Control of grape powdery mildew with synthetic, biological, and organic fungicides: 2022 field trials

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Report Summary

Powdery mildew is caused by the biotrophic fungus *Erysiphe necator*[1]; this polycyclic disease of grape causes losses to crop quality and yield and is considered one of the most economically important disease of grapes worldwide. This report details the findings of our annual powdery mildew fungicide trials on grapevine (*Vitis vinifera*, Cultivar Chenin Blanc – 11- yrs-old). Along with Chardonnay, Muscat blanc, Roussanne and Carignane, Chenin blanc is one of the highly susceptible wine varieties [2]. This trial was conducted at the University of California Davis Plant Pathology Fieldhouse Facility (38.522591, -121.760719) from April to July 2022. Treatments were applied to run-off using a mist blower backpack sprayer (Stihl SR 430). Treatments were performed in a complete randomized block design with five replicates of two vines each. Trial I consisted of synthetic fungicides and combinations of soft chemistry and synthetic products. Trial II consisted of soft chemistry products, including biologicals, sulfurs, nutrient applications, oils, and other materials. Spray frequencies varied from 7-day to 21-day intervals. Spraying was completed on July 13th based on the berry brix level and treatments were evaluated for disease incidence and severity on July 23rd, 2022.

Materials and Methods

A. Experimental design

Table 1. 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/**A**cre	50 gallons =0.88 gal/5 reps 100 gallons (late April,) = 1.77 gal/5 reps 150 gallons (late May) = 2.65 gal/5 reps		
Equipment	Stihl SR 430 mist blower backpack sprayers		

B. Experimental treatments

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

Acknowledgements

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[1] Wilcox, Wayne Frank, et al. Compendium of Grape Diseases, Disorders, and Pests. Second Edition. APS Press, The American Phytopathological Society, 2015.

[2] Vasquez, Stephen. n.d. Grape Cultivar Susceptibility to Grapevine Powdery Mildew. UC Cooperative Extension.

C. Map

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

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

D. Vine Management

During the application period, vines were irrigated by drip irrigation. Sucker shoot removal and leafing were done on June 21st.

E. Data Collection and Statistics

Daily temperature and precipitation were obtained from a CIMIS weather station in west Davis (CI006). The data is shown in Figure 1. Thomas-Gubler Risk Index data was obtained from IPM.UCANR (Figure 2).

Signs of powdery mildew were observed in middle June on berries.

Powdery mildew incidence and severity were assessed in each treatment by evaluating twenty-five random clusters. **Incidence** was defined as the proportion of clusters in a plot having some symptoms and/or signs of powdery mildew. **Severity** was determined by estimating the percentage of area of a cluster that was infected; the severity value of all clusters was then averaged to give a plot-wide estimate of disease severity. Mean incidence and severity values for each treatment were computed. Trial models were analyzed using the ANOVA Tests for data. Means comparisons were made using Fisher's LSD with α=0.05.

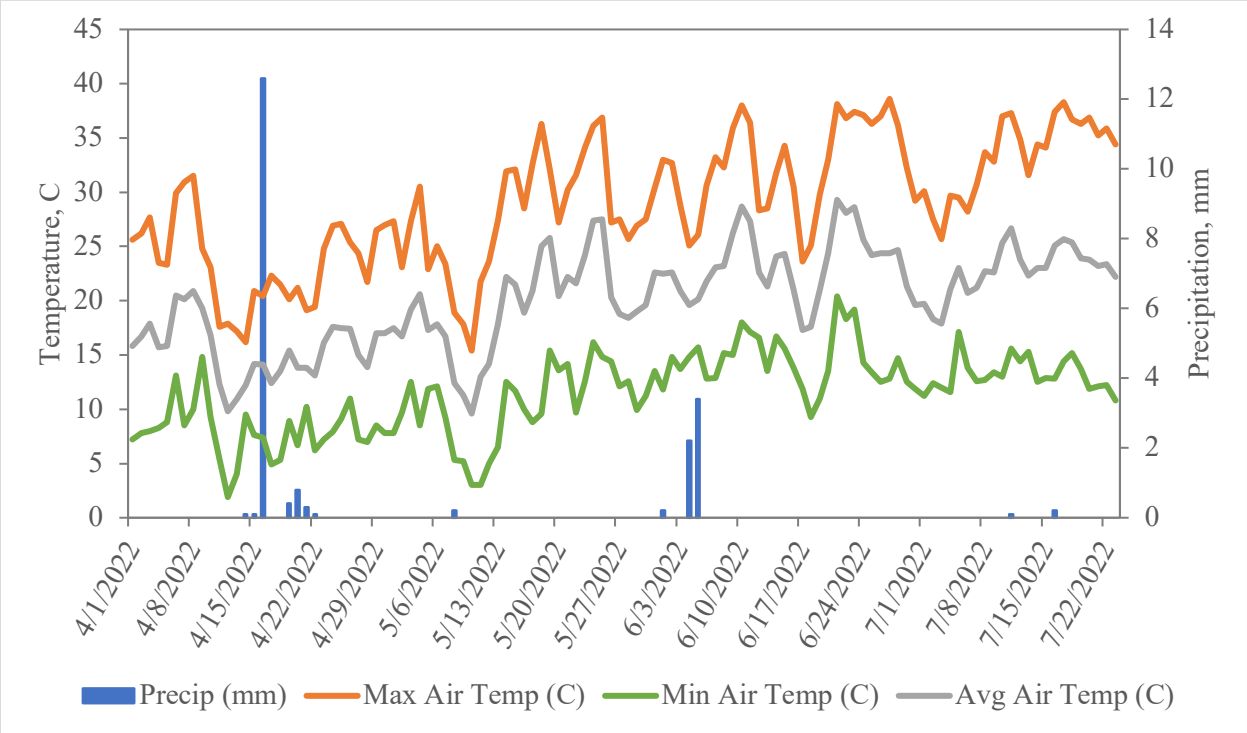

Figure 1. Average daily temperature (°C) and precipitation (mm) from Apr 1 to July 23, 2022, from CIMIS station Davis, CA.

Figure 2. Thomas-Gubler Risk Index data from March 31 to July 25. The Red line data points indicate risk index > 60, between blue and red data points indicate risk index data between 30 and 60 and blue data points are values below 30.

F. Pictures of Treatments

Pictures of each treatment can be reached by clicking on the active link on each trial number in the result tables.

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		
		Miravis Prime 13.4 fl oz + A9180B 0.5 oz +Syl-Coat 0.125% v/v	165		
		Inspire Super 20.0 fl oz + A9180B 0.5 oz + Syl-Coat 0.125% v/v	150		
13	YD	Prolivo 5 fl oz+ Dynamic 0.125%	105, 119, 132, 147, 178, 193	0.8 a	0.01 a
36	BS	PureSpray Green	108	0.8 a	0.01 a
		Inspire Super 20.0 fl oz + Syl-Coat 0.125% v/v	122, 194		
		Aprovia Top 13.3 fl oz + Syl-Coat 0.125% v/v	136, 165, 179		
		Quintec 6.6 fl oz + Syl-Coat 0.125% v/v	150		

50	B+G	BTS-EXP-100 20.5 FL OZ Quintec 5fl oz Mettle 4 fl oz Inspire Super 20 fl oz Luna Experience 8.6 fl oz Vivando 15 fl oz	108, 150 122 136 165 179 194	0.8 a	0.01 a
38	BKD	FAP65 3 lb + Trionic 8 fl oz + Vacciplant 16 fl oz Microthiol Disperss 3 lb + Quintec 4 fl oz + Vacciplant 16 fl oz Microthiol Disperss 3 lb + Tronic 8 fl oz + Vacciplant 16 fl oz Inspire Super 20 fl oz Torino 3.4 fl oz + PhD 6.2 fl oz Luna Experience 8.6 fl oz Vivando 15 fl oz	108 122 136 150 165 179 194	0.1 a	0.04 a
4	KS	Luna Experience 8.6 fl oz Pristine 23 oz Elevate 16oz Parade 3.1 oz	105, 161 119, 178 132, 193 147	1.6 a	0.02 a
15	YC	Oxidate 5.0 1.0% v/v Luna Experience 8.6 fl oz	105, 132,161, 193 119, 147, 178	1.6 a	0.02 a
17	YKS	Flint Extra 3.5 fl oz + Syl-Coat 4 fl oz Provilo 5 fl oz + Syl-Coat 4 fl oz Luna Experince 6.4 fl oz + Syl-Coat 4 fl oz Quintec 4 fl oz + Syl-Coat 4 fl oz Torino 3.4 fl oz + Syl-Coat 4 fl oz Luna Sensation 5 fl oz + Syl-Coat 4 fl oz Vivando 15.4 fl oz + Syl-Coat 4 fl oz	105 119 132 147 161 178 193	1.6 a	0.05 a
58	Pu+R	Sulfur dry flowable 5lb Luna-sensation 0.2 L/ha Switch 17.13 oz Endura 4.5 fl oz	103, 110, 117, 145, 152, 159, 173, 182, 192 124 138 166	1.6 a	0.05 a
51	B+O	BTS-EXP-100 27.4 fl oz Quintec 5fl oz Mettle 4 fl oz Inspire Super 20 fl oz Luna Experience 8.6 fl oz Vivando 15 fl oz	108, 150 122 136 165 179 194	2.4 a	0.02 a
33	GKC	Gatten 6.4 fl oz + Dyne-Amic 0.25% v/v	108, 122, 136, 150, 165, 179, 194	2.4 a	0.06 a
14	YS	Regev 8.5 fl oz + Dyne-Amic 0.125%	105, 119, 132, 147, 178, 193	2.4 a	0.10 a
3	KD	Luna Experience 8.6 fl oz	105, 119, 132, 147, 161, 178, 193	3.2 a	0.08 a

25	RKD	Cevya 5 fl oz	105, 119, 132, 147, 161, 178, 193	4.0 a	0.07 a
57	Pu+O	LALSTOP-G46-WG 1.78oz + LALSTIM-OSMO 4.28 oz Sulfur dry flowable 5lb Luna-sensation 2.7 fl oz Switch 17.13 oz LALSTOP-G46-WG 3.57 oz + LALSTIM-OSMO 4.28 oz	103, 110, 173, 182 117, 145, 192 124 138 152, 159, 166	12.0 a	0.44 a
42	PWD	Parade 3.2 fl oz + Dyen-Amic12.8 fl oz	136, 159, 179	15.2 a	4.23 a
47	PKC	Gatten 6.4 fl oz	136, 159, 179	34.4 b	3.20 a
8	OC+O	ReyZox 11.8 fl oz	105, 119, 132, 147, 161, 178, 193	39.2 b	6.73 a
1	W	Untreated Control	Not Applicable	85.6 c	40.7 b

[z] Products with a '+' sign in between indicate a tank mix.
[y] Means followed by the same letter within a column are not significantly different according to Fisher's LSD test (α=0.05).

Trial II

Table 2. Disease incidence and severity of soft chemistry products, including biologicals, sulfurs, nutrient applications, oils, and other 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 at α=0.05.

Treatment			Application date	Powdery mildew on the cluster[x]	
Pictures-	**Flag[z]**	**Rate/A[y]**	**(Julian day)**	**Incidence, %**	**Severity, %**
35	BD	PureSpray Green 1 gal Sulfur Dry-Flowable 5 lb	103, 110, 117 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	2.4 a	0.10 a
12	Y	P18-16 2 oz + Embrece-EA 16 fl oz Sulfur Dry Flowable 5 lbs	103, 117, 131, 145, 159, 173, 192 110, 124, 138, 152, 166, 182	4.0 a	0.07 a
56	Pu+G	Sulfur dry flowable 5lb JMS Stylet 1% v/v Serifel 10oz	103, 110, 117, 124, 131, 138, 173, 182, 192 145, 152, 159 166	4.0 a	0.18 a
11	ONS	P18-16 1 oz + Embrece-EA 16 fl oz	103, 117, 131, 145, 159,173, 192	10.4 a	0.71 a

61	Y+R	OxiDate 5.0 @ 1.0% v/v + Kinetic 0.125% v/v Sulfur DF 5 lb	117, 131, 145, 159, 173, 192 124, 138, 152, 166, 182	18.4 a	1.05 ab
55	Pu+Y	LALSTOP-G46-WG 1.78 oz + LALSTIM-OSMO 4.28 oz/ Prev AM Ultra 50 fl oz Sulfur dry flowable JMS Stylet 1% v/v LALSTOP-G46 WG 250 g/ha + LALSTIM-OSMO 300 g/ha Serifel 10 oz	103, 166 110 117, 124, 131, 138, 182, 192 173 145, 159 152	28.8 b	2.02 abc
53	B+W	Berezi 5 lb	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182	30.4 b	2.14 abc
2	K	JMS Stylet-oil 1% v/v	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	33.6 b	3.82 abcd
39	BKS	Regalia 2 qt + CS-2005 1 qt	108, 122, 136, 150, 165, 179, 194	37.6 b	4.05 abcd
6	O	Regalia 2 qt	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	39.2 b	6.05 abcdef
22	RD	Esendo 2.8lb + Kinetic 0.125% v/v	105, 119, 132, 147, 161, 178, 193	40.8 b	6.86 abcdef
49	B+Y	Sulfur Dry Flowable 5 lb BTS-EXP-100 27.4 fl oz	103, 110, 117 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	42.4 b	4.93 abcde
40	BKC	CS-2005 32 fl oz	108, 122, 136, 150, 165, 179, 194	44.0 b	18.33 defg
16	YKD	Ninja 8 fl oz	105, 119, 132, 147, 161, 178, 193	47.2 b	4.97 abcde
34	B	PureSpray Green 1 gal	103, 110, 124, 138, 159, 166, 182	47.2 b	15.86 cdefg
48	B+K	Sulfur Dry Flowable 5 lb BTS-EXP-100 20.5 FL OZ	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	52.0 b	5.94 abcdef
29	GD	Vintre 48 fl.oz	108, 122, 136, 150, 165, 179, 194	52.0 b	20.40 fg
60	Y+G	AGS-FunThyme. + Dyne-Amic 0.1% v/v	103, 110, 124, 138, 152, 166	52.8 b	6.93 abcdef

52	B+R	Berezi 3 lb	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	52.8 b	9.06 abcdef
26	RKS	microSURE 4.36 gal	105, 119, 132, 147, 161, 178, 193	56.8 b	15.60 bcdefg
27	RKC	Cinaction 50 fl.oz + OR-009-E 32 fl.oz	105, 119, 132, 147, 161, 178, 193	57.6 b	9.86 abcdef
9	OKD	P18-16 1 oz + Embrece-EA 16 fl oz	105, 119, 132, 147, 161, 178, 193	57.6 b	12.10 abcdefg
59	Pu+W	AGS-Fun-2. + Dyne-Amic 0.1% v/v	103, 110, 124, 138, 152, 166	57.6 b	13.18 abcdefg
54	Pu+K	LALSTOP-G46 3.5oz + LALSTIM-OSMO 4.5oz	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	58.4 b	11.53 abcdefg
32	GKS	X7N68-R007 16 fl oz+ Dyne-Amic 0.25% v/v	108, 122, 136, 150, 179, 194	60.8 b	9.66 abcdef
24	RC+R	Serifel 6 oz	103, 110, 117, 124, 131, 138, 145, 152, 159, 166, 173, 182, 192	61.6 b	11.02 abcdef
19	YRD⁂	BoostBiome BC18 70 oz	105, 119, 132, 147, 161, 178, 193	61.6 b	11.13 abcdef
5	KC	LPI-6724 12.8 fl oz + LI700 (Adj) 0.250 %v/v	105, 117, 138, 159, 166, 182	64.0 b	9.02 abcdef
21	R	Theia 3 lb + Kinetic 0.125% v/v	105, 119, 132, 147, 161, 178, 193	64.8 b	5.70 abcde
7	OS+O	Regalia 2qt	105, 119, 132, 147, 161, 178, 193	65.6 b	6.25 abcdef
30	GS	Vintre 32 fl.oz	108, 122, 136, 150, 165, 179, 194	66.4 b	11.87 abcdefg
28	G	Milagrum plus 40 fl.oz/100 gal + Oroboost 32 fl.oz/100	108, 122, 136, 150, 165, 179, 194	67.2 b	10.26 abcdef
23	RS+R	Howler 2.5 lb + Theia 1.5 lb + Kinetic 0.125% v/v	105, 119, 132, 147, 161, 178, 193	73.6 b	10.51 abcdef
31	GKD	X7N68-R007 16 fl oz	108, 122, 136, 150, 179, 194	76.8 b	25.99 g
20	YRS	Howler 5lb + Kinetic 0.125% v/v	105, 119, 132, 147, 161, 178, 193	78.4 b	10.52 abcdef
10	OKS	P18-16 2 oz + Embrece-EA 16 fl oz	105, 119, 132, 147, 161, 178, 193	80.0 b	19.18 efg
1	W	Untreated Control	Not Applicable	85.6 b	40.70 h

[z] ⁂= Phytotoxicity observed on berries ⁂= Phytotoxicity observed on leaves (minor)

[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 (α=0.05).

H. Appendix: Materials

Product	Active ingredient(s) and concentration	Manufacturer or distributor	Chemical class (Frac Code)
A9180B (Actigard 50WG)	acibenzolar-s-methyl	Syngenta	benzo-thiadiazole (P10)
Abound	azoxystrobin	Syngenta	QoI (11)
AGS-Fun 2	proprietary	Agrospheres	N/A
AGS-FunThyme	proprietary	Agrospheres	N/A
Aprovia Top	difenoconazole (10.95%), benzovindiflupyr (7.30%)	Syngenta Crop Protection, Inc.	DMI (3) / SDHI (7)
Berezi	proprietary	NovaSource	N/A
Boost Biomes BC18	proprietary	Boost Biomes	N/A
BTS-EXP-100	proprietary	Botanical Solution Inc (BSI)	natural compound (P04)
Cevya	mefentrifluconazole	BASF	DMI (3)
CS-2005	copper sulfate pentahydrate	Magna-Bon	inorganic (M01)
Dyne-Amic	polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of c16-c18 fatty acids (99%)	Helena Chemical Co.	adjuvant
Elevate 50 WG	fenhexamid	Arysta LifeScience North America LLC	KRI (17)
Embrece-EA	polyoxyalkylen polyol fatty acid ester, alcohol ethoxylate (78.92%)	Wilbur-Ellis	adjuvant
Esendo	proprietary	AgBiome Innovations	N/A
FAP65	proprietary	UPL	N/A
Flint Extra	trifloxystrobin (50%)	Bayer CropScience	QoI (11)
Gatten	flutianil	Nichino America	thiazolidine (U13)
Howler	*Pseudomonas chlororaphis* strain AFS009 (50%)	AgBiome Innovations	microbial (BM 02)
Inspire Super	difenoconazole (8.4%), cyprodinil (24.1%)	Syngenta Crop Protection, Inc.	DMI-triazole (3)/AP(9)
JMS Stylet-oil	paraffinic oil	JMS Flower Farms	mineral oil (NC)
Kenja 400SC	isofetamid	Summit Agro USA	SDHI (7)
Kinetic	polyoxyethylene-polyoxypropylene copolymer, polyether modified (99%) heptamethyltrisiloxane	Helena Agri-Enterprises, LLC	adjuvant
LALSTIM-OSMO	Glycine betaine	Danster Ferment AG/ Lallemand Plant Care	soil and plant substance
LALSTOP-G46	*Clonostachys rosea* strain j1446 (formerly known as *Gliocladium catenulatum* strain j1446)	Danster Ferment AG/ Lallemand Plant Care	microbial (BM 02)
LPI-6724	proprietary	Nutrien Ag Solutuion	Biocontrol Fungicide (Peptite)
LI1700	NIS adjuvant 0.25% v/v	Nutrien Ag Solutuion	adjuvant
Luna Experience	fluopyram (17.54%), tebuconazole (17.54%)	Bayer CropScience	SDHI (7)/DMI-triazole (3)
Luna Sensation	trifloxystrobin (21.4%), fluopyram (21.4%)	Bayer CropScience	QoI (11) / SDHI (7)
Merivon	pyraclostrobin (21.26%), fluxapyroxad (21.26%)	BASF	QoI (11) / SDHI (7)

Mettle	tetraconazole (11.6%)	Gowan Co.	DMI (3)
microSURE™	proprietary	Strategia Project Management Inc	N/A
Microthiol Disperss	sulfur (80%)	United Phosphorus, Inc.	inorganic (M2)
Miravis Prime	fludioxonil (21.4%), pydiflumetofen (12.8%)	Syngenta	phenylpyrroles (12) / SDHI (7)
Ninja	proprietary	Sepro	N/A
OR-009-E	proprietary	Oro-Agri	N/A
OR-097-A	proprietary	Oro-Agri	N/A
OR-488	proprietary	Oro-Agri	N/A
OR-489	proprietary	Oro-Agri	N/A
Parade	pyraziflumid	Nichino America	SDHI(7)
P18-16	proprietary	Plant Health Care	microbial (BM 02)
Ph-D	polyoxin d zinc salt (11.3%)	Arysta LifeScience	polyoxins (19)
Prev AM Ultra	sodium tetraborohydrate decahydrate	Oro-Agri	N/A
Pristine	pyraclostrobin (12.8%), boscalid (25.2%)	BASF	QoI(11)/SDHI (7)
Prolivo	pyriofenone	Summit Agro USA	benzoylpyridine (50)
PureSpray Green	mineral oil (98%)	Intelligro	mineral oil (NC)
Quintec	quinoxyfen (22.6%)	Dow AgroSciences LLC	aryloxyquinoline (13)
Rally	myclobutanil (40%)	Dow AgroSciences LLC	DMI-triazole (3)
Regalia	extract of *Reynoutria sachalinensis* (5%)	Marrone Bio Innovations	plant extract (P05)
Regev	tea tree oil (40.6%), difenoconazole (20.3%)	Summit Agro USA	plant extract (46) / DMI (3)
ReyZox	azoxystrobin, *Reynoutria* spp. extract	Marrone Bio Innovations	QoI (11) / Plant extract (P05)
Rhyme	flutriafol (22.7 %)	FMC Corporation	DMI-triazole (3)
Serenade ASO	*Bacillus subtilis* qst 713 (26%)	Bayer CropScience	microbial (44, NC)
Sulfur Dry flowable	sulfur (80%)	Wilbur-Ellis	inorganic (M2)
Syl-Coat	polyether-polymethylsiloxane-copolymer and polyether-100%	Wilbur-Ellis	adjuvant
Theia	proprietary	Agbiome	N/A
Torino	cyflufenamid (10%)	Gowan Co.	phenyl-acetamide (U06)
Trionic	triflumizole (42.1%)	United Phosphorus, Inc.	DMI-triazole (3)
Vacciplant	laminarin	Arysta LifeScience	natural compound (P04)
Vivando	metrafenone (25.2%)	BASF	benzophenone (50)
X7N68-R007	proprietary	FMC Corporation	N/A

I. Appendix: Julian Date Calendar for Year 2022

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	32	60	91	121	152	182	213	244	274	305	335
2	2	33	61	92	122	153	183	214	245	275	306	336
3	3	34	62	93	123	154	184	215	246	276	307	337
4	4	35	63	94	124	155	185	216	247	277	308	338
5	5	36	64	95	125	156	186	217	248	278	309	339
6	6	37	65	96	126	157	187	218	249	279	310	340
7	7	38	66	97	127	158	188	219	250	280	311	341
8	8	39	67	98	128	159	189	220	251	281	312	342
9	9	40	68	99	129	160	190	221	252	282	313	343
10	10	41	69	100	130	161	191	222	253	283	314	344
11	11	42	70	101	131	162	192	223	254	284	315	345
12	12	43	71	102	132	163	193	224	255	285	316	346
13	13	44	72	103	133	164	194	225	256	286	317	347
14	14	45	73	104	134	165	195	226	257	287	318	348
15	15	46	74	105	135	166	196	227	258	288	319	349
16	16	47	75	106	136	167	197	228	259	289	320	350
17	17	48	76	107	137	168	198	229	260	290	321	351
18	18	49	77	108	138	169	199	230	261	291	322	352
19	19	50	78	109	139	170	200	231	262	292	323	353
20	20	51	79	110	140	171	201	232	263	293	324	354
21	21	52	80	111	141	172	202	233	264	294	325	355
22	22	53	81	112	142	173	203	234	265	295	326	356
23	23	54	82	113	143	174	204	235	266	296	327	357
24	24	55	83	114	144	175	205	236	267	297	328	358
25	25	56	84	115	145	176	206	237	268	298	329	359
26	26	57	85	116	146	177	207	238	269	299	330	360
27	27	58	86	117	147	178	208	239	270	300	331	361
28	28	59	87	118	148	179	209	240	271	301	332	362
29	29		88	119	149	180	210	241	272	302	333	363
30	30		89	120	150	181	211	242	273	303	334	364
31	31		90		151		212	243		304		365