Final Report: Powdery mildew control on pumpkin with organic and synthetic fungicides: 2013 field trial

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

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

University of California Cooperative Extension,
Department of Plant Pathology,
University of California, Davis – October 2013

Published November 2013 at
http://plantpathology.ucdavis.edu/Cooperative_Extension/Gubler/2013_Fruit_Crop_Fungicide_Trials/

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 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).

We conducted a field trial at the UC Davis plant pathology experimental farm in Solano County, California to evaluate the effectiveness of 'soft-chemistry' and synthetic fungicides in managing powdery mildew on pumpkins (*Cucurbita pepo*) using the susceptible cultivar 'Sorcerer'. We applied fungicides every 7 to 14 days for a five week period beginning Sept 4 and continuing through Oct 9. Following three or six 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 Oct 16.

Temperatures were dry and 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 mid October, disease incidence in untreated plots reached 95-100%.

Figure 1. Pumpkin leaf showing powdery mildew.

Materials and Methods

A. Trial Layout

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	16 feet
No. plants/plot	7-8	Plot area	112 ft^2 (14 ft by 8 ft)
Plant spacing	variable	Area/4 plots	448 ft^2 (=0.0103 acres)
Application period	4 Sept – 9 Oct (7 and 14 day intervals)		
Volume water applied	100 gallons/acre=1.0 gallons/treatment 150 gallons/acre (=1.6 gallons per treatment) 225 gallons/acre (=2.3 gallons per treatment)		

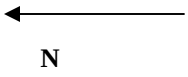
B. Experimental Treatments

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.

Treatment	No.	Flag color	Application interval (days)	Application rate (per acre)	FP/application
Unsprayed control	1	W	None	none	none
Topguard	2	Br	7	14 fl oz	4.3 ml
Rhyme	3	Y	7	3.5 fl oz	1.1 ml
Rhyme	4	O	7	7 fl oz	2.1 ml
Rhyme	5	C	7	14 fl oz	4.3 ml
Rhyme + Dyneamic	6	G/P	7	3.5 fl oz + 0.25% (v/v)	1.2 ml + 9.5 ml (at 100 gal) or 15.1 ml (at 150 gal) or 21.8 ml (at 225 gal)
IKF-309	7	G	7	4 fl oz	1.2 ml
IKF-309 alt Quintec	8	K	7	4 fl oz alt 6 fl oz	1.2 ml alt 1.8 ml
IKF-309 alt Procure	9	G/O	7	4 fl oz alt 8 fl oz	1.2 ml alt 2.4 ml
Phyton 27 AG	10	S	7	25 fl oz/100 gal	7.6 ml(at 100 gal) or 11.4ml (at 150 gal) or 17.1 ml (at 225 gal)
Phyton 27 AG + HiWett	11	Pu	7	25 fl oz/100 gal + 0.1% (v/v)	7.6 ml (at 100 gal) or 11.4 ml (at 150 gal) or 17.1 ml (at 225 gal) + 3.8 ml (at 100 gal) or 6.1 ml (at 150 gal) or 8.7 ml (at 225 gal)
Fontelis alt Quintec	12	O/Y	7	16 fl oz alt 4 fl oz	4.8 ml alt 1.2 ml
Fontelis	13	G/R	7	16 fl oz	4.8 ml
Quintec + Dyneamic	14	S/Y	14	6 fl oz + 0.125% (v/v)	1.8 ml + 0.5 ml (at 100 gal) or 0.8 ml (at 150 gal) or 1.1 ml (at 225 gal)
Rally + Dyneamic	15	K/O	14	5 oz +0.125% (v/v)	1.5 g + 0.5 ml (at 100 gal) or 0.8 ml (at 150 gal) or 1.1 ml (at 225 gal)
Rally + Dyneamic alt Quintec + Dyneamic	16	G/Y	14	5 oz + 0.125% (v/v) alt 6 fl oz + 0.125% (v/v)	(1.5 g alt 1.8 ml) + 0.5 ml (at 100 gal) or 0.8 ml (at 150 gal) or 1.1 ml (at 225 gal)
Centurion II	17	G/Pu	14	0.25% (v/v)	9.5ml (at 100 gal) or 15.2 ml (at 150 gal) or 21.8 ml (at 225 gal)
Centurion II + NuFilm-P	18	P	14	0.25% (v/v) + 4 fl oz/100 gal	9.5ml (at 100 gal) or 15.2 ml (at 150 gal) or 21.8 ml (at 225 gal) + 1.2 ml (at 100 gal) or 1.8 ml (at 150 gal) or 2.7 ml (at 225 gal)
Centurion II	19	R	14	0.3% (v/v)	11.4 ml (at 100 gal) or 17.1 ml (at 150 gal) or 26.1 ml (at 225 gal)

C. Trial Map

Grey box = unused plot (plant density too low).



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

D. Plant Management

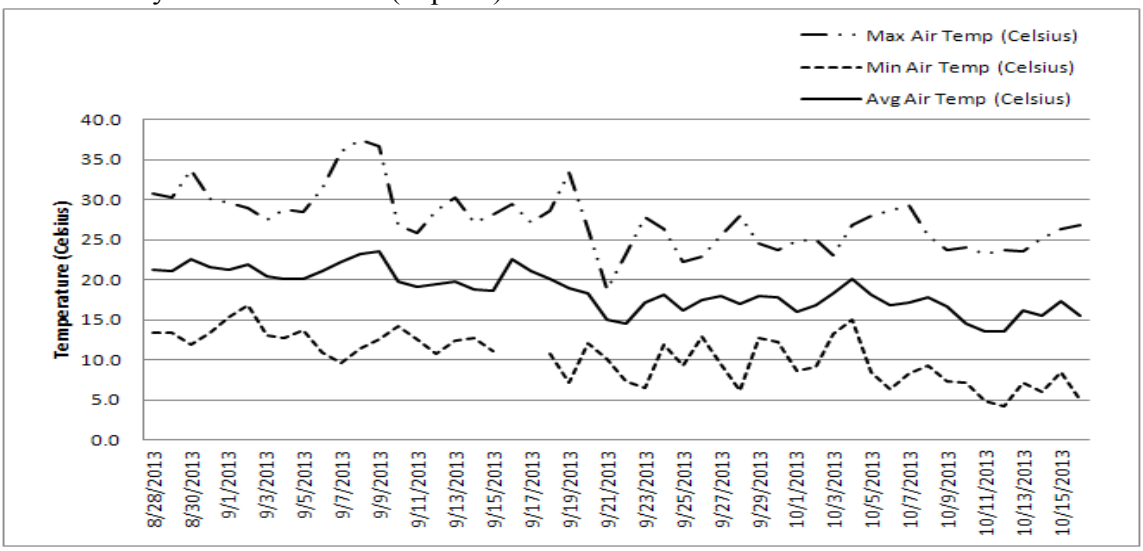
Plants were watered every two weeks by furrow irrigation.

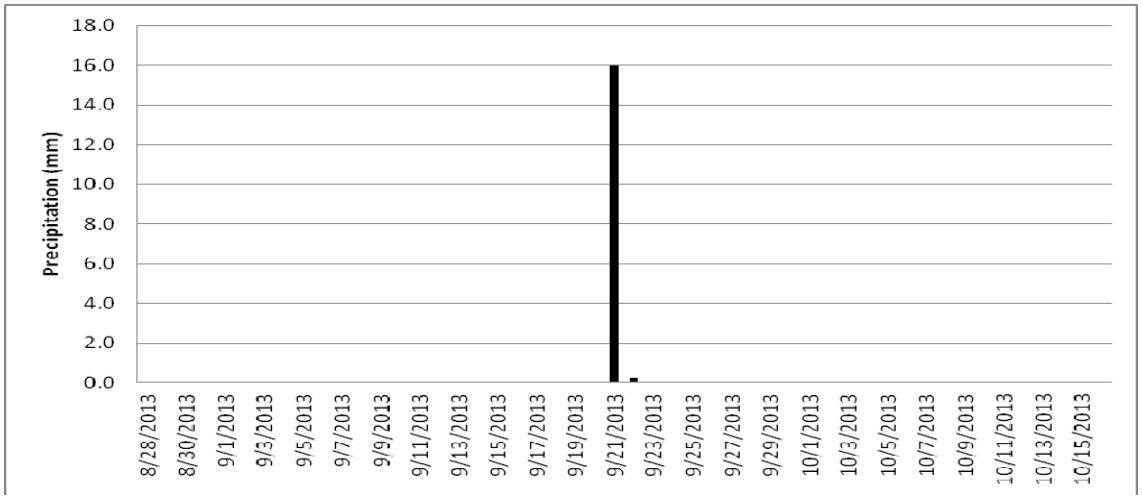
E. Disease and Statistical Analysis

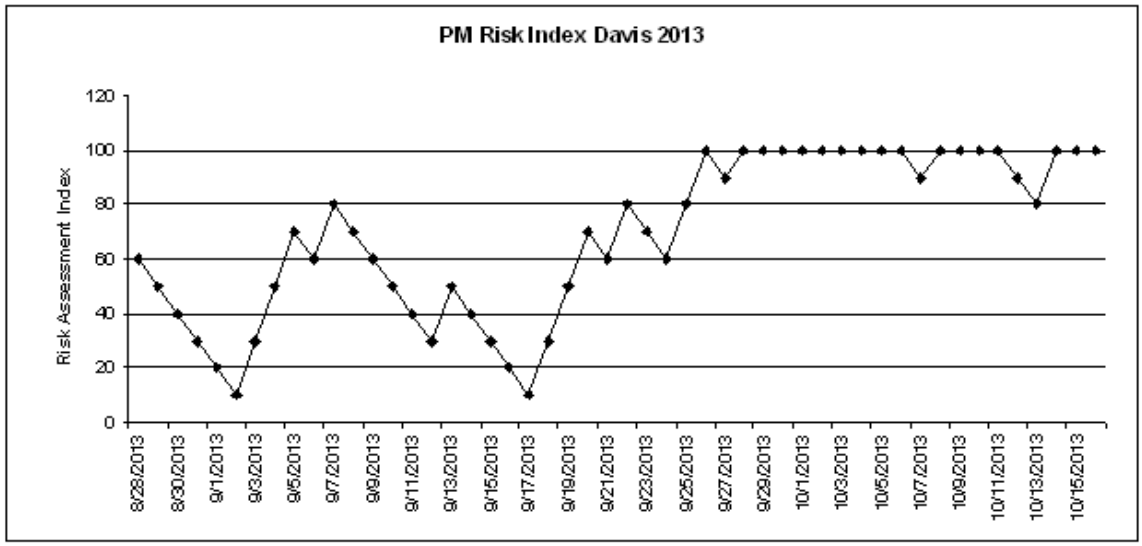
Disease was assessed on Oct 16. Powdery mildew incidence and severity were assessed in each plot by evaluating ten random leaves. Incidence was defined as the proportion of leaves in a plot having some living powdery mildew. Severity was determined by estimating the percentage of leaf surface area that was infected. Data was analyzed using a one-way ANOVA and means were compared using Fisher's protected LSD test ($\alpha = 0.05$).

F. Weather and Disease

Weather from CIMIS weather station in Dixon, California. Weather for the spray season was somewhat dry with 1 rain event (Sept 21) of 16 mm of rain.







Results

Table 1. Treatment effects on disease severity and incidence on the upper surfaces of leaves of pumpkin. Treatments sharing the same letter within a column are not significantly different according to Fisher's protected LSD test at $\alpha = 0.05$.

Treatment	Top leaf Severity (%)		Top Leaf Incidence (%)	
Untreated control	41.63	a	95.0	ab
Centurion II, 0.3% (v/v), 14d	40.65	a	100.0	a
Centurion II, 0.25% (v/v), 14d	33.38	a	90.0	ab
Phyton 27 AG, 25 fl oz/100 gal, 7d	21.88	b	95.0	ab
Rhyme, 3.5 fl oz, 7d	18.00	bc	82.5	ab
Centurion II, 0.25% (v/v) + NuFilm-P, 4 fl oz/100 gal, 14d	12.73	bcd	82.5	ab
Phyton 27 AG, 25 fl oz/100 gal + HiWett, 0.1% (v/v)	8.48	cde	75.0	b
Rhyme, 7 fl oz, 7d	4.05	de	47.5	c
Topguard, 14 fl oz, 7d	3.60	de	47.5	c
Rhyme, 3.5 fl oz + Dyneamic, 0.25% (v/v), 7d	2.88	de	32.5	cd
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14d	2.25	e	32.5	cd
Rhyme, 14 fl oz, 7d	1.25	e	15.0	de
Fontelis, 16 fl oz, 14d	1.10	e	25.0	de
Rally, 5 oz + Dyneamic, 0.125% (v/v), 14d	1.03	e	15.0	de
IKF-309, 4 fl oz, 7d	0.80	e	15.0	de
Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14d	0.73	e	20.0	de
Fontelis 16 fl oz alt Quintec, 4 fl oz, 7d	0.70	e	20.0	de
IKF-309, 4 fl oz alt Procure, 8 fl oz, 7d	0.55	e	20.0	de
IKF-309, 4 fl oz alt Quintec, 6 fl oz, 7d	0.10	e	5.0	e

Table 2. 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 Fisher's protected LSD test at $\alpha = 0.05$.

Treatment	Bottom Leaf Severity (%)		Bottom Leaf Incidence (%)	
Untreated control	37.13	a	100	a
Centurion II, 0.3% (v/v), 14d	35.88	a	97.5	a
Centurion II, 0.25% (v/v), 14d	31.45	ab	92.5	a
Rhyme, 3.5 fl oz, 7d	22.93	bc	95	a
Phyton 27 AG, 25 fl oz/100 gal, 7d	22.20	bc	95	a
Centurion II, 0.25% (v/v) + NuFilm-P, 4 fl oz/100 gal, 14d	19.98	cd	100	a
Phyton 27 AG, 25 fl oz/100 gal + HiWett, 0.1% (v/v)	11.93	de	97.5	a
Rhyme, 7 fl oz, 7d	10.98	de	87.5	abc
Topguard, 14 fl oz, 7d	9.28	ef	90	ab
Rally, 5 oz + Dyneamic, 0.125% (v/v), 14d	7.35	ef	70	bcdef
Rhyme, 14 fl oz, 7d	6.75	ef	80	abcde
Rhyme, 3.5 fl oz + Dyneamic, 0.25% (v/v), 7d	6.00	ef	85	abcd
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14d	4.93	ef	62.5	ef
IKF-309, 4 fl oz, 7d	4.20	ef	60	ef
Fontelis 16 fl oz alt Quintec, 4 fl oz, 7d	3.93	ef	65	def
IKF-309, 4 fl oz alt Procure, 8 fl oz, 7d	3.33	ef	67.5	cdef
Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14d	3.25	ef	68.3	cdef
Fontelis, 16 fl oz, 14d	2.70	ef	50	fg
IKF-309, 4 fl oz alt Quintec, 6 fl oz, 7d	1.70	f	35	g

Acknowledgements

We thank M. Frelinger for assistance with rating and staff at the Armstrong facility for maintenance of the field.

References

Blancard, D, H Lecoq, M Pitrat and M Javoy. (1994) *A Colour Atlas of Cucurbit Diseases: Observation, Identification, and Control*. Manson Publishing Ltd., London, England.

Davis, RM, TA Turini, BJ Aegerter, WD Gubler and JJ Stapleton. (2008) UC Davis IPM Management Guidelines: Cucurbits, UC ANR Publication 3445, at http://www.ipm.ucdavis.edu/PMG/r116100711.html.

Glawe, DA. (2008) The powdery mildews: a review of the world's most familiar (yet poorly known) plant pathogens. Annual Review Phytopathology 46:27-51.

Janousek, CN, JD Lorber and WD Gubler. (2007) Control of powdery mildew on pumpkin leaves by experimental and registered fungicides: 2007 trials. On-line report published at: http://plantpathology.ucdavis.edu/ext/gubler/fungtrials2007/.

Janousek, CN, H Su and WD Gubler. (2009) Control of powdery mildew on pumpkin leaves: 2008 field trial. UC Davis: Department of Plant Pathology. http://escholarship.org/uc/item/12t1z046.

McGrath, MT, H Staniszewska, N Shishkoff and G Casella. (1996) Fungicide sensitivity of *Sphaerotheca fuliginea* populations in the United States. Plant Disease 80:697-703.

McGrath, MT and CE Thomas. (1996) Powdery mildew. In: *Compendium of Cucurbit Diseases*, Zitter, TA, DL Hopkins and CE Thomas (eds.), APS Press, St. Paul, MN, p.28-30.

Pérez-García, A, D Romero, D Fernández-Ortuño, F López-Ruiz, A de Vicente and JA Torés. (2009) The powdery mildew fungus *Podosphaera fusca* (synonym *Podosphaera xanthii*), a constant threat to cucurbits. Molecular Plant Pathology 10:153-160.

Appendix: materials

Product	Active ingredient(s) and concentration	Class	Manufacturer or Distributor
Centurion II	Cinnamon oil (80%)	oil	Nature's Chem, LLC.
Dyneamic	Polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of C16-C-18 fatty acids (99%)	adjuvant	Helena Chemical Co.
Fontelis	penthiopyrad (20%)	SDHI	DuPont
Hi Wett	polysiloxane polyether copolymer, polyoxyethylene-polyoxypropylene copolymer & alcohol ethoxylate (100%)	adjuvant	First Choice
IKF - 309	proprietary	proprietary	N/A
Nufilm-P	oxyethylene (100%)	adjuvant	Miller Chemical & Fertilizer Corp.
Phyton-27 AG	copper sulfate pentahydrate (21.27%)	other	Phyton Corporation
Procure 480SC	triflumizole (42.14%)	DMI	Chemtura AgroSolutions
Quadris Top 2.71	azoxystrobin (18.2%), difenoconazole (11.9%)	DMI-triazole/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
Topguard	flutriafol (12%)	DMI	Cheminova

Appendix references: (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) Bay, et al, 2012, Pumpkin powdery mildew trial, available at: http://ucanr.edu/sites/plp/Cooperative_Extension/gubler/fungtrials2012/ .
(3) Fungicide trial reports at http://plantpathology.ucdavis.edu/Cooperative_Extension/Gubler/2013_Fruit_Crop_Fungicide_Trials/
(3) various sources including product labels and/or MSDS, or product websites.