Evaluation of fungicide trial for management of grape rot in table grape vineyards and cold storage: 2021 field trials

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Report Summary

Fruits rots caused by different fungi including sour rot caused by *Aspergillus* spp., brown spot caused by *Cladosporium* spp, Botryris bunch rot caused by *Botrytis cinerea* are common on grapes in California. They are fast-growing pathogens infecting numerous crops of commercial value. They lead to a reduction in the yield and quality of table, raisin, and wine grapes, with high economic losses in some locations or years (Flaherty et al. 1992). The pathogens overwinter as sclerotia/conidia in mummified berries on the vine or ground or on dormant canes. In infected fruits, disease symptoms are latent until late in the season. As sugar concentration increases in the berry, the fungus resumes growth and infects the entire fruit, often resulting in berry splitting and sporulation (Fig. 3) on the fruit surface (Flaherty et al. 1992). Free water is a requirement for the pathogen, and favorable conditions include humidity's exceeding 90% and temperatures between 15-27° (Bulit and Dubos 1988, Gubler et al. 2008, Steel et al., 2011). Along with leaf removal and other cultural controls, good spray coverage with a synthetic fungicide is currently the most effective form of disease management.
We examined the efficacy of 16 fungicide treatment programs for control of fruit rot in Allison4 (ALL4) and Autumn King 17 (AK17) grapes in Kern County, CA in 2021.

The trials consisted of soft chemistry products and synthetic fungicides. Treatments were sprayed at A-bloom, B-pre-close, C-veraison, and D-pre-harvest.

Materials and Methods

A. Experimental design

Table 1. Experimental design

Experimental design	Completely randomized design with 4 replicates
Experimental unit	4 adjacent vines = 1 plot
Plot area (Row and vine spacing)	288 ft2 (row spacing = 12 ft, vine spacing = 6 ft) in Allison 4 336 ft2 (row spacing = 12 ft, vine spacing = 7 ft) in Autumn King 17
Area/treatment	1152 ft^2 or 0.02645 acre/treatment in Allison 4 (4 replicates = 1 treatment) 1344 ft^2 or 0.03085 acre/treatment in Autumn King 17
Fungicide Applications, Volume water/Acre	A Bloom, Skipped B Pre-close, AK17 (7/21/2021), ALL4 (07/22/2021) C Veraison, AK17 (7/28/2021), ALL4 (07/29/2021) D Pre-harvest, AK17 (9/16/2021), ALL4 (09/17/2021) Harvested AK17 (10/28/2021), ALL4 (10/21/2021)
Cold Storage Evaluation	AK17 (12/03/2021) 36 days, ALL4 (12/02/2021) 42 days.
Equipment	50-gallon spray tank mounted on a Honda ATV.

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)	Timing
1	Y	Miravis Prime	13.4 fl oz	A,C,D
		Elevate	1lb	B
2	G	Miravis Prime	13.4 fl oz	A
		Elevate	1 lb	B
		Pristine	23 oz	C,D
3	O	Luna Experience	14 oz	A,B,C,D
		Syl-Tac	0.125 % v/v	
4	YKS	Parade	3.1 fl oz	A,B,C,D
		Serenade ASO	3 qt/ A	
5	B	OxiDate 5.0	5 fl oz	A,B,C,D
		Syl-Tac (surfactant)	0.125 % v/v	
6	K	Pristine	23 oz	A,B,C,D
7	Pu	Luna Experience	8.6 fl oz	A, C
		Elevate	1lb/A	B, D
8	OKS	Cueva	1 gal	A,C
		Scala	18 fl oz	B,D
9	R	Vacciplant	16 oz	A
		Serenade ASO	3 qt	B
		BTS EXP 100	27.4 fl oz	C,D
10	BKS	PerCarb	3 lb	A,B,C,D
		Syl-Tac	0.125 % v/v	A,B,C,D
11	WYD	Luna Experience	8.6 fl oz	A, D
		Vanguard	10 oz	B, C
		Syl-Tac	0.125 % v/v	A, B, C, D
12	KS	Product G	3.5 oz	A, B, C, D
		Adjuvat O	4.5 oz	A, B, C, D
13	RS	BTS EXP 100	27.4 fl oz	A, B, C, D
14	BS	Stargus	3qt	A, C
		Serenade ASO	3 qt	B, D
15	W	UNTREATED	-	-

C. Map

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

Disease was assessed between September 21-24 for both trials. Bunch rot (Botrytis Bunch Rot and Sour Rot) incidence and severity were assessed in each treatment by evaluating twenty-five random clusters in the field. Incidence was defined as the proportion of clusters in a plot having some berry 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.
After 36 (AK17) and 42 (ALL4) days the treatments were evaluated based the following symptoms: black dot, wound, infected wound, mildew scar, black dot, pedicel end rot, slip skin, and fruit rot (Fig. 1). However, pedicel end rot, slip skin and rot were considered as the results of sour rot.
Trial models were analyzed using the ANOVA Tests for data. Means comparisons were made using Fisher's LSD with α=0.05.

Fig. 1. Symptoms evaluated on grape berries. A. wound, B. infected wound, C. mildew scar, D. black dot, E. pedicel end rot, F. slip skin, and G. fruit rot.

Table 3. Field Trial disease incidence and severity in Allison-4 grapes.

Treatments	Treatment No.	Flag	Mean Incidence (%)	Mean Severity (%)
Miravis Prime 13.4 fl oz/ Elevate 1lb	1	Y	88.0 n.s.	306.8 n.s.
Miravis Prime 13.4 fl oz/Elevate 1 lb/Pristine 23 oz	2	G	79.0	226.8
Luna Experience 14 oz + Syl-Tac 0.125 % v/v	3	O	88.0	219.8
Parade 3.1 fl oz + Serenade ASO 3 qt/ A	4	YKS	88.0	247.3
OxiDate 5.0 5 fl oz + Syl-Tac 0.125 % v/v	5	B	82.4	187.6
Pristine 23 oz	6	K	89.3	196.3
Luna Experience 8.6 fl oz / Elevate 1lb/A	7	Pu	90.0	309.3
Cueva 1 gal / Scala 18 fl oz	8	OKS	85.0	263.8
Vacciplant 16 oz/ Serenade ASO 3 qt/ BTS EXP 100 27.4 fl oz	9	R	87.0	321.8
PerCarb 3 lb + Syl-Tac 0.125 % v/v	10	BKS	85.0	264.5
Luna Experience 8.6 fl oz + Syl-Tac 0.125 % v/v / Vanguard 10 oz + Syl-Tac 0.125 % v/v	11	WYD	97.0	335.8
Product G 3.5 oz + Adjuvat O 4.5 oz	12	KS	82.7	266.0
BTS EXP 100 27.4 fl oz	13	RS	91.0	244.3
Stargus 3qt/Serenade ASO 3 qt	14	BS	88.0	207.2
Untreated Control	15	W	85.0	203.8

n.s. = not significant at $P = 0.05$. Data were arcsine $\sqrt{(x/100)}$ transformed before the analysis but the nontransformed data are presented.

Table 4. Field Trial disease incidence and severity in Autumn King-17 grapes.

Treatments	Treatment No.	Flag	Mean Incidence (%)	Mean Severity (%)
Miravis Prime 13.4 fl oz/ Elevate 1lb	1	Y	91.0 n.s.	37.0 n.s.
Miravis Prime 13.4 fl oz/Elevate 1 lb/Pristine 23 oz	2	G	111.8	42.0
Luna Experience 14 oz + Syl-Tac 0.125 % v/v	3	O	71.8	51.0
Parade 3.1 fl oz + Serenade ASO 3 qt/ A	4	YKS	39.5	40.0
OxiDate 5.0 5 fl oz + Syl-Tac 0.125 % v/v	5	B	40.8	31.0
Pristine 23 oz	6	K	90.8	31.0

Luna Experience 8.6 fl oz / Elevate 1lb/A	7	Pu	63.5	30.0
Cueva 1 gal / Scala 18 fl oz	8	OKS	63.0	40.0
Vacciplant 16 oz/ Serenade ASO 3 qt/ BTS EXP 100 27.4 fl oz	9	R	122.8	40.0
PerCarb 3 lb + Syl-Tac 0.125 % v/v	10	BKS	79.3	34.0
Luna Experience 8.6 fl oz + Syl-Tac 0.125 % v/v / Vanguard 10 oz + Syl-Tac 0.125 % v/v	11	WYD	90.5	39.0
Product G 3.5 oz + Adjuvat O 4.5 oz	12	KS	123.0	48.0
BTS EXP 100 27.4 fl oz	13	RS	112.5	35.0
Stargus 3qt/Serenade ASO 3 qt	14	BS	59.3	34.0
Untreated Control	15	W	82.5	36.0

n.s. = not significant at $P = 0.05$. Data were arcsine $\sqrt{(x/100)}$ transformed before the analysis but the nontransformed data are presented.

Table 5. Cold storage evaluation of average sour rot incidence (pedicel end rot, slip skin and fruit rot) per treatment

Treatments	**Treatment No.**	**Flag**	**Incidence, n° of infected berries per box**	
			Allison 4	Autumn King 17
Miravis Prime 13.4 fl oz/ Elevate 1lb	1	Y	6.5 abc	7.3 bcde
Miravis Prime 13.4 fl oz/Elevate 1 lb/Pristine 23 oz	2	G	8.8 abcd	5.0 abc
Luna Experience 14 oz + Syl-Tac 0.125 % v/v	3	O	20.3 e	4.5 abc
Parade 3.1 fl oz + Serenade ASO 3 qt/ A	4	YKS	7.5 abcd	6.3 bcd
OxiDate 5.0 5 fl oz + Syl-Tac 0.125 % v/v	5	B	14.8 de	3.8 ab
Pristine 23 oz	6	K	5.3 ab	1.8 a
Luna Experience 8.6 fl oz / Elevate 1lb/A	7	Pu	5.8 abc	4.3 ab
Cueva 1 gal / Scala 18 fl oz	8	OKS	3.5 a	3.5 ab
Vacciplant 16 oz/ Serenade ASO 3 qt/ BTS EXP 100 27.4 fl oz	9	R	8.8 abcd	1.8 a
PerCarb 3 lb + Syl-Tac 0.125 % v/v	10	BKS	7.0 abc	3.3 ab
Luna Experience 8.6 fl oz + Syl-Tac 0.125 % v/v / Vanguard 10 oz + Syl-Tac 0.125 % v/v	11	WYD	12.5 bcd	10.3 de
Product G 3.5 oz + Adjuvat O 4.5 oz	12	KS	11.8 bcd	11.0 e

BTS EXP 100 27.4 fl oz	13	RS	10.0 abcd	8.5 cde
Stargus 3qt/Serenade ASO 3 qt	14	BS	13.3 cde	10.3 de
Untreated	15	W	9.5 abcd	7.0 bcde

Means of four replicates followed by the same letter in each column did not differ significantly, separated according to the Fisher's LSD test ($P < 0.05$).

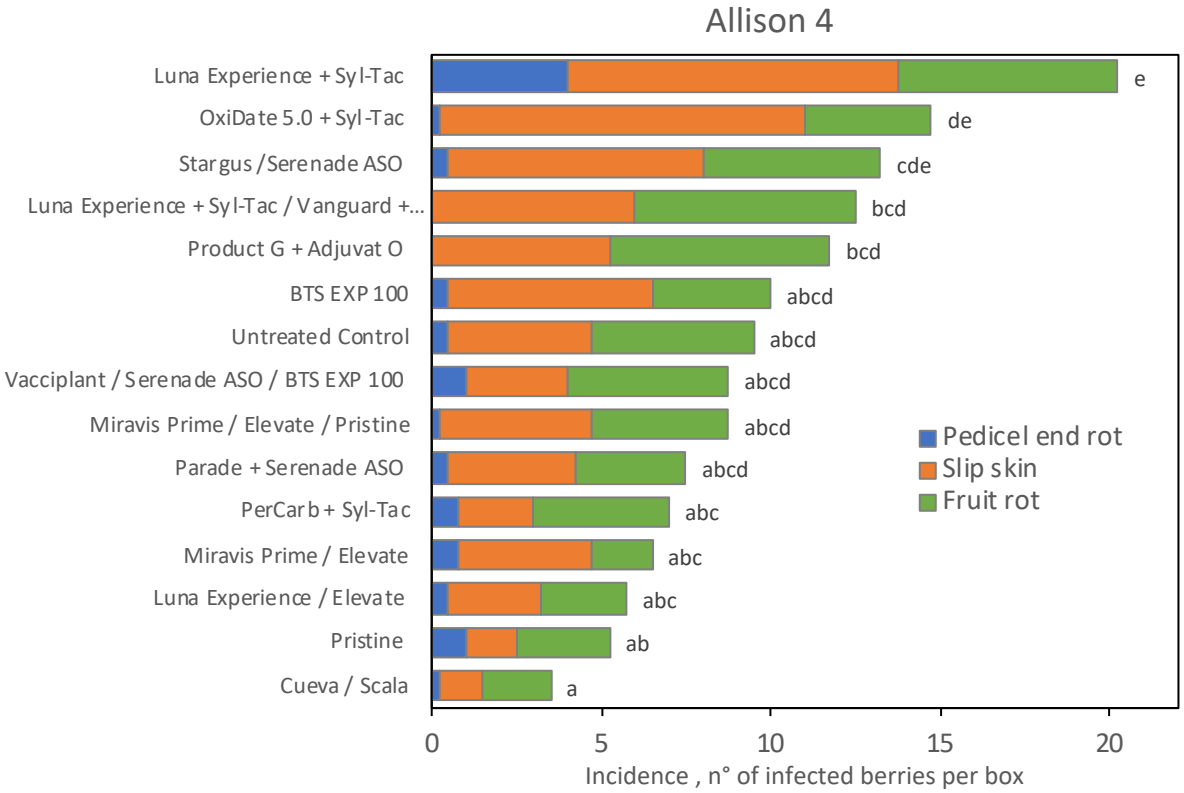

Figure 2. Cold storage evaluation of average sour rot incidence (pedicel end rot, slip skin and fruit rot) per treatment on 'Allison 4'

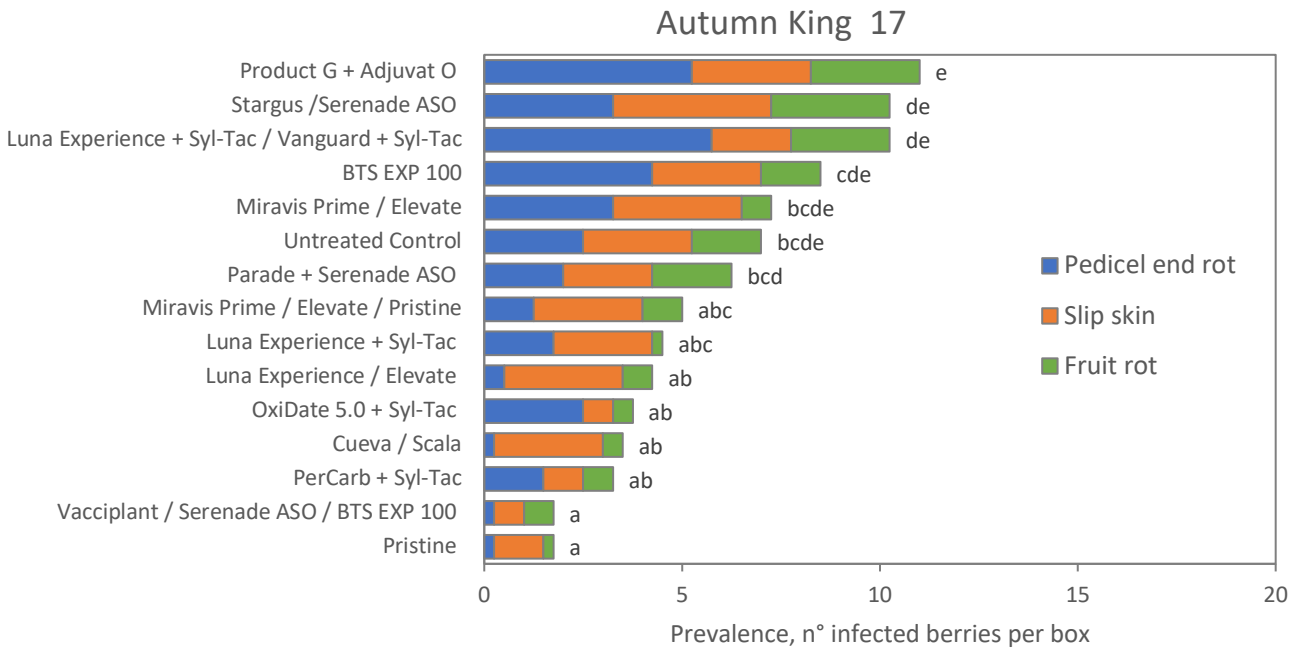

Figure 3. Cold storage evaluation of average sour rot incidence (pedicel end rot, slip skin and fruit rot) per treatment on 'Autumn King 17'

Acknowledgements

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Appendix: Materials

Product	Active ingredient(s) and concentration	Manufacturer or distributor	Chemical class (Frac Code)
Adjuvat O	proprietary	Scott laboratories	N/A
BTS-EXP-100	proprietary	Botanical Solution Inc (BSI)	N/A
Cueva	Copper octanoate (10%)	Certis USA	inorganic (M01)
Elevate	fenhexamid (50%)	Arysta Lifescience	KRI (17)
Luna Experience	fluopyram (17.54%), tebuconazole (17.54%)	Bayer CropScience	SDHI (7)/DMI-triazole (3)
Miravis Prime	Fludioxonil (21.4%), Pydiflumetofen (12.8%)	Syngenta	phenylpyrroles (12)/SDHI (7)
Oxidate 5.0	Hydrogen PeroxidePeroxyacetic Acid	Biosafe systems	N/A
Parade	pyraziflumid	Nichino America	SDHI(7)
Percab	Sodium Carbonate Peroxyhydrate	Biosafe systems	N/A
Pristine	pyraclostrobin (12.8%), boscalid (25.2%)	BASF	QoI(11)/SDHI (7)
Product G	proprietary	Scott laboratories	N/A
Scala	pyrimethanil (54.6%)	Bayer CropScience	AP(9)
Serenade ASO	*Bacillus subtilis* qst 713 (26%)	Bayer CropScience	biological
Stargus	*Bacillus amyloliquefaciens* strain f72	Marrone Bio Innovations	Biological
Vacciplant	proprietary	Arysta LifeScience	natural compound (P04)
Vanguard	cyprodinil (75%)	Syngenta	AP(9)