Title

Control of grape powdery mildew with synthetic, biological, and organic fungicides: 2009 field trials

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Control of grape powdery mildew with synthetic, biological, and organic fungicides: 2009 field trials

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Report Summary

Powdery mildew is an economically-important pathogen of grapes worldwide. This report details the findings of our annual powdery mildew fungicide trials on grapevine cultivar Chardonnay (*Vitis vinifera*). The trials were conducted at Herzog Ranch, near Courtland, California in 2009. Treatments were placed in five adjacent trials in the vineyard. Spraying commenced in mid April, shortly after a heavy rainfall event that likely promoted the release of powdery mildew (*Uncinula necator*) ascospores from overwintering chasmothecia. Spraying was completed in mid July and treatments were evaluated for disease incidence and severity on 21 July 2009, at about the beginning of veraison.

Trial I consisted of IR-4-funded biofungicide research that focused on two products: caprylic acid (a novel control agent in current development) and Actinovate (a registered product containing the bacterium *Streptomyces lydicus* WYEC106). Trials II-V included various fungicide products (either currently registered or in various stages of product development) including strobilurins, demethylase inhibitors, oils, and other materials. Spray frequencies varied from weekly applications to 21 day intervals.

Temperatures were mild during much of the 2009 growing season, providing optimal conditions for the asexual reproduction and dispersal of powdery mildew. Risk index data was high from about mid-May through the rest of the evaluation period and the pathogen quickly colonized leaves. Disease pressure was higher than in similar trials conducted in 2007 or 2008. By mid-June, heavy to severe mildew was evident on untreated clusters.

Treatment performances varied widely. Biological fungicides generally reduced disease severity, but were more effective when used in a combination program with synthetic materials. As a stand-alone product, caprylic acid was most effective when applied weekly at a concentration of 0.3% (v/v). At a concentration of 0.5% it consistently showed phytotoxic effects on berries. A few organic materials performed well, lowering disease severity to <10%: paraffinic oil + Foliar Supreme (sulfur + nutrient cocktail) and two types of fertilizers alternated with trifloxystrobin. Among synthetic products, difenoconzaole + cyprodinil, flutriafol, fluopyram, fluopyram + tebuconazole, quinoxyfen + alcohol ethoxylate (an adjuvant), various GWN4617 treatments, picoxystrobin, penthiopyrad, boscalid + pyraclostrobin alternated with triflumizole, and metrafenone gave good to excellent control of disease severity on fruit. These trials easily separate highly effective materials from those which give only moderate control of powdery mildew, however long-term assessment of treatment efficacy is best evaluated with experiments conducted at multiple locations, across several growing seasons, and on multiple grape cultivars.

Materials and Methods

A. Experimental design

Trial I: IR-4 biofungicide treatments

Experimental design	Complete randomized design with 6 replicates.		
Experimental unit	2 adjacent vines = 1 plot		
Plot area	154 ft^2 (row spacing = 11 ft, vine spacing = 7 ft)		
Area/treatment	924 ft^2 (6 reps. = 1 treatment)	Area/treatment	0.0212 acre/treatment
Volume water/acre	100 gallons (pre-bloom in mid-April), = 2.1 gallons/6 replicates 150 gallons (pre-bloom to pea-sized berries, late April - early June), = 3.2 gallons/6 reps 200 gallons (late season), = 4.2 gallons/6 reps		
Application method	Handgun sprayers (attached to Nifty Fifty brand 25 or 50 gallon sprayers).		

Trials II-V: Synthetic and organic treatments

Experimental design	Complete randomized design with 5 replicates.		
Experimental unit	2 adjacent vines = 1 plot		
Plot area	154 ft^2 (row spacing = 11 ft, vine spacing = 7 ft)		
Area/treatment	770 ft^2 (5 reps. = 1 treatment)	Area/treatment	0.0177 acre/treatment
Volume water/acre	100 gallons (pre-bloom in mid-April), = 1.8 gallons/5 replicates 150 gallons (pre-bloom to pea-sized berries, late April - early June), = 2.7 gallons/5 reps 200 gallons (late season), = 3.5 gallons/5 reps		
Application method	Handgun sprayers (attached to Nifty Fifty brand 25 or 50 gallon 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.

Trial I

Treatment[1]	Active ingredient(s)	Flag	Frequency (days)	Application rate (per acre)	FP[2]/6 replicates
Unsprayed control	none	BKS	none	none	none
Water control	water	RS	7	150 gallons then 200 gallons	3.2 gal (at 150 gal) 4.2 gal (at 200 gal)
AMV-4024	caprylic acid	GD	7	0.3% (v/v)	36 ml (at 150 gal) 48 ml (at 200 gal)
AMV-4024	caprylic acid	YKC	14	0.5% (v/v)	61 ml (at 150 gal) 81 ml (at 200 gal)
AMV-4024	caprylic acid	GS	21	0.5% (v/v)	61 ml (at 150 gal) 81 ml (at 200 gal)
AMV-4024 alt[3] Actinovate	caprylic acid, *Streptomyces lydicus*	K	14 alt 7	0.5% (v/v) alt 12 oz	61 ml (at 150 gal) 81 ml (at 200 gal) alt 7.2 g
JMS Stylet-oil alt AMV-4024	paraffinic oil, caprylic acid	KD	14	1% (v/v) alt 0.5% (v/v)	121 ml (at 150 gal) 161 ml (at 200 gal) alt 61 ml (at 150 gal) 81 ml (at 200 gal)
Flint alt AMV-4024	trifloxystrobin, caprylic acid	KS	21 alt 14	2 oz alt 0.5% (v/v)	1.2 g alt 61 ml (at 150 gal) 81 ml (at 200 gal)
Quintec alt AMV-4024	quinoxyfen, caprylic acid	O	21 alt 14	6.6 fl oz alt 0.5% (v/v)	4.1 ml alt 61 ml (at 150 gal) 81 ml (at 200 gal)
Flint	trifloxystrobin	OD	21	2 oz	1.2 g
Actinovate	*Streptomyces lydicus*	OKS	7	12 oz	7.2 g
Serenade MAX	*Bacillus subtilis*	YS	7	32 oz	19.2 g
Actinovate alt Serenade MAX	*Streptomyces lydicus, Bacillus subtilis*	Pu	7	12 oz alt 32 oz	7.2 g 19.2 g
JMS Stylet-oil	paraffinic oil	RD	14	1% (v/v)	121 ml (at 150 gal) 161 ml (at 200 gal)
JMS Stylet-oil alt Actinovate	paraffinic oil, *Streptomyces lydicus*	RKC	14 alt 7	1% (v/v) alt 12 oz	121 ml (at 150 gal) 161 ml (200 gal) alt 7.2 g
Whey	whey	RKD	7	6 lb	57.7 g
Actinovate + Whey	*Streptomyces lydicus* & whey	RKS	7	12 oz + 6 lb	7.2 g + 57.7 g
Flint alt Actinovate AG	trifloxystrobin, *Streptomyces lydicus*	W	21 alt 7	2 oz alt 12 oz	1.2 g alt 7.2 g
Flint alt Quintec	trifloxystrobin, quinoxyfen	YC	21	2 oz alt 6.6 fl oz	1.2 g alt 4.1 ml
Kumulus	sulfur	YKS	14	6 lb	57.7 g
Flint alt Companion	trifloxystrobin, *Bacillus subtilis*	YRD	21 alt 7	2 oz alt 3 qt	1.2 g alt 60 ml

[1] On April 15, Flint was applied at approximately 2 oz/acre in 100 gallons water/acre on all treatments except the unsprayed control. Vines showed no canopy at this stage (shoots were typically only a few dm length). [2] FP = formulated product. [3] alt = alternated with.

Trial II

Treatment[1]	Active ingredient(s)	Flag	Frequency (days)	Application rate (per acre)	FP[2]/5 replicates
Unsprayed control	none	BD	none	none	none
Quintec alt[3] Flint	quinoxyfen, trifloxystrobin	BS	21	6.6 fl oz alt 2 oz	3.5 ml alt 1.0 g
Inspire Super (2x) alt Flint	difenoconazole + cyprodinil, trifloxystrobin	G	14	14 fl oz (2x) alt 2 oz	7.3 ml (2x) alt 1.0 g
Inspire Super (2x) alt Flint	difenoconazole + cyprodinil, trifloxystrobin	GKD	14	20 fl oz (2x) alt 2 oz	10.5 ml (2x) alt 1.0 g
Inspire Super (2x) alt Flint	difenoconazole + cyprodinil, trifloxystrobin	GS	21	20 fl oz (2x) alt 2 oz	10.5 ml (2x) alt 1.0 g
Inspire Super (2x) alt Flint	difenoconazole + cyprodinil, trifloxystrobin	KS	14-21 (RI)	20 fl oz (2x) alt 2 oz	10.5 ml (2x) alt 1.0 g
Regalia + NuFilm P	*Reynoutria sachilinensis* extract	OC	7	0.5% (v/v) + 0.02% (v/v)	51 ml (at 150 gal) 68 ml (at 200 gal) + 2.0 ml (at 150 gal) 2.7 ml (at 200 gal)
Topguard	flutriafol	OD	14	5 fl oz	2.6 ml
Topguard	flutriafol	OKS	14	8 fl oz	4.2 ml
Topguard	flutriafol	OS	14	10 fl oz	5.2 ml
Topguard	flutriafol	OYS	14	28 fl oz	14.7 ml
Phyton 016-B	copper sulfate pentrahydrate	RC	14	40 fl oz	20.9 ml
OM-1 (JMS Stylet-oil with 1 % adjuvant)	paraffinic oil	RD	14	2% (v/v)	204 ml (at 150 gal) 272 ml (at 200 gal)
OM-2 (JMS Stylet-oil with 2 % adjuvant)	paraffinic oil	RKC	14	2% (v/v)	204 ml (at 150 gal) 272 ml (at 200 gal)
OM-2 + Foliar Supreme	paraffinic oil, sulfur + potash + phosphoric acid	RKS	14	2% (v/v) + 80 fl oz	204 ml (at 150 gal) 272 ml (at 200 gal) + 42 ml
SilverDYNE	silver colloid	Pu	14	0.015% (v/v)	1.0 ml (at 100 gal) 1.5 ml (at 150 gal) 2.0 ml (at 200 gal)
SilverDYNE	silver colloid	YD	14	0.03% (v/v)	2.0 ml (at 100 gal) 3.1 ml (at 150 gal) 4.0 ml (at 200 gal)
Unicorn	sulfur + tebuconazole	YKC	14-21	2.0 lb	16.1 g
Unicorn	sulfur + tebuconazole	YRD	14-21	2.5 lb	20.1 g
Prev AM	sodium tetraborohydrate decahydrate	OKD	14	0.4% (v/v)	41 ml (at 150 gal) 54.5 ml (at 200 gal)
JMS Stylet-oil then PureSpray + Champion (2x) then PureSpray	paraffinic oil, petroleum oil, copper hydroxide	YS	14	1% then 1% (v/v) + 2 lb then 1% (v/v)	102 ml (at 150 gal) then 102 ml + 16.1 g then 102 ml (at 150 gal) 136 ml (at 200 gal)

[1] On April 15, Pristine was applied at approximately 8 oz/acre in 100 gallons water/acre on all treatments except the unsprayed controls, Inspire Super treatments, and both SilverDYNE treatments. Vines showed no canopy at this stage (typically a few dm length). [2]FP = formulated product.
[3]alt = alternated with.

Trial III

Treatment[1]	Active ingredient(s)	Flag	Frequency (days)	Application rate (per acre)	FP[2]/5 replicates
Unsprayed control	none	BKS	none	none	none
Adament alt[3] Quintec	trifloxystrobin + tebuconazole & quinoxyfen	GD	21	4 oz alt 6.6 fl oz	2.0 g 3.5 ml
USF2015	unknown	GKD	21	5 fl oz	2.6 ml
USF2017	unknown	GS	21	6 fl oz	3.1 ml
USF2017 alt Flint	unknown, trifloxystrobin	K	21	6 fl oz 2 oz	3.1 ml 1.0 g
MicroThiol	sulfur	KC	14	5 lb	40.1 g
MicroThiol + Vintre	sulfur, alcohol ethoxylate	KD	14	3 lb 0.25% (v/v)	24.1 g + 25.5 ml (at 150 gal) 34 ml (at 200 gal)
MicroThiol + Vintre	sulfur & alcohol ethoxylate	KS	14	5 lb 0.25% (v/v)	40.1 g + 25.5 ml (at 150 gal) 34 ml (at 200 gal)
Quintec	quinoxyfen	O	14	4 fl oz	2.1 ml
Quintec + Vintre	quinoxyfen, alcohol ethoxylate	OD	14	4 fl oz 0.25% (v/v)	2.1 ml + 25.5 ml (at 150 gal) 34 ml (at 200 gal)
Flint	trifloxystrobin	OKS	14	2 oz	1.0 g
Flint + Vintre	trifloxystrobin, alcohol ethoxylate	OS	14	2 oz + 0.25% (v/v)	1.0 g + 25.5 ml (at 150 gal) 34 ml (at 200 gal)
Vintre	alcohol ethoxylate	Pu	14	0.25% (v/v)	25.5 ml (at 150 gal) 34 ml (at 200 gal)
Nutrol (KeeP) + Hi Wett + Kumulus	fertilizer, sulfur	RC	14	7 lb + 2 fl oz + 1.5 lb	56.2 g + 1.0 ml + 12.0 g
Nutrol (KeeP) + Hi Wett alt Flint	fertilizer, trifloxystrobin	RD	14	10 lb + 2 fl oz alt 2 oz	80.3 g + 1.0 ml alt 1.0 g
HiPeak + Hi Wett + Kumulus	potassium phosphate salts, sulfur	RKC	14	7 lb + 2 fl oz + 1.5 lb	56.2 g + 1.0 ml + 12.0 g
HiPeak fertilizer + Hi Wett alt Flint	potassium phosphate salts, trifloxystrobin	RKD	14	10 lb + 2 fl oz alt 2 oz	80.3 g + 1.0 ml alt 1.0 g
GWN-4617	unknown	RS	10-14 RI	3.4 fl oz	1.8 ml
GWN-4617	unknown	W	14-21 RI	3.4 fl oz	1.8 ml
GWN-4617	unknown	YC	21	3.4 fl oz	1.8 ml
GWN-4617 (3x) Pristine (1x) then Vintage (1x) Flint (1x)	unknown, pyraclostrobin + boscalid, fenarimol, trifloxystrobin	YKC	14 then 21 then 14 then 21	3.4 fl oz then 10.5 oz then 5 fl oz then 2 oz	1.8 ml then 5.3 g then 2.6 ml then 1.0 g
Pristine (1x) then GWN-4617 (3x) then Vintage (1x) then Flint (1x)	pyraclostrobin + boscalid, unknown, fenarimol, trifloxystrobin	YKS	21 then 14 then 14 then 21	10.5 oz 3.4 fl oz then 5 fl oz then 2 oz	5.3 g then 1.8 ml then 2.6 ml then 1.0 g
Pristine (1x) then Vintage (1x) then Flint (1x) then GWN-4617 (3x)	pyraclostrobin + boscalid, fenarimol, trifloxystrobin, unknown	YRD	21 then 14 then 21 then 14	10.5 oz then 5 fl oz then 2 oz then 3.4 fl oz	5.3 g then 2.6 ml then 1.0 g then 1.8 ml
GWN-4617 alt Vintage	unknown alt fenarimol	YRS	14	3.4 fl oz alt 5 fl oz	1.8 ml alt 2.6 ml

[1] On April 15-16, approximately 4-8 oz/acre of Pristine was applied in about 50-100 gallons/acre on all treatments except the unsprayed control. Vines showed no canopy at this stage (typically a few dm length). Treatments OD, OKS, and OS were accidentally treated with Topguard on 26 May, but they were rinsed with water on the same day; correct products were applied the next day. [2]FP = formulated product. [3]alt = alternated with.

Trial IV

Treatment[1]	Active ingredient(s)	Flag	Frequency (days)	Application rate (per acre)	FP[2]/5 replicates
Unsprayed control	none	BD	none	none	none
Quintec + Sylgard 309	quinoxyfen, polysiloxane	BS	21	6.6 fl oz + 0.03% (v/v)	3.5 ml + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal)
BAS560 03F + Sylgard 309	metrafenone, polysiloxane	G	14	10.24 fl oz + 0.03% (v/v)	5.4 ml + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal)
BAS560 03F + Sylgard 309	metrafenone, polysiloxane	GKD	21	15.36 fl oz + 0.03% (v/v)	8.0 ml + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal)
Pristine + Sylgard 309	pyraclostrobin + boscalid, polysiloxane	GS	21	10.5 oz + 0.03% (v/v)	5.3 g + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal)
Sovran + Sylgard 309	kresoxim methyl, polysiloxane	K	21	5 oz + 0.03% (v/v)	2.5 g + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal)
Pristine	pyraclostrobin + boscalid	KD	14	8 oz	4.0 g
YT669	picoxystrobin	KS	14	12 fl oz	6.3 ml
LEM17 SC	penthiopyrad	O	14	20 fl oz	10.5 ml
LEM17 SC	penthiopyrad	OD	14	24 fl oz	12.6 ml
LEM17 SC	penthiopyrad	OKS	21	24 fl oz	12.6 ml
LEM17 SC + Kumulus	penthiopyrad,sulfur	OS	14	14 fl oz + 6 lb	7.3 ml + 48.2 g
LEM17 SC + Kumulus	penthiopyrad, sulfur	OYS	14	20 fl oz + 6 lb	10.5 ml + 48.2 g
LEM17 SC + Kumulus	penthiopyrad, sulfur	Pu	21	20 fl oz + 6 lb	10.5 ml + 48.2 g
LEM17 SC + Kumulus	penthiopyrad, sulfur	RC	21	24 fl oz + 6 lb	12.6 ml + 48.2 g
Mettle + Sylgard 309	tetraconazole, polysiloxane	RD	21	5 fl oz 0.03% (v/v)	2.6 ml + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal)
Timorex Gold	tea tree oil	RKC	14	0.5% (v/v)	51 ml (at 150 gal) 68 ml (at 200 gal)
Timorex Gold	tea tree oil	RKD	14	0.75% (v/v)	77 ml (at 150 gal) 103 ml (at 200 gal)
Pristine alt[3] Timorex Gold	pyraclostrobin + boscalid, tea tree oil	RKS	14	8 oz alt 0.5 %	4.0 g alt 51 ml (at 150 gal) 68 ml (at 200 gal)
Viticure	triflumizole	RS	21	6 fl oz	3.1 ml
Viticure	triflumizole	W	21	8 fl oz	4.2 ml
Quintec alt Viticure	quinoxyfen alt triflumizole	YC	21	6.6 fl oz alt 8 fl oz	3.5 ml alt 4.2 ml
Flint then Flint + Viticure	trifloxystrobin, triflumizole	YD	21	2 oz then 2 oz + 8 fl oz	1.0 g then 1.0 g + 4.2 ml
Pristine + Sylgard 309 alt Viticure	pyraclostrobin + boscalid, polysiloxane, triflumizole	YKC	21	10.5 oz + 0.03 % (v/v) alt 8 fl oz	5.3 g + 3.1 ml (at 150 gal) 4.1 ml (at 200 gal) alt 4.2 ml
Ph-D	polyoxin-D	YKS	14	6.2 oz	3.1 g
Ph-D	polyoxin-D	YS	14	12 oz	6.0 g

[1] On April 15, Pristine was applied at approximately 8 oz/acre in 100 gallons water/acre on all treatments except the unsprayed control. Vines showed no canopy at this stage (typically a few dm length). [2]FP = formulated product. [3]alt = alternated with.

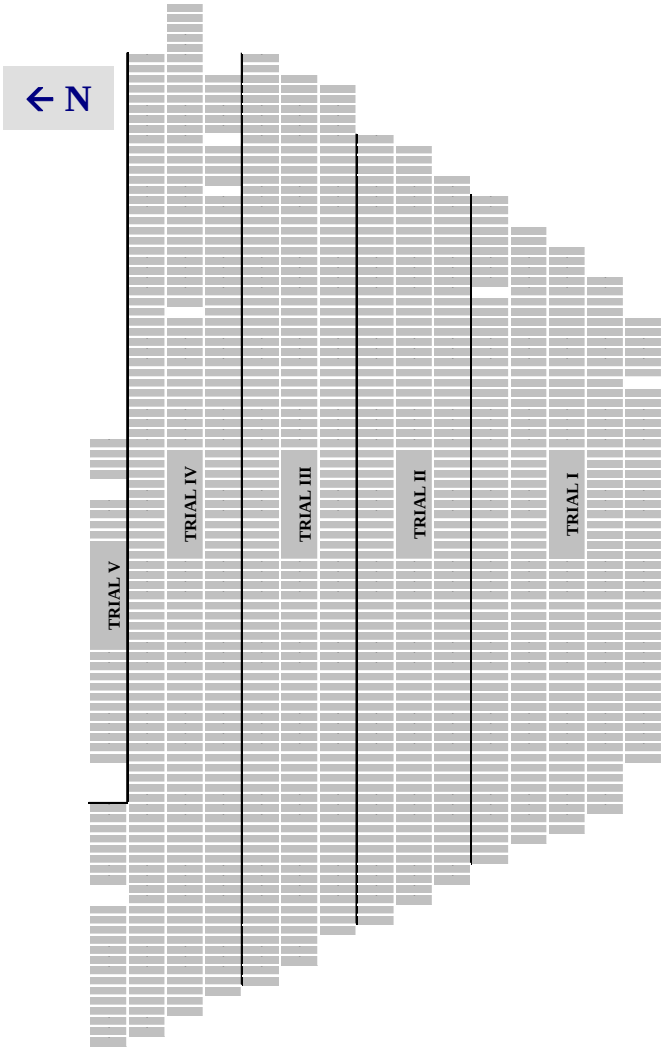
Trial V[1]

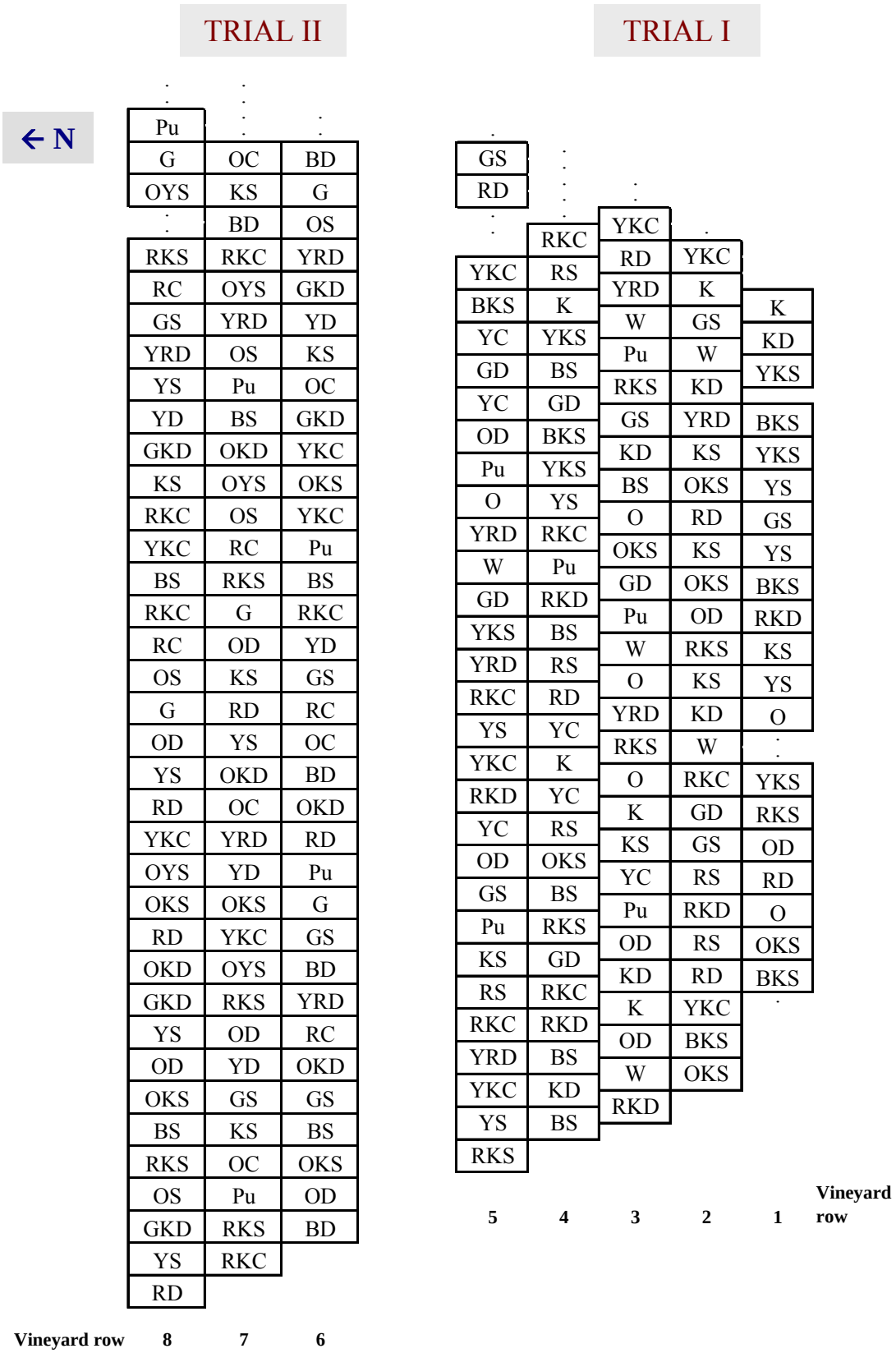
Treatment[1]	Active ingredient(s)	Flag	Frequency (days)	Application rate (per acre)	FP[2]/5 replicates
Unsprayed control	none	K+YD	none	none	none
Cueva	copper octanoate	GD	14	1% (v/v)	102 ml (at 150 gal) 136 ml (at 200 gal)
Cueva	copper octanoate	YRD	14	2% (v/v)	204 ml (at 150 gal) 272 ml (at 200 gal)

[1] This experiment was started relatively late; first applications made on 8 May 2009. [2]FP = formulated product.

C. Maps of the trials

Overview map

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RD YKC GS
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YS OD RC
OD YD OKD
OKS GS GS
BS KS BS
RKS OC OKS
OS Pu OD
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YS RKC
RD
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RD YKC
YKC RS
YRD K K
BKS K W GS KD
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O YS O RD GS
YRD RKC OKS KS YS
W Pu GD OKS BKS
GD RKD Pu OD RKD
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RKD YC K GD RKS
YC RS KS GS OD
OD OKS YC RS RD
GS BS Pu RKD O
Pu RKS OD RS OKS
KS GD KD RD BKS
RS RKC K YKC
RKC RKD OD BKS
YRD BS W OKS
YKC KD RKD
YS BS
RKS
Vineyard row 5 4 3 2 1

← N

TRIALS IV&V

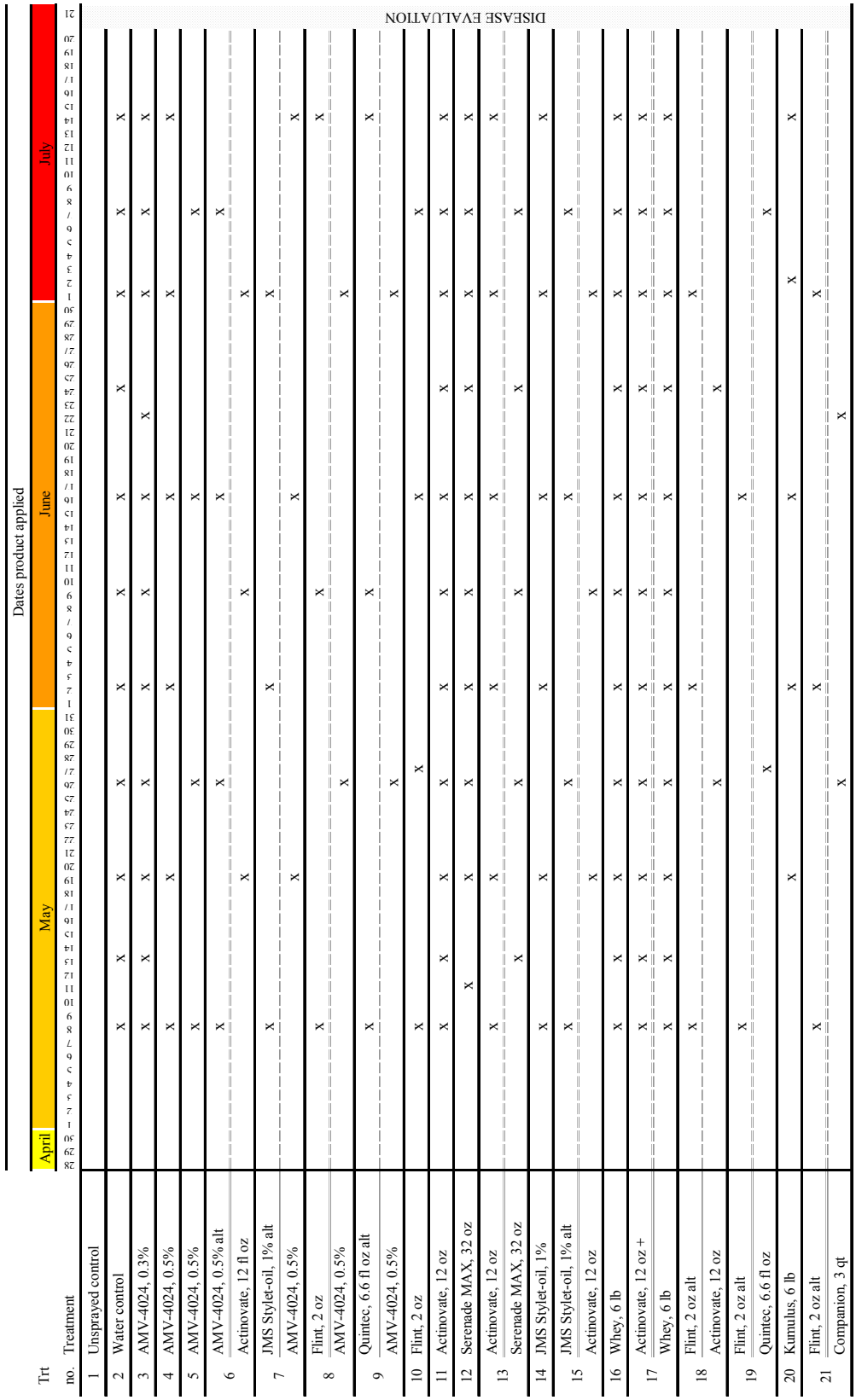
Vineyard row 15	14	13	12
:	:	Pu	:
:	:	YKS	:
:	:	O	:
:	BS	W	:
:	YC	YKS	:
:	RKS	Pu	:
:	RS	OS	:
:	OD	OYS	:
:	OS	RC	:
:	K	:	GKD
:	GS	OKS	OKS
:	YS	RD	GS
:	OS	KD	G
:	RKD	GKD	O
:	GS	W	RD
GD	RD	OYS	KS
K+YD	RKS	YKS	GKD
:	KD	RS	OYS
YRD	W	RC	OD
K+YD	O	YS	RD
YRD	KS	BD	OD
GD	BS	RKS	YC
K+YD	YS	OYS	GKD
YRD	OS	Pu	RS
K+YD	KS	YS	OD
GD	YC	RC	RS
YRD	OKS	YKC	RKS
GD	YD	KD	KS
GD	G	YC	BD
YRD	GS	KS	YKC
K+YD	BS	W	OD
:	YKC	RKS	K
*	K	YD	RKC
GKD	G	KD	O
RD	YD	BS	RKD
YKC	KD	BD	YKS
RKD	OKS	O	Pu
:	K	RKC	OKS
RC	RKC	BD	W
RKC	RC	YD	RKD
RS	K	YC	G
OS	G	RKC	YKS
YD	Pu	YKC	OYS
RKD	BD	GS	
BS	YS		

TRIAL III

Vineyard row 11	10	9
:	RD	:
KS	GKD	:
:	GS	:
RKC	O	W
RC	YKC	RS
W	GD	KD
KD	OS	OKS
Pu	KS	RKD
BKS	BKS	YRS
OS	Pu	YRD
YKC	RD	YC
O	YKS	O
YC	OKS	RD
OD	RS	YKS
KS	K	GS
W	Pu	GKD
KC	O	RS
OS	YRS	OD
K	W	GD
KD	KC	KD
GS	RC	K
YKC	YC	BKS
YKS	W	RC
OD	KC	GD
OS	RKC	GKD
RKC	RD	RKD
YRD	YRS	KC
GD	YC	YC
RS	BKS	GKD
RC	RKC	YRD
YKS	RD	GS
KS	Pu	OD
GKD	BKS	YKC
RKD	OKS	YKS
YKC	YRD	OKS
K	OD	K
O	OS	OKS
Pu	RC	KD
KC	RKD	RS
GD	KS	YRS
YRS	YRD	
RKD	RKC	
GS		

D. Application history

TRIAL I



Trt no.	Treatment
1	Unsprayed control
2	Water control
3	AMV-4024, 0.3%
4	AMV-4024, 0.5%
5	AMV-4024, 0.5%
6	AMV-4024, 0.5% alt Actinovate, 12 fl oz
7	JMS Stylet-oil, 1% alt AMV-4024, 0.5%
8	Flint, 2 oz AMV-4024, 0.5%
9	Quintec, 6.6 fl oz alt AMV-4024, 0.5%
10	Flint, 2 oz
11	Actinovate, 12 oz
12	Serenade MAX, 32 oz
13	Actinovate, 12 oz Serenade MAX, 32 oz
14	JMS Stylet-oil, 1%
15	JMS Stylet-oil, 1% alt Actinovate, 12 oz
16	Whey, 6 lb
17	Actinovate, 12 oz + Whey, 6 lb
18	Flint, 2 oz alt Actinovate, 12 oz
19	Flint, 2 oz alt Quintec, 6.6 fl oz
20	Kumulus, 6 lb
21	Flint, 2 oz alt Companion, 3 qt

Grape powdery mildew research trials, 2009. Department of Plant Pathology, University of California, Davis.

TRIAL II

Trt no.	Treatment	Dates product applied: April 28 29 30	May 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	June 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	July 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	DISEASE EVALUATION
1	Unsprayed control					
2	Quintec, 6.6 fl oz alt	x		x		
	Flint, 2 oz		x		x	
3	Inspire Super, 14 fl oz alt	x		x	x	
	Flint, 2 oz		x		x	
4	Inspire Super, 20 fl oz alt	x		x	x	
	Flint, 2 oz		x		x	
5	Inspire Super, 20 fl oz alt		x		x	
	Flint, 2 oz			x	x	
6	Inspire Super, 20 fl oz alt		x	x		
	Flint 20 oz			x	x	
7	Regalia, 0.5 % +	x	x x x x x	x x x x x	x x x	
	NuFilm P, 0.02%	x	x x x x x	x x x x x	x x x	
8	Topguard, 5 fl oz	x	x	x	x	
9	Topguard, 8 fl oz	x	x	x	x	
10	Topguard, 10 fl oz	x	x	x	x	
11	Topguard, 28 fl oz	x	x	x	x	
12	Phyton, 40 fl oz	x	x	x	x	
13	OM-1, 2%	x	x	x	x	
14	OM-2, 2%	x	x	x	x	
15	OM-2, 2% +	x	x	x	x	
	Foliar Supreme, 80 fl oz	x	x	x	x	
16	SilverDYNE, 0.015%	x	x	x	x	
17	SilverDYNE, 0.03%	x	x	x	x	
18	Unicorn, 2.0 lb	x	x	x	x x	
19	Unicorn, 2.5 lb	x	x	x	x x	
20	Prev AM, 0.4%	x	x	x	x	
21	JMS Stylet-oil, 1% then	x				
	PureSpray, 1% +		x	x	x	
	Champion		x	x		

TRIAL III

Dates product applied (only the dates with at least one application are shown as columns; July 21 = DISEASE EVALUATION)

Trt no.	Treatment	Apr 28	Apr 30	May 8	May 12	May 13	May 19	May 20	May 26	May 27	Jun 2	Jun 9	Jun 10	Jun 16	Jun 22	Jun 24	Jul 1	Jul 7	Jul 8	Jul 14	Jul 21 DISEASE EVALUATION
1	Unsprayed control																				
2	Quintec 6.6 fl oz (3x)	x						x									x				
	Adament, 4 oz (1x)												x								
3	USF2015A, 5 fl oz	x					x						x				x				
4	USF2017B, 6 fl oz	x					x						x				x				
5	USF2017B, 6 fl oz alt	x											x								
	Flint, 2 oz						x										x				
6	MicroThiol, 5 lb		x		x				x				x		x			x			
7	MicroThiol, 5 lb +		x		x				x				x		x			x			
	Vintre, 0.25%		x		x				x				x		x			x			
8	MicroThiol, 5 lb +		x		x				x				x		x			x			
	Vintre, 0.25%		x		x				x				x		x			x			
9	Quintec, 4 fl oz	x				x				x		x			x			x			
10	Quintec, 4 fl oz +	x				x				x		x			x			x			
	Vintre, 0.25%	x				x				x		x			x			x			
11	Flint, 2 oz	x				x				x			x		x			x			
12	Flint, 2 oz +	x				x				x		x			x			x			
	Vintre, 0.25%	x				x				x		x			x			x			
13	Vintre, 0.25%	x			x					x		x			x			x			
14	Nutrol, 7 lb +		x			x			x				x			x			x		
	Hi Wett, 2 fl oz +		x			x			x				x			x			x		
	Kumulus, 1.5 lb		x			x			x				x			x			x		
15	Nutrol, 10 lb +	x							x							x					
	Hi Wett, 2 fl oz alt	x							x							x					
	Flint, 2 oz					x							x					x			
16	Hi Peak 7 lb +		x			x			x				x			x			x		
	Hi Wett, 2 fl oz +		x			x			x				x			x			x		
	Kumulus, 1.5 lb		x			x			x				x			x			x		
17	HiPeak, 10 lb +	x							x							x					
	Hi Wett, 2 fl oz alt	x							x							x					
	Flint, 2 oz					x							x					x			
18	GWN-4617, 3.4 fl oz	x		x			x			x			x		x		x			x	
19	GWN-4617, 3.4 fl oz	x			x				x				x		x			x			
20	GWN-4617, 3.4 fl oz	x					x						x				x				
21	GWN-4617, 3.4 fl oz then	x			x				x												
	Pristine, 10.5 oz then												x								
	Vintage, 5 fl oz then																x				
	Flint, 2 oz																			x	
22	Pristine, 10.5 oz then		x																		
	GWN-4617, 3.4 fl oz then						x				x			x							
	Vintage, 5 fl oz then																x				
	Flint, 2 oz																			x	
23	Pristine, 10.5 oz then		x																		
	Vintage, 5 fl oz then						x														
	Flint, 2 oz then										x										
	GWN-4617, 3.4 fl oz														x			x			
24	GWN-4617, 3.4 fl oz then	x							x						x						
	Vintage, 5 fl oz				x								x					x			

TRIAL IV

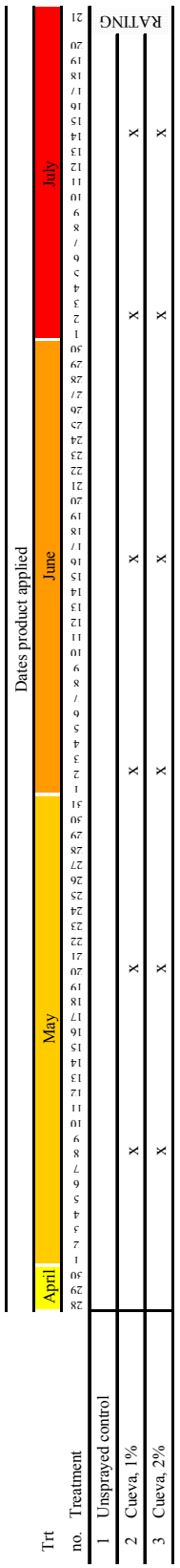
Dates product applied

Trt no.	Treatment	April			May																														
		28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	Unsprayed control																																		
2	Quintec, 6.6 fl oz +			x																				x											
	Sylgard 309, 0.03%			x																				x											
3	BAS560 03F, 15.36 fl oz +			x												x														x					
	Sylgard 309, 0.03%			x												x														x					
4	BAS560 03F, 15.36 fl oz +			x																				x											
	Sylgard 309, 0.03%			x																				x											
5	Pristine, 10.5 oz +			x																				x											
	Sylgard 309, 0.03%			x																				x											
6	Sovran, 5 oz +			x																				x											
	Sylgard 309, 0.03%			x																				x											
7	Pristine, 8 oz			x												x													x						
8	YT 669, 12 fl oz			x												x														x					
9	LEM17, 20 fl oz			x												x														x					
10	LEM17, 24 fl oz			x												x														x					
11	LEM17, 24 fl oz			x																			x												
12	LEM17, 14 fl oz +			x												x														x					
	Kumulus 6 lb			x												x														x					
13	LEM17, 20 fl oz +			x												x														x					
	Kumulus 6 lb			x												x														x					
14	LEM17, 20 fl oz +			x																			x												
	Kumulus 6 lb			x																			x												
15	LEM17, 24 fl oz +			x																			x												
	Kumulus, 6 lb			x																			x												
16	Mettle, 5 fl oz +			x																				x											
	Sylgard 309, 0.03%			x																				x											
17	Timorex Gold, 0.5%			x												x														x					
18	Timorex Gold, 0.75%			x												x														x					
19	Pristine 8 oz, alt			x																									x						
	Timorex Gold, 0.5%															x																			
20	Viticure, 6 fl oz	x																					x												
21	Viticure, 8 fl oz																						x												
22	Quintec, 6.6 fl oz alt	x																																	
	Viticure, 8 fl oz																						x												
23	Flint, 2 oz then	x																																	
	Flint, 2 oz +																						x												
	Viticure, 8 fl oz																						x												
24	Pristine, 10.5 oz +			x																															
	Sylgard 309 alt			x																															
	Viticure, 8 fl oz																						x												
25	Ph-D, 6.2 oz			x												x														x					
26	Ph-D, 12 oz			x												x														x					

Trt no.	Treatment	June																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Unsprayed control																														
2	Quintec, 6.6 fl oz +									x																					
	Sylgard 309, 0.03%									x																					
3	BAS560 03F, 15.36 fl oz +									x													x								
	Sylgard 309, 0.03%									x													x								
4	BAS560 03F, 15.36 fl oz +									x																					
	Sylgard 309, 0.03%									x																					
5	Pristine, 10.5 oz +										x																				
	Sylgard 309, 0.03%										x																				
6	Sovran, 5 oz +									x																					
	Sylgard 309, 0.03%									x																					
7	Pristine, 8 oz										x												x								
8	YT 669, 12 fl oz									x													x								
9	LEM17, 20 fl oz									x													x								
10	LEM17, 24 fl oz									x													x								
11	LEM17, 24 fl oz									x																					
12	LEM17, 14 fl oz +									x													x								
	Kumulus 6 lb									x													x								
13	LEM17, 20 fl oz +									x													x								
	Kumulus 6 lb									x													x								
14	LEM17, 20 fl oz +									x																					
	Kumulus 6 lb									x																					
15	LEM17, 24 fl oz +									x																					
	Kumulus, 6 lb									x																					
16	Mettle, 5 fl oz +									x																					
	Sylgard 309, 0.03%									x																					
17	Timorex Gold, 0.5%										x												x								
18	Timorex Gold, 0.75%										x												x								
19	Pristine 8 oz, alt																						x								
	Timorex Gold, 0.5%										x																				
20	Viticure, 6 fl oz									x																					
21	Viticure, 8 fl oz									x																					
22	Quintec, 6.6 fl oz alt									x																					
	Viticure, 8 fl oz																														
23	Flint, 2 oz then																														
	Flint, 2 oz +									x																					
	Viticure, 8 fl oz									x																					
24	Pristine, 10.5 oz +										x																				
	Sylgard 309 alt										x																				
	Viticure, 8 fl oz																														
25	Ph-D, 6.2 oz									x													x								
26	Ph-D, 12 oz									x													x								

Trt no.	Treatment	July																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21 DISEASE EVALUATION
1	Unsprayed control																					
2	Quintec, 6.6 fl oz +	x																				
	Sylgard 309, 0.03%	x																				
3	BAS560 03F, 15.36 fl oz +							x														
	Sylgard 309, 0.03%							x														
4	BAS560 03F, 15.36 fl oz +		x																			
	Sylgard 309, 0.03%		x																			
5	Pristine, 10.5 oz +		x																			
	Sylgard 309, 0.03%		x																			
6	Sovran, 5 oz +		x																			
	Sylgard 309, 0.03%		x																			
7	Pristine, 8 oz								x													
8	YT 669, 12 fl oz							x														
9	LEM17, 20 fl oz								x													
10	LEM17, 24 fl oz								x													
11	LEM17, 24 fl oz		x																			
12	LEM17, 14 fl oz +								x													
	Kumulus 6 lb								x													
13	LEM17, 20 fl oz +								x													
	Kumulus 6 lb								x													
14	LEM17, 20 fl oz +		x																			
	Kumulus 6 lb		x																			
15	LEM17, 24 fl oz +		x																			
	Kumulus, 6 lb		x																			
16	Mettle, 5 fl oz +		x																			
	Sylgard 309, 0.03%		x																			
17	Timorex Gold, 0.5%								x													
18	Timorex Gold, 0.75%								x													
19	Pristine 8 oz, alt																					
	Timorex Gold, 0.5%								x													
20	Viticure, 6 fl oz	x																				
21	Viticure, 8 fl oz	x																				
22	Quintec, 6.6 fl oz alt																					
	Viticure, 8 fl oz	x																				
23	Flint, 2 oz then																					
	Flint, 2 oz +	x																				
	Viticure, 8 fl oz	x																				
24	Pristine, 10.5 oz +																					
	Sylgard 309 alt																					
	Viticure, 8 fl oz	x																				
25	Ph-D, 6.2 oz								x													
26	Ph-D, 12 oz								x													

TRIAL V



Trt no.	Treatment	RATING
1	Unsprayed control	
2	Cueva, 1%	X
3	Cueva, 2%	X

E. Vine management

During the evaluation period (mid-April to mid-July), vines were irrigated one time by flooding. Sucker shoots were removed by local field personnel on approximately 28 May 2009. Leaf removal around the clusters (on only the north side of the vines) was conducted by our research group on 29 May 2009. Additional small-scale removal of leaves, suckers, and overhanging shoots was also conducted at various times during the season.

F. Data collection and statistics

Daily temperature and precipitation data were obtained from the Russell Road weather station, located close to the research site (data at http://www.ipm.ucdavis.edu). Gubler-Thomas Risk Index values were computed using data from a Metos weather station situated between trials IV and V (indicated by a * on map above).

Disease was assessed on 21 July at early veraison. Normally, 20-25 clusters were evaluated for powdery mildew incidence and severity in each plot. Incidence was defined as the proportion of clusters in a plot hosting at least some living powdery mildew. Severity was determined by estimating the percentage of berries in a cluster that were infected; the severity value of all clusters was then averaged to give a plot wide estimate of disease severity. Visual estimates of severity were made for more heavily infected clusters. However, when disease was less common, the number of infected berries per cluster was counted. This value was then converted into a percentage by dividing by the average number of berries for 4 cluster size classes (small: 65 berries/cluster; medium: 91 berries/cluster; large: 145 berries/cluster; extra-large: 198 berries/cluster). Mean incidence and severity values and standard errors were computed for each treatment and compared statistically by using Fisher's LSD test (at $\alpha = 0.10$) in SAS9.1. Trial IV showed a number of very substantial outlying plots with elevated disease, often towards the eastern end of the trial, perhaps due to poor or no spray coverage (see grayish plots on map above). These plots were removed prior to analysis.

Results

Figure 1. (A) Powdery mildew on unsprayed clusters in trial I. (B) Berry phytotoxicity due to application of AMV-2024 at 0.5 % in Trial I.

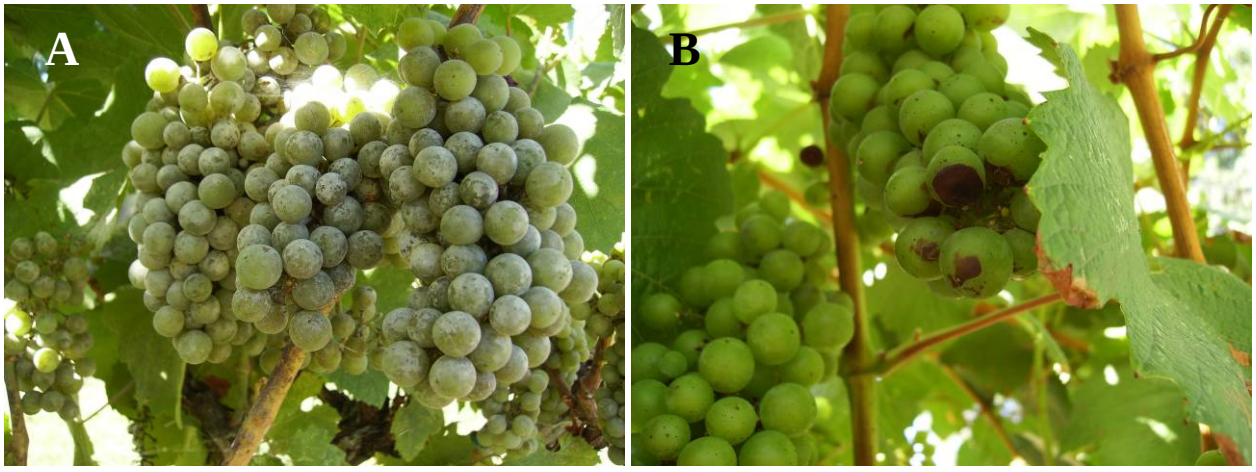


Figure 2. Weather data, powdery mildew risk index values, and disease progression in the trials from April to until disease evaluation on 21 July. (A-B) daily records of precipitation and temperatures for the CIMIS Russell Road weather station (http://wwwcimis.water.ca.gov/). (C) Powdery mildew risk index, calculated by an on site Metos weather station. (D) Powdery mildew incidence on the upper surface of untreated leaves collected every 1-2 weeks from the general research area (means ± 1 standard deviation; n=6).

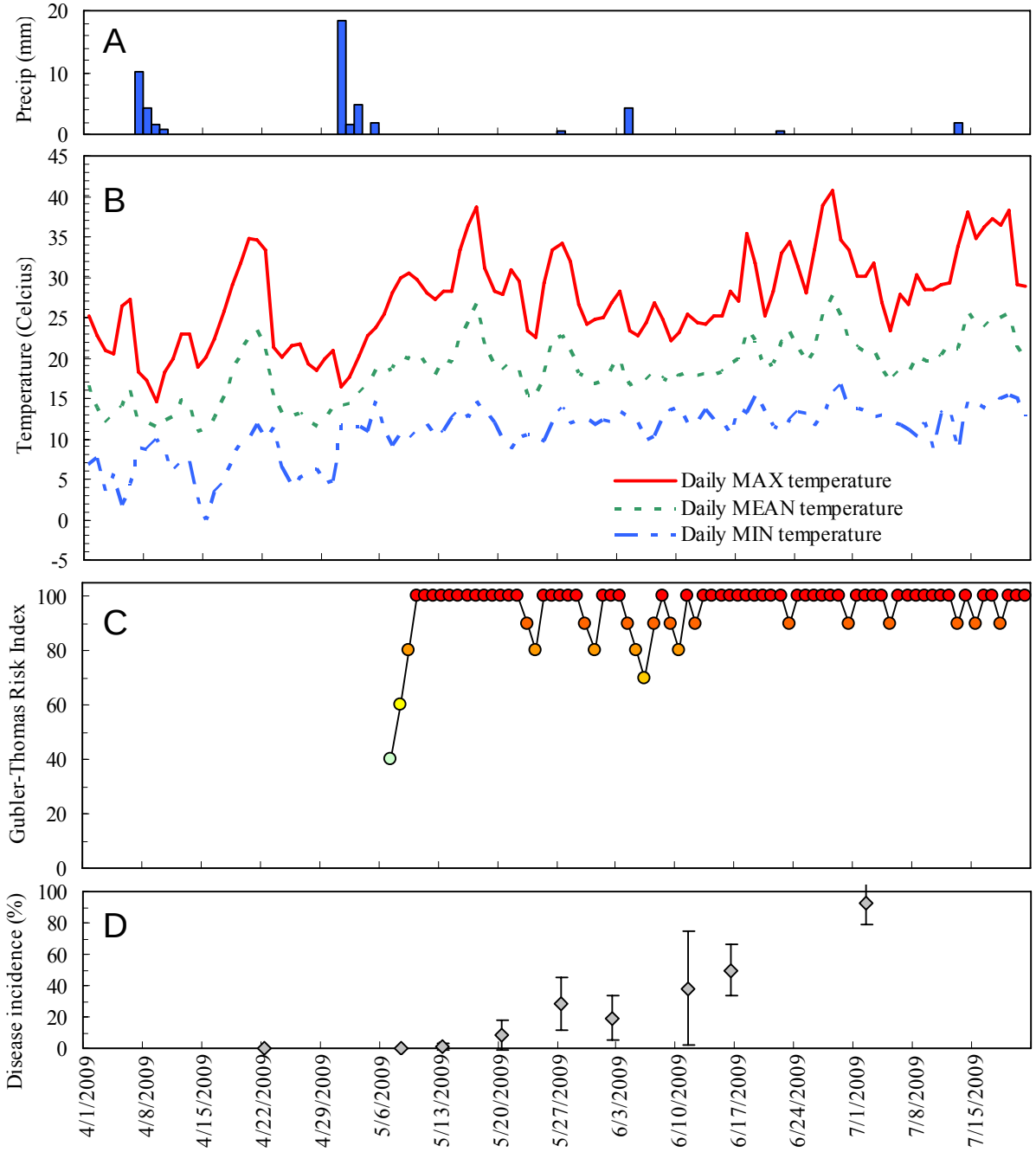


Table 1. Disease severity and incidence in trial I treatments (means ± 1 SE; n = 6). Product names are followed by amount applied (per acre) and the frequency of application. Treatment means with the different letters are significantly different according to Fisher's LSD test at α = 0.10; alt = alternated with.

Treatment	Disease Severity (%)		Disease Incidence (%)	
Flint, 2 oz, 21 d alt Companion, 3 qt, 7 d	8.0 ± 3.7	i	75.5 ± 8.2	f
Flint, 2 oz, 21 d alt Quintec, 6.6 fl oz, 21 d	8.8 ± 3.0	hi	78.2 ± 8.3	f
Flint, 2 oz, 21 alt AMV-4024, 0.5%, 14 d	9.1 ± 1.3	hi	91.2 ± 3.5	abcde
Quintec, 6.6 fl oz, 21 d alt AMV-4024, 0.5%, 14 d	9.6 ± 2.3	hi	84.8 ± 5.8	cdef
Flint, 2 oz, 21 d	12.6 ± 4.2	hi	86.8 ± 6.1	bcdef
Flint, 2 oz, 21 d alt Actinovate, 12 oz, 7 d	13.4 ± 4.2	ghi	82.5 ± 9.3	def
AMV-4024, 0.3%, 7 d	17.2 ± 4.7	fghi	81.0 ± 9.1	ef
Actinovate, 12 oz, 7 d alt Serenade MAX, 32 oz, 7 d	23.4 ± 6.9	efghi	94.8 ± 2.0	abc
Actinovate, 12 oz + Whey, 6 lb, 7 d	24.2 ± 7.5	defgh	93.5 ± 4.3	abcd
Kumulus, 6 lb, 14 d	29.0 ± 8.3	cdefg	96.7 ± 3.3	ab
Serenade MAX, 32 oz, 7 d	30.4 ± 5.6	bcdef	98.7 ± 1.3	a
Whey, 6 lb, 7 d	30.5 ± 9.5	bcdef	90.7 ± 4.9	abcde
JMS Stylet-oil, 1%, 14 d	33.8 ± 7.4	bcde	95.0 ± 3.4	abc
AMV-4024, 0.5%, 14 d	34.8 ± 6.6	bcde	100.0 ± 0.0	a
JMS Stylet-oil, 1%, 14 d alt Actinovate, 12 oz, 7 d	34.8 ± 11.0	bcde	95.3 ± 3.3	abc
JMS Stylet-oil, 1%, 14 d alt AMV-4024, 0.5%, 14 d	37.7 ± 9.8	bcde	98.3 ± 1.7	a
Actinovate, 12 oz, 7 d	39.7 ± 5.9	bcd	100.0 ± 0.0	a
AMV-4024, 0.5%, 14 d alt Actinovate, 12 oz, 7 d	41.6 ± 6.7	bc	98.3 ± 1.7	a
AMV-4024, 0.5%, 21 d	45.1 ± 7.8	b	98.7 ± 1.3	a
Water control, 7 d	45.8 ± 11.0	b	95.3 ± 4.7	abc
Unsprayed control	91.1 ± 4.6	a	100.0 ± 0.0	a

Table 2. Disease severity and incidence in trial II treatments (means ± 1 SE; n = 5). Product names are followed by amount applied (per acre) and the frequency of application. Treatment means with the different letters are significantly different according to Fisher's LSD test at α = 0.10; alt = alternated with.

Treatment	Disease Severity (%)		Disease Incidence (%)	
Inspire Super, 20 fl oz, 14 d (2x) alt Flint, 2 oz, 14 d	0.6 ± 0.3	f	18.4 ± 7.0	i
Topguard, 28 fl oz, 14 d	2.6 ± 1.0	f	34.4 ± 14.2	ghi
Topguard, 5 fl oz, 14 d	2.9 ± 1.0	f	49.6 ± 10.8	efgh
Topguard, 8 fl oz, 14 d	6.1 ± 1.8	ef	59.2 ± 14.2	def
OM-2, 2% + Foliar Supreme, 80 fl oz, 14 d	6.9 ± 3.1	ef	50.7 ± 11.9	efgh
Inspire Super, 20 fl oz, 14-21 d (2x) alt Flint, 2 oz, 14-21 d	6.9 ± 6.1	ef	32.8 ± 17.6	hi
Topguard, 10 fl oz, 14 d	12.1 ± 8.0	def	57.6 ± 14.9	defg
OM-2, 2%, 14 d	13.8 ± 6.4	def	60.8 ± 13.4	def
Inspire Super, 14 fl oz, 14 d (2x) alt Flint, 2 oz, 14 d	15.6 ± 14.9	def	41.6 ± 13.8	fghi
Quintec, 6.6 fl oz, 21 d alt Flint, 2 oz, 21 d	16.0 ± 11.3	def	68.0 ± 18.1	cde
Inspire Super, 20 fl oz, 21 d (2x) alt Flint, 2 oz, 21 d	18.2 ± 9.8	cdef	74.4 ± 9.7	bcd
Unicorn, 2.5 lb, 14-21 d	24.1 ± 3.8	cde	96.0 ± 3.1	ab
JMS Stylet-oil, 1 % then Purespray, 1%, 14 d	27.6 ± 9.9	cd	100.0 ± 0.0	a
Unicorn, 2 lb, 14-21 d	28.9 ± 9.1	bcd	90.4 ± 6.0	abc
Phyton 016-B, 40 fl oz, 14 d	36.0 ± 7.5	bc	99.2 ± 0.8	a
Regalia, 0.5% + NuFilm P, 0.02%, 7 d	37.2 ± 7.8	bc	98.4 ± 1.0	a
OM-1, 2%, 14 d	37.6 ± 15.4	bc	96.8 ± 3.2	ab
Prev AM, 0.4%, 14 d	48.2 ± 15.6	b	99.2 ± 0.8	a
SilverDYNE, 0.03%, 14 d	80.4 ± 7.2	a	100.0 ± 0.0	a
SilverDYNE, 0.015%, 14 d	88.4 ± 5.5	a	100.0 ± 0.0	a
Unsprayed control	95.8 ± 3.7	a	100.0 ± 0.0	a

Table 3. Disease severity and incidence in trial III treatments (means ± 1 SE; n = 5). Product names are followed by amount applied (per acre) and the frequency of application. Treatment means with the different letters are significantly different according to Fisher's LSD test at α = 0.10; alt = alternated with.

Treatment	Disease Severity (%)		Disease Incidence (%)	
USF2017, 6 fl oz, 21 d alt Flint 2 oz, 21 d	0.2 ± 0.1	g	10.4 ± 4.8	j
USF2017, 6 fl oz, 21 d	0.2 ± 0.1	g	7.2 ± 4.5	j
Quintec, 4 fl oz + Vintre, 0.25%, 14 d	0.6 ± 0.2	g	24.8 ± 7.5	hij
GWN-4617, 3.4 fl oz, 10-14 d	0.7 ± 0.5	g	18.4 ± 7.5	ij
GWN-4617, 3.4 fl oz, 14 d alt Vintage, 5 fl oz, 14 d	1.0 ± 0.2	g	44.8 ± 8.3	fghi
USF2015, 5 fl oz, 21 d	1.3 ± 1.1	fg	20.8 ± 13.5	ij
Pristine, 10.5 oz, 21 d then Vintage, 5 fl oz, 14 d then Flint, 2 oz, 21 d then GWN-4617, 3.4 fl oz, 14 d (2x)	1.6 ± 1.1	fg	40.0 ± 15.4	ghi
Flint, 2 oz + Vintre, 0.25%, 14 d	1.8 ± 1.7	fg	24.0 ± 17.1	hij
Quintec, 4 fl oz, 14 d	2.7 ± 1.3	fg	52.8 ± 15.6	efg
Flint, 2 oz, 14 d	3.9 ± 2.7	efg	45.6 ± 16.4	fghi
Adament, 4 oz, 21 d alt Quintec 6.6 fl oz, 21 d	4.4 ± 2.5	efg	51.2 ± 20.0	efgh
Pristine, 10.5 oz, 21 d then GWN-4617, 3.4 fl oz, 14 d (3x) then Vintage, 5 fl oz, 14 d then Flint, 2 oz	4.4 ± 1.3	efg	60.8 ± 9.2	defg
GWN-4617, 3.4 fl oz, 21 d	5.0 ± 2.5	efg	64.8 ± 8.9	cdefg
HiPeak, 10 lb + Hi Wett, 2 fl oz, 14 d alt Flint, 2 oz, 14 d	5.6 ± 3.0	efg	54.4 ± 17.5	efg
GWN-4617, 3.4 fl oz, 14-21 d	6.6 ± 3.6	efg	54.4 ± 18.5	efg
GWN-4617, 3.4 fl oz, 14 d (3x) then Pristine, 10.5 oz, 21 then Vintage, 5 fl oz, 14 d then Flint, 2 oz	6.6 ± 3.6	efg	73.6 ± 12.3	abcde
Nutrol, 10 lb + Hi Wett, 2 fl oz, 14 d alt Flint, 2 oz, 14 d	9.6 ± 5.9	defg	72.0 ± 12.1	bcdef
MicroThiol, 5 lb + Vintre 0.25%, 14 d	12.7 ± 6.7	def	67.2 ± 12.7	cdefg
Vintre, 0.25%, 14 d	14.8 ± 4.3	cde	97.6 ± 1.0	ab
HiPeak, 7 lb + Hi Wett, 2 fl oz + Kumulus, 1.5 lb, 14 d	14.9 ± 8.2	bcde	82.4 ± 7.9	abcd
MicroThiol, 3 lb + Vintre, 0.25%, 14 d	18.2 ± 7.2	bcd	90.4 ± 5.5	abc
MicroThiol, 5 lb, 14 d	25.7 ± 12.5	bc	91.2 ± 4.5	abc
Nutrol, 7 lb + Hi Wett, 2 fl oz + Kumulus, 1.5 lb, 14 d	26.3 ± 11.0	b	86.4 ± 7.5	abcd
Unsprayed control	94.5 ± 4.7	a	100.0 ± 0.0	a

Table 4. Disease severity and incidence in trial IV treatments (means ± 1 SE); plots from the end of rows 13 and 14 were removed prior to analysis (n = 3 to 5, depending on treatment). Product names are followed by amount applied (per acre) and the frequency of application. Treatment means with the different letters are significantly different according to Fisher's LSD test at α = 0.10; alt = alternated with.

Treatment	Disease Severity (%)		Disease Incidence (%)	
Pristine, 10.5 oz + Sylgard 309, 0.03%, 21 d	0.1 ± 0.0	d	5.3 ± 1.3	k
YT669, 12 fl oz, 14 d	0.1 ± 0.1	d	7.2 ± 3.4	k
LEM17, 20 fl oz, 14 d	0.7 ± 0.7	d	17.0 ± 14.4	ik
LEM17, 24 fl oz, 14 d	0.9 ± 0.3	d	28.0 ± 10.2	hijk
Pristine, 10.5 oz + Sylgard 309, 0.03%, 21 d alt Viticure 8 fl oz, 21 d	1.2 ± 0.9	d	25.0 ± 10.8	ijk
LEM17, 20 fl oz + Kumulus, 6 lb, 14 d	1.8 ± 0.9	d	29.6 ± 7.9	hijk
Pristine, 8 oz, 14 d alt Timorex Gold, 0.5%, 14 d	2.0 ± 1.0	d	21.3 ± 7.1	ijk
LEM17, 24 fl oz + Kumulus, 6 lb, 21 d	2.5 ± 0.8	d	42.4 ± 9.3	eghij
BAS560 03F, 15.36 fl oz + Sylgard 309, 0.03%, 21 d	2.6 ± 2.2	d	33.3 ± 17.3	ehijk
Flint, 2 oz, 21 d then Flint, 2 oz + Viticure 8 fl oz, 21 d	2.8 ± 1.8	d	42.4 ± 17.2	eghij
LEM17, 20 fl oz + Kumulus, 6 lb, 21 d	2.9 ± 0.9	cd	50.7 ± 14.7	defhi
LEM17, 24 fl oz, 21 d	3.4 ± 2.0	d	47.2 ± 17.2	defhj
Quintec, 6.6 fl oz, 21 d alt Viticure, 8 fl oz, 21 d	3.7 ± 1.7	cd	56.0 ± 15.1	defh
Quintec, 6.6 fl oz + Sylgard 309, 0.03%, 21 d	5.7 ± 2.7	cd	62.0 ± 21.0	def
Viticure, 6 fl oz, 21 d	6.8 ± 3.6	cd	56.0 ± 15.7	defh
Viticure, 8 fl oz, 21 d	7.9 ± 3.3	cd	65.0 ± 15.6	cdg
Pristine, 8 oz, 14 d	8.1 ± 3.0	cd	56.8 ± 12.0	defh
Sovran, 5 oz + Sylgard 309, 0.03%, 21 d	8.6 ± 7.5	cd	50.0 ± 16.8	defhj
Mettle, 5 fl oz + Sylgard 309, 0.03%, 21 d	12.4 ± 4.3	cd	72.0 ± 11.4	abdf
LEM17, 14 fl oz + Kumulus 6 lb, 14 d	13.0 ± 7.5	cd	66.7 ± 18.5	bdef
BAS560 03F, 10.24 fl oz + Sylgard 309, 0.03%, 21 d	17.7 ± 12.2	c	50.4 ± 20.1	defhj
Timorex Gold, 0.5%, 14 d	45.4 ± 11.5	b	95.2 ± 2.3	abf
Ph-D, 6.2 oz, 14 d	50.7 ± 10.0	b	96.0 ± 2.3	abc
Ph-D, 12 oz, 14 d	57.7 ± 12.0	b	99.0 ± 1.0	ab
Timorex Gold, 0.75%, 14 d	59.3 ± 13.8	b	98.0 ± 1.2	ab
Unsprayed control	90.0 ± 7.7	a	100.0 ± 0.0	a

Table 5. Disease incidence and severity in trial V treatments (means ± 1 SE; n = 5). Product names are followed by amount applied (per acre) and the frequency of application. Treatment means with the different letters are significantly different according to Fisher's LSD test at α = 0.10.

Treatment	Disease Severity (%)		Disease Incidence (%)	
Cueva, 2 %, 14 d	61.4 ± 7.3	b	96.0 ± 4.0	a
Cueva, 1 %, 14 d	75.2 ± 8.8	b	99.2 ± 0.8	a
Unsprayed control	100.0 ± 0.0	a	100.0 ± 0.0	a

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Appendix: Materials

Product	Active ingredient(s) and concentration	Manufacturer or distributor	Chemical class
Actinovate AG	*Streptomyces lydicus* WYEC 108 (0.0371%)	Natural Industries, Inc.	biological - microbial
Adament 50WG	trifloxystrobin (25%) + tebuconazole (25%)	Bayer	QoI (strobilurin) + DMI (triazole)
AMV-4024	caprylic acid (extract of palm and coconut oil)	Summerdale Inc., oil supplied by Cognis Oleochemical	biological
BAS56 003F	metrafenone (300 g/L)	BASF	benzophenone
Champion	copper hydroxide (77%)	Nufarm Americas, Inc.	copper
Companion	*Bacillus subtilus* GB03 (0.03%)	Growth Products, Ltd	biological - microbial
Cueva	copper octanoate (10%)	Neudorff	fatty acid-linked copper salt
Flint 50WG	trifloxystrobin (50%)	Bayer	QoI
Foliar Supreme	phosphoric acid (P_2O_5) (16%) + potash (K_2O) (10%) + sulfur (30%)	First Choice	sulfur + other
GWN-4617	unknown	Gowan Co.	unknown
HiPeak	potassium dihydrogenorthophospate + dipotassium hydrogenorthophospate	Rotem Amvert Negal, Ltd.	fertilizer
Hi Wett	polysiloxane polyether copolymer, polyoxyethylene-polyoxypropylene copolymer & alcohol ethoxylate (100%)	First Choice	adjuvant
Inspire Super	difenoconazole (8.4%) + cyprodinil (24%)	Syngenta Crop Protection, Inc.	DMI (triazole) + anilinopyrimidine
JMS Stylet-oil	paraffinic oil (97.1%)	JMS Flower Farms, Inc.	oil
Kumulus DF	sulfur (80%)	BASF	sulfur
LEM17 SC	penthiopyrad (20%)	DuPont	carboxamide
Mettle	tetraconazole (10-12.5%)	Isagro-USA	DMI (triazole)
MicroThiol	sulfur (80%)	Ceresagri, Inc.	sulfur
NuFilm P	poly-1-p-menthene	Miller Chemical and Fertilizer Corporation	adjuvant
Nutrol (KeeP fertilizer)	phosphate (50%), potash (30%)	Rotem BKG	fertilizer
OM1	paraffinic oil + OE444 (an oil-based adjuvant)	OE444: DuGussa/Goldschmidt	oil
OM2	paraffinic oil + OE444	OE444: DuGussa/Goldschmidt	oil
Phyton-016-B	copper sulfate pentahydrate (21.4%)	Phyton Corporation	other
Ph-D	polyoxin-D (11.3%)	Arysta Life Sciences	chitin synthesis inhibitor
PrevAM	sodium tetraborohydrate decahydrate (0.99%)	OroAgri, Inc.	
Pristine	pyraclostrobin (12.8%) boscalid (25.2%)	BASF	QoI + carboxamide
PureSpray	petroleum oil (98%)	Petro-Canada	oil
Quintec	quinoxyfen (22.6%)	Dow AgroSciences LLP	quinoline
Regalia SC	*Reynoutria sachilinensis* extract	Marrone Organic Innovations	biological
Rubigan	fenarimol (12%)	Gowan Co.	DMI (pyrimidine)
Serenade MAX	*Bacillus subtilis* QST713 (14.6%)	AgraQuest Inc.	biological - microbial
SilverDYNE	silver colloid (3.6%)	World Health Alliance International Inc.	other
Sovran	kresoxim methyl (50%)	BASF	QoI
Sylgard 309	polysiloxane (80%)	Dow Corning Corp	adjuvant
Timorex Gold	oil derived from the tea tree, *Melaleuca alterniflora* (23.8%)	Biomor Israel Ltd.	oil
Topguard	flutriafol (12%)	Cheminova	DMI (triazole)
Unicorn	sulfur (70%) + tebuconazole (4.5%)	Sulfur Mills, Ltd.	sulfur, DMI
USF2015 (Luna Privilege)	fluopyram	Bayer	pyridinyl ethylbenzamide
USF2017 (Luna Experience)	fluopyram + tebuconazole	Bayer	pyridinyl ethylbenzamide, DMI (triazole)
Vintage SC	fenarimol (11.6%)	Gowan Co.	DMI (pyrimidine)
Vintre	alcohol ethoxylate (8.92%)	OroAgri	adjuvant
Viticure	triflumizole (42.14%)	Crompton Manufacturing Company (Chemtura Corp.)	DMI (imidazole)
Whey	whey		other
YT669	picoxystrobin (250 mg/L)	DuPont	QoI

Appendix sources: (1) Janousek et al. 2006, 2007 and 2008 grape powdery mildew reports at http://plantpathology.ucdavis.edu/ext/, (2) Adaskaveg et al. 2008 at http://plantpathology.ucdavis.edu/ext/gubler/fungtrials2008/, (3) http://www.epa.gov/opprd001/factsheets/, (4) http://www.frac.info/frac/publication/anhang/FRAC_Code_List_2007_web.pdf, (5) http://www.bayercropscience.com/, (6) product-specific MSDS and/or labels or personal communication.