Evaluation of fungicide programs for management of bunch rot of grapes: 2021 field trials

Karina Elfar, Samuel Wells, Karen Alarcon, Powen Pai, Marcelo Bustamante, Molly Arreguin, and Akif Eskalen
Department of Plant Pathology, University of California, Davis, CA, 95616

University of California Cooperative Extension,
Department of Plant Pathology,
University of California, Davis, August 2021

Published 2021 at: https://ucanr.edu/sites/eskalenlab/Fruit_Crop_Fungicide_Trials/

Report Summary

Bunch rot of grapes causes economic losses to table, raisin, and wine grape production worldwide. The organisms responsible are largely filamentous fungi, the most common of these being *Botrytis cinerea* (gray mold); however, there are a range of other fungi responsible for the rotting of grapes such as *Aspergillus niger, A. carbonarius, Alternaria tenuis, Cladosporium herbarum, Rhizopus arrhizus, Penicillium* sp.,and others (Summer Bunch Rot or Sour Rot) (Smith et al. 2016, Steel et al 2013).

The fungi overwinters most commonly in berry mummies on the ground or left hanging on the vine and in canes. After precipitation or irrigation the overwintering fruiting bodies release their spores, that are moved by wind or splashing rain. Infections require free water for a definite period of time depending on temperature. Flowers can become infected through the stigma and scar tissue on the receptacle (tip of the pedicel) left by the detachment of the calyptra during bloom; generally the fungus then becomes dormant until late in the season when sugar concentration increases in the infected berry. The fungus then resumes growth and spreads throughout the berry. Infected berries split and leak, thus allowing the pathogen to grow and sporulate on berry surfaces and spread to adjoining berries by mid-season. Spores from infected fruit can directly infect intact, ripe berries as harvest approaches. Late-season infections are most severe when relative humidity exceeds 92%, free moisture is present on the fruit surface, and temperatures are in the 58° to 82°F range. Berries that have been damaged by insects, birds, machinery, etc. may become infected at any time after the fruit begins to ripen because the juice in the berry can provide the necessary water and nutrients for fungal growth (ipm.ucanr.edu).
Along with leaf removal and other cultural controls, good spray coverage with synthetic, biological, or organic fungicides are currently the most effective form of disease management
.
In this trial, we examined the efficacy of 37 synthetic, biological, and organic fungicide treatment programs (Table 2) for control of Bunch rot in Riesling grapes in Clarksburg, CA in 2021.

Materials and Methods

A. Experimental design

Table 1. 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 12th, 100 gallons = 1.5152 gal/5 reps B pre-close, June 11th, 150 gallons = 2.2727 gal/5 reps C veraison, July 21st, 150 gallons = 2.2727 gal/5 reps		
Equipment	Stihl SR 450 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.

Table 2. Experimental fungicide treatments

Treatment No	Flag	Treatment	Application rate (per acre)	FP/5 reps	Interval (days)
1	W	Untreated Control	none	none	none
2	K	JMS Stylet	1 %	57.3 ml at 100 gal or 86.0 ml at 150 gal	ABC
3	KD	Luna Experience /	8.6 fl oz	3.9 ml	A
		Pristine /	23 oz	9.9 gr	B
		Elevate	16 oz	6.9 gr	C
4	KS	Serenade ASO	4 qt	57.4 ml	ABC
5	KC	Magna-Bon CS 2005	20 oz	8.6 gr	ABC
6	O	MinerAll	8.5 lb	58.4 gr at 100 gal or 87.6 gr at 150 gal	ABC
7	OKD	Boost Biomes BC18	5^13 CFU/acre	12.8 ml	ABC
8	OKS	SA-0650004	20 fl oz	9 ml	ABC
9	Y	Mevalone (SA-0650001) + Kinetic	55 fl oz 0.125 %	24.6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	ABC
10	YKD	Mevalone (SA-0650001) + Kinetic/	55 fl oz 0.125 %	24.6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	A
		Elevate 50WDG /	16 oz	6.9 gr	B
		Mevalone (SA-0650001) + Kinetic /	55 fl oz 0.125 %	24.6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	C
11	YKS	Mevalone (SA-0650001) + Kinetic /	55 fl oz 0.125 %	24.6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	A
		Pristine /	23 oz	9.9 gr	B
		Mevalone (SA-0650001) + Kinetic /	55 fl oz 0.125 %	24.6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	C
12	YKC	Elevate /	16 oz	6.9 gr	A
		Pristine /	23 oz	9.9 gr	B
		Elevate /	16 oz	6.9 gr	C
13	YRD	Parade +	3.1 oz	1.3 gr	ABC

		Dyne-Amic	0.25 %	14.3 ml at 100 gal or 21.5 ml at 150 ga	
14	YRS	Nanospada	3.3 L	188.1 ml at 100 gal or 283.8 ml at 150 gal	ABC
15	R	Luna Experience + Syl-Coat /	8.6 fl oz 4 fl oz	3.9 ml 1.8 ml	A
		Scala + Syl-Coat /	18 fl oz 4 fl oz	8.1 ml 1.8 ml at 100 gal or 2.7 ml at 150 gal	B
		Scala + Syl-Coat	18 fl oz 4 fl oz	8.1 ml 1.8 ml at 100 gal or 2.7 ml at 150 gal	C
16	RD	Luna Experience + Syl-Coat /	8.6 fl oz 4 fl oz	3.9 ml 1.8 ml at 100 gal or 2.7 ml at 150 gal	A
		Vangard + Syl-Coat	10 oz 4 fl oz	4.3 gr 1.8 ml at 100 gal or 2.7 ml at 150 gal	B
		Vangard + Syl-Coat	10 oz 4 fl oz	4.3 gr 1.8 ml at 100 gal or 2.7 ml at 150 gal	C
17	RKD	NSTKI-014	3 lb	20.6 gr	ABC
18	RKS	NSTKI-014	5 lb	34.4 gr	ABC
19	RKC	NSTKI-014	7 lb	48.1 gr	ABC
20	GKD	Luna Experience /	8.6 fl oz	3.9 ml	A
		PHD /	6.2 oz	2.7 gr	B
		Elevate	1 lb	6.9 gr	C
21	GKS	Elevate /	1 lb	6.9 gr	A
		Luna Experience /	8.6 fl oz	3.9 ml	B
		Elevate	1 lb	6.9 gr	C
22	GKC	Elevate + Vacciplant /	1 lb 16 fl oz	6.9 gr 7.2 ml	A
		Luna Experience + Vacciplant /	8.6 fl oz 16 fl oz	3.9 ml 6.9 ml	B
		Elevate + Vacciplant	1 lb 16 fl oz	6.9 gr 7.2 ml	C
23	BD	Vacciplant	16 fl oz	7.2 ml	ABC
24	BS	Fun Thyme + Dynamic	128 fl oz 0.125 %	57.4 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	ABC
25	BKS	Fun Thyme + Dynamic	256 fl oz 0.125 %	114.7 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	ABC
26	BKD	Product G + Adjuvat O	3.5 oz 4.5 oz	1.5 gr 1.9 gr	ABC

27	BC	MicroSure™	4.4 gal	252.4 ml	ABC
28	BKC	EXP14 + Embrace-EA	3 lb 32 fl oz	20.6 gr 14.3 ml at 100 gal or 21.5 ml at 150 gal	ABC
29	Pu	EXP14 + Syl-Coat	3 lb 4 fl oz	20.6 gr 1.8 ml at 100 gal or 2.7 ml at 150 gal	ABC
30	P	EXP14 + Glacier EA	3 lb 16 fl oz	20.6 gr 7.2 ml at 100 gal or 10.8 ml at 150 gal	ABC
31	PKD	BTS EXP 100	27.4 fl oz	12.3 ml	ABC
32	PKS	BTS EXP 100 + Kinetic	27.4 fl oz 0.05 %	12.3 ml 2.9 ml at 100 gal or 4.3 ml at 150 ga	ABC
33	PKC	Luna Experience /	8.6 fl oz	3.9 ml	A
		BS-200 /	27.4 fl oz	12.3 ml	B
		Pristine /	23 oz	9.9 gr	C
34	YC	Esendo + Syl-Coat /	2.8 lb 0.125 %	19.2 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga	ABC
35	GS	Howler + Syl-Coat /	5 lb 0.125 %	34.4 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga	ABC
36	B	Theira + Syl-Coat /	4 lb 0.125 %	27.5 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga	A
		Howler + Syl-Coat + Luna Experience	2.5 lb 0.125 % 4.3 fl oz	17.2 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga 1.9 ml	BC
37	YS	Vangard + Syl-Coat /	10 oz 0.125 %	4.3 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga	A
		Miravis Prime + Syl-Coat	13.4 fl oz 0.125 %	6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	BC
38	YD	Miravis Prime + Syl-Coat /	13.4 fl oz 0.125 %	6 ml 7.2 ml at 100 gal or 10.8 ml at 150 ga	A
		Switch + Syl-Coat /	14 oz 0.125 %	6 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga	B
		Vangard + Syl-Coat /	10 oz 0.125 %	4.3 gr 7.2 ml at 100 gal or 10.8 ml at 150 ga	C

C. Map

Row 1	Row 2	Row 3	Row 4	Row 5	Row 6
x	37-YS	x	x	x	12-YKC
25-BC	33-PKC	7-OKD	20-GKD	24-BS	38-YD
21-GKS	24-BS	2-K	9-Y	36-B	17-RKD
22-GKC	21-GKS	8-OKS	1-W	20-GKD	35-GS
12-YKC	10-YKD	30-P	19-RKC	34-YC	29-Pu
31-PKD	35-GS	x	6-O	11-YKS	9-Y
8-OKS	19-RKC	x	29-Pu	28-BKC	x
13-YRD	1-W	x	26-BKD	1-W	12-YKC
6-O	2-K	32-PKS	31-PKD	19-RKC	3-KD
34-YC	35-GS	25-BC	27-BKS	21-GKS	15-R
7-OKD	33-PKC	17-RKD	37-YS	13-YRD	16-RD
16-RD	27-BKS	32-PKS	30-P	6-O	36-B
26-BKD	28-BKC	8-OKS	32-PKS	28-BKC	29-Pu
14-YRS	31-PKD	17-RKD	3-KD	36-B	1-W
8-OKS	9-Y	22-GKC	27-BKS	15-R	32-PKS
6-O	11-YKS	38-YD	4-KS	7-OKD	33-PKC
5-KC	30-P	24-BS	31-PKD	11-YKS	10-YKD
3-KD	23-BD	x	13-YRD	27-BKS	14-YRS
2-K	28-BKC	x	22-GKC	37-YS	38-YD
4-KS	31-PKD	10-YKD	7-OKD	16-RD	4-KS
34-YC	25-BC	13-YRD	36-B	15-R	1-W
16-RD	5-KC	22-GKC	38-YD	20-GKD	5-KC
23-BD	37-YS	36-B	15-R	30-P	15-R
5-KC	23-BD	38-YD	20-GKD	5-KC	2-K
18-RKS	18-RKS	15-R	30-P	15-R	25-BC
26-BKD	22-GKC	19-RKC	10-YKD	12-YKC	14-YRS
13-YRD	x	35-GS	9-Y	38-YD	21-GKS
20-GKD	9-Y	27-BKS	4-KS	24-BS	6-O
2-K	11-YKS	14-YRS	33-PKC	4-KS	22-GKC
18-RKS	36-B	25-BC	30-P	19-RKC	34-YC
16-RD	23-BD	18-RKS	28-BKC	5-KC	8-OKS
13-YRD	3-KD	20-GKD	29-Pu	32-PKS	10-YKD
26-BKD	37-YS	17-RKD	14-YRS	18-RKS	35-GS
Row 1	Row 2	Row 3	Row 4	Row 5	Row 6

D. Vine Management

During the application period, vines were irrigated by drip irrigation. Sucker shoot removal and leafing were done during the duration of trial.

F. Data Collection and Statistics

Daily temperature and precipitation were obtained from a CIMIS weather station in Sacramento Valley (Station 155). The temperature data is shown in Figure 1.

Disease was assessed on August 16th 2021. Bunch rot (Botrytis Bunch Rot and Sour Rot) 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 bunch rot. 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.

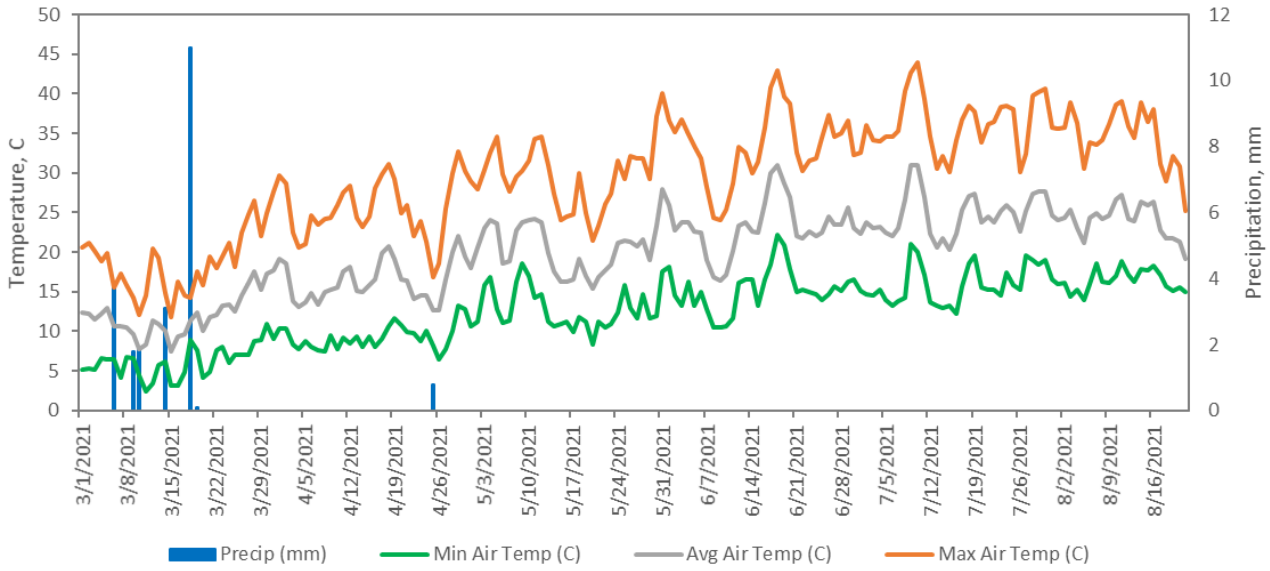

Figure 1. Average daily temperature (°C) and precipitation (mm) from March 1st to August 21st, 2021 from CIMIS station 155 Sacramento Valley CA.

Table 3. Disease incidence and severity. 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; Data percentages were arcsine√(x/100) transformed but non transformed data are presented. /= followed by.

Pictures	Treatment	Flag	Mean Incidence, %	Mean Severity, %
https://photos.app.goo.gl/bswPgzgE26bxb3Mn9	Mevalone (SA-0650001) 55 fl oz + Kinetic Adj 0.125 (%v/v) / Pristine 23 oz + Kinetic Adj 0.125 (%v/v) / Mevalone (SA-0650001) 55 fl oz + Kinetic Adj 0.125 (%v/v)	YKS	5.6 a	0.32 a
https://photos.app.goo.gl/LaNXwGVCRzExsunC6	EXP14 3 lb + Embrace-EA 32 fl oz	BKC	6.4 ab	0.38 ab
https://photos.app.goo.gl/RTrXu62xz9ihQYns8	NSTKI-014 3 lb	RKD	8.8 abcd	1.04 abcdefg
https://photos.app.goo.gl/BsR2mwE1vHfyHTWy6	Vangard 10 oz + Syl-Coat 0.125%/ Miravis Prime 13.4 oz + Syl-Coat 0.125%/ Miravis Prime 13.4 oz+ Syl-Coat 0.125%	YS	8.8 abcd	0.62 abc
https://photos.app.goo.gl/ssCRvvp2fow9vBaq5	Theira 4 fl oz + Syl-Coat 0.125%/Luna Experience 8.6 fl oz /Theira 4 fl oz + Syl-Coat 0.125%	B	9.6 abc	1.66 abcdefg
https://photos.app.goo.gl/nAJuEAJFroFioUNc6	Elevate 1 lb +Vacciplant 16 oz / Vacciplant 16 oz +Luna Experience 8.6 oz / Elevate 1 lb + Vacciplant 16 oz	GKC	9.6 abcd	0.6 abcd
https://photos.app.goo.gl/ifzmLmvDcL7jYKqA9	EXP14 3 lb + Syl-Coat 4 fl oz	Pu	10.4 abcd	1.06 abcde
https://photos.app.goo.gl/Putx3SnVvyw7p2sGA	Miravis Prime 13.4 oz+ Syl-Coat 0.125% / Switch 14 oz+ Syl-Coat 0.125% / Vangard 10 oz+ Syl-Coat 0.125%	YD	10.4 abcd	0.44 ab
https://photos.app.goo.gl/hbNwDfpzmewWdCZK8	Elevate 16 oz / Pristine 23 oz/ Elevate 16 oz	YKC	10.4 abcd	0.74 abcde
https://photos.app.goo.gl/xFnLRcfnSdLvHvEt7	Luna Experience 8.6 fl oz / Prinsite 23 oz / Elevate 16oz (Conventional Standard Program)	KD	11.2 abcd	0.9 abcdefg
https://photos.app.goo.gl/heELsrLFg21hTHga8	Elevate 1 lb / Luna Experience 8.6 / Elevate 1 lb	GKS	12 abcd	1.64 abcdefgh
https://photos.app.goo.gl/eqvNp5PhtjG8VZrb7	BTS-EXP-100 27.4 fl oz + Kinetic 0.05% (v/v)	PKS	13.6 abcde	1.32 abcdefgh
https://photos.app.goo.gl/t1dyWagbKjgDPRRG7	Luna Experience 8.6 oz + Syl-Coat 4 oz/ Scala 18 oz + Syl-Coat 4 oz / Scala 18 oz+ Syl-Coat 4 oz	R	13.6 abcde	0.96 abcde
https://photos.app.goo.gl/MwuwLi5jiFDQ5CTC6	NSTKI-014 5 lb	RKS	13.6 abcde	1.08 abcdef
https://photos.app.goo.gl/1kqqK6rDFCWhKkUN7	JMS Stylet 1% v/v	K	15.2 abcde	2.98 efghi
https://photos.app.goo.gl/mecbFHRZQjaxHjkbA	Boost Biomes BC18 5^13 CFU/acre	OKD	15.2 bcde	1.42 abcdefgh

https://photos.app.goo.gl/dUBDLeX1E6uggrRx7	Fun Thyme 128 floz + Dynamic 0.125 % v/v	BS	16 bcde	1.46 abcdefgh
https://photos.app.goo.gl/FR1PRVh8WsCF4uARA	SA-0650004 -28 fl oz	OKS	16 abcde	2.68 bcdefghi
https://photos.app.goo.gl/LTCE8wdMZsCvhchi7	Luna Experience 8.6 oz + Syl-Coat 4 oz / Vanguard 10 oz + Syl-Coat 4 oz/ Vanguard 10oz + Syl-Coat 4 oz	RD	16 bcde	1.12 abcdefg
https://photos.app.goo.gl/ukEuEerSpBUH1aB96	Mevalone (SA-0650001) 55 fl oz + Kinet**ic** Adj 0.125 (%v/v) / Elevate 50WDG 16 oz + Kinetic Adj 0.125 (%v/v) / Mevalone (SA-0650001) 55 fl oz + Kinetic Adj 0.125 (%v/v)	YKD	16 bcde	1.82 abcdefgh
https://photos.app.goo.gl/pde34sBxcBDvrUNa6	Parade 3.1 fl oz + Dyne-Amic 0.25% (v/v)	YRD	16 abcde	2.78 abcdefghi
https://photos.app.goo.gl/ijp12cu2TuR7SRd3A	Luna Experience 8.6 oz, PHD 6.2 oz, Elevate 1 lb	GKD	16.8 bcde	1.56 abcdefgh
https://photos.app.goo.gl/KEwkYouw563SUWBi6	MinerAll 8.5 lb	O	16.8 bcde	2.02 bcdefghi
https://photos.app.goo.gl/RVWEu3KQoo7bDn558	Nanospada (1 part to 30 parts dilution with water for 100 ga)	YRS	16.8 abcde	2.04 abcdefgh
https://photos.app.goo.gl/x5HHXH96jYRf7f4g8	Luna Experience 8.6 oz / BS-200 27.4 fl oz / Prinsite 23 oz	PKC	17.6 abcde	2.52 bcdefghi
https://photos.app.goo.gl/UCjZHcqYyLqiT7Gb9	Mevalone (SA-0650001) 55 fl oz + Kinetic Adj 0.125 (%v/v)	Y	17.6 bcde	2.28 abcdefghi
https://photos.app.goo.gl/5UHwEJTSqK6A2W5c7	Howler 5fl oz + Syl-Coat 0.125%/ Luna Experience 8.6 fl oz / Howler 5fl oz + Syl-Coat 0.125%	GS	18.4 bcde	2.06 bcdefghi
https://photos.app.goo.gl/4MyxwcKK33vby4Bx5	Magna-Bon CS 2005 20 oz	KC	18.4 cde	4.08 hij
https://photos.app.goo.gl/cGbZLAGy5SMiV4ex7	NSTKI-014. 7 lb	RKC	18.4 bcde	1.16 abcdefgh
https://photos.app.goo.gl/jip6rsCKWCiUndES7	Fun Thyme 256 floz + Dynamic 0.125 % v/v (switched to 128 fl oz for the 3rd spray)	BKS	20 cde	3.84 fghij
https://photos.app.goo.gl/QycHbGxCGQn18gfF9	MicroSure™ 4.4 ga	BC	20.8 cdef	3.2 cdefghi
https://photos.app.goo.gl/5Gg6zhhfJHbrKXYK7	Product G 3.5 oz + Adjuvat O 4.5 oz	BKD	20.8 bcde	3.48 defghi
https://photos.app.goo.gl/cpUh2ixSEZ8XAGVs5	EXP14 3 lb + Glacier EA 16 fl oz	P	20.8 def	2.86 cdefghi
https://photos.app.goo.gl/5PSWBKGyMUbkBSzBA	BTS-EXP-100 27.4 fl oz	PKD	21.6 def	3.48 cdefghi
https://photos.app.goo.gl/9M63eLwoVXfjdyNy8	Vacciplant 16 oz	BD	22.4 def	4.3 ghij
https://photos.app.goo.gl/p6PGmZeVzWWNVYET8	Esendo 2.8 fl oz+ Syl-Coat 0.125%/Luna Experience 8.6 fl oz / Esendo 2.8 fl oz + Syl-Coat 0.125%	YC	28.8 efg	2.54 defghi
https://photos.app.goo.gl/XYD5a8MtsNDUt9vU8	Serenade ASO 4 qt (Biological Standard)	KS	38.4 fg	5.14 ij
https://photos.app.goo.gl/mxnkoNW7kb7Dr3qs5	Untreated Control	W	44 g	7.34 j

Acknowledgements

Thanks to the various industry donors for providing testing materials. Thanks to David Ogilvie for his collaboration and Wilson Vineyards for providing vines for the trials.

References

Bulit, J., & Dubos, B. (1988). Botrytis bunch rot and blight. Compendium of grape diseases, 13-15.

Flaherty, D. L., Christensen, L. P., Lanini, W. T., Marois, J. J., Phillips, P. A., & Wilson, L. T. (1992). Grape pest management (No. Ed. 2). University of California.

Gubler, W.D., Smith, R.J., Varela, L.G., Vasquez, S., Stapleton, J.J., & Purcell, A.H. (2008) UC IPM Pest Management Guidelines: Grape, UC ANR Publication 3348, Diseases, available at: http://www.ipm.ucdavis.edu/PMG/r302100111.html.

Smith, R. J. Bettiga, L. J., Gubler, W. D. Leavitt, G. M. Purcell,A. H., Stapleton, J. J., Varela, & S. Vasquez. (2016). Summer Bunch Rot (Sour Rot). UC IPM Pest Management Guidelines: Grape, UC ANR Publication 3348, Diseases, available at: http://ipm.ucanr.edu/PMG/r302100211.html

Steel, C. C., Greer, L. A., Savocchia, S., & Samuelian, S.K. (2015). Effect of temperature on *Botrytis cinerea*, *Colletotrichum acutatum* and *Greeneria uvicola* mixed fungal infection of *Vitis vinifera* grape berries. VITIS-Journal of Grapevine Research, 50(2), 69.

Steel, C.C., Blackman, J. W., & Schmidtke, L.M. (2013). Grapevine Bunch Rots: Impacts on Wine Composition, Quality, and Potential Procedures for the Removal of Wine Faults. J Agric Food Chem 61, 5189−5206

Appendix: Materials

Product	Active ingredient(s) and concentration	Manufacturer or distributor	Chemical class (Frac Code)
Adjuvat O	proprietary	Scott laboratories	adjuvant
Fun Thyme	proprietary	Agrospheres	N/A
Boost Biomes BC18	proprietary	Boost Biomes	N/A
BTS-EXP-100	proprietary	Botanical Solution Inc	N/A
Dyne-Amic	polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of c16-c18 fatty acids (99%)	Helena Chemical Co.	adjuvant
Elevate 50WDG	fenhexamid (50%)	Arysta Lifescience	KRI (17)
Embrece-EA	Polyoxyalkylen polyol fatty acid ester, Alcohol ethoxylate (78.92%)	Wilbur-Ellis	adjuvant
Esendo	proprietary	AgBiome Innovations	N/A
EXP14	proprietary	Biotalys	N/A
Glacier EA	Methylated seed oil (96%)	Wilbur-Ellis	adjuvant
Howler	Pseudomonas chlororaphis strain AFS009 (50%)	AgBiome Innovations	biological
JMS Stylet	paraffinic oil (97.1%)	JMS Flower Farms, Inc.	Oil
Kinetic	Polyoxyethylene-polyoxypropylene copolymer, Polyether modified (99%) heptamethyltrisiloxane	Helena Agri-Enterprises, LLC	adjuvant
Luna Experience	fluopyram (17.54%), tebuconazole (17.54%)	Bayer CropScience	SDHI (7)/DMI-triazole (3)

Magna-Bon CS 2005	proprietary	Magna-Bon	N/A
Mevalone (SA-0650001)	proprietary	Sipcam	N/A
MinerALL	proprietary	MinerALL Clay INC	N/A
Miravis Prime	Fludioxonil (21.4%), Pydiflumetofen (12.8%)	Syngenta	phenylpyrroles (12)/SDHI (7)
Nanospada	proprietary	Katana Ag.	N/A
NSTKI-014	proprietary	Tkinet	N/A
Parade	pyraziflumid	Nichino America	SDHI (7)
PHD	Polyoxin D zinc salt (11.3%)	Arysta LifeScience	polyoxins (19)
Pristine	pyraclostrobin (12.8%), boscalid (25.2%)	BASF	QoI(11)/SDHI (7)
Product G	proprietary	Scott laboratories	N/A
MicroSure™	proprietary	microSURE™ Agricultural Solutions LLC	N/A
SA-0650004	proprietary	Sipcam	N/A
Serenade ASO	*Bacillus subtilis* qst 713 (26%)	Bayer CropScience	biological
Switch	cyprodinil 37.5% + Fludioxonil 25.0%	Syngenta	AP (9)/ Phenylpyrroles (12)
Syl-Coat	polyether-polymethylsiloxane-copolymer and polyether-100%	Wilbur-Ellis	adjuvant
Theira	proprietary	Agbiome	N/A
Vacciplant	proprietary	Arysta LifeScience	natural compound (P04)
Vangard	cyprodinil (75%)	Syngenta	AP(9)