Final Report: Powdery mildew control of Cucurbit with organic and synthetic fungicides: 2014 field trial

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Report Summary

Powdery mildew is an important disease in commercial members of the Cucurbit family. The specific pathogen that infects cucurbits in California is *Podosphaera fusca* (synonyms: *P. xanthii*, *Sphaerotheca fulginea* and *S. fusca*), (Janousek et al. 2009, McGrath and Thomas 1996, Pérez-García et al. 2009). Over-wintering chasmothecia produce ascospores that infect then develop into whitish colonies on leaves, leaf petioles, and stems (McGrath and Thomas 1996, Glawe 2008). Wind or insect vectors disperse asexually-produced conidia and thus spread the disease (Blancard et al. 1994). Favorable conditions for disease epidemics include temperatures between 20-27°C and lower-intensity light (McGrath and Thomas 1996). Disease outbreaks in the Central Valley of California tend to occur during late summer and autumn months, but coastal areas may be continuously threatened (Davis et al. 2008). Infections have the potential to reduce the yield and quality of fruit and can lead to early plant senescence (Blancard et al. 1994, McGrath and Thomas 1996).

A field trial at the UC Davis plant pathology experimental farm in Solano County, California was conducted to evaluate the effectiveness of 'soft-chemistry' and synthetic fungicides in managing powdery mildew on pumpkins (*Cucurbita pepo*) using the susceptible cultivar 'Lil' Pump-Ke-Mon'. We applied fungicides every 7 or 14 days for a five week period beginning Aug 26 and continuing through Sep 23. Following three or five applications, depending on treatment, we assessed disease incidence and powdery mildew colony density on the upper and lower surfaces of leaves in each treatment on Sep 27.

Temperatures were dry and mild during much of the 2014 growing season, providing optimal conditions for the asexual reproduction and dispersal of powdery mildew. Overall disease pressure was moderate. By the end of September, disease incidence in the untreated plots reached 100%.

Figure 1. Pumpkin leaf showing powdery mildew.

Materials and Methods

A. Trial Layout

Table 1: Experimental design and treated area/treatment.

Experimental design	Complete randomized block design with 4 replicates.		
Application method	Handgun sprayers (attached to Nifty Fifty brand 25 or 50 gallon sprayers).		
Plot length	14 feet	Bed spacing	10 feet
No. plants/plot	7-8	Plot area	70 ft^2 (14 ft by 5 ft)
Plant spacing	variable	Area/4 plots	280 ft^2 (=0.0064 acres)
Application period	26 Aug – 23 Sept (7 and 14 day intervals)		
Volume water applied	100 gallons/acre=0.64 gallons/treatment 150 gallons/acre (=0.96 gallons per treatment) 225 gallons/acre (=1.28 gallons per treatment)		

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, "alt" = alternated with.

Table 2: Experimental fungicide treatments. "alt" = alternated with; "FP" = formulated product

Treatment	No.	Flag color	Application interval (days)	Application rate (per acre)	FP/application
Unsprayed control	1	W	None	none	none
Pyriofenone	2	Br	7	4 fl oz	0.8 ml
Pyriofenone	3	Y	7	5 fl oz	0.9 ml
Pyriofenone alt Quintec	4	C	7	4 fl oz alt 6 fl oz	0.8 ml alt 1.1 ml
Pyriofenone alt Quadris	5	G/P	7	4 fl oz alt 15.4 fl oz	0.8 ml alt 2.9 ml
Rhyme	6	O	7	3.5 fl oz	0.7 ml
Rhyme	7	G	7	7 fl oz	1.3 ml
Topguard	8	K	7	14 fl oz	2.6 ml
Rhyme + Dyneamic	9	G/O	7	3.5 fl oz + 0.25 % (v/v)	0.7 ml + 6.1 ml at 100 gal or 9.1 ml at 150 gal or 12.1 ml at 200 gal
OxiPhos (rate phytotoxicity)	10	P	7	5 qt	30.3 ml
OxiDate 2.0 + Silwet ECO (rate phytotoxicity)	11	R	7	2.5% (v/v) + 0.05% (v/v)	60.6 ml at 100 gal or 90.8 ml at 150 gal or 121.1 ml at 200 gal + 1.2 ml at 100 gal or 1.8 ml at 150 gal or 2.4 ml at 200 gal
Timorex Gold	12	G/Y	7	27.4 fl oz	5.2 ml
Quintec + Dyneamic alt Timorex Gold	13	G/Pu	10-14	6 fl oz + 0.125% (v/v) alt 27.4 fl oz	1.1 ml + 3.0 ml at 100 gal or 4.5 ml at 150 gal or 6.1 ml at 200 gal alt 5.2 ml
(Rally alt Quintec) + Dyneamic	14	G/R	10-14	(5 oz alt 6 fl oz) + 0.125% (v/v)	(0.9 g alt 1.1 ml) + 3.0 ml at 100 gal or 4.5 ml at 150 gal or 6.1 ml at 200 gal
Quintec + Dyneamic	15	Pu	10-14	6 fl oz + 0.125% (v/v)	1.1 ml + 3.0 ml at 100 gal or 4.5 ml at 150 gal or 6.1 ml at 200 gal
Rally + Dyneamic	16	B	10-14	5 oz + 0.125% (v/v)	0.9 g + 3.0 ml at 100 gal or 4.5 ml at 150 gal or 6.1 ml at 200 gal
Pyriofenone	17	S	14	5 fl oz	0.9 ml

C. Trial Map

Figure 2: Map layout; Grey box = unused plot (plant density too low).

S ←

O	G/P	O	x	S	W
x	C	G/P	x	R	B
G	Y	B	G/Pu	G	G/Pu
K	Br	P	W	G/O	G/R
G/O	W	G/Y	R	Pu	x
P	K	S	K	P	x
R	Br	B	Y	O	x
G/Y	W	G/R	G/O	G/P	x
G/Pu	Y	G/Pu	S	K	x
G/R	G	R	Br	Br	x
Pu	x	G/O	G/Y	G/Y	x
B	Pu	C	Pu	Y	x
S	G/P	P	G/R	C	x
x	x	O	C	G	x

D. Plant Management

Plants were watered every two weeks by furrow irrigation.

E. Disease and Statistical Analysis

Disease was assessed on Sep 27. Powdery mildew incidence and severity were assessed in each plot by evaluating ten random leaves. Incidence was defined as the proportion of leaves in a plot having some living powdery mildew. Severity was determined by estimating the percentage of leaf surface area that was infected. Data was analyzed using a one-way ANOVA and means were compared using Student's t-test ($\alpha = 0.05$).

F. Weather and Disease

Weather from a CIMIS weather station in Davis, California was followed. Weather for the spray season was somewhat dry with 2 precipitation events of 0.1 mm on Sep 19 and 10.6 mm on Sep 25. Overall disease pressure was moderate with disease severity reached 36.8% (upper leaf) and 41% (bottom leaf) in the untreated control and incidence reached 100%.

Figure 3: Daily temperature data from CIMIS weather station for Aug 25 to Sep 29 period.

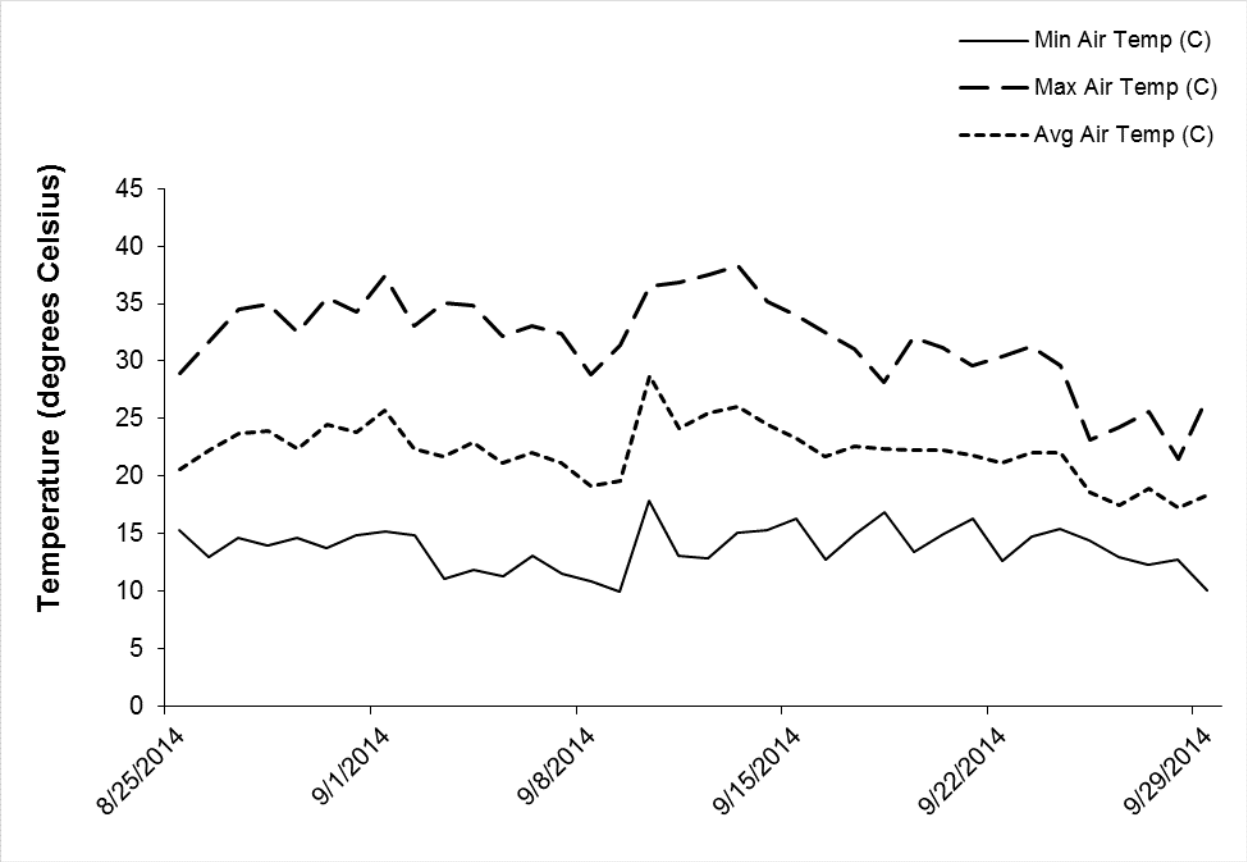


Figure 4: Daily precipitation data from CIMIS weather station for Aug 25 to Sep 29 period.

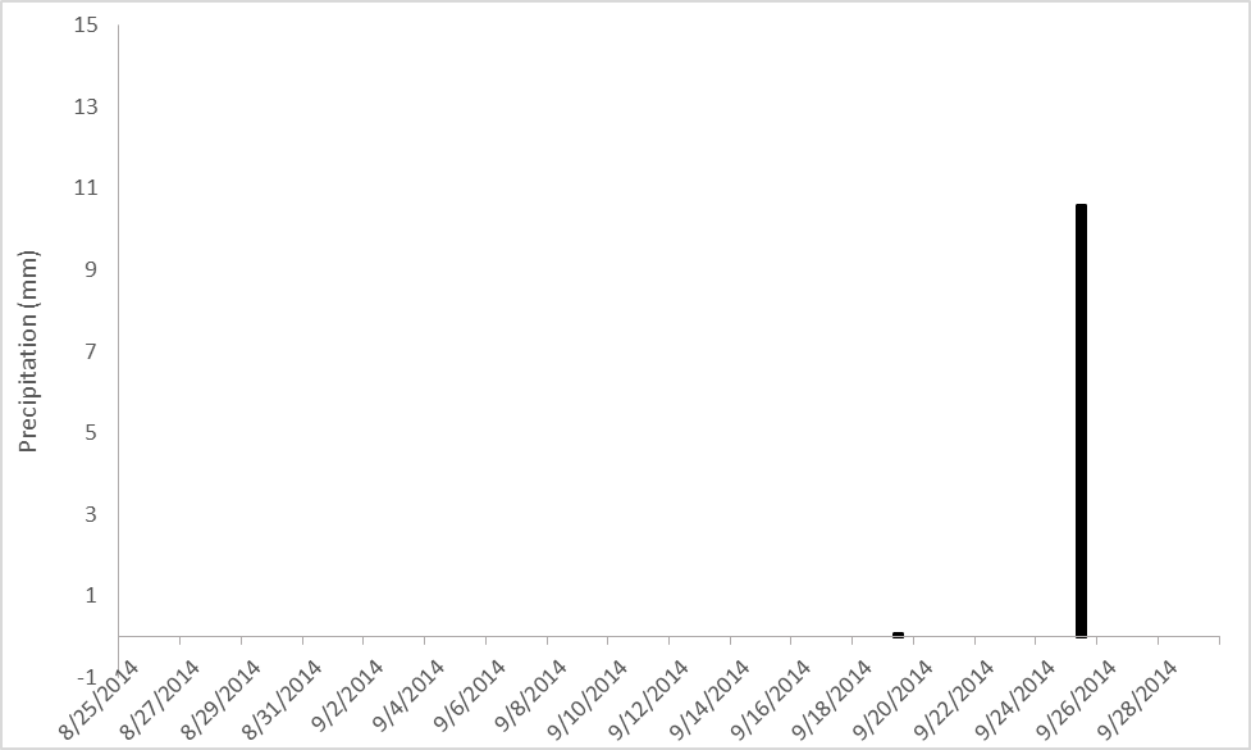
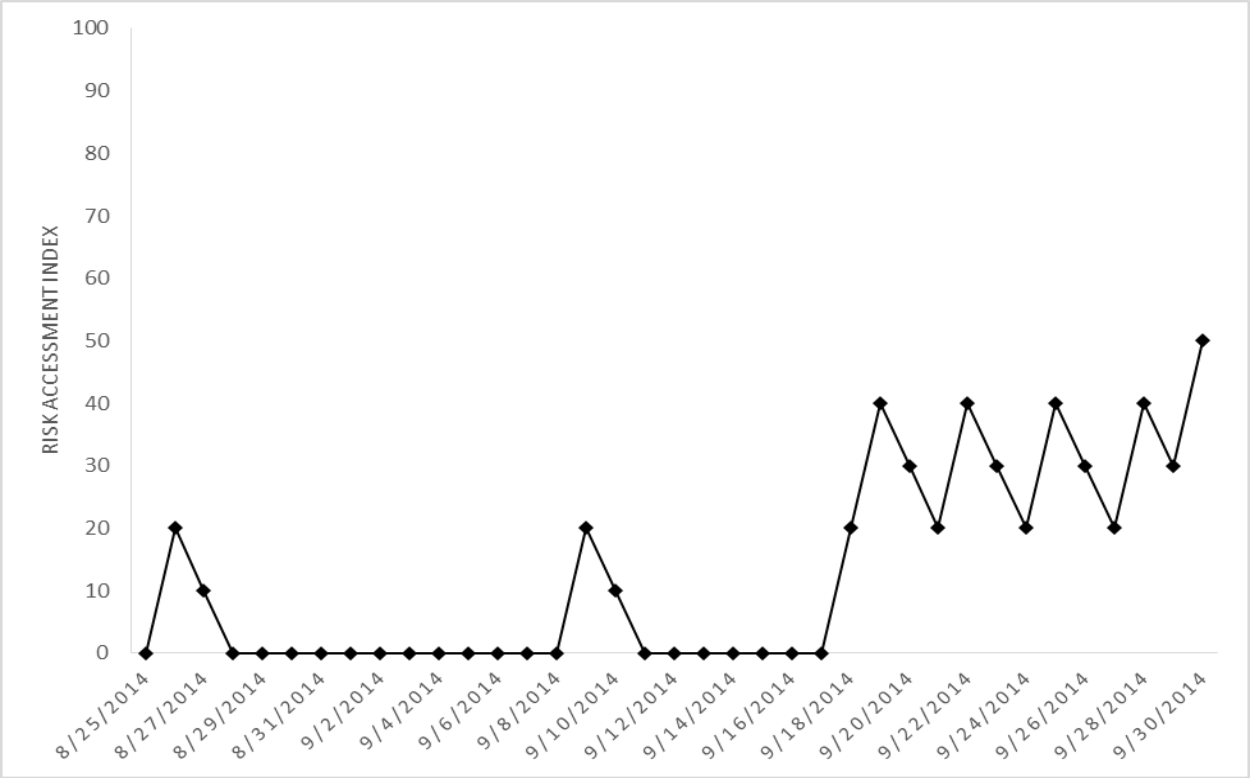


Figure 5: Thomas-Gubler Powdery Mildew risk index data from Aug 25-Sep 30. Late season disease pressure is evident as the index begins to increase on approximately 9/18.



Results

Table 3: Treatment effects on disease incidence and severity on the upper surfaces of leaves of pumpkin. Treatments sharing the same letter within a column are not significantly different according to Student's t-test at $\alpha = 0.05$.

Treatment	Top Leaf Incidence (%)		Top Leaf Severity (%)	
Pyriofenone 4 fl oz alt Quintec 6 fl oz, 7d	10.00	f	0.45	e
Quintec 6 fl oz + Dyneamic 0.125% (v/v), 10-14d	35.00	ef	1.50	e
Pyriofenone 5 fl oz, 7d	30.00	ef	1.90	e
Rhyme 3.5 oz + Dyneamic 0.25 % (v/v), 7d	45.00	de	2.08	e
Pyriofenone 4 fl oz, 7d	30.00	ef	2.55	e
Rhyme 7 oz, 7d	42.50	de	2.95	e
Rhyme 3.5 oz, 7d	45.00	de	3.25	e
Topguard 14 oz, 7d	57.50	cde	3.58	e
Pyriofenone 4 fl oz alt Quadris 15.4 fl oz, 7d	52.50	cde	4.40	de
(Rally 5 oz alt Quintec 6 fl oz) + Dyneamic 0.125% (v/v), 10-14d	47.50	de	5.48	de
Rally 5 oz + Dyneamic 0.125% (v/v), 10-14d	67.50	bcd	6.03	de
Quintec 6 fl oz + Dyneamic 0.125% (v/v) alt Timorex Gold 27.4 fl oz, 10-14d	77.50	abc	6.13	de
Pyriofenone 5 fl oz, 14d	52.50	cde	6.13	de
OxiPhos 5 qt, 7d	80.00	abc	10.13	cd
Oxidate 2.0 2.5 % (v/v) + Silwet ECO 0.05 % (v/v), 7d	80.00	abc	12.23	c
Timorex Gold 27.4 fl oz, 7d	95.00	ab	19.75	b
Untreated Control	100.00	a	36.75	a

Table 4: Treatment effects on disease severity and incidence on the bottom surfaces of leaves of pumpkin. Treatments sharing the same letter within a column are not significantly different according to Student's t-test at $\alpha = 0.05$.

Treatment	Bottom Leaf Incidence (%)		Bottom Leaf Severity (%)	
Quintec 6 fl oz + Dyneamic 0.125% (v/v), 10-14d	50.00	d	2.33	f
Pyriofenone 4 fl oz alt Quintec 6 fl oz, 7d	42.50	d	3.30	ef
(Rally 5 oz alt Quintec 6 fl oz) + Dyneamic 0.125% (v/v), 10-14d	60.00	cd	5.45	def
Rhyme 7 oz, 7d	80.00	abc	6.40	def
Topguard 14 oz, 7d	77.50	bc	7.68	def
Rhyme 3.5 oz + Dyneamic 0.25 % (v/v), 7d	85.00	ab	8.65	cdef
Rhyme 3.5 oz, 7d	85.00	ab	8.73	cdef
Quintec 6 fl oz + Dyneamic 0.125% (v/v) alt Timorex Gold, 27.4 fl oz, 10-14d	95.00	ab	9.15	cdef
Pyriofenone 5 fl oz, 7d	90.00	ab	10.43	cdef
Pyriofenone 4 fl oz alt Quadris 15.4 fl oz, 7d	92.50	ab	10.73	cdef
Pyriofenone 4 fl oz, 7d	90.00	ab	12.70	cde
Rally 5 oz + Dyneamic 0.125% (v/v), 10-14d	97.50	ab	14.00	cd
OxiPhos 5 qt, 7d	95.00	ab	17.50	bc
Pyriofenone 5 fl oz, 14d	90.00	ab	18.00	bc
Oxidate 2.0 2.5 % (v/v) + Silwet ECO 0.05 % (v/v), 7d	97.50	ab	23.75	b
Timorex Gold 27.4 fl oz, 7d	95.00	ab	24.50	b
Untreated Control	100.00	a	41.00	a

Acknowledgements

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Appendix: materials

Product	Active ingredient(s) and concentration	Class	Manufacturer or Distributor
Dyneamic	Polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of C16-C-18 fatty acids (99%)	adjuvant	Helena Chemical Co.
Oxidate 2.0	hydrogen dioxide (27.1%) peroxyacetic acid (2.0%)	oxidizer	BioSafe Systems, LLC
Oxiphos	mono- and di-potassium salts of phosphorus acid (27.1%) hydrogen peroxide (14%)	phosphorous acid	BioSafe Systems, LLC
Pyriofenone	proprietary	proprietary	N/A
Quadris	azoxystrobin (22.9%)	QoI	Syngenta Crop Protection, Inc
Quintec	quinoxyfen (22.6%)	quinoline	Dow Agrosciences, LLC
Rally 40 WSP	myclobutanil (40%)	DMI-triazole	Dow Agrosciences, LLC
Rhyme	flutriafol (12%)	DMI	Cheminova
Silwet ECO	n/a	adjuvant	Momentive
Timorex Gold	oil derived from the tea tree, *Melaleuca alterniflora* (23.8%)	Biomor Israel Ltd.	oil
Topguard	flutriafol (12%)	DMI	Cheminova

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) Gubler Lab field trials, available at http://plantpathology.ucdavis.edu/Cooperative_Extension/ (3) product-specific MSDS and/or labels.