Final Report:
Control of grape powdery mildew with synthetic, biological and organic fungicides: 2013 field trials

Ian S. Bay, Trang T. Nguyen, and W. Douglas Gubler

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

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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 (*Vitis vinifera*) (Cultivar Chardonnay). Trials were conducted at Herzog Ranch, near Courtland, California in 2013. Treatments were placed in four adjacent trials in the vineyard in complete randomized design. Spraying commenced in mid April. Powdery mildew pressure increased slowly, held in check by cool temperatures early on, but quickly built to very high disease pressure levels as temperatures warmed. Spraying was completed on July 18 and treatments were evaluated for disease incidence and severity on July 25.

The trials consisted of soft chemistry products, including biologicals, sulfurs, nutrient applications, oils, and other materials, as well as synthetics. Spray frequencies varied from weekly applications to 21 day intervals. Many applications were based on the Gubler-Thomas Risk Index, with application intervals based on the index.

Temperatures were mild during much of the 2013 growing season, providing optimal conditions for the asexual reproduction and dispersal of powdery mildew. Overall disease pressure was moderate. By late June, heavy mildew coverage was evident on untreated clusters. By the time of disease evaluation, disease severity in untreated plots in all three trials reached 95-100%.

Materials and Methods

A. Experimental design

Trials II-IV: Synthetic and organic treatments

Experimental design	Complete randomized design with 5 replicates.		
Experimental unit	2 adjacent vines = 1 plot (Trial 2A is 1 vine= 1plot)		
Plot area	154 ft^2 (row spacing = 11 ft, vine spacing = 7 ft)		
Area/treatment	770 ft^2 (5 reps x 2 vines = 1 treatment)	Area/treatment	0.0177 acre/treatment
Volume water/acre	100 gallons (pre-bloom in mid-April), = 1.8 gallons/5 replicates 125 gallons (certain products), = 2.2 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 250 gallons (late season),= 4.4 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

No.	Flag.	Treatment	Frequency (days)	Application rate (per acre)	FP/5 replicates
1	W	Untreated	none	none	none
2	OD	Timorex Gold	10	0.86 qt	14.4 ml
3	OS	Timorex Gold alt Quintec	10	0.86 qt alt 4 fl oz	14.4 ml alt 2.1 ml
4	GKD	Champ WG (50% Cu)	10	2 lb	16.1 g
5	GS	Champ WG	10	6 lb	48.2 g
6	KD	AG Copp 75 (75% Cu)	10	1.33 lb	10.7 g
7	GD	AG Copp 75	10	4 lb	32.1 g
8	YKC	AG Copp 75 Organic	10	1.33 lb	10.7 g
9	BC	AG Copp 75 Organic	10	4 lb	32.1 g
10	Y	Chem Copp 50 (50% Cu)	10	2 lb	16.1 g
11	PKS	Chem Copp 50	10	6 lb	48.2 g
12	BS	Nordox 75 WG (75% Cu)	10	1.33 lb	10.7 g
13	YC	Nordox 75 WG	10	4 lb	32.1 g
14	BD	AG Copp 75 Organic	20	4 lb	32.1 g
15	GKS	AG Copp 75	20	4 lb	32.1 g
16	YD	K-Phite 7LP	14	3 qt	50.2 ml
17	K	K-Phite 7LP + DKP XTRA	21	3 qt + 2 gal	50.2 ml + 134 ml
18	YKS	Kumulus (at budbreak) then Fracture + Dyneamic	14	5lb/100 gal then 24.4 fl oz + 0.25% (v/v)	41 g then 12.8 ml + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
19	YS	Kumulus (at budbreak) then Fracture + Dyneamic alt Abound + Dyneamic	14	5lb/100 gal then 24.4 fl oz + 0.25% v/v alt 15.4 fl oz + 0.25% (v/v)	41 g then (12.8 ml alt 8.1 ml) + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
20	RKD	Kumulus (at budbreak) then Fracture + Abound + Dyneamic alt Procure + Dyneamic	14	5lb/100 gal then 21 fl oz + 10 fl oz + 0.25% (v/v) alt 8 fl oz +0.25% (v/v)	41 g then (11 ml + 5.2 ml alt 4.2 ml) + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
21	B	Kumulus (at budbreak) then Abound + Dyneamic alt Fracture + Dyneamic	14	5lb/100 gal then 15.4 fl oz + 0.25% (v/v) alt 24.4 fl oz	41 g then (8.1 ml alt 12.8 ml) + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
22	Pu	Kumulus (at budbreak) then Fracture + Dyneamic	14	5 lb/100 gal then 18.3 fl oz + 0.25% (v/v)	41 g then 9.6 ml + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
23	OKD	Centurion II	7	0.2 % (v/v)	13.6 ml (at 100 gal) or 20.4 ml (at 150 gal) or 27.2 ml (at 200 gal) or 34 ml (at 250 gal)
24	KS	Centurion II	14	0.2% (v/v)	13.6 ml (at 100 gal) or 20.4 ml (at 150 gal) or 27.2 ml (at 200 gal) or 34 ml (at 250 gal)

Trial II

No.	Flag	Treatment	Frequency (days)	Application rate (per acre)	FP/5 replicates
1	W	Untreated Control	None	None	none
2	OD	Quintec + Dyneamic	21	6.6 fl oz + 0.125% (v/v)	3.5 ml + 8.5 ml (at 100 gal) or 12.75 ml (at 150 gal) or 17 ml (at 200 gal) or 21.25 ml (at 250 gal)
3	OS	Rally + Dyneamic alt Quintec + Dyneamic	14	5 oz + 0.125% (v/v) alt 4 fl oz + 0.125% (v/v)	(2.5 g alt 2.1 ml) + 8.5 ml (at 100 gal) or 12.75 ml (at 150 gal) or 17 ml (at 200 gal) or 21.25 ml (at 250 gal)
4	GKD	Luna Exp + Dyneamic alt Quintec + Dyneamic	21	8 fl oz + 0.125% (v/v) alt 6.6 fl oz + 0.125% (v/v)	(4.2 ml alt 3.5 ml) + 8.5 ml (at 100 gal) or 12.75 ml (at 150 gal) or 17 ml (at 200 gal) or 21.25 ml (at 250 gal)
5	GS	Pristine + Dyneamic alt Quintec + Dyneamic	21	10.5 oz + 0.125% (v/v) alt 6.6 fl oz + 0.125% (v/v)	5.3 g alt 3.5 ml + 8.5 ml (at 100 gal) or 12.75 ml (at 150 gal) or 17 ml (at 200 gal) or 21.25 ml (at 250 gal)
6	KD	Torino + Dyneamic alt Quintec + Dyneamic	14	3.4 fl oz + 0.125% (v/v) alt 6.6 fl oz + 0.125% (v/v)	1.8 ml alt 3.5 ml + 8.5 ml (at 100 gal) or 12.75 ml (at 150 gal) or 17 ml (at 200 gal) or 21.25 ml (at 250 gal)
7	GD	Rhyme	14	2.5 fl oz	1.3 ml
8	YKC	Rhyme	14	5.0 fl oz	2.6 ml
9	BC	Rhyme	14	10 fl oz	5.2 ml
10	YKD	Topguard	14	10 fl oz	5.2 ml
11	PKS	Quintec alt Flint (standard)	(21 alt 14)	6.6 fl oz alt 2 oz	3.5 ml alt 1 g
12	BS	Luna Experience + Dyneamic	21	6 fl oz + 0.25% (v/v)	3.1 ml + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
13	O	(Luna Experience alt Flint + Sonata) + Dyneamic	14	(6 fl oz alt 2 oz + 2 qt) + 0.25% (v/v)	(3.1 ml alt 1 g + 33.5 ml) + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
14	BD	(Luna Experience alt Flint) + Dyneamic	14	(6 fl oz alt 3 oz) + 0.25% (v/v)	(3.1 ml alt 1.5 g) + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
15	GKS	Luna Experience alt Flint + Stylet oil	14	6 fl oz alt 2 oz + 1% (v/v)	3.1 ml alt 1 g + 68.1 ml (at 100 gal) or 102.2 ml (at 150 gal) or 136.2 ml (at 200 gal) or 170.3 ml (at 250 gal)
16	YD	Luna Experience alt Sonata + Stylet oil	14	6 fl oz alt 3 qt + 1% (v/v)	3.1 ml alt 50.2 ml + 68.1 ml (at 100 gal) or 102.2 ml (at 150 gal) or 136.2 ml (at 200 gal) or 170.3 ml (at 250 gal)
17	K	Luna Tranquility + Dyneamic	14	16 fl oz + 0.25% (v/v)	8.4 ml + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)
18	YKS	Sonata + Dyneamic	14	3 qt + 0.25%	50.2 ml + 17 ml (at 100 gal) or 25.5 ml (at 150 gal) or 34 ml (at 200 gal) or 42.5 ml (at 250 gal)

19	YS	Merivon + ORUS 009 alt Vivando + ORUS 009	14-21 (RI)	5 fl oz + 32 fl oz/100 gal alt 15.4 fl oz + 32 fl oz/100 gal	2.6 ml + 17 ml alt 8.1 ml + 17 ml
20	RKD	Merivon alt Vivando	14-21 (RI)	5 fl oz alt 15.4 fl oz	2.6 ml alt 8.1 ml
21	B	Inspire Super + Dyneamic alt Quintec + Dyneamic (last spray I.S.)	14	20 fl oz + 0.1% (v/v) alt 4 fl oz + 0.1% (v/v)	(10.5 ml alt 2.1 ml) + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
22	Pu	A15457 + Dyneamic alt Quintec + Dyneamic (last spray A15..)	14	10.3 fl oz + 0.1% (v/v) alt 4 fl oz + 0.1% (v/v)	(5.4 ml alt 2.1 ml) + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
23	OKD	A19334 + Dyneamic alt Quintec + Dyneamic (last spray A19334)	14	13 fl oz + 0.1% (v/v) alt 4 fl oz + 0.1% (v/v)	6.8 ml alt 2.1 ml + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
24	KS	Inspire Super + Dyneamic then Taegro 13 WP + Dyneamic then Quintec + Dyneamic then Inspire Super + Dyneamic then Taegro 13 WP + Dyneamic (4x)	14	20 fl oz + 0.1% (v/v) then 5.2 oz then 4 fl oz + 0.1% (v/v) then 5.2 oz (4x)	10.5 ml + then 2.6 g then 2.1 ml then 10.5 ml then 2.6 g (4x)) + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal) then
25	OKS	MCW-710 SC	14	6.0 fl oz	3.1 ml
26	BKS	MCW-710 SC	14	8.6 fl oz	4.5 ml
27	R	MCW-710 SC alt Quintec	14	8.6 fl oz alt 4 fl oz	4.5 ml alt 2.1 ml

Trial IIA (end of row 16)

No.	Flag	Treatment	Frequency (days)	Application rate (per acre)	FP/5 replicates
1	OKS	MBI-10605	7	2 qt	17 ml
2	Pu	Luna Exp then Flint then MBI-10605	21 then 14 then 7	6 fl oz then 2 oz then 2 qt	1.6 ml then 0.5 g then 17 ml

Trial III

No.	Flag	Treatment	Frequency (days)	Application rate (per acre)	FP/5 replicates
1	W	Untreated Control	None	None	none
2	OD	Rally then Pristine then Rally then Quintec, then Flint then Quintec then Flint then Rally (standard)	14-17 (RI)	5 oz then 8 oz then 5 oz then 4.0 fl oz then 2.0 then 4.0 fl oz then 2.0 then 5.0 oz	2.5 g then 4.0 g then 2.5 g then 2.1 ml then 1.0 g then 2.1 ml then 1.0 g then 2.5 g
3	OS	Torino SC	14-17 (RI)	3.4 fl oz	1.8 ml
4	OKD	Rally then Torino then Rally then Torino, then Flint then Quintec then Flint then Rally	14-17 (RI)	5 oz then 3.4 fl oz then 5 oz then 3.4 fl oz then 2.0 oz then 4.0 fl oz then 2.0 oz then 5.0 oz	2.5 g then 1.8 ml then 2.5 g then 1.8 ml then 1.0 g then 2.1 ml then 1.0 g then 2.5 g
5	GS	Rally then Pristine then Rally then Torino, then Flint then Torino then Flint then Rally	14-17 (RI)	5 oz then 8 oz then 5 oz then 3.4 fl oz then 2.0 oz then 3.4 oz then 2.0 oz then 5.0 oz	2.5 g then 4.0 g then 2.5 g then 1.8 ml then 1.0 g then 1.8 ml then 1.0 g then 2.5 g
6	KD	IKF-309	7-14	5 fl oz	2.6 ml
7	GD	IKF-309 alt Quintec	7-14 alt 14	4 fl oz alt 6.5 fl oz	2.1 ml alt 3.4 ml
8	YKC	IKF-309 alt Rally	7-14 alt 14	4 fl oz alt 5 oz	2.1 ml alt 2.5 g

9	BC	IKF-309 (2x) alt Quintec (2x)	7-14 (2x) alt 14 (2x)	4 fl oz (2x) alt 6.5 fl oz (2x)	2.1 ml (2x) alt 3.4 ml (2x)
10	YKD	IKF-309 (2x) alt Rally (2x)	7-14 (2x) alt 14 (2x)	4 fl oz (2x) alt 5 oz (2x)	2.1 ml (2x) alt 2.5 g (2x)
11	PKS	Phyton 27 AG	10-14 (RI)	25 oz/100 gal	13.1 ml (at 100 gal) 19.7 ml (at 150 gal) 26.2 ml (at 200 gal) 32.8 ml (at 250 gal)
12	BS	Phyton 27 AG + HiWett	10-14 (RI)	25 oz/100 gal + 0.1% (v/v)	13.1 ml (at 100 gal) 19.7 ml (at 150 gal) 26.2 ml (at 200 gal) 32.8 ml (at 250 gal) + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
13	O	Phyton 27 AG	10-14 (RI)	40 oz/100 gal	21 ml (at 100 gal) 31.5 ml (at 150 gal) 42 ml (at 200 gal) 52.5 ml (at 250 gal)
14	BD	Phyton 27 AG + HiWett	10-14 (RI)	40 oz/100 gal + 0.1% (v/v)	21 ml (at 100 gal) 31.5 ml (at 150 gal) 42 ml (at 200 gal) 52.5 ml (at 250 gal) + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
15	GKS	Timorex Gold	10	0.43 qt	7.2 ml
16	YD	Timorex Gold	10	0.65 qt	10.8 ml
17	K	Timorex Gold	10	0.86 qt	14.4 ml
18	YKS	Timorex Gold + Inspire	10	0.43 + 5.25 fl oz	7.2 + 2.7 ml
19	YS	Inspire	10	5.25 fl oz	2.7 ml
20	B	Timorex Gold (spray before infection occurs 4x then rate)	7	0.86 qt	14.4 ml

Trial IV

No.	Flag	Treatment	Frequency (days)	Application rate (per acre)	FP/5 replicates
1	W	Untreated Control	None	None	none
2	OD	Stylet oil (2x) then LI 6365 (2x) then Rampart + Liberate(2x) then LI 6265 (2x)	7 (2x) then 14	0.5% (v/v) then 10 fl oz then 3 qt + 0.125% (v/v) then 10 fl oz	27.2 ml (at 100 gal) then 4.2 ml then 40.2 ml + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal) then 4.2 ml
3	OKD	Stylet oil (2x) then LI 6365 + Franchise(2x) then Rampart + Liberate(2x) then LI 6265 + Franchise (2x)	7 (2x) then 14	0.5% (v/v) then 10 fl oz + 0.125% (v/v) then 3 qt + 0.125% (v/v) then 10 fl oz + 0.125% (v/v)	27.2 ml then 4.2 ml then 40.2 ml then 4.2 ml + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
4	GKC	Stylet oil (2x) then LI 6365 + Liberate (2x) then Rampart + Liberate (2x) then LI 6365 + Liberate (2x)	7 (2x) then 14	0.5% (v/v) then 10 fl oz + 0.125% (v/v) then 3 qt + 0.125% (v/v) then 10 fl oz + 0.125% (v/v)	27.2 ml then 4.2 ml then 40.2 ml then 4 g + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)

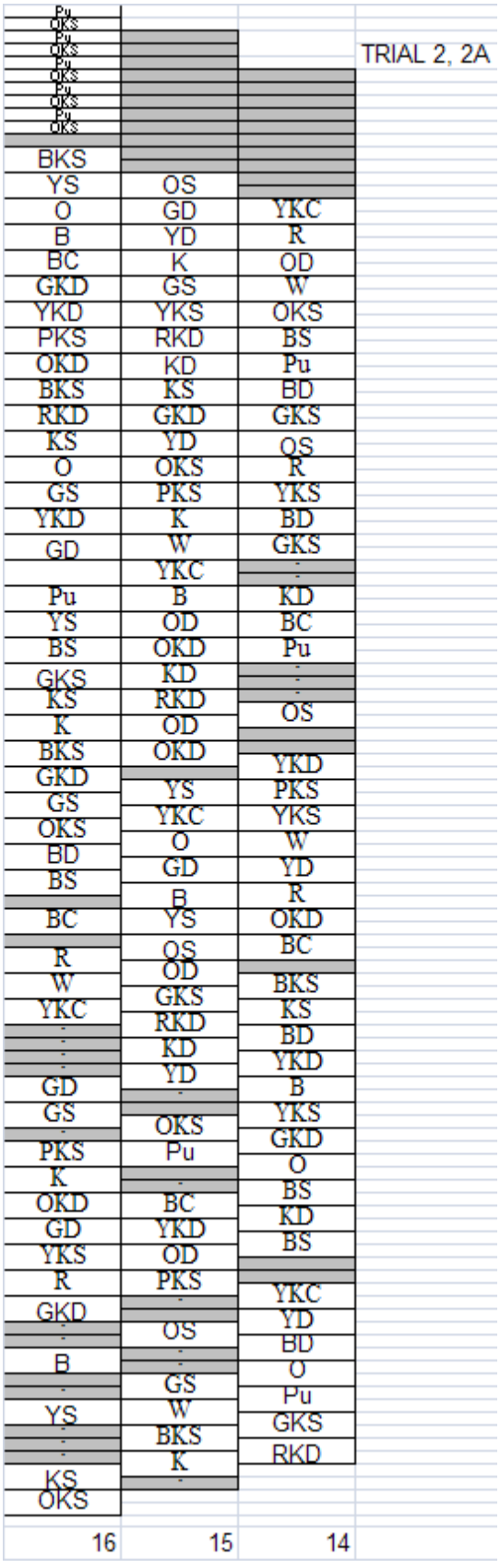
5	YS	Stylet oil (2x) then Abound + Dyneamic (2x) then Rampart + Liberate (2x) then Abound + Dyneamic (2x)	7 (2x) then 14	0.5% (v/v) then 10 fl oz + 0.125% (v/v) then 3 qt + 0.125% (v/v) then 10 fl oz + 0.125% (v/v)	27.2 ml then 4.2 ml then 40.2 ml then 4.2 ml + 6.8 ml (at 100 gal) or 10.2 ml (at 150 gal) or 13.6 ml (at 200 gal) or 17 ml (at 250 gal)
6	OS	Exp 4 alt Flint	7 alt 14	0.25% (v/v) alt 2 oz	13.6 ml (at 100 gal), 20.5 ml(at 150 gal), 26.6 ml (at 200 gal), 33.3 ml (at 250 gal) alt 0.8 g
7	K	Exp 4 + Flint	14	0.25% + 1 oz	13.6 ml (at 100 gal), 20.5 ml(at 150 gal), 26.6 ml (at 200 gal), 33.3 ml (at 250 gal) + 0.4 g
8	GD	Flint	14	2 oz	0.8 g

C. Maps

← N

		TRIAL 1
		PKS
	OS	YS
B	YD	RKD
Y	BC	GKD
YKS		KS
GD	OKD	OD
BS	Pu	KD
	GKS	K
YKC	W	YC
W	GS	BD
KS	GKD	YD
YS	GS	BS
OKD	BC	KD
	RKD	GKS
B	BD	GD
YC	YKS	OD
OS	PKS	K
	YKC	Y
Pu	Y	OKD
OS	GS	B
	RKD	YS
YC	GKD	KD
BD	YKC	BS
K	GD	YKS
PKS	YD	KS
GKS		BC
W	Pu	
GKD	OD	
YC	YS	RKD
YKC	GS	KS
OKD	B	YD
	GD	Pu
GKS	Y	KD
	OD	PKS
BC	YKS	W
		BD
	OS	BS
		K
GD	PKS	RKD
	BS	KS
BC	BD	GKS
YD	YKC	B
GS	YS	Y
K	Pu	W
OS	GKD	OD
YKS	YC	OKD
KD		
13	12	11

← N



TRIAL 3


BKS
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YD
BD
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YS
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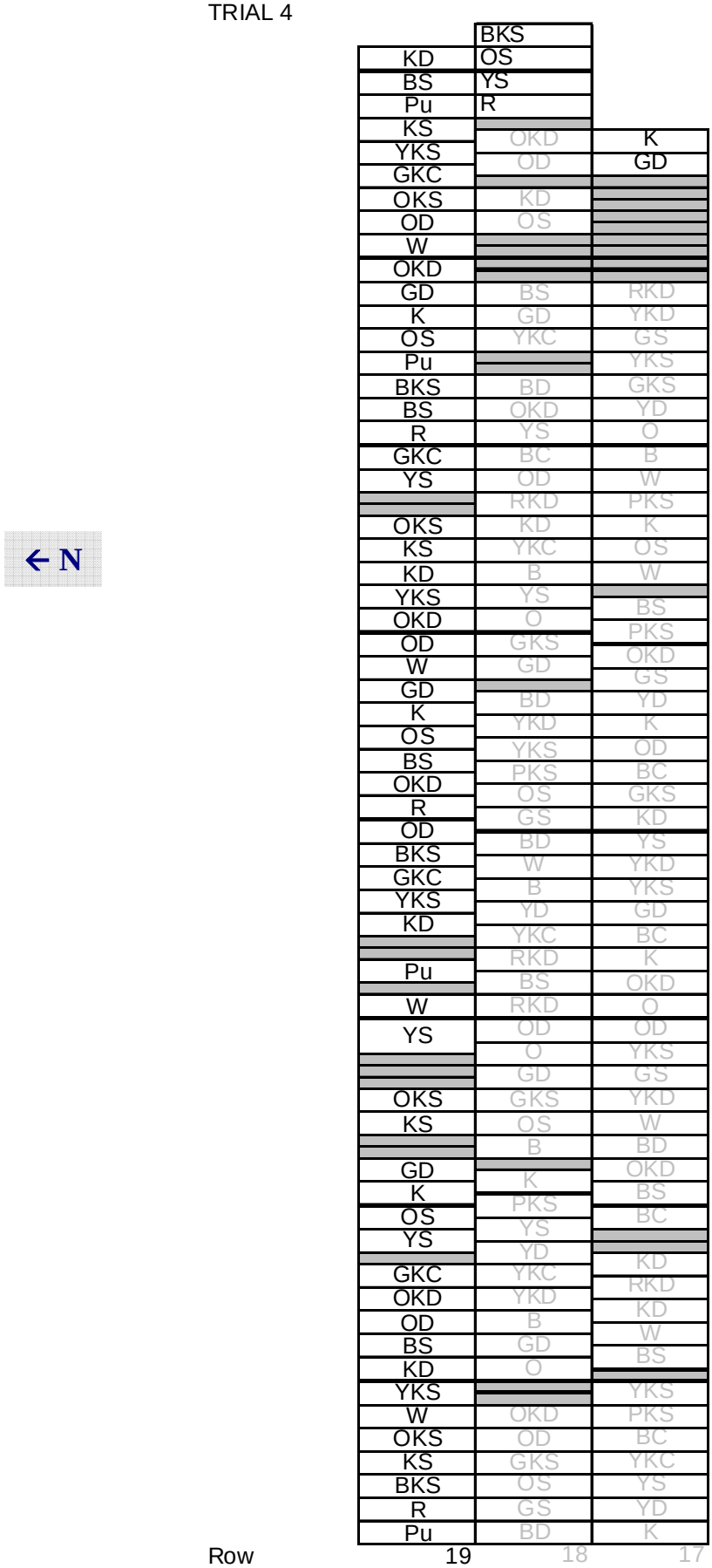
TRIAL 4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Pu R
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Pu YKS
BKS BD GKS
BS OKD YD
R YS O
GKC BC B
YS OD W
RKD PKS
OKS KD K
KS YKC OS
KD B W
YKS YS BS
OKD O PKS
OD GKS OKD
W GD GS
GD BD YD
K YKD K
OS YKS OD
BS PKS BC
OKD OS GKS
R GS KD
OD BD YS
BKS W YKD
GKC B YKS
YKS YD GD
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RKD K
Pu BS OKD
W RKD O
YS OD OD
O YKS
GD GS
OKS GKS YKD
KS OS W
B BD
GD K OKD
K PKS BS
OS YS BC
YS YD
GKC YKC KD
OKD YKD RKD
OD B KD
BS GD W
KD O BS
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BKS OS YS
R GS YD
Pu BD K
Row 19 18 17

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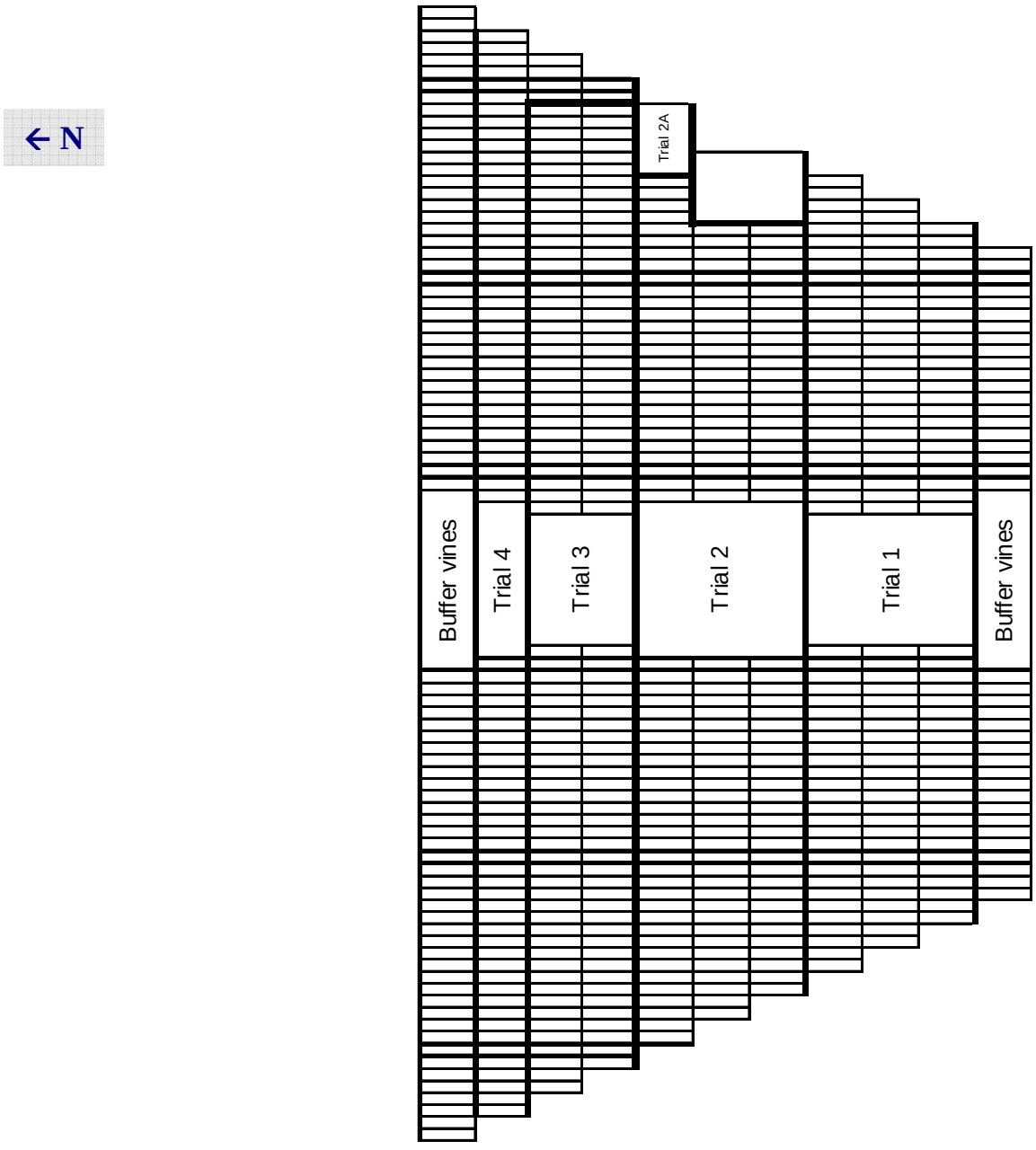
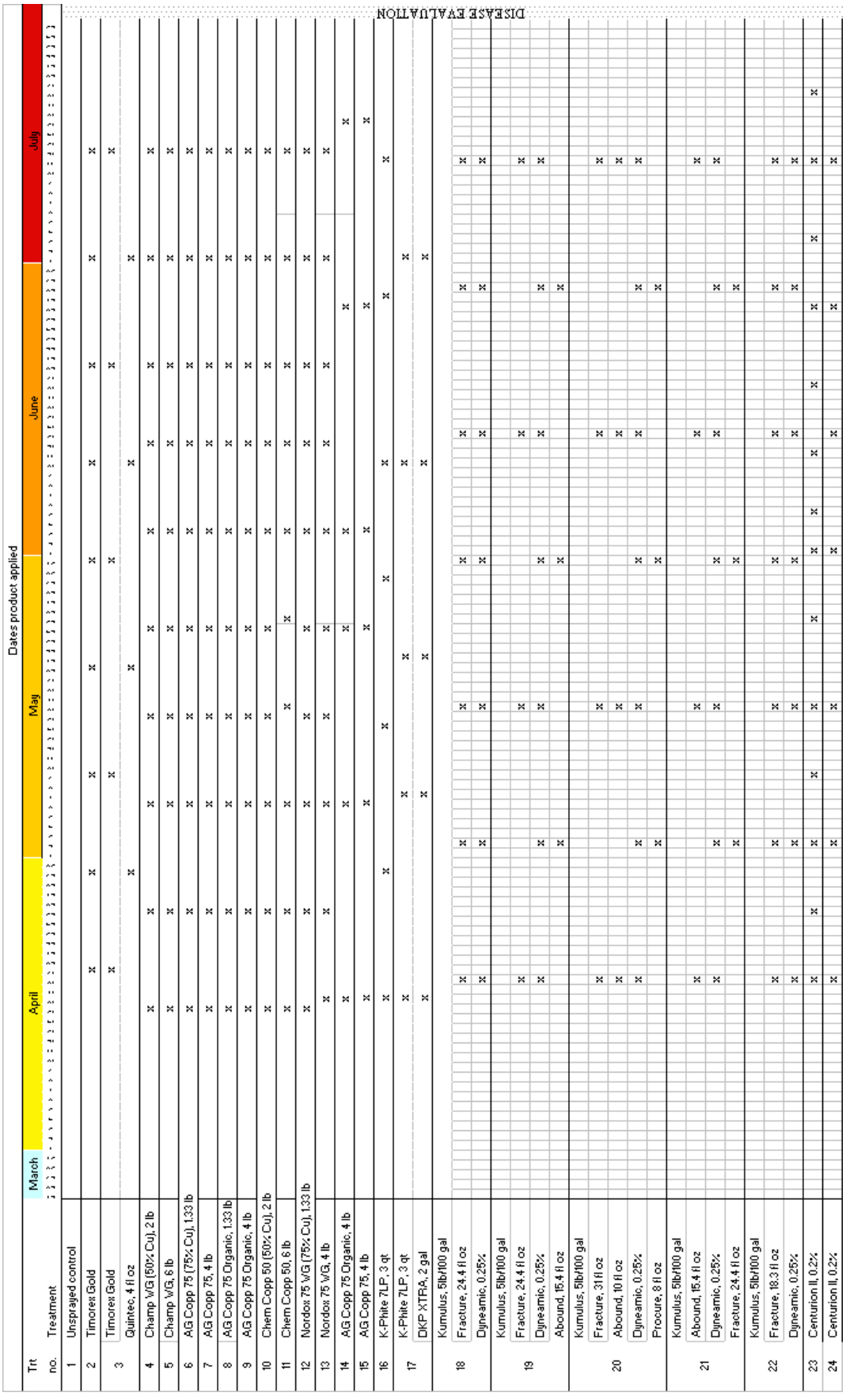
Overview map



D. Application history

TRIAL 1



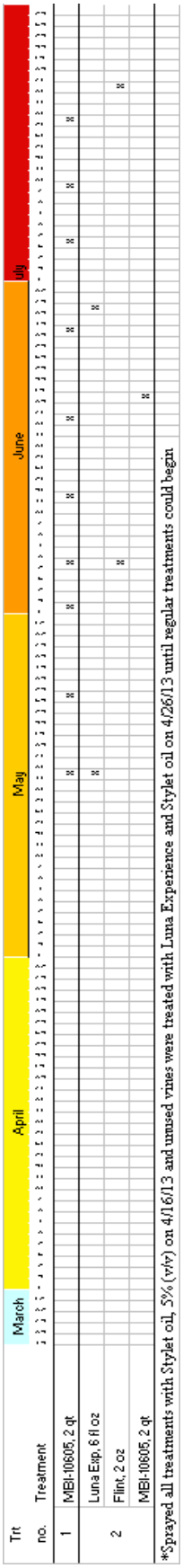
TRIAL 2

Trt no.	Treatment	March	April	May	June	July
1	Unsprayed control					
2	Quintec, 6.6 fl oz		x	x	x	x
	Dyneamic, 0.125%		x	x	x	x
3	Rally, 5 oz		x	x	x	x
	Dyneamic, 0.125%		x	x	x	x
	Quintec, 4 fl oz		x	x	x	x
4	Luna Exp, 8 fl oz		x	x	x	x
	Dyneamic, 0.125%		x	x	x	x
	Quintec, 6.6 fl oz		x	x	x	x
5	Pristine, 10.5 oz		x	x	x	x
	Dyneamic, 0.125%		x	x	x	x
	Quintec, 6.6 fl oz		x	x	x	x
6	Torino, 3.4 fl oz		x	x	x	x
	Dyneamic, 0.125%		x	x	x	x
	Quintec, 6.6 fl oz		x	x	x	x
7	Rhyme, 2.5 fl oz		x	x	x	x
8	Rhyme, 5 fl oz		x	x	x	x
9	Rhyme, 10 fl oz		x	x	x	x
10	Topguard, 10 fl oz		x	x	x	x
11	Quintec, 6.6 fl oz		x	x	x	x
	Flint, 2 oz		x	x	x	x
12	Luna Exp, 6 fl oz		x	x	x	x
	Dyneamic, 0.25%		x	x	x	x
13	Luna Exp, 6 fl oz		x	x	x	x
	Flint, 2 oz		x	x	x	x
	Sonata, 2 qt		x	x	x	x
	Dyneamic, 0.25%		x	x	x	x
14	Luna Exp, 6 fl oz		x	x	x	x
	Flint, 2 oz		x	x	x	x
	Dyneamic, 0.25%		x	x	x	x
15	Luna Exp, 6 fl oz		x	x	x	x
	Flint, 2 oz		x	x	x	x
	Stylet oil, 1%		x	x	x	x
16	Luna Exp, 6 fl oz		x	x	x	x
	Sonata, 3 qt		x	x	x	x
	Stylet oil, 1%		x	x	x	x
17	Luna Tranquility, 16 fl oz		x	x	x	x
	Dyneamic, 0.25%		x	x	x	x
18	Sonata, 3 qt		x	x	x	x
	Dyneamic, 0.25%		x	x	x	x
19	Merivon, 5 fl oz		x	x	x	x
	ORIUS 009, 32 fl oz/100 gal		x	x	x	x
	Vivando, 15.4 fl oz		x	x	x	x
20	Merivon, 15.4 fl oz		x	x	x	x
	Vivando, 15.4 fl oz		x	x	x	x
21	Inspire Super, 20 fl oz		x	x	x	x
	Dyneamic, 0.1%		x	x	x	x
	Quintec, 4 fl oz		x	x	x	x
22	A15457, 10.3 fl oz		x	x	x	x
	Dyneamic, 0.1%		x	x	x	x
	Quintec, 4 fl oz		x	x	x	x
23	A19334, 13 fl oz		x	x	x	x
	Dyneamic, 0.1%		x	x	x	x
	Quintec, 4 fl oz		x	x	x	x
24	Inspire Super, 20 fl oz		x	x	x	x
	Dyneamic, 0.1%		x	x	x	x
	Taegro 13 WP, 5.2 oz		x	x	x	x
	Quintec, 4 fl oz		x	x	x	x
25	MCW-710 SC, 6 fl oz		x	x	x	x
26	MCW-710 SC, 8.6 fl oz		x	x	x	x
27	MCW-710 SC, 8.6 fl oz		x	x	x	x
	Quintec, 4 fl oz		x	x	x	x

DISEASE EVALUATION

*Treatments 22 and 23 were sprayed with Stylet oil, 5% (v/v) on 4/19/13 and 4/26/13

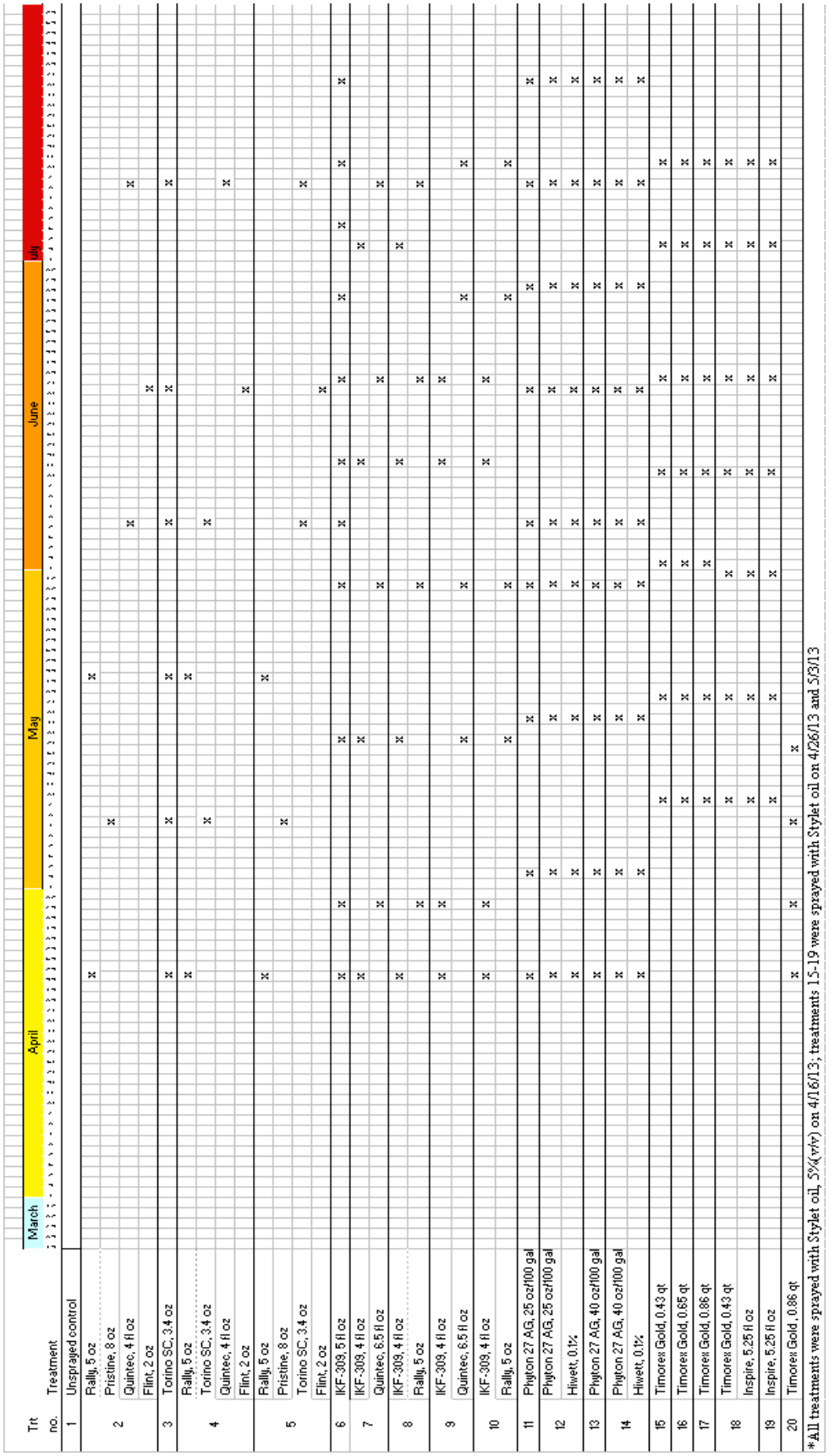
TRIAL 2A



Trt no.	Treatment
1	MBI-10605, 2 qt
2	Luna Exp, 6 fl oz
	Flint, 2 oz
	MBI-10605, 2 qt

*Sprayed all treatments with Stylet oil, 5% (v/v) on 4/16/13 and unused vines were treated with Luna Experience and Stylet oil on 4/26/13 until regular treatments could begin

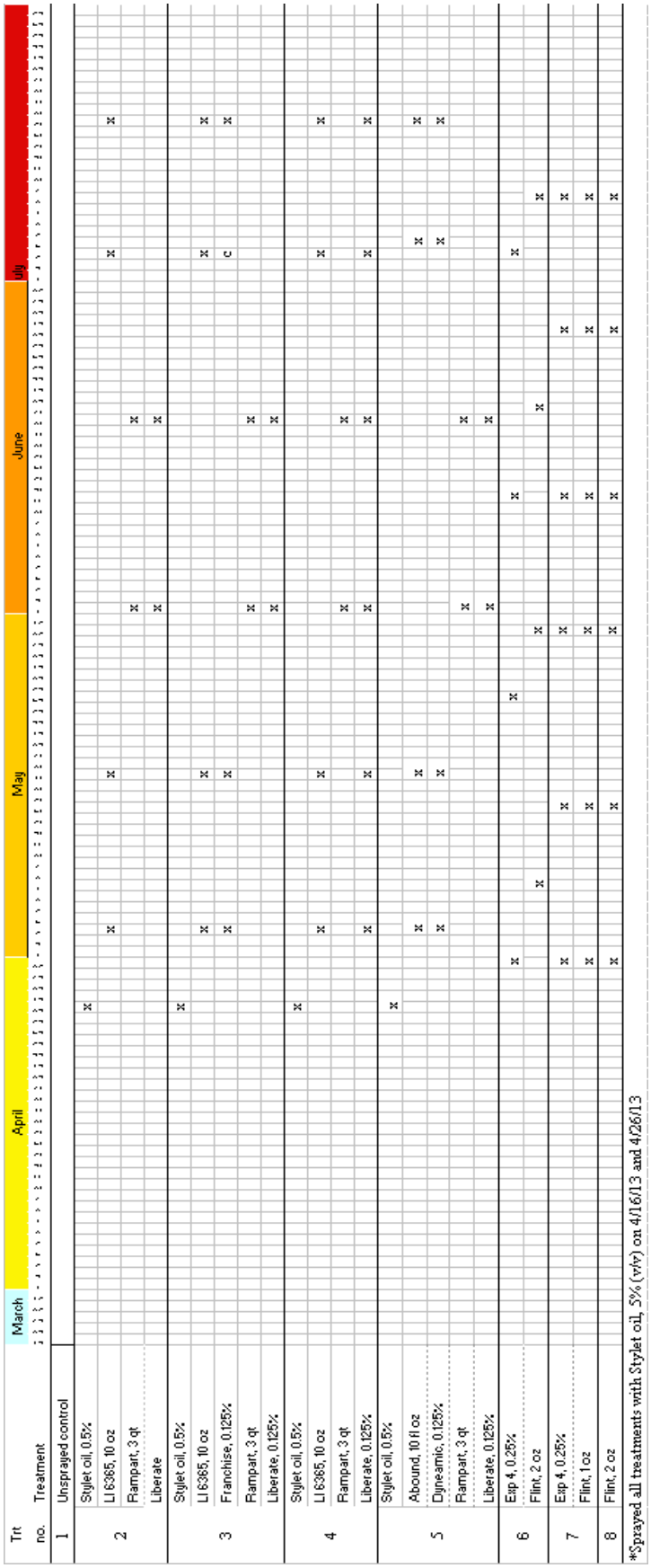
TRIAL 3



Trt no.	Treatment
1	Unsprayed control
2	Rally, 5 oz
	Pristine, 8 oz
	Quintec, 4 fl oz
	Flint, 2 oz
3	Torino SC, 3.4 oz
4	Rally, 5 oz
	Torino SC, 3.4 oz
	Quintec, 4 fl oz
	Flint, 2 oz
5	Rally, 5 oz
	Pristine, 8 oz
	Torino SC, 3.4 oz
	Flint, 2 oz
6	IKF-309, 5 fl oz
7	IKF-309, 4 fl oz
	Quintec, 6.5 fl oz
8	IKF-309, 4 fl oz
	Rally, 5 oz
9	IKF-309, 4 fl oz
	Quintec, 6.5 fl oz
10	IKF-309, 4 fl oz
	Rally, 5 oz
11	Phyton 27 AG, 25 oz/100 gal
12	Phyton 27 AG, 25 oz/100 gal
	Hiwett, 0.1%
13	Phyton 27 AG, 40 oz/100 gal
14	Phyton 27 AG, 40 oz/100 gal
	Hiwett, 0.1%
15	Timorex Gold, 0.43 qt
16	Timorex Gold, 0.65 qt
17	Timorex Gold, 0.86 qt
18	Timorex Gold, 0.43 qt
	Inspire, 5.25 fl oz
19	Inspire, 5.25 fl oz
20	Timorex Gold, 0.86 qt

*All treatments were sprayed with Stylet oil, 5%(v/v) on 4/16/13; treatments 15-19 were sprayed with Stylet oil on 4/26/13 and 5/3/13

TRIAL 4


Trt no.
Treatment
March
April
May
June
July
1
Unsprayed control
2
Stylet oil, 0.5%
LI 6365, 10 oz
Rampart, 3 qt
Liberate
3
Stylet oil, 0.5%
LI 6365, 10 oz
Franchise, 0.125%
Rampart, 3 qt
Liberate, 0.125%
4
Stylet oil, 0.5%
LI 6365, 10 oz
Rampart, 3 qt
Liberate, 0.125%
5
Stylet oil, 0.5%
Abound, 10 fl oz
Dyneamic, 0.125%
Rampart, 3 qt
Liberate, 0.125%
6
Exp 4, 0.25%
Flint, 2 oz
7
Exp 4, 0.25%
Flint, 1 oz
8
Flint, 2 oz
*Sprayed all treatments with Stylet oil, 5% (v/v) on 4/16/13 and 4/26/13

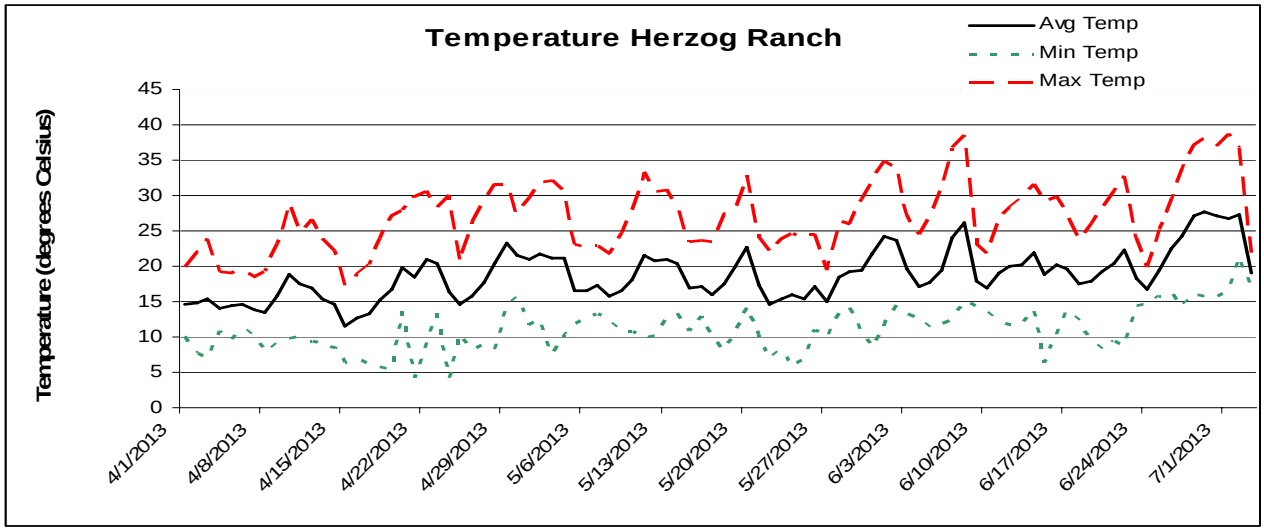
E. Vine management

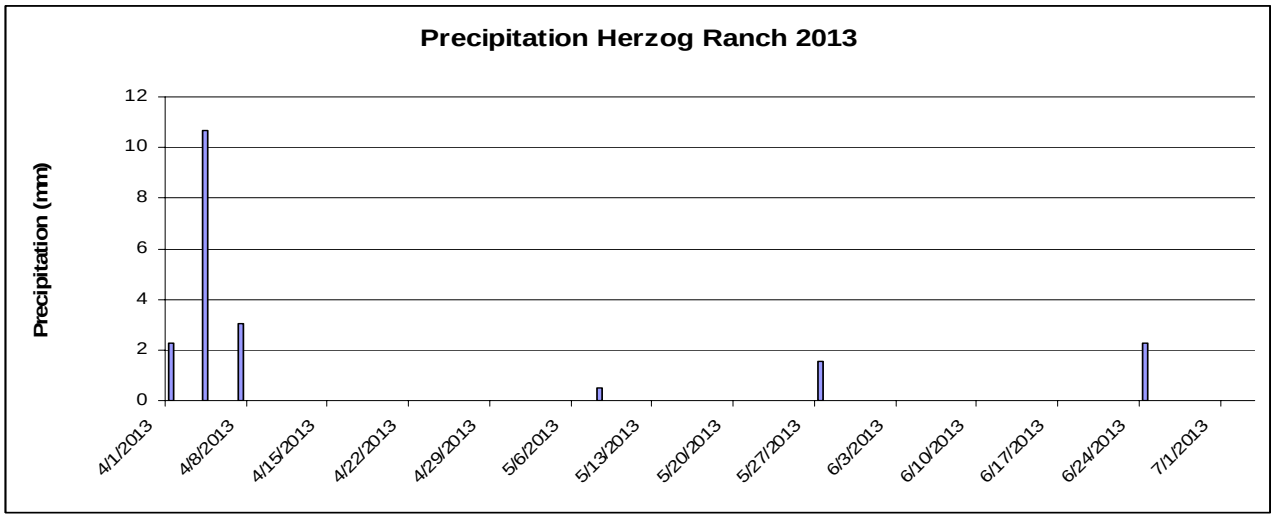
During the application period (mid April to late July), vines were irrigated 4 times by flooding. Sucker shoots were removed by local field personnel during the second week of May 2013. Leaf removal around the clusters was conducted on May 23 and June 6 2013. Sucker and leaf removal were done in all trials. Overhanging shoots were hedged on July 6 2013.

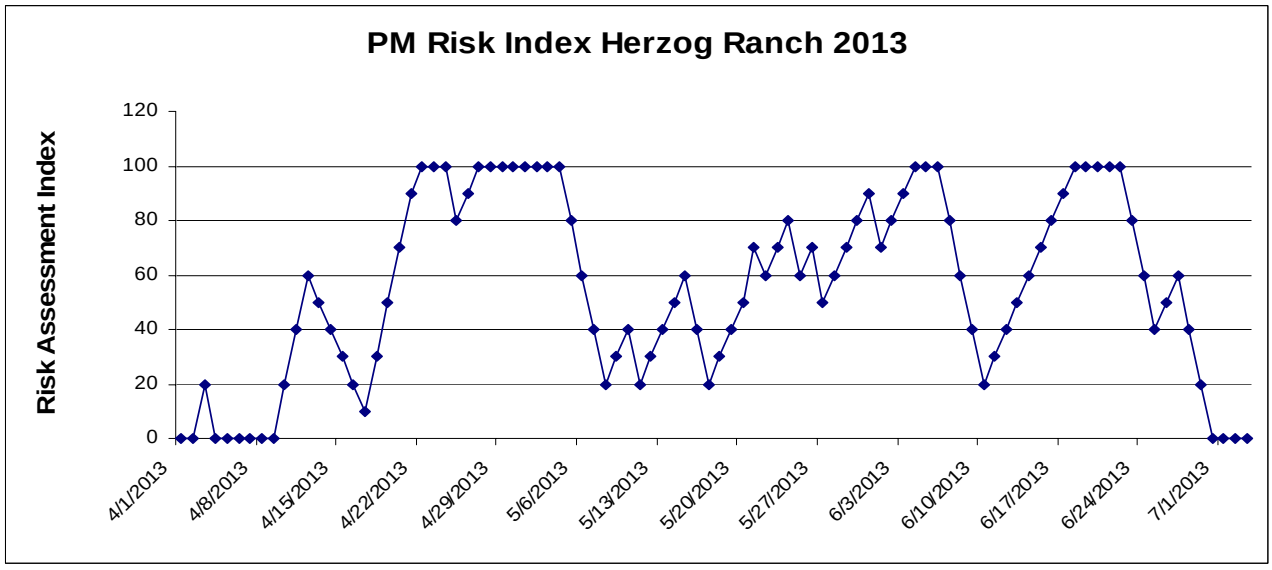
F. Data collection and statistics

Daily temperature, precipitation and Gubler-Thomas Risk Index values were computed and obtained from a Metos weather station (Pessl Instruments Gmbh, Weksweg 107, 8160 Weiz, Austria) located at the site. Effect of plot position on plot mean severity was based on data values for all plots from all trials. Disease was assessed on 25 July. Powdery mildew incidence and severity were assessed in each plot by evaluating twenty five random clusters. Incidence was defined as the proportion of clusters in a plot having 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. Mean incidence and severity values for each treatment along with standard error were computed. Trial models were analyzed using the ANOVA Tests for data; P-values for trials 1, 2, 2A, 3 and 4 were all at least $P<0.0005$. Means comparisons were made using Fisher's LSD with $\alpha=0.05$.

Figure 1. Weather data, powdery mildew risk index values, and disease progression in the trials from 1 Apr to until 3 July. (A-B) daily records of precipitation and temperatures from the Powdery Mildew index website, http://www.fieldclimate.com. (C) Powdery mildew risk index, calculated by an on site Metos weather station.







Results and discussion

Table 1. Disease incidence and severity in trial 1. Product names are followed by rate (per acre) and the frequency of application. Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05; alt =alternated with.

Treatment	Disease Severity %		Disease Incidence %	
Timorex Gold, 0.86 qt alt Quintec, 4 fl oz, 10 d	4.51	i	55.20	d
Timorex Gold, 0.86 qt, 10d	7.65	hi	55.20	d
Centurion II, 0.2% (v/v), 7 d	18.00	ghi	76.00	bcd
Kumulus (at budbreak), 5 lb/100 gal, then Fracture, 24.4 fl oz + Dyneamic, 0.25% (v/v), 14 d	18.96	ghi	83.00	abc
Champ WG, 2 lb, 10 d	19.82	ghi	83.20	abc
AG Copp 75, 1.33 lb, 10 d	20.50	ghi	72.80	cd
Champ WG, 6 lb, 10 d	23.97	gh	98.40	ab
K-Phite 7LP, 3 qt, 14 d	25.20	fgh	76.00	bcd
Kumulus (at budbreak), 5 lb/100 gal then Fracture, 18.3 fl oz + Dyneamic, 0.25% (v/v), 14 d	26.01	fgh	88.00	abc
Kumulus (at budbreak) then Fracture, 21 fl oz + Abound, 10 fl oz + Dyneamic, 0.25% (v/v) alt Procure, 8 fl oz + Dyneamic, 0.25% (v/v), 14 d	27.40	fg	77.60	abcd
Kumulus (at budbreak), 5 lb/100 gal then Fracture, 24.4 fl oz + Dyneamic, 0.25% (v/v) alt Abound, 15.4 fl oz + Dyneamic, 0.25% (v/v), 14 d	29.80	efg	84.80	abc
Kumulus (at budbreak), 5 lb/100 gal then Abound + Dyneamic, 15.4 fl oz alt Fracture, 24.4 fl oz + Dyneamic, 0.25% (v/v), 14 d	31.26	efg	92.00	abc
Chem Copp 50, 2 lb, 10 d	43.76	def	94.40	abc
AG Copp 75, 4 lb, 10 d	48.03	de	92.00	abc
Nordox 75 WG, 4 lb, 10 d	48.28	de	97.60	ab
Chem Copp 50, 6 lb, 10 d	51.90	cd	99.20	a
Centurion II, 0.2% (v/v), 14 d	54.30	cd	88.00	abc
Nordox 75 WG, 1.33 lb, 10 d	54.60	cd	97.60	ab
AG Copp 75 Organic, 4 lb, 10 d	58.78	bcd	98.40	ab
AG Copp 75 Organic, 1.33 lb, 10 d	68.00	bc	100.00	a
AG Copp 75, 4 lb, 20 d	69.20	bc	99.20	a
AG Copp 75 Organic, 4 lb, 20 d	74.76	b	100.00	a
K-Phite 7LP, 3 qt + DKP XTRA, 2 gal, 21 d	75.36	b	99.20	a
Untreated Control	96.30	a	100.00	a

Table 2. Disease incidence and severity in trial 2. Product names are followed by rate (per acre) and the frequency of application. Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05; alt =alternated with. Treatments 22 and 23 were sprayed with Stylet oil, 5% (v/v) on 4/19/13 and 4/26/13.

Treatment	Disease Severity %	Disease Incidence %
(Luna Experience, 6 fl oz alt Flint, 3 oz) + Dyneamic, 0.25% (v/v), 14d	0.0 d	0.0 g
(Luna Experience, 6 fl oz alt Flint, 2 oz + Sonata, 2 qt) + Dyneamic 0.25% (v/v), 14d	0.0 d	0.0 g
Luna Experience, 6 fl oz alt Sonata, 3 qt + Stylet oil, 1% (v/v), 14d	0.0 d	0.0 g
Merivon, 5 fl oz + ORUS 009, 32 fl oz/ 100 gallon alt Vivando, 15.4 fl oz + ORUS 009, 32 fl oz/ 100 gallon, 14-21d (RI)	0.0 d	0.8 fg
Merivon, 5 fl oz alt Vivando, 15.4 fl oz, 14-21d (RI)	0.0 d	3.2 fg
Luna Experience, 6 fl oz + Dyneamic, 0.25% (v/v), 21d	0.1 d	0.8 fg
Luna Tranquility, 16 fl oz + Dyneamic, 0.25% (v/v), 14d	0.1 d	2.4 fg
Inspire Super, 20 fl oz + Dyneamic, 0.1% (v/v) alt Quintec, 4 fl oz + Dyneamic, 0.1% (v/v) (last spray I.S.), 14d	0.1 d	2.4 fg
Pristine, 10.5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6.6 fl oz + Dyneamic, 0.125% (v/v), 21d	0.1 d	6.4 fg
Luna Experience, 6 fl oz alt Flint, 2 oz + Stylet oil, 1% (v/v), 14d	0.1 d	2.4 fg
A19334, 13 fl oz + Dyneamic, 0.1% (v/v) alt Quintec, 4 fl oz + Dyneamic, 0.1% (v/v) (last spray A19334), 14d	0.2 d	4.0 fg
Topguard, 10 fl oz, 14d	0.2 d	7.2 fg
Quintec, 6.6 fl oz + Dyneamic, 0.125% (v/v), 21d	0.2 d	8.0 fg
Rhyme, 10 fl oz, 14d	0.4 d	12.0 efg
A15457, 10.3 fl oz + Dyneamic, 0.1% (v/v) alt Quintec, 4 fl oz + Dyneamic, 0.1% (v/v) (last spray A15457), 14d	0.4 d	10.4 efg
Sonata, 3 qt + Dyneamic, 0.25% (v/v), 14d	1.0 d	20.0 defg
Quintec, 6.6 fl oz, 21d, alt Flint, 2 oz, 14d (standard)	1.1 d	23.2 cdef
Inspire Super, 20 fl oz + Dyneamic, 0.1% (v/v) then Taegro 13 WP, 5.2 oz + Dyneamic, 0.1% (v/v) then Quintec, 4 fl oz + Dyneamic, 0.1% (v/v) then Inspire Super, 20 fl oz + Dyneamic, 0.1% (v/v) then Taegro 13 WP, 5.2 oz + Dyneamic , 0.1% (v/v) (4x), 14d	1.3 cd	23.2 cdef
Luna Experience, 8 fl oz + Dyneamic, 0.125% (v/v) alt Quintec, 6.6 fl oz + Dyneamic, 0.125% (v/v), 21d	1.4 cd	16.8 defg
MCW-710 SC, 8.6 fl oz, 14d	2.1 cd	32.8 cde
MCW-710 SC, 8.6 fl oz alt Quintec, 4 fl oz, 14d	2.1 cd	14.4 defg
Rhyme, 2.5 fl oz, 14d	2.8 cd	44.8 c
Rhyme, 5 fl oz, 14d	3.1 cd	36.0 cd
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 4 fl oz + Dyneamic. 0.125% (v/v), 14d	3.9 cd	20.8 defg
Torino, 3.4 fl oz + Dyneamic, 0.125% (v/v) alt Quintec, 6.6 fl oz + Dyneamic, 0.125% (v/v), 14d	7.2 c	44.8 c
MCW-710 SC, 6 fl oz, 14d	18.3 b	68.8 b
Untreated Control	99.6 a	100.0 a

Table 2A. Disease incidence and severity in trial 2A. Product names are followed by rate (per acre) and the frequency of application. Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05; alt =alternated with.

Treatment	Disease Severity %		Disease Incidence %	
Stylet oil, 0.5% (v/v), 7d then Luna Exp, 8 fl oz + Stylet oil, 0.5% (v/v), 21d then MBI-10605, 2 qt, 7d	0.1	b	5.3	b
Stylet oil, 0.5% (v/v), 7d then Luna Exp, 8 fl oz + Stylet oil, 0.5% (v/v), 21d then Luna Experience, 6 fl oz, 21d then Flint, 2 oz, 14d, then MBI-10605, 2 qt, 7d	0.1	b	6.7	b
Untreated Control	99.6	a	100	a

Table 3. Disease severity in trial 3. Product names are followed by rate (per acre) and the frequency of application. Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05; alt =alternated with. All treatments were sprayed with Stylet oil, 0.5%(v/v) on 4/16/13; treatments 15-19 were sprayed with Stylet oil on 4/26/13 and 5/3/13.

Treatment	Disease Severity %		Disease Incidence %	
IKF-309, 4 fl oz (2x), 7-14 d alt Quintec, 6.5 fl oz (2x), 14 d	0.06	h	4.80	h
Phyton 27 AG, 40 fl oz/100 gal + HiWett, 0.1% (v/v), 10-14 d (RI)	0.08	h	5.60	h
Timorex Gold, 0.43 qt + Inspire, 5.25 fl oz, 10 d	0.16	h	6.40	h
Inspire, 5,25 fl oz, 10 d	0.46	gh	11.20	h
IKF-309, 4 fl oz, 7-14 d alt Quintec, 6.5 fl oz, 14 d	0.47	gh	23.20	gh
Phyton 27 AG, 25 fl oz/100 gal + HiWett, 0.1% (v/v), 10-14 d (RI)	1.31	fgh	12.80	h
IKF-309, 4 fl oz, (2x) 7-14 d alt Rally, 5 oz, (2x), 14 d	2.02	fgh	41.60	efg
IKF-309, 4 fl oz, 7-14 d alt Rally, 5 oz, 14 d	2.56	fgh	54.40	def
Torino SC, 3.4 fl oz, 14-17 d (RI)	4.80	efgh	61.60	def
IKF-309, 5 fl oz, 7-14 d	5.16	efgh	28.80	fgh
Rally, 5 oz then Torino, 3.4 fl oz then Rally, 5 oz then Torino, 3.4 fl oz then Flint, 2 oz then Quintec, 4.0 fl oz then Flint, 2 oz then Rally, 5 oz, 14-17 d (RI)	7.86	efgh	53.60	def
Rally, 5 oz then Pristine, 8 oz then Rally, 5 oz then Quintec, 4.0 fl oz then Flint, 2.0 oz then Torino, 3.4 fl oz then Flint, 2.0 oz then Rally, 5 oz, 14-17 d (RI)	14.42	defg	73.60	bcd
Phyton 27 AG, 25 fl oz/100 gal, 10-14 d (RI)	14.58	def	69.60	cd
Rally, 5 oz then Pristine, 8 oz then Rally, 5 oz then Torino, 3.4 fl oz then Flint, 2.0 oz then Torino, 3.4 fl oz then Flint, 2.0 oz then Rally, 5 oz, 14-17 d	18.18	de	79.20	abcd
Phyton 27 AG, 40 fl oz/100 gal, 10-14 d (RI)	25.78	cd	93.60	abc
Timorex Gold, 0.86 qt, 10 d	26.32	cd	94.40	abc
Timorex Gold, 0.43 qt, 10 d	36.61	bc	92.00	abc
Timorex Gold, 0.65 qt, 10 d	40.47	b	96.00	ab
Untreated Control	99.48	a	100.00	a

Table 4. Disease severity in trial 4. Product names are followed by rate (per acre) and the frequency of application. Treatment means followed by the same letter are not significantly different according to Fisher's LSD at α=0.05; alt =alternated with. All treatments were sprayed with Stylet oil, 5% (v/v) on 4/16/13 and 4/26/13.

Treatment	Disease Severity %		Disease Incidence (%)	
Stylet oil, 0.5% (v/v) (2x), 7d, then LI 6365, 10 fl oz (2x) then Rampart, 3 qt + Liberate, 0.125% (v/v) (2x) then LI 6265, 10 fl oz (2x), 14d	0.7	e	11	ef
Stylet oil, 0.5% (v/v) (2x), 7d, then LI 6365, 10 fl oz + Liberate, 0.125% (2x) then Rampart, 3 qt + Liberate, 0.125% (v/v) (2x) then LI 6365, 10 fl oz + Liberate, 0.125% (v/v) (2x), 14d	1.5	e	16	ef
Stylet oil, 0.5% (v/v) (2x), 7d, then LI 6365, 10 fl oz + Franchise, 0.125% (v/v) (2x) then Rampart, 3 qt + Liberate, 0.125% (v/v) (2x) then LI 6265, 10 fl oz + Franchise (2x), 0.125% (v/v), 14d	1.7	e	21	def
Stylet oil, 0.5% (v/v) (2x), 7d, then Abound, 10 fl oz + Dyneamic, 0.125% (v/v) (2x) then Rampart, 3 qt + Liberate, 0.125% (v/v) (2x) then Abound, 10 fl oz + Dyneamic, 0.125% (v/v) (2x), 14d	3.8	cde	31	de
Exp 4, 0.25% (v/v), 7d, alt Flint, 2 oz, 14d	11.2	cd	53	bc
Exp 4, 0.25% (v/v) + Flint, 1 oz, 14d	28.6	b	92	a
Flint, 2 oz, 14d	29.0	b	85	a
Untreated Control	96.6	a	100	a

Acknowledgements

We thank John Baranek for research cooperation and John and Cathy for the luncheon.. Thanks to Bob Silvera for use of the vineyard. Thanks to the various industry donors for providing of testing materials. We thank J. Hanstad, C. Swett, H. Yokahama-Hatch, B. McGuire, Ara Abramians, A. Haack, M. Hearn for assisting with disease evaluation in the field.

Appendix: Materials

Product	Active ingredient(s) and concentration	Manufacturer or distributor	Chemical class (after Adaskaveg et al. 2008)
A15457	proprietary	proprietary	N/A
A19334	proprietary	proprietary	N/A
Abound	azoxystrobin (22.9%)	Syngenta Crop Protection, Inc.	QoI
AG Copp 75	cuprous oxide (75% copper)	American Chemet Corporation	copper
AG Copp 75 Organic	cuprous oxide (75% copper)	American Chemet Corporation	copper
Centurion II	Cinnamon oil (80%)	Nature's Chem, LLC.	oil
Champ WG	copper hydroxide (50% copper)	American Chemet Corporation	copper
Chem Copp 50	cuprous oxide (50% copper)	American Chemet Corporation	copper
DKP XTRA	nitrogen (3%), phosphoric acid (18%), soluble potash (20%)	Plant Food Systems, Inc.	phosphonates
Dyneamic	polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of C16-C18 fatty acids (99%)	Helena Chemical Co.	adjuvant
Exp 4	proprietary	proprietary	N/A
Flint 50WG	trifloxystrobin (50%)	Bayer	QoI
Fracture	protein extracted from the plant of the genus Lupinus, 20%	FMC Corporation	natural compound
Franchise	lecithin, methylesters of fatty acids, and alcohol ethoxylate (100%)	Loveland Products, Inc.	adjuvant
Hi Wett	polysiloxane polyether copolymer, polyoxyethylene-polyoxypropylene copolymer & alcohol ethoxylate (100%)	First Choice	adjuvant
IKF-309	proprietary	ISK Biosciences	N/A
Inspire	difenoconazole (23.2%)	Syngenta Crop Protection, Inc	DMI
Inspire Super 2.82	difenoconazole (8.4%), cyprodinil (24%)	Syngenta Crop Protection, Inc.	DMI + anilinopyrimidine
JMS Stylet-Oil	paraffinic oil (97.1%)	JMS Flower Farms, Inc.	oil
K-Phite 7LP	potassium phosphate (56%)	Plant Food Systems, Inc.	phosphonates
Kumulus DF	sulfur (80%)	BASF	sulfur

LI 6365	proprietary	proprietary	N/A
Liberate	lecithin, methylesters of fatty acids, and alcohol ethoxylate (100%)	Loveland Products, Inc.	adjuvant
Luna Experience	fluopyram (17.54%), tebuconazole (17.54%)	Bayer	DMI-triazole/ N/A
Luna Tranquility	fluopyram (11.3%) pyrimethanil (33.8%)	Bayer	SDHI/AP
MBI-10605	proprietary	proprietary	N/A
MCW-710 SC	proprietary	proprietary	N/A
Merivon	fluxabyroxad (21.26%) pyraclostrobin (21.26%)	BASF	SDHI + QoI
Nordox 75 WG	cuprous oxide (75% copper)	American Chemet Corporation	copper
ORUS 009	proprietary	proprietary	N/A
Phyton-27 AG	copper sulfate pentahydrate (21.27%)	Phyton Corporation	other
Pristine	pyraclostrobin (12.8%) boscalid (25.2%)	BASF	QoI + carboxamide
Procure 480SC	triflumizole (42.14%)	Chemtura AgroSolutions	DMI
Quintec	quinoxyfen (22.6%)	Dow AgroSciences LLP	quinoline
Rally 40 WSP	myclobutanil (40%)	Dow AgroSciences LLP	DMI
Rampart	mono- and dipotassium salts of phosphorous Acid (53%)	Loveland Products, Inc.	phosphonates
Rhyme	flutriafol (12%)	Cheminova	DMI
Sonata	*Bacillus pumilus* QST 2808 (1.38%)	Agraquest	biological
Taegro 13 WP	*Bacillus subtilis* Strain FZB24	Syngenta Crop Protection, Inc	biological
Timorex Gold	oil derived from the tea tree, *Melaleuca alterniflora* (23.8%)	Biomor Israel Ltd.	oil
Topguard	flutriafol (12%)	Cheminova	DMI
Torino	cyflufenamid (10%)	Gowan Co.	N/A
Vivando	metrafenone (300g/L)	BASF	benzophenone

Appendix sources: (1) Adaskaveg, et al. 2012. Efficacy and timing of fungicides, bactericides and biologicals for deciduous tree fruit, nut, strawberry, and vine crops 2012, available at http://ucanr.edu/sites/plp/files/146650.pdf. (2) Janousek et al. 2008. Grape powdery mildew trials, available at http://ucanr.edu/sites/plp/Cooperative_Extension/gubler/fungtrials2008/, (3) Bay, et al, 2012, Grape powdery mildew Trials available at: http://ucanr.edu/sites/plp/Cooperative_Extension/gubler/fungtrials2012/ , (4) product-specific MSDS and/or labels.