Chemical and biological control of *Botrytis* bunchrot of grapes: 2006 results

Christopher N. Janousek, Kenneth C. Asay, and W. D. Gubler[1]

Department of Plant Pathology, University of California, Davis, CA 95616.

University of California Cooperative Extension,
Department of Plant Pathology,
University of California, Davis, December 2006

[1.] Address correspondence to: wdgubler@ucdavis.edu
Published: December 2006 at http://plantpathology.ucdavis.edu/ext/index.htm, minor revisions, March 2007.

Grape bunch rot trial, 2006

Location	St. Helena, Napa Co., California (38°25.8' N, 122°22.7' W)
Principle investigator	Doug Gubler, Ph.D.
Researchers	Ken Asay, Chris Janousek, Ph.D.
Crop	Grape, Johannesburg Riesling variety
Vineyard	Established in 1991; density = 908 vines/acre.
Disease	Bunch Rot, *Botrytis cinerea*

Material and Methods

1. Trial layout and method

Objective	Efficacy of fungicides for control of *Botrytis* bunch rot.		
Experimental design	Randomized complete block design. Unsprayed vines used on all sides of the experimental area.		
Application method	Backpack sprayers.		
Vine spacing	6 ft	Row spacing	10 ft
Replicate unit	3 vines	Replicate unit area	180 ft^2
Area/Treatment	720 ft^2 (4 reps.=1 treatment)	Area/Treatment	0.017 acre/treatment
Vol. water/acre	150 gallons 180 gallons	Vol. water/Treatment	2.5 gallons 3.0 gallons
Applications	**A** = late May 2006 (BioNatrol-M treatments only), **B** = 6-8 June 2006, **C** = 26-27 June (berries are pea-sized and larger), **D** = 15-17 August (following veraison)		
Treatment interval	3 weeks from B to C; about 7 weeks from C to D.	Evaluation stage	About 1.5 weeks following harvest (29 October, 1 Nov.)
Disease evaluation	Disease severity estimated as the mean proportion of symptomatic berries on 25 clusters located throughout each plot. Disease incidence estimated as the proportion of those 25 clusters that showed >0% severity.		
Data transformation	None; analyses conducted on proportions (0.0 to 1.0). Proportions were converted to percentages for Table 1.		
Statistical analysis	Type III, 2 factor mixed model ANOVAs on incidence and severity. *A posteriori* comparison of treatment means with Tukey-Kramer tests at $p<0.05$. 4 additional unsprayed plots (YKS) were pooled with the control plots for the analyses (n=8).		

2. Experimental treatments

Trt no.	Flag	Institution	Product(s)	FP/Acre	FP/Treatment	Notes
1a	W	UC Davis	Untreated	none		
1b	OKS	UC Davis	Additional unsprayed plots	none		
2	YD	Valent	V-10135 (DF-5) 50DF	0.25 lb ai	3.9 g	
3	O	Valent	V-10135 (DF-5) 50DF	0.375 lb ai	5.8 g	
4	OD	Valent	V-10135 (DF-5) 50DF	0.50 lb ai	7.7 g	
5	PC	Valent	Vangard 75WD	0.47 lb ai	4.8 g	
6	GS	Valent	Endura 70WD	0.2 lb ai	2.2 g	
7	GD	Valent	V-10135 (DF-5) 50DF alt Endura 70WD	0.375 lb ai 0.2 lb ai	5.8 g 2.2 g	
8	KD	Natural Industries	Micro 108 + Silwet L-77	6 oz 7 fl oz	2.9 g 3.5 ml	
9	YKS	Syngenta	Vangard	10 oz	4.8 g	
10	OS	Ecosmart	Sporan EC	4 pints	32.2 ml	
11	RS	Ecosmart	Sporan EC alt Elevate	4 pints 0.5 lb ai	32.2 ml 7.7 g	
12	RKC	Bayer	USF2014 480SC	18 oz	9.0 ml	
13	RD	DuPont	DPX LEM17-045 (20% ai)	2 oz ai	5.0 ml	
14	LG+Pu	DuPont	DPX LEM17-046 50WG (50% ai)	2 oz ai	1.9 g	
15	Pu	DuPont	DPX LEM17-045	3.5 oz ai	8.8 ml	
16	OKD	DuPont	DPX LEM17-045	5.0 oz ai	10.1 ml	
17	KC	DuPont	DPX LEM17-045	6.4 oz ai	16.1 ml	
18	YC	DuPont	Endura 70WD	5.6 oz ai	3.9 g	
19	YKC	Arysta	Elevate 50WD	1 lb	7.7 g	
20	LG	Arysta	Elevate 50WD + Evito	1 lb 2 fl oz	7.7 g 1.0 ml	
21	YS	Crompton	Procure 480SC	6 fl oz	3.0 ml	
22	GKD	Crompton	Elite	4 oz	2.6 g	
23	GKC	AgraQuest	Serenade MAX + Flint + Latron B-1956	1 lb 2 oz 0.03% v/v	7.7 g 1.0 g 2.8 ml	3.4 ml of Latron B-1956 sticker used for 180 gal/acre applications.
24	BS	AgraQuest	Serenade MAX + Latron B-1956 alt Vangard + Latron B-1956	2 lb 0.03% v/v 10 oz 0.03% v/v	15.4 g 2.8 ml 4.8 g 2.8 ml	3.4 ml sticker used for 180 gal/acre applications.
25	P	Doosan	BioNatrol-M + Latron B-1956	1400 ml 135 ml	23.8 ml 2.3 ml	
26	RKS	Doosan	BioNatrol-M + Latron B-1956	1841 ml 135 ml	31.3 ml 2.3 ml	
27	KS	Agrimm Technologies	Sentinel + Nu Film 17	82 g 294 ml	1.4 g 5 ml	
28	LG+O	Bayer	Scala	9.0 oz	4.5 ml	

Notes: 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. "FP" = formulated product; "ai" = active ingredient. 150 gallons water per acre used during first application; 180 gallons of water per acre applied on 26-27 June 2006 and 15-17 August.

3. Materials

Institution	Product	Active Ingredient(s)	Concentration	Tol	Contact
Bayer	USF2014 480SC	pyrimethanil trifloxystrobin	38.8% 5.4%	N	Matt Elhardt matt.ehlhardt@bayercropscience.com
	Scala	pyrimethanil	54.6%	Y	
Valent	V-10135 50WD	V-10135	50%	N	Tom DeWitt tom.dewitt@valent.com
	Vanguard 75WD	cyprodinil	75%	Y	
	Endura 70WD	boscalid	70%	Y	
	Elevate 50WD	fenhexamid	50%	Y	
Syngenta	Vangard 75WG	cyprodinil	75%	Y	David Vitolo david.vitolo@syngenta.com
Natural Industries	Micro 108	*Streptomyces lydicus*	1 x 10^7 CFU/g	N	Tim Lichatowich tim@naturalindustries.com
	Silwet L-77	silicone surfactant	100%	Y	
DuPont	DPX LEM17-045	DPX-LEM17	20%	N	Stephen Colbert stephen.f.colbert@usa.dupont.com
	DPX LEM17-046	DPX-LEM17	50%	N	
	Endura 70WD	boscalid	70%	Y	
Arysta	Elevate 50WD	fenhexamid	50%	Y	Randy Dobbs rsdodds@comcast.net
	Evito	fluostrobin	40.3%	N	
Crompton	Procure 480SC	triflumizole	480 g/L	Y	Curtis Sandberg curtis_sandberg@cromptoncorp.com
	Elite	tebuconazole	45%	Y	
AgraQuest	Serenade MAX	*Bacillis subtilis*	10-15%	Y	Paul Walgenbach PWalgenbach@agraquest.com
	Flint	trifloxystrobin	50%	Y	
	Latron B-1956	non-ionic surfactant	77%	Y	
	Vangard	cyprodinil	75%	Y	
Doosan	BioNatrol-M	soybean oil	42%	N	Phil Grau philgrau@aol.com
	Latron B-1956	non-ionic surfactant	77%	Y	
Agrimm Technologies	Sentinel	*Trichoderma atroviride*	2.5 x 10^9 CFU/g	Y	John Hunt j.hunt@agrimm.co.nz
	Nu Film 17	di-1-p-menthene	96%	Y	

Note: "Tol" denotes EPA approval for harvest for grapes.

4. Fungicide applications

Experimental treatment		Dates applied								
No.	**Fungicide(s)**	**5/30**	**6/6**	**6/7**	**6/8**	**6/26**	**6/27**	**8/15**	**8/16**	**8/17**
1	Unsprayed control									
2	V-10135, 0.25 lb ai/acre		x			x		x		
3	V-10135, 0.375 lb ai/acre		x			x		x		
4	V-10135, 0.50 lb ai/acre			x		x		x		
5	Vangard 75WD			x		x		x		
6	Endura 70WD			x		x			x	
7	V-10135 alt		x					x		
	Endura 70WD					x				
8	Micro 108 + Silwett L-77				x	x				x
9	Vangard 75WD			x		x		x		
10	Sporan EC			x		x			x	
11	Sporan EC alt			x					x	
	Elevate						x			
12	USF2014			x		x			x	
13	DPX LEM 17-045, 2 oz ai/acre			x			x		x	
14	DPX LEM 17-046, 2 oz ai/acre			x			x		x	
15	DPX LEM 17-045, 3.5 oz ai/acre			x			x		x	
16	DPX LEM 17-045, 5 oz ai/acre			x			x		x	
17	DPX LEM 17-045, 6.4 oz ai/acre			x			x		x	
18	Endura 70WD			x		x			x	
19	Elevate 50WD			x			x			x
20	Elevate + Evito			x			x			x
21	Procure 480SC				x		x			x
22	Elite			x		x			x	
23	Serenade MAX + Flint + Latron B-1956				x		x			x
24	Serenade MAX + Latron B-1956 alt				x					x
	Vangard + Latron B-1956						x			
25	BioNatrol-M + Latron B-1956	x		x		x				x
26	BioNatrol-M + Latron B-1956	x		x		x				x
27	Sentinel + Nu Film 17				x		x		x	
28	Scala			x			x			x
Application		A		B		C			D	

Note: Fungicide applications indicated by (x).

5. Plot Map

row 2	row 3	row 4	row 5
x	RS	x	x
x	YKC	x	x
x	GS	OD	RD
x	KS	OS	KC
OKD	x	x	KS
YKS	x	RKS	YS
YC	W	KD	x
GKC	PC	OKS	YD
Pu	YD	LG+O	x
RD	OKS	YC	OKD
GKD	x	LG	RS
KC	LG+Pu	O	Pu
BS	RKS	RKC	GKC
P	LG	LG+Pu	YKS
OD	OS	GKD	YKC
LG+O	GD	GS	PC
KD	RKC	BS	GD
YS	O	P	W
Block 3		**Block 4**	
YD	LG	OKD	YC
RD	GD	O	OKS
x	RKS	KC	GS
RS	RKC	YS	KD
BS	YS	Pu	x
OS	YC	GKD	LG
P	x	KS	LG+O
YKC	YKS	RKC	x
OD	PC	YKS	x
KD	KS	GKC	LG+Pu
KC	x	YKC	RS
GS	Pu	OS	OD
OKS	GKC	PC	W
LG+Pu	LG+O	RKS	BS
OKD	O	P	YD
GKD	W	RD	GD
Block 1		**Block 2**	

X: extra vines.

Results

Botrytis symptoms (Figure 1) were observed in September on some clusters and were present throughout the experimental vineyard at the time of rating in late October and early November. On 1 November, symptomatic berries from 25 randomly chosen clusters were collected and were later washed in sterile water, diluted, and then plated on potato dextrose agar plates with tetracycline. After about 1 week of growth, these plates confirmed that *Botrytis* was present.

Fungicide treatments had no effect on disease incidence ($F_{27,85}$=1.0, p>0.4). Incidence ranged from 68% to 95% across all experimental plots, indicating wide-spread occurrence of the disease. In contrast, disease severity was significantly affected by fungicide treatment ($F_{27,85}$=1.7, p=0.04). The lowest disease severity was seen in BioNatrol-M (1841ml/acre) and Vanguard (10 oz/acre) treatments and highest severity was in control plots. However, no pair-wise comparisons of treatment means were significantly different at α=0.05 (Tukey-Kramer test; Table 1).

Figure 1. *Botrytis* symptoms in Beringer vineyard clusters in September 2006. Only non-raisined, purplish berries were rated as having disease.

Figure 2. Increase in berry sugar content (mean ±1S.D. BRIX) over the course of the experiment. The first two sampling points consisted of juice from single fruits on different clusters; subsequent measurements were made on the juice extracted from entire clusters.

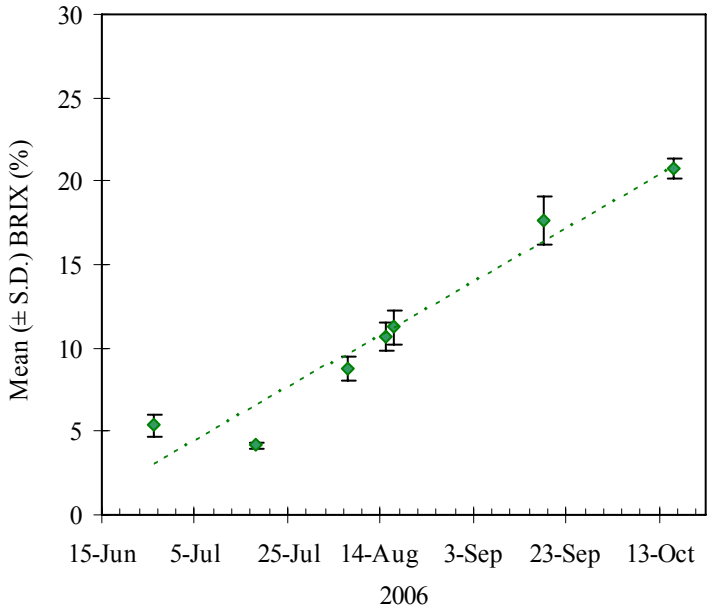

Table 1. Disease incidence and severity in control and fungicide-treated plots (means ±1.S.E.).

		Disease severity		Disease incidence	
Product	**Application rate**	**Mean**	**±S.E.**	**Mean**	**±S.E.**
Controls & Additional controls (n=8)	none	18.0%	1.9%	90.5%	2.5%
V-10135 50WD	0.375 lb ai/acre	17.1%	5.4%	95.0%	3.8%
DPX-LEM 17-045	5 oz/acre	15.2%	3.1%	89.0%	6.4%
Elite	4 oz/acre	14.2%	4.0%	78.0%	15.7%
Sporan EC	4 pints/acre	14.1%	3.5%	86.0%	6.2%
Serenade MAX + Flint + Latron B-1956	1 lb/acre+2 oz/acre+0.03%	13.3%	2.8%	84.0%	3.3%
Endura	0.2 lb ai/acre	12.9%	3.5%	85.0%	6.6%
BioNatrol-M + Latron B-1956	1400 ml/acre + 125 ml/acre	12.8%	3.4%	82.0%	3.8%
Sentinel + Nu Film 17	82 g/acre + 294 ml/acre	12.3%	3.7%	87.0%	6.6%
Sporan EC alt Elevate	4 pints/acre alt 0.5 lb ai/acre	12.1%	3.2%	78.0%	7.4%
DPX-LEM 17-045	2 oz/acre	11.5%	1.3%	79.0%	11.9%
Endura	5.6 oz/acre	11.5%	6.1%	75.0%	9.7%
V-10135 50WD	0.5 lb/acre	11.5%	2.5%	86.0%	4.2%
V-10135 50WD	0.25 lb ai/acre	11.4%	2.9%	90.0%	3.5%
DPX-LEM 17-045	3.5 oz/acre	11.3%	2.9%	79.0%	11.4%
DPX-LEM 17-046	2 oz ai/acre	11.3%	2.9%	86.0%	2.6%
Procure	6 fl oz/acre	11.2%	3.6%	78.0%	9.6%
Scala	9 oz/acre	10.6%	4.8%	80.0%	11.2%
Elevate + Evito	1 lb/acre + 2 fl oz/acre	9.8%	4.4%	68.0%	11.4%
Micro 108 + Silwett L-77 sticker	6 oz/acre + 7 fl oz/acre	9.2%	3.4%	70.0%	15.2%
Serenade MAX + Latron B-1956 alt Vanguard + Latron B-1956	2 lb/acre + 0.03% alt 10 oz/acre + 0.03%	9.2%	1.5%	79.0%	6.8%
USF2014	18 oz/acre	9.1%	3.8%	78.0%	12.1%
Elevate	1 lb/acre	8.9%	3.0%	72.0%	14.0%
V-10136 alt Endura	0.375 lbs/acre alt 0.2 lbs/acre	8.8%	2.3%	75.0%	5.3%
Vanguard	0.47 lb ai/acre	8.5%	3.2%	73.0%	10.4%
DPX-LEM 17-045	6.4 oz/acre	8.3%	3.8%	70.0%	19.1%
BioNatrol-M + Latron B-1956	1841 ml/acre + 125 ml/acre	7.9%	1.4%	80.0%	6.5%
Vanguard	10 oz/acre	7.5%	2.1%	76.0%	9.8%

Conclusions

Treatments demonstrated only a mild influence on disease severity and no effect on *Botrytis* incidence in the trial. An additional pre-harvest application of fungicides may have improved the efficacy of the biological and chemical controls used in the experiment. Though differences among treatments were not highly significant, the trend toward better control was evident with some of the newer fungicides and Elevate and Vangard (the most recently registered products). The late rains caused there to be a significant increase in disease and at the same time we did not make additional fungicide applications immediately after the rain.

Acknowledgements

We thank D. Johnson from Beringer Vineyards for access to the research site and F. Trouillas, F. Peduto, R. Herche, and J. Jertberg for assistance with the field rating. F. Trouillas kindly helped with spraying. We acknowledge the many companies who donated the materials used in this trial and whose financial contributions benefit the lab's research.