Research update on managing Powdery mildew, Summer Bunch Rot (Sour Rot) and Grapevine Trunk Diseases

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UCDAVIS
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Current Issues in Vineyard Health
Davis, CA
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DEPARTMENT OF PLANT PATHOLOGY
UC DAVIS

Outline

1. Introduction
2. Powdery mildew
3. Summer Bunch Rot - Sour Rot
4. Grapevine Trunk Diseases
5. Field Fungicide Efficacy Trials: Research Update
6. Conclusion

Current project on grapevine

1. *In vitro* fungicide screening via spiral plater
2. Field fungicide trials to manage PM and Gray Mold
3. Grapevine Trunk Diseases

   -Dormant pruning wound protection

   -Biocontrol of GTD

   -Nursery practices for clean plant material

   -Aspergillus vine canker

   -Biocontrol of Pierce's diseases

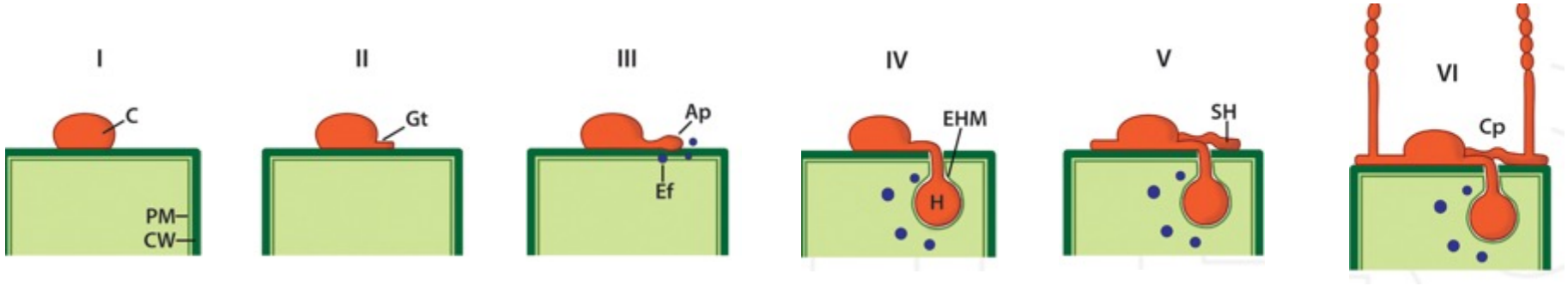
Powdery mildew of Grapevine

Background

- *Erysiphe necator* (formerly *Uncinula necator*), an obligate parasite of *Vitis* species that was first described in North America in 1834.

- After its introduction to Europe, grape powdery mildew was observed throughout all grapevine-growing regions, including California in 1859.

Infection by *Erysiphe necator*



I- Conidium,
C- attachment

II-Conidium germination and germ tube (Gt) formation)

III-Appressorium (Ap) differentiation

IV- Haustorium Development H-Extra-haustorial membrane (EHM) and secretion of virulence factor or effectors (Ef)

V-Colonization of secondary hyphae (SH) formation

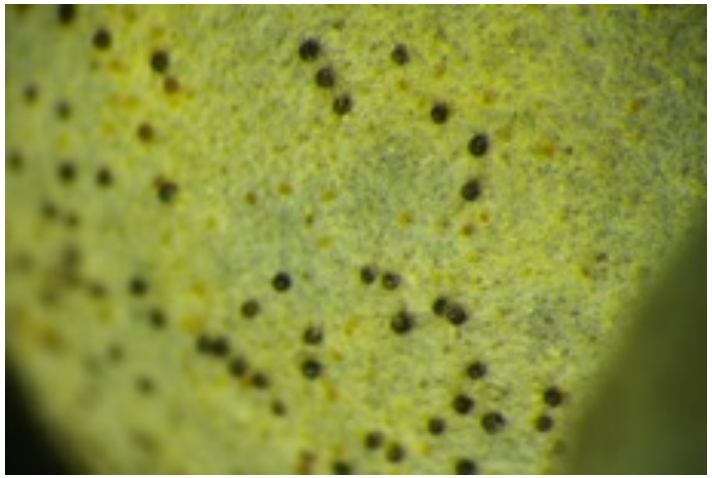
VI-Production of asexual reproductive organs or conidiophores

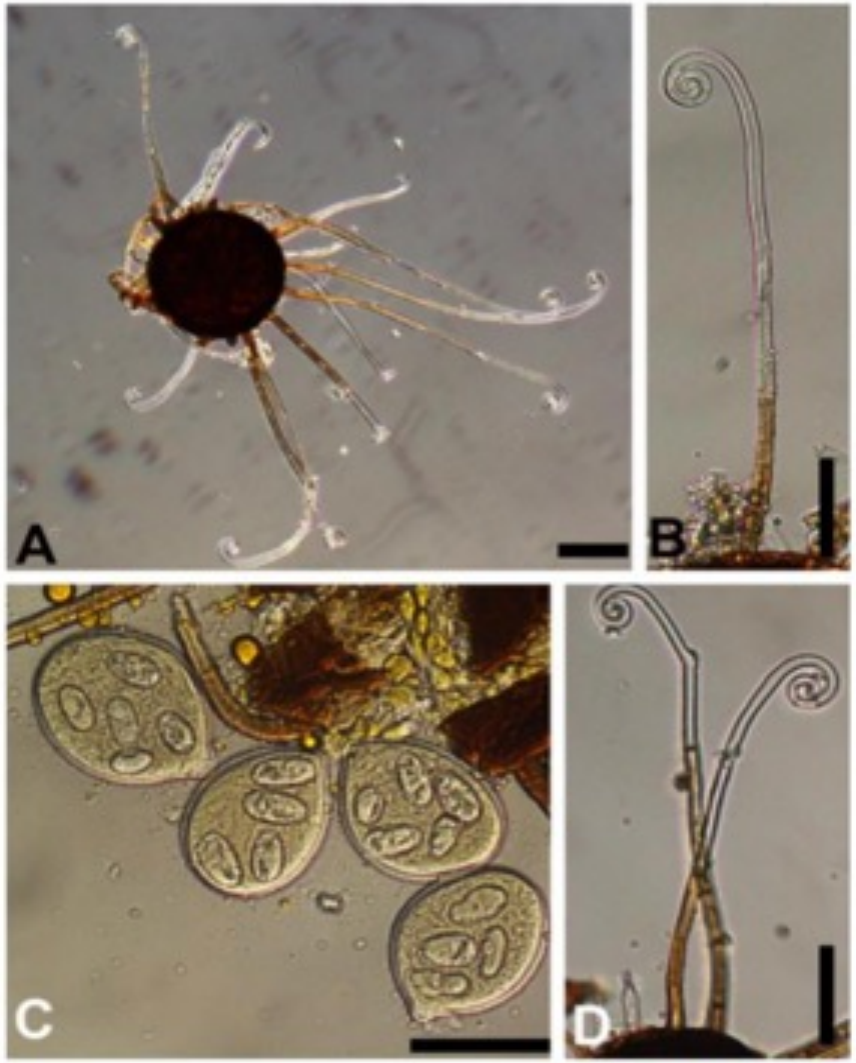
6-8 days

Armijio et al. 2016 Grape and Wine Biotechnology

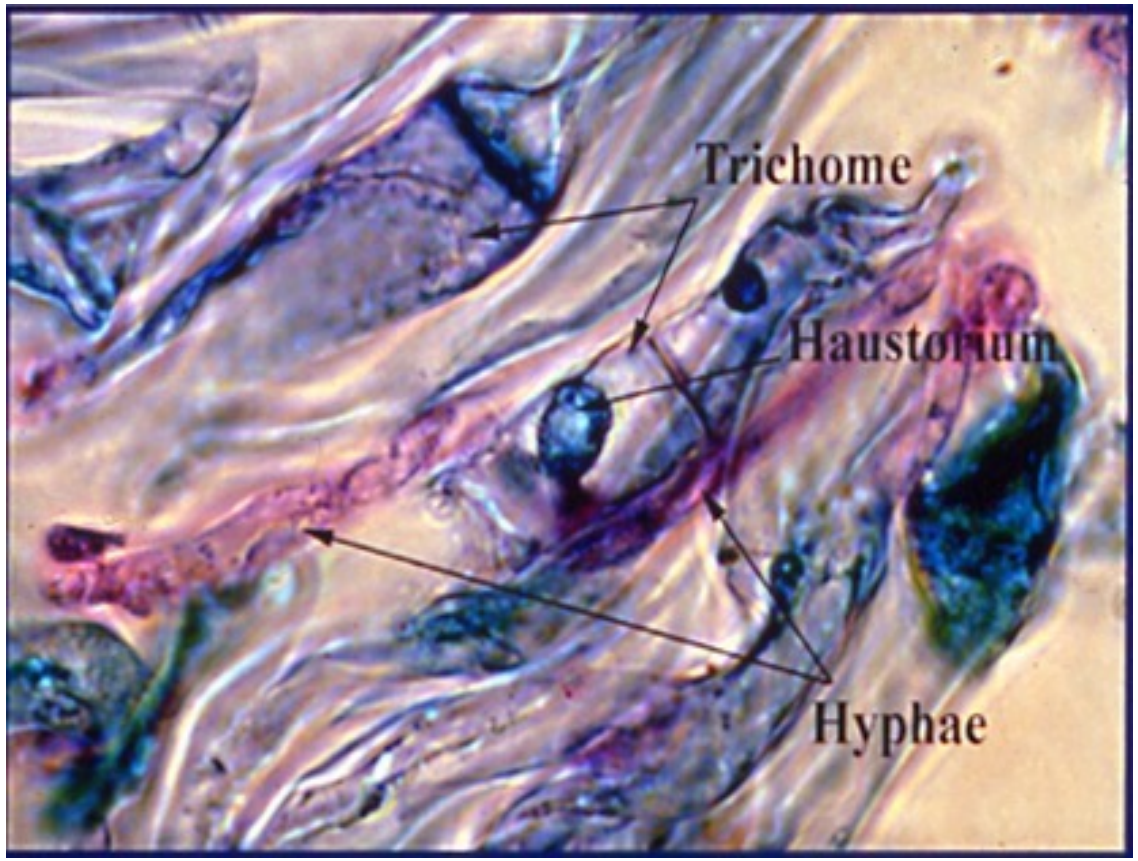
Symptoms

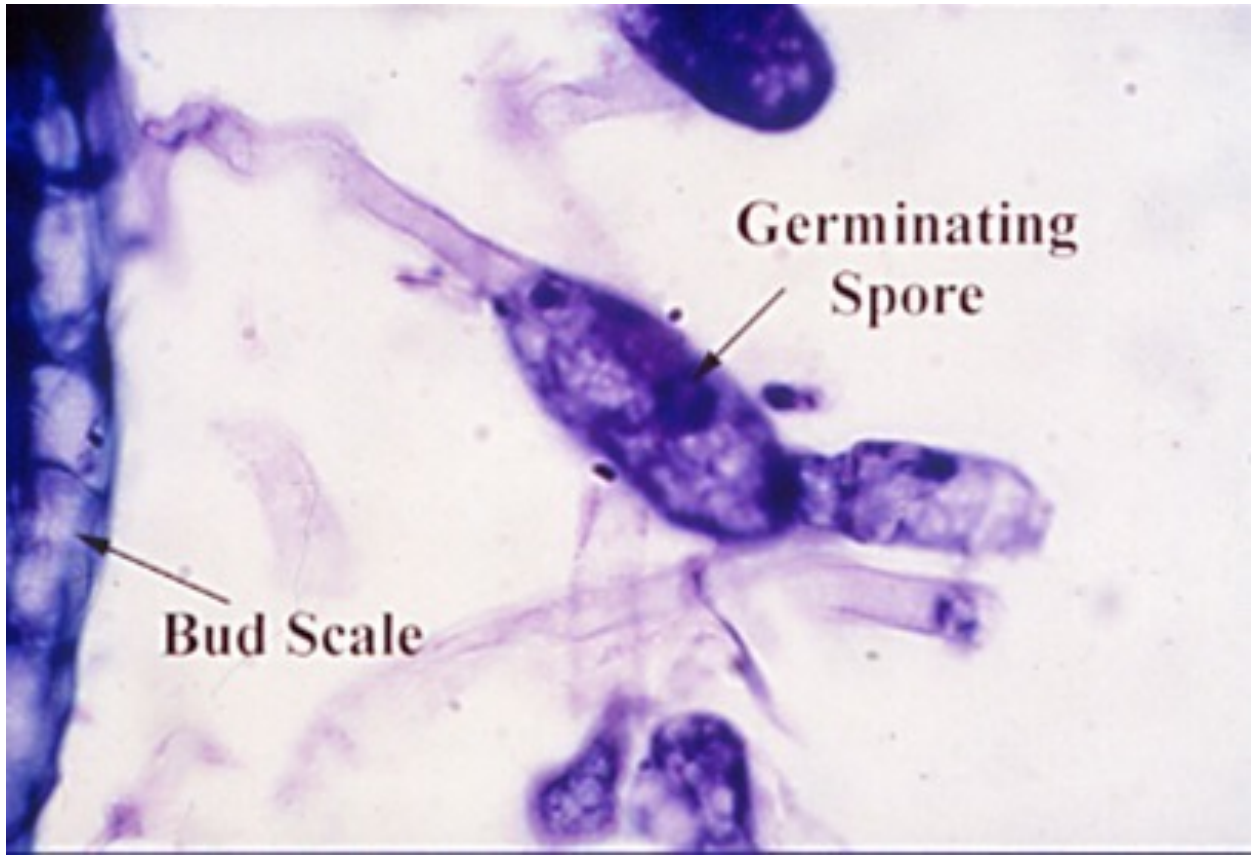
Chasmothecia of *Erysiphe necator*





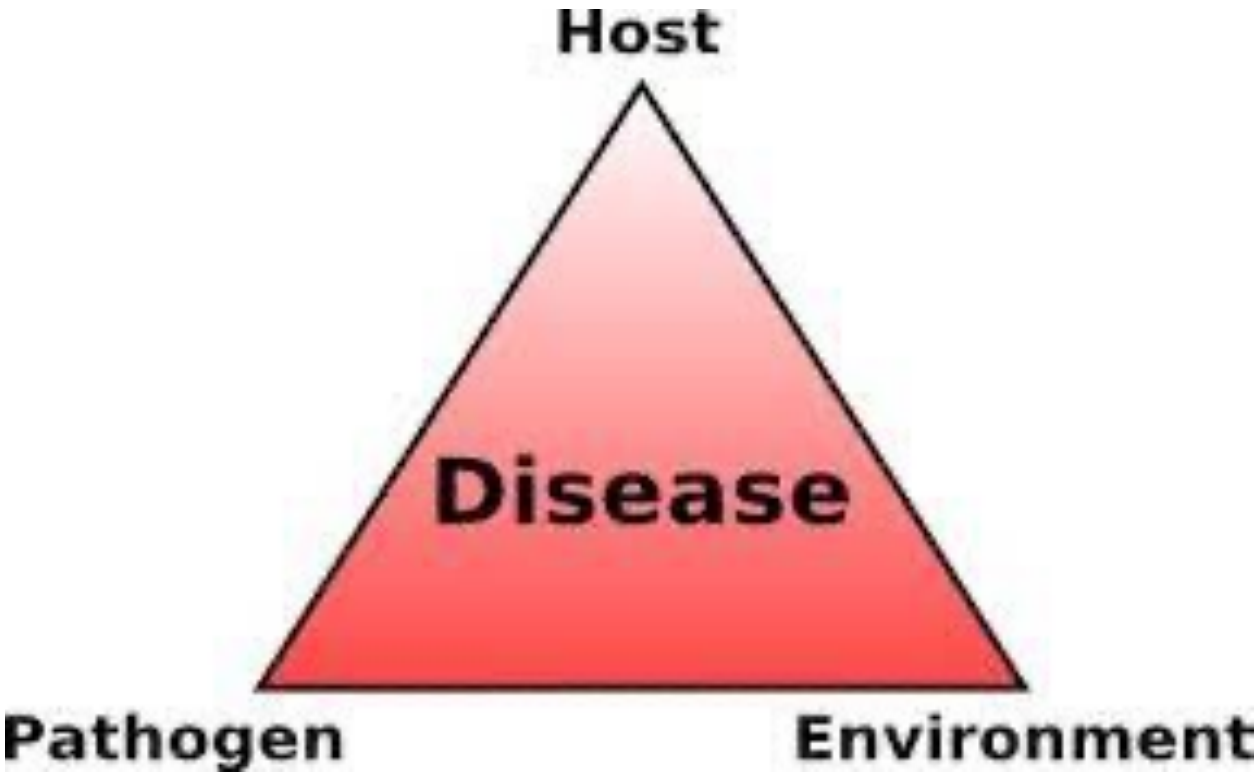
The pathogen can overwinter in dormant buds





Rumbolz and Gubler, 2005

What makes a “bad” disease year?



Field Trial to Evaluate biocontrol agents and Fungicides to control Powdery

2023 Field fungicide efficacy trials

Experimental design

Experimental design	Randomized complete block design with 5 replicates		
Experimental unit	2 adjacent vines = 1 plot		
Row and tree spacing	11 ft (row) and 7 ft (vine)	Plot unit area	154 ft2
Area/treatment	770 ft_2 or 0.0177 acre/treatment (5 replicates = 1 treatment)		
Volume water/Acre	50 gallons =0.88 gal/5 reps 100 gallons (mid May,) = 1.77 gal/5 reps 150 gallons (early June) = 2.65 gal/5 reps		
Equipment	Stihl SR 430 mist blower backpack sprayers		

https://ucanr.edu/sites/eskalenlab/Fruit_Crop_Fungicide_Trials/

Trial Map

ROW / VINE	BLOCK 5						BLOCK 4						BLOCK 3					BLOCK 2				BLOCK 1					ROW / VINE
	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
-31	X	X	X	X	13-YD	X	X	X	X	19-YRD	X	32-GKS	43-PWS	X	X	18-YKC	X	X	18-YKC	26-RKS	X	17-YKS	X	X	X	X	-31
-30	36-BS	30-GS	X	X		X	47-PKC	X	26-RKS		37-BC			X	51-B+O		4-KS	1-W		X	X		26-RKS	18-YKC	29-GD	19-YRD	-30
-29			X	X	X	55-Pu+Y		P		44-PWC		4-KS	53-B+W	16-YKD		P			X	57-Pu+O	P	10-OKS					-29
-28	P	P	11-ONS	P	X		P		X		49-B+Y						16-YKD	54-Pu+K	32-GKS					16-YKD	46-PKS	4-KS	-28
-27					54-Pu+K	X		34-B	X	5-KC		X	X	13-YD	1-W	39-BKS				31-GKD	41-Pu	11-ONS	31-GKD				-27
-26	38-BKD	58-Pu+R	50-B+G	X		53-B+W			X				X				52-B+R	27-RKC	9-OKD					53-B+W	22-RD+R	X	-26
-25				PWD	34-B		X	X		25-RKD	54-Pu+K	27-RKC	8-OC+O	P		29-GD				45-PKD	37-BC	P	27-RKC			50-B+G	-25
-24	26-RKS	X				P	X	2-K	28-G						X		P	14-YS	22-RD+R					49-B+Y	42-PWD		-24
-23		8-OC+O	46-PKS		P		X		1-W	36-BS	3-KD	22-RD+R	36-BS	P	37-BC	27-RKC				P	11-ONS	57-Pu+O	12-Y			X	-23
-22	X					X	40-BKC	X									12-Y	50-B+G	10-OKS					2-K			-22
-21	X	3-KD		20-YRS		2-K		55-Pu+Y	X	23-RS+R	7-OS+O	10-OKS	55-Pu+Y	42-PWD	52-B+R	33-GKC				P	36-BS	55-Pu+Y			35-BD	48-B+K	-21
-20	4-KS		X		7-OS+O		56-Pu+G		P								P	X	47-PKC				33-GKC	3-KD			-20
-19		X	29-GD	X				X			13-YD	24-RC+R	P	45-PKD	X	9-OKD		X		17-YKS	51-B+O	41-Pu			44-PWC	X	-19
-18	X	44-PWC		47-PKC	9-OKD	X	X	X	X	12-Y					19-YRD		43-PWS	20-YRS	44-PWC				45-PKD	56-Pu+G		P	-18
-17	X		28-G			51-B+O	58-Pu+R	43-PWS	9-OKD		X	X	X	46-PKS		54-Pu+K				2-K	53-B+W	36-BS			51-B+O		-17
-16	12-Y	37-BC		X	41-Pu					33-GKC	6-O	46-PKS	X		23-RS+R		3-KD	7-OS+O	X				38-BKD	15-YC		32-GKS	-16
-15			43-PWS	X		19-YRD	X	X	45-PKD				22-RD+R			50-B+G			39-BKS	40-BKC	48-B+K	34-B			24-RC+R		-15
-14	18-YKC	X		P	15-YC		X	X		15-YC	52-B+R			15-YC	40-BKC		25-RKD	55-Pu+Y					P	5-KC		X	-14
-13		X	x			5-KC	X	38-BKD	X			X	X			P			33-GKC	15-YC	8-OC+O	9-OKD			28-G	X	-13
-12	27-RKC	31-GKD	x	X	24-RC+R		X		8-OC+O	53-B+W	P	X	31-GKD	28-G	X		35-BD	49-B+Y					47-PKC	40-BKC		X	-12
-11			35-BD	X		32-GKS	X	41-Pu				31-GKD			49-B+Y	14-YS			5-KC	56-Pu+G	X	P			X	X	-11
-10	X	X		57-Pu+O	39-BKS				X		29-GD		30-GS	X			26-RKS	29-GD			P		7-OS+O	6-O	30-GS	X	-10
-9	14-YS	X	X			X	20-YRS	X	X	17-YKS		X		47-PKC	5-KC	X				30-GS		39-BKS				X	-9
-8		X	48-B+K	X	10-OKS	23-RS+R		50-B+G	14-YS		P	6-O	4-KS			17-YKS	3-KD	35-BD	58-Pu+R				P	13-YD	P	X	-8
-7	X	X		45-PKD			X			30-GS				58-Pu+R	57-Pu+O					28-G	23-RS+R	52-B+R				X	-7
-6	X	16-YKD	6-O		22-RD+R	X	42-PWD	X	P		16-YKD	2-K	P			20-YRS	34-B	24-RC+R	34-B				8-OC+O	58-Pu+R	37-BC	X	-6
-5				X		49-B+Y		11-ONS		57-Pu+O				24-RC+R	12-Y					X		43-PWS				X	-5
-4	17-YKS	X	X	X	25-RKD				X		48-B+K	44-PWC	10-OKS			38-BKD	56-Pu+G	38-BKD	6-O	25-RKD	X		1-W	20-YRS	X	X	-4
-3		52-B+R	X	X		40-BKC	56-Pu+G	51-B+O	18-YKC	35-BD				48-B+K	41-Pu						X	23-RS+R			X	X	-3
-2			X	X							39-BKS	32-GKS	7-OS+O			X	11-ONS	19-YRD	46-PKS	42-PWD	13-YD		14-YS	54-Pu+K	25-RKD	X	-2
-1	33-GKC	X	X	X	1-W	X	X	X	X	X				X	X	X						X				X	-1
VINE / ROW	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	VINE / ROW
	BLOCK 5						BLOCK 4						BLOCK 3					BLOCK 2				BLOCK 1					

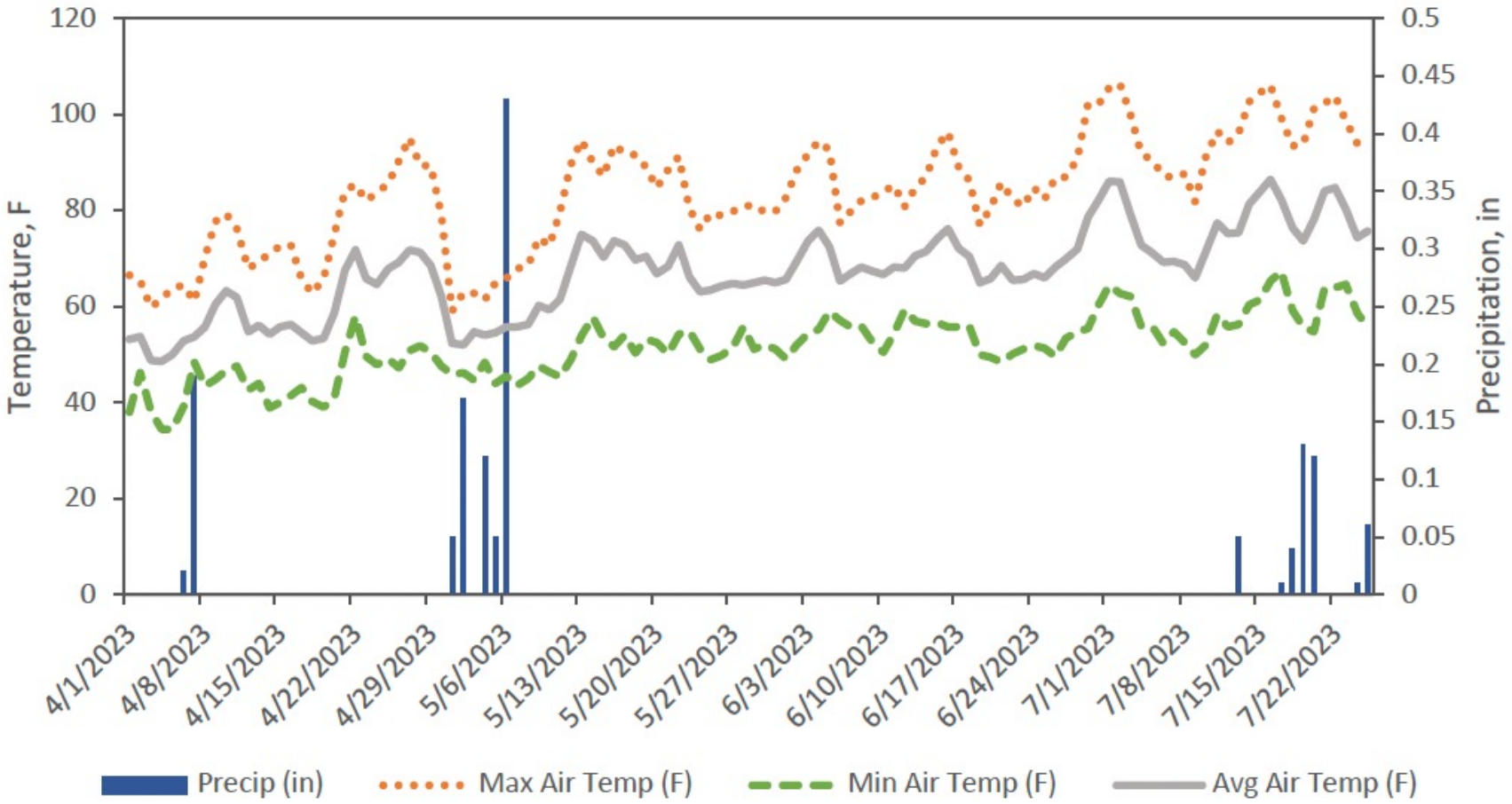
27

N

Color			
B	Blue	**Pu**	Purple
G	Green	**R**	Red
K	Black	**Y**	Yellow
O	Orange	**W**	White
P	Pink	**N**	Gray

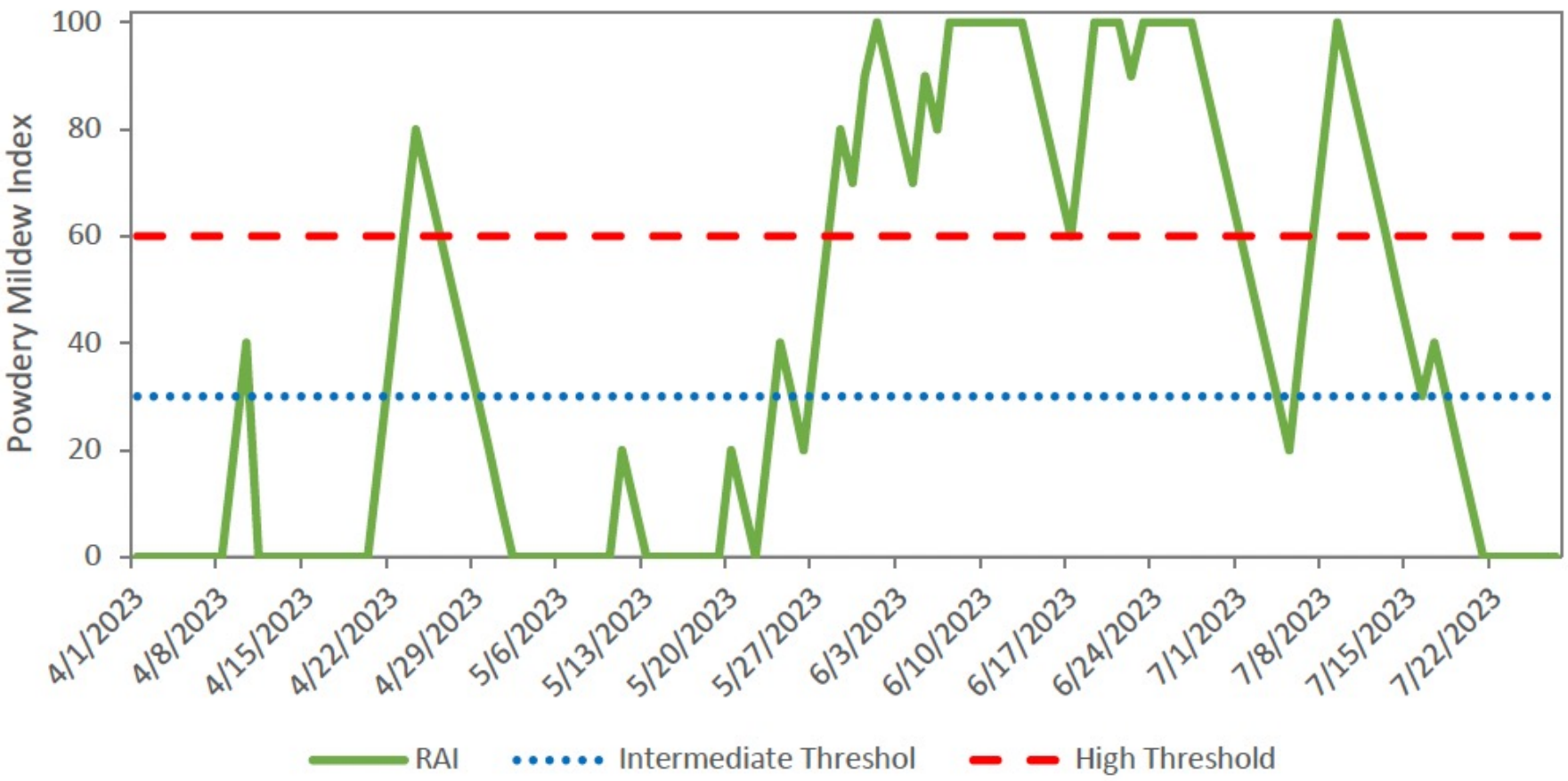
Pattern	
C	Checker
D	Dot
S	Stripe

2023 Field climatic data



Average daily temperature (ÅãC) and precipitation (mm) from Apr 1 to July 25, 2022, from CIMIS station #226.

Thomas-Gubler Risk Index data



2023 Powdery Mildew Field Trial 1

Treatment			Application date (Julian day)	Powdery mildew on the cluster [x]	
Pictures	Flag [z]	Rate/A[y]		Incidence, %	Severity, %
8	OC+O	Luna Experience 8.6 fl oz	124	4e	0.1b
		Pristine 23 oz	138		
		Endura 2.8 oz	152, 165		
		Torjan 4 floz	181		
		Quintec 6 fl oz	194		
23	RS+R	Cevya 4 floz + Syl-Coat 4 fl oz/100 gal	124	5e	0.2b
		Gatten 6.4 floz+ Syl-Coat 4 fl oz/100 gal	138		
		Luna sensation 5 floz + Syl-Coat 4 fl oz/100 gal	152		
		Vivando 15.4 floz+ Syl-Coat 4 fl oz/100 gal	165		
		Inspire super 16 floz+ Syl-Coat 4 fl oz/100 gal	181		
		Prolivo 4 floz+ Syl-Coat 4 fl oz/100 gal	194		
37	BC	Inspire Super 20 fl oz + Dyne-Amic 0.125% v/v	124, 194	4e	0.2b
		Aprovia Top 13.3 fl oz + Dyne-Amic 0.125% v/v	138		
		Quintec 6.6 fl oz + Dyne-Amic 0.125% v/v	152		
		Miravis Prime 13.4 fl oz + Dyne-Amic 0.125% v/v	165		
		Aprovia Top 13.3 fl oz + Dyne-Amic 0.125% v/v	181		
39	BKS	Aprovia Top + A9180A 13.3 fl oz + 1.0 oz + Dyne-Amic 0.125% v/v	165, 194	5e	0.2b
		Quintec + A9180A 6.6 fl oz + 1.0 oz + Dyne-Amic 0.125% v/v	124		
		Miravis Prime + A9180A 13.4 fl oz/+ 1.0 oz + Dyne-Amic 0.125% v/v	138		
		Inspire Super + A9180A 20.0 fl oz + 1.0 oz + Dyne-Amic 0.125% v/v	152		
		Miravis Prime + A9180A 13.4 fl oz + 1.0 oz + Dyne-Amic 0.125% v/v	181		
10	OKS	Sulfur Dry Flowable 5 lb	123, 130, 137, 144	10e	0.3b
		V6M-5-7 27.4 fl oz + Dyne-Amic 0.125% v/v	150		
		Luna Experience 8.6 fl oz	164		
		Pristine 23 oz	180		
		Elevate 16oz	193		
38	BKD	Aprovia Top 13.3 fl oz + Dyne-Amic 0.125% v/v	165, 194	7e	0.3b
		Quintec 6.6 fl oz+ Dyne-Amic 0.125% v/v	124		
		Miravis Prime 13.4 fl oz + Dyne-Amic 0.125% v/v	138		
		Inspire Super 20 fl oz+ Dyne-Amic 0.125% v/v	152		
		Miravis Prime 13.4 fl oz + Dyne-Amic 0.125% v/v	181		
29	GD	Parade 3.1 fl oz + Dyne-Amic 0.25% v/v	123, 137, 150, 164, 180, 193	6e	0.3b
		Luna Experience 8.6 fl oz	124		

2023 Powdery Mildew Field Trial 2

Treatment			Application date (Julian day)	Powdery mildew on the cluster [x]			
Pictures	Flag [z]	Rate/A[y]		Incidence, %		Severity, %	
41	Pu	Sulfur 5lb	124, 138	24	f	1.4	f
		Saponel 0.5% + Sulphur 5lb	150				
		Saponel 1% + Kobber 30g/100L	158				
		HML32 1.25L/100L + Kobber 30g/100L + Sulphur 5lb	164, 172, 180, 188, 193				
15	YC	Shielder (OR-536) 4 lbs/a + Oroboost (OR-097A) 32 fl. oz/100 gal	123, 130, 137, 144, 150, 158, 164, 172, 180, 188, 193	63	cde	6.7	ef
40	BKC	Sulfur 5lb	124, 138	61	de	7.7	ef
		Saponel 0.5% + Sulphur 5lb	150				
		Saponel 1% + Kobber 30g/100L	158				
		HML32 1.25L/100L + Kobber 30g/100L + Potum 300g/100L	164, 172, 180, 188, 193				
35	BD	Sulfur dry	123, 130, 137, 144, 158	63	cde	9.2	ef
		Kaligreen 5lb	164, 172, 180, 188, 193				
12	Y	Milagrum Plus (OR-488) 40 fl oz/100 gal + Oroboost (OR-097A) 32 fl oz/100gal	123, 130, 137, 144, 150, 158, 164, 172, 180, 188, 193	67	bcde	11.1	ef
47	PKC	Sulfur DF 5 lb	123, 130, 137, 144, 150, 158, 164, 172, 180, 188, 193	56	e	12.0	ef
43	PWS	Sulfur 5lb	124, 138	72	abcde	12.4	ef
		NSA 1% + Kobber 33g/100L +HML Silco (225ml/100L or 100g/100L	150, 158, 165, 172, 180, 188, 193				
42	PWD	Sulfur 5lb	124, 138	67	bcde	16.9	ef
		Saponel 0.5% + Sulphur 5lb	150				
		Saponel 1% + Kobber 30g/100L	158				
		HML32 1.25L/100L + Kobber 30g/100L + HML Silco 225ml/100L	164, 193				
		Saponel 1% + Kobber 30g/100L + HML Silco (225ml/100L or 100g/100L)	172, 188				
25	RKD	Cinnaction (OR-489-E) 50 fl oz/100 gal + Attitude (OR-278F) 32 fl oz/100 gal	123, 130, 137, 144, 150, 158, 164, 172, 180, 188, 193	78	abcde	20.9	ef
46	PKS	PureSpray Green 1 gal	123, 130, 137, 144	78	abcde	21.7	ef
		Sulfur Dry-Flowable 5 lb	150, 158, 164, 172, 180, 188, 193				
11	ONS	Bio Project S10 68 fl oz + Bio Project ID 0.9 27 fl oz	124	60	de	28.6	def
		Bio Project S10 27 fl oz + Bio Project ID 0.9 27 fl oz	138				
		Bio Project ID 0.9 27 fl oz + Bio Project MT 0.9 27 fl oz	152				
		Bio Project S10 68 fl oz + Bio Project MT 0.9 27 fl oz	165				
		Bio Project S10 68 fl oz + Bio Project ID 0.9 34 fl oz + Bio Project	180				

Sulfur advantages

- Lime sulfur
- Dusting Sulfur
- Wettable sulfur
  - -Micronized
  - -Dry Flowable

- Is a natural product
- Inexpensive
- Effective
- Used hundreds of years
  - -No Case of resistance

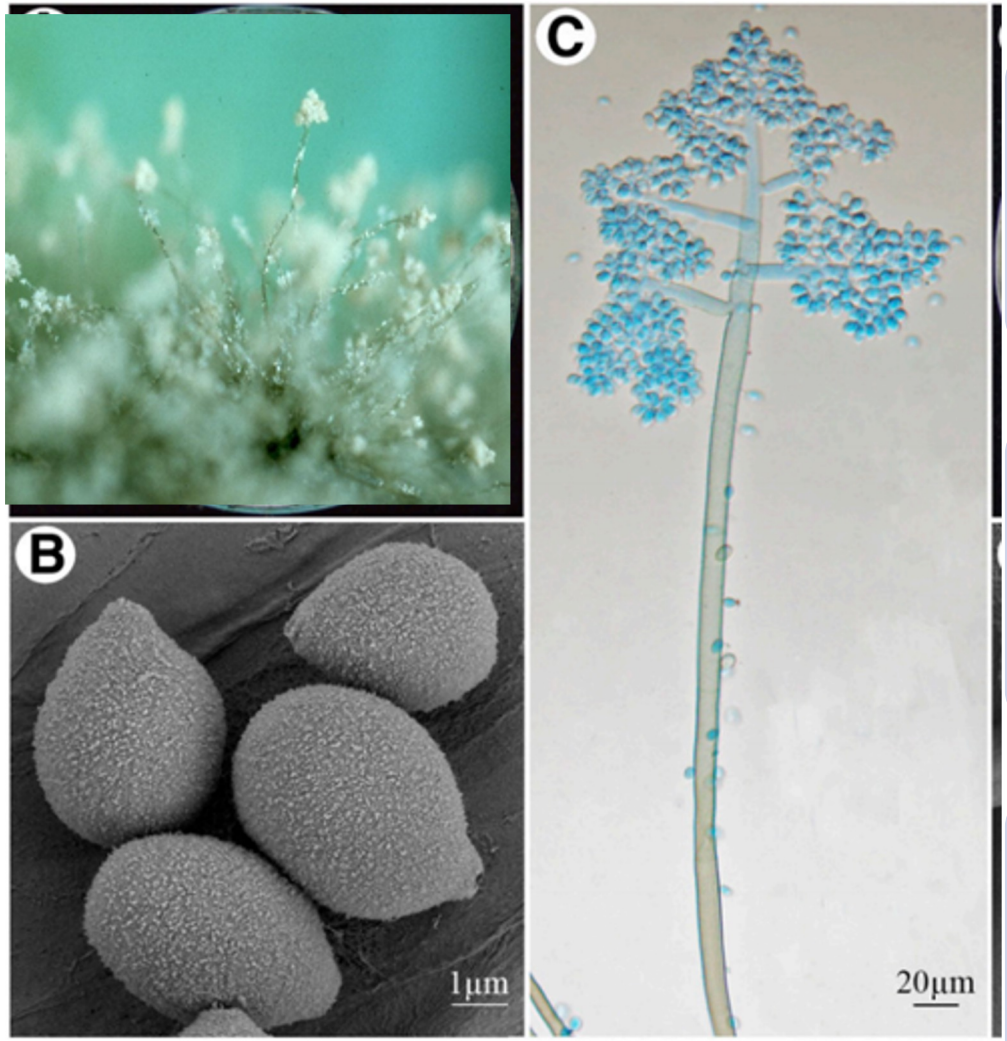
Sulfur disadvantages

- Washes off easily with rain
- Less effective in cool weather
- May burn wines in hot weather

Downy mildew *Plasmopara viticola* of grapevine

Pathogens involved with Bunch Rot / Gray Mold

Botrytis cinerea



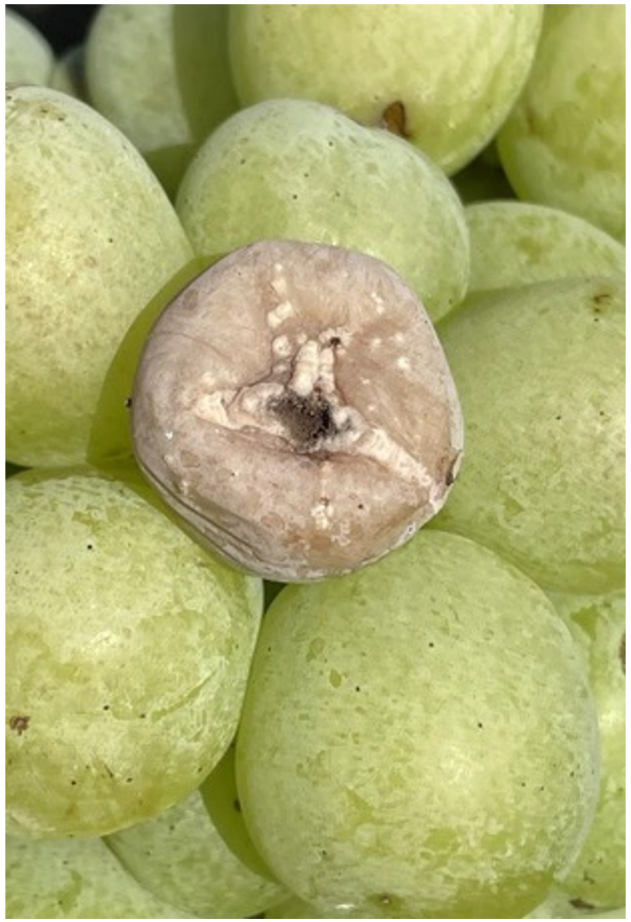
Zhou et al 2018, Plant Disease

- Fungus is ubiquitous
- Attacks juvenile tissue, ripe fruit Brix >8
- After infection, the fungus can produce sclerotia (resting structure).

Summer bunch rot (Sour rot)

- **In California, sour rot has been attributed to a complex of microorganisms including *Botrytis cinera, Aspergillus niger*, *A. carbonarius,* and others (Latham et al 2008)**

Other common symptoms of sour rot



Non-Summer Botrytis symptoms

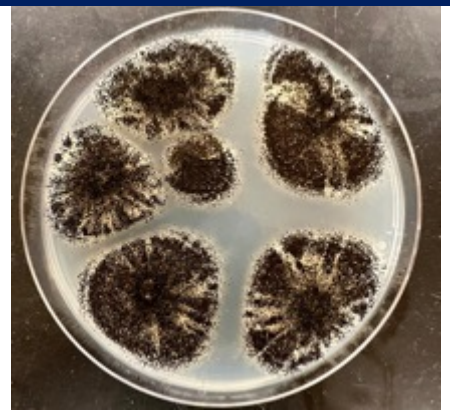
Black Measles

Esca

Sunburn

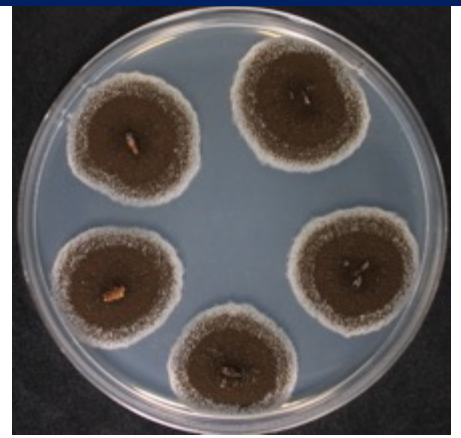
Pathogens involved with Summer Bunch rot (Sour Rot)

Botrytis cinerea

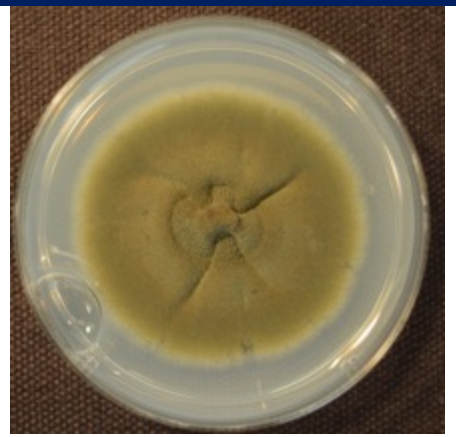


Aspergillus carbonarius

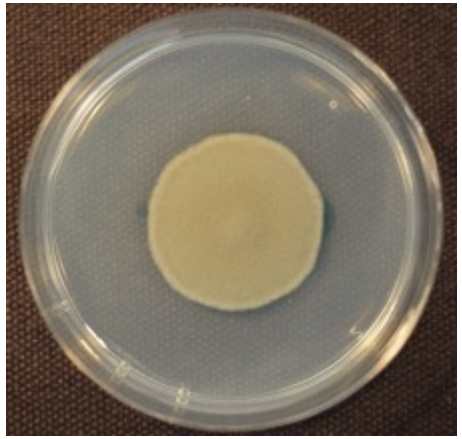
Aspergillus niger



Aspergillus tubingensis



Cladosporium sp.



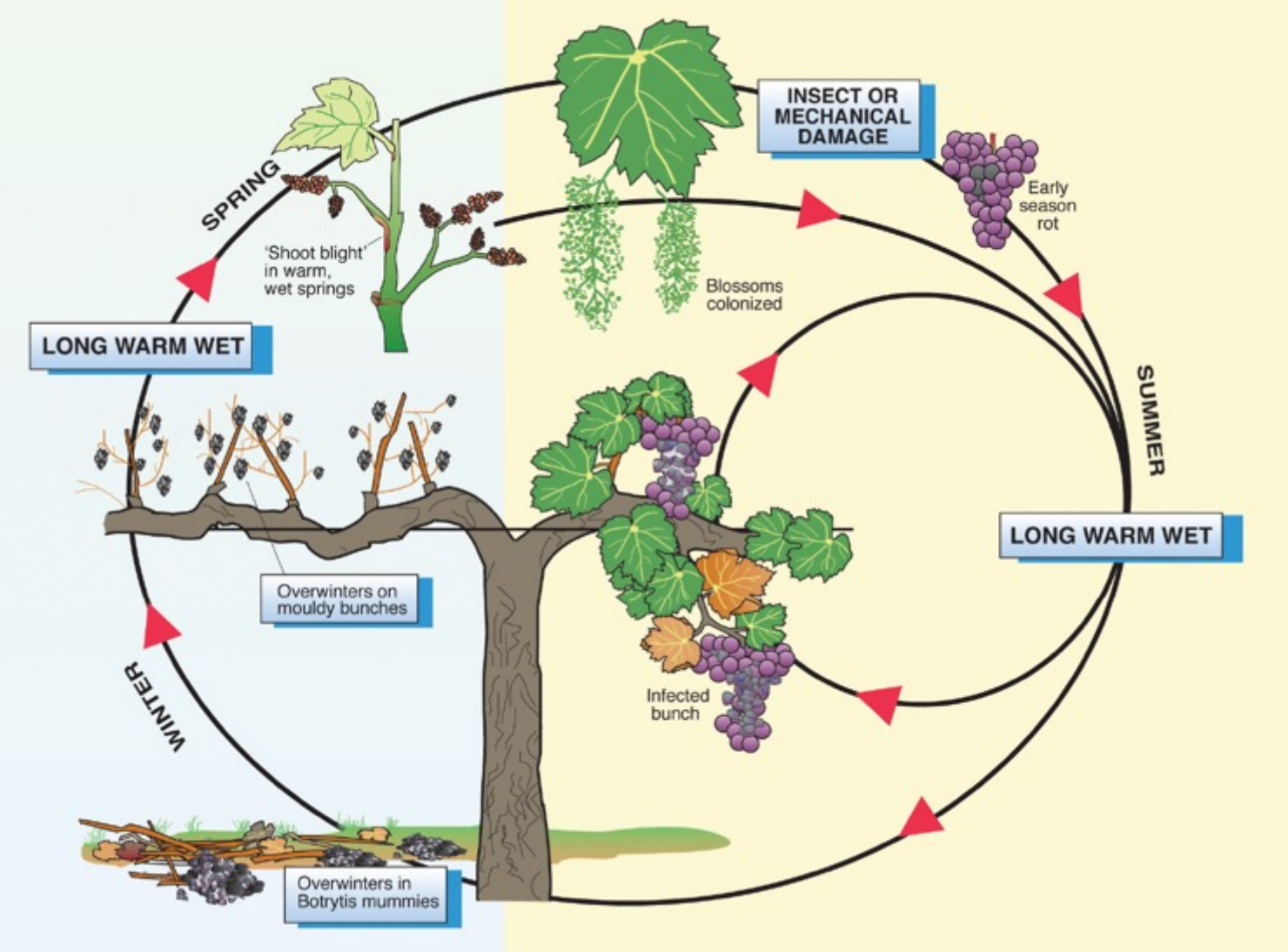
Penicillium sp.

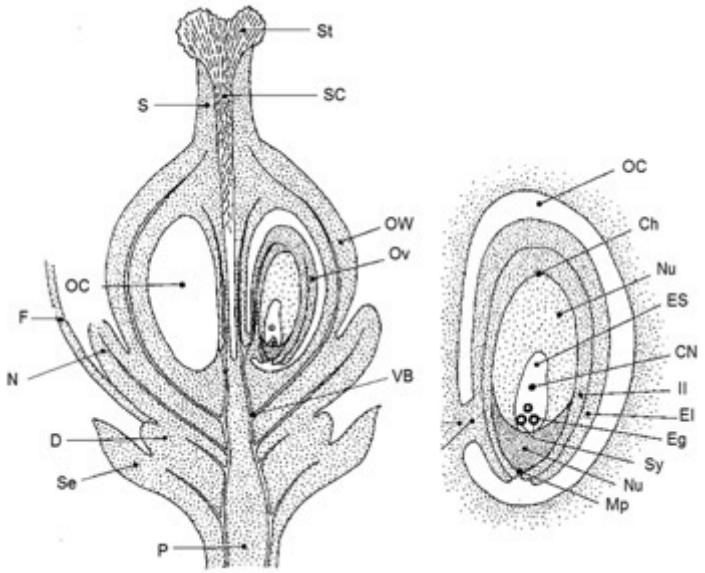
Rhizopus sp.

Yeast

Bacteria

Life cycle of Botrytis bunch rot

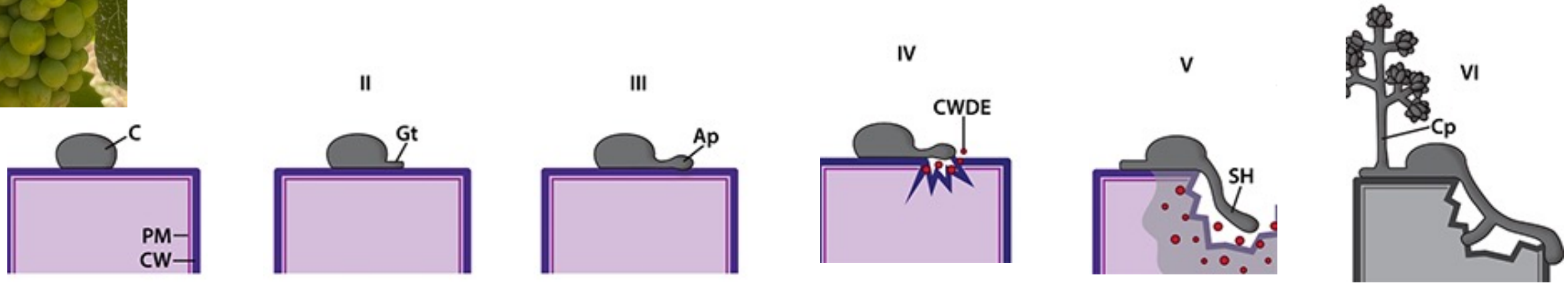




Drosophila

https://www.awri.com.au/wp-content/uploads/botrytis_intro.pdf

Infection by *Botrytis cinerea*



I- Conidium,
C- attachment

II-Conidium germination and germ tube (Gt) formation)

III-Appressorium (Ap) differentiation

IV- Secretion of cell wall degrading enzymes (CWDE)

V-Colonization of secondary hyphae (SH) formation

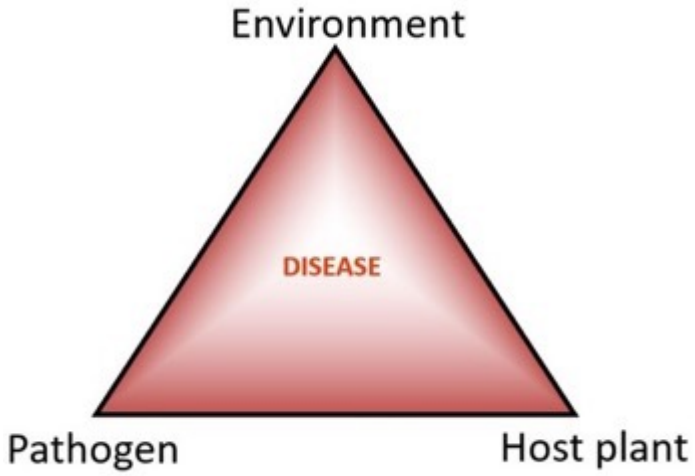
VI-Development of asexual reproductive organs or conidiophores

24-48 hours

Armijio et al. 2016 Grape and Wine Biotechnology

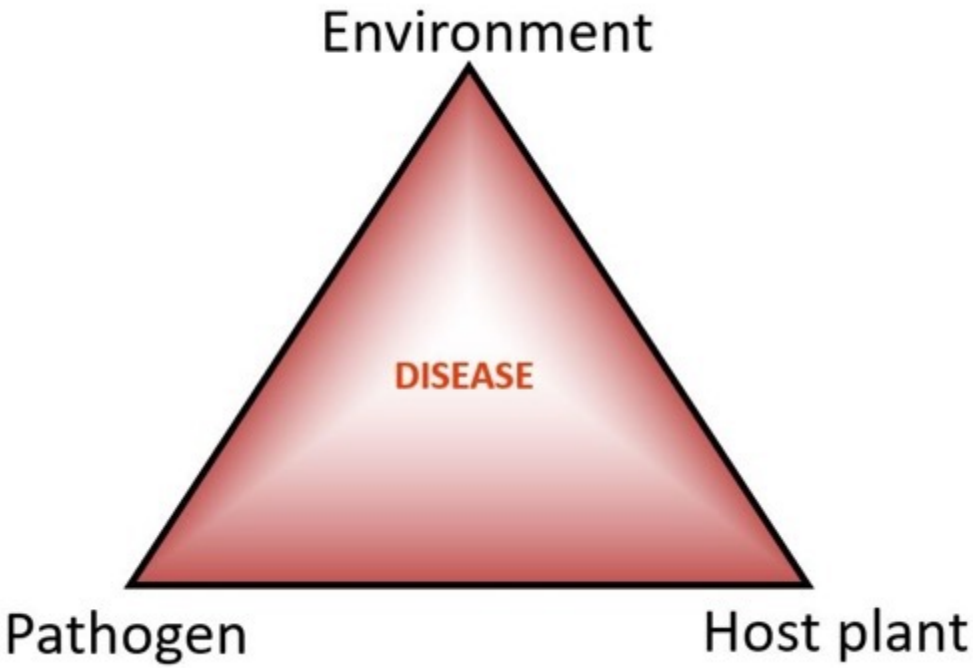
Factors affecting grapevine susceptibility

- **Weather**
- **Site**
- **Micro-climate/Canopy architecture**
- **Grapevine growth stage**
- **Tissue Damage**
- **Varietal susceptibility:** Chardonnay, Chenin Blanc, Grenache, Muller, Thurgau, Pinot Gris, Pinot Noir, Riesling, Sauvignon Blanc, Semillon, Traminer, and Sultana



Cultural practices affect summer bunch rot

- Leaf removal
- Decreased fertilizer
- Cluster Architecture



Fungicide efficacy

- **Timing**
  - Bloom, Preclose, Veraison, Preharvest
- **Application**
  - Full coverage, Both sides of vine
- **Phenology**
  - Blossoms, young fruit, older fruit, leaves, shoots

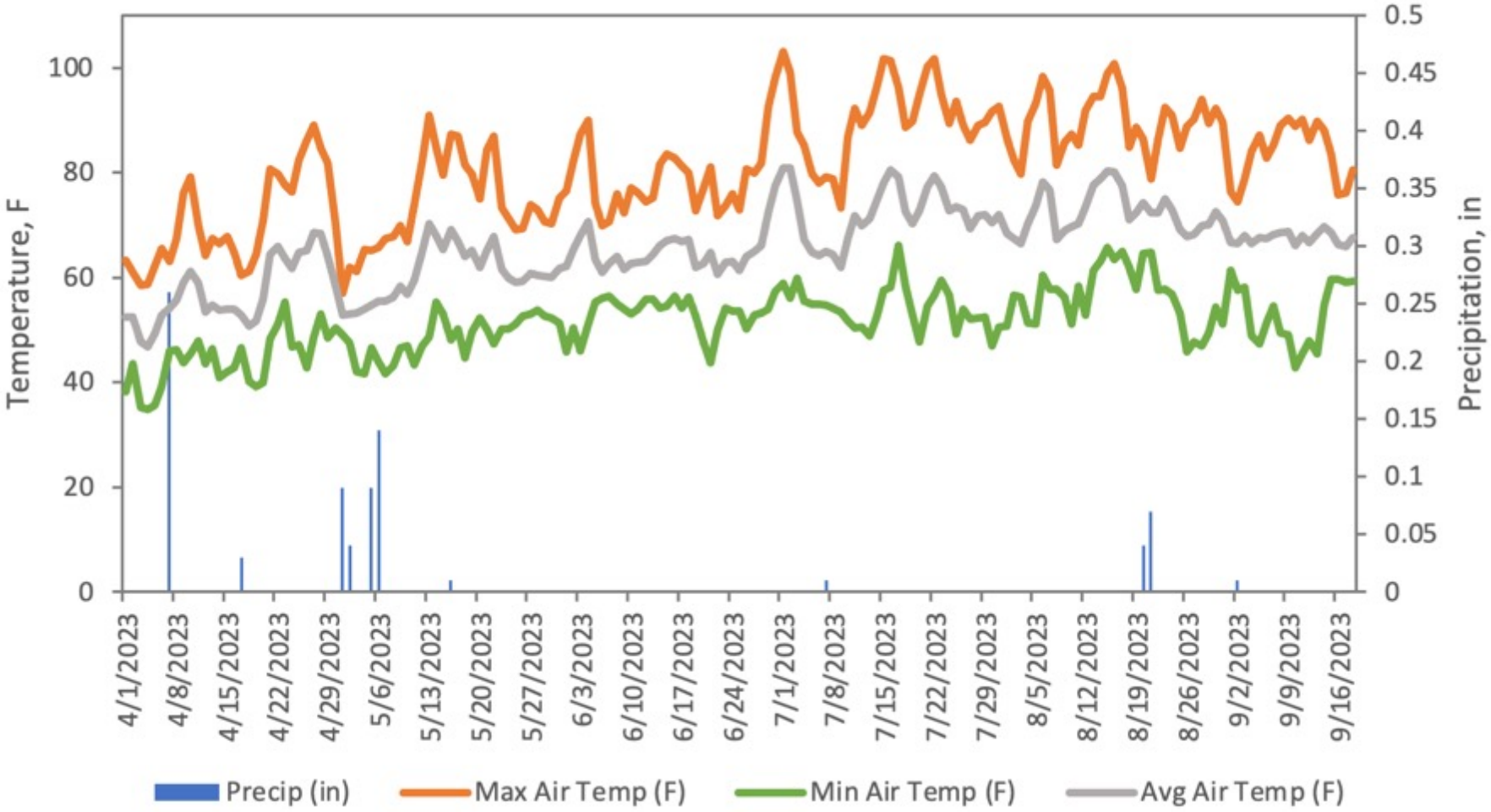
2023 Field fungicide efficacy trials

Experimental design

Experimental design	Completely randomized design with 5 replicates		
Experimental unit	3 adjacent vines = 1 plot		
Row and tree spacing	11 ft (row) and 5 ft (vine)	Plot unit area	165 ft^2
Area/treatment	825 ft^2 or 0.01956 acre/treatment (5 replicates = 1 treatment)		
Fungicide Applications, Volume water/Acre	A bloom, May 25th, 100 gallons = 1.5152 gal/5 reps B pre-close, June 22th, 150 gallons = 2.2727 gal/5 reps C veraison, August 6st, 150 gallons = 2.2727 gal/5 reps D pre-harvest, August 23rd, 150 gallons = 2.2727 gal/5 reps		
Equipment	Stihl SR 430 Backpack Sprayers		

https://ucanr.edu/sites/eskalenlab/Fruit_Crop_Fungicide_Trials/

2023 Field climatic data



Average daily temperature (ÅãC) and precipitation (mm) from Apr 1 to July 25, 2022, from CIMIS station #243.

2023 Summer Bunch Rot Field Trials

Treatment [x]			Application time [y]	Bunch rot on the clusters [z]	
No.	Flag	Rate/Acre		Incidence, %	Severity, %
40	BKC	Evoca 3 lb + Activator-90 16 fl oz/100 gal	A,D	8.0 a	1.0 a
		Pristine 23 oz	B		
		Elevate 16 oz	C		
50	B+G	SA-0650004 28 fl oz	A	14.4 ab	0.9 a
		Vangard WG 10 oz	B		
		SA-0650004 28 floz	C		
		Ph-D 6.2 oz + Syl-Coat 4 fl oz	D		
29	GD	Miravis Prime 13.4 fl oz + Dyne-Amic 0.125% v/v	A, C	15.2 a-c	1.4 a
		Vangard 10.0 oz + Dyne-Amic 0.125% v/v	B		
		Switch 14.0 oz + Dyne-Amic 0.125% v/v	D		
42	PWD	Mevalon 55 fl oz	A	16.0 a-d	1.0 a
		Vangard WG 10 oz	B		
		Elevate 50WDG 1 lb	C		
		Ph-D 6.2 oz + Syl-Coat 4 fl oz	D		
6	O	V6M-5-7 27.4 fl oz + Dyne-Amic 0.125%v/v	A,B,C,D	17.6 a-e	1.8 a
30	GS	Vangard 10.0 oz+ Dyne-Amic 0.125% v/v	A, D	17.6 a-e	2.0 a
		Miravis Prime 13.4 fl oz + Dyne-Amic 0.125% v/v	B, C		
27	RKC	Kaligreen 5lb	A,B,C,D	20.0 a-g	2.6 a-c
41	Pu	Evoca 3 lb + Activator-90 16 fl oz	A, B, D	20.0 a-g	0.9 a
		Elevate 16 oz	C		

Eskalen lab website

Flag 18-YKC-2022- Powdery Mildew Trial

G. Results

Trial I

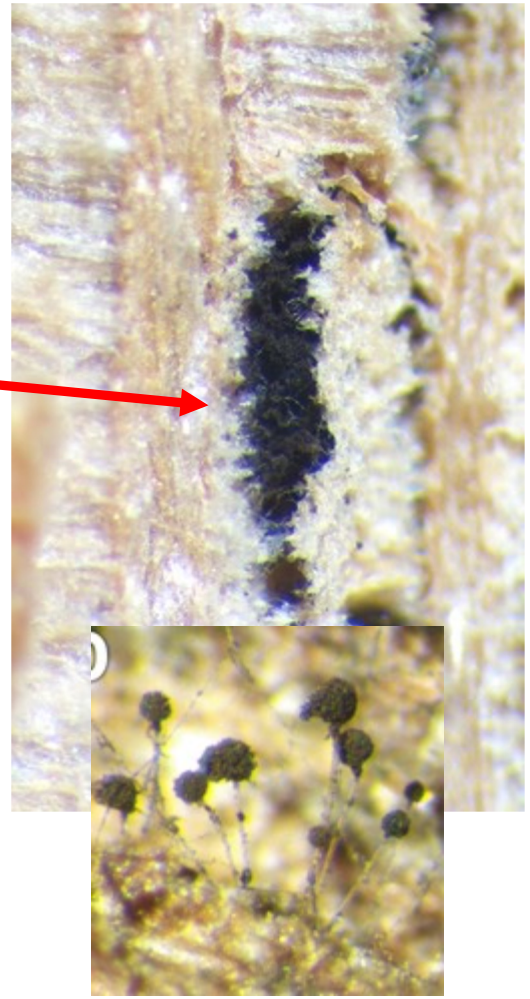
Table 1. Disease incidence and severity of synthetic fungicides and combinations of soft chemistry and synthetic products. Product names are followed by rate (per acre). Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05;

Treatment			Application date	Powdery mildew on the cluster [y]	
Pictures	- Flag	Rate/A[z]	(Julian day)	Incidence, %	Severity, %
18	YKC	Abound 15.5 fl oz + Syl-Coat 4 fl oz	105	0.0 a	0.00 a
		Prolivo 5 fl oz + Syl-Coat 4 fl oz	119		
		Kenja 22 fl oz + Rally 4 oz + Syl-Coat 4 fl oz	132		
		Quintec 4oz + Syl-Coat 4 fl oz	147		
		Torino 3.4 oz + Syl-Coat 4 fl oz	161		
		Merivon 4oz + Syl-Coat 4 fl oz	178		
		Vivando 15.4 oz + Syl-Coat 4 fl oz	193		
37	BC	PureSpray Green 1 gal	103, 110, 117	0.0 a	0.00 a
		Luna Experience 8.6 fl oz	124, 182		
		Pristine 23 oz	138		
		Elevate 16oz	152		
		Parade 3.1 fl oz	166		
41	Pu	Parade 3.1 fl oz + Dyne-Amic 0.25% v/v	108, 122, 136, 150, 165, 179, 194	0.0 a	0.00 a
62	Y+O	Aprovia Top 13.3 fl oz +Syl-Coat 0.125% v/v	122, 179	0.0 a	0.00 a
		Quintec 6.6 fl oz + Syl-Coat 0.125% v/v	136, 194		
		Miravis Prime 13.4 fl oz +Syl-Coat 0.125% v/v	165		
		Inspire Super 20.0 fl oz +Syl-Coat 0.125% v/v	150		
63	Y+W	Aprovia Top 13.3 fl oz + A9180B 0.5 oz +Syl-Coat 0.125% v/v	122, 179	0.0 a	0.00 a
		Quintec 6.6 fl oz + A9180B 0.5 oz + Syl-Coat 0.125% v/v	136, 194		

Unusual fall symptoms on virus free grapevines

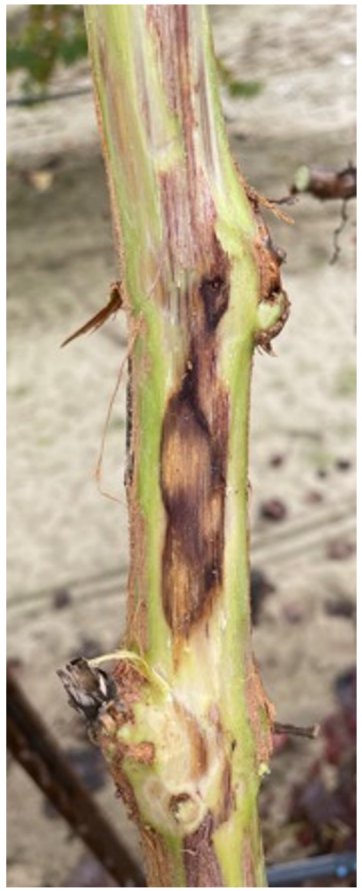
Grenache cv./ Freedom

External Symptoms

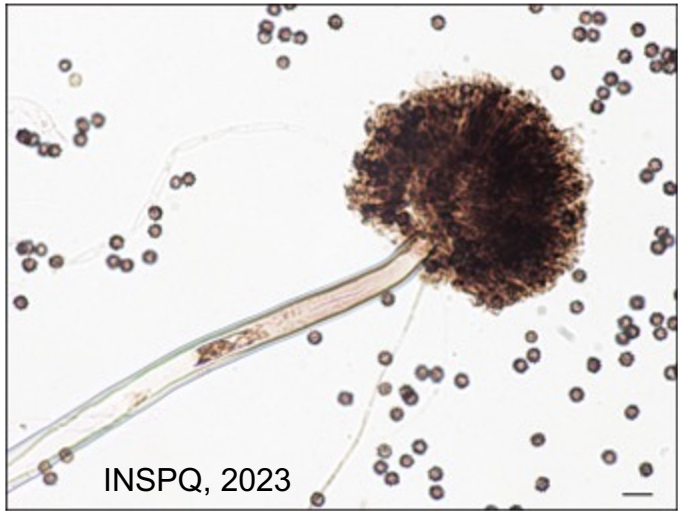


Internal symptoms:

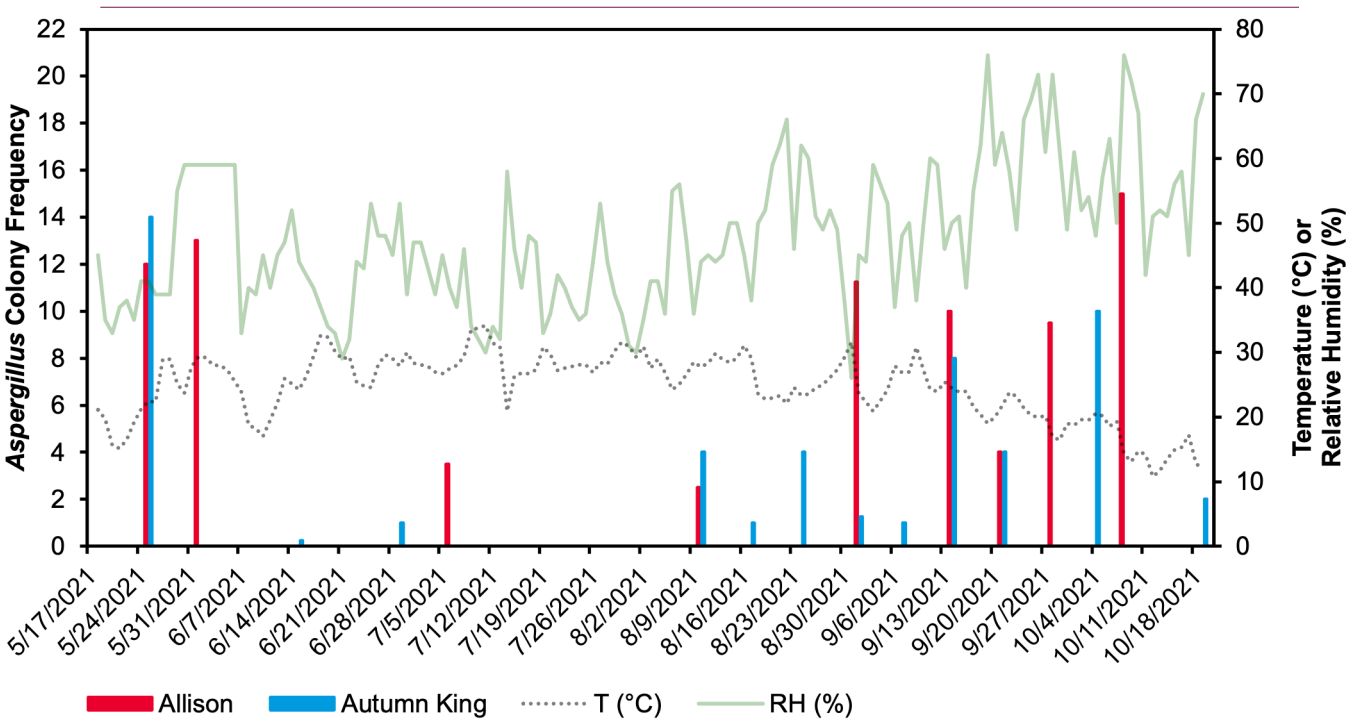
Survey of AVC- and SR-associated isolates

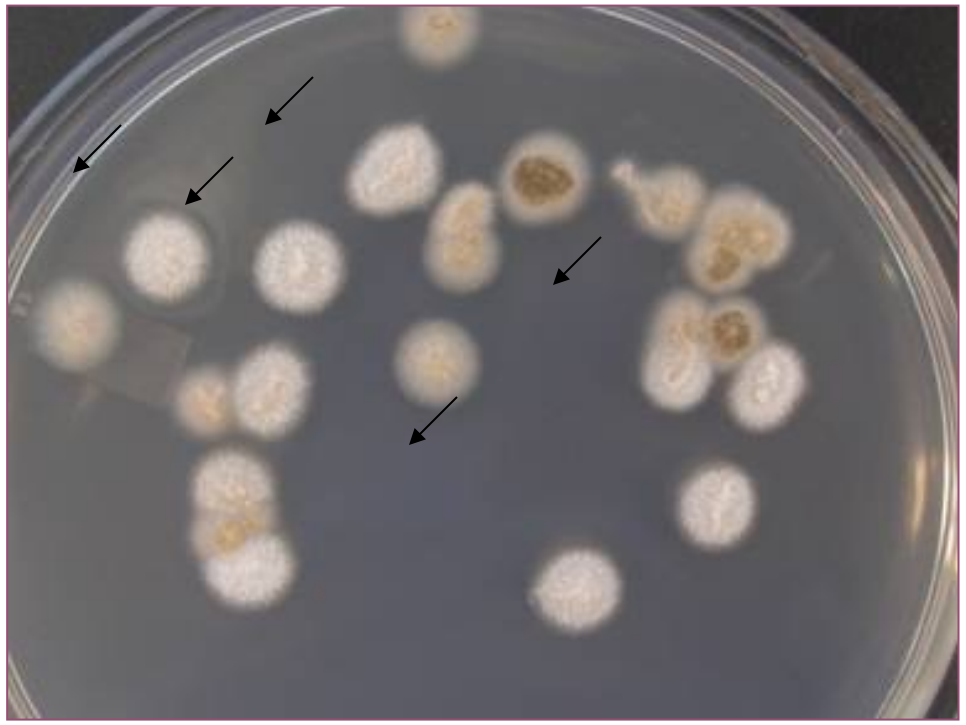


Origin	Number of isolates (*n*)
AVC samples 2021	10
AVC isolates 2000 (T. J. Michailides)	5
Sour Rot isolates	255
Spore trap isolates	20
Total	**290**



Spore dispersal pattern of summer bunch rot pathogens

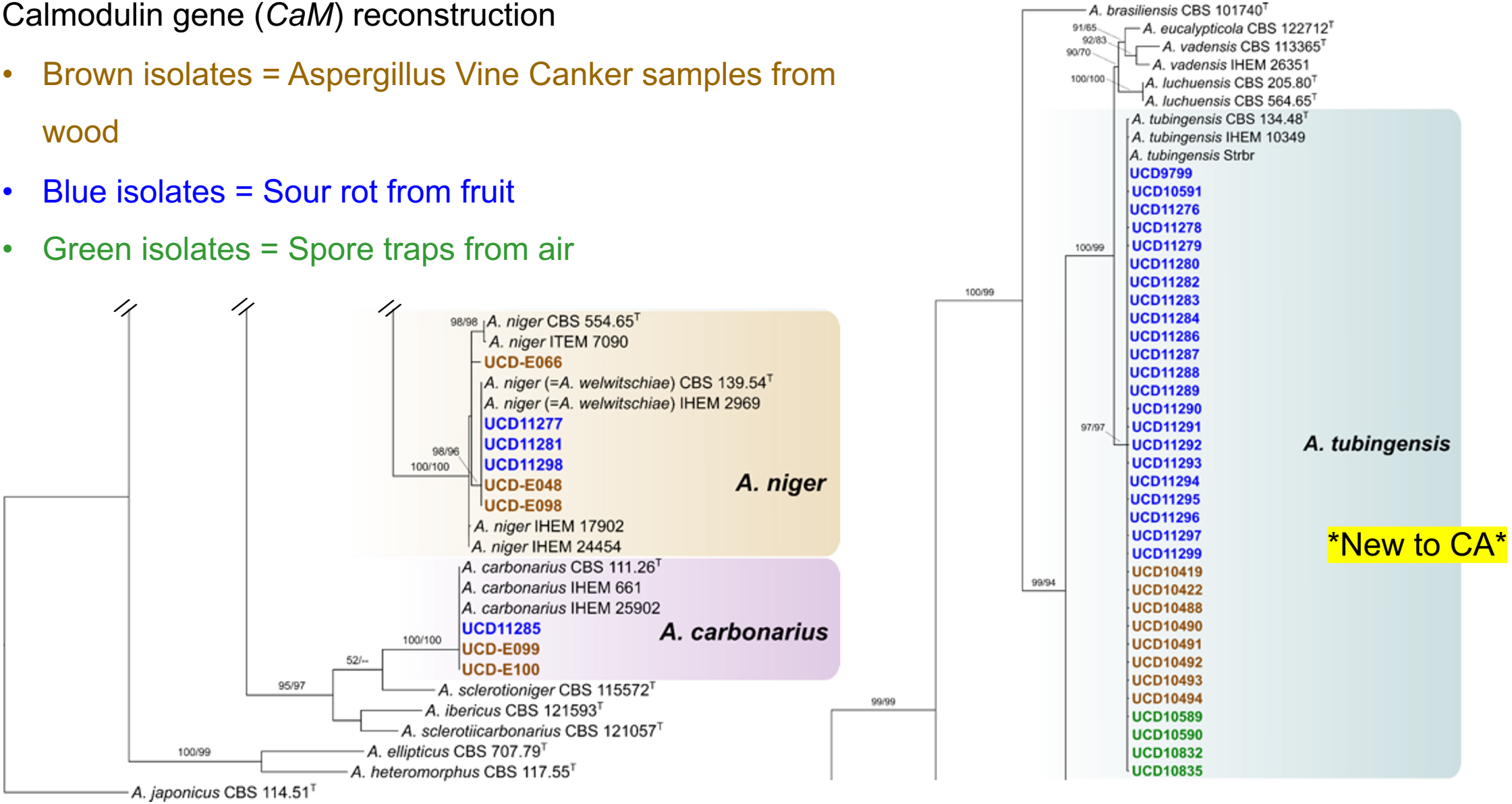




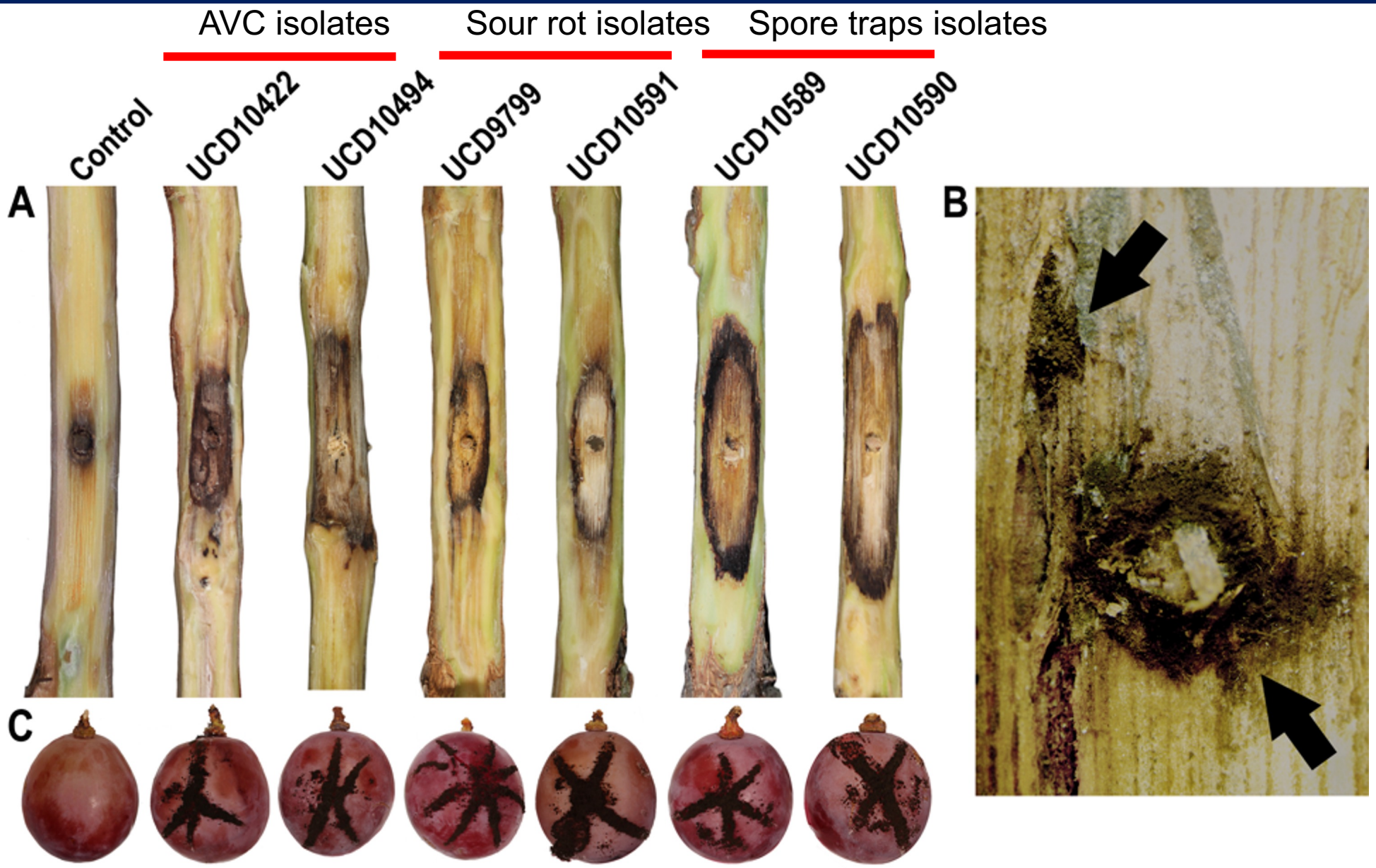
Identification of *Aspergillus* spp.

Calmodulin gene (*CaM*) reconstruction

- Brown isolates = Aspergillus Vine Canker samples from wood
- Blue isolates = Sour rot from fruit
- Green isolates = Spore traps from air

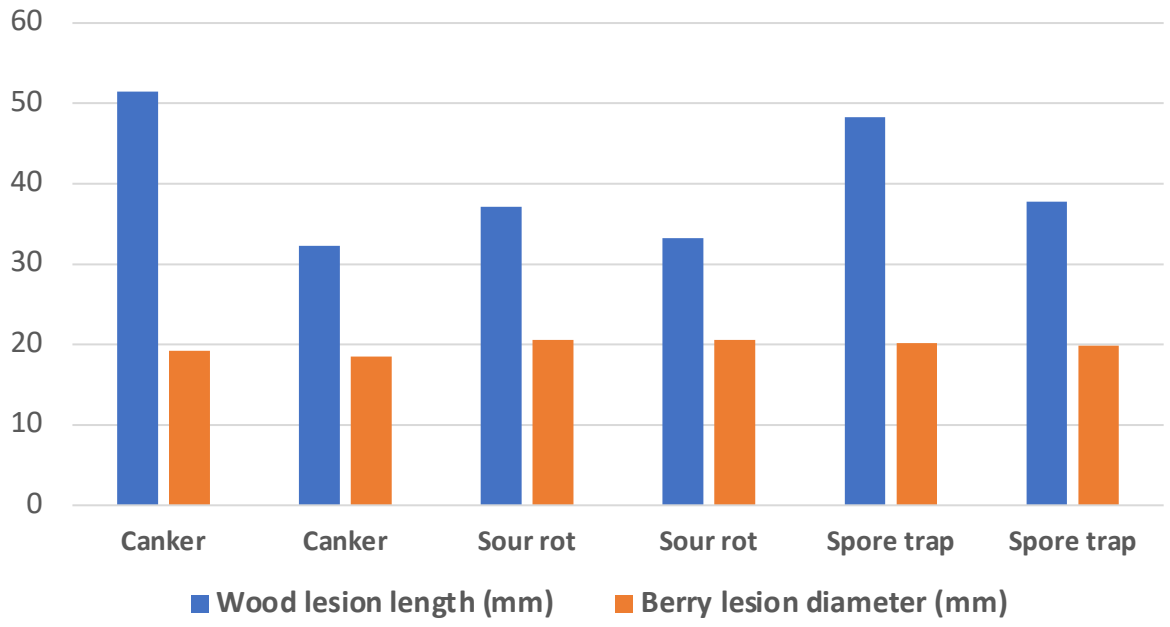


Pathogenicity of *Aspergillus tubingensis*



Pathogenicity of *Aspergillus tubingensis*

Isolate	Origin	Wood lesion length (mm)	Berry lesion diameter (mm)
UCD10422	Canker	51.5 a	19.2 abc
UCD10494	Canker	32.3 a	18.5 abc
UCD9799	Sour rot	37.1 a	20.6 a
UCD10591	Sour rot	33.2 a	20.6 a
UCD10589	Spore trap	48.3 a	20.2 ab
UCD10590	Spore trap	37.8 a	19.9 ab

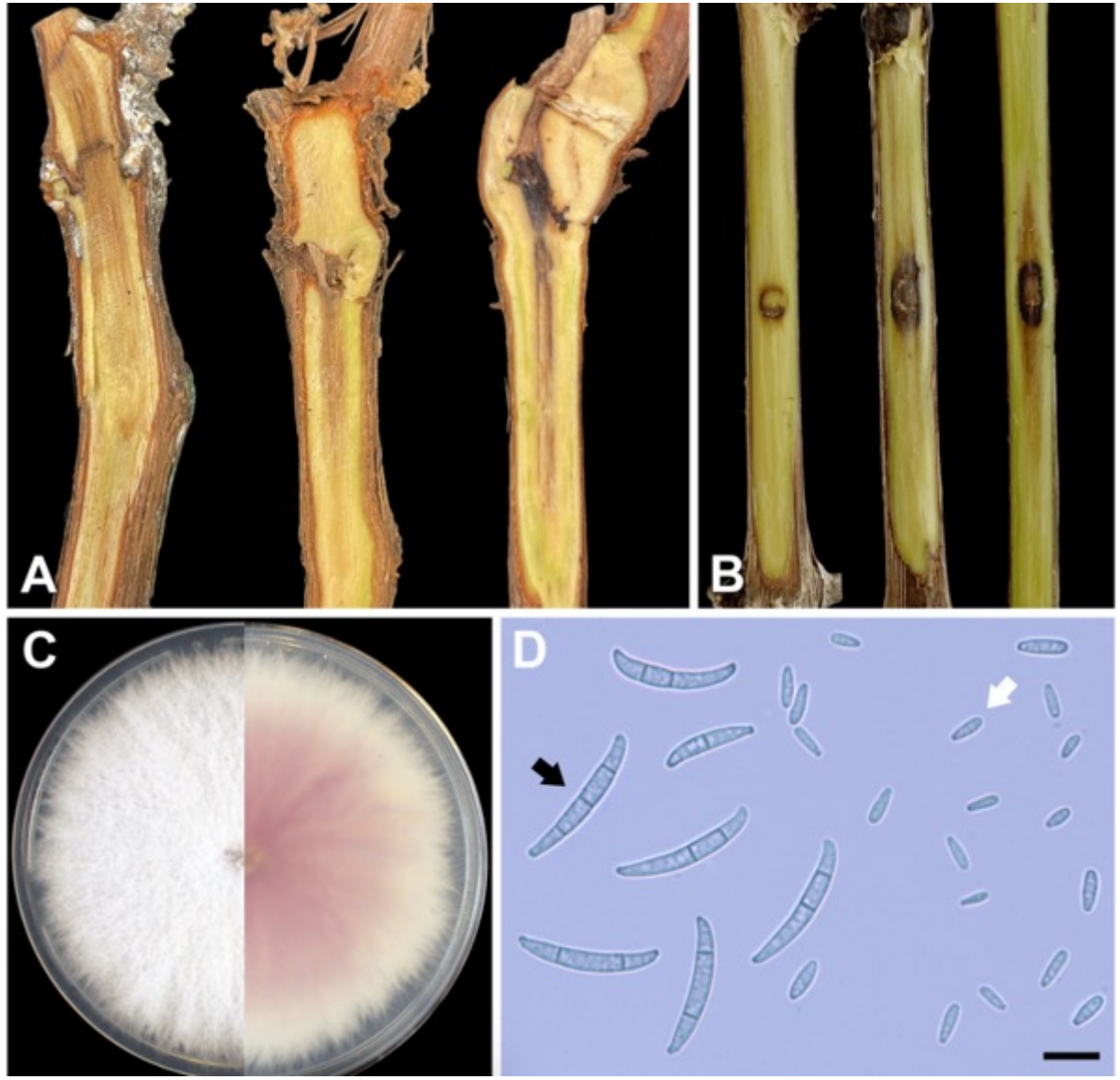


Lesion length and diameter (mm) values obtained from pathogenicity tests in wood and ripen berries of 'Red Globe' grapevines.

Bustamante et. al. Reassessing the etiology of Aspergillus vine canker and summer bunch rot of table grapes in **California *Plant Disease, 2023***

Macrophomina Charcoal Rot *(Macrophomina phaseolina)*

Fusarium annulatum



Graft Union

Bustamante et al. 2023 First Report of *Fusarium annulatum* Associated with Young Vine Decline in California. Plant Disease.

Infection of GTD on different parts of the vine

Spurs

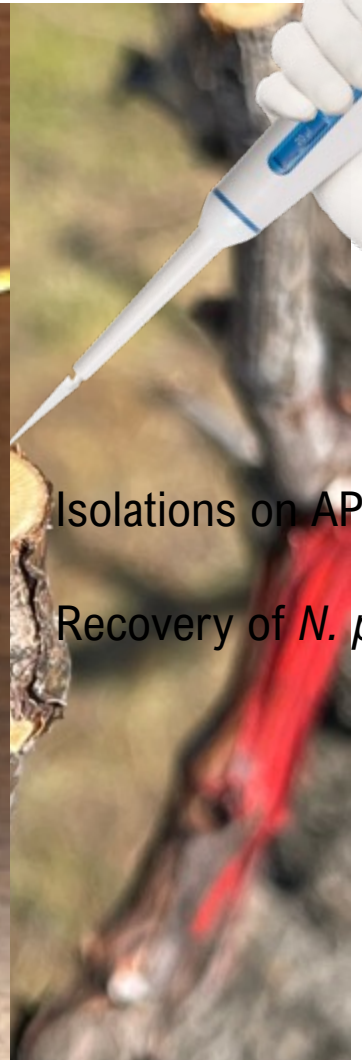
Cordon

Trunk

Rootstock

Field pruning wound protection trials

1) Treatment



2) Inoculation
N. parvum
(2,000 conidia)

Isolations on APDA

Recovery of *N. parvum* (%)

3) Evaluation of infection

Pruning wound protection trials

Product name	Active Ingredient	Manufacturer
Untreated (non-inoculated)	-	-
Esendo, 2.8 lbs	pre-mix of Howler and azoxystrobin	AgBiome Innovations
Parade, 4.7 fl oz	pyraziflumid	Nichino America
Luna Sensation, 7.6 oz	fluopyram (17.54%), tebuconazole (17.54%)	Bayer CropScience
1 L Vitiseal ready-to-use (V-RTU). This is NOT to be diluted.	Acrylic Co-Polymer	VitiSeal International LLC
UCD 8189 + 8344, $1x10^5$ cfu/ml	Aureobasidium pullulans-8189+8344	N/A
Topsin M 1.25 lbs	Triophanate-methyl	United Phosphorus Inc.
Guarda, 2.56 fl oz/ga	thyme oil	BioSafe Systems, LLC
Biotam, 2 lbs	Trichoderma asperellum (ICC 012) + Trichoderma gamsii (ICC 080)	Isagro USA
Vintec, 2.8 oz	Trichoderma atroviride strain SC1	Bi-PA
Botector, 8 oz	Aureobasidium pullulans strain DSM14940/14941 1	Westbridge Agricultural Products
Crab Life Powder, 0.5 lbs	Chitin	Conchazul de Mexico
PerCarb, 4 lbs	sodium carbonate peroxyhydrate (85%)	BioSafe Systems, LLC
2 X 0.5 L experimental new Vitiseal formulation, ready-to-use (X-RTU). This is NOT to be diluted.	Acrylic Co-Polymer	VitiSeal International LLC
Rhyme, 5 fl oz (applied as pruning wound spray)	Flutriafol (22.7 %)	FMC
TrichosSymBio, 25.6 fl oz	Trichoderma harzianum T78 (of 5 x 10^{11} cfu)	Symborg
UCD-10631, 10% fermented product	Bacillus velezensis UCD-10631	N/A
Parade, 3.1 fl oz	Pyraziflumid	Nichino America
UCD 8717, ($1x10^5$ cfu/ml)	Trichoderma hamatum -8717	N/A
Positive Control (Inoculated with N. parvum)	-	-
Baby detergent 2%	Dreft Stage 1 Liquid Detergent	Dreft
microSURE (Agriwash), 4.36 gal	Proprietary	Strategia Project Management Inc
CS2005, 32 fl oz	Copper Sulfate Pentahydrate	Magna-Bon
GCM (Gelatinise and Chitinase Microorganism)	Bacillus velezensis CE100	N/A
Theia, 3 lbs	Bacillus subtilis strain AFS032321	AgBiome Innovations
UCD-10719, 10% fermented product	Serratia plymuthica UCD-10719	N/A
Vitiseal ready-to-use (V-RTU) applied using FELCO 19 - Special application - FELCO 8 with spraying device	Acrylic Co-Polymer	VitiSeal International LLC

Treatments of pruning wound protection trial in 2022

Product name	Active Ingredient	Manufacturer	MPI, %[z]
Untreated (non-inoculated)	-	-	0.0 f
Esendo, 2.8 lbs	pre-mix of Howler and azoxystrobin	AgBiome Innovations	6.7 ef
Parade, 4.7 fl oz	pyraziflumid	Nichino America	6.7 ef
Luna Sensation, 7.6 oz	fluopyram (17.54%), tebuconazole (17.54%)	Bayer CropScience	8.3 ef
1 L Vitiseal ready-to-use (V-RTU). This is NOT to be diluted.	Acrylic Co-Polymer	VitiSeal International LLC	11.1 ef
UCD 8189 + 8344, $1x10^5$ cfu/ml	*Aureobasidium pullulans-8189+8344*	N/A	12.2 def
Topsin M 1.25 lbs	Triophanate-methyl	United Phosphorus Inc.	13.3 cdef
Guarda, 2.56 fl oz/ga	thyme oil	BioSafe Systems, LLC	13.3 cdef
Biotam, 2 lbs	*Trichoderma asperellum* (ICC 012) + *Trichoderma gamsii* (ICC 080)	Isagro USA	13.3 cdef
Vintec, 2.8 oz	*Trichoderma atroviride* strain SC1	Bi-PA	24.4 bcdef
Botector, 8 oz	*Aureobasidium pullulans* strain DSM14940/14941 1	Westbridge Agricultural Products	25.0 bcdef
Crab Life Powder, 0.5 lbs	Chitin	Conchazul de Mexico	26.7 bcdef
PerCarb, 4 lbs	sodium carbonate peroxyhydrate (85%)	BioSafe Systems, LLC	28.9 abcdef
2 X 0.5 L experimental new Vitiseal formulation, ready-to-use (X-RTU). This is NOT to be diluted.	Acrylic Co-Polymer	VitiSeal International LLC	31.1 abcdef
Rhyme, 5 fl oz (applied as pruning wound spray)	Flutriafol (22.7 %)	FMC	33.3 abcdef
TrichosSymBio, 25.6 fl oz	*Trichoderma harzianum* T78 (of 5 x 10^{11} cfu)	Symborg	33.3 abcdef

Results of pruning wound protection trial for *Neofusicoccum parvum* in 2022

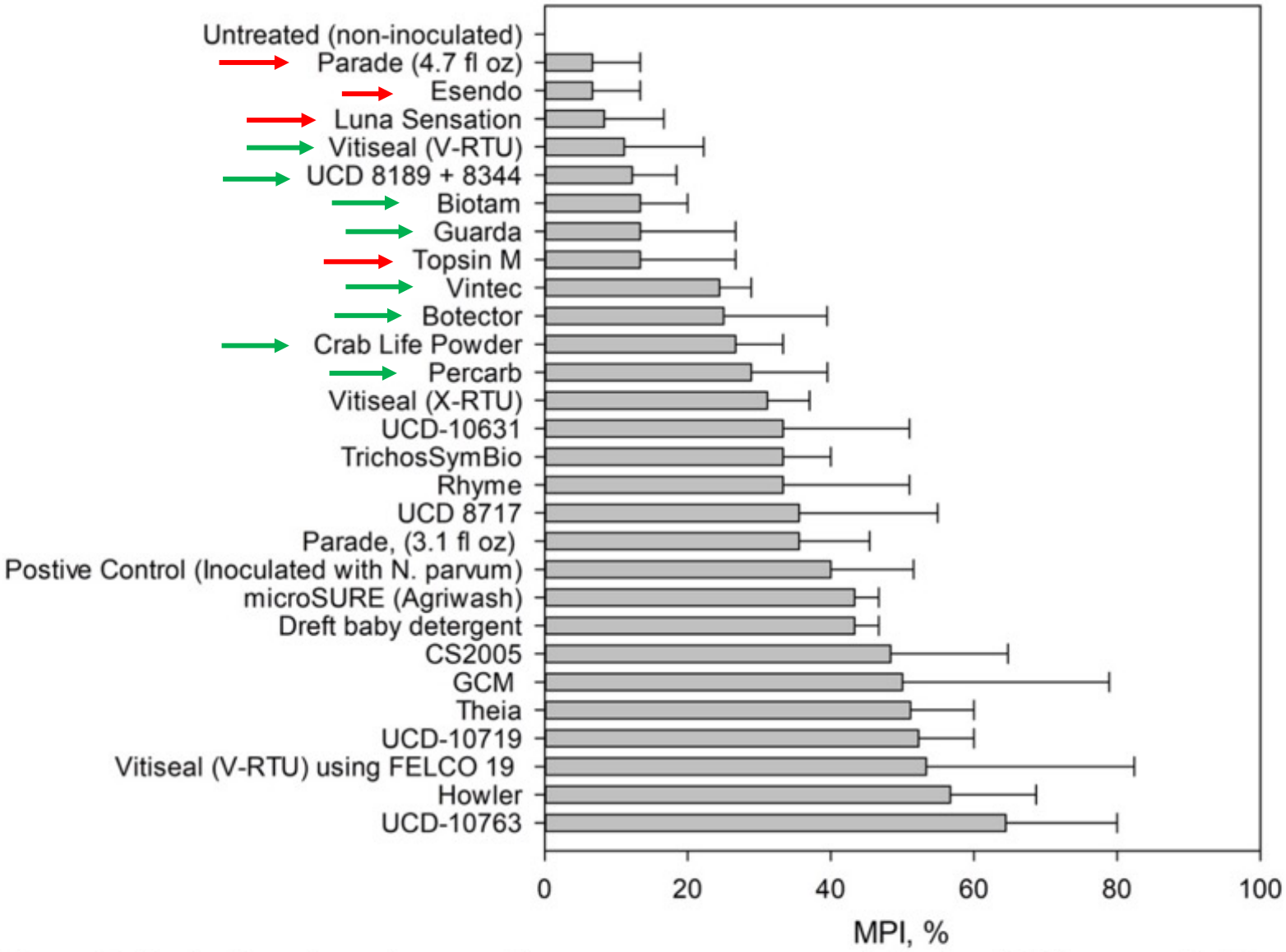
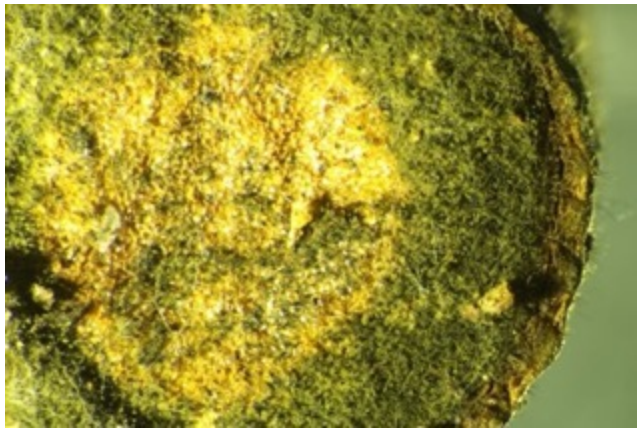


Figure 2. Evaluation of pruning wound treatments mean percent infection (MPI) rates with *N. parvum* located at UC Davis Plant Pathology Field Station, 2022. Bars = standard errors.

https://ucanr.edu/sites/eskalenlab/files/378928.pdf

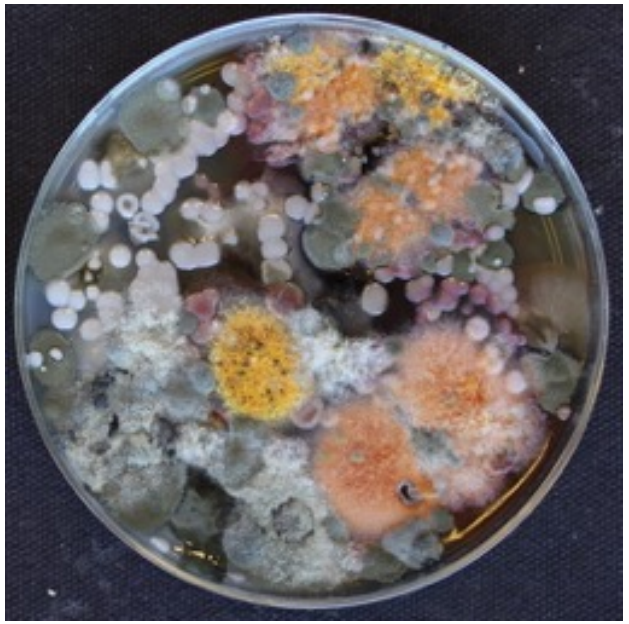
Recovery of biological treatments from inoculated canes

	Recovery %			
	Sacramento County		Kern County	
Treatment	***E. lata***	***N. parvum***	***E. lata***	***N. parvum***
Bacillus velezensis	0	25	25	5
Bacillus subtilis strain QST 713	0	5	0	0
Bacillus sp.	0	5	10	0
Trichoderma hamatum	0	20	20	15
Trichoderma asperellum and *Trichoderma gamsii* + a blend of crab and lonbster shell powder	35	10	30	30
Trichoderma asperellum and *Trichoderma gamsii*	60	45	20	30
Aureobasidum pullulans strain DSM14940/14941	65	100	25	30
Trichoderma atroviride	70	100	45	80
Aureobasidum pullulans	100	100	25	60



https://ucanr.edu/sites/eskalenlab/

Identification of Naturally Occurring Biological Control Agents in California Vineyards



Protecting pruning wound is essential

	Commercial name	Active ingredient	Manufacturer
Biocontrol	Biotam	(*Trichoderma asperellum* + *T. gamsii*	SepRo
	Vintec	*Trichoderma atroviride* SC1	BI-PA
	Botector	*Aerobasidium pullulans*	Westbridge
	GCM	*Bacillus velezensis CE100*	BSR
Plant extract	Guarda	Thyme oil	Biosafe System
Synthetic fungicides	Topsin-M	Triophanate-methyl	United Phosphorous
	Luna sensation	Fluopyram/Trifloxystrobin	Bayer CropScience
	Esendo	Azoxystrobin + Pseudomonas chlororapsis	Agbiome
	Rhyme	Flutriafol	FMC
	Parade	Pyraziflumid	Nichino America
Sealant	Vitiseal	Acrylic C0-Polymer	Vitiseal International
Disinfectant	PerCarb	Sodium carbonate peroxyhydrate (85%)	Biosafe Systems

https://ucanr.edu/sites/eskalenlab/

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- Andrew Richards, Grad Student
- Maha Afifi

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