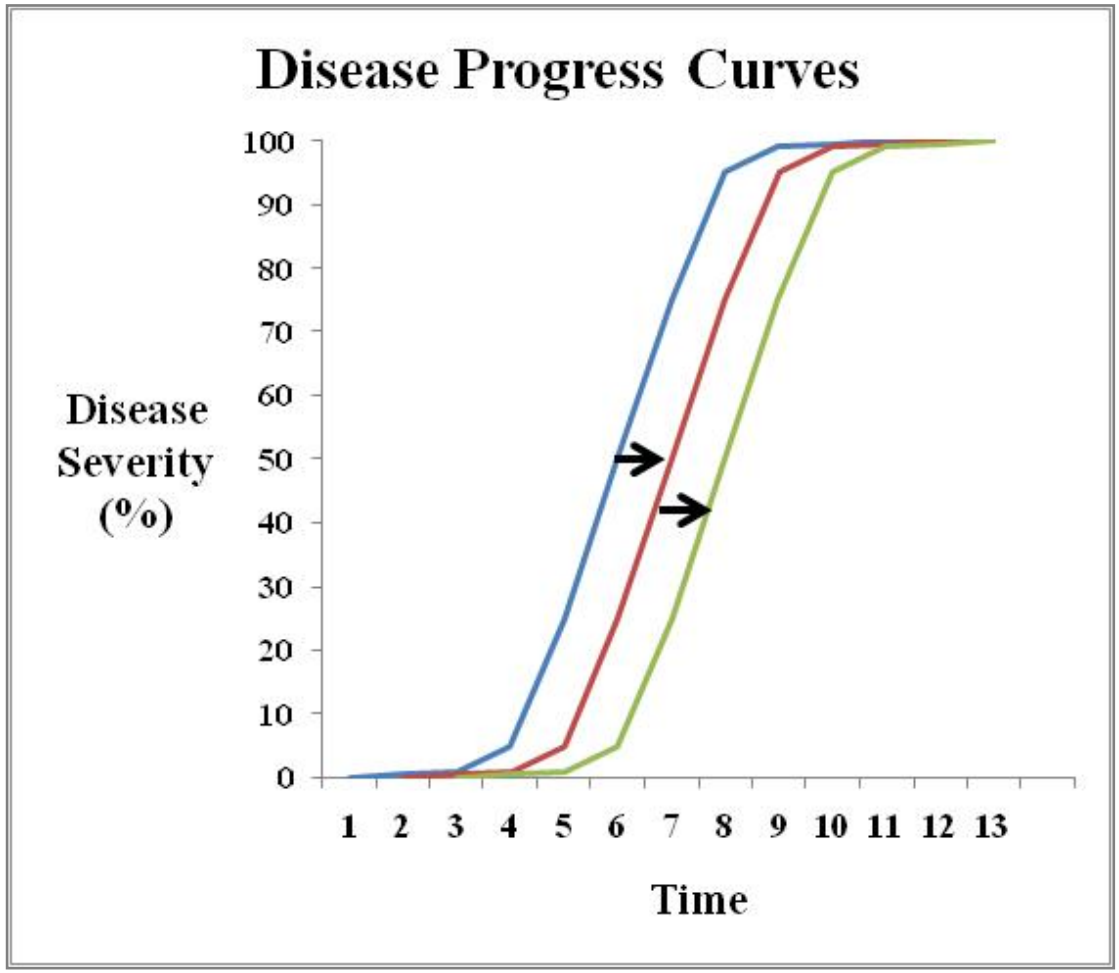
SCIENCE TO PRACTICE

Knowledge to Know-How.

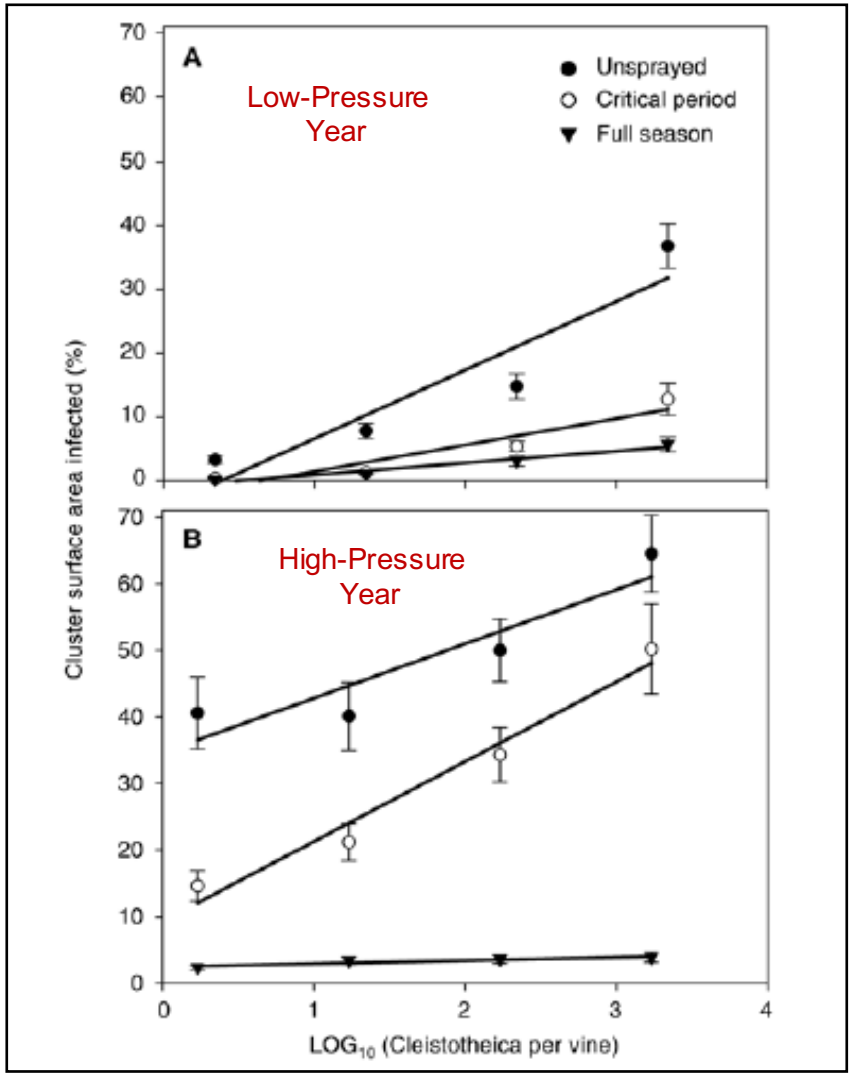
CONTROLLING DISEASE PROGRESS



$$y = y_0 e^{r_E t}$$

Primary inoculum vs. Secondary spread

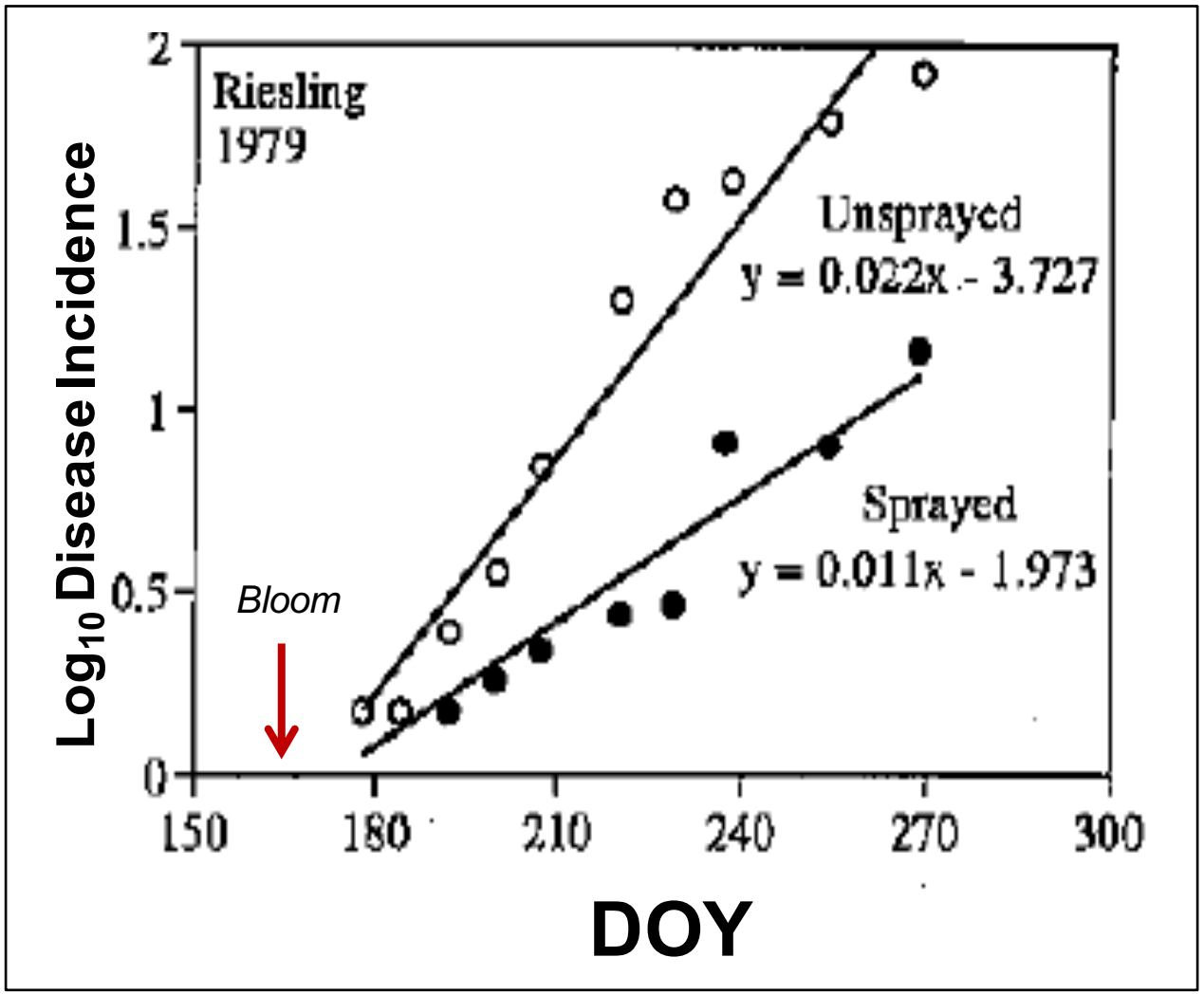
CRITICAL WINDOWS – PRIMARY INOCULUM (Y_0),



- Sprays:
  - CP- only 3 sprays, starting at bloom, 10-d intervals
  - FS – 8 total sprays, starting at 15” shoot growth
- Primary inoculum role
  - As expected, level of final disease influenced by primary inoculum (y_0), but
  - Low primary inoculum (y_0) can result in high levels of disease if rate (r_E) is high

Moyer, et. al. 2014. AJEV 65:315-324.

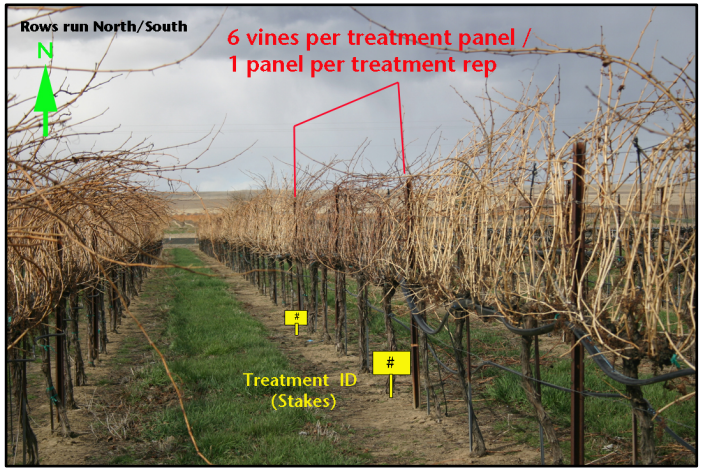
MOST SPRAYS DIRECTED AT CONTROLLING RATE

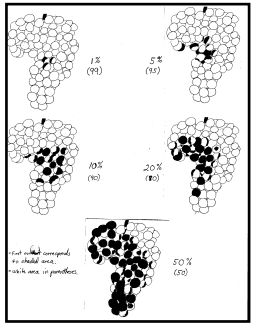


- Unsprayed vineyard
  - High r_E
- Sprayed vineyard
  - Low r_E
- Other factors influencing r_E:
  - Temperature
  - Humidity
  - **Host resistance**

Gadoury, et. al. 1997. Vitic. Enol. Sci. 52:225-229.

RESEARCH METHODOLOGY





Leaf Removal Timing:
Control Prebloom Bloom 3 wks FS

15" Shoots 22 May	Start Bloom 10 June	100% Bloom 19 June	Bunch Hang 7 July	Pea size 17 July	Véraison 31 July

DISCLAIMER

Indication of particular active ingredient does not imply endorsement.

Trade name use of product is for example purposes only; it does not imply endorsement.

It is a violation of the law to disregard label directions.

CASE STUDY – ONTOGENIC RESISTANCE & SPRAYS

- The timing of fungicide application is exceptionally important in polycyclic diseases
  - Did you reduce primary inoculum?
  - Did you reduce the development rate?
- It is even more important given inherent efficacy differences of products
  - Is it best to use lower-efficacy products as a means to reduce y_0 or as a means to slow r_E?
  - Should you avoid lower-efficacy products entirely? (Not necessarily!)

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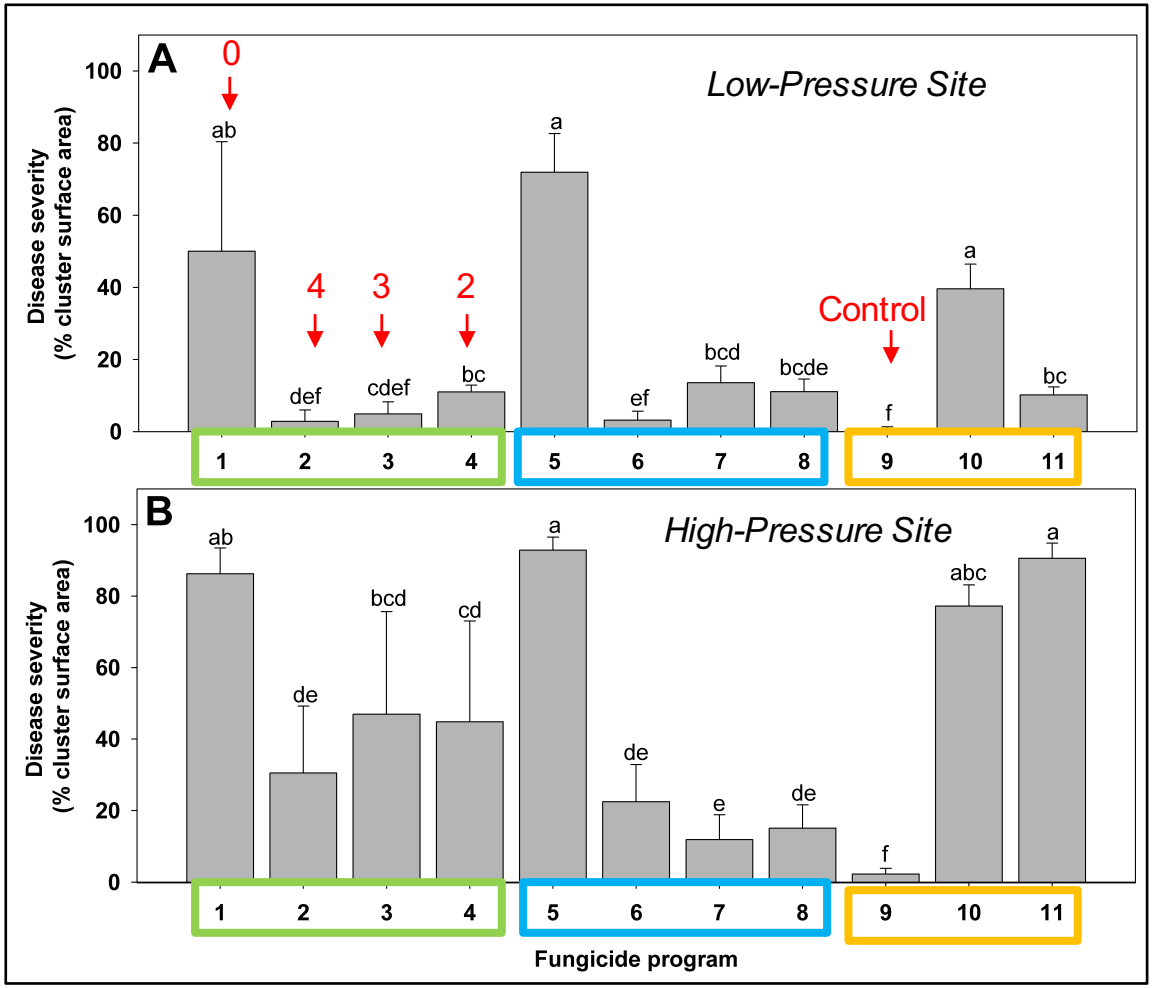
INTEGRATING BIO & SYNTHETIC FUNGICIDES

NOTE: FOR EXPERIMENT PURPOSES ONLY; DO NOT TRY PROGRAMS SUCH AS 9 IN A COMMERCIAL SETTING. ALWAYS ROTATE FRAC CODES, AND DO NOT APPLY MORE THAN 2 FRAC 11s A SEASON

Vine phenological stage[a]	15-30 cm shoot growth	Rachis elongation / prebloom	Full bloom / 100% capfall	Fruit set	4 weeks postbloom	Bunch closure	Veraison	Veraison + 10 days[b]
Program	Active Ingredient							
1	Regalia	Regalia	Regalia	Regalia	Regalia	Regalia	Regalia	Regalia
2	Regalia	Quintec[c]	Luna Privilege[c]	Quintec[c]	Luna Privilege[b]	Regalia	Regalia	Regalia
3	Regalia	Quintec[c]	Luna Privilege[c]	Quintec[c]	Regalia	Regalia	Regalia	Regalia
4[d]	Regalia	Regalia	Quintec / Luna Privilege[c]	Regalia	Regalia	Regalia	Regalia	Regalia
5	Sonata	Sonata	Sonata	Sonata	Sonata	Sonata	Sonata	Sonata
6	Sonata	Quintec[c]	Luna Privilege[c]	Quintec[c]	Luna Privilege[c]	Sonata	Sonata	Sonata
7	Sonata	Quintec[c]	Luna Privilege[c]	Quintec[c]	Sonata	Sonata	Sonata	Sonata
8	Sonata	Sonata	Quintec / Luna Privilege[c]	Sonata	Sonata	Sonata	Sonata	Sonata
9[e]	Luna Privilege[c]	Quintec[c]	Luna Privilege[c]	Quintec[c]	Luna Privilege[c]	Quintec[c]	Luna Privilege[c]	Quintec[c]
10	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur	sulfur
11	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated

Moyer, M. et al. 2016. Plant Health Progress.

INTEGRATING BIO & SYNTHETIC FUNGICIDES



- Reduce disease rate until ontogenic resistance sets in
- Controlling rates through as early as 100% bloom can help reduce final disease

Moyer, M. et al. 2016. Plant Health Progress.

READ IN *PLANT HEALTH PROGRESS*

Plant Health Research

Efficacy of Biopesticides and Leaf Removal in Grapevine Powdery Mildew Management

Michelle M. Moyer, Assistant Professor, Department of Horticulture; **Jensena M. Newhouse,** Research Technician, Department of Horticulture; and **Gary G. Grove,** Professor, Department of Plant Pathology; Washington State University Irrigated Agriculture Research and Extension Center, Prosser 99350

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ABSTRACT

Moyer, M. M., Newhouse, J. M., and Grove, G. G. 2016. Efficacy of biopesticides and leaf removal in grapevine powdery mildew management. Plant Health Prog. 17:84-91.

Integrating biological-based fungicides into conventional spray programs may help with fungicide resistance management. However, little is known about how to best integrate these products while still maintaining maximum disease control. Programs with as few as one synthetic fungicide or as many as three synthetic fungicides added to a biopesticide-based rotation during the bloom period of *Vitis vinifera* had significantly better disease control than a biopesticide-only-based program. When integrated with different timings of fruit-zone leaf removal, specific combinations of biopesticide programs and fruit-zone leaf removal enhanced the efficacy of that program to be on par with disease control seen in a program entirely based on synthetic fungicides. This suggests that when designing a fungicide program using biopesticides as a base, the addition of a synthetic fungicide during the window of ontogenic susceptibility in clusters and the adoption of cultural practices such as leaf removal can significantly improve the efficacy of that program.

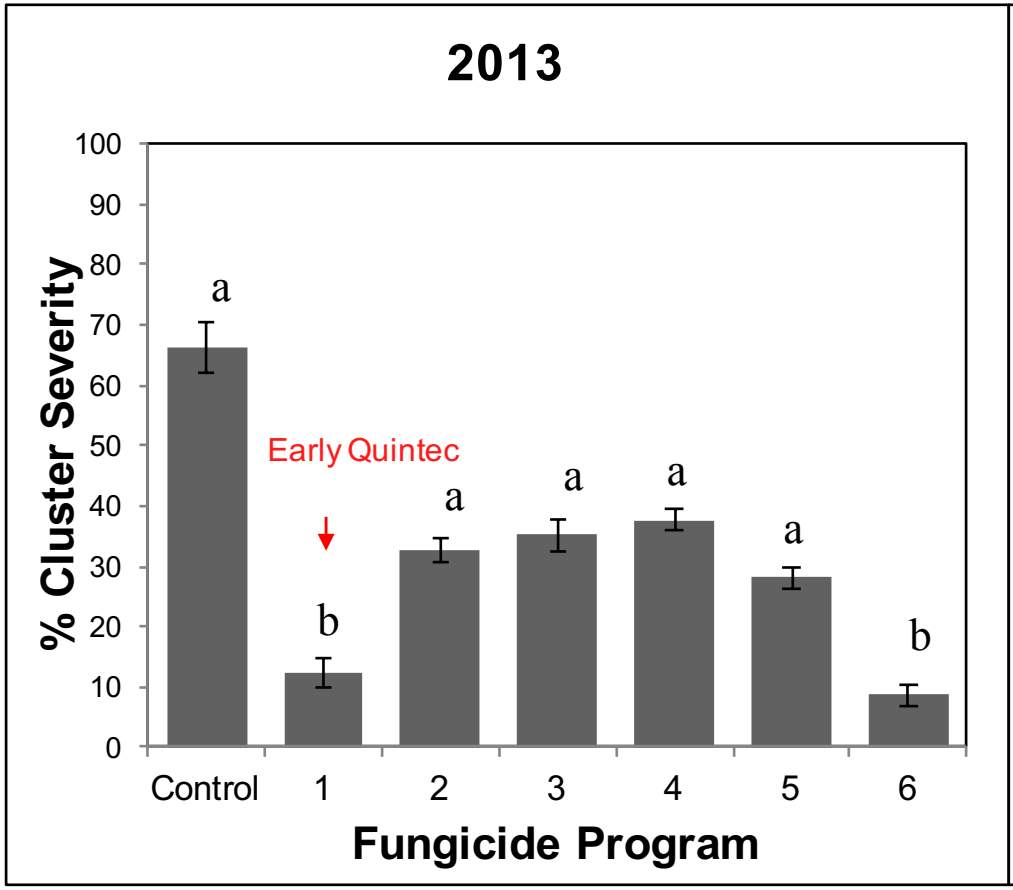
Moyer, M.M., J.M. Newhouse, and G.G. Grove. 2016**.** [Efficacy of Biopesticides and Leaf Removal in Grapevine Powdery Mildew Management]. Online. Plant Health Progress 17:84-91

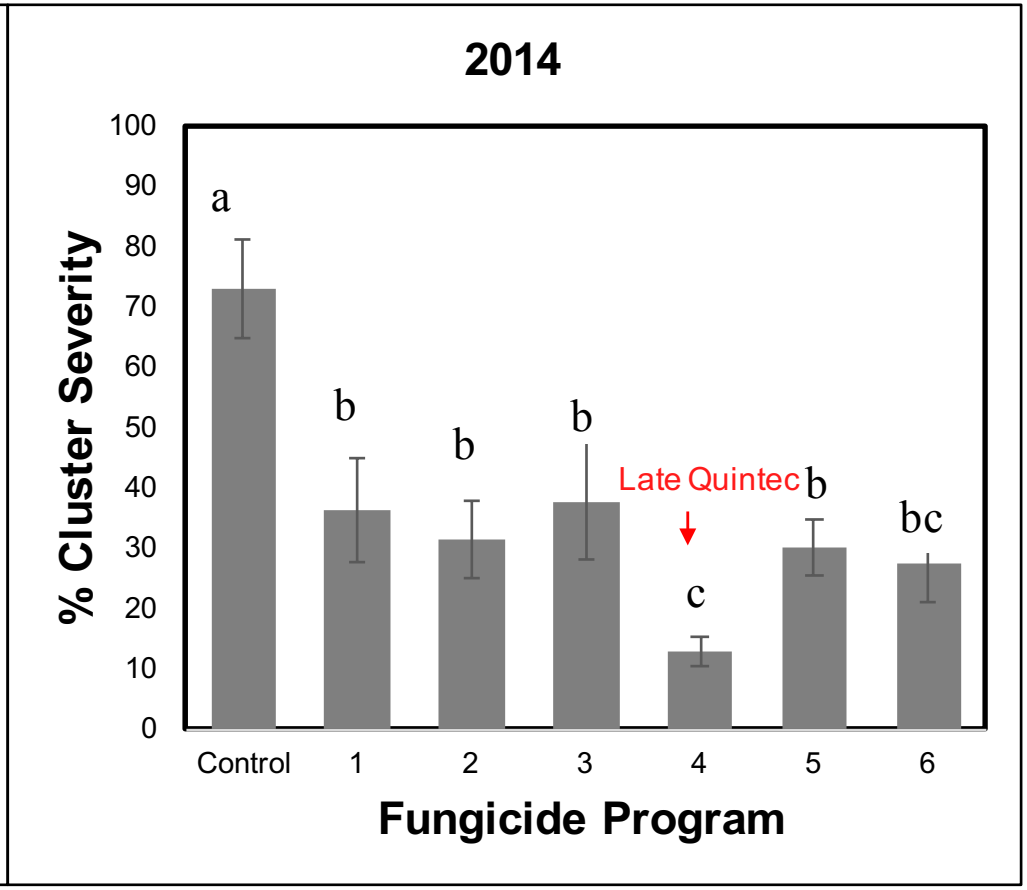
TIMING SYNTHETIC PRODUCTS (2013 & 2014)

NOTE: FOR EXPERIMENT PURPOSES ONLY; DO NOT TRY PROGRAMS SUCH AS 9 IN A COMMERCIAL SETTING. ALWAYS ROTATE FRAC CODES, AND DO NOT APPLY MORE THAN 2 FRAC 11s A SEASON

Vine phenological stage	15-30 cm shoot growth	Rachis elongation / prebloom	Full bloom / 100% capfall	Fruit set	4 weeks postbloom	Bunch closure
Program	Active Ingredient					
Control	Unsprayed	Unsprayed	Unsprayed	Unsprayed	Unsprayed	Unsprayed
1	Rally	Quintec	Rally	Rally	Rally	Rally
2	Rally	Rally	Quintec	Rally	Rally	Quintec
3	Rally	Rally	Rally	Quintec	Rally	Rally
4	Rally	Rally	Rally	Rally	Quintec	Rally
5	Rally	Rally	Torino	Rally	Rally	Rally
6	Rally	Rally	Vivando	Rally	Rally	Rally

TARGETED MOA





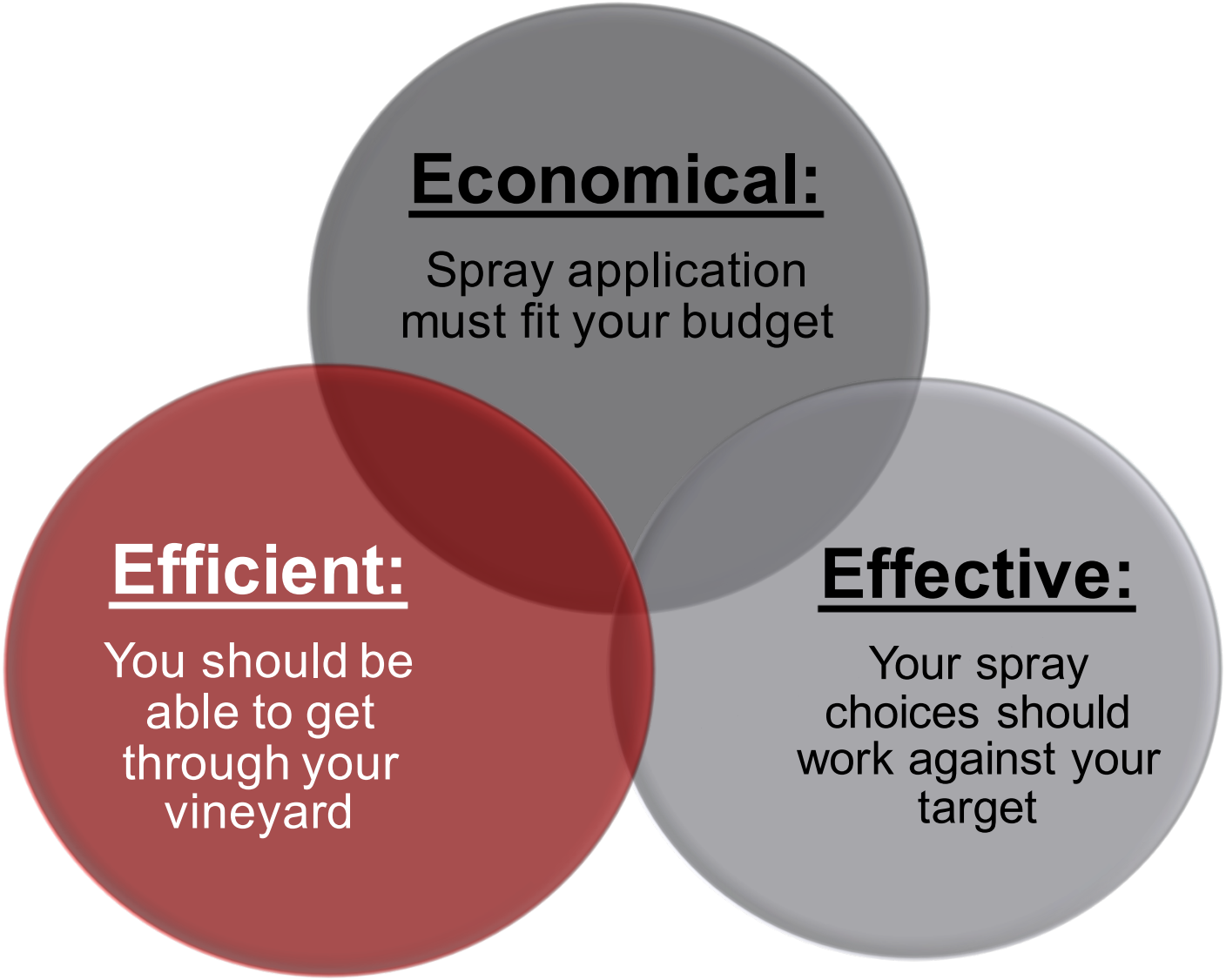
** Data log transformed for analysis. Means separation Tukeys HSD α=0.05*

WHAT WE CAN IMPROVE

Future research in mildew management.

PM CAN BE CONTAINED… WITH TECHNIQUE

MICHELLE'S 3 E'S OF SUSTAINABLE SPRAYING



SPRAY INTERVALS AND LARGE ACREAGE ☹

Powdery Mildew Information		
	Conventional	Latent Period (d)
Budbreak	8-Apr	
Date of 1st infection	**17-Apr**	
Date to sporulation of next generation	30-Apr	15
	9-May	9
	18-May	9
	26-May	8
	2-Jun	7
	9-Jun	7
	18-Jun	9

- Spray "intervals" were acceptable
- Takes 12-15 days to complete 1 spay
- So the first spray on one block occurs 2 weeks after the first spray on another…

Product	Application Date	Days between Application
JMS Stylet Oil 2% solution in 50 gal of water per acre	2-May	
Procure 8 fl oz and JMS Stylet Oil 2% solution in 50 gal of water per acre	17-May	15
Quintec 6.6 fl oz and Micro Sulfur 3 lbs in 50 gal of water per acre	30-May	13
Flint 3 oz in 75 gal of water per acre	14-Jun	14

Product	Application Date	Days between Application
JMS Organic Stylet Oil 2% solution in 50 gal of water per acre	13-May	
JMS Organic Stylet Oil 2% solution in 50 gal of water per acre	22-May	9
Micro Sulfur 3.5 lbs in 50 gal of water per acre	2-Jun	11
Micro Sulfur 3.5 lbs in 75 gal of water per acre	16-Jun	14

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IMPROVING PRACTICES GIVEN OUR ENVIRONMENT

EVALUATING SPRAYERS AND COVERAGE

- Sprayer Technology Evaluation
- Coverage and Biology
  - Chemical MOA and Disease Control
- Development of Extension curriculum
- Partners: Gwen Hoheisel (Extension), Lav Khot, BSE)

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QUESTIONS?

VITICULTURE EXTENSION

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