

Managing Diseases of Major Vegetable Crops in the Palo Verde Valley

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Plant Disease

Susceptible host



Favorable
environment

Virulent
pathogen

Cucurbit Yellow Stunting Disorder



Wintermantel et al., 2017

First appears as a light green or light yellow mottle

Cucurbit Yellow Stunting Disorder



Wintermantel et al., 2017

Progresses to complete interveinal chlorosis

Cucurbit Yellow Stunting Disorder



Wintermantel et al., 2017

Leaves can become thick and brittle

Cucurbit Yellow Stunting Disorder



Wintermantel et al., 2017

First appear on oldest leaves, then to younger leaves

Cucurbit Yellow Stunting Disorder



Wintermantel et al., 2017

Fruit do not show symptoms but sugars can be reduced

Cucurbit yellow stunting disorder virus

- Vectored by sweet potato whitefly (*Bemisia tabaci*)
- Acquiring the virus
 - Minimum of 2 hours of feeding
 - Most efficient after 18 hours of feeding (> 80% acquisition), increases to 48 hours
- Retains the virus: 7 to 9 days after acquisition
- Transmission dynamics are similar to acquisition
 - After transmission, symptoms may not appear for 3 to 4 weeks

Cucurbit Hosts of CYSDV

- All cucurbit crops or garden plants: melons, watermelon, cucumber, zucchini
- Cucurbit weeds
- Efficiently transmitted

B. Wintermantel, B. Gilbertson, J. McCreight, E. Natwick

Cucurbit Hosts of CYSDV



W. Cranshaw, Colorado St. Univ.



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Buffalo gourd (*Cucurbita foetidissima*)

Non-Cucurbit Hosts of CYSDV

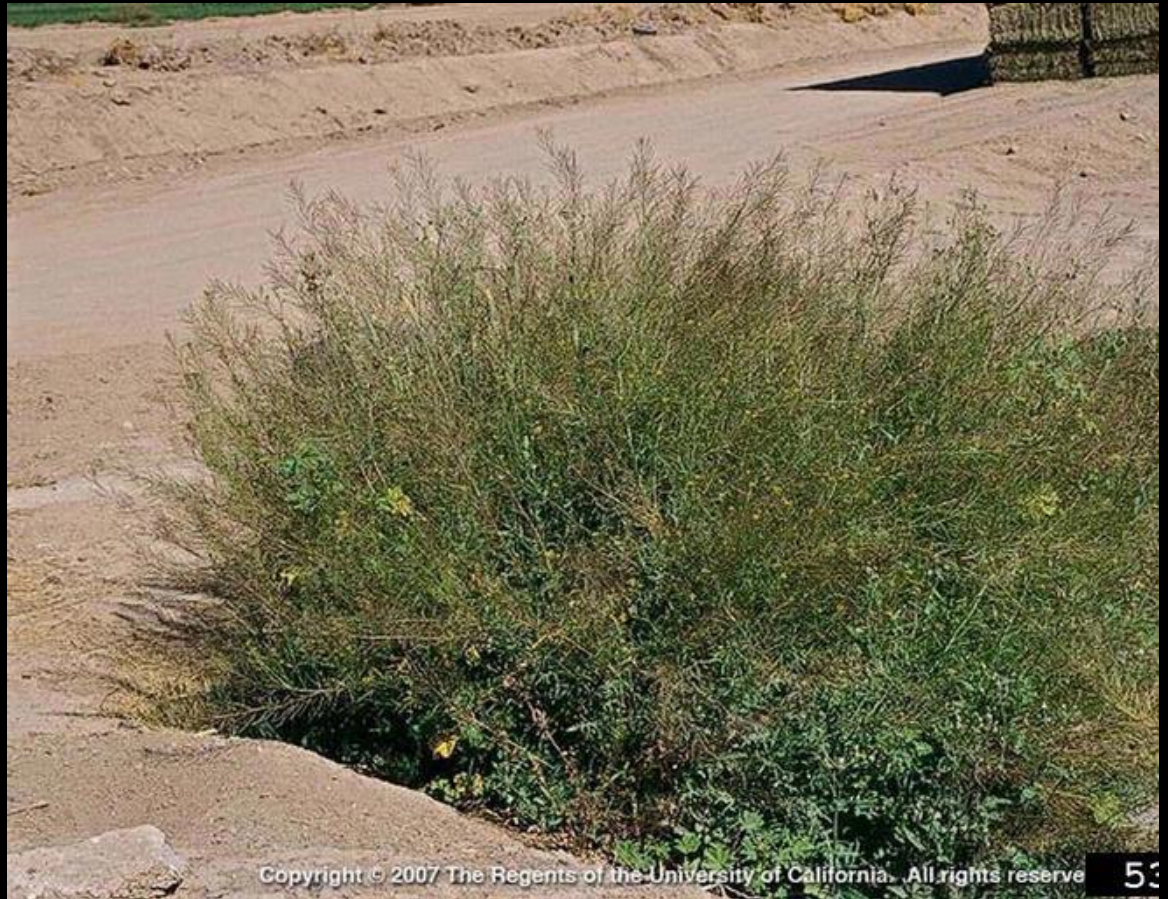
- Key hosts
- Alfalfa (Fabaceae)
 - Survey: high rate of positive detection
 - Transmission: high (one experiment only)
 - **Does not show symptoms**
- London rocket (Brassicaceae; *Sisymbrium irio*)
 - Survey: high rate of detection (6 plants sampled)
 - Transmission: high to and from
 - **Does not show symptoms**

Non-Cucurbit Hosts of CYSDV



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London rocket (*Sisymbrium irio*)

Other Non-Cucurbit Hosts of CYSDV

- Other hosts: may be less important as reservoirs
- Snap bean, common bean (Fabaceae)
 - Survey: high rate of positive detection
 - Transmission: low to moderate
 - Shows symptoms
- Silverleaf nightshade (Solanaceae; *Solanum elaeagnifolium*)
 - Survey: high rate of detection (6 plants sampled)
 - Transmission: not tested
- Alkali mallow (Malvaceae; *Sida hederacea*)
 - Survey: low rate of detection
 - Transmission: low (may be avoided by whiteflies)
 - Shows symptoms

Powdery Mildew of Melons

- True fungus
- Obligate biotroph (obligate parasite)
 - Requires living host to grow and reproduce
- About 900 species
 - Can be generalists or host-specific

Powdery Mildew of Melons



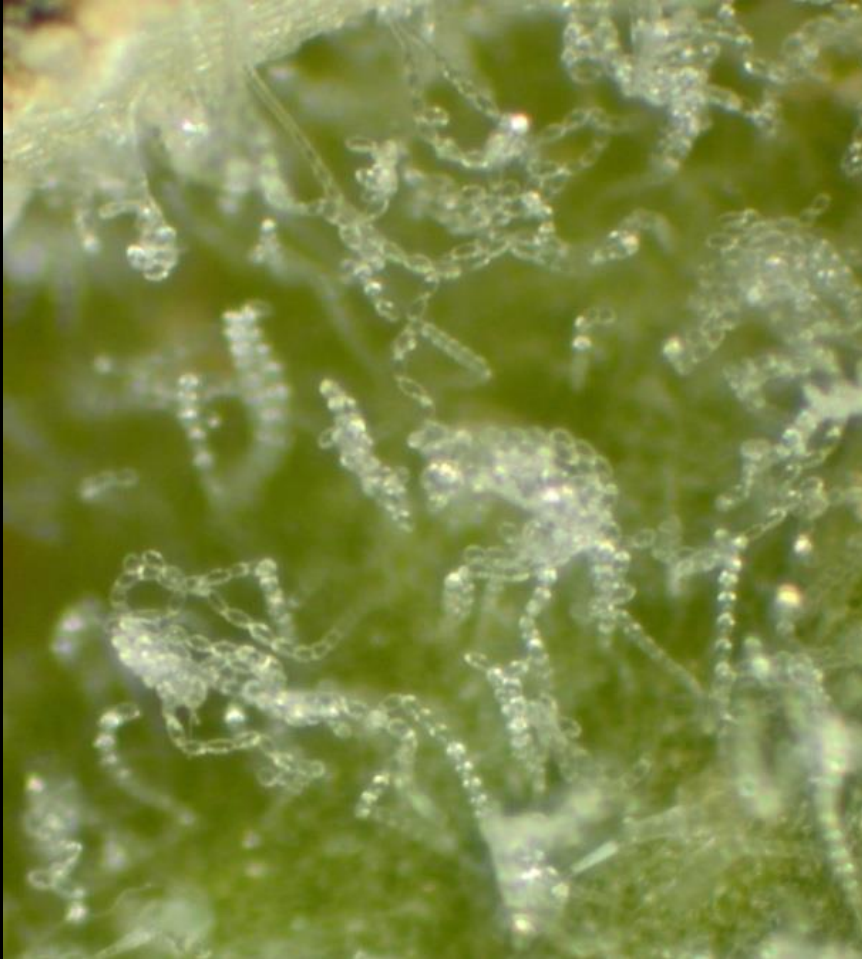
First appears on older or shaded leaves, on lower surface

Powdery Mildew of Melons

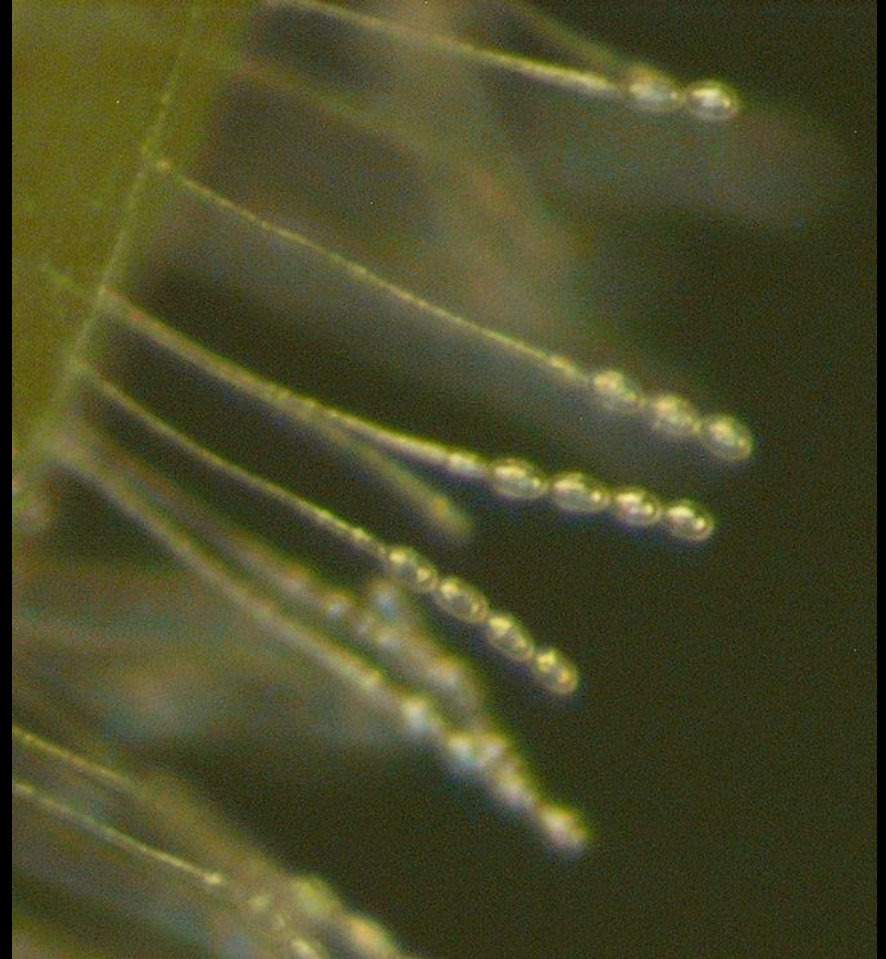


Reduces yield, defoliation leads to sunburn

Signs



B. Watt, U. Maine



West. Aus. Dept. of Ag. And Food

Spores produced in chains

Powdery Mildew of Melons



Podosphaera xanthii

Powdery Mildew of Melons



Podosphaera xanthii

Also infects many different hosts:

Nightshade (Solanaceae)

Eggplant

Chili pepper

Daisy (Asteraceae)

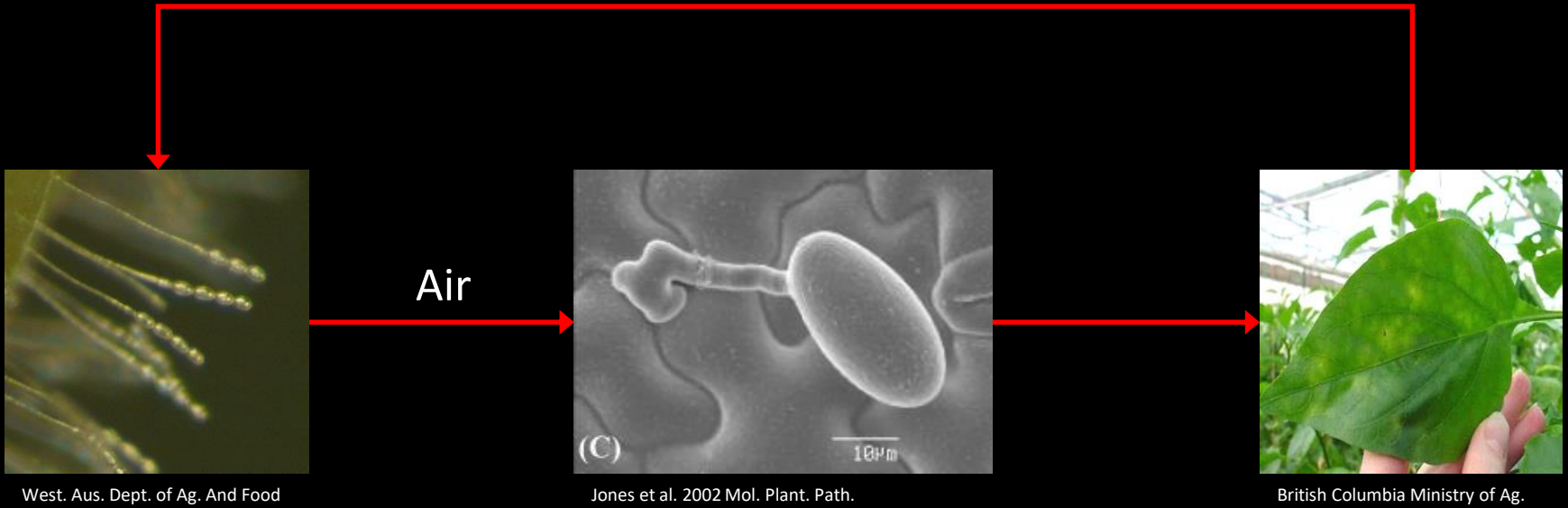
Sunflower

Legume (Fabaceae)

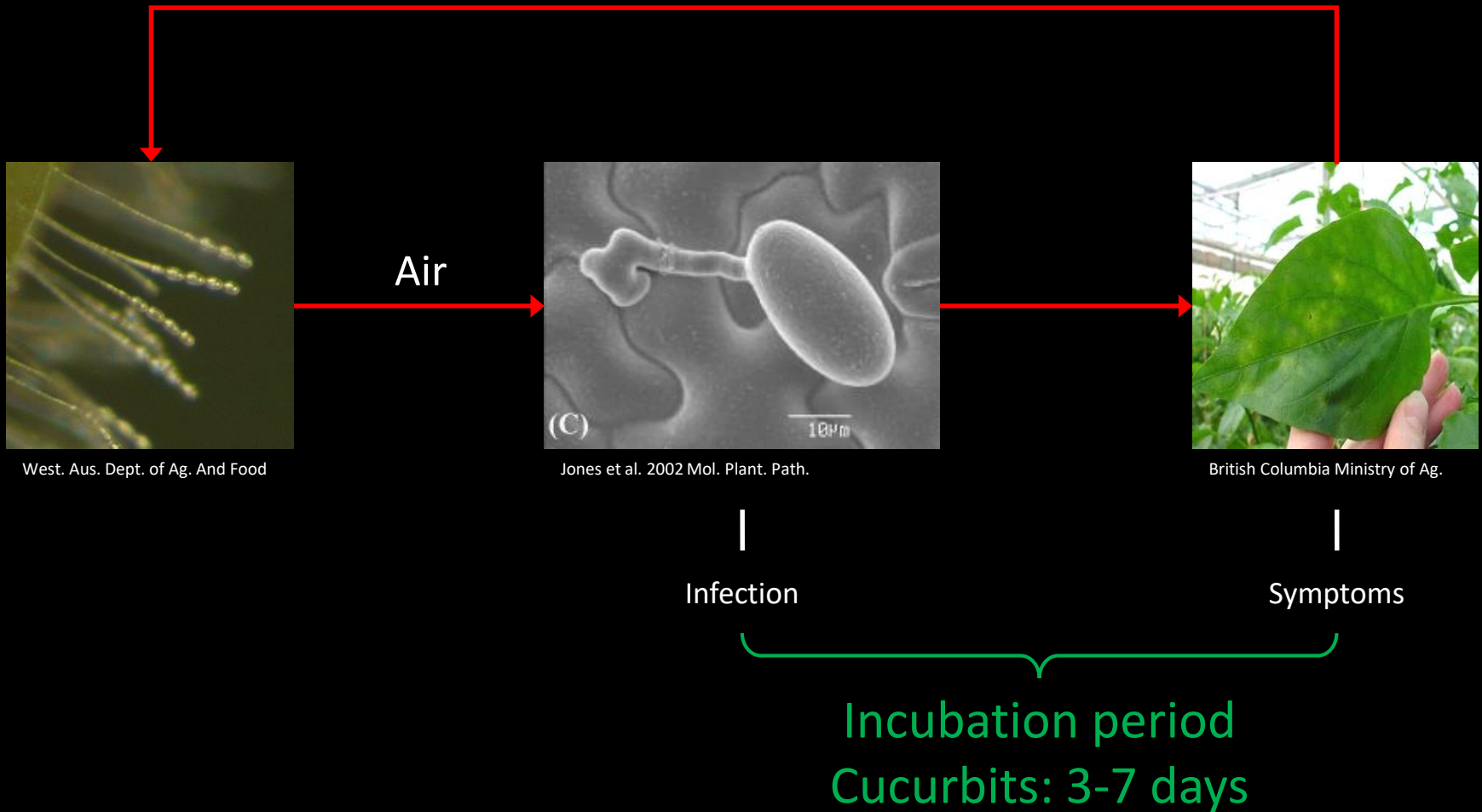
Cowpea

Bean

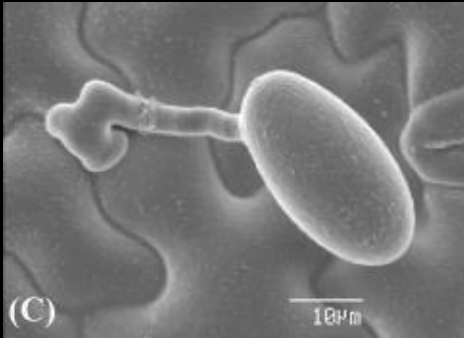
Disease Cycle



Disease Cycle



Environmental Conditions



Jones et al. 2002 Mol. Plant. Path.

Infection



British Columbia Ministry of Ag.

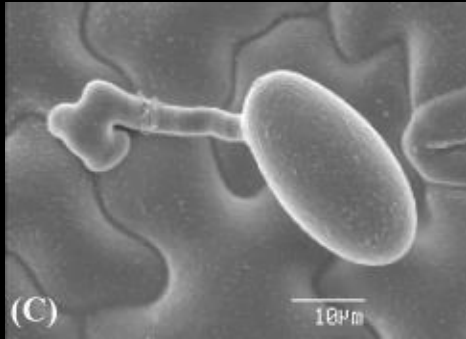
Symptoms



West. Aus. Dept. of Ag. And Food

Spore production

Environmental Conditions



Jones et al. 2002 Mol. Plant. Path.

Infection



British Columbia Ministry of Ag.

Symptoms



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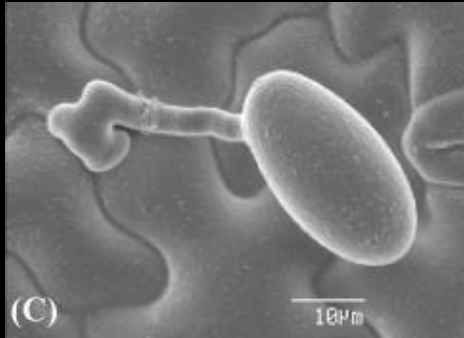
Spore production

High relative humidity in canopy
(50-90%)

FAVORABLE

Dry leaf surfaces

Environmental Conditions



Jones et al. 2002 Mol. Plant. Path.



British Columbia Ministry of Ag.



West. Aus. Dept. of Ag. And Food

Infection

Symptoms

Spore production

High relative humidity in canopy
(50-90%)

FAVORABLE

Dry leaf surfaces

Optimal: 60° to 81°F (can occur 50° to 90°F)

UNFAVORABLE: free moisture on leaf

Host Resistance – Different Sources

- Melon and cucumber
 - Widely available, effective for pathogen races 1 and 2
 - Other races present:
 - Race 3
 - Race S identified in 2003
- Squash and pumpkin
 - Number of copies of one gene
 - One copy = heterozygous; intermediate resistance
- Watermelon: no bred resistance but is naturally the least susceptible

Chemical Management

- Timing
 - Begin early with aggressive scouting
- Preventive program
 - Penetrant fungicides
- Spray coverage throughout canopy
 - Especially to lower leaf surfaces

Cantaloupe powdery mildew fungicide efficacy summary

Michael Matheron and Martin Porchas, University of Arizona Cooperative Extension,
Yuma Agricultural Center

Trade name	FRAC #	Mean percent efficacy	# of trials	Trade name	FRAC #	Mean percent efficacy	# of trials
Procure	3	95	16	Quadris	11	56	11
Rhyme	3	95	5	Quintec	13	97	19
Rally	3	86	18	Serenade	44	54	5
Mettle	3	82	5	Taegro	44	55	4
Inspire Super	3, 9	94	5	Timorex Gold	46	54	4
Fontelis	7	97	4	Torino	U6	100	7
Endura	7	81	9	Prolivo	U8	98	3
Luna Sensation	7, 11	96	4	Vivando	U8	92	5
Merivon	7, 11	87	3	Microthiol Disperss	M2	97	12
Cabrio	11	72	13	Bravo	M5	68	7
Flint	11	64	13	Actinovate	-----	30	7

Fungicide Resistance in *P. xanthii*

- FRAC Group 3: DMIs (demethylation inhibitors) – **reduced sensitivity**
- 7: SDHI (succinate dehydrogenase inhibitors) – **resistance common**
- 11: strobilurins (QoI) – **resistance widespread**
- 13: quinoxifen – **reduced sensitivity**
- U6: cyflufenamid – **resistance**
- 50: metrafenone – **reduced sensitivity**

Downy mildew

- Water molds
 - Like *Pythium*, *Phytophthora*
- Obligate biotroph (obligate parasite)
 - Requires living host to grow and reproduce
- Over 700 species, generally host-specific

Onion



Lettuce



Photo: M. McGrath, Cornell

Spinach



Photo: B. Watt, Univ. of Maine

Brassica



Photo: G. Holmes, Cal Poly-SLO

*Peronospora
destructor*

*Bremia
lactucae*

*Peronospora
effusa*

*Hyaloperonospora
brassicae*

Peronospora destructor



Onion



Kickof, en.wikipedia.org

Garlic

...And
Others

Peronospora destructor



Onion



Kickof, en.wikipedia.org

Garlic

...And
Others

Hyaloperonospora brassicae



R. Melanson, Miss. St. Univ.

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Broccoli



W.M. Brown, Jr., Bugwood.org

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Chinese cabbage

...And
Others

Peronospora destructor



Onion



Garlic

...And
Others



Peronospora effusa



Spinach



Hyaloperonospora brassicae



Broccoli



Chinese cabbage

...And
Others

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Disease Cycle

Time



Infection



Symptoms



Sporulation



Infection



Time

Onion

Spinach



Infection



Symptoms



Sporulation



Infection

Latent Period

8 to 16 days

9 days



Time

Onion

Spinach



Infection



Symptoms



Sporulation



Infection

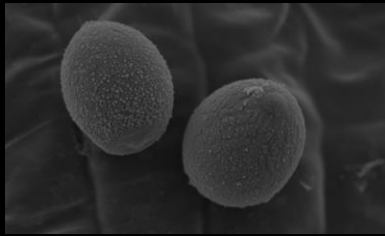
- High relative humidity at night
- Previous day air temperature < 80°F
- No rain after midnight

- “Warm” and dry morning
- Light winds

Time

Onion

Spinach



Infection



Symptoms



Sporulation



Infection

- High relative humidity at night
- Previous day air temperature $< 80^{\circ}\text{F}$
- No rain after midnight

- Leaf wetness beginning at sunrise
- Length of wetness needed is proportional to air temperature ($> \sim 70^{\circ}\text{F}$)

- Warm and dry morning
- Light winds

- Moist
- Cool
- Light winds

Cultural Management

Time



Infection



Symptoms



Sporulation



Infection

- Minimize leaf wetness
 - Avoid sprinkler irrigation
 - Avoid microclimates prone to high humidity
 - Avoid full canopy during periods of high relative humidity
 - Orient rows with prevailing wind

Fungicides – Spinach

- Ridomil (FRAC Group 4) MZ (M3) or Bravo (M5)
- Orondis Ultra (49 + 40)
- Actigard/Blockade (P01)
- Revus (40)
- Zampro (40 + 45)
- Aliette (P07)
- Ranman (21)
- Kphite (P07)
- Presidio (43)

Fungicides – Spinach – Organic

- copper
- Milstop
- Taegro
- Timorex
- Oxidate
- Actinovate
- LifeGard

Spinach – Fungicide Programs

		2016	2017			2018		
Product	FRAC	A	A	B	C	A	B	C
Ridomil Gold	4	1	1	1	1	2	1	1
Quadris	11		1	1	1		1	1
Actigard	P1	2		2, 3	2	1	2	2
Orondis Ultra	49 + 40	1		4	3, 4	2	3	3
Revus	40	3				3	4	5
Zampro	40 + 45					4		
Presidio	43		2, 4					
Prophyt	P07		3					
Forum	40		2					

Within a column, numbers indicate order product was applied within each program

Mike Matheron, Univ. of Arizona, Yuma (Plant Disease Management Reports 2016, 2017, 2018)

Onion Downy Mildew

How does environment affect disease development
in controlled conditions?



Do weather models accurately describe disease in
the field?

Onion Downy Mildew

How does environment affect disease development in controlled conditions?



Do weather models accurately describe disease in the field?



Make data and tools available to local growers



Can weather models be used to time fungicide applications?

Field Trial

Trt #	Model	Interval
1	Standard Calendar	7 or 14
2	DOWNCAST	Weather-based
3	DOWNCAST de Visser	Weather-based
4	DOWNCAST Guelph	Weather-based
5	MILIONCAST	Weather-based
6	ONIMIL	Weather-based
7	Untreated	-
8	Untreated	-

Field Trial

Timing Code	Product	AI	FRAC Code	Product /A	Interval
A	Ridomil Gold Bravo	mefenoxam + chlorothalonil	4 + M5	2.5 pt	7-14
B	Dithane F-45	mancozeb	M3	2.4 qt	7
C	Orondis Ultra	oxathiapiprolin + mandipropamid	49 + 40	5.5 fl oz	7-10
D	Reason	fenamidone	11	5.5 fl oz	5-10
E	Presidio + Dithane	fluopicolide + mancozeb	43 + M3	4.0 fl oz + 2.4 qt	7-10
F	Zampro	dimethomorph + ametoctradin	40 + 45	14.0 fl oz	5-7



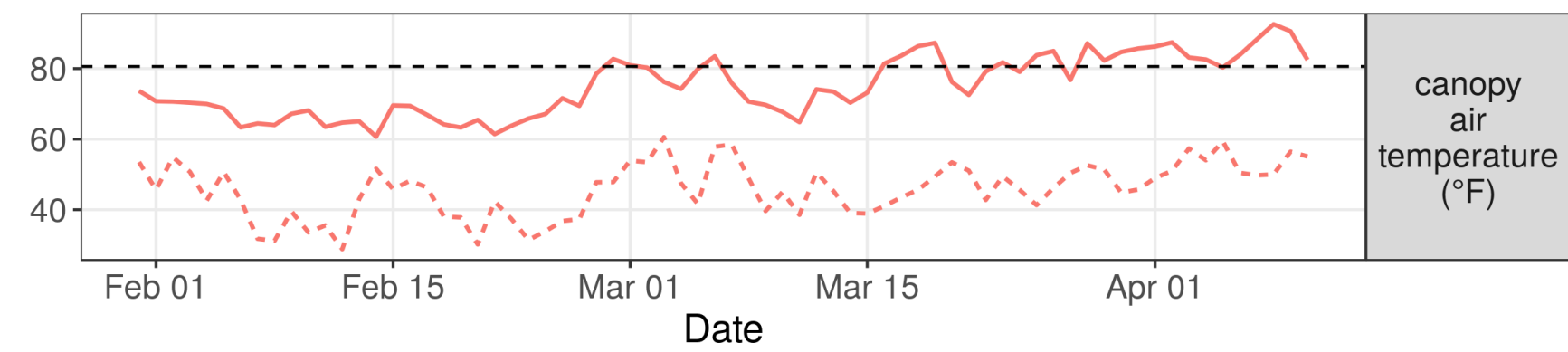
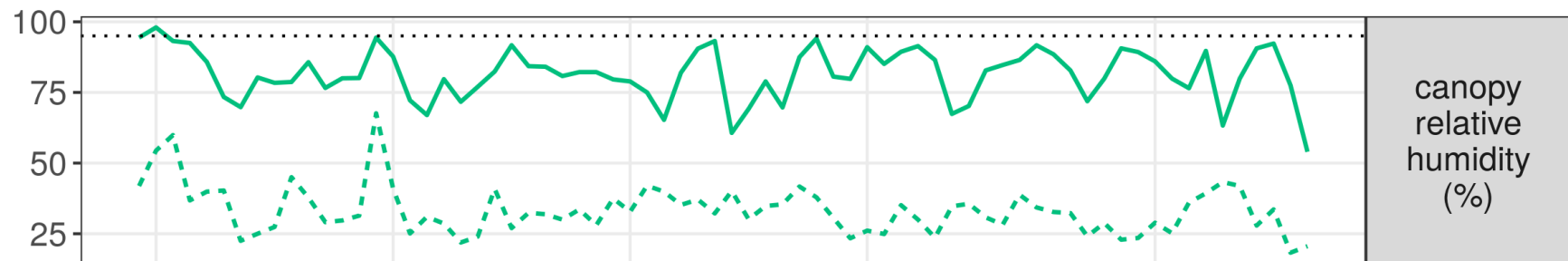
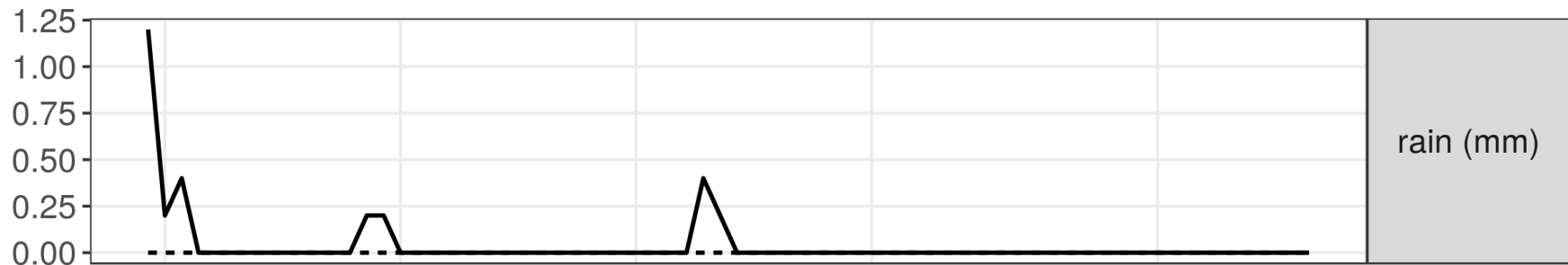
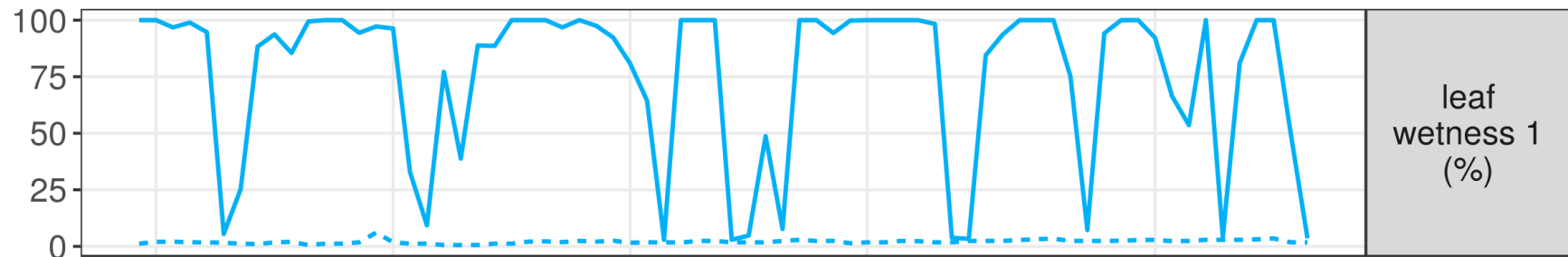
Weather Monitoring

- Two leaf wetness sensors
 - 45 degree angle
- Temp/relative humidity “in canopy”



Weather Monitoring

- Two leaf wetness sensors
 - 45 degree angle
- Temp/relative humidity “in canopy”



Model Output (2017-2018)

Date	Standard Calendar	DOWNCAST			DOWNCAST deVisser			DOWNCAST Guelph			ONIMIL		
	App	Spore	Inf	App	Spore	Inf	App	Spore	Inf	App	Spore	Inf	App
Feb. 15	-	1.00	1.00	-	0.33	1.00	-	1.00	1.00	-	0.008	0.00	-
Feb. 16	A	0.00	0.00	A	0.00	0.00	A	0.00	1.00	A	0.00	0.00	-
Feb. 28	B	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-
Mar. 12		0.00	0.00	-	0.67	1.00	-	0.00	0.00	-	0.00	0.00	-
Mar. 14	C	0.00	0.00	-	0.00	0.00	B	0.00	0.00	-	0.00	0.00	-
Mar. 23	D	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-	0.00	0.00	-

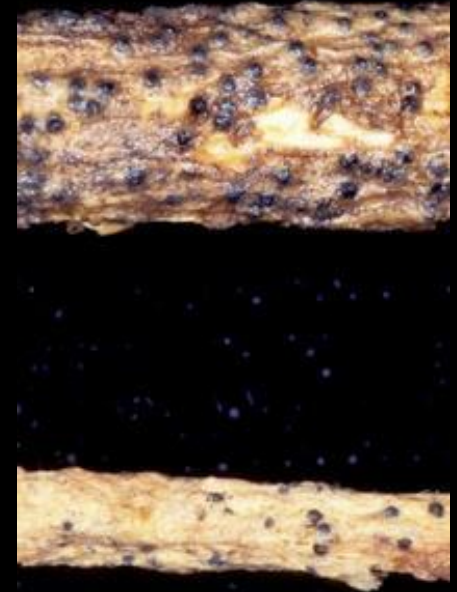
We Are Looking for Samples!



Onion downy
mildew



Spinach downy
mildew



Monosporascus
vine decline

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