Management of Grape Powdery Mildew with Synthetic, Biological, and Organic Fungicides: 2024 Field Trial

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July 2024

Published 2024 at: https://ucanr.edu/sites/eskalenlab/Fruit_Crop_Fungicide_Trials
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Report Summary

Powdery mildew of grapes is caused by the biotrophic fungus *Erysiphe necator*[1]. The disease causes significant economic losses associated with reductions in grape quality and yield worldwide, making it one of the most critical factors to manage in the vineyard. This report shows the results of our annual powdery mildew fungicide trial conducted at an experimental vineyard at the Plant Pathology Field Station of the University of California, Davis (38°31'21.3" N, 121°45'38.6" W). The trial was carried out from April to July 2024, using 13-year-old vines of the Chenin Blanc cultivar. Chenin Blanc is highly susceptible to powdery mildew, similar to Chardonnay, Muscat Blanc, Roussanne, and Carignane[2]. Treatments were applied to runoff using mist blower backpack sprayers (Stihl SR 430). The trial had a complete randomized block design with five replicates of two vines each. The trial was divided into two groups based on the nature of fungicides. Group I consisted of synthetic fungicides and combinations of soft chemistry and synthetic products. Group II included soft chemistry fungicides, including biologicals, sulfur, nutrients, oils, and other materials. Spray frequencies varied from 7-day to 14-day intervals, starting on April 18th. Spraying was completed on June 28th based on the berry maturity level, and disease incidence and severity were evaluated on July 9th, 2024.

Materials and Methods

A. Experimental design

Table 1. Details of the experimental design, vine spacing, spray volumes and equipment utilized in the trial.

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 ft^2
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		

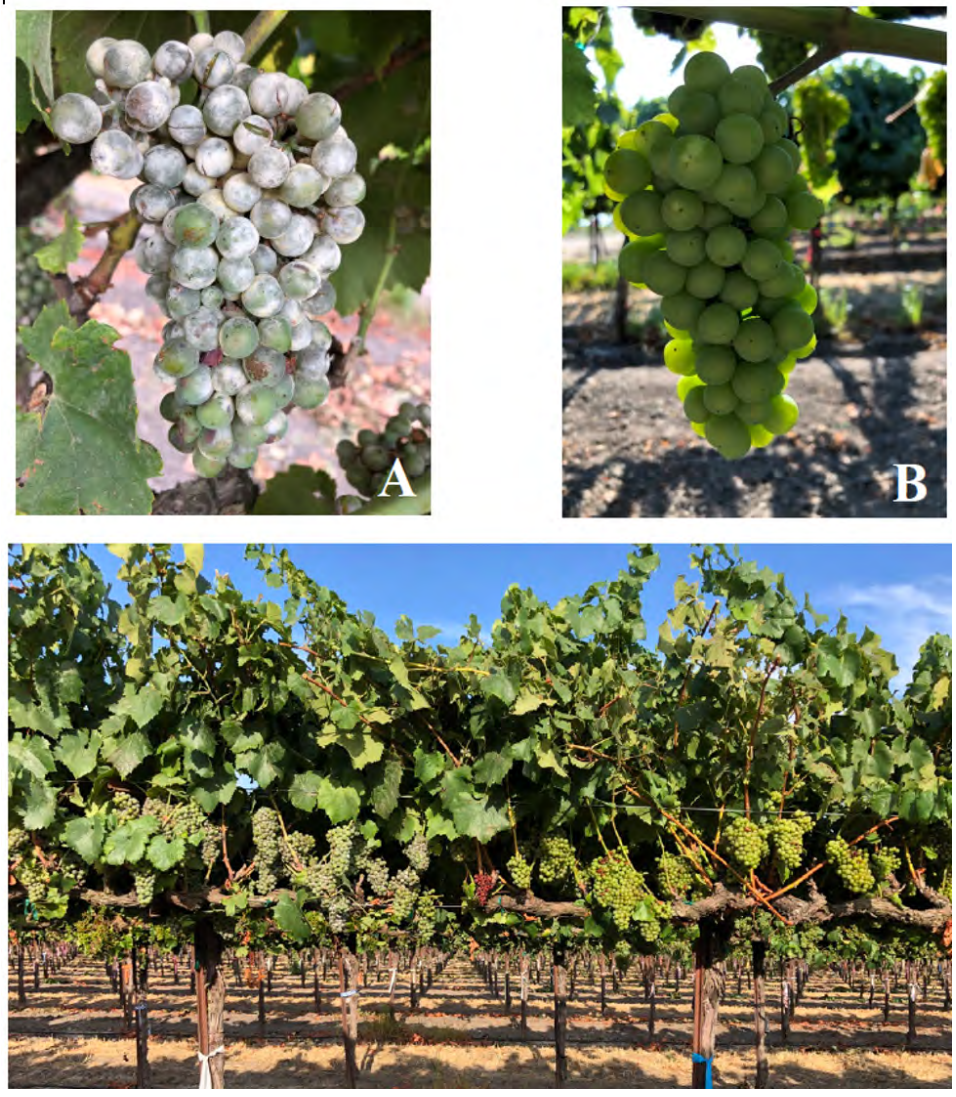
[1] Wilcox, W. F., Gubler, W. D., and Uyemoto, J. K. 2015. Compendium of grape diseases, disorders, and pests (2nd ed.). American Phytopathological Society. 232p.
[2] Gubler, W. D., Rademacher, M. R., Vasquez, S. J., and Thomas, C. S. 1999. Control of powdery mildew using the UC Davis powdery mildew risk index. APS*net* Features. http://doi.org/10.1094/APSnetFeature-1999-0199

B. Experimental treatments

The treatments described in this report were applied for experimental purposes only and crops treated in a similar manner may not be suitable for commercial or other use.

Acknowledgments

We thank Bryan Pellissier, Alexa (Lexi) Sommers-Miller, and the various industry donors for their collaboration. Thanks to the Department of Plant Pathology at UC Davis for providing space and service.



Infested cluster with powdery mildew from untreated control (**A**). Berries treated with Luna Experience (**B**). The left vine (white flag) represents untreated control, and the right vine (blue flag) treatment with synthetic fungicide (**C**).

https://ucanr.edu/sites/eskalenlab

C. Map

BLOCK 5 (rows 26–22) | BLOCK 4 (rows 20–16) | BLOCK 3 (rows 15–11) | BLOCK 2 (rows 10–6) | BLOCK 1 (rows 5–1)

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	ROW / VINE
-31	x	x	x	x	x	26-RKD	x	x	x	14-YD	x	7-O	17-YKD	27-RKS	x	29-G	43-PWS	13-Y	1-W	17-YKD	x	56-Pu+G	x	39-BKD	x	x	-31
-30	x	x	x	x	52-B+R		x	x	16-YC		4-KS				x						35-B		31-GS		15-YS	20-YRD	-30
-29	29-G	7-O	x	x			38-BC	8-OS+O		48-B+K		26-RKD		61-Y+R	21-YRS	43-PWS	61-Y+R	33-GKS		10-OKD		37-BS		57-Pu+O			-29
-28			x	2-K	27-RKS	32-GKD			24-RS+R		20-YRD		32-GKD						42-PWD		49-B+Y		x		60-Y+G	x	-28
-27	4-KS	x	60-Y+G				30-GD	17-YKD		52-B+R		x		44-PWC	6-BKS	x		21-YRS		37-BS		45-PKD	25-RC+R	32-GKD		41-Pu	-27
-26		21-YRS		x	44-PWC						35-B	36-BD	14-YD			51-B+O	25-RC+R		5-KC		10-OKD				23-RD		-26
-25			x	28-RKC		13-Y	x	61-Y+R	21-YRS	44-PWC				58-Pu+R				63-Y+W		x		8-OS+O	34-GKC	x		54-Pu+K	-25
-24	x	x	x		53-B+W		x				15-YS	46-PKS			x	56-Pu+G	3-KD		20-YRD	x	x			4-KS	x		-24
-23	x	18-YKS	34-GKC			9-OC+O	x		56-Pu+G	12-ONS			57-Pu+O	30-GD	12-ONS			47-PKC		40-BKC	17-YKD	26-RKD	x		63-Y+W	x	-23
-22	x			24-RS+R	42-PWD		57-Pu+O	x			9-OC+O	4-KS				x	41-Pu		35-B				x	61-Y+R		x	-22
-21	x	19-YKC				61-Y+R		47-PKC	54-Pu+K	19-YKC			47-PKC	22-R	54-Pu+K	3-KD		58-Pu+R		x	38-BC	38-BC	24-RS+R		6-BKS	3-KD	-21
-20	54-Pu+K		x	25-RC+R	62-Y+O		46-PKS				41-Pu	25-RC+R					2-K		26-RKD	49-B+Y				12-ONS			-20
-19		30-GD	57-Pu+O			50-B+G		42-PWD	43-PWS	60-Y+G			52-B+R	63-Y+W	59-Pu+W	62-Y+O		x			x	44-PWC	59-Pu+W		2-K	x	-19
-18	33-GKS			5-KC	31-GS		x				x	60-Y+G					60-Y+G	45-PKD	9-OC+O	22-R	8-OS+O			42-PWD		x	-18
-17		45-PKD	1-W			20-YRD	37-BS		33-GKS		3-KD		x	16-YC	40-BKC	13-Y						1-W	40-BKC		51-B+O	x	-17
-16	x			40-BKC	23-RD			5-KC		10-OKD			x				56-Pu+G	6-BKS	x	57-Pu+O				5-KC		x	-16
-15	51-B+O	x	12-ONS			16-YC	x		25-RC+R		x	45-PKD	9-OC+O	x	42-PWD	55-Pu+Y			29-G		55-Pu+Y	18-YKS	13-Y		43-PWS	x	-15
-14		x		37-BS	41-Pu		53-B+W	x		23-RD	63-Y+W			11-OKS			53-B+W	15-YS		12-ONS				58-Pu+R		x	-14
-13	x	x				6-BKS		49-B+Y	18-YKS			x	x		23-RD	37-BS			54-Pu+K		31-GS	55-Pu+Y	53-B+W		52-B+R	x	-13
-12	36-BD	11-OKS	x		22-R					31-GS	x	5-KC	x	15-YS			7-O	51-B+O		x				7-O		x	-12
-11			15-YS	43-PWS		63-Y+W	x	50-B+G	62-Y+O		39-BKD		36-BD		18-YKS	48-B+K			x	4-KS	x	29-G	9-OC+O		x	x	-11
-10	x				x		x			x		x		x			27-RKS	48-B+K	24-RS+R		52-B+R			33-GKS	x	x	-10
-9	x	x	x	x	3-KD	x	x	58-Pu+R		13-Y	34-GKC	19-YKC	50-B+G	35-B	38-BC	x				14-YD		50-B+G	46-PKS		16-YC	x	-9
-8	x	x	x	46-PKS		59-Pu+W	2-K		45-PKD							31-GS	44-PWC	32-GKD	16-YC		36-BD			14-YD		x	-8
-7	x	x	58-Pu+R		10-OKD			55-Pu+Y		32-GKD	29-G	20-YRD	39-BKD	26-RKD	2-K					39-BKD		30-GD	x		11-OKS	x	-7
-6	x	x		x		x			51-B+O							33-GKS	23-RD	46-PKS	62-Y+O		34-GKC		x	62-Y+O		x	-6
-5	48-B+K	35-B	x	x	55-Pu+Y	38-BC	x			6-BKS	40-BKC	1-W	49-B+Y	41-Pu	7-O					x		21-YRS	48-B+K		36-BD	x	-5
-4			x	17-YKD			14-YD	22-R	27-RKS							28-RKC	30-GD	x	11-OKS	x	x			27-RKS		x	-4
-3	8-OS+O	39-BKD	x		x	47-PKC				59-Pu+W	28-RKC	53-B+W	8-OS+O	34-GKC	x			19-YKC		59-Pu+W	x	19-YKC	x		x	x	-3
-2			x		49-B+Y		56-Pu+G	1-W	11-OKS						10-OKD	24-RS+R	28-RKC		50-B+G		18-YKS		22-R	47-PKC	28-RKC	x	-2
-1	x	x	x	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

N ←

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

FLAG PATTERN	
C	Checker
D	Dot
S	Stripe

D. Vine Management

During the application period, vines were irrigated by drip and sprinkler irrigation. Sucker shoot removal and leafing were done on July 3rd.

E. Data Collection and Statistical Analysis

Daily temperature and precipitation data were obtained from a weather station (CI006) belonging to the California Irrigation Management Information System (CIMIS) located in West Davis (Figure 1). The UC Davis Powdery Mildew Risk Assessment Index model (formerly known as the Gubler-Thomas model) was used to estimate the disease pressure throughout the season. Data was obtained from the UC IPM website (https://ipm.ucanr.edu/weather/grape-powdery-mildew-risk-assessment-index/) and disease risk indexes are shown in Figure 2.

Signs of powdery mildew were first observed on May 15th on berries.

Disease incidence and severity were assessed after evaluating 25 random clusters per treatment on each block (a total of 5 blocks, representing 5 replicates of each treatment). **Incidence** was assessed as the proportion of clusters showing symptoms or signs of powdery mildew per treatment on each block (i.e. number of symptomatic clusters per total clusters evaluated). **Severity** was determined by estimating the area covered by powdery mildew symptoms or signs on each cluster, and percentages of each plot were then averaged. Data of incidence and severity were separately subjected to analysis of variance (ANOVA) using generalized lineal models and means were further compared using Fisher's LSD test (α=5%) in the software InfoStat version 2020.

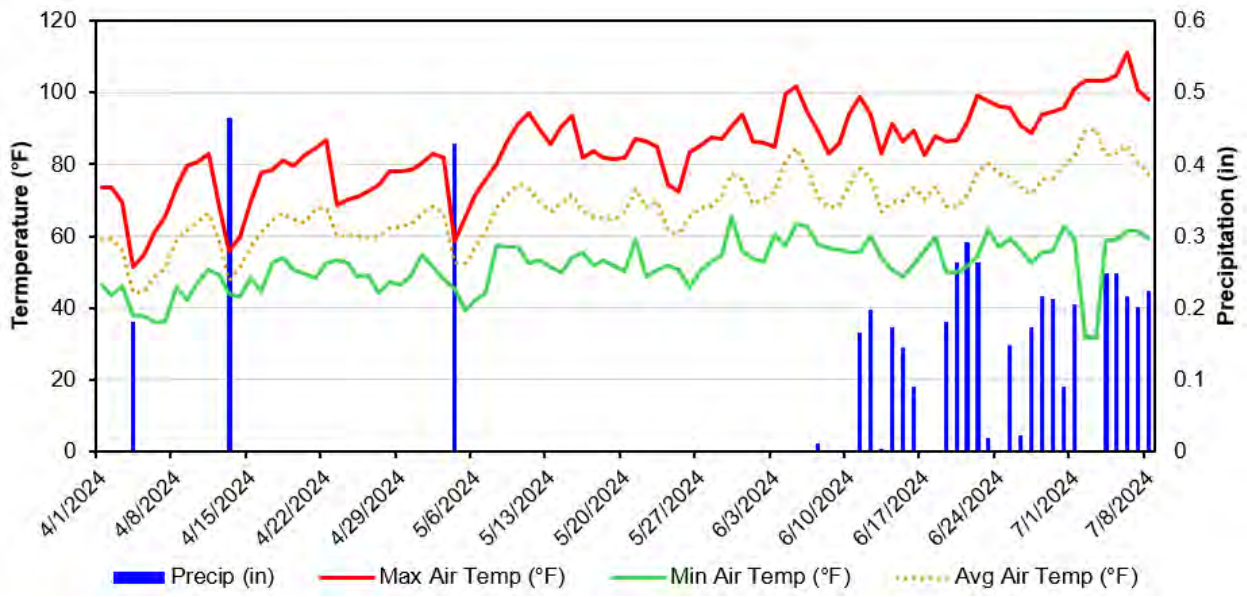


Figure 1. Maximum, average, and minimum temperatures (°F) and precipitation (in) from April 1st to July 8th of 2024 in Davis, CA, based on the CIMIS weather station.

Figure 2. Risk assessment index (RAI) for grape powdery mildew from March 15th to July 14th of 2024. The red line indicates the threshold of high disease pressure (RAI > 60), and the blue line indicates low to moderate disease pressure (RAI > 30). Data was obtained from the UC IPM website.

F. Pictures of Treatments

Clicking on the active link next to each trial number in the result tables will reveal pictures of each treatment.

G. Results

Trial Group I – Synthetic Fungicides

Table 1. Disease incidence and severity of synthetic fungicides and combinations of synthetic with soft chemistry products. Product names are followed by rate (per acre). Means followed by the same letter vertically are not significantly different according to Fisher's LSD test ($p > 0.05$).

Treatment			Application date	Powdery mildew on the cluster[X]	
Nº	Flag[Z]	Rate/A[Y]	(Julian day)	Incidence (%)	Severity (%)
57	Pu+O	Sulfur (5 lb/A)	109, 115, 127	1.6 a	0.0 a
		Aprovia Top (13.3 fl oz/A) + A9180A (1.0 oz/A) + DyneAmic (0.125% v/v)	136		
		Quintec (6.6 fl oz/A) + A9180A (1.0 oz/A) + DyneAmic (0.125% v/v)	145		
		Miravis Prime (13.4 fl oz/A) + A9180A (1.0 oz/A) + Dyn-Amic (0.125% v/v)	152		
		Inspire Super (20.0 fl oz/A) + A9180A (1.0 oz/A) + Dyn-Amic (0.125% v/v)	172		
29	G	Regev (8.5 oz/A) + DyneAmic (0.125% v/v)	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	1.6 a	0.1 ab
10	OKD	Wettable Sulfur (5 lb/A)	109,115,127	2.0 ab	0.1 ab
		V6M-5-14 (27.4 fl oz/A) + DyneAmic (0.0625%)	136,152,165,180		
24	RS+R	Scala DFO (17 fl oz) + DyneAmic (6.4 fl oz)	110, 127, 136, 152, 165, 179	3.2 ab	0.2 ab
9	OC+O	Luna Experience (4.3 fl oz) + Kitae (6 fl oz)	109, 144, 179	4.0 ab	0.2 ab
		Pristine (11.5 oz) + Kitae (6 fl oz)	115, 151		
		Endura (0.8 oz) + Kitae (6 fl oz)	123, 157		
		Trojan (1.15 fl oz) + Kitae (6 fl oz)	128, 165		
		Quintec (3 fl oz) + Kitae (6 fl oz)	136, 173		
38	BC	Luna Experience (8.6 fl oz) + DyneAmic (0.125% v/v)	110	5.6 ab	0.2 ab
		Quintec (6.6 fl oz)	127		
		Mevalone (55 fl oz/A + OSS 6 fl oz/A	137, 165		
		Miravis Prime (13.4 fl oz) + DyneAmic (0.125% v/v)	152, 180		
59	Pu+W	Luna Experience (8.6 fl oz/A)	109, 144, 179	4.8 ab	0.2 ab
		Pristine (23 oz/A)	115, 151		
		Endura (1.6 oz/A)	123, 157		
		Trojan (2.3 fl oz/A)	128, 165		
		Quintec (6 fl oz/A)	136, 173		

56	Pu+G	Sulfur (5 lb/A) Aprovia Top (13.3 fl oz/A) + DyneAmic (0.125% v/v) Quintec (6.6 fl oz/A) + DyneAmic (0.125% v/v) Miravis Prime (13.4 fl oz/A) + DyneAmic (0.125% v/v) Inspire Super (20.0 fl oz/A) + DyneAmic (0.125% v/v)	109, 115, 127 136 143 152, 180 172	4.8 ab	0.2 ab
43	PWS	OxiDate 5.0 (0.5% v/v) + Luna Experience (8.6 fl.oz/A)	110, 127, 137, 152, 172, 180	8.0 abc	0.3 ab
12	ONS	UC-70 (9.1 fl/oz)	110, 127, 136, 151, 165, 179	7.2 abc	0.3 ab
11	OKS	UC-70 (4.7 fl/oz)	110, 127, 136, 151, 165, 179	2.0 ab	0.4 ab
42	PWD	Inspire Super 16 fl oz/A + OxiDate 5.0 (0.5% v/v) Luna Experience 8.6 fl oz/A+ OxiDate 5.0 (0.5% v/v) Pristine (23 oz/A)+OxiDate 5.0 (0.5% v/v) Miravis Prime (13.4 fl oz/A) + OxiDate 5.0 (0.5% v/v) Quintec (4 fl oz/A)+OxiDate 5.0 (0.5% v/v) Aprovia Top (13.3 fl oz/A) + OxiDate 5.0 (0.5% v/v)	110 127 137 152 165 180	8.0 abc	0.4 ab
2	K	Inspire Super (16 fl oz) Luna Experience (8.6 fl oz) Pristine (23 oz) Miravis Prime (13.4 fl oz) Quintec (4 fl oz) Aprovia Top (13.3 fl oz)	110 127 136 152 165 180	5.6 ab	0.4 ab
40	BKC	Luna Experience (8.6 fl oz) + DyneAmic (0.125% v/v) Quintec (6.6 fl oz) Sa-0650004 (28 fl oz/A) Miravis Prime (13.4 fl oz) + DyneAmic (0.125% v/v)	110 127 137, 165 152, 180	6.4 ab	0.4 ab
5	KC	ALD1901 (0.23 lb) Luna Experience (8.6 fl oz) Miravis Prime (13.4 fl oz) Quintec (4 fl oz) Aprovia Top (13.3 fl oz)	110, 136 127 152 165 180	7.2 abc	0.5 ab
4	KS	Luna Experience (8.6 fl oz)	110, 127, 136, 152, 165, 180	12.8 abc	0.6 ab
16	YC	Amara (2 qt) + DyneAmic (0.125% v/v) Luna Experience (8.6 fl oz)	109, 115 127, 137, 152, 165, 180	12.8 abc	0.7 ab
55	Pu+Y	Sulfur (5 lb/A) Inspire Super (20.0 fl oz/A) + DyneAmic (0.125% v/v)	109, 115, 127 136	12.0 abc	0.8 ab

		Aprovia Top (13.3 fl oz/A) + DyneAmic (0.125% v/v)	143		
		Quintec (6.6 fl oz/A) + DyneAmic (0.125% v/v)	152		
		Miravis Prime (13.4 fl oz/A) + DyneAmic (0.125% v/v)	172, 180		
41	Pu	Luna Experience (8.6 fl oz) + DyneAmic (0.125% v/v)	110	14.4 abc	0.8 ab
		Quintec (6.6 fl oz)	127		
		Inspire Super (20 fl oz) + DyneAmic (0.125% v/v)	137		
		Quintec (6.6 fl oz) + DyneAmic (0.125% v/v)	152		
		Vivando (15.4 fl oz) + DyneAmic (0.125% v/v)	172		
		Pristine (23 oz) + DyneAmic (0.125% v/v)	180		
62	Y+O	Romeo (0.23 lb/A) + EMBRECE-EA (1 pt/100gal)	127	12.8 abc	0.9 ab
		BAJA (14 fl oz/A) + EMBRECE-EA (1 pt/100gal)	137, 165		
		SPARRA (44 fl oz/A) + EMBRECE-EA (1 pt/100gal)	152		
		Fervent 475 SC (8.5 fl oz/A) + EMBRECE-EA (1 pt/100gal)	180		
52	B+R	Luna Experience (8.6 fl oz/A)	110, 137, 165	16.8 abc	0.9 ab
		ApF23002 (64fl oz/A) + DyneAmic (0.125% v/v)	127, 151, 180		
25	RC+R	Inspire Super (20 fl oz) + DyneAmic (6.4 fl oz)	110, 127, 137, 152, 172, 180	12.0 abc	0.9 ab
54	Pu+K	Luna Experience (8.6 fl oz/A)	110, 137, 165	10.4 abc	1.0 ab
		ApF23002 (32 fl oz/A) + DyneAmic (0.125% v/v)	127, 151, 180		
51	B+O	Inspire Super (16 fl oz)	110	14.4 abc	1.2 ab
		ApF23002 (64 fl oz/A) + DyneAmic (0.125% v/v)	127, 151, 180		
		Pristine (23 oz/A)	137		
		Quintec (6 fl oz/A)	165		
27	RKS	Cevya (4 fl oz) + DyneAmic 6.4 fl oz	110	20.0 abcd	1.3 ab
		Gatten (6.4 fl oz) + DyneAmic 6.4 fl oz	127		
		Inspire Super (20 fl oz) + DyneAmic 6.4 fl oz)	137		
		Prolivo (5 fl oz) + DyneAmic (6.4 fl oz)	152		
		Vivando (15.4 fl oz) + DyneAmic (6.4 fl oz)	172		
		Inspire Super (3 qt) + DyneAmic (6.4 fl oz)	180		
26	RKD	Cevya (4 fl oz) + DyneAmic (6.4 fl oz)	110	20.0 abcd	2.0 ab
		Gatten (6.4 fl oz) + DyneAmic (6.4 fl oz)	127		
		Scala DFO (17 fl oz) + DyneAmic (6.4 fl oz)	137, 179		
		Prolivo (5 fl oz) + DyneAmic 6.4 fl oz)	152		
		Vivando (15.4 fl oz) + DyneAmic 6.4 fl oz)	172		
49	B+Y	Mettle (5 fl oz/A)	110	20.8 abcd	2.8 ab

		Luna Sensation (7.6 fl oz/A) Torino SC (3.4 oz/A) Quintec (6 oz/A)	127, 172 137, 180 152				
48	B+K	Ecoswing (32 fl oz/A) Luna Sensation (7.6 fl oz/A) Torino SC (3.4 oz/A)	110, 152 127, 172 137, 180	28.0	bcd	2.9	ab
39	BKD	Luna Experience (8.6 fl oz) + DyneAmic (0.125% v/v) Quintec (6.6 fl oz) SA-0130310 (18.5 fl oz/A) + NIS (6 fl oz)	110 127 137, 152, 165, 172, 180	33.6	bcd	3.0	ab
13	Y	Rhyme (5 fl oz)	110, 127, 136, 152, 165, 180	37.6	bcd	3.2	ab
53	B+W	Inspire Super (16 fl oz/A) ApF23002 (32 fl oz/A) + DyneAmic (0.125% v/v) Pristine (23 oz/A) Quintec (6 fl oz/A)	110 127, 151, 180 137 165	28.8	bcd	3.4	ab
37	BS	Luna Experience (8.6 fl oz) + DyneAmic (0.125% v/v) Quintec (6.6 fl oz) SA-0650004 (28 fl oz/A)	110 127 137, 152, 165, 180	52.8	de	6.6	abc
30	GD	Kenja (22 fl oz) + DyneAmic (0.125% v/v)	110, 127, 137, 151, 172, 179	47.2	de	9.5	abc
28	RKC	Prolivo (5 fl oz) + DyneAmic (0.125% v/v)	110, 127, 137, 152, 172, 180	28.0	bcd	9.7	abc
36	BD	Luna Experience (8.6 fl oz) + DyneAmic (0.125% v/v) Quintec (6.6 fl oz) Mevalone (55 fl oz/A) + OSS (6 fl oz/A)	110 127 137, 152, 165, 180	82.4	fgh	17.8	abcd
60	Y+G	Sulfur (5 lb/A) Elevate (1 lb/A) + Aviv (25 fl oz/A)	110, 127, 137 152, 165, 172, 180	84.8	fgh	19.1	abcd
1	W	Untreated control		100	h	89.2	f

[Z] ⁂ = Phytotoxicity observed on berries.

[Y] Products with a '+' sign in between indicate a tank mix.

[X] Means followed by the same letter within a column are not significantly different according to Fisher's LSD test ($p > 0.05$).

Trial Group II – Soft Chemistry Products

Table 2. Disease incidence and severity of soft chemistry products, including biologicals, sulfur, nutrients, oils, and organic materials. Product names are followed by rate (per acre). Treatment means followed by the same letter are not significantly different according to Fisher's LSD test ($p > 0.05$).

Treatment			Application date	Powdery mildew on the cluster[X]	
Nº	Flag[Z]	Rate/A[Y]	(Julian day)	Incidence (%)	Severity (%)
19	YKC	OR-536 (4 lb/A) + OR-097A (16 fl oz/100 gal)	109,115,123,128,136,144,151,157,165,173,179	16.8 ab	1.0 ab
44	PWC	Sulfur DF (5 lb/A) OxiDate 5.0 (1.0% v/v)	109,123,136,151,165,179 115,128,144,157,173	7.0 abc	3.4 ab
7	O⁂	S10 5L/ha (2 L/A)+D0.9 2L/ha (0.8 L/A) S10 5 L/ha (0.8 L/A)+ID0.9 2L/ha (0.8 L/A) ID0.9 2L/ha (0.8 L/A)+MT0.9 2L/ha (0.8 L/A) S10 5,0L/ha (2 L/A)+MT0.9 2L/ha (0.8 L/A) S10 5L/ha (2 L/A)+ID0.9 2,5L/ha (1 L/A) +MT0.9 2,5L/ha (1 L/A) ID0.9 2,5L/ha (1 L/A) +MT0.9 2,5L/ha (1 L/A)	110 127 136 151 165 179	26.4 bcd	4.1 abc
20	YRD	OR-536 (4 lb/A) + OR-097A (32 fl oz/100 gal)	109,115,123,128,136,144,151,157,165,173,179	35.2 bcd	4.3 abc
3	KD	Sulfur DF (5 lb)	109,115,123,128,136,144,151,157,165,173,179	32.0 bcd	4.9 abc
50	B+G	Sulfur DF (5 lb) ApF23002 (64 fl oz/A) + DyneAmic (0.125% v/v)	109,127,136,151,165,179 115,128,144,157,173	50.4 de	5.2 abc
31	GS	ApF23002 (64 fl oz) + DyneAmic (0.125% v/v)	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	39.2 cd	7.2 abc
18	YKS	OR-536 (4 lb/A)	109,115,123,128,136,144,151,157,165,173,179	64.0 ef	10.7 abc
15	YS	AGS26 (14 fl oz) + Sulfur (5 lb/A) + Syl-Coat (4 fl oz/100 gal)	110,127,136,151,165,179	65.6 ef	13.7 abc
35	B	ProBlad (45 fl oz/A)	110,127,137,152,165,179	80.0 efgh	15.0 abc
8	OS+O	Kitae (12 fl oz) + DyneAmic (0.125% v/v)	109,115,123,128,136,144,151,157,165,173,179	69.6 ef	15.4 abc
46	PKS⁂	Ecoswing (32 fl oz/A) Regalia (2 qt) Double Nickel 55 (16 fl oz) Kaligreen (5 lb)	109, 136, 165 115, 144, 173 123, 151, 179 128, 157,	62.4 ef	16.2 abcd
32	GKD	ApF23002 (32 fl oz) + DyneAmic (0.125% v/v)	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	84.0 fgh	20.6 abcd

33	GKS	ProBlad Verde (32 oz/A)	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	75.9	ef	21.7	abcd
47	PKC⁂	Ecoswing (32 fl oz/A) Kaligreen (5 lb) Double Nickel 55 (16 fl oz)	109, 136, 165 115, 128, 144, 157, 173 123, 151, 179	72.8	efg	23.5	abcd
58	Pu+R	Sulfur (5 lb/A) EMP Barrier (0.5% v/v)/50gal + Syl-Coat (4 fl oz/100gal) EMP Barrier (1% v/v)/100gal + Syl-Coat (4 fl oz/100gal) EMP Barrier 2% (v/v)/100gal + Syl-Coat 4 fl. oz per/100gal	110, 127 137 151, 157, 165, 179 173	85.6	fgh	24.0	abcd
34	GKC	Cinnerate (32 oz/100 gal)	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	82.4	fgh	32.3	bcd
45	PKD	Ecoswing (32 fl oz/A)	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	93.6	gh	38.3	bcd
6	BKS	ALD 1901 (0.23 lb/A)	110, 127, 136, 151, 165, 179,	92.8	fgh	38.7	bcd
17	YKD	Amara (2 qt) + DyneAmic	109, 115, 123, 128, 136, 144, 151, 157, 165, 173, 179	92.0	fgh	38.8	bcd
61	Y+R	Lime sulfur reduced rate (1 qt/100 gal)	110, 127, 137, 152, 172, 180	98.4	h	54.6	bcde
14	YD	AGS26 (14 fl oz/A) + Syl-Coat (4 fl oz /100gal)	110, 127, 136, 151, 165, 179	98.4	h	55.8	cde
23	RD	Kaligreen (3 lb) + Silwet (2 oz/100 gal)	173, 179	98.4	h	60.0	cdef
1	W	Untreated Control	-	100	h	89.2	f

[Z] ⁂ = Phytotoxicity observed on berries.
[Y] Products with a '+' sign in between indicate a tank mix.
[X] Means followed by the same letter within a column are not significantly different according to Fisher's LSD test ($p > 0.05$).

H. Appendix: Treatments

Product	Active ingredient(s)	Manufacturer or distributor	Chemical class (FRAC Code)
A9180A	Proprietary	Syngenta	N/A
AGS26	Proprietary	Agrosphere	N/A
ALD 1901	Proprietary	Agrauxine	N/A
Amara	Proprietary	Nichino America	N/A
ApF23002	Proprietary	Meese	N/A
Aprovia Top	Difenoconazole (10.95%) + benzovindiflupyr (7.30%)	Syngenta	DMI (3), SDHI (7)
Aviv	N/A	N/A	N/A
BAJA	Proprietary	Willbur Ellis	N/A
Bio Project ID0.9	Proprietary	FP Invest	N/A
Bio Project MT0.9	Proprietary	FP Invest	N/A
Bio Project S10	Proprietary	FP Invest	N/A
Cevya	Mefentrifluconazole	BASF	DMI (3)
Cinnerate	Proprietary	SymAgro	N/A
Double Nickel	*Bacillus amyloliquefaciens* strain D747	Nichino America	Microbial (44)
DyneAmic	Methyl esters of C16-C18 fatty acids	Helena Chemical Company	N/A
Ecoswing	Extract of *Swinglea glutinosa*	Gowan	N/A
Elevate	Fenhexamid	Arysta	Hydroxyanilide (17)
EMBRECE-EA	Proprietary	Willbur Ellis	N/A
EMP Barrier	Cinnamon oil 1.5%	GemmaProducts	N/A
Endura	Boscalid	BASF	SDHI (7)
Fervent	Proprietary	Willbur Ellis	N/A
Gatten	Flutianil, 4.7%	Nichino America	Thiazolidine (U-13)
Inspire Super	Difenoconazole + cyprodinil	Syngenta	DMI (3), AP (9)
Kaligreen	Potassium bicarbonate	Brandt	Not classified (NC)
Kenja	Isofetamid	SummitAgro	SDHI (7)
Kitae	Chitosan hydrochloride	Green Impulse	N/A
Lime Sulfur	Calcium polysulfide and thiosulfate	Brandt	Inorganic (M-02)
Luna Experience	Fluopyram (17.54%) + tebuconazole (17.54%)	Bayer	SDHI (7), DMI (3)
Luna Sensation	Fluopyram (21.4%) + trifloxystrobin (21.4)	Bayer	SDHI (7), QoI (11)
Mettle	Tetraconazole	Gowan	DMI (3)
Mevalone	Eugenol 3.2% + geraniol 6.4% + thymol 6.4%	Sipcam Agro	Terpene (BM01)
Miravis Prime	Fludioxonil (21.4%) + pydiflumetofen (12.8%)	Syngenta	PP (12), SDHI (7)
NIS	Adjuvant	N/A	N/A

OR-097A	Proprietary	Oro-Agri	N/A
OR-536	Proprietary	Oro-Agri	N/A
OSS	Adjuvant	N/A	N/A
OxiDate 5.0	Hydrogen peroxide + peroxyacetic acid	BioSafe	N/A
Pristine	Pyraclostrobin + boscalid	BASF	QoI (11), SDHI (7)
ProBlad Verde	Banda de Lupinus albus doce (BLAD)	SymAgro	N/A
Prolivo	Pyriofenone	Summit Agro	(50)
Quintec	Quinoxyfen	Corteva	Aryloxyquinoline (13)
Rally	Myclobutanil	Corteva	DMI (3)
Regalia	Extract of *Reynoutria sachalinensis*	Marrone Bio Innovations	Plant extract (P-05)
Regev	Tea tree oil (40.6%) + difenoconazole (20.3%)	Summit Agro	Terpene (BM02)
Rhyme	Flutriafol (22.7%)	FMC Corporation	DMI (3)
Romeo	Proprietary	Willbur Ellis	N/A
SA-0130310	Proprietary	Sipcam Agro	N/A
SA-0650004	Proprietary	Sipcam Agro	N/A
Scala DFO	pyrimethanil + difenconazole	Bayer	AP (9)
Serenade ASO	*Bacillus subtilis* strain QST 713	Bayer	Microbial (44)
Silwet	Surfactant	Helena Chemical Company	N/A
SPARRA	Proprietary	Willbur Ellis	N/A
Sulfur DF	Sulfur (80%)	Willbur Ellis	Inorganic (M-02)
Switch	Cyprodinil + fludioxonil	Syngenta	AP (9), PP (12)
Syl-Coat	Copolymer, polyether (100%)	Willbur Ellis	N/A
Toledo	Tebuconazole	Rotam Agrochemical	DMI (3)
Torino	Cyflufenamid	Gowan	U-06
Trojan	Tetraconazole (13.8%)	FMC	DMI (3)
UC-70	Proprietary	BASF	SDHI (7)
V6M-5-14	Proprietary	Corteva	N/A
Vivando	Metrafenone	BASF	(50)

I. Appendix: Julian Date Calendar for Year 2024

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	61	92	122	153	183	214	245	275	306	336
2	2	33	62	93	123	154	184	215	246	276	307	337
3	3	34	63	94	124	155	185	216	247	277	308	338
4	4	35	64	95	125	156	186	217	248	278	309	339
5	5	36	65	96	126	157	187	218	249	279	310	340
6	6	37	66	97	127	158	188	219	250	280	311	341
7	7	38	67	98	128	159	189	220	251	281	312	342
8	8	39	68	99	129	160	190	221	252	282	313	343
9	9	40	69	100	130	161	191	222	253	283	314	344
10	10	41	70	101	131	162	192	223	254	284	315	345
11	11	42	71	102	132	163	193	224	255	285	316	346
12	12	43	72	103	133	164	194	225	256	286	317	347
13	13	44	73	104	134	165	195	226	257	287	318	348
14	14	45	74	105	135	166	196	227	258	288	319	349
15	15	46	75	106	136	167	197	228	259	289	320	350
16	16	47	76	107	137	168	198	229	260	290	321	351
17	17	48	77	108	138	169	199	230	261	291	322	352
18	18	49	78	109	139	170	200	231	262	292	323	353
19	19	50	79	110	140	171	201	232	263	293	324	354
20	20	51	80	111	141	172	202	233	264	294	325	355
21	21	52	81	112	142	173	203	234	265	295	326	356
22	22	53	82	113	143	174	204	235	266	296	327	357
23	23	54	83	114	144	175	205	236	267	297	328	358
24	24	55	84	115	145	176	206	237	268	298	329	359
25	25	56	85	116	146	177	207	238	269	299	330	360
26	26	57	86	117	147	178	208	239	270	300	331	361
27	27	58	87	118	148	179	209	240	271	301	332	362
28	28	59	88	119	149	180	210	241	272	302	333	363
29	29	60	89	120	150	181	211	242	273	303	334	364
30	30		90	121	151	182	212	243	174	304	335	365
31	31		91		152		213	244		305		366