

Controlling Fungicide-Resistant Powdery Mildew Populations

Living in a World with Resistant Pathogens

Walt Sanders



UNIVERSITY OF
GEORGIA

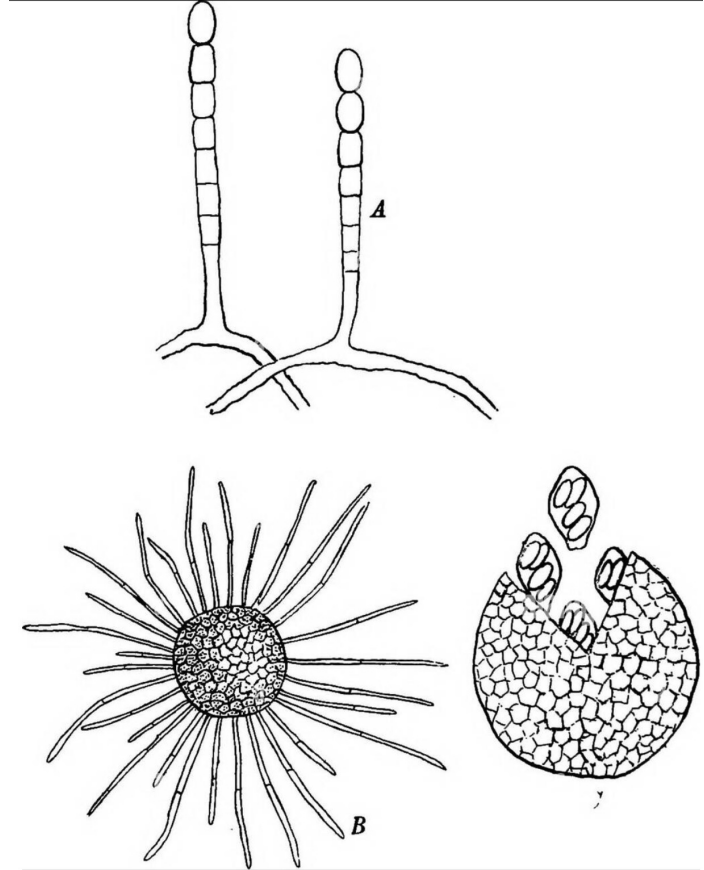
A bit about myself

- 1st year master's student in plant pathology
- Principle investigator: Dr. Phil Brannen
- On my committee: Dr. Sarah Lowder

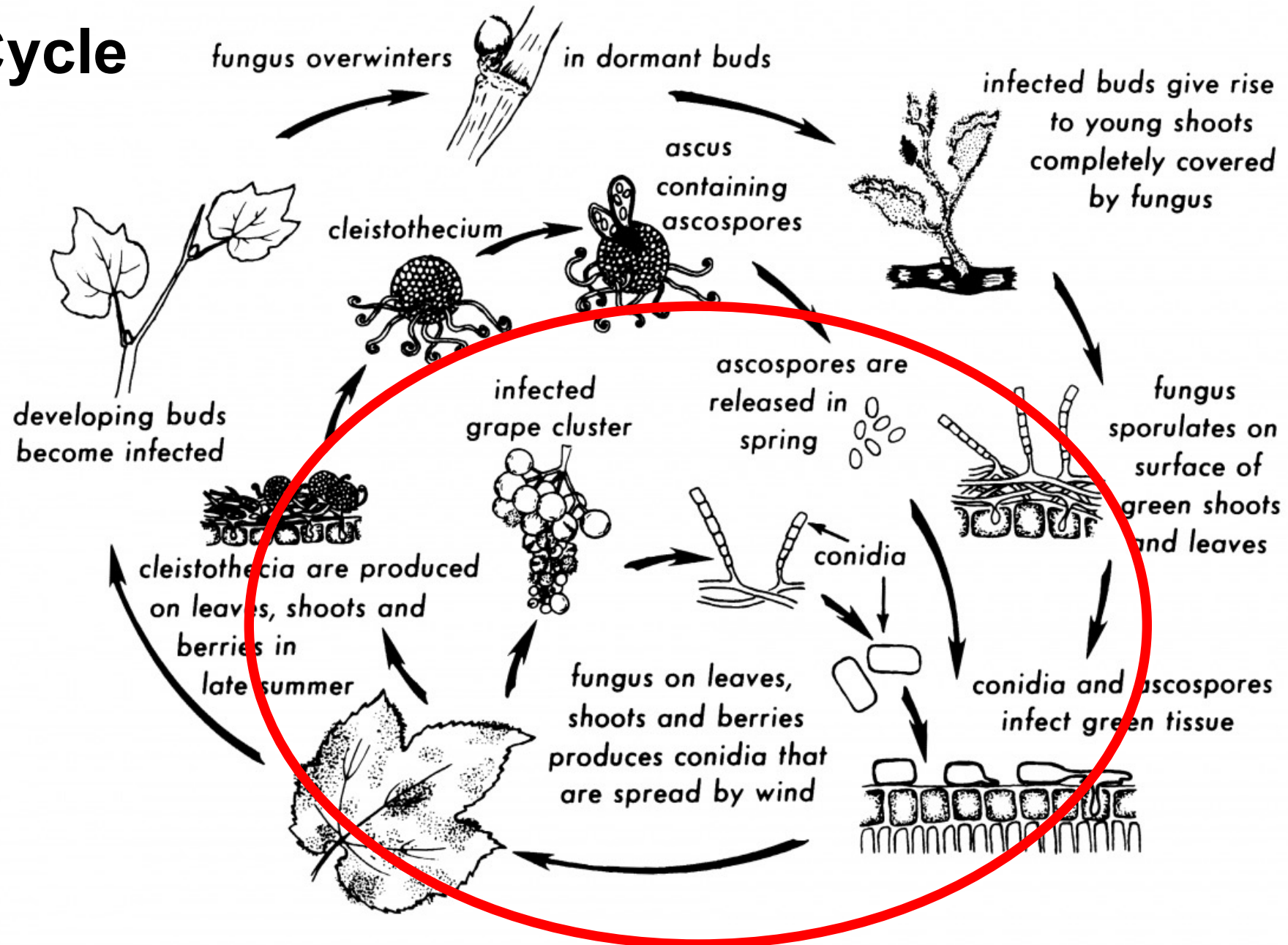


Grapevine powdery mildew (GPM)




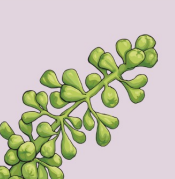
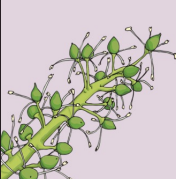


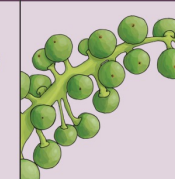
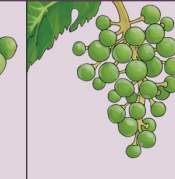




- *Erysiphe necator*
- Ascomycete fungi
- Interferes with photosynthesis and decreases fruit quality
- Zero tolerance for disease
- Even small amounts alter the flavor of the wine

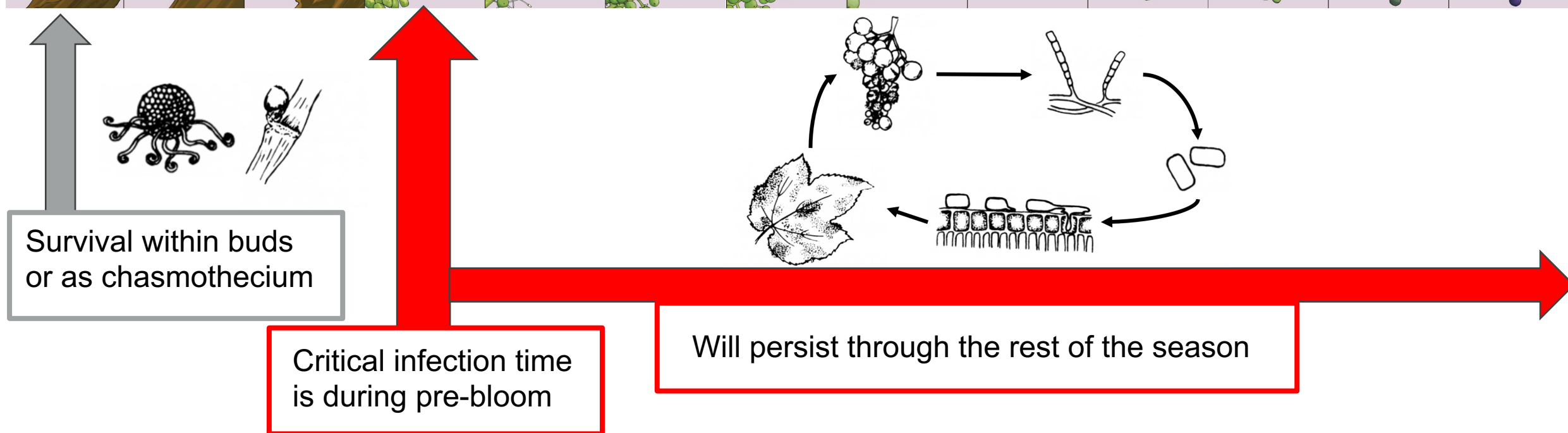


Life Cycle



Critical Infection time

1	2	3	4	5	6	7	8	9	10	11	12	13
DORMANT	BUD SWELL	BUD BREAK	PREBLOOM	BLOOM	FRUIT SET	BB-SIZED FRUIT	PEA-SIZED FRUIT	BERRY TOUCH	BUNCH CLOSURE	VERAISON	PREHARVEST	HARVEST
												



Fungicides	FRAC Code	Contact or Systemic
Abound (azoxystrobin)	11	Systemic
Aprovia (benzovindiflupyr)	7	Systemic
Inspire Super (difenoconazole + cyprodinil)	3 + 9	Systemic
Luna Experience (fluopyram + tebuconazole)	3 + 7	Systemic
Microthiol Disperss (sulfur)	M2	Contact protectant
Pristine (pyraclostrobin + boscalid)	7 + 11	Systemic
Quintec (quinoxifen)	13	Contact protectant
Rally (myclobutanil)	3	Systemic
Stylet-oil (paraffinic oil)	NC	Contact protectant
Torino (cyflufenamid)	U6	Contact protectant
Vivando (metrafenom)	U8	Contact protectant

DMIs, SDHIs, and QoIs

FRAC | MODE OF ACTION

3	Sterol inhibitor - DMI
7	Succinate dehydrogenase inhibitor - SDHI
11	Quinone outside inhibitor - QoI

- Primary control method
- Specific mode of action
- Resistance issues

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Resistance detected at the GMRC

- Powdery mildew swabbing followed by PCR
- QoI and DMI resistance at Blairsville station



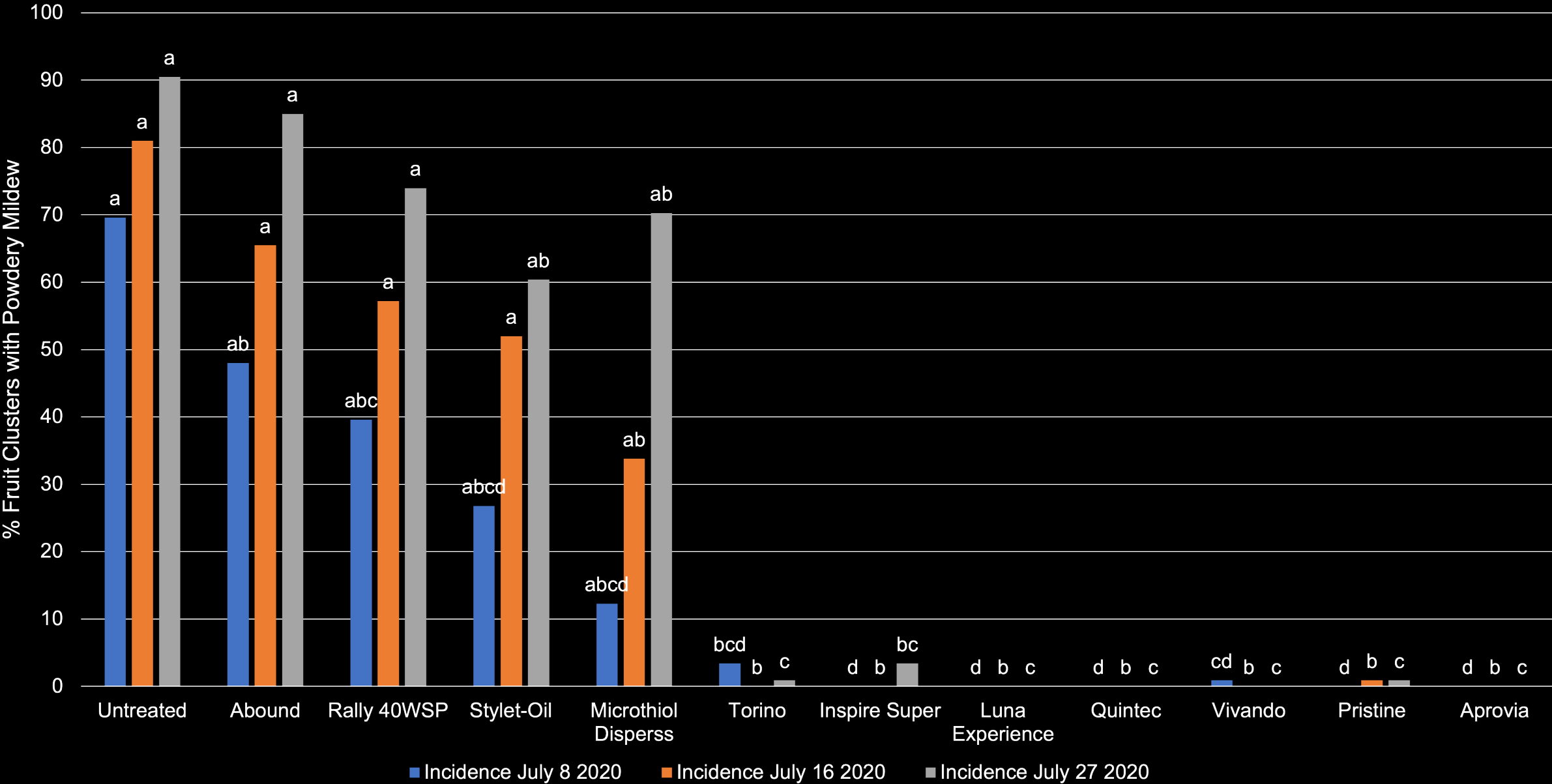
GA Swab Y136F Summary **DMI**

Status	Total	%
Mutant Type	17	23
Wild Type	0	0
Mixed	58	77
Total	75	100

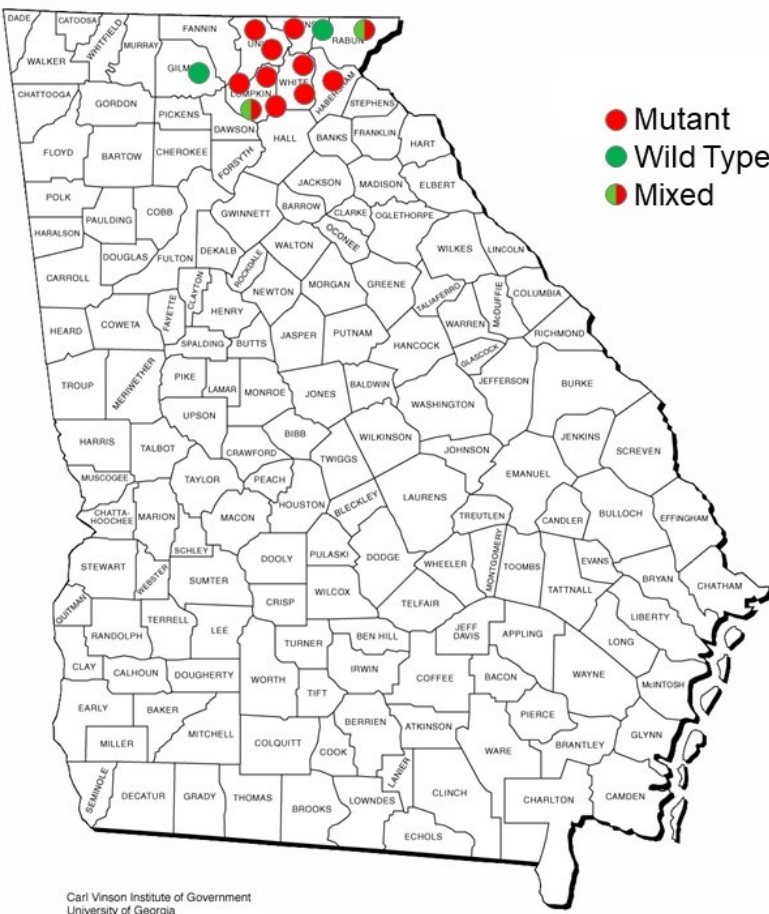
GA Swab G143A Summary **QoI**

Status	Total	%
QoI resistant	75	100
QoI sensitive	0	0
Mix Sensitive/Resistant	0	0
Total	75	100

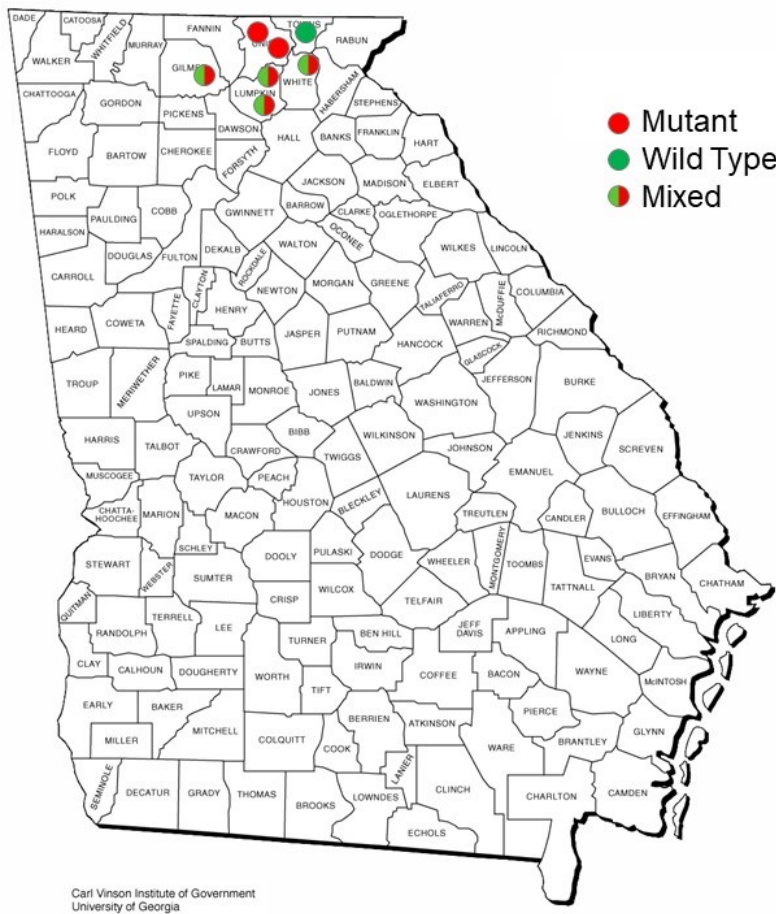
Powdery Mildew Cluster Incidence 2020



Resistance detected in Georgia

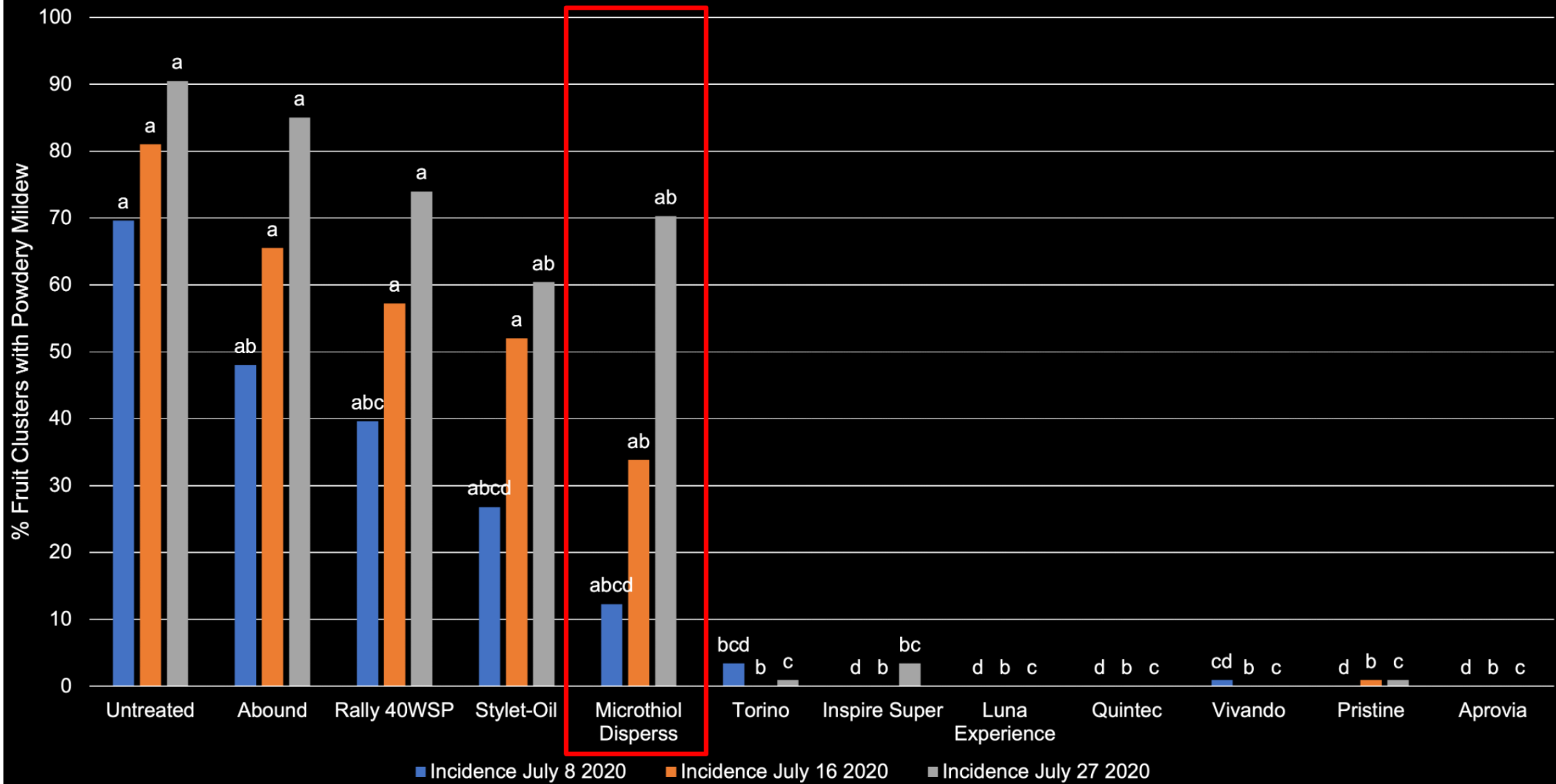


QoI Resistance



DMI Resistance

Powdery Mildew Cluster Incidence 2020



Phytotoxicity

- Several experiments conducted in Australia
- Necrosis or burning of leaf margins
- Premature defoliation
- Phytotoxicity at $>85^{\circ}\text{F}$ and $>75\%$ humidity
- Hybrids have greater sensitivity



Project: Powdery Mildew Control with Sulfur

- Increasing efficacy:
 - Surfactants
 - Air Induction nozzles
- Phytotoxicity:
 - When does it occur exactly?





Clark McAllister –
Dawson and Lumpkin
County Extension



John Scaduto –
Rabun County
Extension

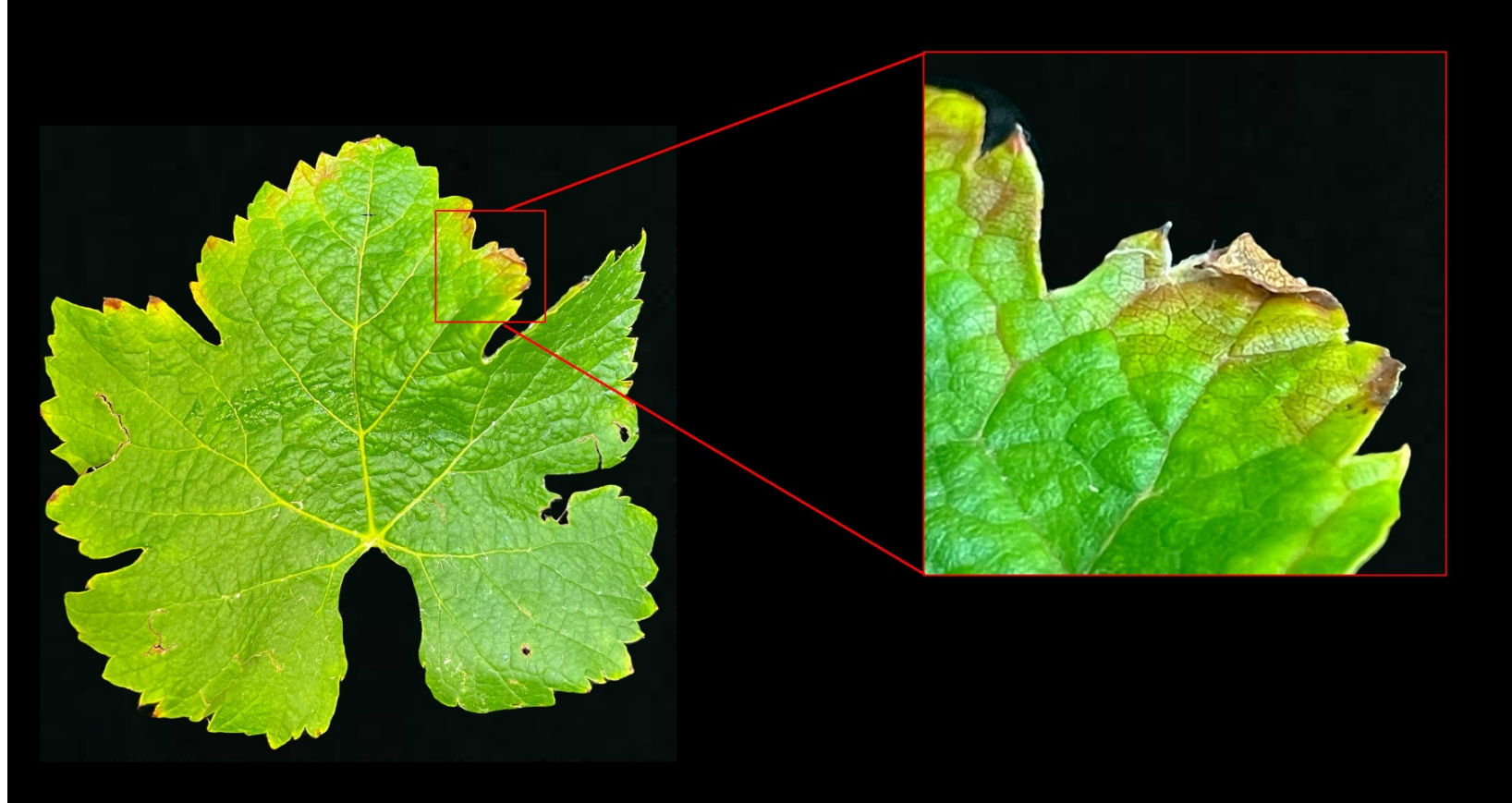


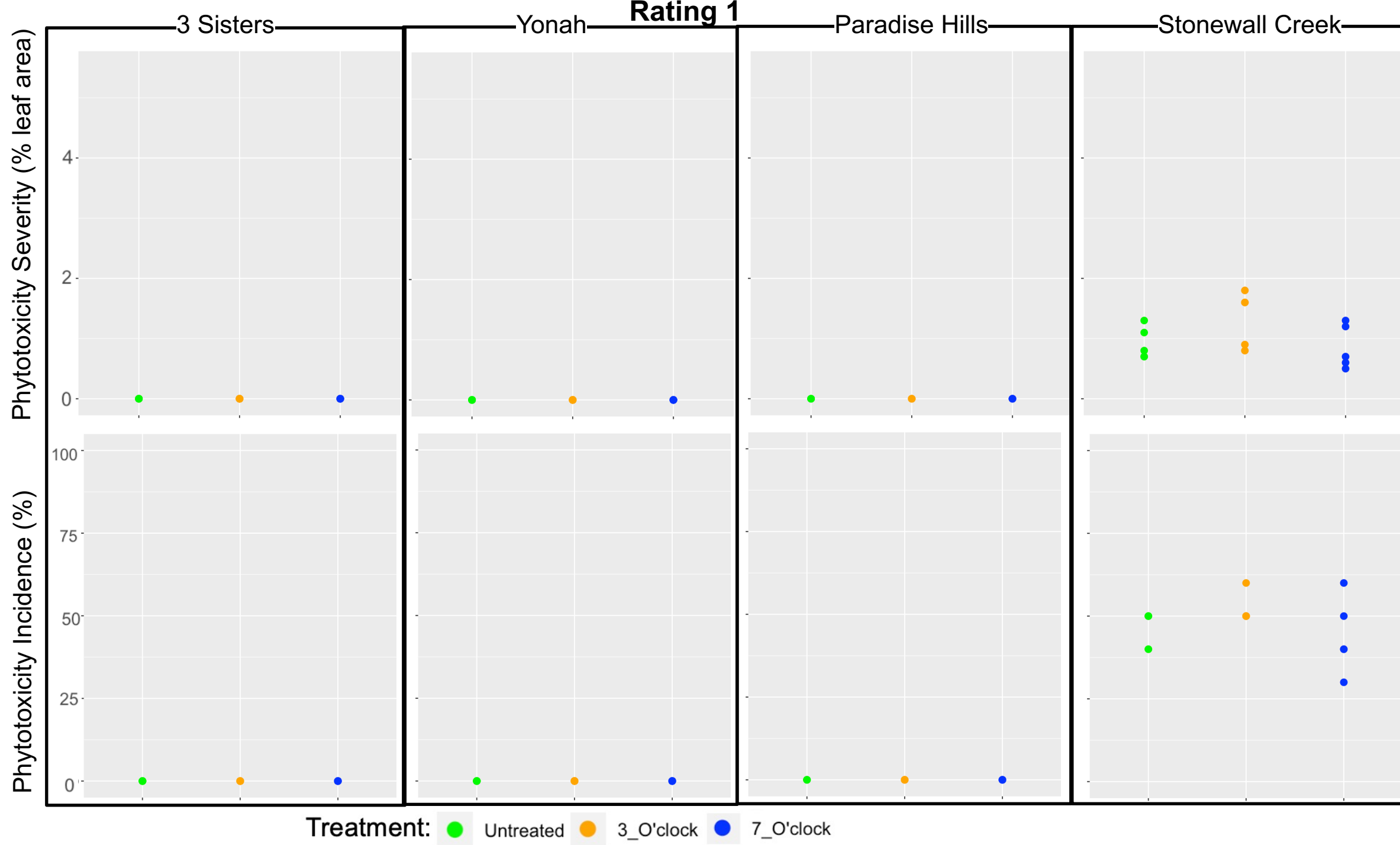
Nathan Eason –
White County
Extension

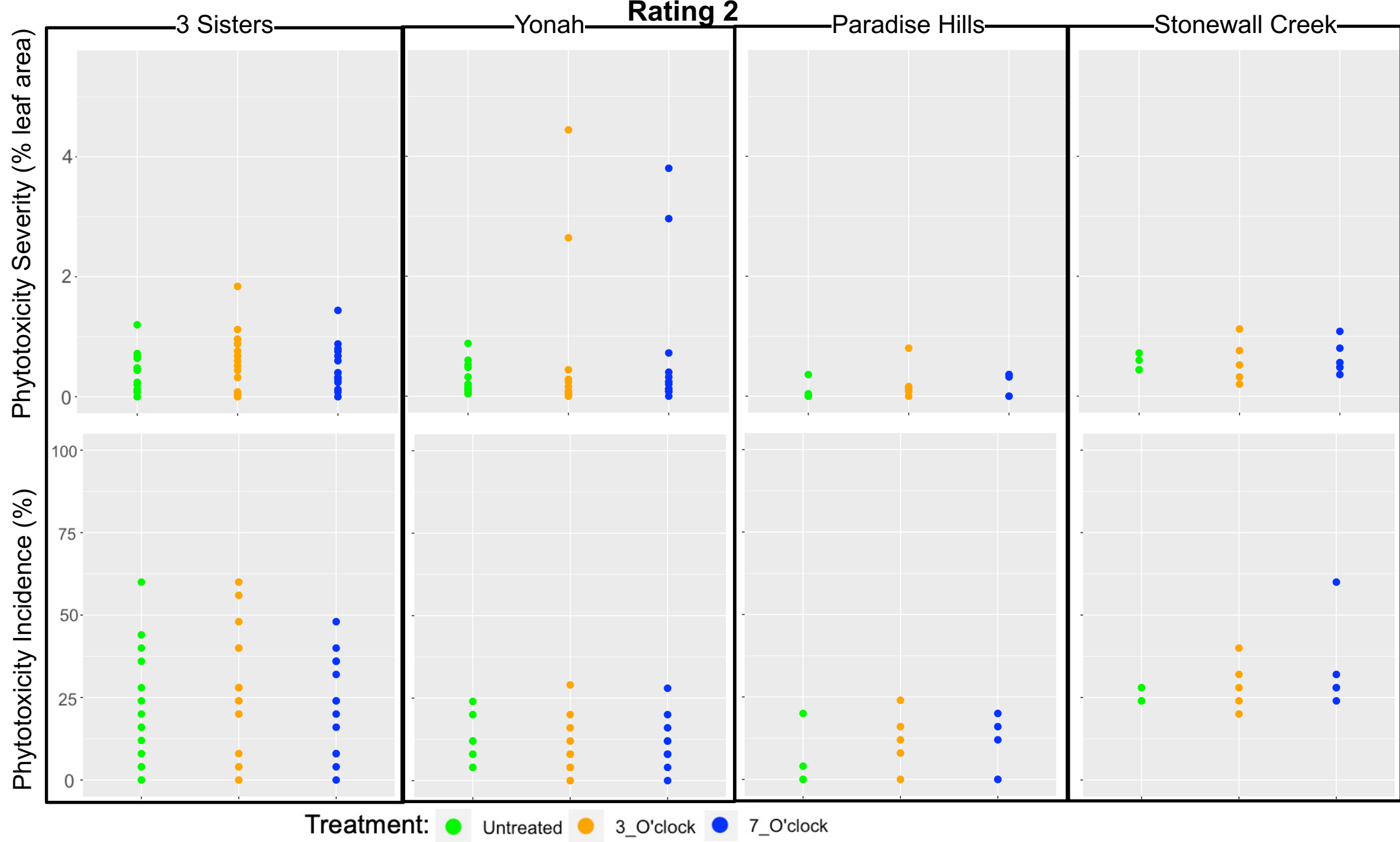


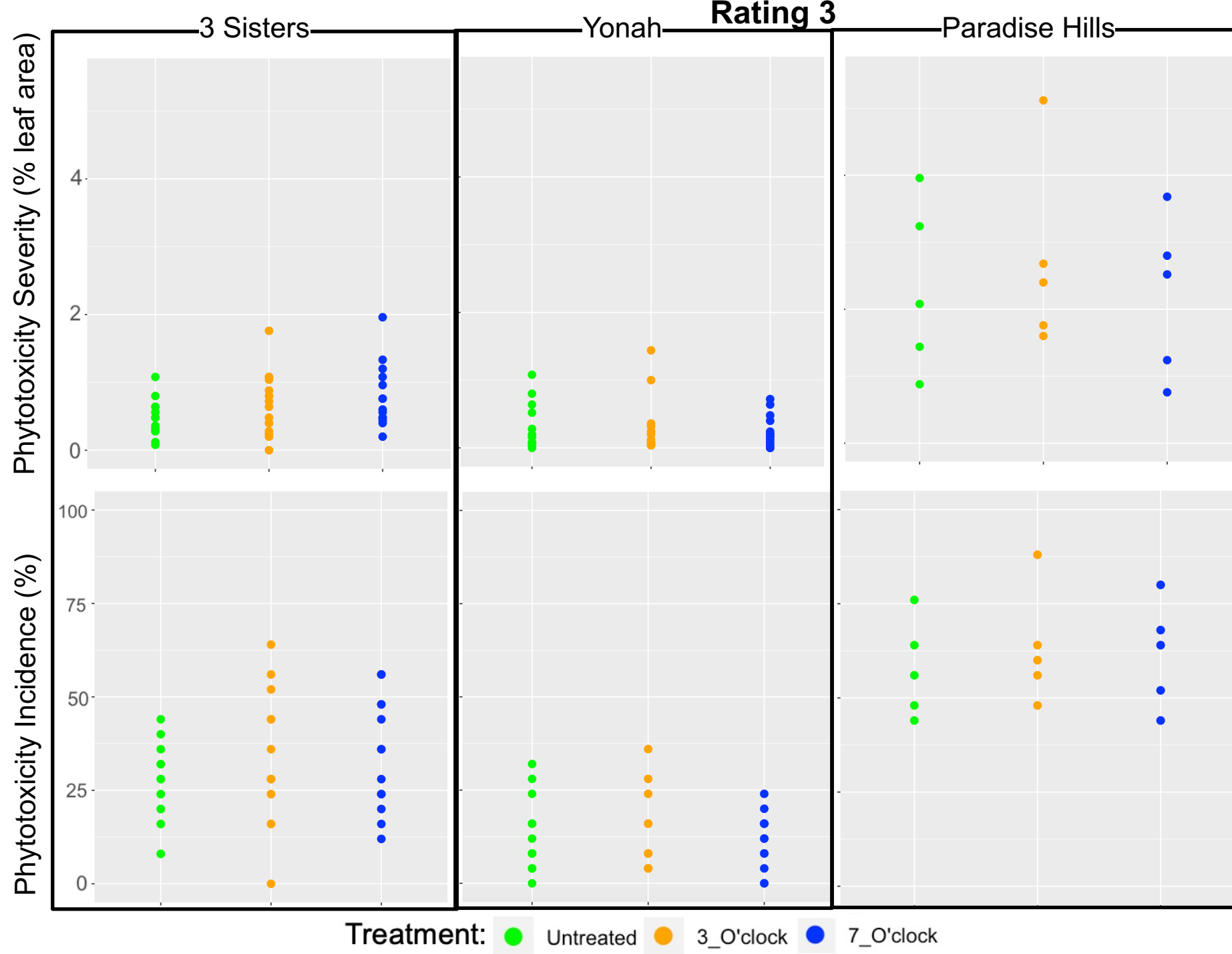
Jacob Williams –
Towns and Union
County Extension

Rating



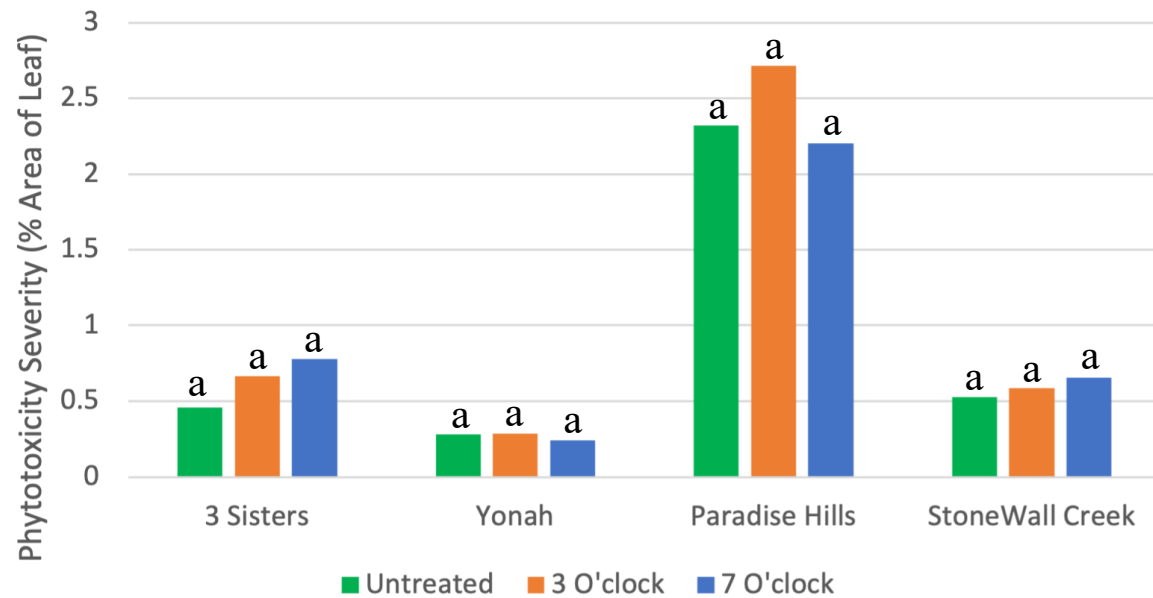




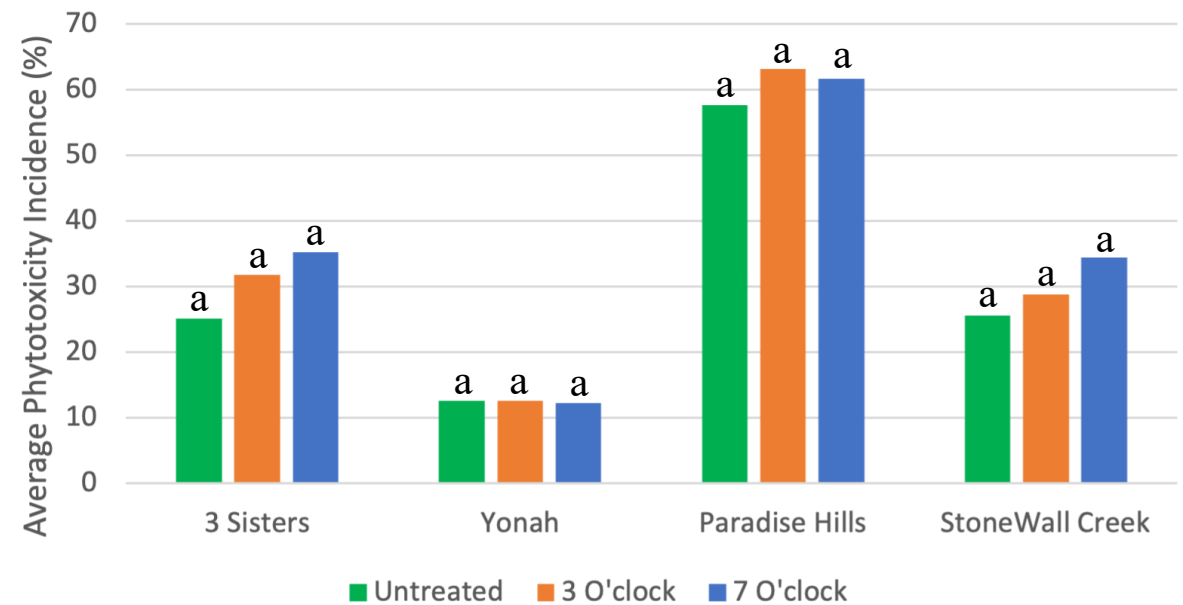


Sites

Average Phytotoxicity Severity

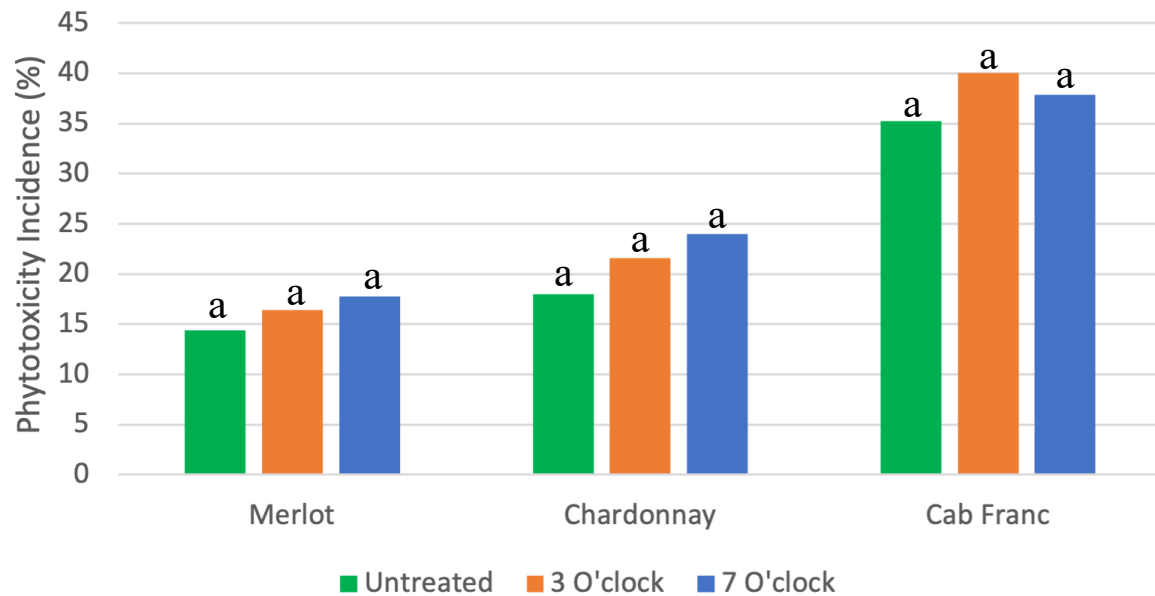


Average Phytotoxicity Incidence

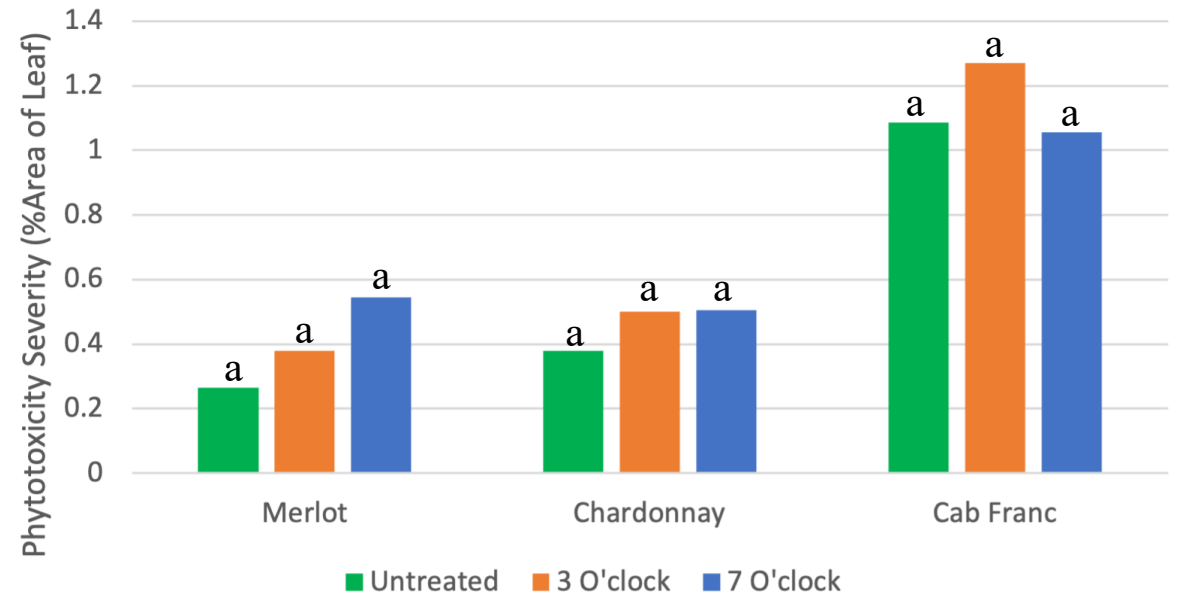


Cultivars

Average Phytotoxicity Incidence



Average Phytotoxicity Severity



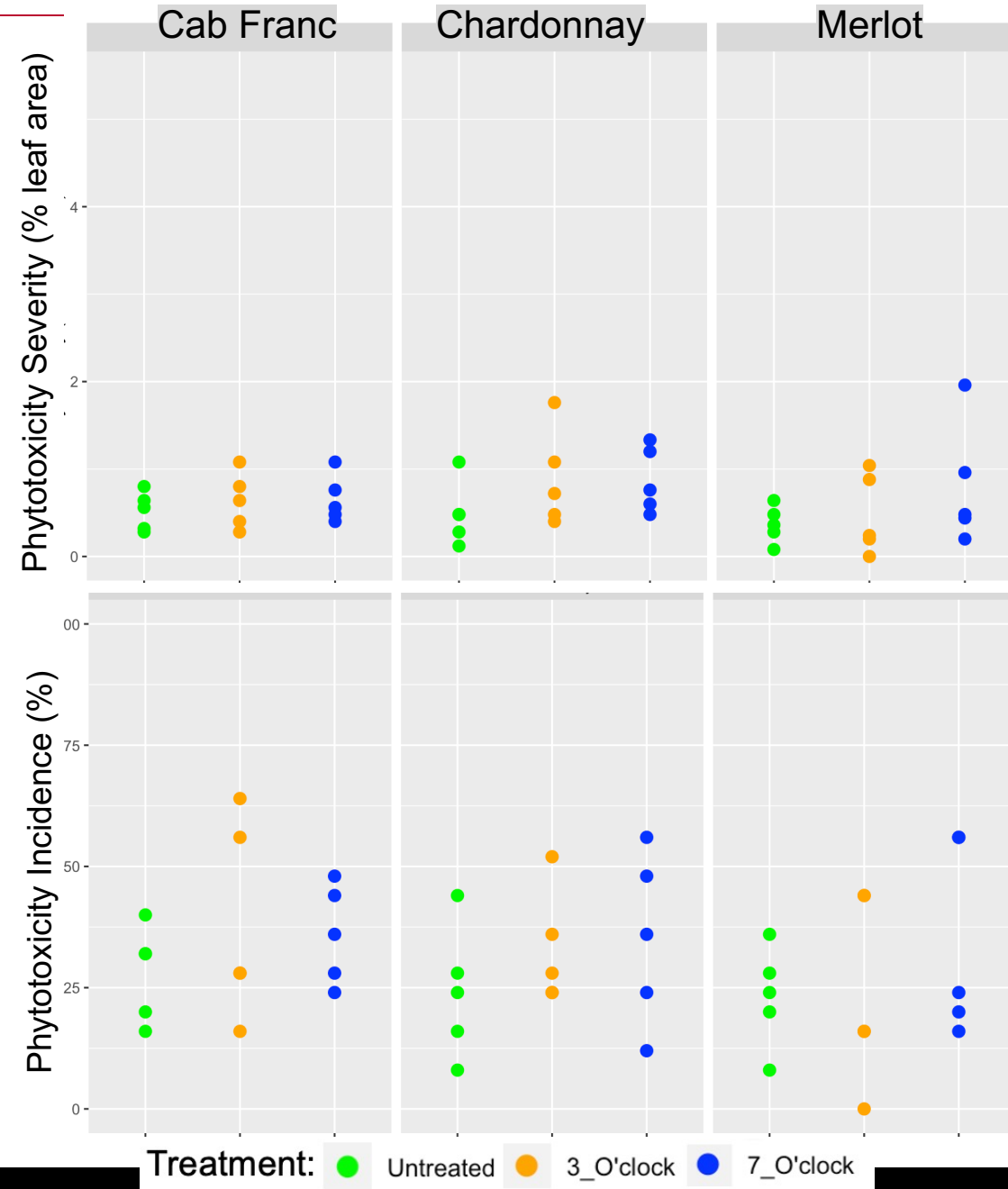
3 Sisters on August 23rd

3 O'clock:

- 85.79 °F
- 59.69% Humidity
- Leaf Temperature: 98 °F

7 O'clock:

- 81.82 °F
- 66.46% Humidity
- Leaf Temperature: 82 °F





Untreated



3 O'clock



7 O'clock



Untreated



3 O'clock



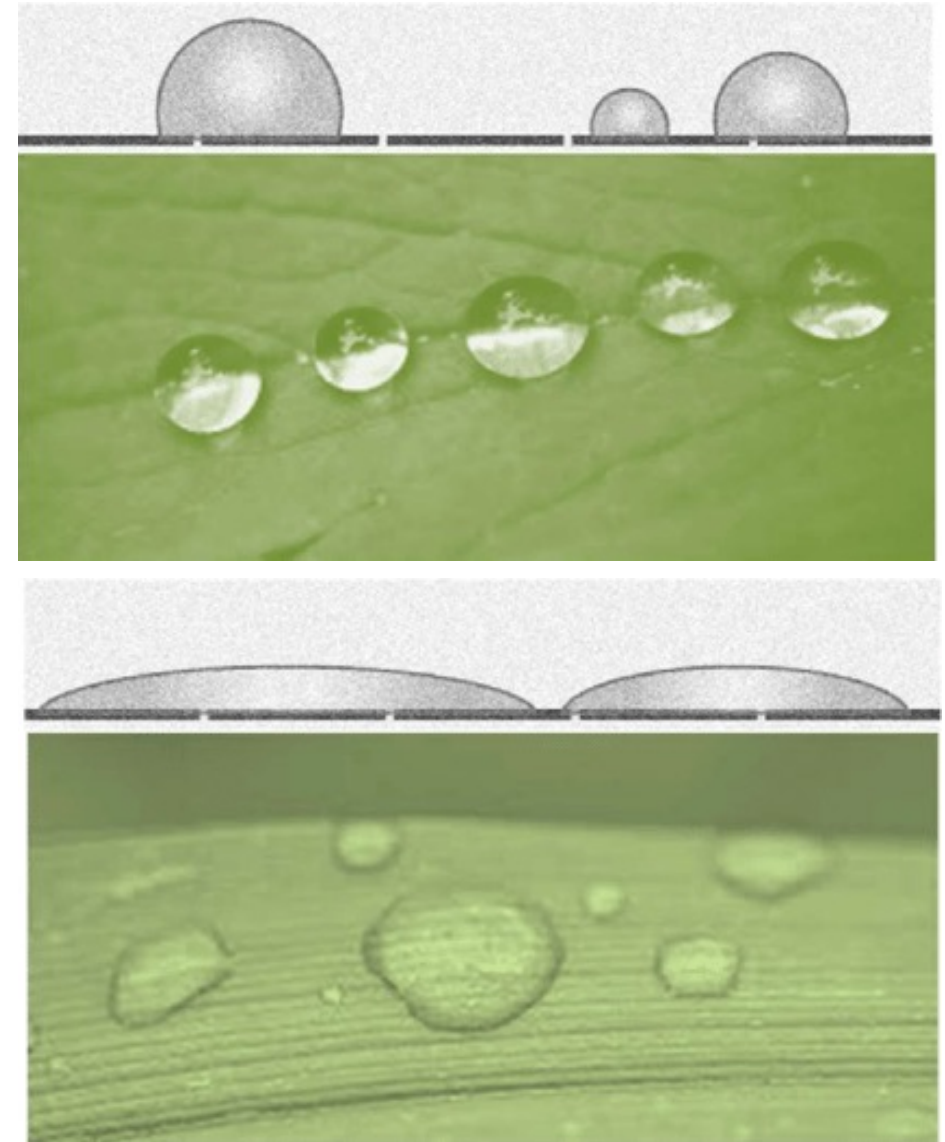
7 O'clock



Trials at the Blairsville Station

Surfactants

- Surfactants: soap-like compounds which spread water droplets on leaf surfaces
- Improve coverage with contact fungicides



Potential in Surfactants

Treatment and amount/A	Application timing *	Leaf powdery mildew incidence 29 Jun**	Leaf powdery mildew incidence 22 Jul **	Leaf mildew severity 29 Jun**	Leaf powdery mildew severity 22 Jul **
Untreated	---	100.0 a	100.0 a	40.8 a	43.2 a
Microthiol Disperss 80DF 10 lb	ABCD	89.6 ab	31.2 b	21.9 bcd	4.4 b
Microthiol Disperss 80DF 10 lb + Bond Max 1.5 fl oz	ABCD	85.6 b	20.8 bc	19.1 d	2.1 b
Microthiol Disperss 80DF 10 lb + LI 700 0.25 pt	ABCD	89.6 ab	27.2 b	19.4 cd	3.2 b
Microthiol Disperss 80DF 10 lb + Vintre 16 fl oz	ABCD	98.4 a	28.8 b	29.6 b	2.3 b
Microthiol Disperss 80DF 10 lb + Hi-Wett 9.5 fl oz	ABCD	85.6 b	10.4 c	13.7 d	0.6 b
Microthiol Disperss 80DF 10 lb + Trend 90 4 fl oz	ABCD	96.0 ab	27.2 b	29.4 bc	2.5 b

*Treatment dates: A = 1 Jun (post bloom), B = 14 Jun (first cover), C = 28 Jun (bunch closure), D = 11 Jul (second cover)

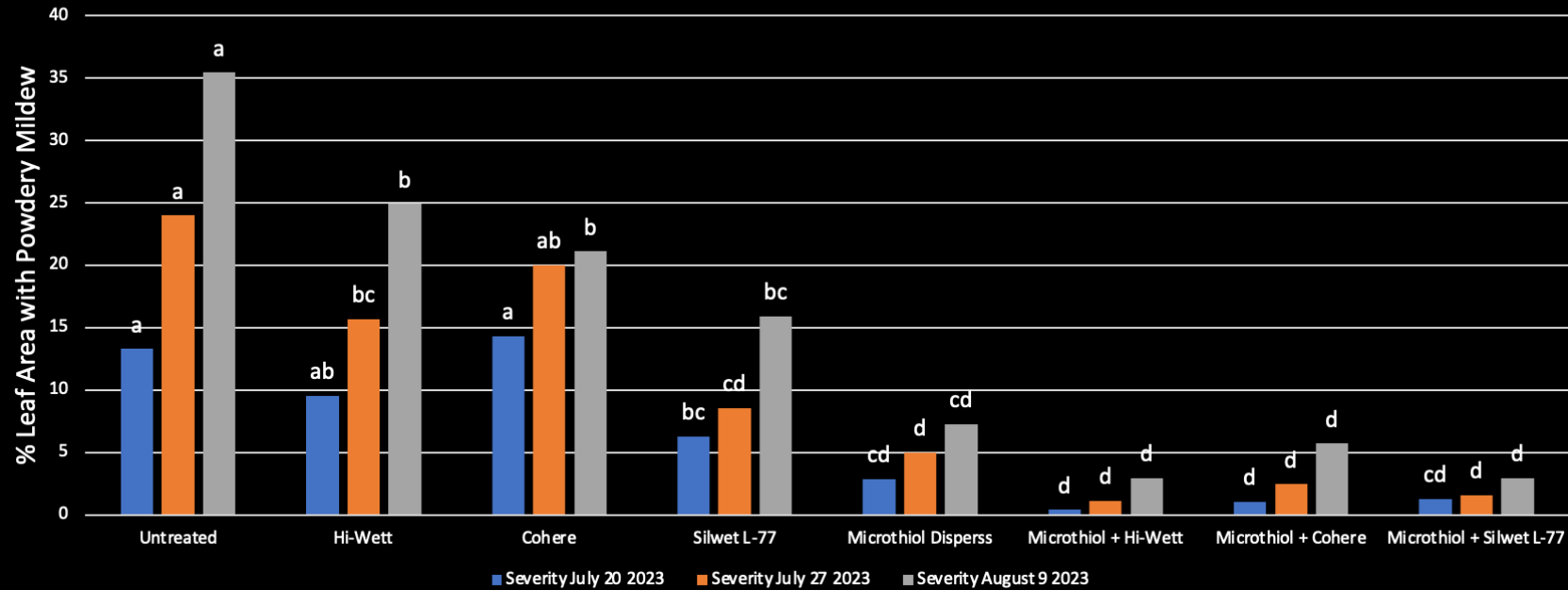
**Powdery mildew incidence (% infected leaves) and severity (% of leaf covered by powdery mildew) were calculated from 25 leaves per treated plant. Means followed by the same letter are not significantly different when comparing each pair using Student's t test statistic ($P \leq 0.05$).

Surfactant Trial Layout

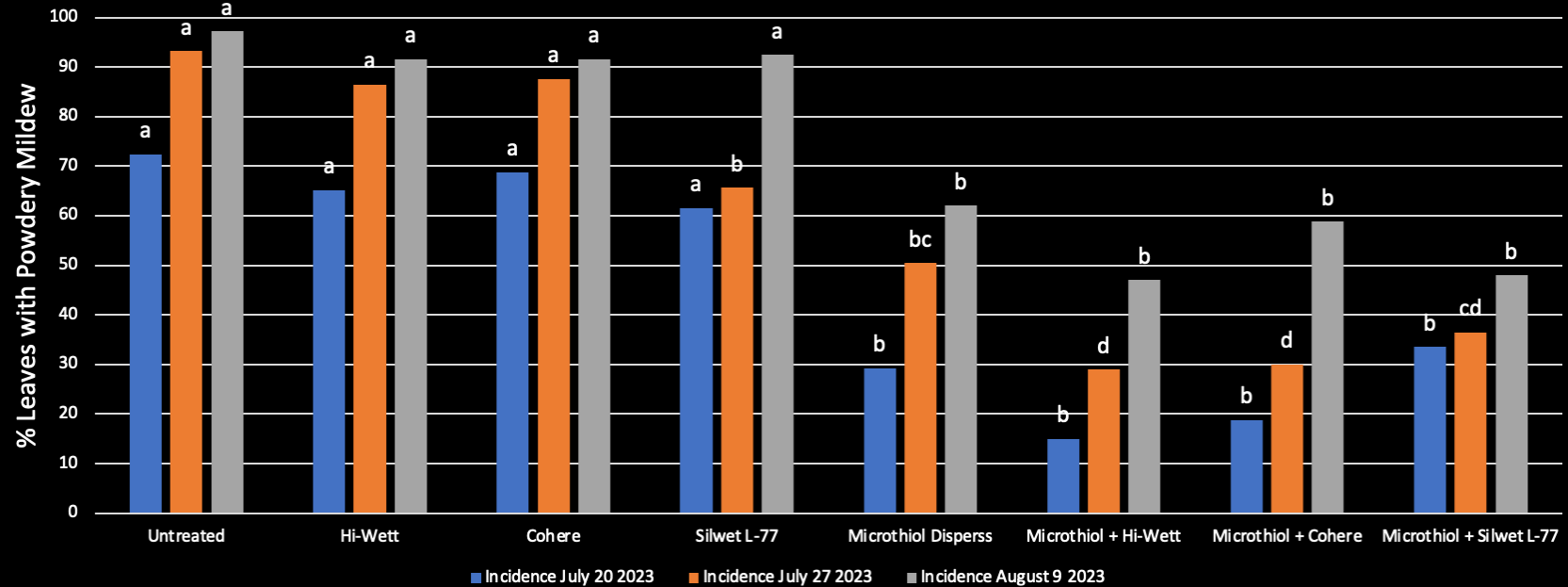
- 3 surfactant products
 - Non-ionic organosilicone
- Sprayed with and without sulfur
- 5 replications
- Rated for powdery mildew incidence and severity

Treatment	Treatment Color	Treatment Number
Untreated	White	1
Hi-Wett	Green	2
Cohere	Red	3
Silwet L-77	Orange	4
Microthiol	Pink	5
Microthiol Hi-wett	Yellow	6
Microthiol Cohere	Blue	7
Microthiol Silwet L-77	Yellow/Black	8

Powdery Mildew Leaf Severity 2023



Powdery Mildew Leaf Incidence 2023



Synergy

Surfactant Treatment + Sulfur		Percent Disease Control ¹			
		Observed [*]	Expected ^{**}	O-E	Chi-Square Test ^{***}
Cohere	Incidence	59.0	48.7	+10.3	ss
	Severity	86.4	78.1	+8.3	s
Hi-Wett	Incidence	60.8	47.5	+13.3	ss
	Severity	90.8	74.2	+16.6	ss
Silwet L-77	Incidence	56.0	58.3	-2.3	-
	Severity	90.7	81.8	+8.9	ss

¹Percent disease control is derived from AUDPCs developed for incidence and severity

^{*} Average percent control of surfactant product combined with Microthiol Disperss as observed in-field

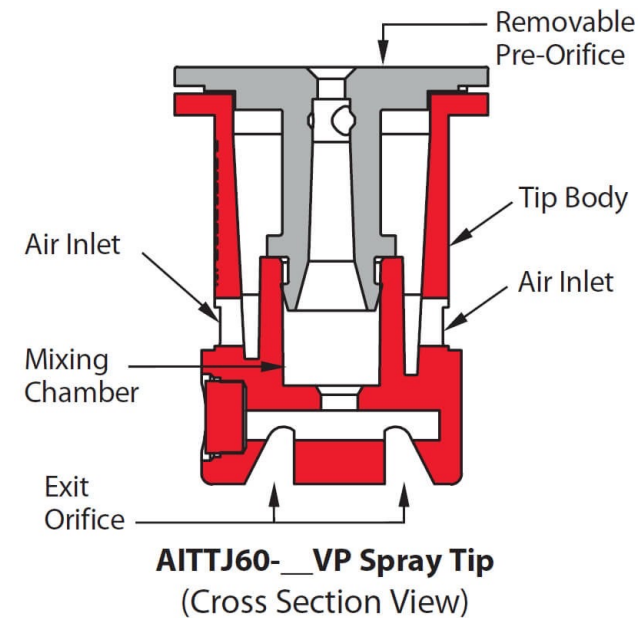
^{**} Expected average percent control as calculated through individual product performance when using the Colby formula (Colby, 1967)

^{***} Chi-square test, difference between observed and expected values significantly different at 5% level (s) and 1% level (ss)



Air Induction Nozzles

- Inject air into droplets, making them larger
- Should increase penetration/retention into the canopy
- Potential increase in efficacy
- Synergistic effects with surfactants





Nozzle Trial Layout

- 2 surfactant products
- Sprayed with and without sulfur
- Once with cone nozzles, once with air induction nozzles
- 5 replications
- Rated for powdery mildew incidence and severity

Treatment	Treatment Color	Treatment Number	Nozzle
Untreated Control	White	1	~
Microthiol	Green	2	Cone
Microthiol	Red	3	Cone
Hi-wett	Red		Cone
Microthiol	Orange	4	Cone
Cohere	Orange		Cone
Microthiol	Pink	5	Air Induction
Microthiol	Yellow	6	Air Induction
Hi-wett	Yellow		Air Induction
Microthiol	Blue	7	Air induction
Cohere	Blue		Air Induction



Conclusions from this Year

1. Surfactants seem to have some impact on disease control
 - More testing needed

 2. Sulfur doesn't have a significant phytotoxic effect on *Vinifera* varieties
 - Repeat trial next year
-
- Hopefully, we will have nozzle data to share next year



Questions???