

Managing Winegrape Powdery Mildew and Botrytis Bunch Rot Using Biofungicides

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CAL POLY

Biopesticides

- Biopesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs. (EPA)

Biopesticides

plant extract,
microbial
metabolites

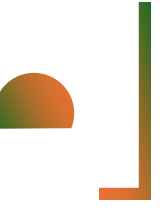
- Biopesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs. (EPA)

Bacillus spp.,
Trichoderma
spp.

Bt gene

- Biofungicides

California Grape Industry



(Volpe, 2010)

\$5.23B in 2021

 **Total Grape Acres: 881,000**

- 128,000 ac; table grape
- 138,000 ac; raisin grape
- **615,000 ac; wine grape**
 - **29,151 ac, organic wine grape (2022)**

 **Wine Grape Economic Impact**

- Wine grapes account for **\$3.6 B**
- **81% of US** wine grape
- CA; **4th** leading wine producer (cdfa.ca.gov)



Grapevine diseases

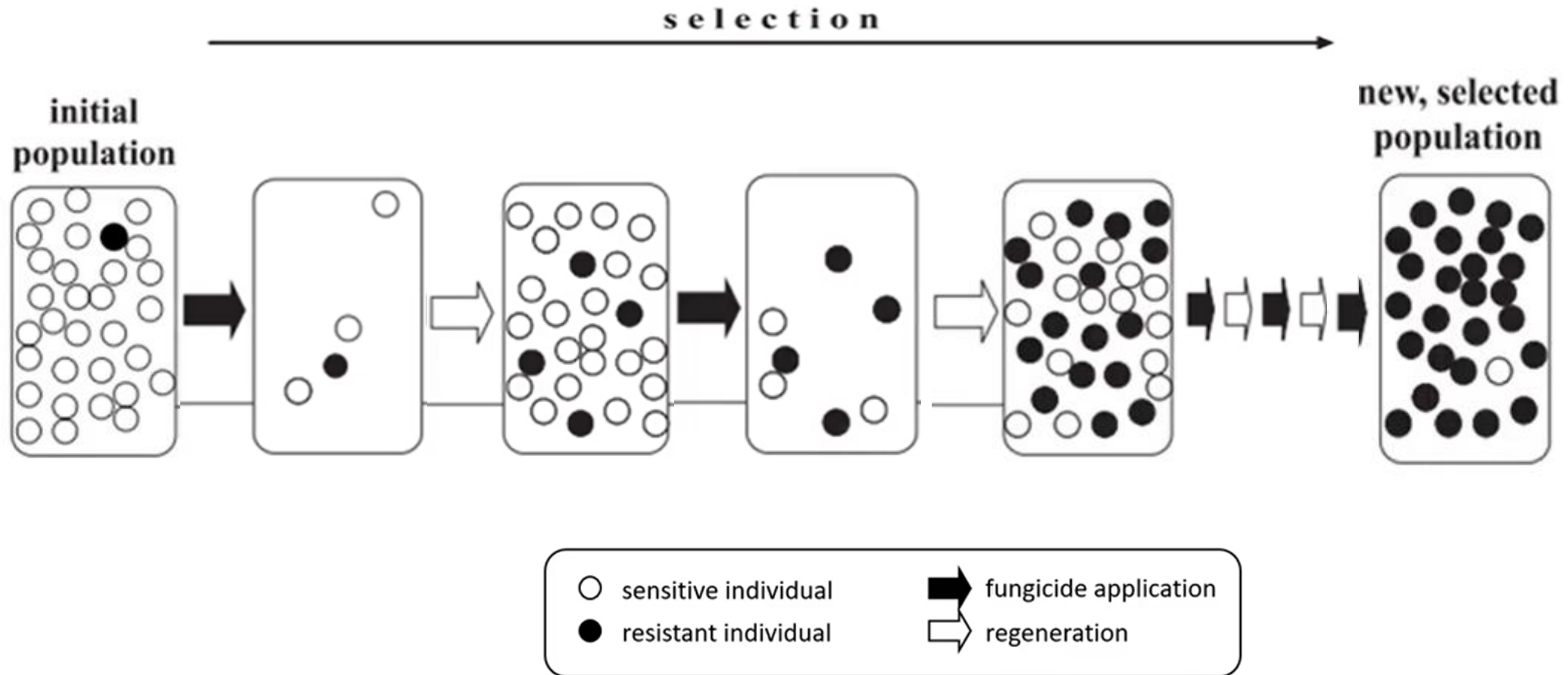
- Powdery mildew
- Botrytis bunch rot
- Grapevine trunk disease
- ...



Use of biofungicides

- A significant part of integrated pest management
 - Replace or reduce synthetic pesticides usage

Fungicide Resistance Accumulation



Adapted from Diesling et al. 2008

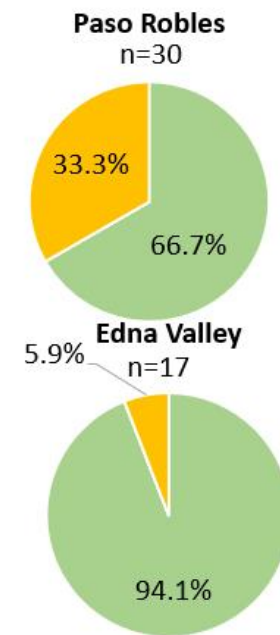
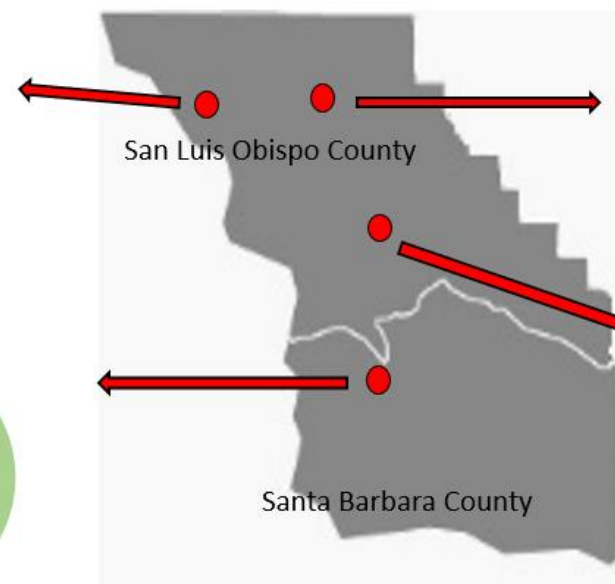
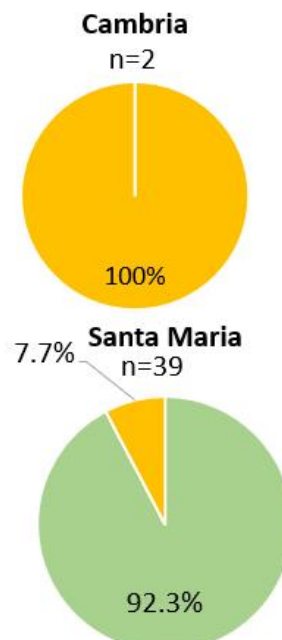
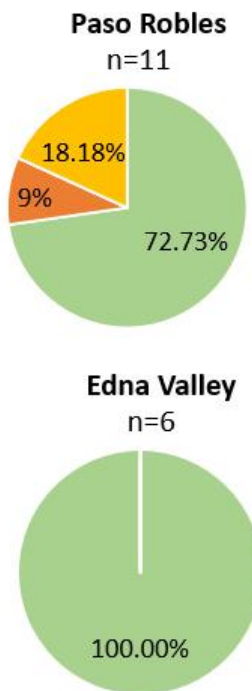
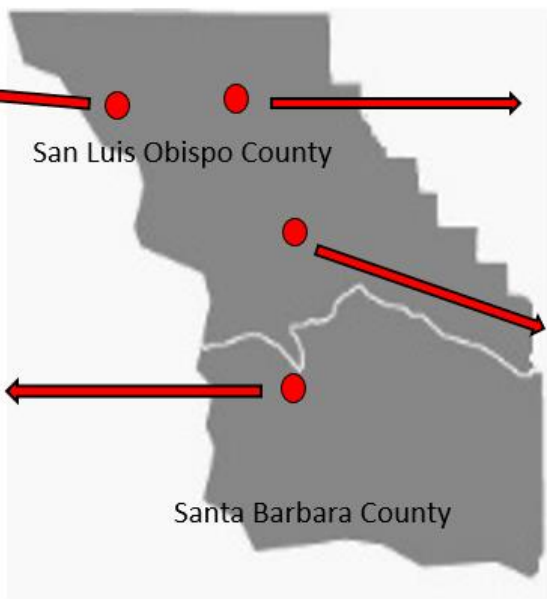
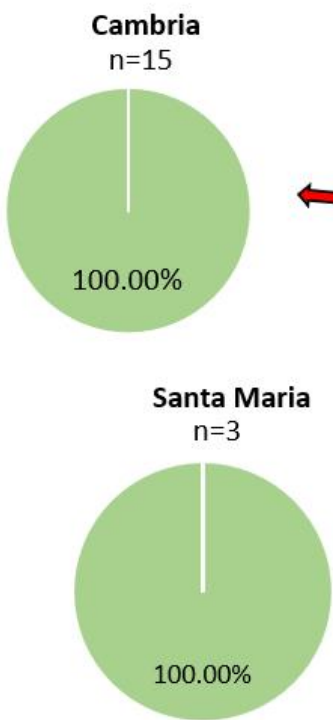
Pyrimethanil (FRAC 9) Screening Results

Botrytis cinerea

- Highly Resistant
- Moderately Resistant
- Highly Sensitive
- Moderately Sensitive

2020

2021



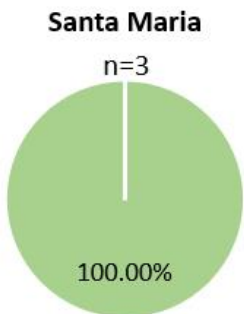
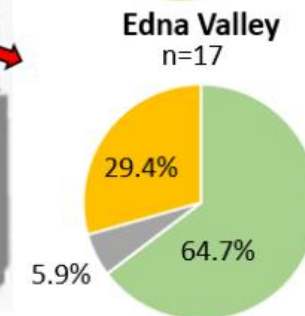
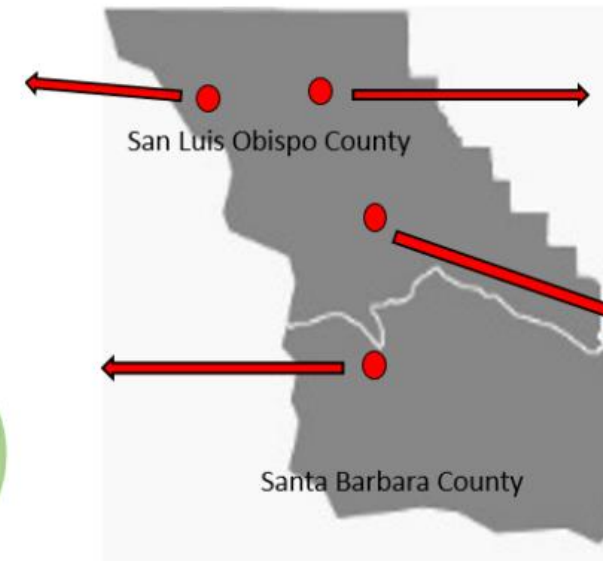
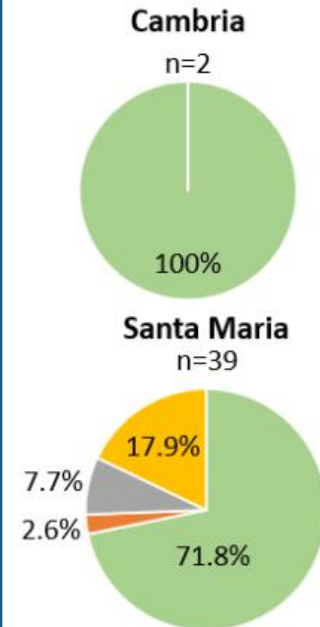
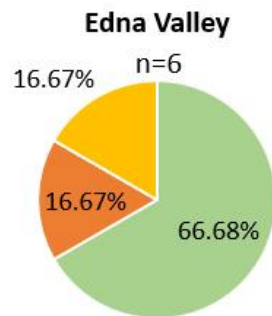
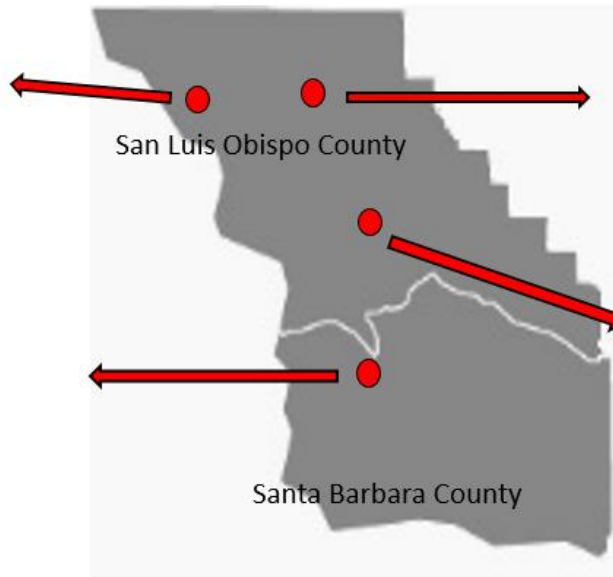
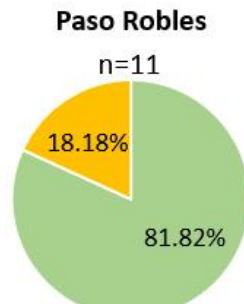
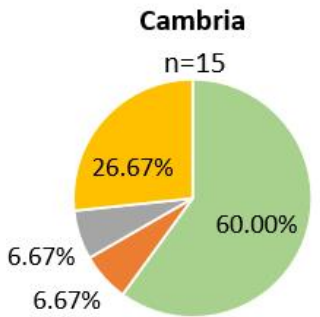
Boscalid (FRAC 7) Screening Results

Botrytis cinerea

- Highly Resistant
- Moderately Resistant
- Highly Sensitive
- Moderately Sensitive

2020

2021



Use of biofungicides

- A significant part of integrated pest management
 - Replace or reduce synthetic pesticides usage
- Multi-mode of action
 - Antibiosis, competition, hyper parasitism, etc.
- Long-term suppression of pest populations
 - Biocontrol microbial organisms may replicate and persist within the target
 - Reduced shelf life, efficacy varies due to biotic and abiotic environment
- Comparatively lower risks to humans and the environment
 - Quick decomposition
 - Target-specific
 - Fast EPA registration
 - Efficacy??

Powdery mildew - significance

- Powdery mildew management costs >\$300 million (Fuller et al., 2014)
- Reduction in yield and quality
- Sensory and compositional effects
 - 1-5% infection in Chardonnay (Stummer et al., 2003)



Botrytis cinerea – symptoms and signs



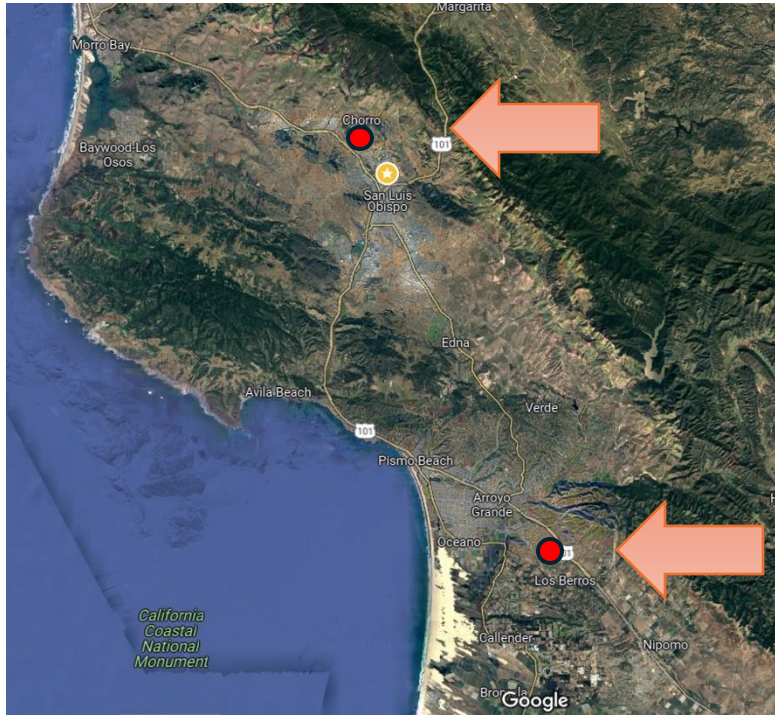
(S. Koike, UCCE 2012)



(Photo by S. Ding)



(Photo by S. Ding)



- Central Valley**
- Warm Mediterranean or even a desert climate
 - Cool and wet winter
 - Hot and dry summer
 - Rain early spring

- Central Coast**
- Mediterranean climate
 - Mild winter
 - Warm to hot summer
 - Rain between December to April



Edgar Godoy-Monterroso

(Volpe, 2010)

Biofungicides



Microbial fungicides

- Actinovate® AG, *Streptomyces lydicus*
- Serenade®, *Bacillus subtilis*



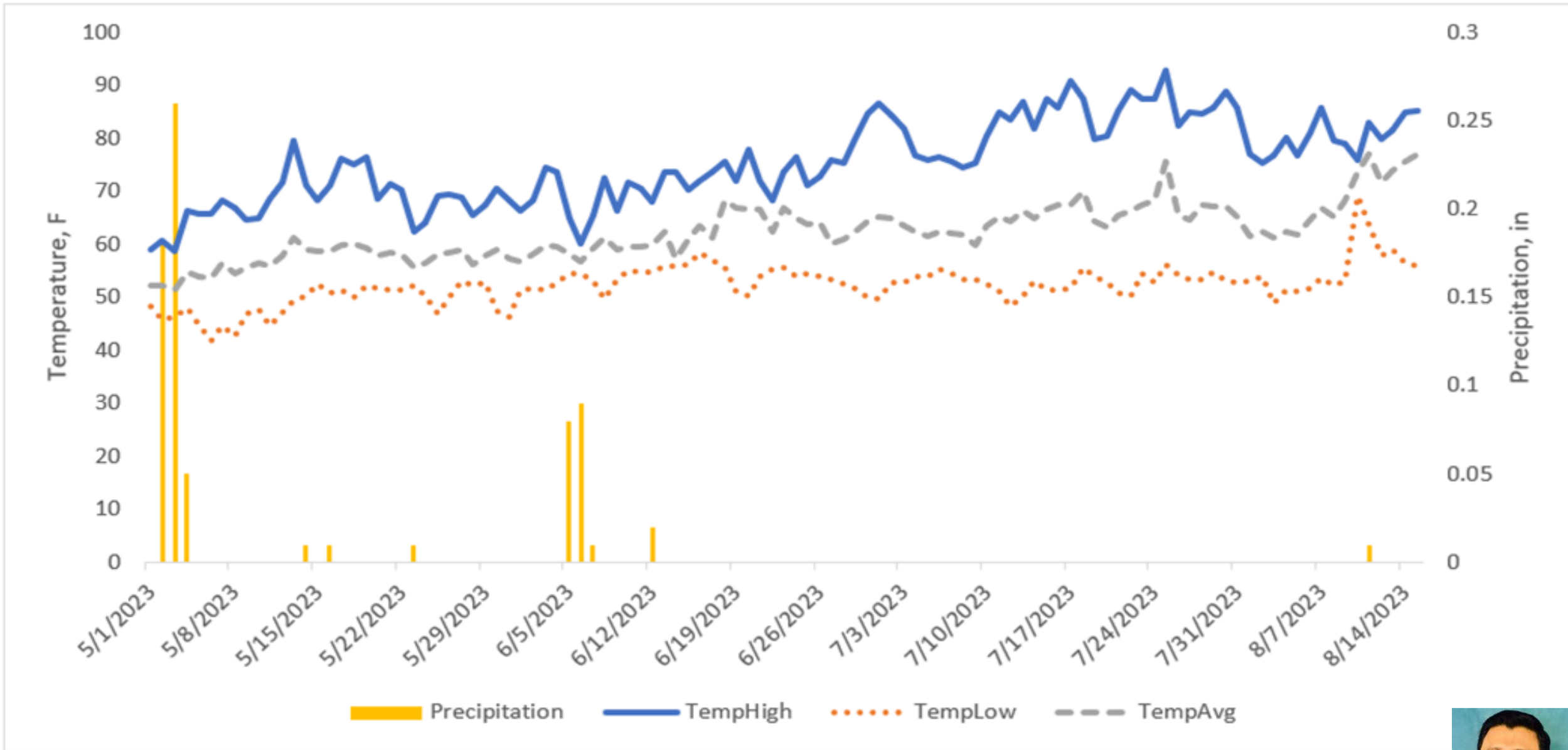
Biochemical fungicides

- Plant Extracts and compounds
- Regalia®, Extract of *Reynoutria sachalinensis*



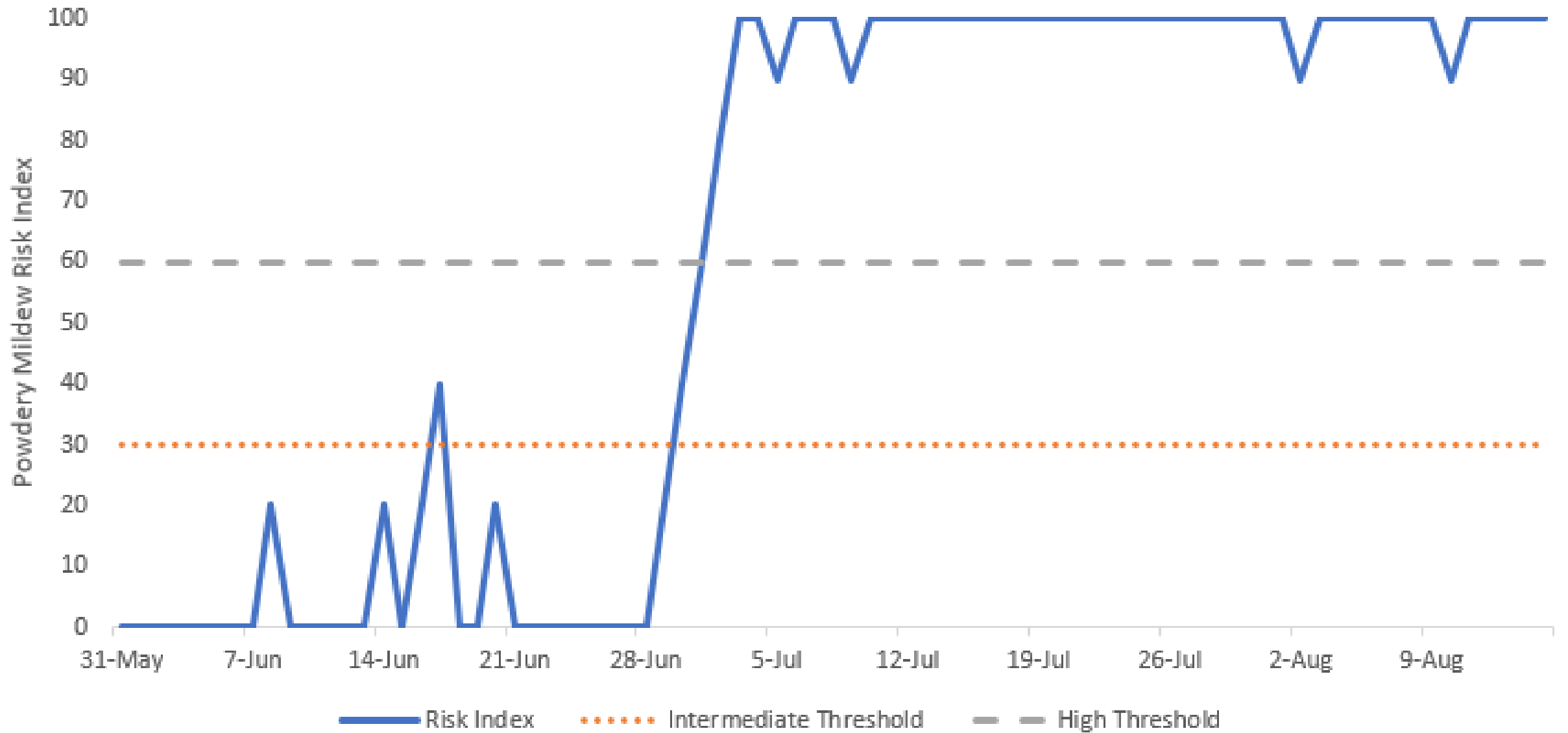
Treatments

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Regalia	Regalia	Regalia	Regalia	Actinovate	Actinovate	Actinovate	Actinovate	Serenade	Serenade	Serenade	Serenade		
Weekly	Bi-weekly	Based Risk index		Weekly	Bi-weekly	Based Risk index		Weekly	Bi-weekly	Based Risk index			
↑		↑	Integrated	↑		↑	Integrated	↑		↑	Integrated		
	↑		↑		↑		↑		↑		↑	↑	↑
												Grower standard	Non-Treated



Trestle Vineyard, average daily temperature (° F) and precipitation (inches) from May 1st to August 15th, 2023.





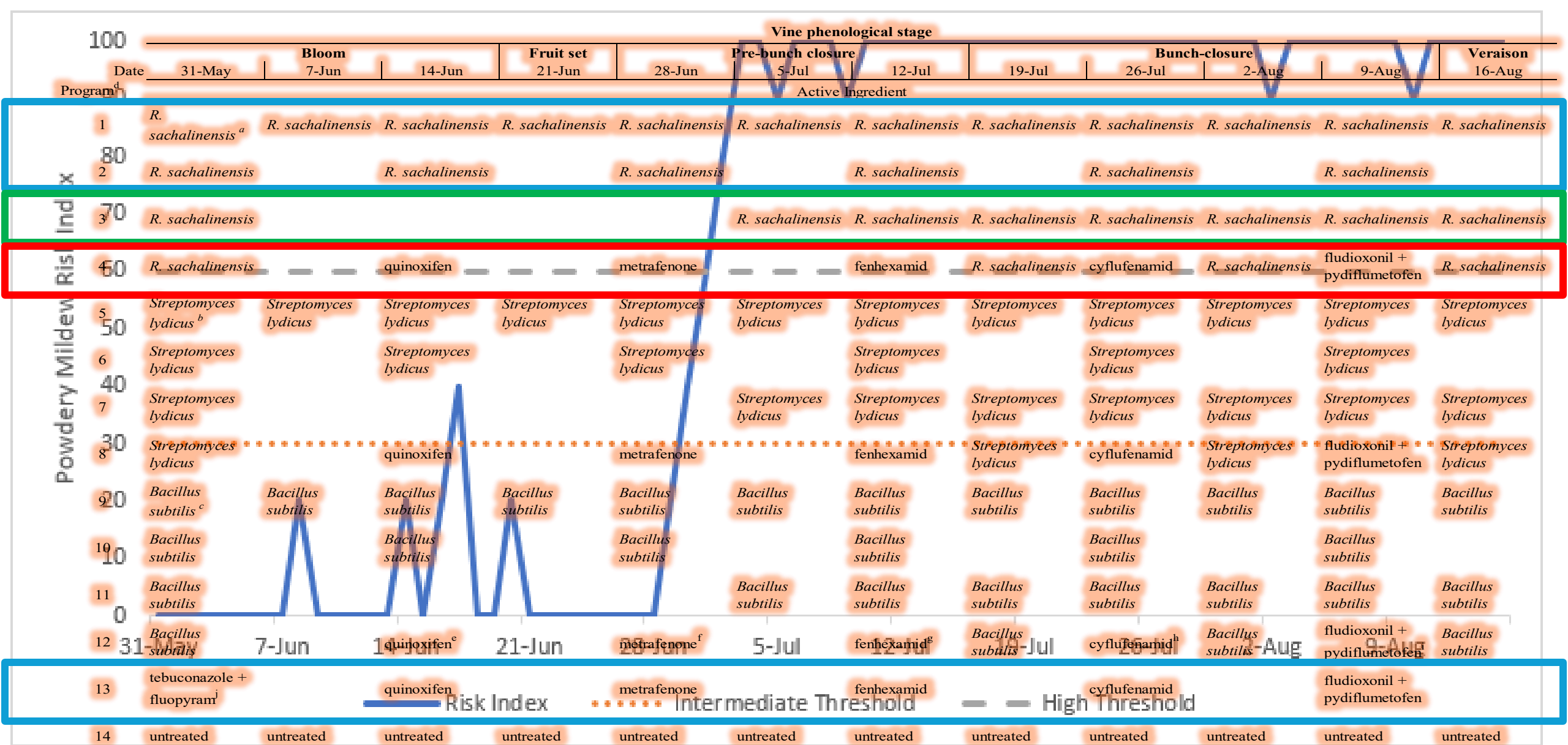
Trestle Vineyard, Thomas-Gubler Risk Index data from May 31st to August 15th, 2023.



Table 1. Fungicide application dates and product rotations for 2023.

Date	Vine phenological stage											
	Bloom		Fruit set		Pre-bunch closure			Bunch-closure				Veraison
	31-May	7-Jun	14-Jun	21-Jun	28-Jun	5-Jul	12-Jul	19-Jul	26-Jul	2-Aug	9-Aug	16-Aug
Program ^d	Active Ingredient											
1	<i>R. sachalinensis</i> ^a	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>
2	<i>R. sachalinensis</i>		<i>R. sachalinensis</i>		<i>R. sachalinensis</i>		<i>R. sachalinensis</i>		<i>R. sachalinensis</i>		<i>R. sachalinensis</i>	
3	<i>R. sachalinensis</i>					<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>	<i>R. sachalinensis</i>
4	<i>R. sachalinensis</i>		quinoxifen		metrafenone		fenhexamid	<i>R. sachalinensis</i>	cyflufenamid	<i>R. sachalinensis</i>	fludioxonil + pydiflumetofen	<i>R. sachalinensis</i>
5	<i>Streptomyces lydicus</i> ^b	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>
6	<i>Streptomyces lydicus</i>		<i>Streptomyces lydicus</i>		<i>Streptomyces lydicus</i>		<i>Streptomyces lydicus</i>		<i>Streptomyces lydicus</i>		<i>Streptomyces lydicus</i>	
7	<i>Streptomyces lydicus</i>					<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>	<i>Streptomyces lydicus</i>
8	<i>Streptomyces lydicus</i>		quinoxifen		metrafenone		fenhexamid	<i>Streptomyces lydicus</i>	cyflufenamid	<i>Streptomyces lydicus</i>	fludioxonil + pydiflumetofen	<i>Streptomyces lydicus</i>
9	<i>Bacillus subtilis</i> ^c	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>
10	<i>Bacillus subtilis</i>		<i>Bacillus subtilis</i>		<i>Bacillus subtilis</i>		<i>Bacillus subtilis</i>		<i>Bacillus subtilis</i>		<i>Bacillus subtilis</i>	
11	<i>Bacillus subtilis</i>					<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>	<i>Bacillus subtilis</i>
12	<i>Bacillus subtilis</i>		quinoxifen ^e		metrafenone ^f		fenhexamid ^g	<i>Bacillus subtilis</i>	cyflufenamid ^h	<i>Bacillus subtilis</i>	fludioxonil + pydiflumetofen ⁱ	<i>Bacillus subtilis</i>
13	tebuconazole + fluopyram ^j		quinoxifen		metrafenone		fenhexamid		cyflufenamid		fludioxonil + pydiflumetofen	
14	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated	untreated

^a Extract of *Reynoutria sachalinensis* (Regalia (R) Biofungicide)^b Strain WYEC 108 (Actinovate)^c Strain QST 713 (Serenade ASO)^d A modified vegetable oil surfactant was added to all applications at a rate of 5 ml per gallon of spray solution. Always follow label instructions regarding fungicide group rotations.^e Quintec; ^f Vivando; ^g Elevate; ^h Torino; ⁱ Miravis Prime; ^j Luna Experience

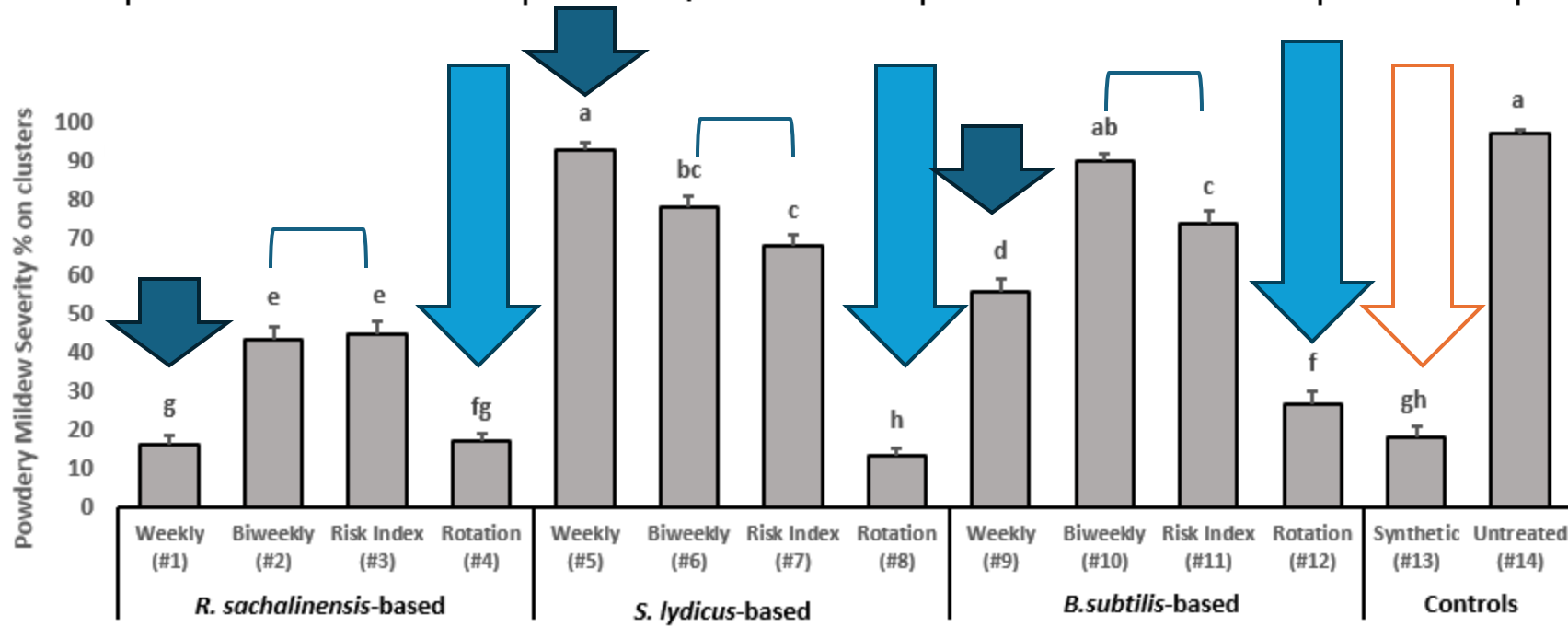
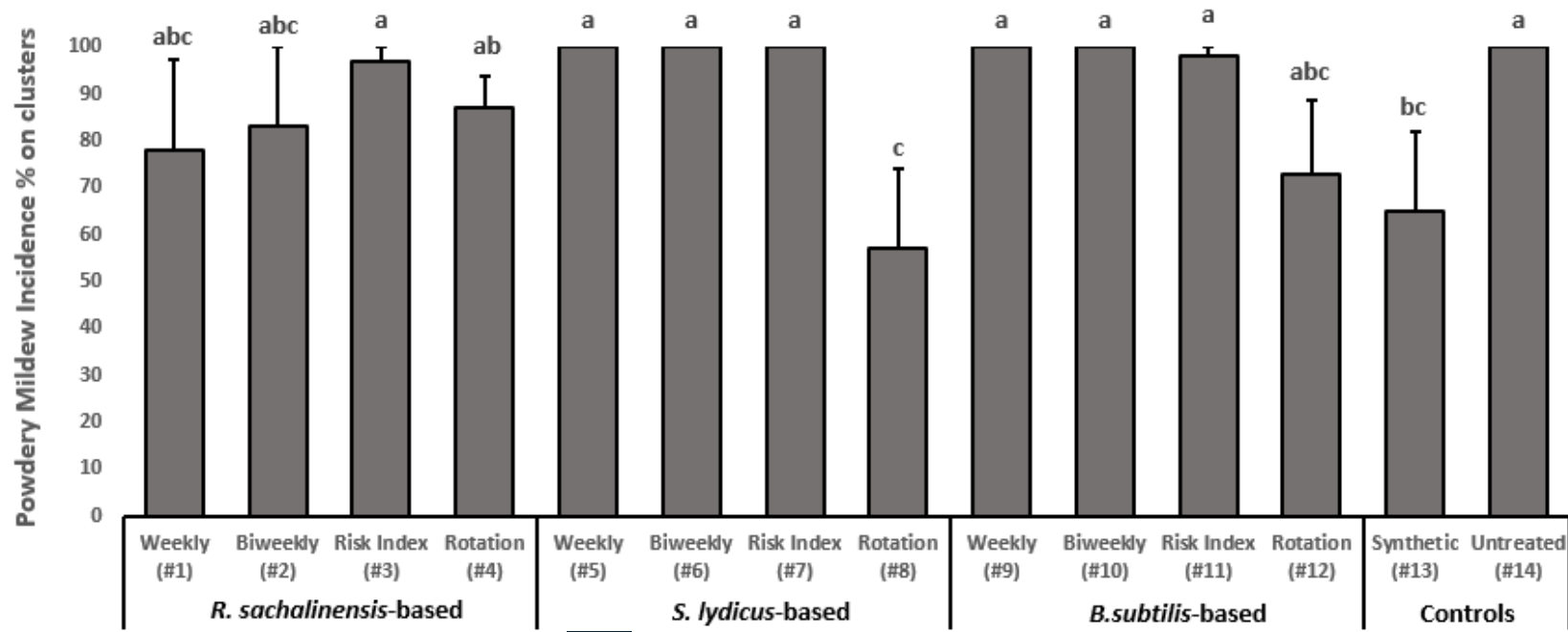


Trestle Vineyard, Thomas-Gubler Risk Index data from May 31st to August 15th, 2023.

2023
Chardonnay

Trestle Vineyard

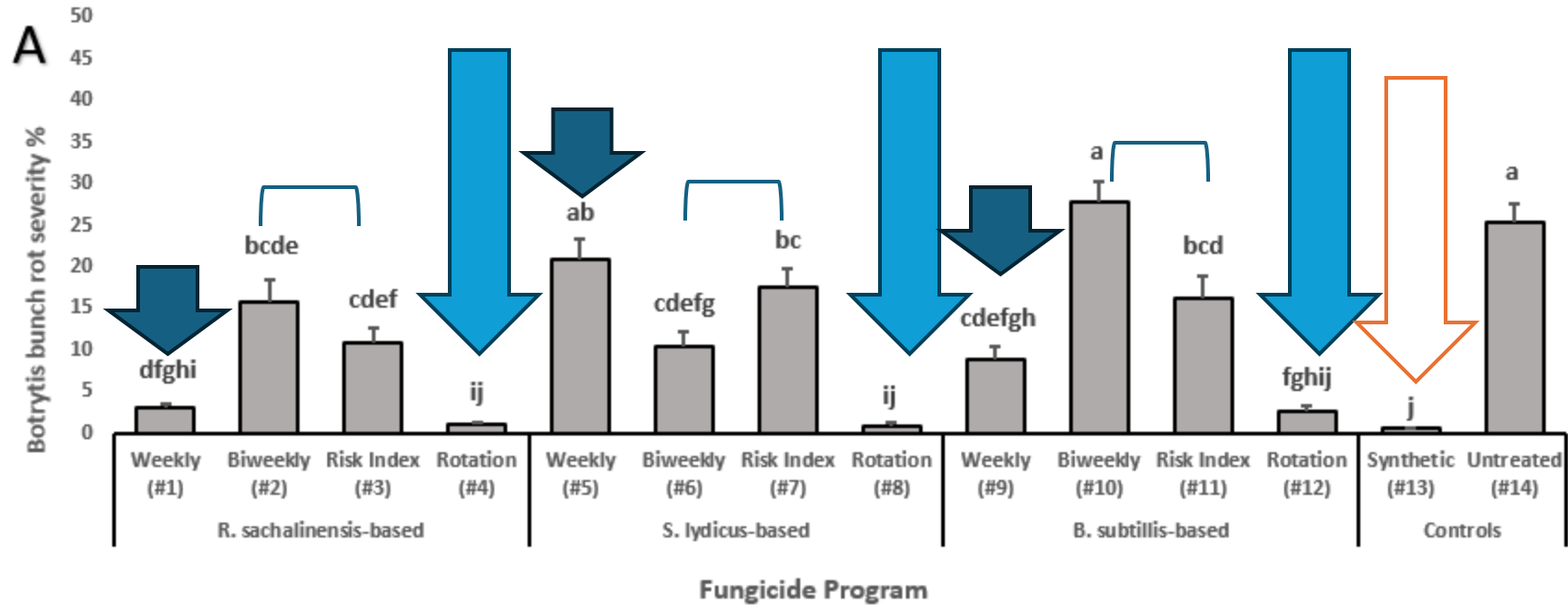
Powdery mildew
on clusters

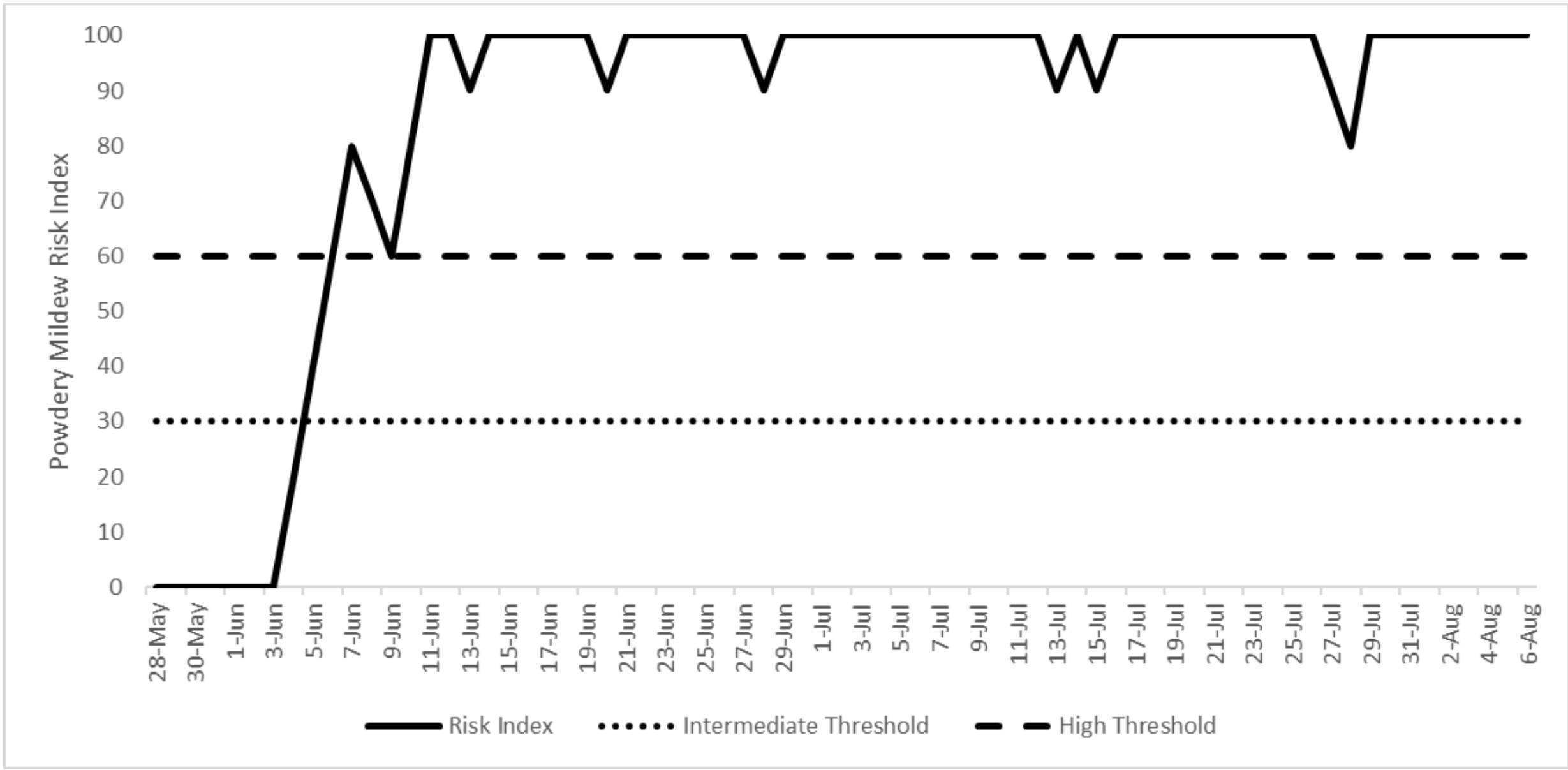


2023
Chardonnay

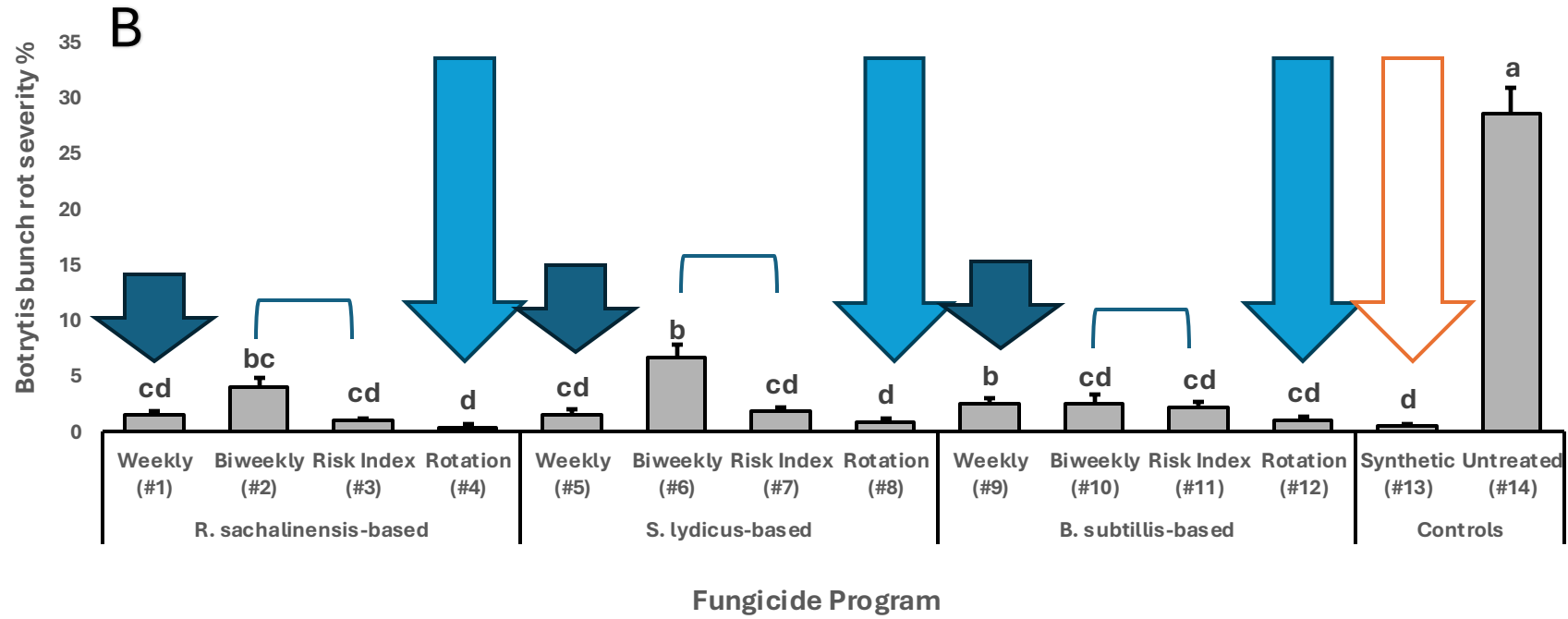
Trestle Vineyard

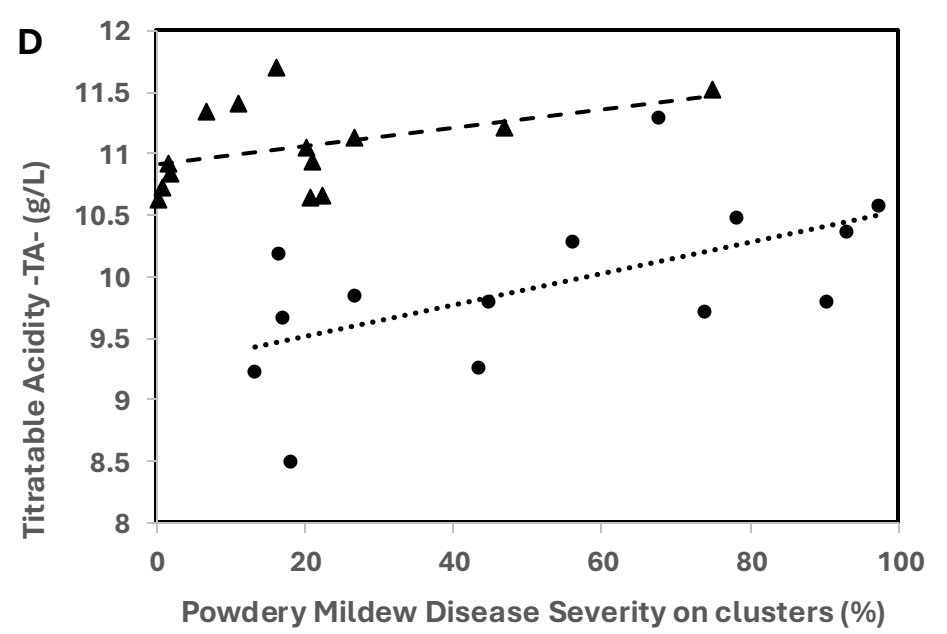
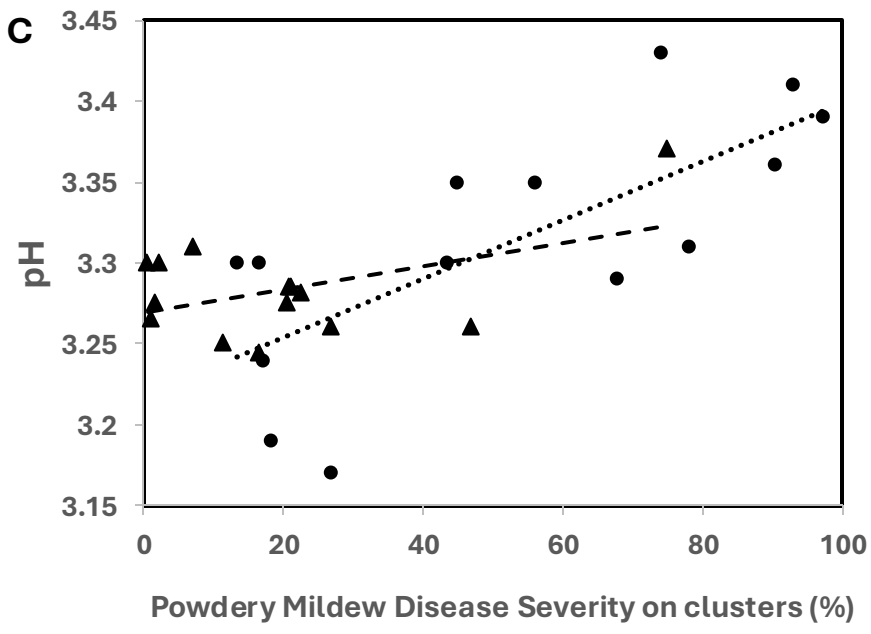
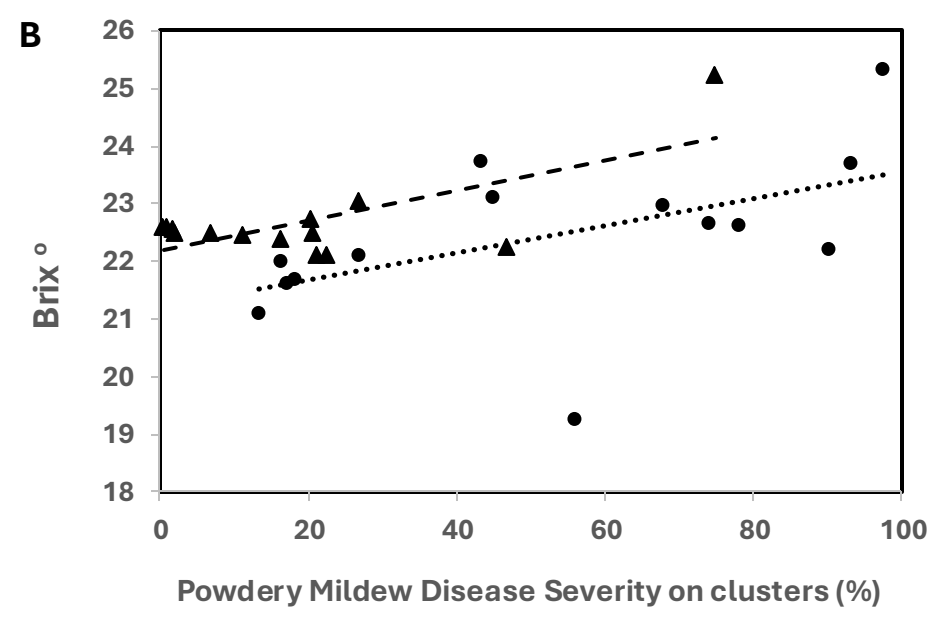
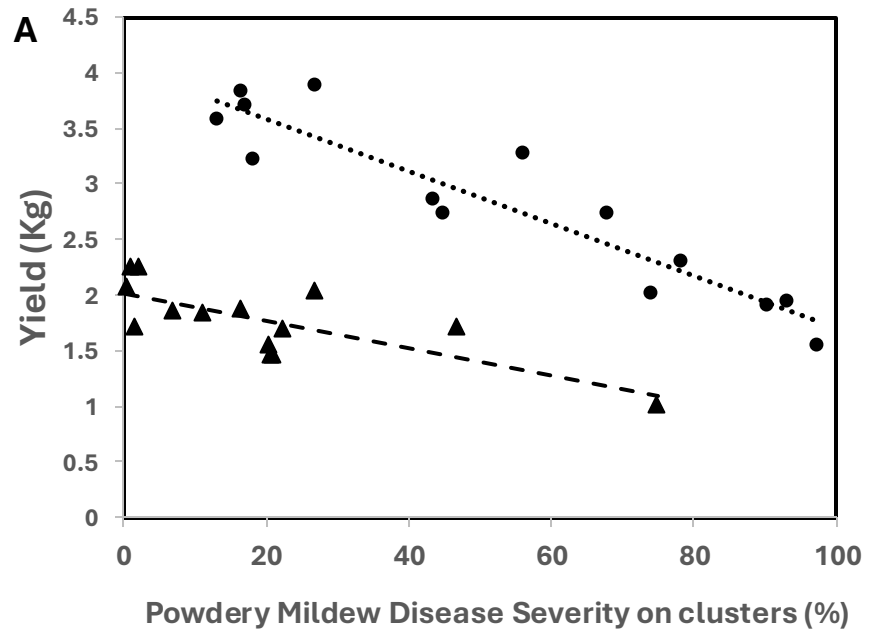
Botrytis bunch rot

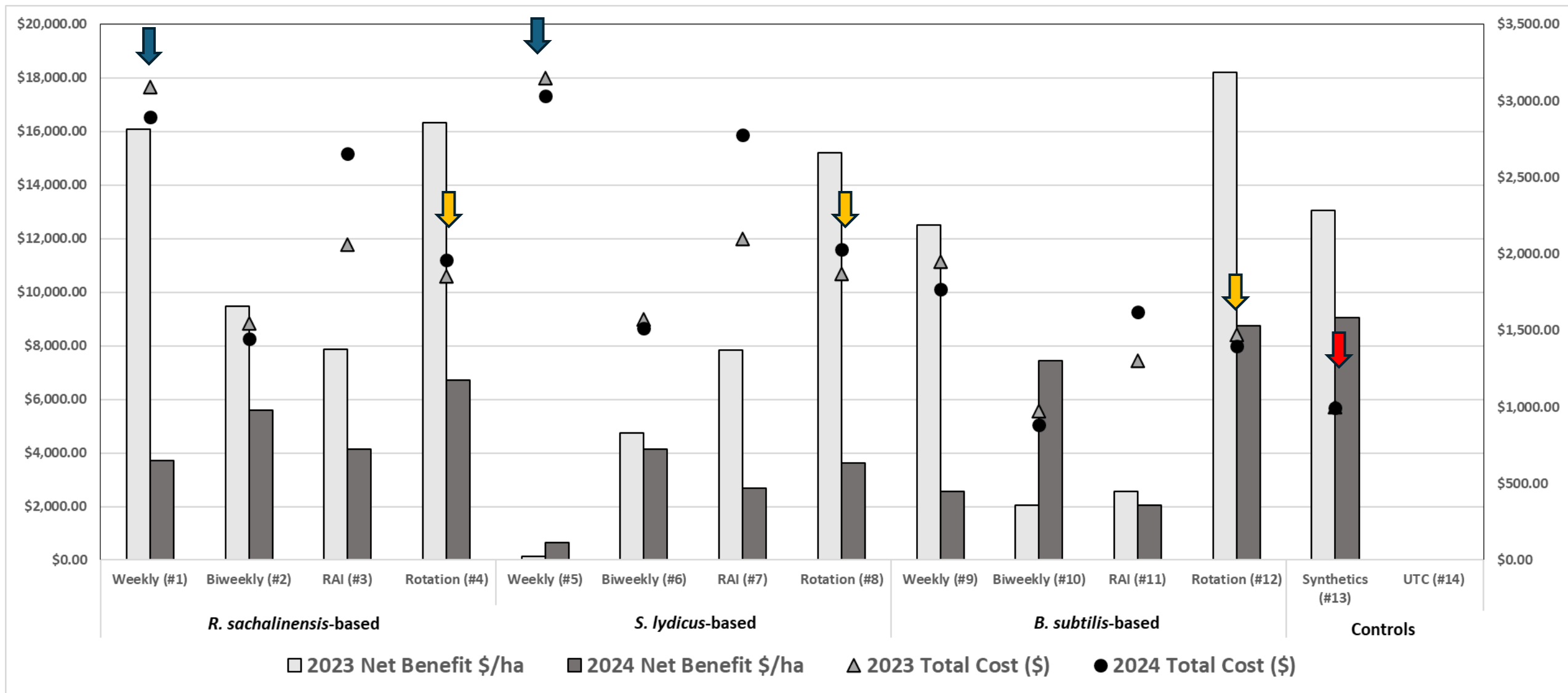




Trestle Vineyard, Thomas-Gubler Risk Index data from May 28th to August 6th, 2024.







Takeaways

- Effective powdery mildew management is important in vineyards
 - It negatively impacts yield and berry chemistry
- Weekly applications and rotational programs were most effective
- Powdery mildew risk index may help reduce the use of biofungicides
- Biofungicides may improve disease control when combined with other disease management practices



Acknowledgement

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Thank you!

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