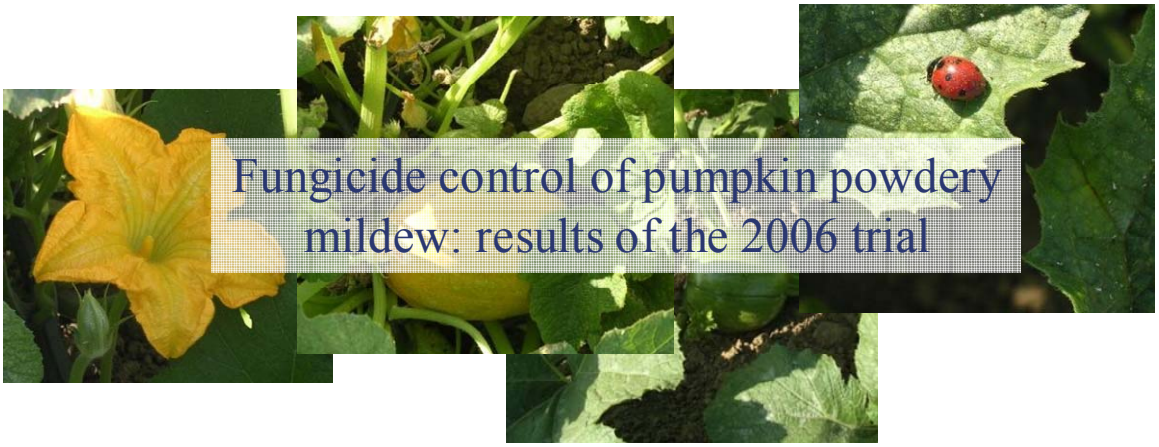


Fungicide control of pumpkin powdery mildew: results of the 2006 trial

Christopher N. Janousek, Kenneth C. Asay, and W. D. Gubler[1]

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

University of California Cooperative Extension,
Department of Plant Pathology,
University of California, Davis, December 2006

[1.] Address correspondence to: wdgubler@ucdavis.edu
Published: December 2006 at http://plantpathology.ucdavis.edu/ext/index.htm, with minor revisions, March 2007.

Cucurbit Powdery Mildew Trial, 2006

Principle investigator	Doug Gubler, Ph.D.
Researchers	Chris Janousek, Ph.D., Ken Asay
Cooperators	Tom Kominek, Richard Webb
Location	UC Davis Plant Pathology Farm (center of experimentally-treated area at 38°31.23' N, 121°45.83' W, approximately 8 meters above sea level).
Crop	Pumpkin, "Howdy Doody" variety
Disease	Powdery mildew, *Podosphaera xanthii* (=*Sphaerotheca fuliginea*)
Objective	Assessment of fungicide protection against foliar powdery mildew.

Materials and methods

1. Trial layout and method

Experimental design	Randomized block design with planted rows as blocks.		
Application method	Stihl air-assist backpack sprayers.		
Initial plot length	8 feet	Bed spacing	10 feet
No. plants/Plot	5	Plot area	112 ft^2 (14 ft by 8 ft)
Plant spacing	18 inches	Area/4 replicate plots	448 ft^2 (=0.0103 acres)
Volume water/Acre	200 gallons	Volume water/Treatment	7.8 liters
Applications began	6 September 2006	Applications ended	5 October 2006
Application interval	14 days	Evaluation dates	19-23 October 2006
Field evaluation of disease	Twenty randomly collected leaves per plot were rated for disease incidence and severity. Incidence was defined as the number of leaves with at least some disease present. Severity was defined as the mean proportion of powdery mildew coverage on each of the 20 leaves. Individual leaves were also assigned to young, medium, or old age classes based on visual inspection.		
Data transformation	Untransformed data were used to test incidence; residual plots of raw data were acceptable. Severity data were square-root transformed; this gave a somewhat improved distribution of residuals with respect to predicted values over that of untransformed data.		
Statistical evaluation	Type III, two factor analyses of variance (blocks: random factor; treatment: fixed factor) were conducted on (a) disease incidence, (b) disease severity, and (c) disease severity in the older leaf age class with SAS® 9.1 software.		

Figure 1. Pumpkin plots at UCD's Experimental Farm. One replicate of each treatment was randomly assigned to each row of plants.

2. Experimental treatments

Trt no.	Flag	Product	Interval (days)	Applications	FP/Acre	FP/Treat-ment	Notes
1	W	Unsprayed control	none	-	-	-	
2	G	Water control	14	ABC	-	-	Water only applied.
3	B	Rally	14	ABC	4 oz	1.2 g	
4	Br	Procure alt Flint	14	AC B	6 fl oz 2 oz	1.8 ml 0.6 g	
5	P	Procure	14	ABC	10 fl oz	3.0 ml	
6	LG	Procure alt Quintec	14	AC B	6 fl oz 6 fl oz	1.8 ml 1.8 ml	
7	O	Topguard	14	ABC	7 fl oz	2.1 ml	
8	Pu	Topguard	14	ABC	14 fl oz	4.3 ml	
9	K	Quintec	14	BC	6 fl oz	1.8 ml	

Notes: 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. "FP" denotes formulated product; "alt" indicates that products are alternated.

3. Fungicide information

Institution	Product	Active ingredient and concentration	Tol.	Contact
UCD	Rally 40W	myclobutanil, 40%	Y	
Crompton	Procure 480SC	triflumizole, 480 g/l	Y	Curt Sandberg curtis_sandberg@cromptoncorp.com
	Flint 50WDG	trifloxystrobin, 50%	Y	
	Quintec 2.08SC	quinoxyfen, 300 g/l	Y	
Cheminova	Topguard	flutriafol, 125 g/l	N	Terry Baker tlb.us@cheminova.com

Note: "Tol" denotes products that have EPA approval for use with pumpkins.

4. Fungicide applications

Date	Wed. 6 September 2006	Thurs. 21 September 2006	Thurs. 5 October 2006
Application	A	B	C
Plant status	Vines running and flowering; fruits up to softball sized and bit larger.	Fruits ranging from golf ball-size to beach ball-size.	Many pumpkins are ripening. Some flowers and new runners are present, but foliage is deteriorating.
Disease status	Not present.	Not present.	Powdery mildew colonies present on older leaves.
Volume water	200 gal/acre	200 gal/acre	200 gal/acre
Treatment 1	-	-	-
Treatment 2	Water	Water	Water
Treatment 3	Rally	Rally	Rally
Treatment 4	Procure	Flint	Procure
Treatment 5	Procure	Procure	Procure
Treatment 6	Procure	Quintec	Procure
Treatment 7	Topguard	Topguard	Topguard
Treatment 8	Topguard	Topguard	Topguard
Treatment 9	-	Quintec	Quintec
Notes		Block 3 coverage lighter for treatment no. 7. Pesticide applied by UCD farm assistant this morning before fungicide application.	The control plot in Block 4 was sprayed partially with Procure fungicide. The control moved to an unmarked plot at the end of the row.

5. Plot map

	P		B
G		W	
	O		G
Pu		Br	
	W		
-		B	-
	K		
LG		-	P
	LG		
P		G	O
	Br		
B		LG	
	Pu		K
O		P	
	B		Br
K		Pu	
	G		-
W		K	
	-		Pu
Br		O	
			W
Block 1	Block 2	Block 3	Block 4

6. Experimental chronology

Date	Activity
week of 17 July	Cucurbits planted.
about 9 Aug. 2006	Research area fenced.
M 14 Aug. 2006	Rows 1 and 2 thinned to about 5 plants per 8 feet with at least 8 ft between plots.
Th 17 Aug. 2006	Rows 3 and 4 thinned as above.
Tu 22 Aug. 2006	Row 5 thinned as above.
Tu 29 Aug. 2006	Field irrigated.
W 6 Sept. 2006	First application of fungicides.
Tu 12 Sept. 2006	Field irrigated.
Th 21 Sept. 2006	Diazinon pesticide applied for insect control prior to fungicide application.
Th 21 Sept. 2006	Second fungicide application.
F 22 Sept. 2006	Strong wind event in Davis. Leaves heavily damaged.
Tu 27 Sept. 2006	Field irrigated.
Th 5 Oct. 2006	Fungicide application 3.
Th 12 Oct. 2006	Field irrigated.
Th 19 Oct. 2006	Began evaluation of disease in blocks 1 and 2.
F 20 Oct. 2006	Continued disease evaluation in blocks 2 and 3.
M 23 Oct. 2006	Completed rating of disease in blocks 3 and 4.

Notes: The area was weeded periodically from mid-August through the experimental period. Irrigation prior to 29 August occurred roughly every two to three weeks.

Results

Mean powdery mildew incidence was 74% in unsprayed controls, 86% water-only control plots, and ranged from 59% and 14% in fungicide treated plots (Table 1). Type III analysis of variance rejected the null hypothesis of no difference in disease incidence across the trial ($F_{8,24}$=11.0, $p<0.0001$). The Procure, Procure alternated with Quintec, Rally, and Quintec treatments significantly reduced leaf powdery mildew incidence below that of unsprayed and water-only control plots ($p\leq0.05$, Tukey's HSD test). The Topguard (at 7 fl oz/acre) and Procure alternated with Flint treatments did not show significant reductions in disease incidence relative to the unsprayed control, but all treatments except Topguard at 7 fl oz/acre had statistically lower powdery mildew incidence than plots sprayed only with water.

Disease severity on the upper surface of leaves was 14% in water controls plots, 7% in the unsprayed controls, and less than 1% in all fungicide treatments except for Procure alternated with Flint (where severity=1.3%), giving a highly significant treatment effect on powdery mildew coverage ($F_{8,24}$=14.7, $p<0.0001$; Table 1). Pair-wise treatment comparison of severity by Tukey's HSD test (at $p\leq0.05$) suggested that all fungicide treatments reduced powdery mildew severity below that of the water-only control. Moreover, all fungicide treatments had significantly lower disease severity than the unsprayed control except for Topguard applied at 7 fl oz/acre and Procure alternated with Flint. The overall ANOVA tests for incidence and severity were both conducted at power >0.99.

Disease severity tended to be highest in the medium-aged and older leaves (leaves with some yellowing and/or necrosis and those with substantial yellowing and/or necrosis respectively; Figure 3). This pattern was especially evident in the water control and also occurred in many fungicide treatments. Fungicide effects on leaf powdery mildew severity within the oldest age class was examined further statistically. All leaves from the oldest age class were pooled within each plot (disease severity on young and medium-aged leaves was ignored) and a 2-factor ANOVA (block and treatment) was conducted on square root-transformed data. As with severity on data from all combined age classes (Table 1), fungicide treatment had a significant effect on disease severity on older leaves ($F_{8,24}$=12.9, $p<0.0001$). All seven fungicide treatments exhibited lower powdery mildew relative to the unsprayed and water-only controls (Tukey's HSD test at $p\leq0.05$; Figure 4).

Figure 2. Powdery mildew on pumpkin leaves from the experiment. Photographs by K. Asay, October 2006.

Table 1. Disease incidence and severity on the upper surface of pumpkin leaves. Incidence is reported as mean ±1S.E. Severity data (which was square-root transformed for the ANOVA) is given in means followed by upper and lower 95% confidence limits. Treatments indicated by the same letter did not differ statistically at α=0.05.

Treatment	Application rate and frequency	mean incidence ±1 S.E.	Tukey HSD grouping	mean severity, 95% confidence intervals	Tukey HSD grouping
Water only control	200 gal/acre, 14 days	86.3 ±1.3%	a	14.1%, 23.5% - 6.5%	a
Unsprayed control	none	73.8 ±8.3%	ab	7.0%, 21.6% - 0.0%	ab
Topguard	7 fl oz acre, 14 days	58.8 ±8.0%	abc	0.7%, 0.9% - 0.4%	bc
Procure alt Flint	6 fl oz/acre alt 2 oz/acre, 14 days	48.8 ±8.3%	bcd	1.3%, 4.3% - 0.1%	bc
Rally	4 oz/acre, 14 days	33.2 ±13.8%	cd	0.0%, 0.1% - 0.0%	c
Topguard	14 fl oz/acre, 14 days	32.5 ±12.0%	cd	0.1%, 0.2% - 0.0%	c
Quintec	6 fl oz/acre, 14 days	28.8 ±10.9%	cd	0.7%, 2.8% - 0.3%	c
Procure	10 fl oz/acre, 14 days	16.3 ±2.4%	d	0.0%, 0.0% - 0.0%	c
Procure alt Quintec	6 fl oz/acre alt 6 fl oz/acre, 14 days	13.8 ±5.5%	d	0.0%, 0.1% - 0.0%	c

Figure 3. Mean disease severity (±1S.E.) according to leaf age class in treated and control plots (n=4). *Young* leaves were largely green. *Medium*-aged leaves had some signs of yellowing and necrosis. *Old* leaves showed substantial yellowing and/or brown necrotic tissue.

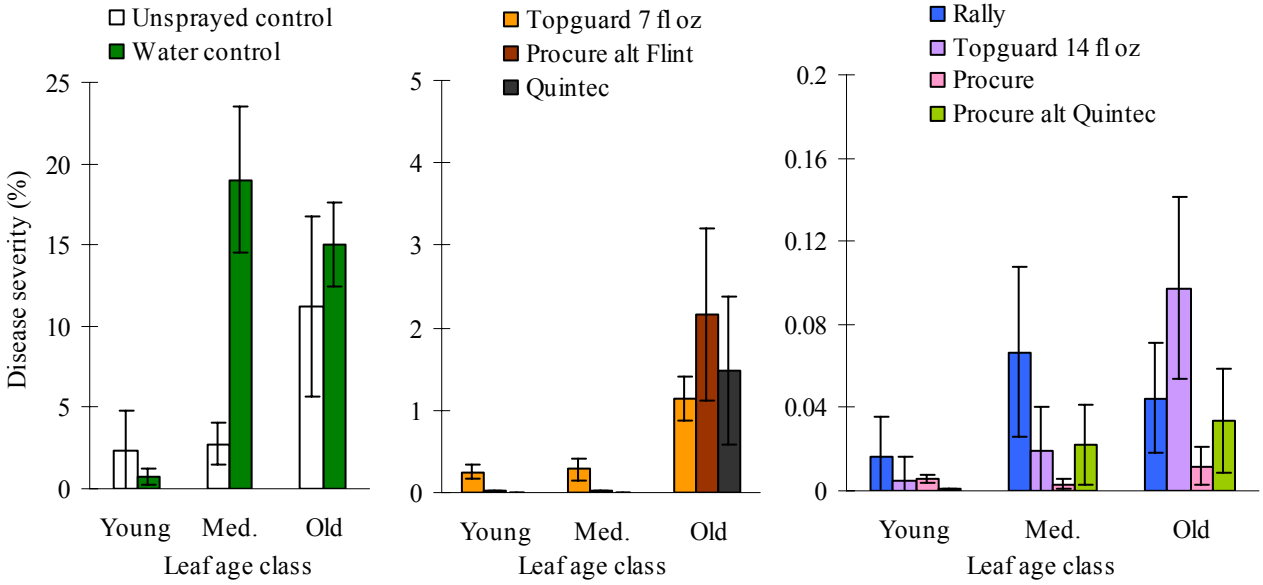
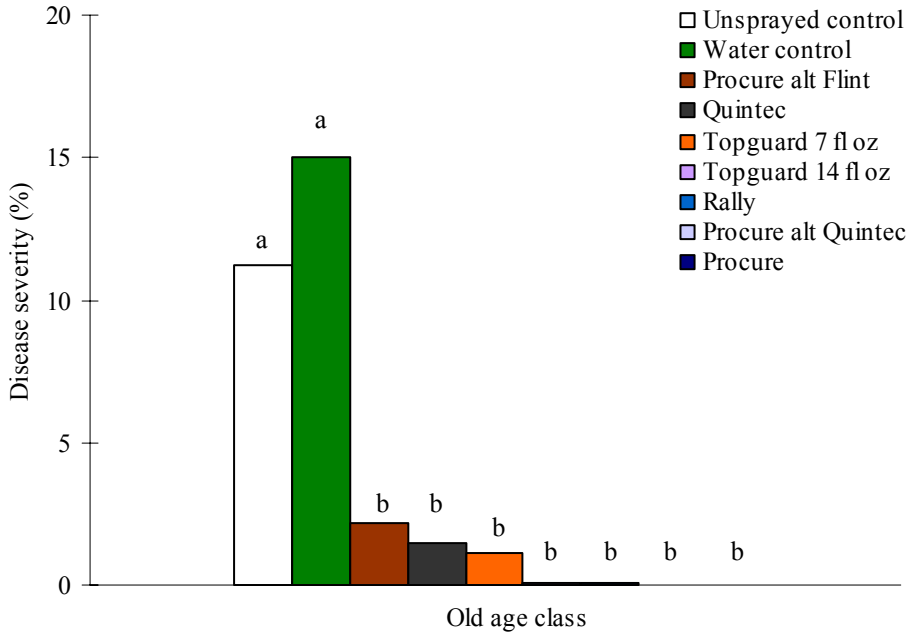


Figure 4. Mean disease severity (±1S.E.) on older leaves only in treated and control plots. Letters designate non-significant groupings according to Tukey's HSD test (α=0.05).



Discussion

Disease incidence was rather high across the trial generally, but infection on many leaves was limited to less than 1% of the leaf surface. All of the fungicides reduced disease severity in the plots below 2% suggesting that products were generally effective at controlling disease. Fungicides also were effective at reducing disease cover in older leaves, the most vulnerable age class in plants. Incidence data suggested that Procure and Procure alternated with Quintec tended towards top performance in the trial, but either additional replication of experimental units or increased disease pressure would be required to demonstrate statistical differences between many of the products.

Acknowledgements

We thank T. Kominek and R. Webb for planting and maintenance of the crop and the donors whose funding has enabled this research.