THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Foliar Vine Crop Diseases and Their Management

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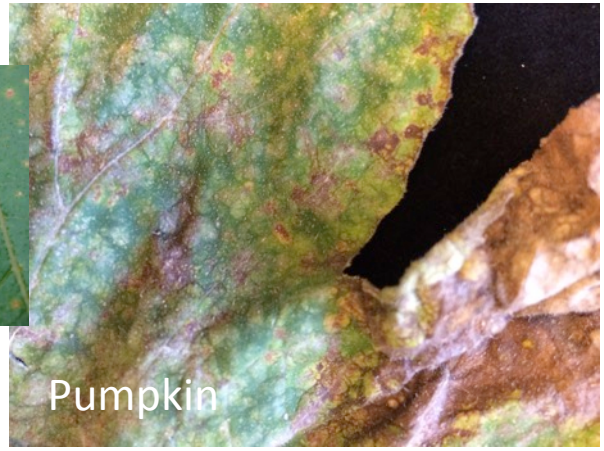
Cucurbit Downy Mildew

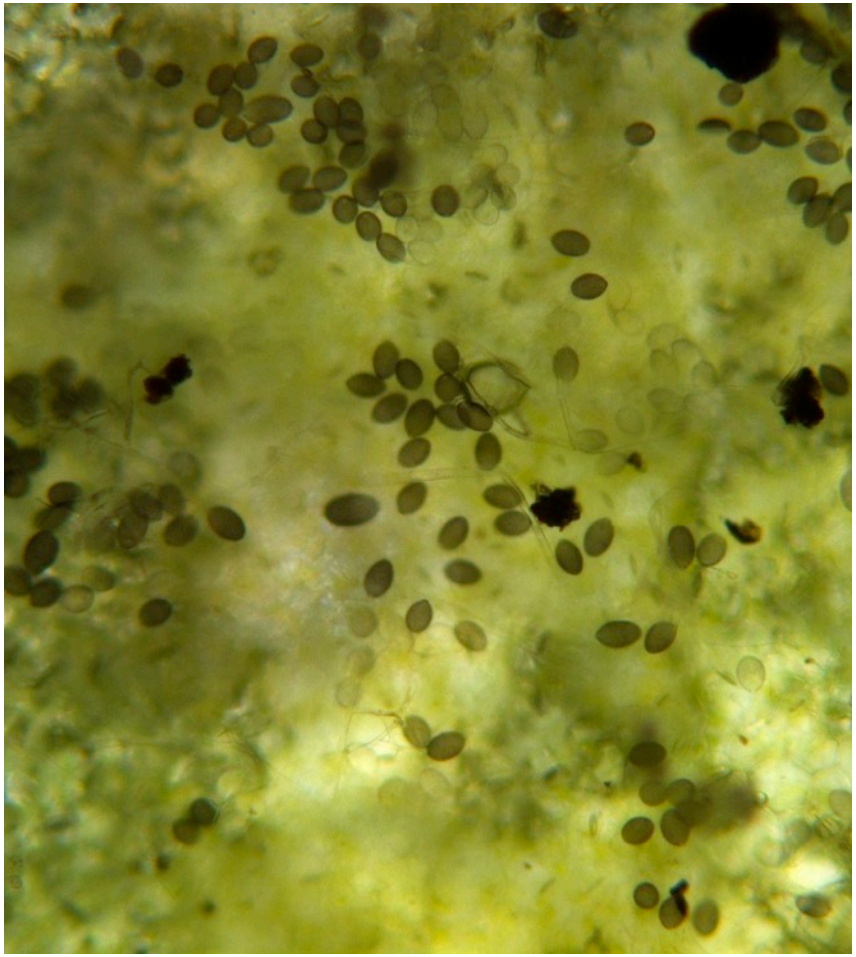
- Destructive disease of vine crops
- All vine crops are susceptible
  - But susceptibility varies
- Pathogen does not survive the winter in northern states – requires living green tissue

Vine Crops - Susceptibility to Downy Mildew



Cucumber > Cantaloupe > Pumpkin > Watermelon

Downy Mildew Pathogen

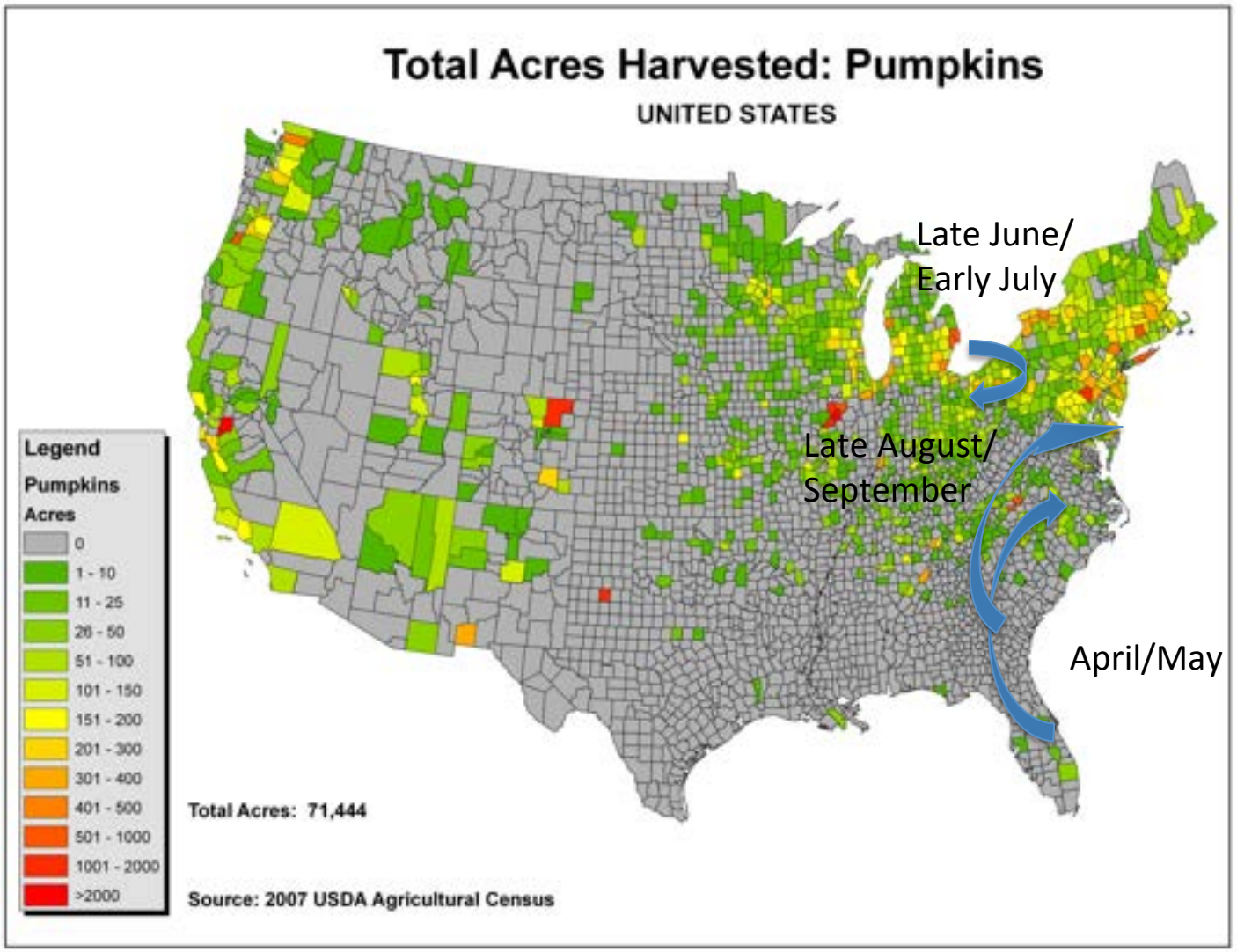


- Sporangia are carried on wind currents
  - Sensitive to UV light (sunlight)
  - Produced on undersides of leaves
  - Different forms of the pathogen affect different hosts
    - At least 5 pathotypes

Downy Mildew Pathotypes

Host	Pathotype				
	1	2	3	4	5
Cucumber	+	+	+	+	+
Netted melon	+	+	+	+	+
Honeydew melon	-	+	+	+	+
Bitter melon	-	-	+	+	+
Watermelon	-	-	-	+	+
Squash	-	-	-	-	+

Migrations of Downy Mildew Spores



Managing Pumpkin Downy Mildew

- Partially resistant pumpkin varieties not widely available
- Cultural practices
- Monitoring
- Well-timed fungicide applications

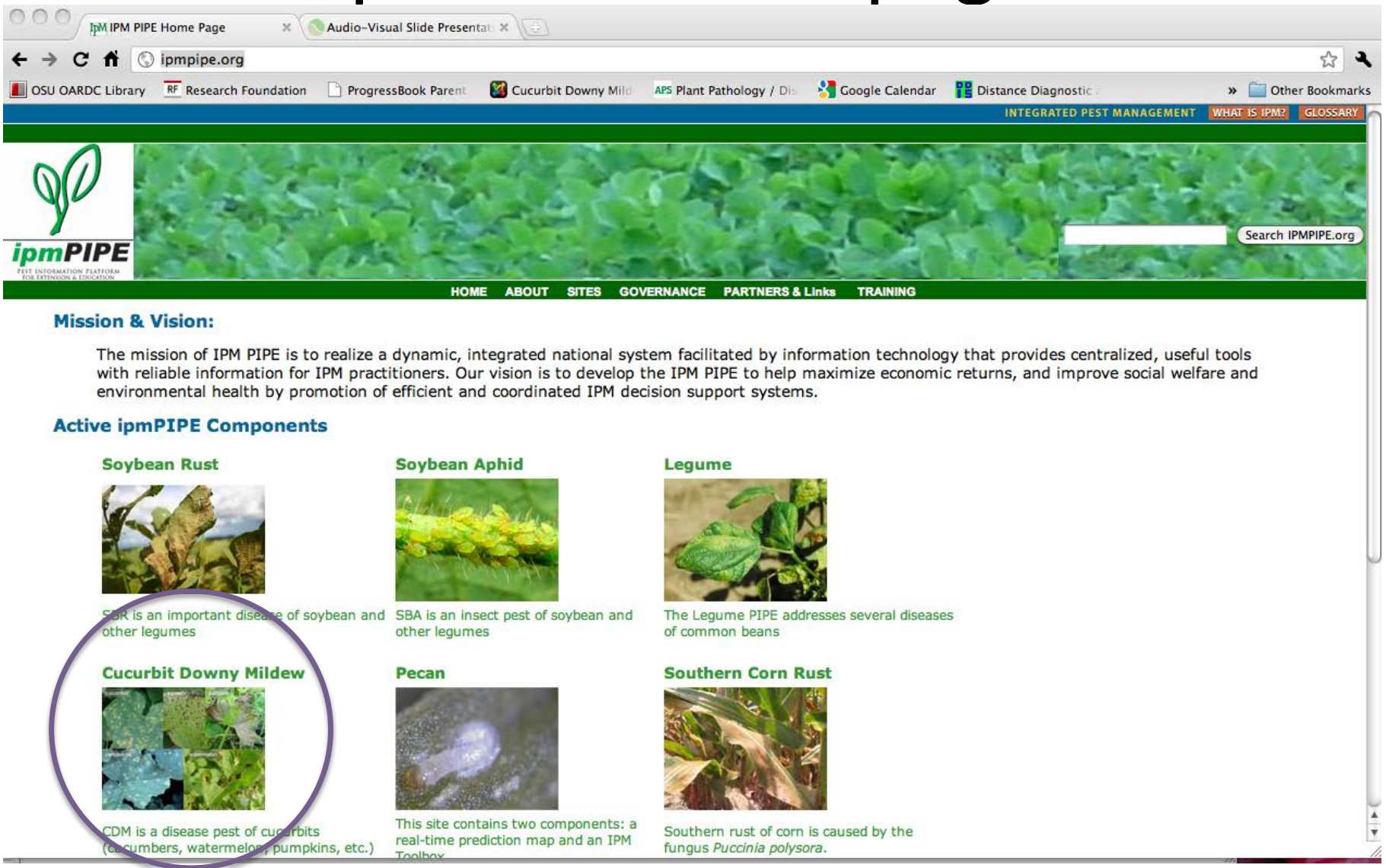
Cultural Practices

- Select areas with good drainage, airflow, full sunlight and low relative humidity
- Avoid overhead irrigation to prevent leaf wetness
- Insure adequate but not excessive fertility

Monitoring Downy Mildew

- ipmPIPE
  - Integrated Pest Management Pest Information Platform for Extension and Education
  - http://ipmpipe.org/
  - FREE online resource

ipmPIPE Homepage



CDM ipmPIPE

- Reports locations of downy mildew outbreaks
- Forecasts downy mildew occurrence
  - Threats
  - Risks
- Uses meteorological models to track spore movement
- Large network of collaborators report disease outbreaks
  - Identify spore sources

Reporting Downy Mildew Outbreaks -

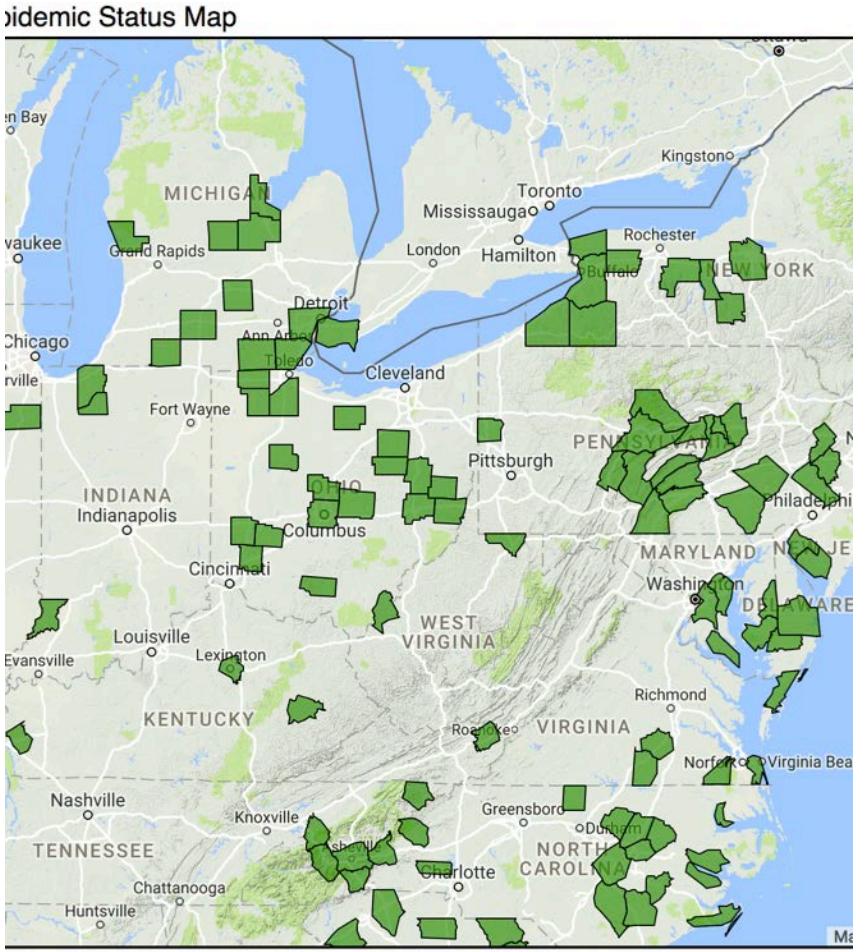
- Sentinel plots
  - Cucumber, cantaloupe, pumpkin, squash, watermelon
- Plots are scouted at least weekly and downy mildew reported to CDM ipmPIPE

Local Alerts for Downy Mildew

- Ohio -
  - Twitter @OhioVeggieDoc
  - Ohio Veggie Disease News http://u.osu.edu/miller.769/
  - Ohio VegNet Newsletter http://u.osu.edu/vegnetnews/
- Michigan – Vegetable CAT Alert http://ipmnews.msu.edu/vegetable/
- Indiana – Vegetable Crops Hotline http://www.btny.purdue.edu/pubs/vegcrop/index2009.html

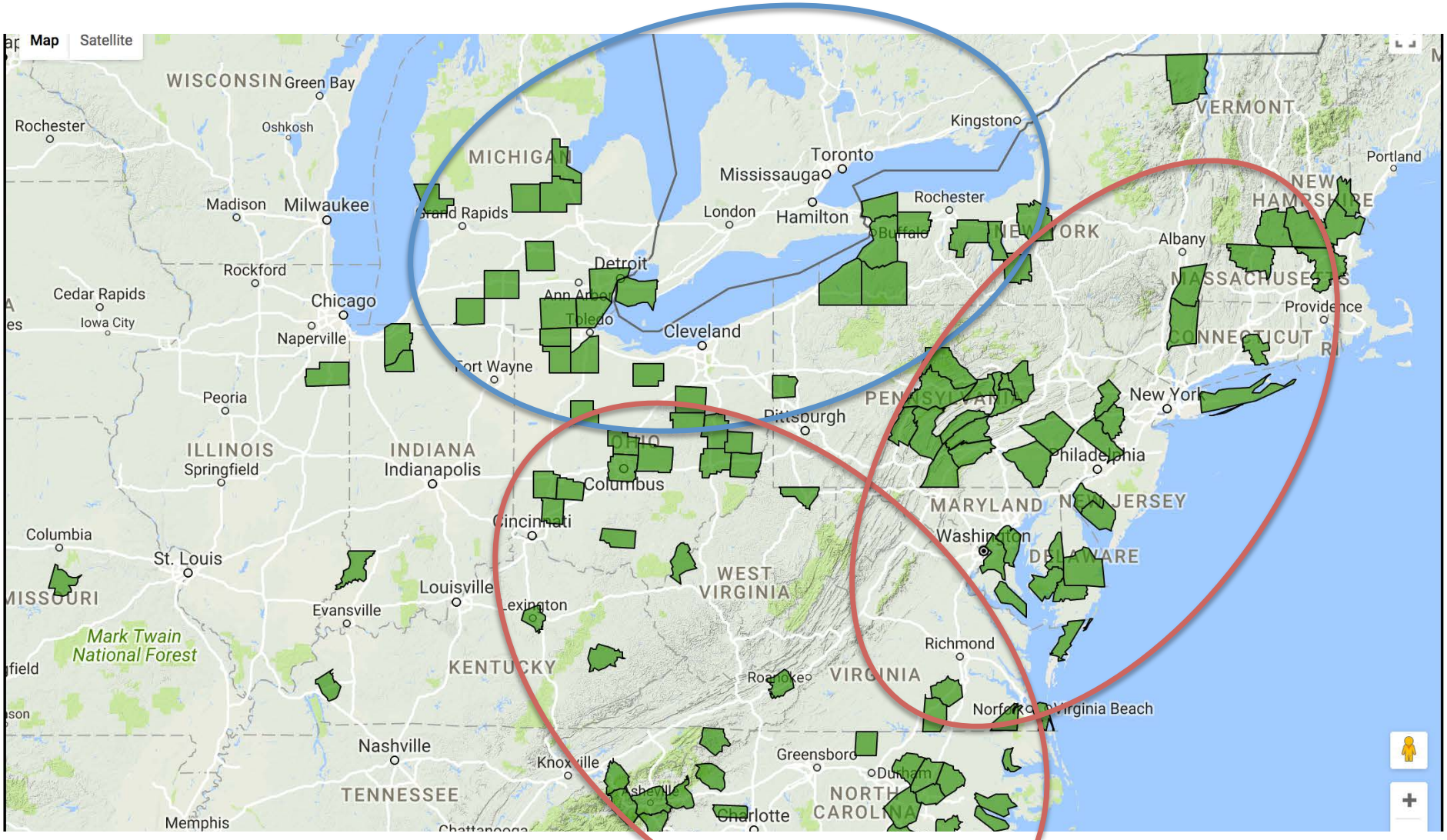
Cucurbit Downy Mildew - 2017

- Reported in 18 OH counties
  - Assume widespread
  - Started in northern OH cucumbers, moved to central and southern OH cuc/melons
  - Late detection in squash/ pumpkin
- Cucumber
  - Wayne – June 28
  - Huron – July 8
- Cantaloupe
  - Wayne – July 19
- Pumpkin, squash
  - Pike, Guernsey, Tuscawaras – September 5
  - Warren – September 7



cdm.ipmpipe.org

Cucurbit Downy Mildew



Downy Mildew Fungicide Bioassay

- Important to test fungicides for efficacy
  - Fungicide resistance development is common
  - Lost/reduced efficacy reported for: Revus, Previcur Flex, Presidio, Quadris/strobilurins

- Bioassay samples natural inoculum from field (Celeryville, OH in 2017)

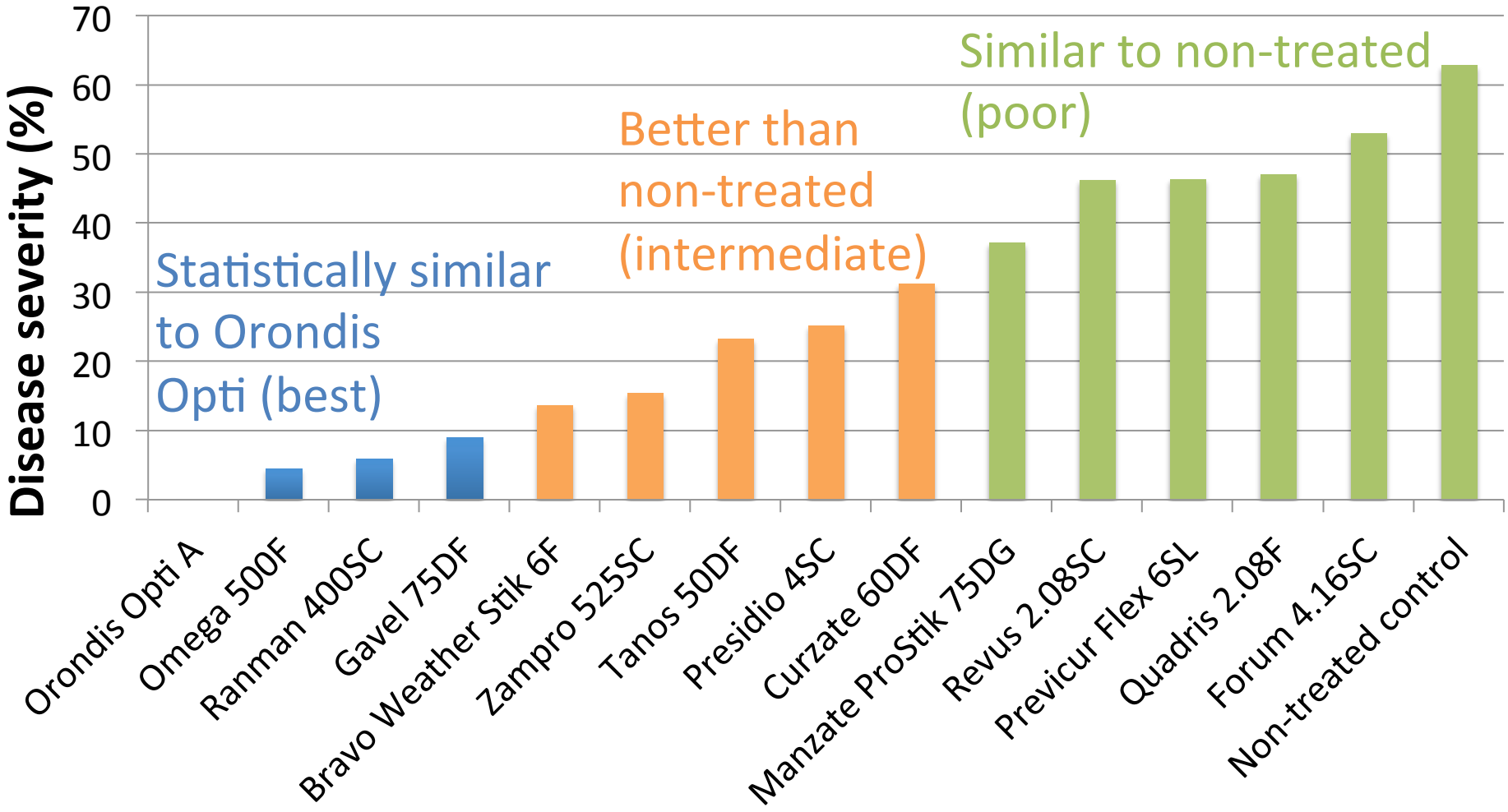
Cucumber Downy Mildew Seedling Bioassay 2017

Fungicides Tested

Orondis Opti A	oxathiopiprolin
Omega 500F	fluazinam 40%
Ranman 400SC	cyazofamid 23.3%
Gavel 75DF	zoxamide 8.3% + mancozeb 66.7%
Bravo Weather Stik 6F	chlorothalonil 54%
Zampro 525SC	dimethomorph 20.2% + ametoctradin 26.9%
Tanos 50DF	cymoxanil 25% + famoxadone 25%
Presidio 4SC	fluopicolide 39.5%
Curzate 60DF	cymoxanil 60%
Manzate ProStik 75DG	mancozeb 75%
Revus 2.08SC	mandipropamid 23.3%
Previcur Flex 6SL	propamocarb HCl 66.5%
Quadris 2.08F	azoxystrobin 22.9%
Forum 4.16SC	dimethomorph 43.5%
Water	

Cucumber Downy Mildew Bioassay

Disease Severity 5 Days after DM Exposure



South Carolina Comparison - Bioassay

- Pumpkins may be affected by downy mildew strains from the southeastern US

- Clemson University (Tony Keinath)
  - Conducted same bioassay with same products (except Orondis) in 2017
  - Cucumber seedlings

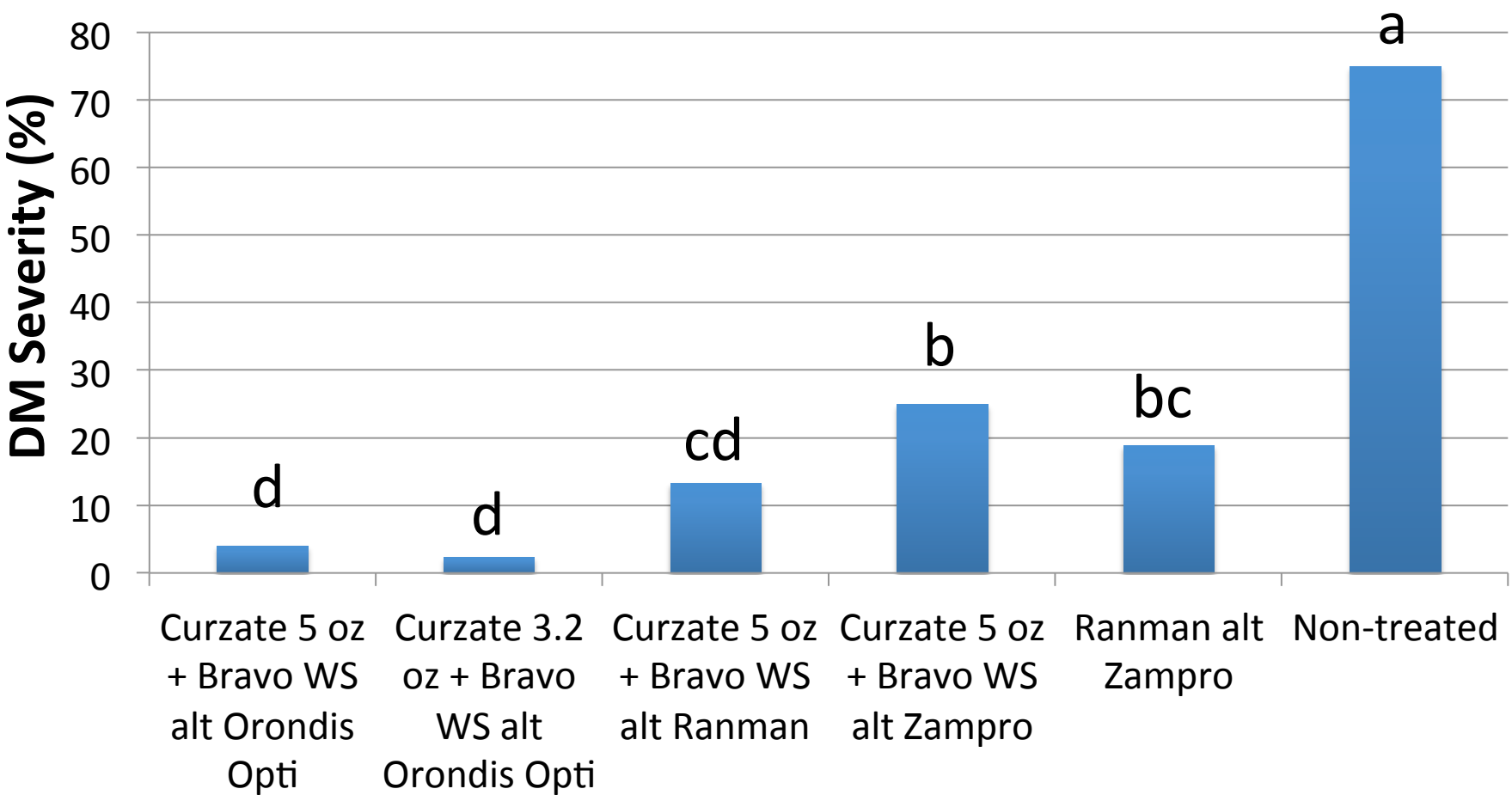
Fungicides Tested

Fungicide	OSU results	Clemson Results
Orondis Opti A	Best	Not tested
Omega 500F	Best	Best
Ranman 400SC	Best	Best
Gavel 75DF	Best	Best
Bravo Weather Stik 6F	Intermediate	Best
Zampro 525SC	Intermediate	Intermediate
Tanos 50DF	Intermediate	Poor
Presidio 4SC	Intermediate	Poor
Curzate 60DF	Intermediate	Intermediate
Manzate ProStik 75DG	Poor	Intermediate
Revus 2.08SC	Poor	Poor
Previcur Flex 6SL	Poor	Best
Quadris 2.08F	Poor	Poor
Forum 4.16SC	Poor	Poor

Evaluation of Curzate for Cucumber DM Control

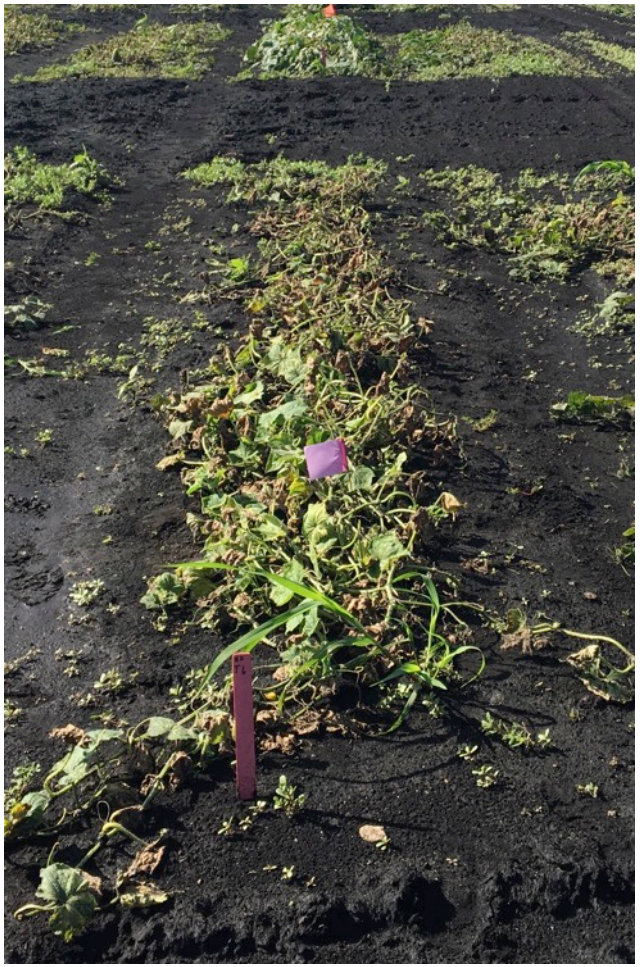
- Standard field trial conducted at OARDC Muck Crops Research Station in Celeryville in 2017
- Variety Dasher II
- Curzate has ~2 days kickback activity but relatively short residual (3-5 days)
- Several programs tested

Cucumber Downy Mildew – Disease Severity (%)



Curzate 5 oz + Bravo WS alt Orondis Opti

Curzate 5 oz + Bravo WS alt Zampro



Non-treated Control

Cucumber Downy Mildew Management Recommendations - Fungicides

- **Preventative applications recommended to maximize control and delay fungicide resistance**

- Protection before disease appears in area:
  - Apply chlorothalanil (e.g. Bravo Weather Stik) or mancozeb (e.g. Manzate Pro Stik) on a 7-10 day schedule

- After disease appears in area:
  - Shorten above application interval to 7 days, unless conditions are very dry and warm, or variety has intermediate resistance

Pumpkin/Squash DM Recommendations

- Monitor downy mildew alerts
  - @Ohioveggiedoc; Ohio Veggie Disease News (u.osu.edu/miller.769); CDM ipmPIPE (cdm.ipmpipe.org); VegNet (u.osu.edu/vegnetnews/)

- Protection before disease appears in area:
  - Apply chlorothalanil (e.g. Bravo Weather Stik) or mancozeb (e.g. Manzate Pro Stik) on a 7-10 day schedule
    - Chlorothalanil may be sufficient entire season if DM appears late or not at all

- After disease appears in area:
  - Consider adding “Best” or “Intermediate” fungicide to program

Recap: Cucurbit DM Fungicides

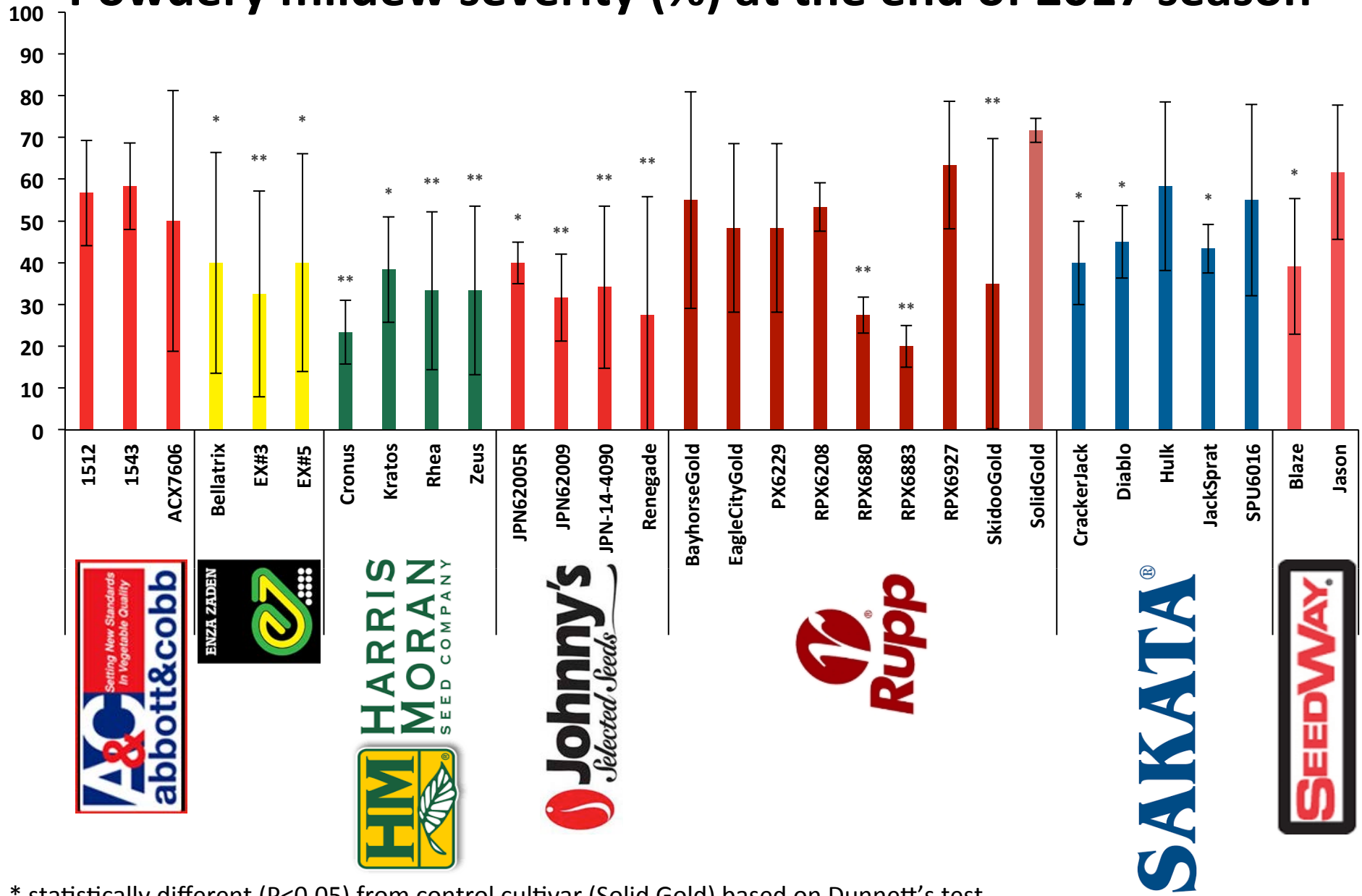
Product	PHI (days)	FRAC Code	Tier*	Comments
Orondis Opti	0	U15/M5	1	Highly effective against downy mildews
Ranman	0	21	1	High rate recommended
Gavel	5	22 + M3	1	
Zing!	0	22 + M5	1	Like Gavel but chlorothalanil replaces mancozeb
Omega	7	29	1	Long PHI limits use in cucumber
Tanos	3	11 + 27	2 (3)	Must be tank mixed with mancozeb or similar; poor in Clemson (SC) test
Chlorothalanil	0	M5	2	Protectant; alone or tank mix partner
Presidio	2	43	2 (3)	Poor in Clemson (SC) test
Curzate	3	27	2	Up to 2 days curative activity but 3-5 d residual
Zampro	0	40 + 45	2	
Mancozeb	5	M3	3	Protectant; tank mix partner
Revus, Quadris, Forum, Previcur Flex				Not recommended; Previcur Flex “1” in SC testtest

*Based on 2017 efficacy data; 1=best, 2=moderate, 3=marginal-poor

Cucurbit Powdery Mildew Management

- Field and greenhouse (bioassay) evaluations of pumpkin cultivars for PM resistance
- Bioassay for fungicide efficacy on pumpkins
- Powdery mildew inoculum from three OH locations
- Funded by OVSFRDP

Powdery mildew severity (%) at the end of 2017 season



* statistically different (P<0.05) from control cultivar (Solid Gold) based on Dunnett's test

** statistically different (P<0.01) from control cultivar (Solid Gold) based on Dunnett's test

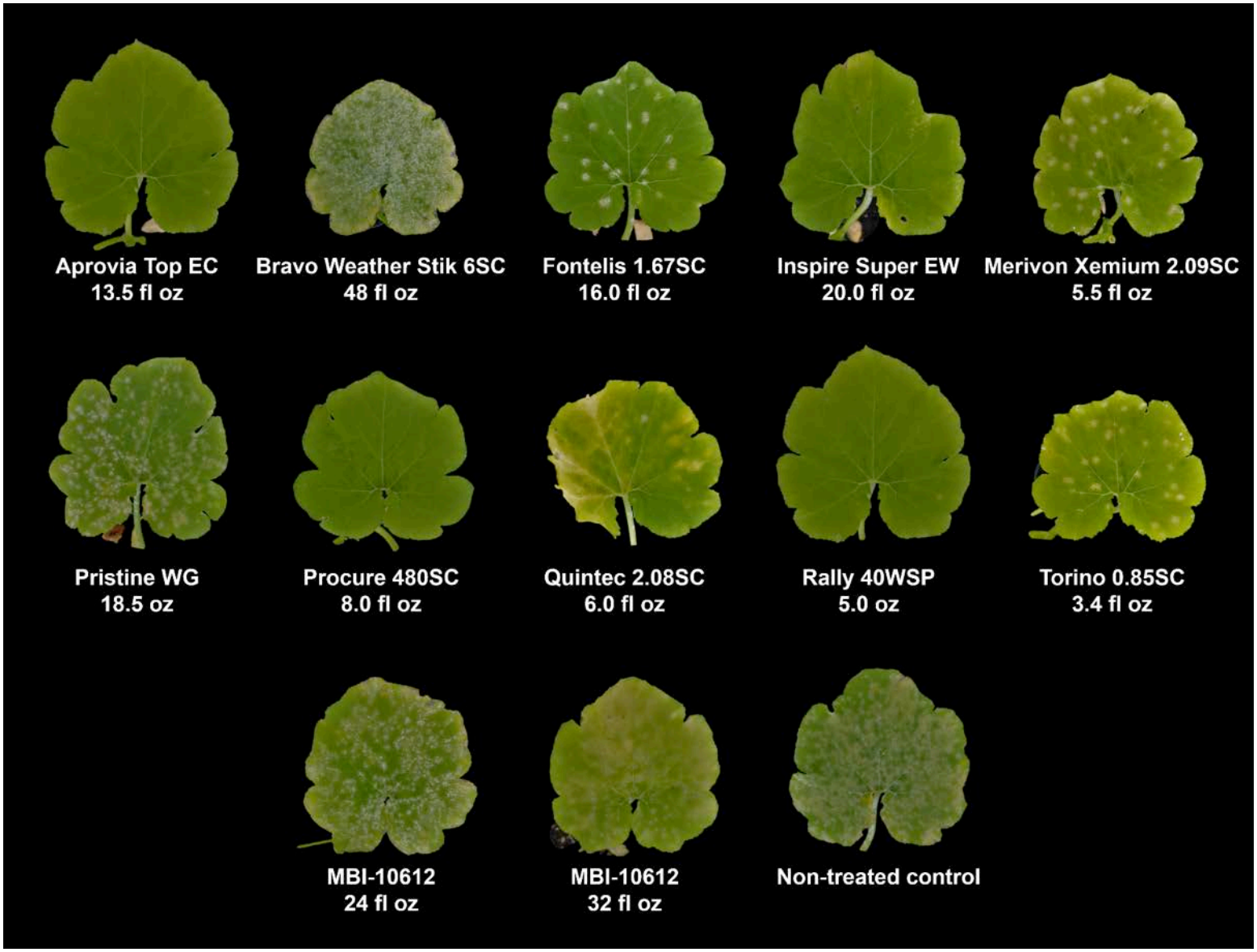
Powdery Mildew Bioassay – Fungicide Efficacy

		2016		
FRAC	Product and rate/A	Very good in 3 of 3 locations	Very good in 2 of 3 locations	Fair or poor
3	Procure 480SC 6.0 fl oz	X		
13	Quintec 2.08SC 6.0 fl oz	X		
3	Rally 40WSP 3.5 oz	X		
3,7	Aprovia Top EC 14.5 fl oz	X		
3,9	Inspire Super EW 18.0 fl oz	X		
7	Fontelis 1.67SC 14.0 fl oz		X	
7,11	Merivon Xemium 2.09SC 5.0 fl oz		X	
U6	Torino 0.85SC 3.4 fl oz		X	
7,11	Pristine WG 15.0 oz			X
M5	Bravo Weather Stik 6SC 48 fl oz			X

		2017 – early season inoculum			
FRAC	**Product and rate/A**	**Very good in 3 of 3 locations**	**Very good in 2 of 3 locations**	**Very good in 1 of 3 locations**	**Fair or poor**
3	Procure 480SC 8.0 fl oz	X			
13	Quintec 2.08SC 6.0 fl oz	X			
3	Rally 40WSP 5.0 oz	X			
3,7	Aprovia Top EC 13.5 fl oz		X		
3,9	Inspire Super EW 20.0 fl oz		X		
7	Fontelis 1.67SC 16.0 fl oz			X	
7,11	Merivon Xemium 2.09SC 5.5 fl oz			X	
U6	Torino 0.85SC 3.4 fl oz			X	
7,11	Pristine WG 18.5 oz				X
M5	Bravo Weather Stik 6SC 48 fl oz				X
	MBI-10612 24 fl oz				X
	MBI-10612 32 fl oz				X

		2017 – late season inoculum			
FRAC	**Product and rate/A**	**Very good in 3 of 3 locations**	**Very good in 2 of 3 locations**	**Very good in 1 of 3 locations**	**Fair or poor**
3	Procure 480SC 8.0 fl oz	X			
3	Rally 40WSP 5.0 oz	X			
13	Quintec 2.08SC 6.0 fl oz		X		
3,7	Aprovia Top EC 13.5 fl oz		X		
3,9	Inspire Super EW 20.0 fl oz		X		
7	Fontelis 1.67SC 16.0 fl oz			X	
7,11	Merivon Xemium 2.09SC 5.5 fl oz			X	
U6	Torino 0.85SC 3.4 fl oz			X	
7,11	Pristine WG 18.5 oz				X
M5	Bravo Weather Stik 6SC 48 fl oz				X
	MBI-10612 24 fl oz				X
	MBI-10612 32 fl oz				X

Late season inoculum
South Charleston

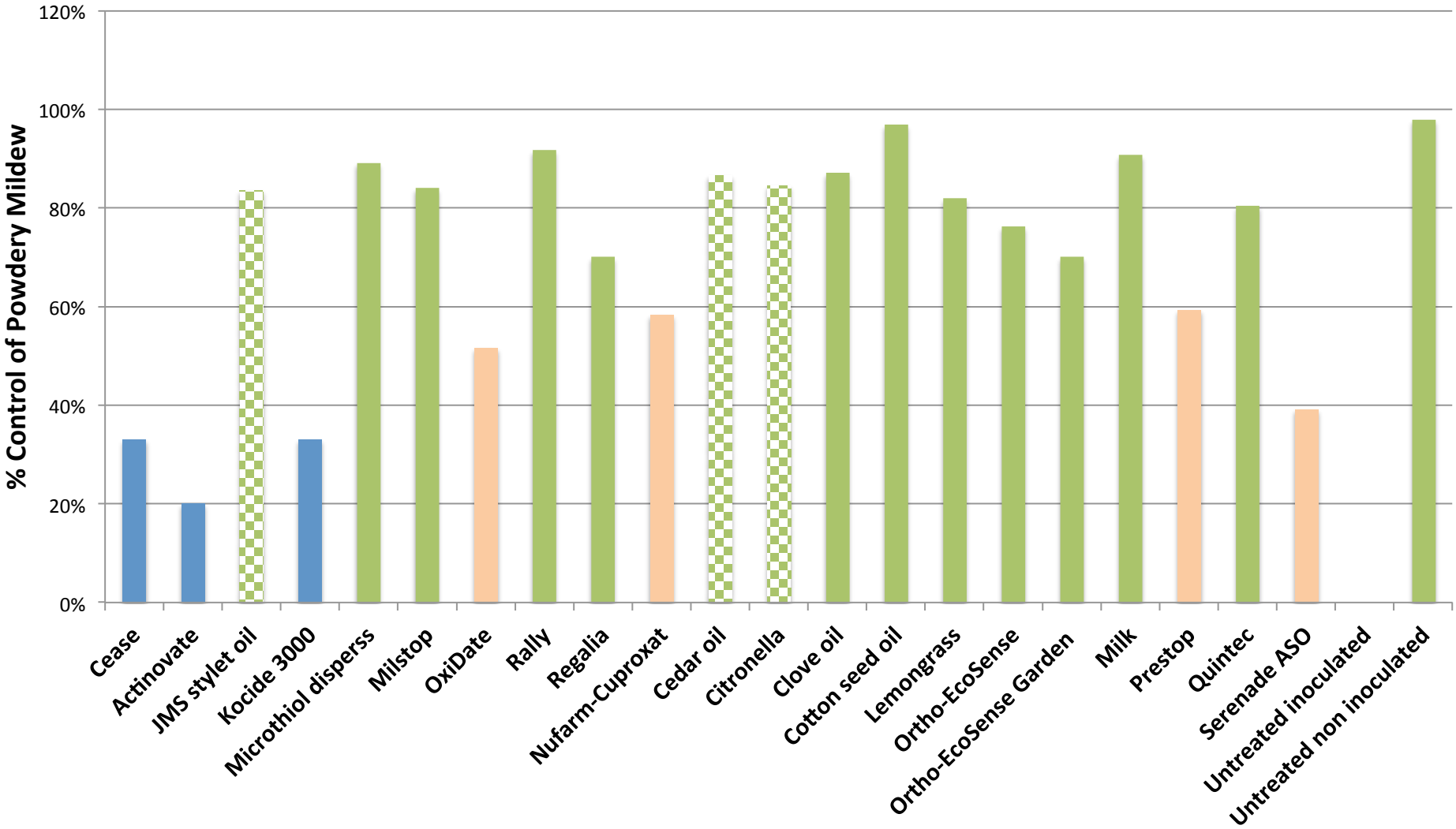


Alternative Suppression of Powdery Mildew

Products Tested

Product	Type	Active Ingredient
Cease	Biological	*Bacillus subtilis QST713*
Actinovate	Biological	*Streptomyces lydicus* WYEC 108
Prestop	Biological	*Gliocladium catenulatum J1446*
Serenade ASO	Biological	*Bacillus subtilis QST713*
Oxidate	Chemical	Hydrogen dioxide
Milstop	Chemical	Potassium bicarbonate
JMS stylet oil	Natural product	Paraffinic oil
Cedar oil	Natural product	
Citronella	Natural product	
Clove oil	Natural product	
Cottonseed oil	Natural product	
Lemongrass	Natural product	
Milk, 40%	Natural product	
Ortho Ecosense Rose/flower	Fungicide	Sulfur + pyrethrin
Ortho Ecosense Garden	Fungicide	Copper soap
Quintec	Fungicide	Quinoxyfen

Suppression of Powdery Mildew - Tomato



Summary: Powdery Mildew

- Cottonseed oil, Rally 40WSP, whole milk and Microthiol Disperss provided > 87% control

- Cedar oil, lemongrass, Regalia, citronella, both Ortho-Eco sense products, clove oil, Milstop, JMS stylet oil, and Quintec reduced the severity of powdery mildew 40-60%

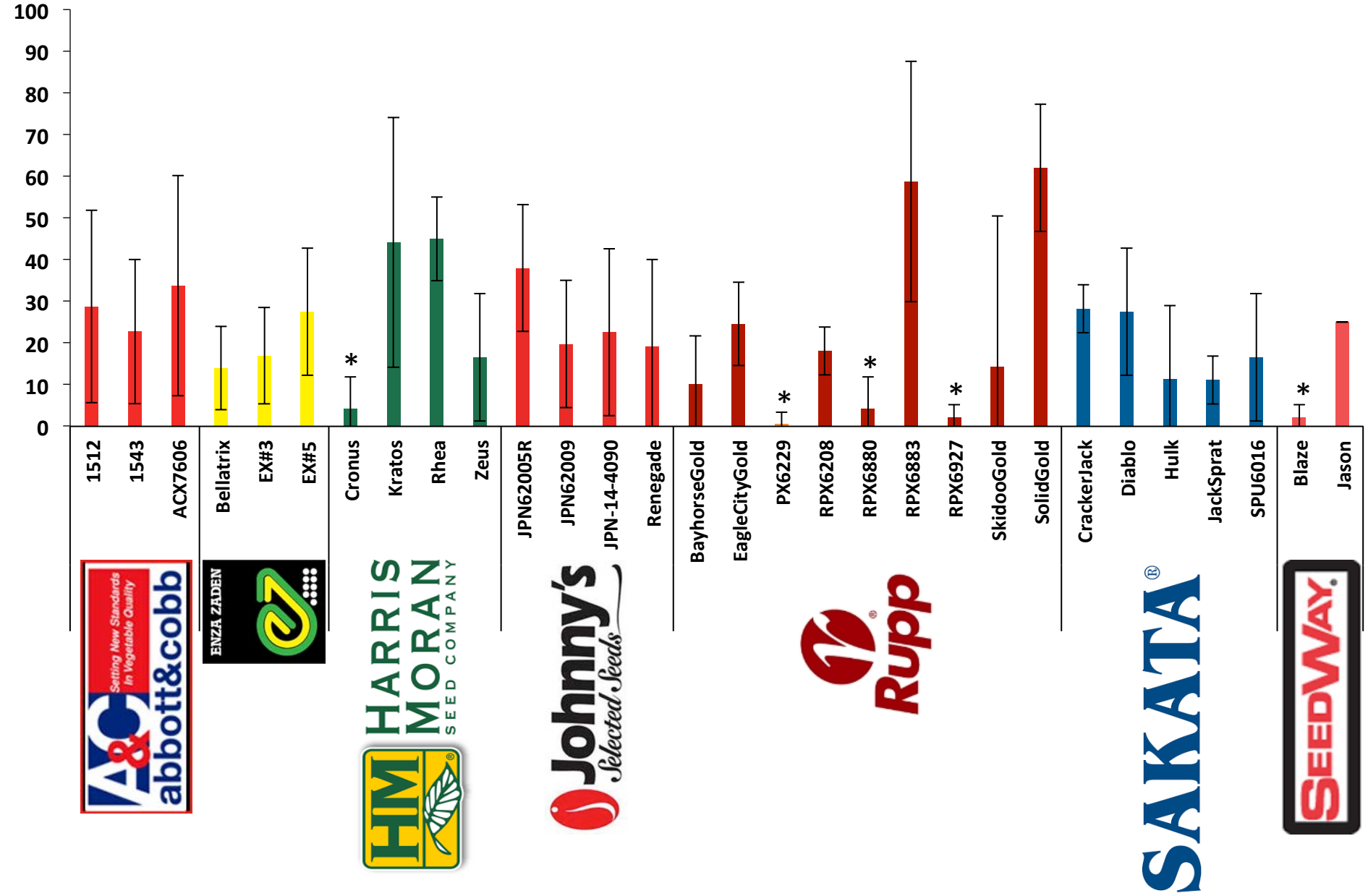
- JMS stylet oil, cedar oil and citronella damaged foliage significantly; **care should be taken to test products before use**

Plectosporium Blight

- Appeared naturally in cultivar trial
- Symptoms – typical diamond- or spindle-shaped lesions on stems, petioles, handles, leaf veins
  - Fruit symptoms – small white circular lesions may be severe

Plectosporium Blight

Plectosporium severity (%) at the end of 2017 season



* statistically different (P<0.05) from highest (Solid Gold) based on Tukey's test

Anthracnose

- *Colletotrichum orbiculare*
- Foliage, stems and fruit infected
- Lesions: shotholes on leaves; shallow elongated tan areas on stems and petioles; sunken, watersoaked lesions on fruit

Disease Cycle

- Pathogen survives in crop residue and infected volunteer plants
- Seedborne
- Conidia dispersed primarily by watersplash
- Favored by warm temperatures, high relative humidity

Management

- Disease resistant cultivars available for cucumber, watermelon
- “Pathogen-free” seed
- Reduce inoculum by deep plowing residue
- Crop rotation > 1yr
- Avoid overhead irrigation, working in wet fields
- Apply fungicides

Bacterial Diseases of Vine Crops

Disease	Cucumber	Squash	Pumpkin	Water-melon	Melon	Seed-borne
Angular leaf spot	√	√	√	√	√	√
Bacterial fruit blotch	√	√	√	√	√	√
Bacterial leaf spot	√	√	√	√	√	√
Yellow vine decline		√	√	√		
Bacterial wilt	√	√	√		√	
Bacterial rind necrosis				√	√	

Angular Leaf Spot of Cucurbits

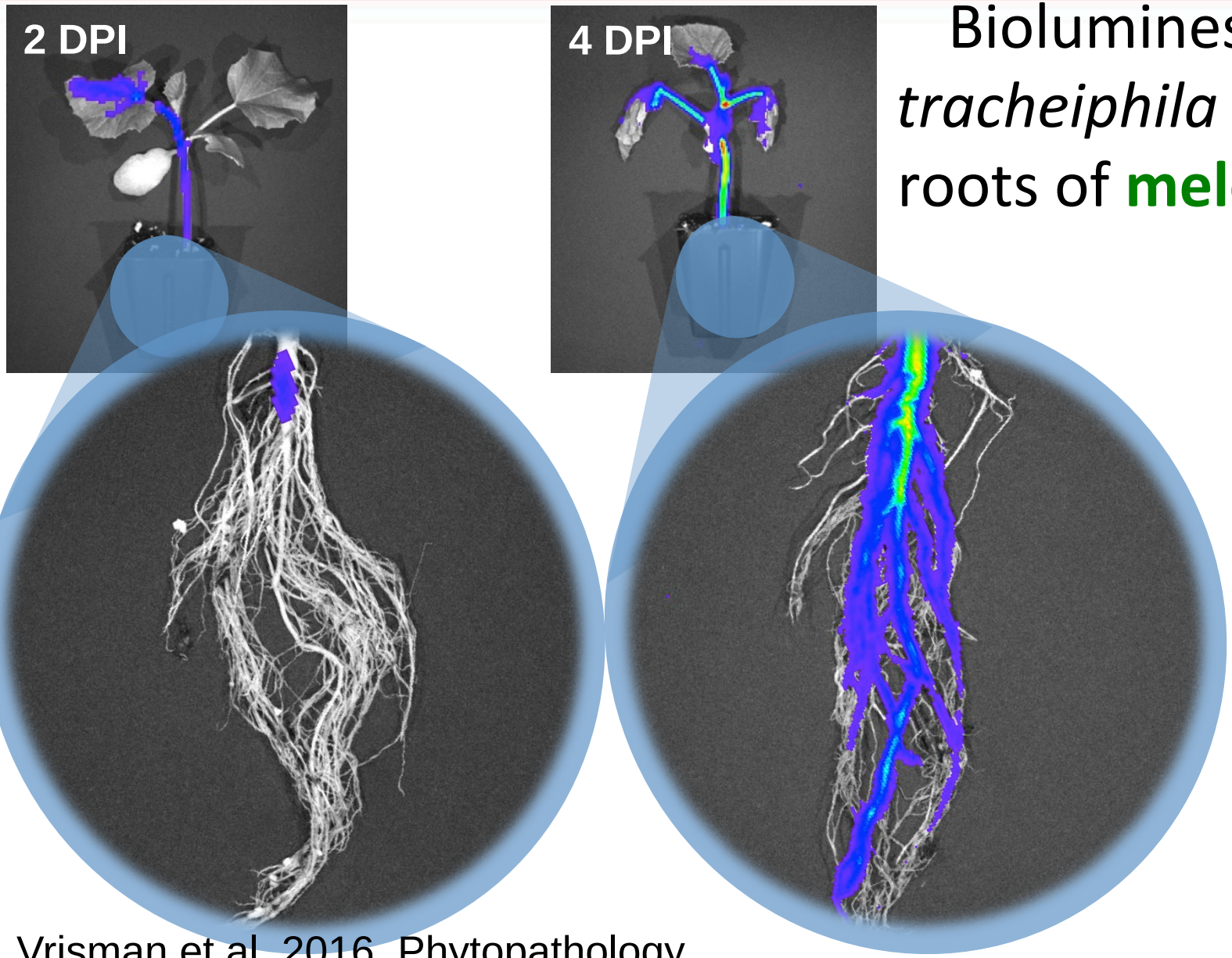
- Cucumber most susceptible but all cucurbits may be affected
- Favored by moderate temperatures and high moisture

Bacterial Leaf Spot

Bacterial Wilt of Cucurbits

- Transmitted by cucumber beetles
- Cucumbers most susceptible but other cucurbits affected
- Plants infected early likely to wilt and die

Bioluminescent *E. tracheiphila* colonizes roots of **melon** plants



Vrisman et al. 2016. Phytopathology

Yellow Vine Decline

Squash bug eggs

- Leaves turn yellow, phloem discolored (honey yellow), plants collapse
- Transmitted by squash bug

Bacterial wilt management

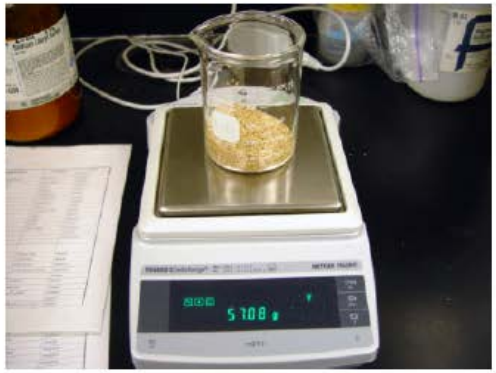
- Manage the vector
  - At-plant or foliar insecticides as soon as plants emerge and on 5-day intervals until cucumber beetle infestations subside
  - Row covers to exclude beetles

6-Step Integrated Management Program

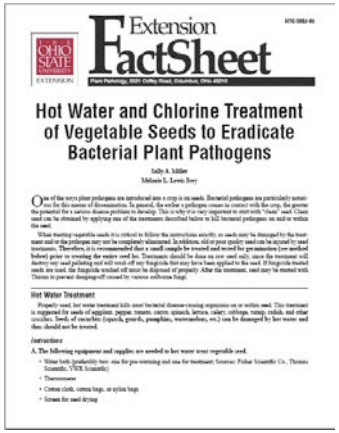
1. Use clean seed – Clorox seed treatment effective for BLS
2. Choose a resistant variety – Some available for ALS
3. Use pathogen-free transplants – Scouting, dry-growing, copper in greenhouse
4. Choose the best site and rotate – Well-drained soil, good air circulation
5. Use appropriate cultural practices – Avoid overhead irrigation, improve soil organic matter content, optimize fertility; exclude vectors
6. Use crop protectants as needed – Insecticides for cucumber beetles, squash bugs; bactericides not highly effective for ALS or BLS in field

Seed Treatment with Bleach

Step 1: Agitate seed in a solution of 25 oz Clorox plus 100 oz water with one teaspoon surfactant for 1 minute. Use 1 gallon of disinfectant solution per pound of seed (conversions provided below) and prepare a fresh solution for each batch.



Step 2: Rinse seed thoroughly in cold running tap water for 5 minutes.



Extension FactSheet

Hot Water and Chlorine Treatment of Vegetable Seeds to Eradicate Bacterial Plant Pathogens

Sally A. Miller
Melanie L. Lewis Ivey

One of the very first pathogens we introduced into a crop is on seeds. Bacterial pathogens are particularly notorious for this means of dissemination. In general, the earlier a pathogen comes in contact with the crop, the greater the potential for a serious disease problem to develop. This is why it is very important to start with "clean" seed. Clean seed can be obtained by applying one of the treatments described below to kill bacterial pathogens on and/or within the seed.

When treating vegetable seeds it is critical to follow the instructions strictly, as seeds may be damaged by the treatment and/or the pathogen may not be completely eliminated. In addition, old or poor quality seed can be injured by seed treatment. Therefore, it is recommended that a small sample be treated and tested for germination (see method below) prior to treating the entire seed lot. Treatment should be done on raw seed only, since the treatment will destroy any seed pelleting and will wash off any fungicide that may have been applied to the seed. If fungicide treated seeds are used, the fungicide residual will need to be disposed of properly. After the treatment, seed may be treated with Thiram to prevent damping-off caused by various soilborne fungi.

Hot Water Treatment

Properly used, hot water treatment kills most bacterial disease-causing organisms on or within seed. This treatment is suggested for seeds of eggplant, pepper, tomato, carrot, spinach, lettuce, celery, cabbage, turnip, rutabaga, and other crucifers. Seeds of cucurbits (squash, gourds, pumpkins, watermelons, etc.) can be damaged by hot water and thus should not be treated.

Instructions

A. The following equipment and supplies are needed to hot water treat vegetable seed.

- Water bath (preferably two: one for pre-warming and one for treatment; Sources: Fisher Scientific Co., Thomas Scientific, VWR Scientific)
- Thermometer
- Cotton cloth, cotton bags, or nylon bags
- Screen for seed drying

Then dry seeds in a single layer.

Plant within 2 weeks.

Thanks

- OSU Plant Pathology
  - Jhony Mera
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- OARDC Muck Crops
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  - Carlos Perez & crew
- OARDC Piketon
  - Brad Bergefurd
  - Thom Harker
- OARDC NCARS
  - Matt Hofelich
  - Frank Thayer
  - Bob Shaw & crew
- Seminis Vegetable Seeds, Rupp Seeds, Syngenta Seeds
- Syngenta Crop Protection, Monsanto, Bayer CropScience, Valent USA, Dow AgroSciences, DuPont Crop Protection, FMC Agricultural Products Group, BASF Corporation USA, Certis USA, Morrone Bio Innovations
- OVSFRDP

OSU Vegetable Pathology Program

- Diagnostic Lab Contacts
  - Sally Miller miller.769@osu.edu
  - Francesca Rotondo rotondo.11@osu.edu
  - Sample submission form: http://u.osu.edu/vegetablepathologylab/files/2017/09/Plant-Sample-Submission-Fillable-1mtmzu6.pdf

- Ohio Veggie Disease News
  - u.osu.edu/miller.769/
- Veggie Disease Facts
  - u.osu.edu/veggiediseasefacts/
- High Tunnel Disease Facts
  - u.osu.edu/hightunneldiseasefacts/
- Twitter
  - @ohioveggiedoc