
Powdery mildew control on pumpkin with organic and synthetic fungicides: 2012 field trial

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Summary

Powdery mildew is an important disease in commercial members of the cucumber 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 colonies on leaves, leaf petioles, and stems (McGrath and Thomas 1996, Glawe 2008). Wind disperses conidia. (Blancard et al. 1994). Favorable conditions for disease epidemics include temperatures between 20-27°C and low-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 (Davey et al. 2008). Infections have the potential to reduce the yield and quality of fruit and can lead to early plant death (Blancard et al. 1994, McGrath and Thomas 1996).

Disease management in cucurbits usually involves foliar applications of synthetic fungicides and/or use of disease resistant cultivars (McGrath and Thomas 1996). Fungicides such as azoxystrobin, myclobutanil, quinoxyfen, trifloxystrobin, triflumizole, and micronized sulfur can be used to treat plants (Davis et al. 2008). Sulfur has the advantage of little or no risk of selecting for resistant mildew strains (Blancard et al. 1994). Previous work in our lab has shown that quinoxyfen, triflumizole, and penthiopyrad are highly effective at managing powdery mildew in disease susceptible varieties (Janousek et al. 2007, 2009).

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 six week period beginning Aug 22 and continuing through Oct 3. Following four or seven applications (depending on treatment) we assessed disease incidence and powdery mildew colony density on the upper and lower surfaces of leaves in each treatment.

Figure 1. a) Pumpkins in field at maturity and b) Pumpkin leaf showing powdery mildew.



Materials and Methods

Experimental design	Complete randomized block design with 4 replicates.		
Application method	Backpack sprayers		
Plot length	14 feet	Bed spacing	16 feet
No. plants/plot	Approximately 7	Plot area	112 ft ² (14 ft by 8 ft)
Plant spacing	variable	Area/4 plots	448 ft ² (=0.0103 acres)
Application period	22 Aug – 3 Oct (7 and 14 day intervals)		
Volume water applied	100 gallons/acre=1.0 gallons/acre 150 gallons/acre (=1.6 gallons per treatment) 225 gallons/acre (=2.3 gallons per treatment)		

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Table 1. Pumpkin Trial - 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
Material B + HiWett	2	Br	7	8.5 lbs/100 gal + 7.5 fl oz	38.6 g (100 gal) 57.9 g (150 gal) 86.9 (225 gal) + 2.3 ml
Material C + HiWett	3	Y	7	8.5 lbs/100 gal + 7.5 fl oz	38.6 g (100 gal) 57.9 g (150 gal) 86.9 (225 gal) + 2.3 ml
Biological 1	4	O	7	3 lb	14 g
Biological 2	5	C	7	1 gal	39 ml
Material B + Bio 1 + HiWett	6	LG	7	5 lb/100 gal + 3 lb + 5 fl oz	22.7 g(100 gal) 34 g (150 gal) 51.1 g (225 gal) + 14 g + 1.5
Material C + Bio 1 + HiWett	7	G	7	5 lb/100 gal + 3 lb + 5 fl oz	22.7 g(100 gal) 34 g (150 gal) 51.1 g (225 gal) + 14 g + 1.5
Material B + Bio 2 + HiWett	8	K	7	5 lb/100 gal + 1 gal + 5 fl oz	22.7 g(100 gal) 34 g (150 gal) 51.1 g (225 gal) + 39 ml + 1.5
Material C + Bio 2 + HiWett	9	B	7	5 lb/100 gal + 1 gal + 5 fl oz	22.7 g(100 gal) 34 g (150 gal) 51.1 g (225 gal) + 39 ml + 1.5
Quintec + Dyneamic	10	S	14	6 fl oz + 0.125% (v/v)	1.8 ml + 4.7 ml (100 gal) 7.1 ml (150 gal) 10.9 ml (225 gal)
Rally + Dyneamic	11	Pu	14	5 oz + 0.125% (v/v)	1.5 g + 4.7 ml (100 gal) 7.1 ml (150 gal) 10.9 ml (225 gal)
Rally + Dyneamic alt Quintec + Dyneamic	12	O/C	14	5 oz alt 6 fl oz (+ 0.125% (v/v))	1.5 g alt 1.8 ml + 4.7 ml (100 gal) 7.1 ml (150 gal) 10.9 ml (225 gal)
Fontelis	13	Pu/C	7	8 fl oz	2.4 ml
Fontelis (crop safety) 4 apps	14	LG/C	7	16 fl oz	4.8 ml
YT669 (crop safety) 3 apps	15	O/S	7	8 fl oz	2.4 ml
YT669 (crop safety)3 apps	16	G/O	7	16 fl oz	4.8 ml
Topguard	17	Pu/G	7	7 fl oz	2.1 ml
Topguard	18	Y/O	7	10 fl oz	3.0 ml
Topguard	19	Br/C	7	14 fl oz	4.2 ml
Topguard	20	P	7	28 fl oz	8.4 ml

Topguard + Dyneamic	21	R	7	7 fl oz + 0.25%	2.1 ml + 4.7 ml (100 gal) 7.1 ml (150 gal) 10.9 ml (225 gal)
Topguard + Quintec	22	R/LG	7	10 fl oz + 6 fl oz	3.0 ml + 1.8 ml
Quadris + Dyneamic	23	P/C	7	13 fl oz + 0.25%	4.0 ml + 4.7 ml (100 gal) 7.1 ml (150 gal) 10.9 ml (225 gal)
IKF-309	24	S/LG	7	4 fl oz	1.2 ml
IKF-309	25	Y/LG	7	5 fl oz	1.5 ml
IKF-309	26	R/Y	14	4 fl oz	1.2 ml
IKF-309	27	P/O	14	5 fl oz	1.5 ml
IKF-309 alt Rally	28	R/O	7	4 fl oz alt 5 oz	1.2 ml alt 1.5 g

Figure 2. Layout of plots in the experimental area. Grey box = unused plot (plant density too low).

Pumpkins

		O/S	K	C	Pu/G			
B	Pu/C	Pu/C	S	Y/O	LG/C	Pu/C	G/O	
R	Br/C	K	O	S/LG	R/Y	LG	K	
R/LG	P	R/O	P	R/LG	Y/LG	P/C	Br	
LG		P	Pu/G	O/C	LG			
LG/C	S/LG	O/C	LG	P/C		R/Y	Y	
S	G	G/O	P/O	B	Br/C	Y/O	R/LG	
K		R/Y	P/C		G	O	Pu/G	
C		W	O	G/O	O/S	S/LG	W	
O/S	Y/O	Y	R	Pu	R	LG/C		
O/C	G/O	B	Br	W	Y	R	R/O	
W	R/O	LG/C	G	Y/LG	O/C		Pu	
P/O	Br	Y/O	Br/C	Pu/C	B	S		
P/C	Y/LG	S/LG	C	Br	Br/C	C		
Y	Pu	R/LG	Y/LG	P/O	P/O	P		
O	Pu/G	S	Pu	R/O	G	O/S		
R/Y								
Row	1	2	3	4	5	6	7	8

Results and Discussion

Figure 3. Precipitation and daily high, low and average temperatures for Davis, California (from <http://www.cimis.water.ca.gov/>) during the experimental period.

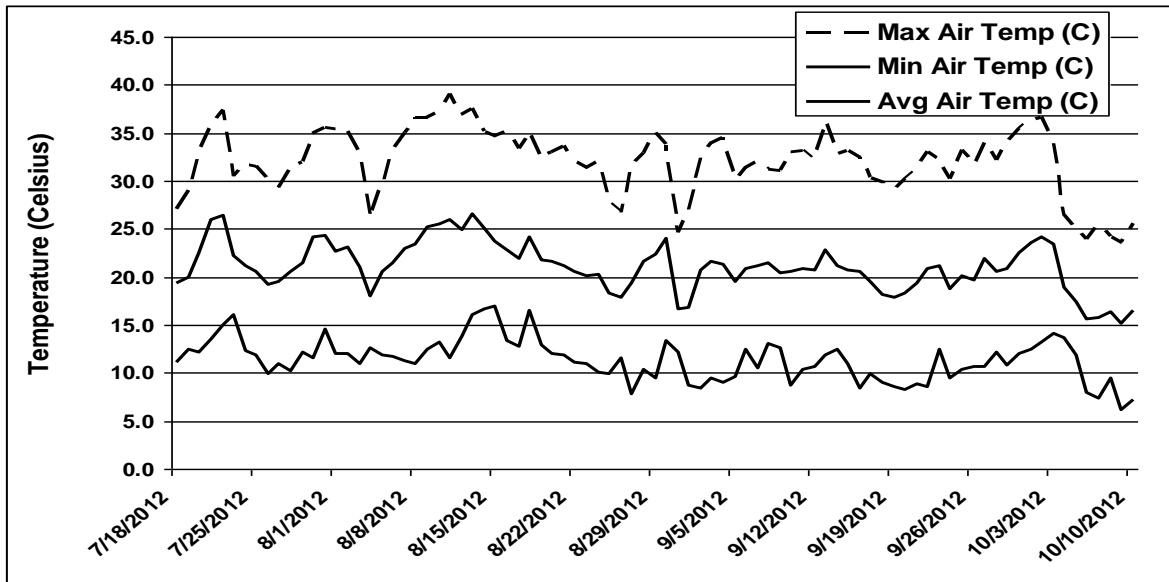
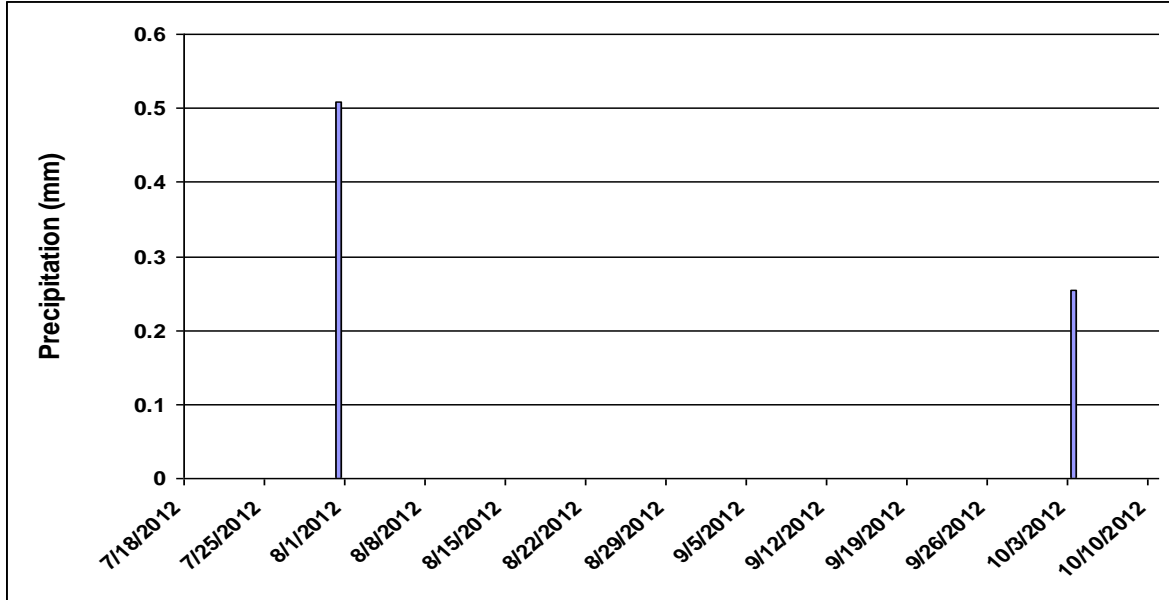


Table 3. Treatment effects on disease incidence on the upper surfaces of leaves of pumpkin. Treatments sharing the same letter within a column are not significantly different according to Fisher's protected LSD test at $\alpha = 0.05$.

Treatment	Top Leaf Incidence (%)	Means Comparison
Topguard, 7 fl oz + Dyneamic, 0.25% (v/v) 7 d	0.0	f
Topguard, 10 fl oz + Quintec, 6 fl oz, 7 d	0.0	f
IKF-309, 5 fl oz, 7 d	0.0	f
IKF-309, 4 fl oz, 7 d	0.0	f
IKF-309, 4 fl oz alt Rally, 5 oz, 7 d	0.0	f
IKF-309, 4 fl oz, 14 d	0.6	f
Topguard, 28 fl oz, 7 d	1.3	f
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6 fl oz + Dyneamic, 0.125%	1.3	f
Quadris Top, 13 fl oz + Dyneamic, 0.25% (v/v), 7 d	2.5	f
Fontelis, 8 fl oz, 7 d	2.5	f
Topguard, 14 fl oz, 14 d	3.8	f
IKF-309, 5 fl oz, 14 d	3.8	f
Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14 d	5.0	f
Rally, 5 oz + Dyneamic, 0.125% (v/v), 14 d	6.3	f
Topguard, 10 fl oz, 7 d	8.8	f
Topguard, 7 fl oz, 7 d	11.3	ef
Material B, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	30.0	de
Material C, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	35.0	cd
Material B, 8.5 lbs/100 gal + HiWett, 7.5 fl oz	46.3	bcd
Material B, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	52.5	bc
Material C, 8.5 lb/100 gal + HiWett, 7.5 fl oz, 7 d	55.0	bc
Biological 2, 1 gal, 7d	55.0	bc
Biological 1, 3 lb, 7 d	60.0	b
Material C, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	63.8	b
Unsprayed Control	98.8	a

Table 4. Treatment effects on disease severity 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 Severity (%)	Means Comparison
Topguard, 7 fl oz + Dyneamic, 0.25% (v/v) 7 d	0.0	c
Topguard, 10 fl oz + Quintec, 6 fl oz, 7 d	0.0	c
IKF-309, 5 fl oz, 7 d	0.0	c
IKF-309, 4 fl oz, 7 d	0.0	c
IKF-309, 4 fl oz alt Rally, 5 oz, 7 d	0.0	c
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6 fl oz + Dyneamic, 0.125%	0.0	c
Topguard, 28 fl oz, 7 d	0.0	c
Quadris Top, 13 fl oz + Dyneamic, 0.25% (v/v), 7 d	0.0	c
Fontelis, 8 fl oz, 7 d	0.0	c
Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14 d	0.1	c
IKF-309, 4 fl oz, 14 d	0.1	c
Topguard, 14 fl oz, 14 d	0.1	c
IKF-309, 5 fl oz, 14 d	0.1	c
Rally, 5 oz + Dyneamic, 0.125% (v/v), 14 d	0.1	c
Topguard, 10 fl oz, 7 d	0.1	c
Topguard, 7 fl oz, 7 d	0.1	c
Material C, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	0.5	c
Material B, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	1.3	c
Material B, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	1.6	c
Material B, 8.5 lbs/100 gal + HiWett, 7.5 fl oz	2.7	bc
Biological 2, 1 gal, 7d	3.3	bc
Material C, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	3.8	bc
Biological 1, 3 lb, 7 d	3.9	bc
Material C, 8.5 lb/100 gal + HiWett, 7.5 fl oz, 7 d	6.4	b
Unsprayed Control	34.9	a

Table 5. Treatment effects on disease incidence on the lower 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 Incidence (%)	Means Comparison
Topguard, 10 fl oz + Quintec, 6 fl oz, 7 d	0.0	d
IKF-309, 5 fl oz, 7 d	0.0	d
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14 d	2.5	cd
Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14 d	2.5	cd
IKF-309, 4 fl oz alt Rally, 5 oz, 7 d	2.5	cd
IKF-309, 4 fl oz, 7 d	3.8	cd
Topguard, 7 fl oz + Dyneamic, 0.25% (v/v), 7 d	5.0	cd
Topguard, 28 fl oz, 7 d	6.3	cd
Topguard, 14 fl oz, 14 d	6.3	cd
Quadris Top, 13 fl oz + Dyneamic, 0.25% (v/v), 7 d	7.5	cd
Fontelis, 8 fl oz, 7 d	7.5	cd
IKF-309, 5 fl oz, 14 d	10.0	cd
Topguard, 10 fl oz, 7 d	11.3	cd
Rally, 5 oz + Dyneamic, 0.125% (v/v), 14 d	11.3	cd
Topguard, 7 fl oz, 7 d	12.5	cd
IKF-309, 4 fl oz, 14 d	25.0	c
Material C, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	56.3	b
Material C, 8.5 lb/100 gal + HiWett, 7.5 fl oz, 7 d	58.8	b
Material C, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	62.5	b
Material B, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	62.5	b
Material B, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	68.8	b
Material B, 8.5 lbs/100 gal + HiWett, 7.5 fl oz	70.0	b
Biological 1, 3 lb, 7 d	70.0	b
Biological 2, 1 gal, 7d	72.5	ab
Unsprayed Control	95.0	a

Table 6. Treatment effects on disease severity on the lower 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 Severity (%)	Means Comparison
Topguard, 10 fl oz + Quintec, 6 fl oz, 7 d	0.0	d
IKF-309, 5 fl oz, 7 d	0.0	d
Rally, 5 oz + Dyneamic, 0.125% (v/v) alt Quintec, 6 fl oz + Dyneamic, 0.125%	0.0	d
IKF-309, 4 fl oz alt Rally, 5 oz, 7 d	0.0	d
Topguard, 7 fl oz + Dyneamic, 0.25% (v/v) 7 d	0.1	d
Quintec, 6 fl oz + Dyneamic, 0.125% (v/v), 14 d	0.1	d
Topguard, 28 fl oz, 7 d	0.1	d
IKF-309, 4 fl oz, 7 d	0.1	d
Fontelis, 8 fl oz, 7 d	0.1	d
Topguard, 14 fl oz, 14 d	0.1	d
Quadris Top, 13 fl oz + Dyneamic, 0.25% (v/v), 7 d	0.1	d
Topguard, 10 fl oz, 7 d	0.1	d
Rally, 5 oz + Dyneamic, 0.125% (v/v), 14 d	0.2	d
IKF-309, 4 fl oz, 14 d	0.3	d
IKF-309, 5 fl oz, 14 d	0.3	d
Topguard, 7 fl oz, 7 d	0.3	d
Material C, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	0.9	cd
Material C, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	2.4	bcd
Material B, 5 lb/100 gal + Biological 2, 1 gal + HiWett, 5 fl oz, 7 d	3.1	bcd
Material B, 5 lb/100 gal + Biological 1, 3 lb + HiWett, 5 fl oz, 7 d	3.2	bcd
Biological 2, 1 gal, 7d	3.2	bc
Biological 1, 3 lb, 7 d	4.3	bc
Material C, 8.5 lb/100 gal + HiWett, 7.5 fl oz, 7 d	4.4	b
Material B, 8.5 lbs/100 gal + HiWett, 7.5 fl oz	5.2	b
Unsprayed Control	26.2	a

Acknowledgements

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Appendix: materials

Product	Active ingredient(s) and concentration	Class	Manufacturer or Distributor
Biological 1	N/A	N/A	N/A
Biological 2	N/A	N/A	N/A

Dyneamic	Polyalkyleneoxide modified polydimethylsiloxane, nonionic emulsifiers, methyl ester of C16-C-18 fatty acids (99%)	adjuvant	Helena Chemical Co.
Fontelis	penthiopyrad (20%)	N/A	DuPont
Hi Wett	polysiloxane polyether copolymer, polyoxyethylene-polyoxypropylene copolymer & alcohol ethoxylate (100%)	First Choice	adjuvant
IKF - 309	proprietary	proprietary	N/A
Material B	proprietary	proprietary	N/A
Material C	proprietary	proprietary	N/A
Quadris Top 2.71	azoxystrobin (18.2%), difenoconazole (11.9%)	DMI-triazole/QoI	Syngenta Crop Protection, Inc
Quintec	quinoxifen (22.6%)	quinoline	Dow Agrosciences, LLP
Rally 40 WSP	myclobutanil (40%)	DMI-triazole	Dow Agrosciences, LLP
Topguard	flutriafol (12%)	DMI	Cheminova

Appendix 1 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. 2011, Pumpkin powdery mildew trial, available at: http://ucanr.edu/sites/plp/Cooperative_Extension/gubler/fungtrials2011/.

(3) various sources including product labels and/or MSDS, or product websites.