University of California
Agriculture and Natural Resources

Making a Difference for California

Management of *Fusarium* and other Soil Borne Diseases in Tomatoes and Vegetables

Scott Stoddard, Farm Advisor, UCCE Merced County

Pest Management Update Class, Nov. 3, 2015

UC CE University of California Cooperative Extension

Soil diseases

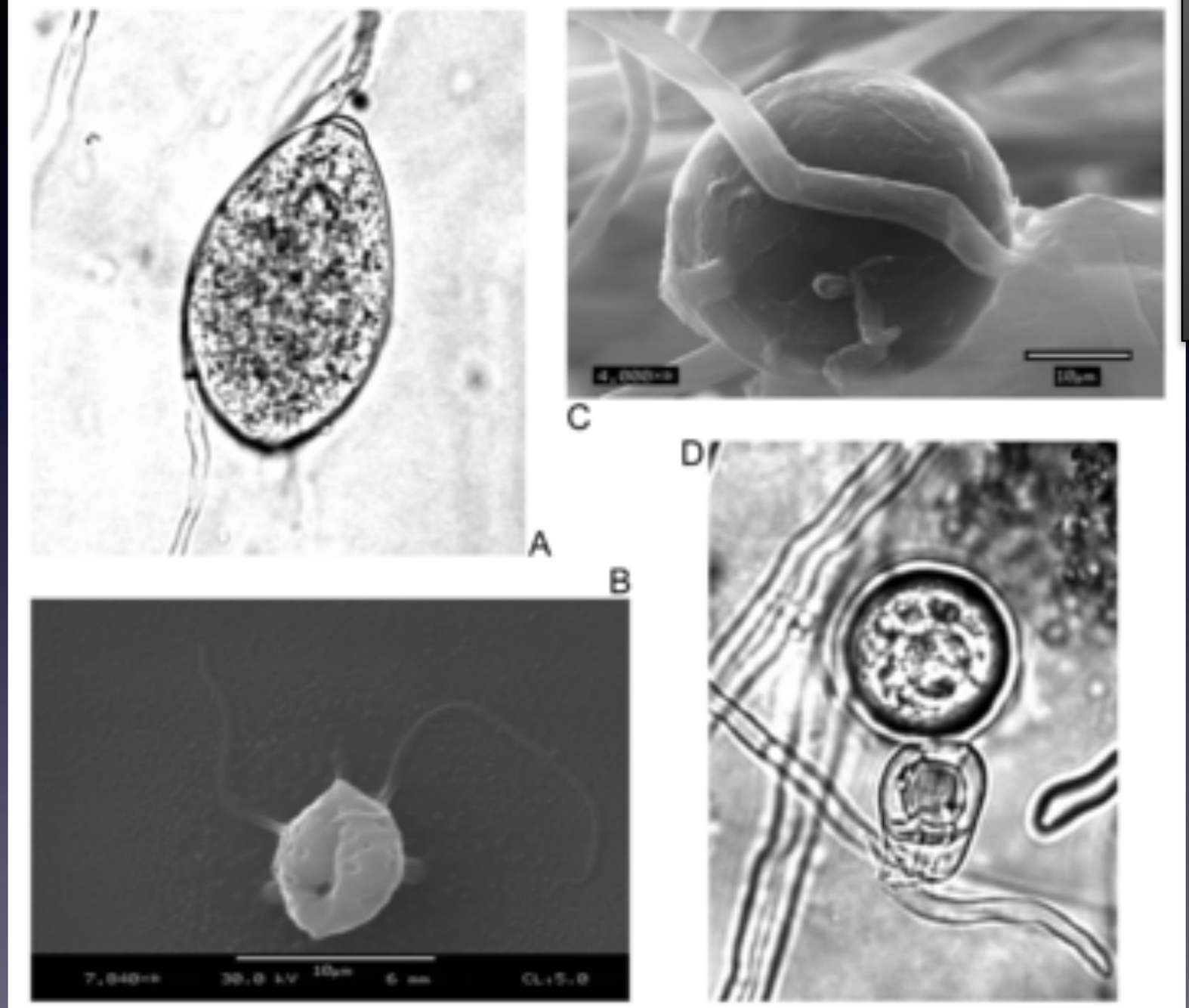
- Phytophthora
- Pythium & Rhizoctonia
- Charcoal rot (Macrophomina)
- Acremonium
- Soil rot
- Verticillium
- Fusarium

Phytophthora root rot

- Infection can occur at any time, more common in compacted, poorly drained, over irrigated soils.
- *P. parasitica and P. capsici*
  - ✦ P. parasitica: classic root rot, more common in Merced
  - ✦ P. capsici: can cause stem cankers/lesions. Common in SJ Co.
- Also cause of Buckeye Rot on fruit.
- Pre-plant & sidedress applications of Ridomil Gold (mefenoxam).

Phytophthora Root Rot

P. capsici



A. Sporangia
B. Zoospore
C. Chlamydospore
D. Oospore

Damping-off

- Pythium
- Rhizoctonia
- Phytophthora
- may also include Fusarium spp., Acremonium, bacteria, and many others
- Management: sanitation, good compost, good drainage, no compaction, Ridomyl
- increased by too much N

Bacteria soft rot

damping
off
usually
impacts
young
plants

Charcoal rot

- *Macrophomina phaseolina*
- affects melons, sweetpotatoes, strawberries, beans, corn, potatoes
- Stress pathogen, likes it when it’s hot
- lasts in soil 3 - 12 years
- in melons, causes fields to collapse 2 weeks before harvest
- more in drip

Charcoal rot management

- Reduce stress (including salts)
- Pre-plant fumigation
- Rotation
- Avoid fields where historically a problem
- Cover crops
- Variety selection

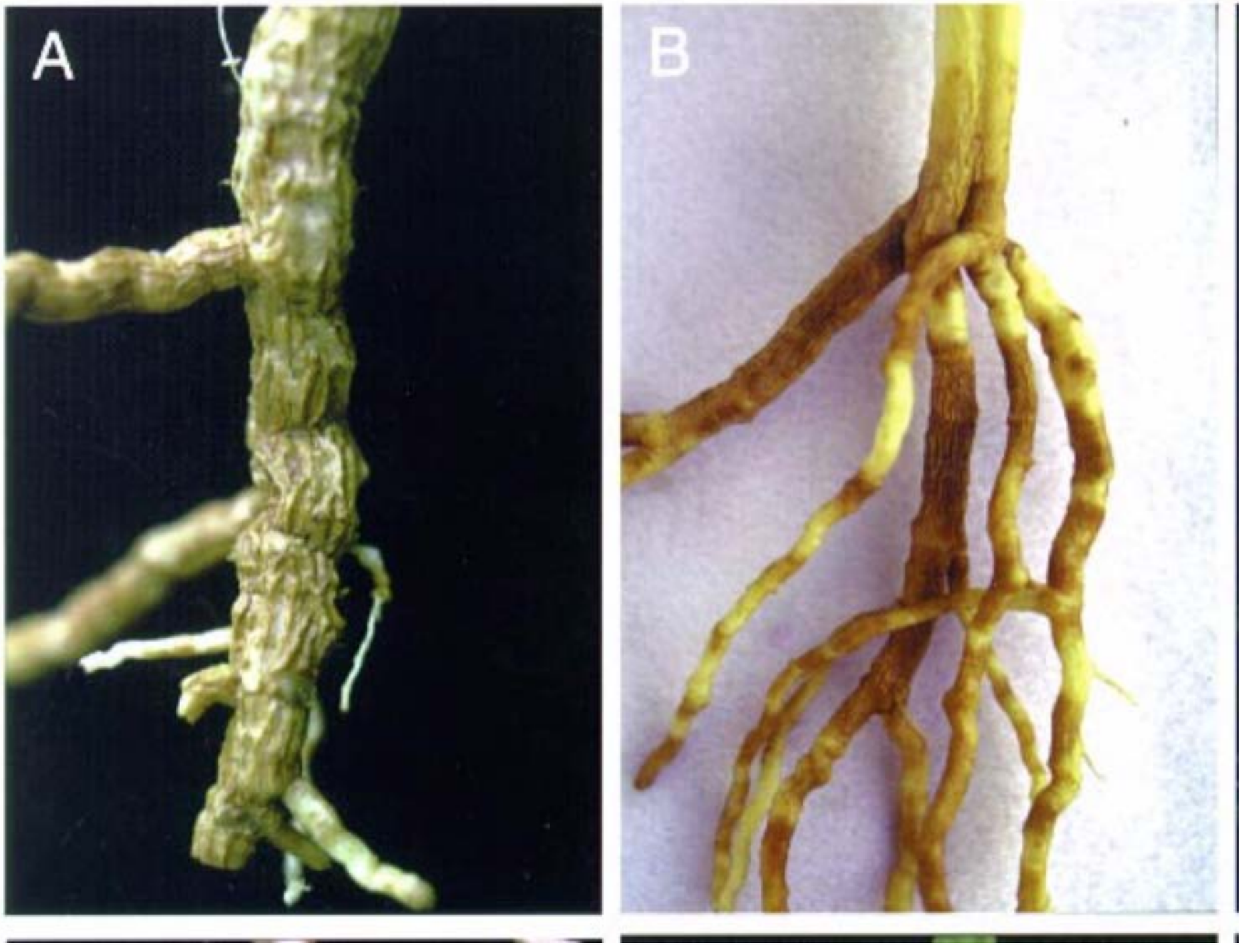
University of California
Agriculture and Natural Resources
Making a Difference for California

Acremonium

- an “acrimonious” disease of melons. Widespread & frequent throughout the state.
- sudden wilting, usually occurs near harvest, often with Pythium
- causes corky bands on roots of melons
- Management: long-term rotation

Occurrence and Pathogenicity of Fungi Associated with Melon Root Rot and Vine Decline in California

B. J. Aegerter, T. R. Gordon, and **R. M. Davis,** Department of Plant Pathology, University of California, Davis 95616



Soil Rot, “Pox”

Streptomyces ipomea

Scab in potatoes

Verticillium

- infects many crops and weeds including tomatoes, melons, strawberries, cotton
- favored by cool air and soil temps
- Causes vascular discoloration
- Reduces yield and vigor, but usually doesn’t kill the plant
- several races
- long-term survival in soil


UC Statewide IPM Project
© 2000 Regents, University of California


UC Statewide IPM Project
© 2000 Regents, University of California

Verticillium management

- Rotate with non-host crops such as corn, small grains
    - tomatoes, peppers, melons, cotton, lettuce all susceptible
- Resistance
- Sanitation
- Solarization
- Fumigation, especially with Pic

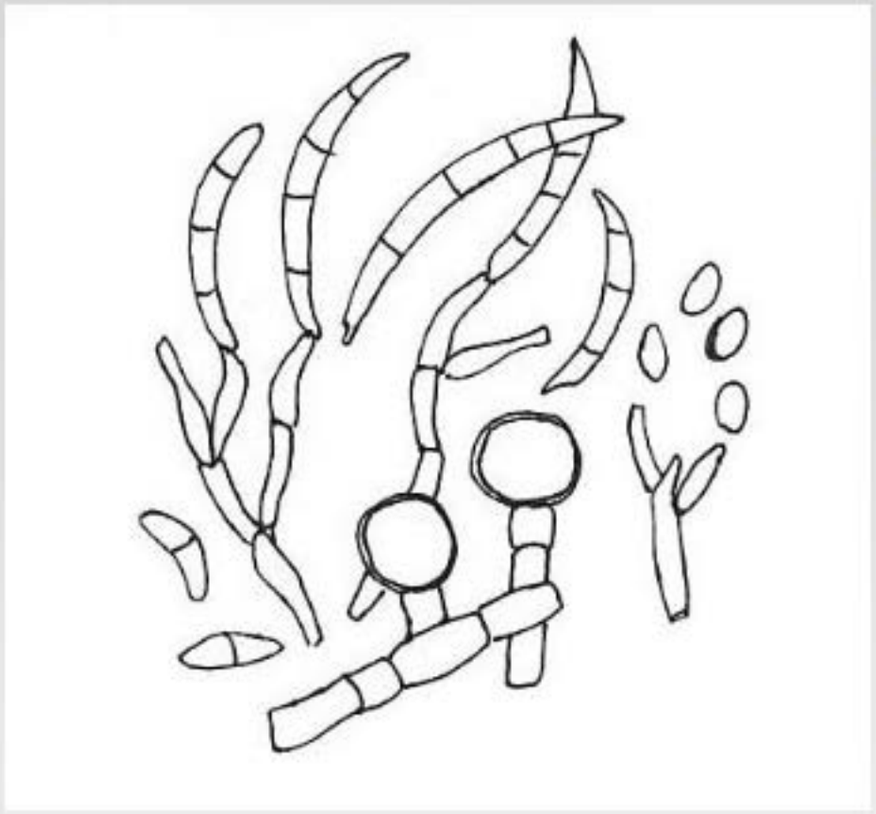
University of California
Agriculture and Natural Resources
Making a Difference for California

Fusarium

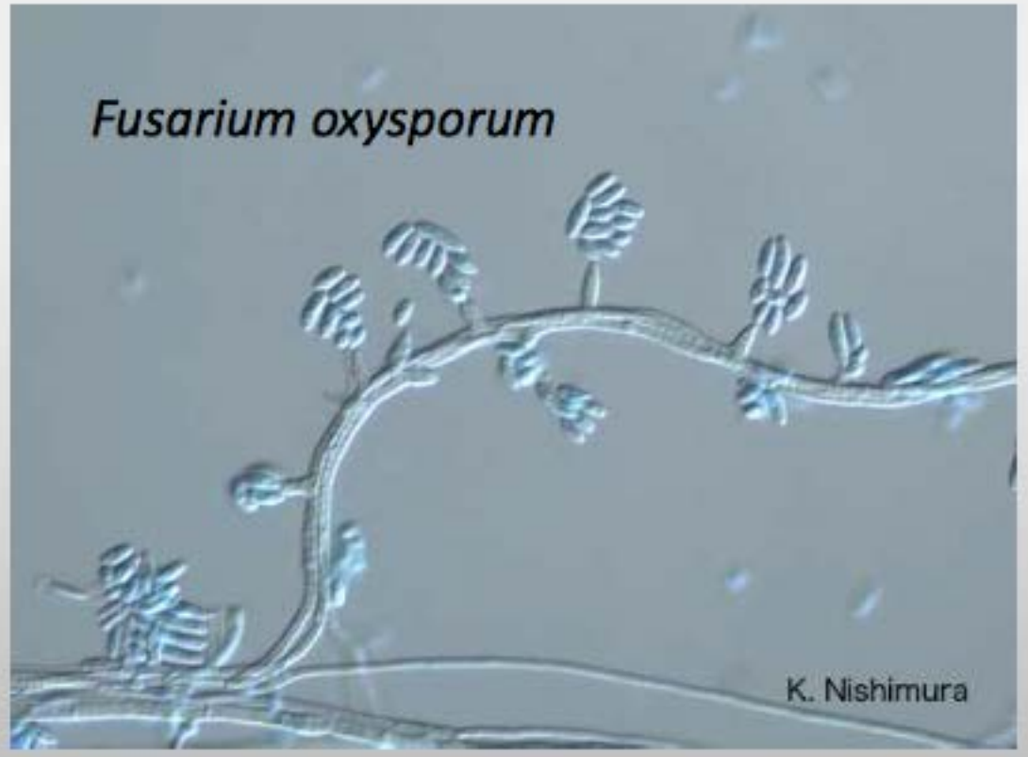
Fusarium Wilt 1, 2, 3
Fusarium Crown and Root Rot
Fusarium Foot Rot

Fusarium spp in tomatoes

- Increasing problem over the last few years
- Resistance to race 2, race 3 is becoming more common
  - ✦ common in Sac Valley and Delta, moving from the north
  - ✦ very few commercial varieties with resistance "FFF", but more are being developed
- Difficult to manage — disease can live in the soil for many years as saprophytes.



Macroconidia
Microconidia
Chlamydospores



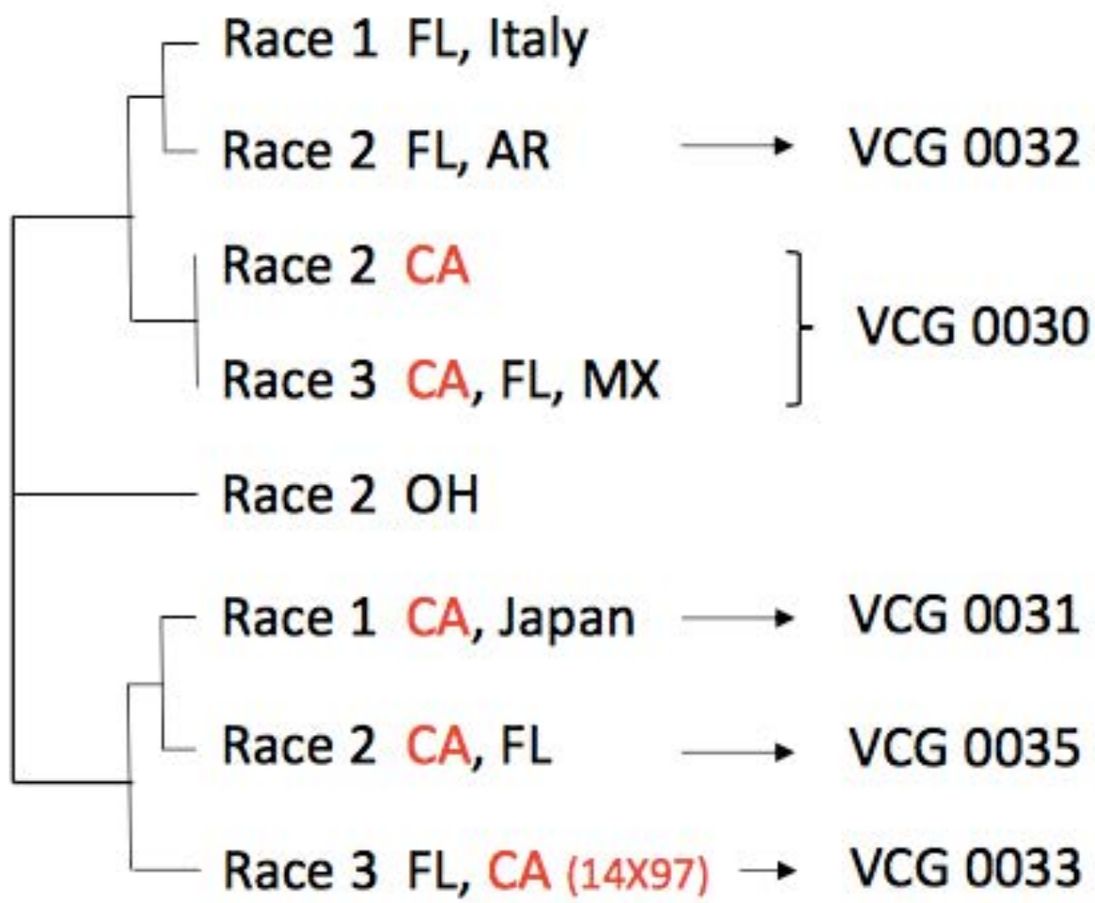
http://fr.wikipedia.org/wiki/Fusarium

Fusarium Wilt *F. o. lycopersici*	Fusarium Crown and Root Rot *F. o. radicis-lycopersici*
1. Wilt	1. Crown and root rot
2. Moves rapidly in vascular tissue	2. No movement in vascular tissue
3. Optimum temperature: 27 C (80 F)	3. Optimum temperature: 18 C (64 F)
4. Limited host range: tomato	4. Wide host range: beans, beets, cucumber, barley, onion, asparagus
5. Genetics	5. Genetics

Fusarium

Verticillium

Fusarium oxysporum f. sp. *lycopersici*



IGS sequences and VCGs

Cai et al Phytopathol 93:1014-1022

✓ Race does not correlate with VCG or genetic similarity

Susceptible Crops

- Tomatoes
- Lettuce
- Melons
- Potatoes
- Sweetpotatoes
- Cole crops

Melons

Sweetpotato


Statewide IPM Project
2000 Regents, University of California

Fusarium problems 2015

- largest number of farm calls for any reason, includes tomatoes, cotton, melons, sweetpotatoes
    - tomatoes: Fusarium Wilt race 3. Cotton: race 4. Melons: Fusarium oxysporum f.sp. melonis. Sweetpotatoes: Fusarium oxysporum
- Significant plant and stand losses
- Widespread throughout the county, including resistant cultivars

onset of symptoms by crop	early	late
Tomatoes		X
melons	X	X
sweetpotatoes		X
cotton	X	

MOVEMENT OF *FUSARIUM OXYSPORUM* VIA EQUIPMENT

Fusarium wilt, race 3

Gene Miyao, UC Farm Advisor
Mike Davis, Plant Pathologist, UC Davis

UNIVERSITY of CALIFORNIA

Fusarium wilt, race 3


FUSARIUM WILT

Fusarium wilt: 'Mechanical spread'

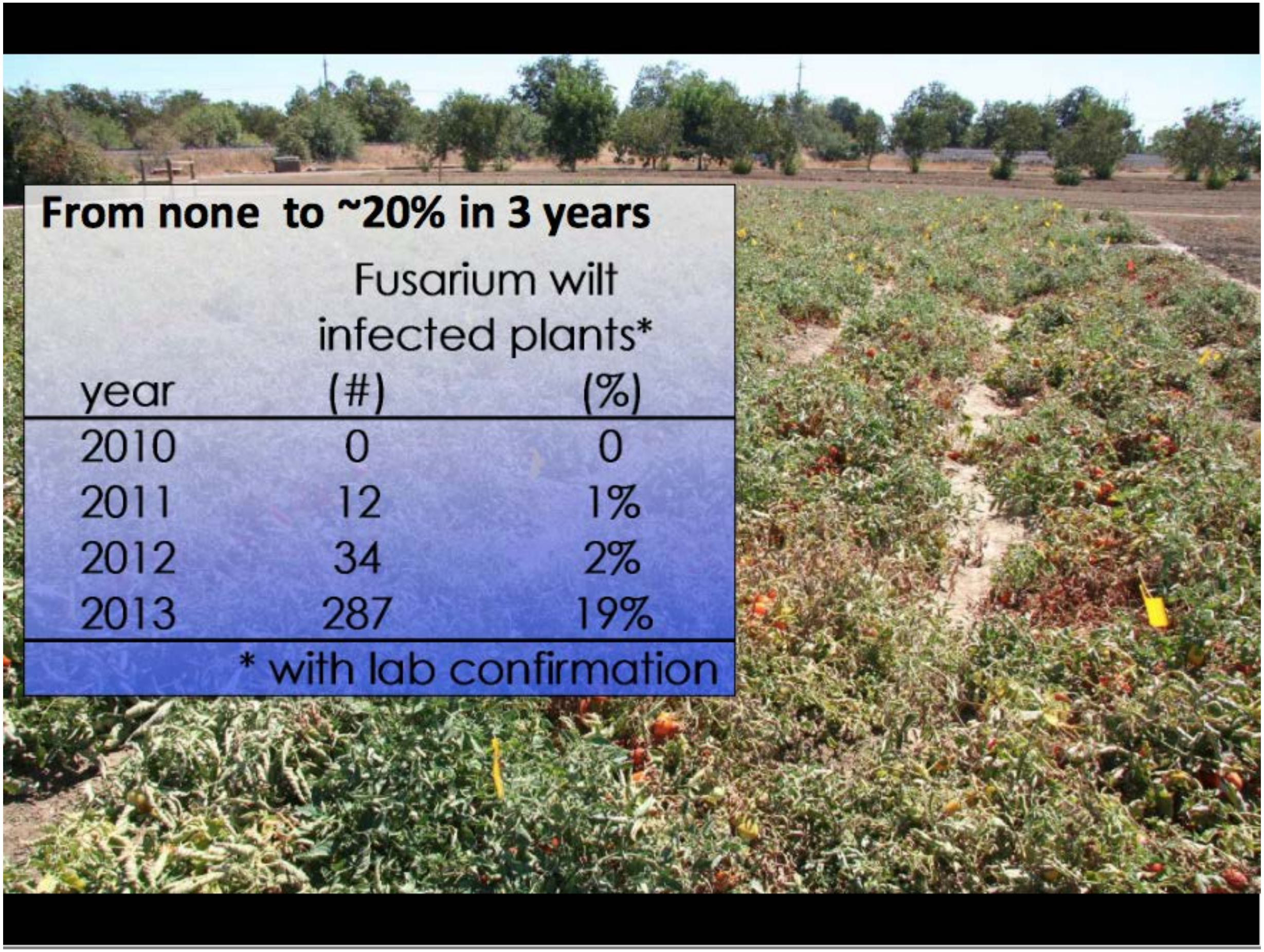
moving infected stem pieces...

...moving infested soil

California Tomato Research Institute

1st Year 2011

Fusarium wilt: 'Mechanical spread'



From none to ~20% in 3 years

year	Fusarium wilt infected plants* (#)	(%)
2010	0	0
2011	12	1%
2012	34	2%
2013	287	19%

* with lab confirmation

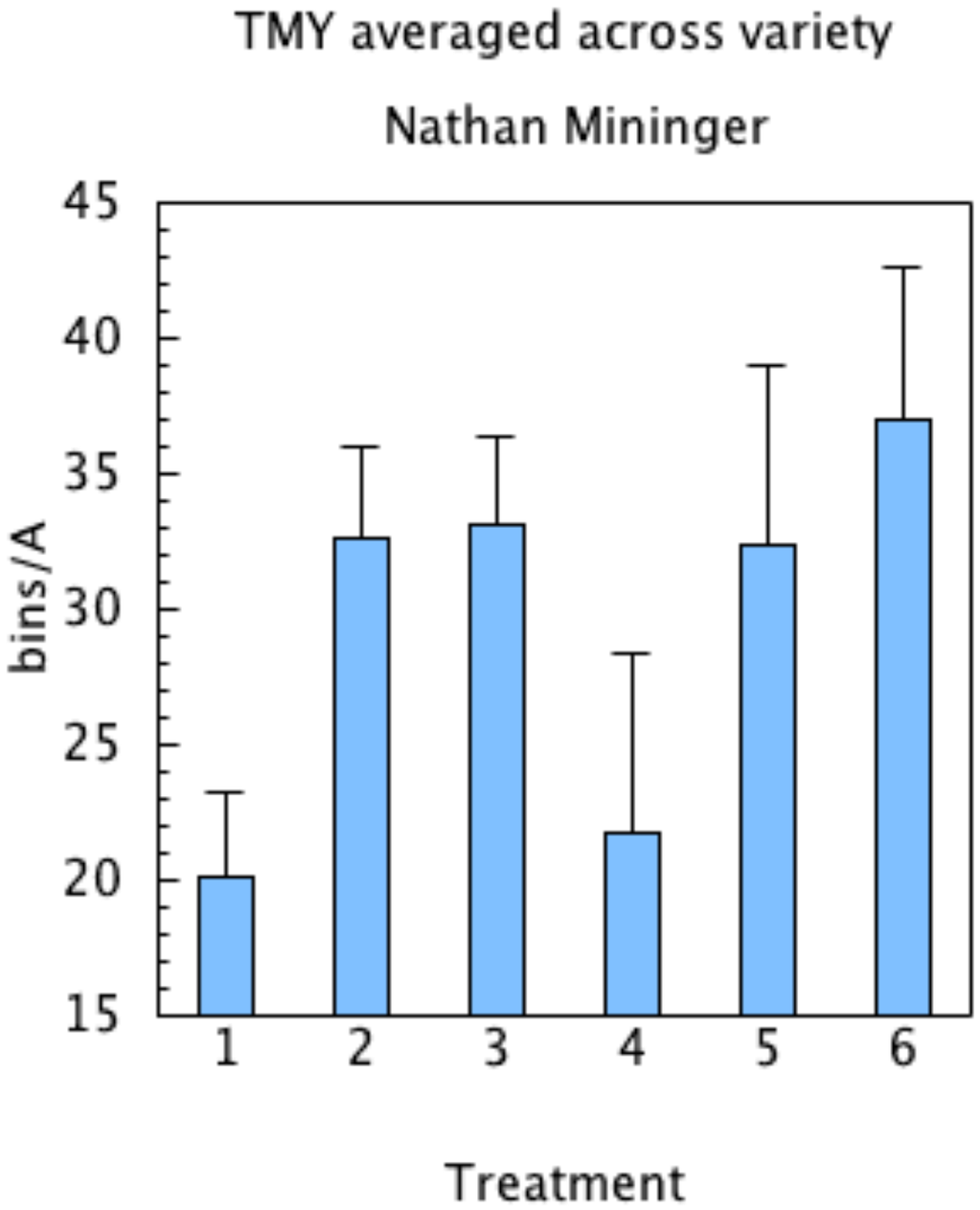
Management of Fusarium

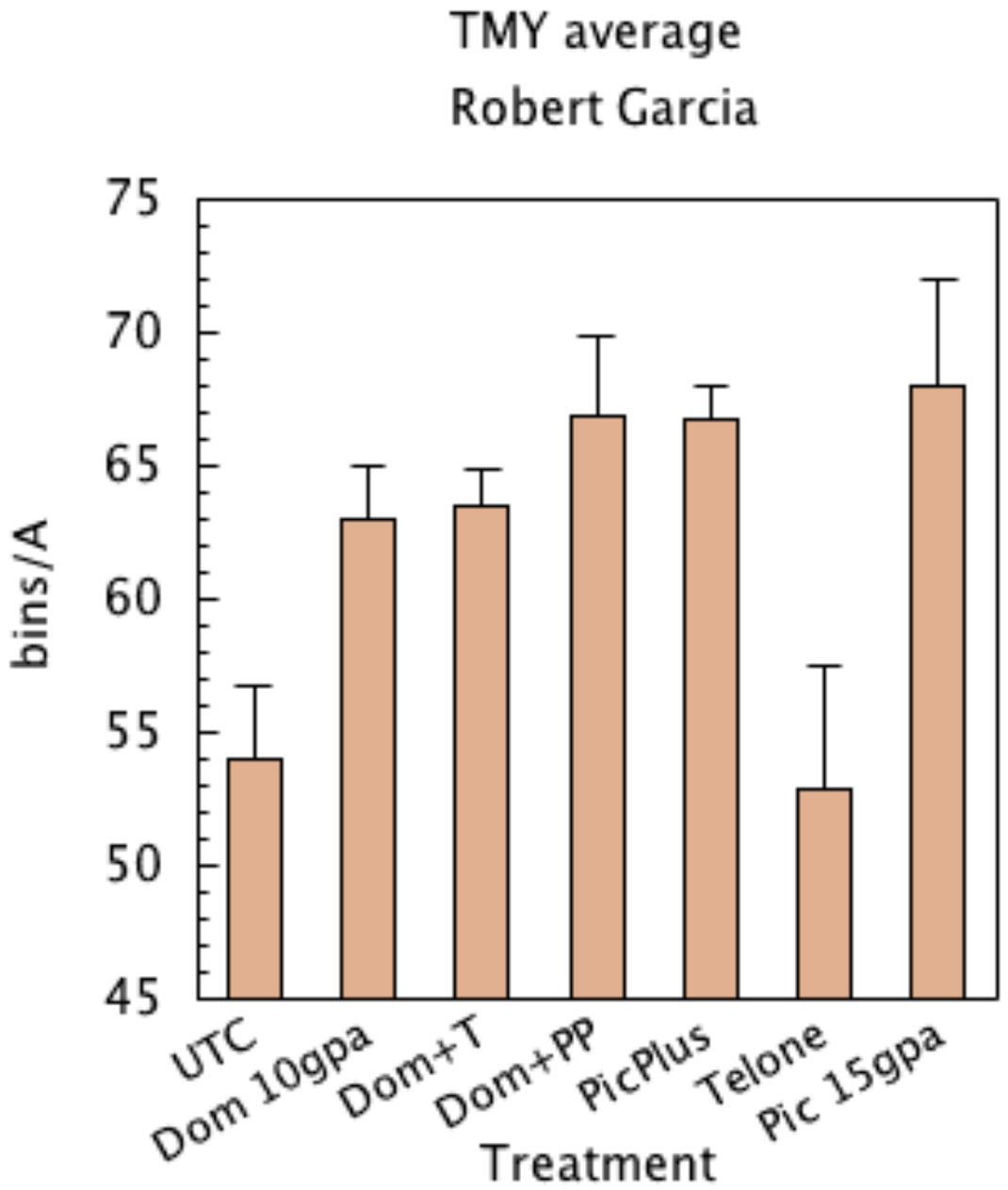
- Containment
- Clean seed
- Soil fumigation (?)
- Fungicide dips (?)
- Crop rotation
- Compost/manure
- Variety resistance

University of California
Agriculture and Natural Resources
Making a Difference for California

Fumigation?

- Florida research in tomatoes shows it can reduce severity and/or delay onset of disease.
- Fumigation trials under tarp and include Pic.
- Potential “rebound” affect.
- Annual applications of Telone in sweetpotatoes does not control the disease in susceptible varieties.
- Nematode management important.





Significant yield increases to fumigants usually occur with sweetpotatoes (resistant cultivars).

Fungicides?

- Best yields and lowest stem rot incidence in sweetpotato trial with susceptible variety when plants dipped with Maxim before planting.

Table 1. Stem rot fungicide efficacy trial in sweetpotatoes (variety Kenne 12), Yagi Bros Farms 2014.

Treatment (1)			July 7 plant count		Harvest yield, lbs per plot (3)				Culls	
	hotbed spray, oz/2 gallons	plant dip	missing	chlorotic	No.1's	Medium	Jumbo	TMY	Stem Rot %	Cuts %
1	UTC (water, 2 gallons)	Water	0.12	0.75	20.6	4.8	5.9	31.3	1.5	15.5
2	Serenade Soil 6.4 fl oz	Serenade Soil	0.38	1.88	14.9	3.7	12.5	31.0	4.8	15.0
3	Botran 5F 6 fl oz	Botran	0.13	2.25	18.1	4.3	12.1	34.5	6.4	11.3
4	Mertect 340 2.5 fl oz	Mertect	1.00	3.38	8.5	2.3	4.1	14.9	18.9	7.4
5	Double Nickle 7.2 fl oz	Maxim 4FS 15 ml/gal	0.38	1.00	20.2	4.6	11.5	36.3	1.4	14.1
6	Topsin 8 oz	Topsin	0.63	3.00	14.1	3.5	8.7	26.3	6.8	4.8
7	UTC with pulled plants	water **	*0.83*	*0.17*	*22.6*	*3.4*	*11.2*	*37.1*	*1.7%*	*17.8%*
		average	0.44	2.04	16.1	3.9	9.1	29.1	6.6	1.3
		hotbed spray LSD 0.05	ns	1.75	5.1	ns	ns	9.2	ns	ns
		plant dip LSD 0.05	ns	ns	ns	ns	ns	ns	ns	ns
		CV, %	151	54	29.4	54	63	21	221	104

Compost/manure

YIELD	2011		2012		2013	
treatment	Wd-Dvs	Dixon	KLand	W. Wlnd	Wd-Dvs	W. Wlnd
Control	34	46	39	43	57	38
compost	45	52	56	55	71	40
% difference	32%	12%	41%	30%	25%	4%
Probability	*	NS	*	NS	*	NS
Soil						
K in ppm	138	250	166	218	120	219
% K of CEC	2.0	2.2			1.7	2.9
PO4-P ppm	40	18			18	21

Muller, Woodland, 2015

K soil: 165 ppm and 2.2%

	treatment	yield ton/A	% sun burn	F. wilt % plants	4-Aug green rating	% K
1	non treated	50.3	11.5	17	6.3	2.4
2	compost 5 tons trench	40.4	20.8	21	2.8	2.8
3	compost 10 tons trench	42.3	19.9	20	2.8	2.6
4	compost 5 tons surface shallow	45.7	18.8	21	3.8	2.5
5	compost 10 tons surface shallow	44.5	19.4	23	3.3	2.5
6	NPK mimic 10 tons compost surface	48.8	15.6	18	5.3	2.6
7	NPK mimic at 10 tons compost deep	53.3	12.1	16	6.3	2.5
8	K @ 50 lbs K20 sidedress	51.5	12.8	14	6.8	2.3
9	K @ 100 lbs K20 sidedress	55.2	10.4	16	7.0	2.5
10	K @ 200 lbs K20 sidedress	54.2	13.1	13	6.8	2.6
11	K @ 400 lbs K20 sidedress	57.5	9.7	13	7.0	2.4
12	K @ 800 lbs K20 sidedress	47.3	13.8	18	4.8	2.5
	LSD 5%	NS	NS	NS	2.7	0.25
	% CV	15	45	26	36	7
	GROUP CONTRASTS					
A	control vs	50.3	11.5	16.8	6.3	2.35
	any compost	43.2	19.7	21.0	3.1	2.60
	Probability	0.10	0.03	0.11	0.01	0.02

G. Miyao, 2015.

Some Diseases That Cannot Be Easily Managed with Crop Rotation:

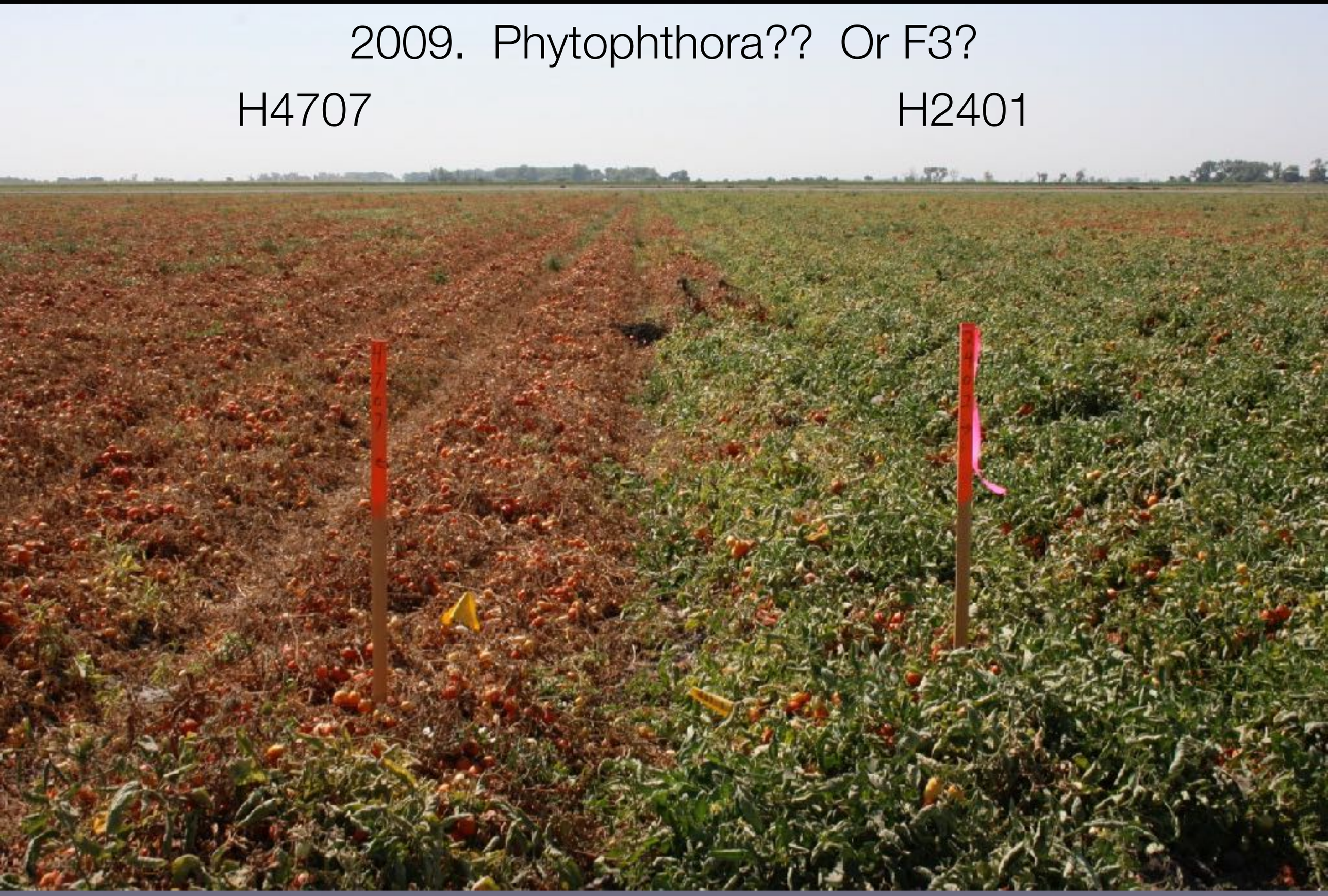
Fusarium wilts of crucifers, cucurbits, pea, spinach and tomato

These diseases are difficult to manage with rotation because the pathogens can persist for many years in soil in the absence of their crop host. They persist as dormant chlamydospores and on roots of some non-host plants (symptomless carriers). **Rotations** of at least **five or seven** years often prevent the pathogen population from building up to a level that can cause economic damage. However, if the disease has been severe in a field, even seven years may not be enough. Selecting **resistant varieties** is a more effective and practical. Multiple races have been identified for many of its host-specific forms. Therefore, knowing what races have occurred in an area is important when selecting resistant varieties. Fusarium wilt fungi also can be seed-borne and are easily moved on infected transplants. They can also be **easily moved** between fields in soil on equipment. These are the major ways they are brought onto a farm. Drought, mechanical damage, low soil pH, soil compaction, and other stress factors can predispose plants to infection by fusarium wilt fungi. Fortunately, the fusarium wilts in various crops are caused by different strains of the fungus *Fusarium oxysporum*. Thus, for example, healthy muskmelons can be grown in a field where fusarium wilt previously affected watermelon.

http://www.sare.org/Learning-Center/Books/Crop-Rotation-on-Organic-Farms/Text-Version/Physical-and-Biological-Processes-In-Crop-Production/Managing-Plant-Diseases-With-Crop-Rotation

2009. Phytophthora?? Or F3?

H4707 H2401



Tomato management summary (2015)

F3 management option		Notes
Variety resistance	SV8232TM, CXD282, BQ141, BQ142, N6412, H1310, BP2	limited seed availability
Rotation	rotating out of tomatoes for several years will reduce but not eliminate the pathogen	some alternate crops can be a host for the disease
Compost/manure	heavy rates (>10 tons/A) have improved yield but not reduced disease incidence.	Gene Miyao, 2015.
Fumigation	Research in Florida on sandy soils has shown reduction of Fusarium with Telone	not evaluated under California conditions
Fungicides/ biologicals	Registered materials for seed coatings can provide early season suppression	not evaluated for transplants

Tomato management summary (2022)

F3 management option		Notes
Variety resistance	SV8232TM, CXD282, BQ141, BQ142, N6412, H1310, BP2, H1662, N6428, SVTM9014	Most new varieties resistant, but demand>supply
Rotation	rotating out of tomatoes for several years will reduce but not eliminate the pathogen, some alternate crops can host	Cassandra Swett
Compost/manure	heavy rates (>10 tons/A) have improved yield but not reduced disease incidence.	Gene Miyao, 2015.
Fumigation	Research in drip tomatoes has shown reduction of Fusarium and improved yield with Vapam	Brenna Aegerter, 2019-20
Fungicides/ biologicals	Transplant and in-furrow drench fungicides usually delay onset of symptoms but mixed yield impacts	Scott Stoddard, 2016 -21

University *of* California
Agriculture and Natural Resources

Making a Difference for California

Thank You