Angular leaf spot, powdery mildew, gummy stem blight, viruses, and downy mildew: Notes for 2018

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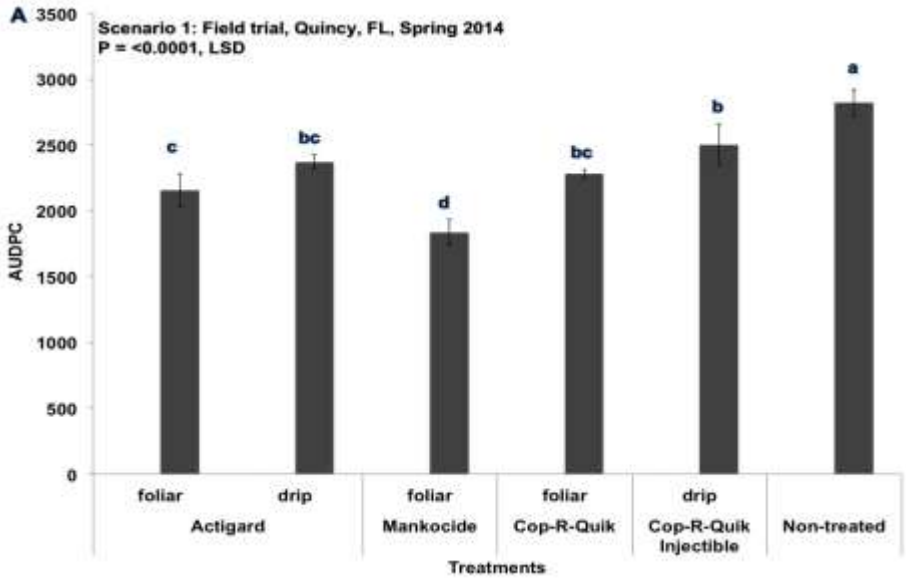
Angular leaf spot affecting watermelon and other cucurbits (since 2010, reported 10-15% yield losses in watermelon, 10-50% in squash and cucumbers)

Pseudomonas syringae pv. *lachrymans* and other strains of *Pseudomonas syringae*


Squash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Scenario 1: Field trial, Quincy, FL, Spring 2014
P = <0.0001, LSD
AUDPC
3500
3000
2500
2000
1500
1000
500
0
c
bc
d
bc
b
a
foliar
drip
foliar
foliar
drip
Actigard
Mankocide
Cop-R-Quik
Cop-R-Quik Injectible
Non-treated
Treatments

Table 4. Environmental variables correlated using Pearson's correlation coefficient with the average weekly bacterial leaf spot severity among the greenhouse inoculated, untreated plots from four field trials, $N = 18$ observations

	Disease severity	
Variable[x]	Correlation coefficient	*P*-value
Temperature	–0.77	0.0002
Rainfall	0.60	0.0081
Dew point	–0.51	0.0309
RF ≥ 0.05cm[y]	0.51	0.0293
RF ≥ 0.1cm[y]	0.57	0.0141
Relative humidity	0.31	0.2065
Relative humidity hours[z]	0.21	0.3992
Solar radiation	–0.48	0.0438

[x] All environmental variables are the weekly averages except the number of hourly precipitation events.
[y] Number of hourly precipitation events ≥0.05 cm or 0.1 cm.
[z] Average number of weekly relative humidity hours ≥90%.

- If **cold + wet weather** is expected in early spring, or during the season, there is risk of *Pseudomonas syringae* pv. lachrymans and related strains on watermelon, squash and other cucurbits.

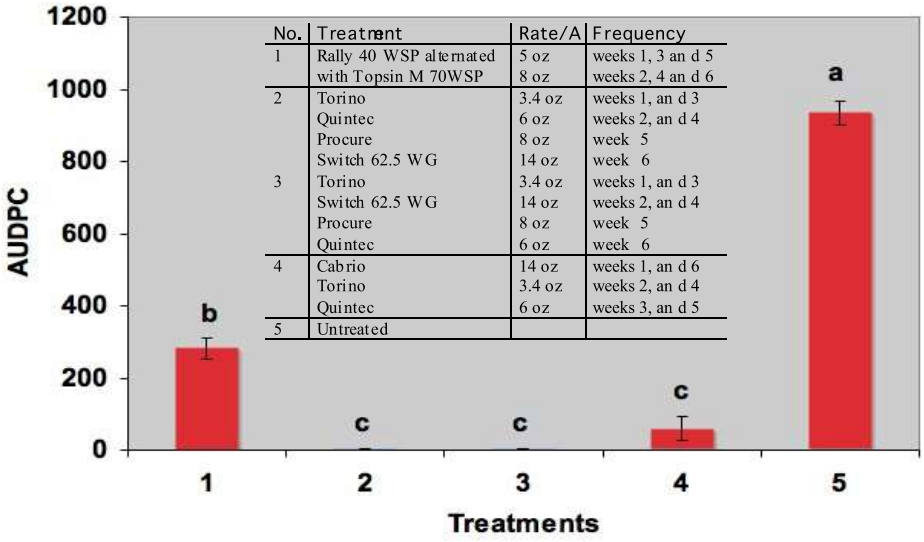
- Copper + Ethylene Bis Dithiocabamate (e.g: Mancozeb) or Mankocide (pre-mix) can effectively manage the disease if applied early in the season
- Based on weather conditions, 2/3 applications may be needed early in the season.
- **Do not use high rate of copper** (Phytotoxicity issues on watermelon and other cucurbits)

- **Actigard** (SAR inducer is also useful in reducing the disease severity if applied early in the season)

Powdery mildew

- Caused by *Podosphaera xanthii* and *Erisiphe cichoracearum*
- Talcum-like symptoms on the upper and lower side of the leaves
- First symptoms: Older leaves, or shaded lower leaves

- The **PM** fungi are obligate parasites
- Primary source of inoculum include conidia dispersed over long distances, from greenhouse cucurbits, and alternate hosts (mostly other cucurbits)



No.	Treatment	Rate/A	Frequency
1	Rally 40 WSP alternated	5 oz	weeks 1, 3 an d 5
	with Topsin M 70WSP	8 oz	weeks 2, 4 an d 6
2	Torino	3.4 oz	weeks 1, an d 3
	Quintec	6 oz	weeks 2, an d 4
	Procure	8 oz	week 5
	Switch 62.5 WG	14 oz	week 6
3	Torino	3.4 oz	weeks 1, an d 3
	Switch 62.5 WG	14 oz	weeks 2, an d 4
	Procure	8 oz	week 5
	Quintec	6 oz	week 6
4	Cabrio	14 oz	weeks 1, an d 6
	Torino	3.4 oz	weeks 2, an d 4
	Quintec	6 oz	weeks 3, an d 5
5	Untreated		

AUDPC- Area Under Disease Progression Curve (**Higher the AUDPC, higher the disease)**

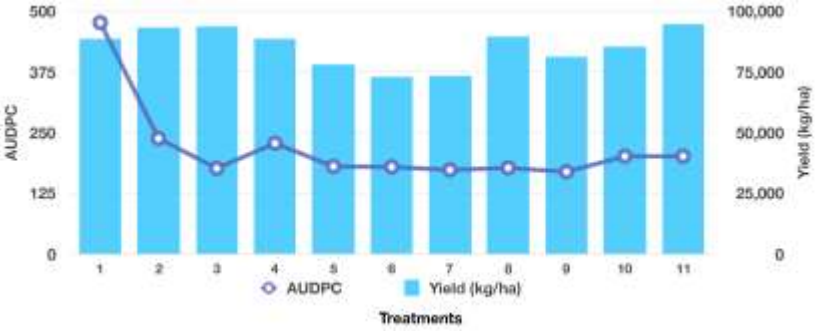
Variety, date of transplanting: Classic, March 28, 2011. **Plant spacing:** 20 plants placed 18 inches apart; **Experiment layout:** 4 replications, Randomized Complete Block Design, **Statistics:** Column means with the same letter are not significant different ($P \leq 0.05$) based on Duncan's multiple range test

Gummy stem blight. Most destructive on watermelon. Can infect muskmelon, cucumber, pumpkin, and squash (recently reported to cause 40-100% losses) caused by *Stagonosporopsis* sp. (*D. bryoniae*)

Disease severity (AUDPC) and yield of watermelons - Spring 2016

	TREATMENT (RATE/A)	AUDPC		YIELD (KG/HA)	
1	Control	477	a	88,594	a
2	Bravo 2 pt (1-6 wk)	238	b	92,996	a
3	Aprovia Top 3.6F 10 fl oz (1-6 wk)	176	b	93,617	a
4	Tebuzol 3.6 F 8 fl oz (1-6 wk)	228	b	88,509	a
5	Ph-D 11.3WDG 6.2 oz (1-6 wk)	180	b	78,055	a
6	Ph-D 11.3WDG 6.2 oz + Tebuzol 8 fl oz (1-6 wk)	179	b	73,124	a
7	F1756aa 32 fl oz (1-6 wk)	173	b	73,363	a
8	Ph-D 11.3WDG 6.2 oz + F1756aa 32 fl oz (1-6 wk)	177	b	89,699	a
9	Ph-D 11.3WDG 6.2 oz + F1756aa 22 fl oz (1-6 wk)	169	b	80,990	a
10	MgO 200 ppm (1-6 wk)	201	b	85,479	a
11	MgO 500 ppm (1-6 wk)	201	b	94,386	a

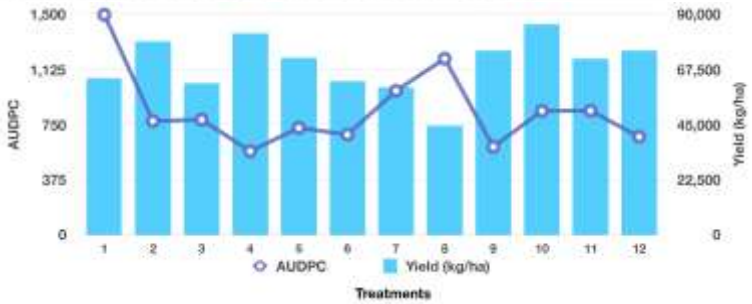
AUDPC: Area Under Disease Progress Curve. Higher the AUDPC, higher the disease severity over the period of the trial.
Different letters next to the treatments means that they are statistically different (Pr>F=0.05; LSD)



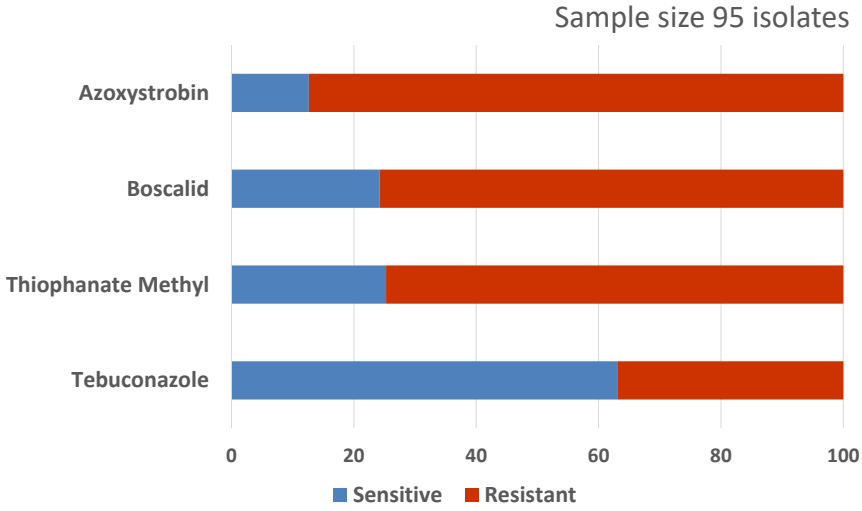
Disease severity (AUDPC) and yield of watermelons - Spring 2015

	TREATMENT (RATE/A)	AUDPC		YIELD (KG/HA)	
1	Control (Untreated)	1,497	a	63,776	ab
2	Actinovate AG (6 oz)	773	cd	78,710	ab
3	Actinovate AG (6 oz) + Actigard (0.5 oz)	783	cd	61,991	ab
4	Topguard EQ (5 fl oz) (1-6 wk)	568	d	82,074	ab
5	Topguard EQ (8 fl oz) (1-6 wk)	727	cd	72,332	ab
6	Topguard EQ (16 fl oz) (1-6 wk)	681	cd	62,796	ab
7	Equation (11 fl oz) (1-6 wk)	979	bc	60,283	ab
8	Equation (15.5 fl oz) (1-6 wk)	1,198	ab	44,531	b
9	Quadris Top (12 fl oz) (1-6 wk)	598	cd	74,977	ab
10	Bravo WeatherStik (2 pt) (1-3 wk) alt Oso (6.5 fl oz) (4-6 wk)	842	b-d	86,014	a
11	Bravo WeatherStik (2 pt) (1-3 wk) alt Oso (6.5 fl oz) (4-6wk) alt Tebustar 3.6L (8 fl oz) (7-8 wk)	844	b-d	71,624	ab
12	Bravo WeatherStik (2 pt) (1-3 wk) alt Tebustar 3.6L (8 fl oz) (4-5wk) alt Inspire Super (20 floz) (6-7 wk)	666	cd	75,227	ab

AUDPC: Area Under Disease Progress Curve. Higher the AUDPC, higher the disease severity over the period of the trial.
Different letters next to the treatments means that they are statistically different (Pr>F=0.05; LSD)



Resistance is present, but varies among the fungicide classes.

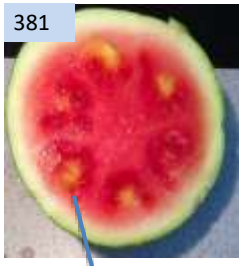


- Rotation of non-cucurbit crops (bahiagrass pastures excellent)
- Duration of rotation: >2 years after a single cucurbit crop with an outbreak of **Gummy stem blight**

- High level of isolate resistance to Quadris (azoxystrobin), Endura (Boscalid) and Topsin (T-methyl) in growers fields in FL and GA **and is risky to use**.
- Rotate, Rotate, available modes of action
- Preventative sprays important
- **Chlorothalonil:** Follow label instructions on watermelon after fruit set. Do not apply on mature watermelons under dry and hot conditions.

Watermelon fruit quality issues and associated viruses in FL and GA in 2016-2017

381



382

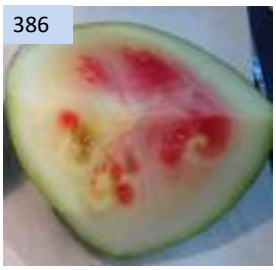
383

Only saprophytes present

384

385

386



387

388

389

Cucurbit leaf crumple virus (CuLCrV)

BEGOMOVIRUS: First found in Florida on squash in 2006.

The virus can infect cucumber, muskmelon, squash, pumpkin, watermelon and bean.

However infection on watermelon was not very high till recently in N. Florida. Historically, no indication of any fruit quality issues on watermelon (However, fruits from infected yellow straightneck squash can have green streaks making them unmarketable). Vectored in a persistent manner by various biotypes of white fly including adult silver leaf whitefly biotype B.

The 2016 confirmations of CuLCrV and a Potyvirus Watermelon Mosaic Virus (WMV; aphid transmitted) in watermelon fruits and leaves in N. Florida and S. Georgia

Date	Sample ID	Type	Location	Cultivar	DNA			Molecular testing			RNA	
					ID	Description	Begomovirus	Virus ID	ID	Description	Potyvirus	Virus ID
10/6/16	381	Fruit	GA	Fascination	381-1 H	Fruit	+	**CuLCrV**				
					381-1 I	Fruit	+	**CuLCrV**	381	Fruit	+	**WMV**
					381-2 H	Fruit	+	**CuLCrV**				
					381-2 I	Fruit	+	**CuLCrV**				
10/6/16	382	Fruit	GA	Exclamation	382-1	Fruit	+	**CuLCrV**	382	Fruit	+	**WMV**
					382-2	Fruit	+	**CuLCrV**				
10/6/16	383	Leaves & Stems	GA	Sweet Dawn		Leaf	NT	NT	383	Leaf	+	**WMV**
10/6/16	384	Leaves & Stems	GA	Exclamation		Leaf	NT	NT	384	Leaf	+	**WMV**
10/6/16	385	Fruit	FL	Joy Ride	385 H	Fruit	+	**CuLCrV**				
					385 I	Fruit	+	**CuLCrV**				
10/6/16	386	Fruit	FL	Exclamation	386 H	Fruit	+	**CuLCrV**				
					386 I	Fruit	+	**CuLCrV**				
10/6/16	387	Leaves & Stems	GA	NA		Leaves	+	**CuLCrV**				
10/6/16	388	Leaves & Stems	GA	NA		Leaves	+	**CuLCrV**				
10/6/16	389	Leaves & Stems	GA	NA		Leaves	+	**CuLCrV**				
10/6/16	390	Leaves & Stems	GA	NA		Leaves	+	**CuLCrV**				
10/17/16	409	Fruit	FL	Exclamation	409 H1	Fruit	+	**CuLCrV**				
					409 H2	Fruit	+	**CuLCrV**	409 H1	Fruit	+	NT
					409 I1	Fruit	+	**CuLCrV**	409 I1	Fruit	+	NT
					409 I2	Fruit	+	**CuLCrV**	409 I2	Fruit	+	NT
10/18/16	410	Fruit	FL	Exclamation	410 H1	Fruit	+	**CuLCrV**				
					410 H2	Fruit	+	**CuLCrV**	410 H1	Fruit	+	NT
					410 I1	Fruit	+	**CuLCrV**	410 I1	Fruit	+	NT
					410 I2	Fruit	+	**CuLCrV**	410 I2	Fruit	-	-
					410 Seed	**Seed**	+	**CuLCrV**	410 seed	Seed	+	NT
10/19/16	411	Fruit	FL	Joy Ride	411 H1	Fruit	+	**CuLCrV**				
					411 H2	Fruit	+	**CuLCrV**	411 H1	Fruit	+	NT
					411 I1	Fruit	+	**CuLCrV**	411 I1	Fruit	+	NT
					411 I2	Fruit	+	**CuLCrV**	411 I2	Fruit	+	NT
10/20/16	412	Fruit	FL	Joy Ride	412 H1	Fruit	+	**CuLCrV**				
					412 H2	Fruit	+	**CuLCrV**	412 H1	Fruit	+	NT
					412 I1	Fruit	+	**CuLCrV**	412 I1	Fruit	+	NT
					412 I2	Fruit	+	**CuLCrV**	412 I2	Fruit	+	NT
10/21/16	413	Fruit	FL	Joy Ride	413 H1	Fruit	+	**CuLCrV**				
					413 H2	Fruit	+	**CuLCrV**	413 H1	Fruit	+	NT
					413 I1	Fruit	+	**CuLCrV**	413 I1	Fruit	+	NT
					413 I2	Fruit	+	**CuLCrV**	413 I2	Fruit	+	NT
10/22/16	414	Fruit	FL	Joy Ride	414 H1	Fruit	+	**CuLCrV**				
					414 H2	Fruit	+	**CuLCrV**	414 H1	Fruit	+	NT
					414 I1	Fruit	+	**CuLCrV**	414 I1	Fruit	+	NT
					414 I2	Fruit	+	**CuLCrV**	414 I2	Fruit	-	-
10/23/16	415	Fruit	FL	Joy Ride	415 H1	Fruit	+	**CuLCrV**				
					415 H2	Fruit	+	**CuLCrV**	415 H1	Fruit	+	NT
					415 I1	Fruit	+	**CuLCrV**	415 I1	Fruit	-	-
					415 I2	Fruit	+	**CuLCrV**	415 I2	Fruit	+	NT

Cucurbit yellow stunting disorder virus (CuLCrV)

CRINIVIRUS: First found in Florida in 2007.

The virus can infect melon, watermelon and squash.

Fruits may appear normal, but can have reduced sugars, and may not ship or store well.

In S. Florida, pigweed has been found to be a non-symptomatic host for the virus.

Potyviruses:
Squash vein yellowing virus (SqVYV) - watermelon vine decline - white fly; can cause fruit quality issues in watermelon
Papaya ringspot virus - watermelon (PRSV-W) - aphid

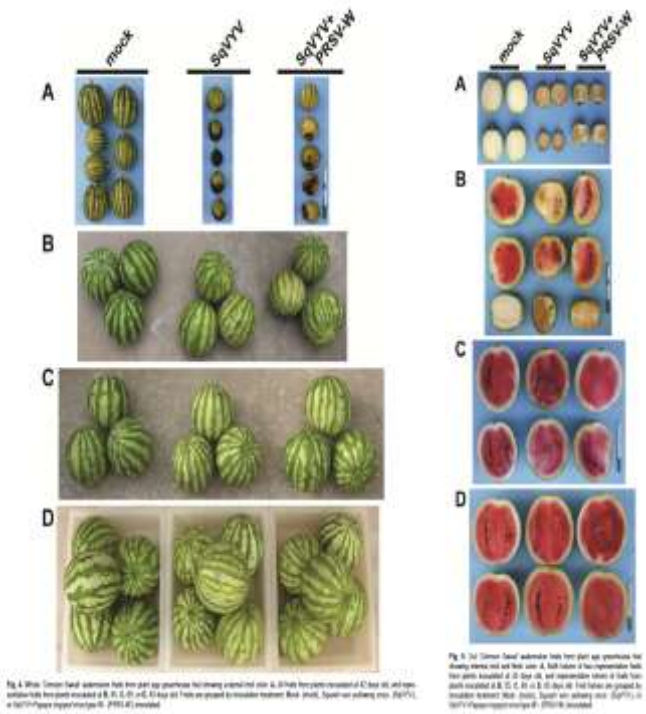
2017: Mixed infection of CuLCrV, CYSDV, SqVYV and/or PRSV, in N. Florida watermelons.

		Location	SqVYV Potyvirus White fly	PRSV-W Potyvirus Aphid	CuLCrV Begomovirus White fly	CYSDV Crinivirus White fly	Lab
1	Fruit	FL, Suw	+	-	+	+	Adkins
2	Fruit	FL, Suw	-	+	-	-	Adkins
3	Fruit	FL, Suw	-	-	-	+	Adkins
4	Fruit	FL, Suw	-	+	+	+	Adkins
5	Fruit	FL, Suw	-	-	-	+	Adkins
6	Fruit	FL, Suw	-	-	+	+	Adkins
7	Fruit	NC	-	-	-	-	Adkins
8	Fruit	FL, Mad	-	-	+	+	Paret
9	Fruit	FL, Mad	-	-	+	+	Paret
10	Fruit	FL, Mad	-	-	+	+	Paret
11	Fruit	FL, Mad	+ (Poty)	+ (Poty)	+	+	Paret
12	Fruit	FL, Mad	+ (Poty)	+ (Poty)	+	+	Paret
13	Fruit	FL, Mad	+ (Poty)	+ (Poty)	+	+	Paret

	Bacterial pathogens present? – Paret
372	*Pseudomonas flectans* and *Enterobacter* spp.
403	-
404	-
405	*Pseudomonas putida*
406	*Pseudomonas putida*
407	*P. putida & other spp.*
408	*Pseudomonas putida*
409	-
410	*Serratia nematodophila & P. putida*
411	*Enterobacter* spp. and *Pseudomonas* spp.
412	*Enterobacter* spp. and *Pseudomonas* spp.
413	*Enterobacter* spp.
414	*Acinetobacter* spp. and *Enterobacter* spp.
415	*Klebsiella* spp, and *Enterobacter* spp.

Can infections of CuLCrV and CYSDV by itself or mixed or in the presence of SqVYV/PRSV-W/WMV be the cause of fruit quality issues in watermelon?

We do not know for sure, but it may be the case. An example of a mixed infection of SqVYV with PRSV-W causing fruit quality issues (Adkins et al. 2013)

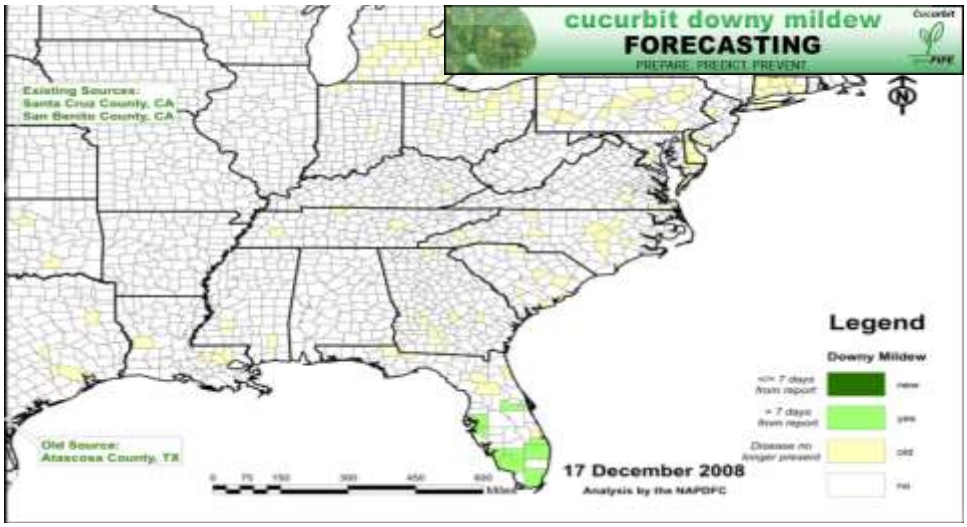


Downy Mildew: *Pseudoperonospora cubensis*

- **Downy Mildew** infects leaves only; rare case of sporulation on fruits and flowers

New sporangia are produced within 4-12 days from infection sites

- The **Downy mildew** pathogen is an obligate parasite. Needs a cucurbit host.
- During winter season, the causal organism survives on cucurbit production in south FL
- Primary inoculum: Air-borne sporangia from infected cucurbits
- Secondary inoculum: air currents, rain splash, contact by workers and tools

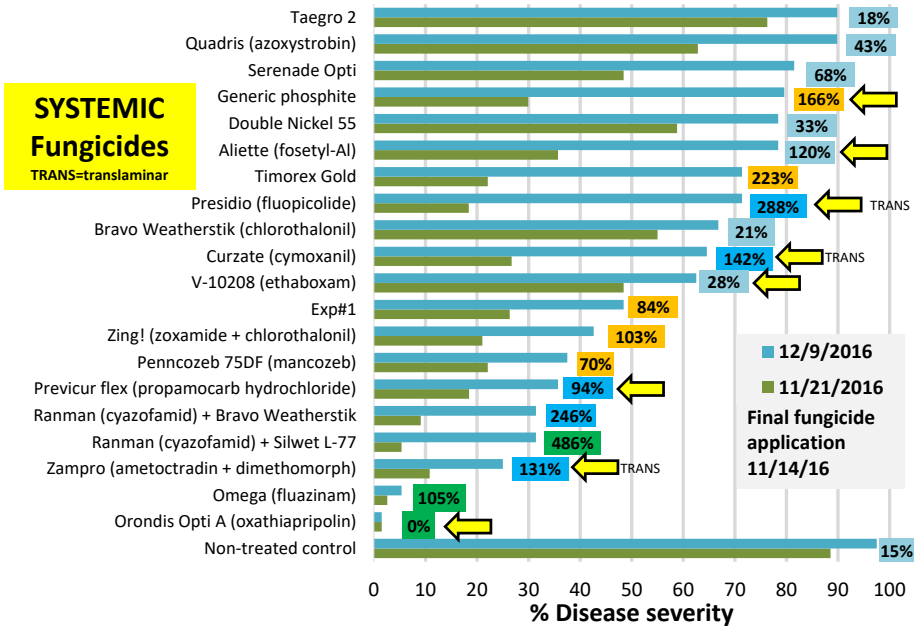


Fungicides Labelled for Cucurbit Downy Mildew

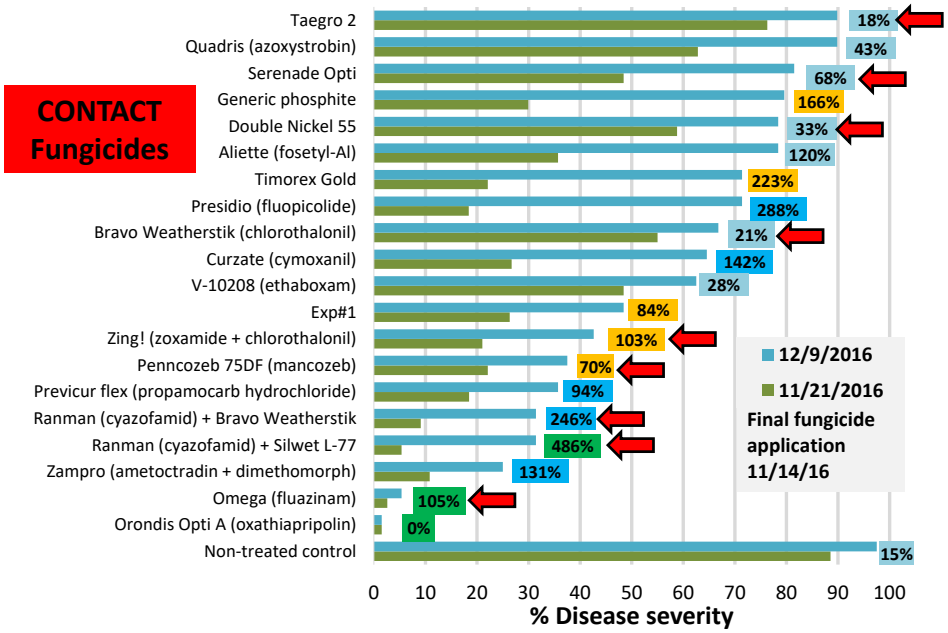
FRAC	Fungicide–active ingredients	Trade Name*	
M1	copper compounds	many brands	
M3	mancozeb	many brands	
M5	chlorothalonil	many brands	
4	mefenoxam	Ridomil	Resistance
11	strobilurins	Quadris, Cabrio, Flint	Resistance
21	cyazofamid	Ranman	Caution
22	zoaxamide	Gavel & Zing!	
27	cymoxanil	Curzate, Tanos & Ariston	
28	propamocarb	Previcur Flex	Caution
29	Fluazinam	Omega	
40	dimethomorph	Acrobat, Forum	Resistance
40	mandipropamid	Revus	Resistance
43	fluopicolide	Presidio	Caution
45	ametoctradin	Zampro	
U15	oxathiapiprolin	Orondis	

*Resistance based on published studies and field data; Caution indicates product failure observed in published University reports.

Change in CDM Severity - Nov 21st to Dec 9th



Change in CDM Severity - Nov 21st to Dec 9th



Summary for Fall 2016 Downy mildew Trial, GCREC, Balm

- Based on change in downy mildew severity from Nov 21st to Dec 9th, few materials had effective residual control.
  - Exception of Omega (contact) and Orondis Opti (systemic), both exhibited effective residual control for 3 weeks.
  - Most contact fungicides (Bravo, Penncozeb, Zing!) and biologicals (Double Nickel, Serenade Opti, Taegro) had low to moderate efficacy, and relatively fair residual control
    - Ranman was a big exception
  - Many systemic fungicides exhibited poor residual control: Aliette, Curzate, Ranman, Presidio, and the generic phosphite.
    - Presidio (translaminar) had the worst residual control, followed by Curzate (translaminar) and Zampro (translaminar)

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National Institute of Food and Agriculture