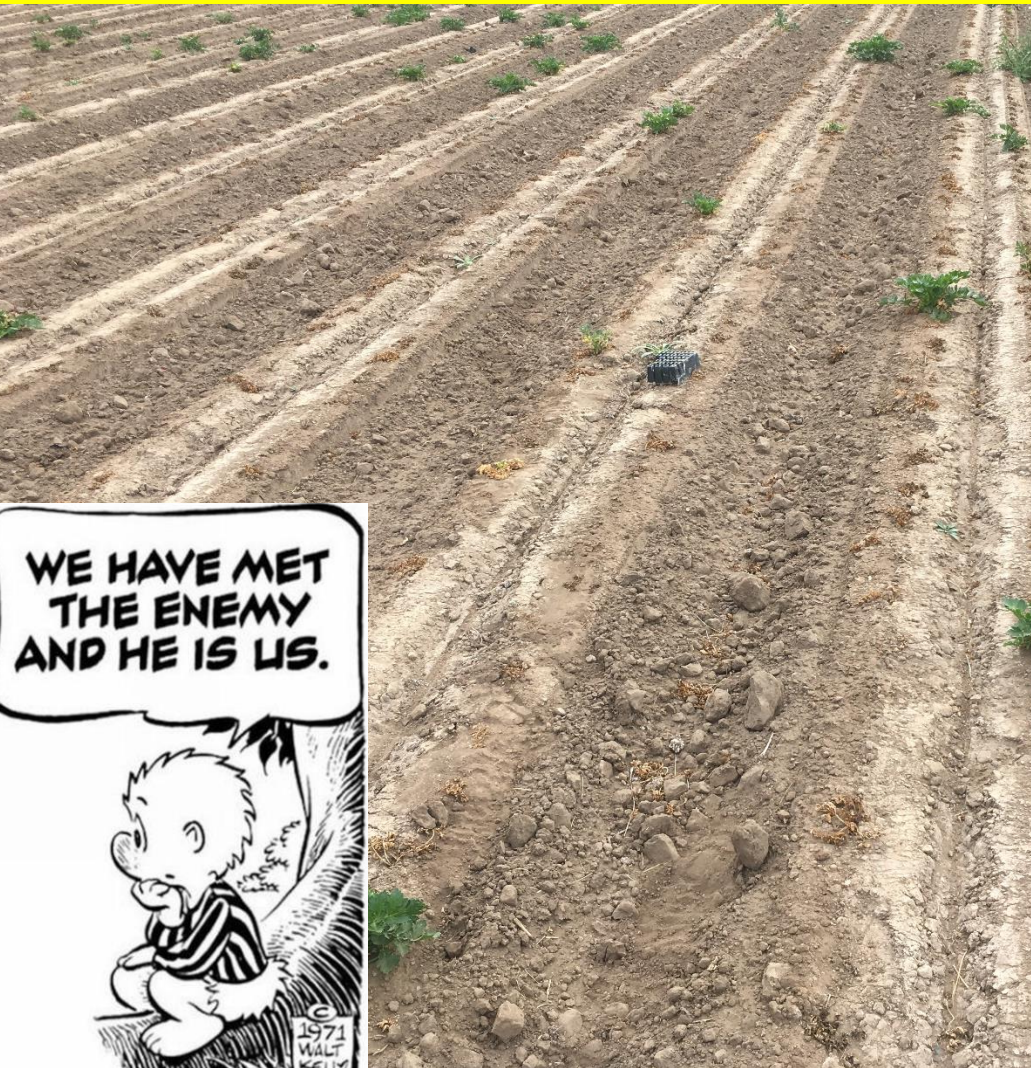


Fusarium wilt in celery & cilantro in Ventura County



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UC Thelma
Hansen Fund

Fusarium wilt in celery & cilantro in Ventura County

- Three causal agents:
 - Two unrelated races of *Fusarium oxysporum* in celery
 - Fusarium yellows, caused by *F. oxysporum* f. sp. *apii* (Foa) race 2
 - Fusarium wilt, caused by *F. oxysporum* f. sp. *apii* (Foa) race 4
 - Fusarium wilt of cilantro, caused (at least mostly) by *F. oxysporum* f. sp. *coriandrii* (Foci)
- Symptoms & diagnosis
- (Human-assisted) dissemination from field-to-field
- Temperature-dependence
- Control: current & future

Pathogen	Host	Year 1 st observed
Fusarium oxysporum f. sp. apii race 2 (Foa race 2)	Celery	1959
F. oxysporum f. sp. apii race 4 (Foa race 4)	Highly aggressive on celery Cilantro is a 2° host	2011
F. oxysporum f. sp. coriandrii (Foci)	Highly aggressive on cilantro	2005?



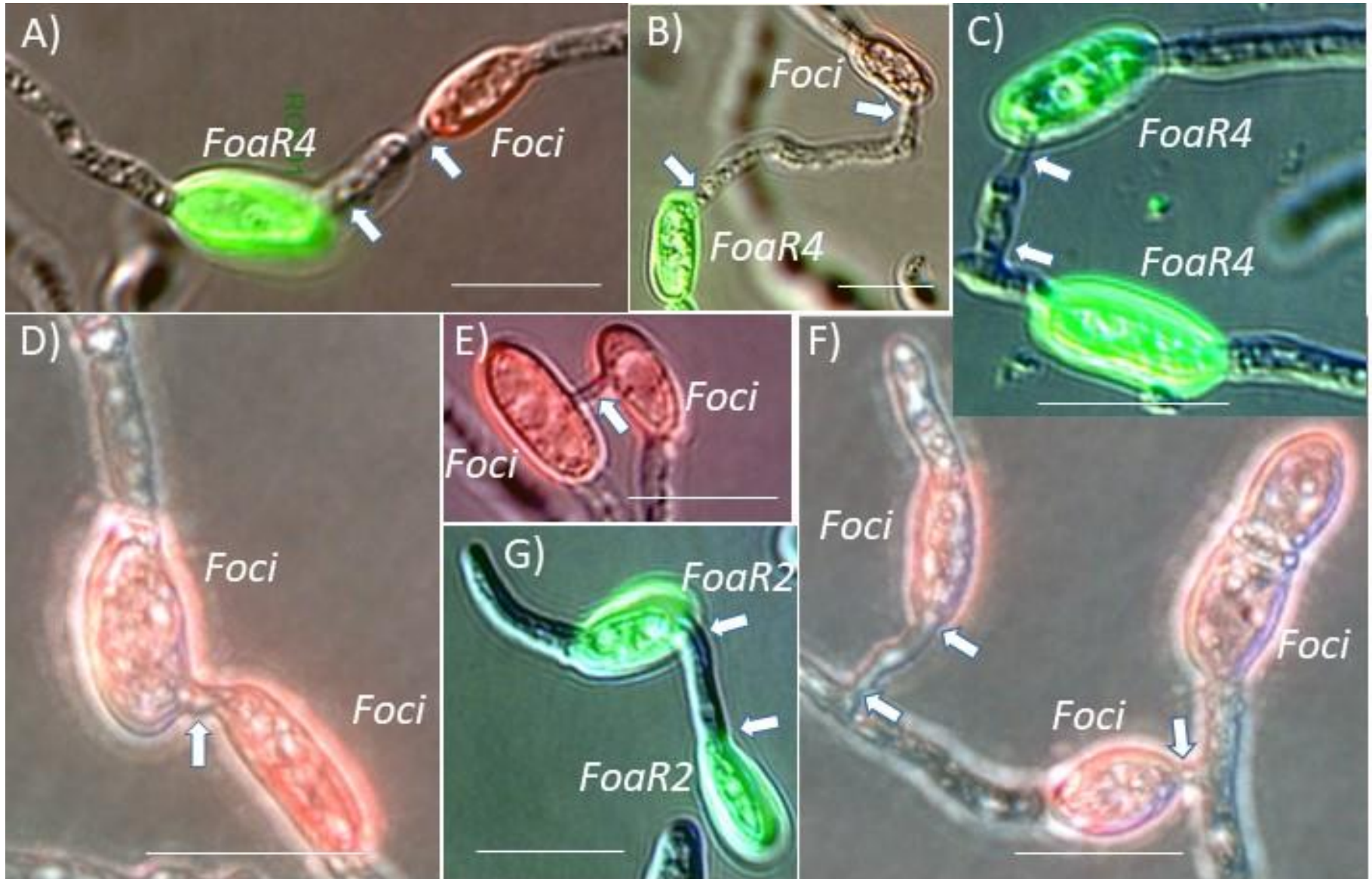
Celery

Tall Utah

Challenger



F. oxysporum f. sp. *apii* race 4 and *F. oxysporum* f. sp. *corianderii* (which causes Fusarium wilt on cilantro) can exchange nuclei/chromosomes with each other.



Comparison of symptoms in the "classic" *Foa* race 2 and *Foa* race 4 on celery

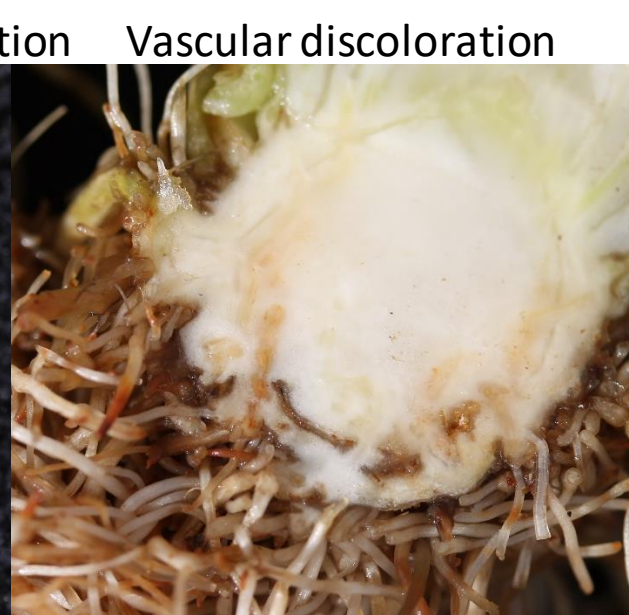
Symptoms	<i>Foa</i> race 2	<i>Foa</i> race 4
Mortality in the field	Causes stunting, but generally not death	Causes death and stunting; death often very rapid in young plants
Vascular discoloration	Localized orangish-brown within the vasculature in roots and crown	Similar to race 2 except discoloration can extend into petioles
Crown	No suckering of crown	Many suckers and adventitious roots on crown; Damage in crown generally more pronounced than in race 2; Lesions in crown are frequently water-soaked or rotted
Roots	Roots present	Roots are frequently sloughed off or rotted
Stalks	Stunted	Dramatically stunted with proliferation/suckering
Foliage	Can cause chlorosis, starts with older leaves and is often limited to a few leaves	Can cause chlorosis and (a green and yellow) mottling
Fungal sporulation in the field	Not observed	Sometimes observed if field sufficiently moist; or if harvested plants put in a moist chambers



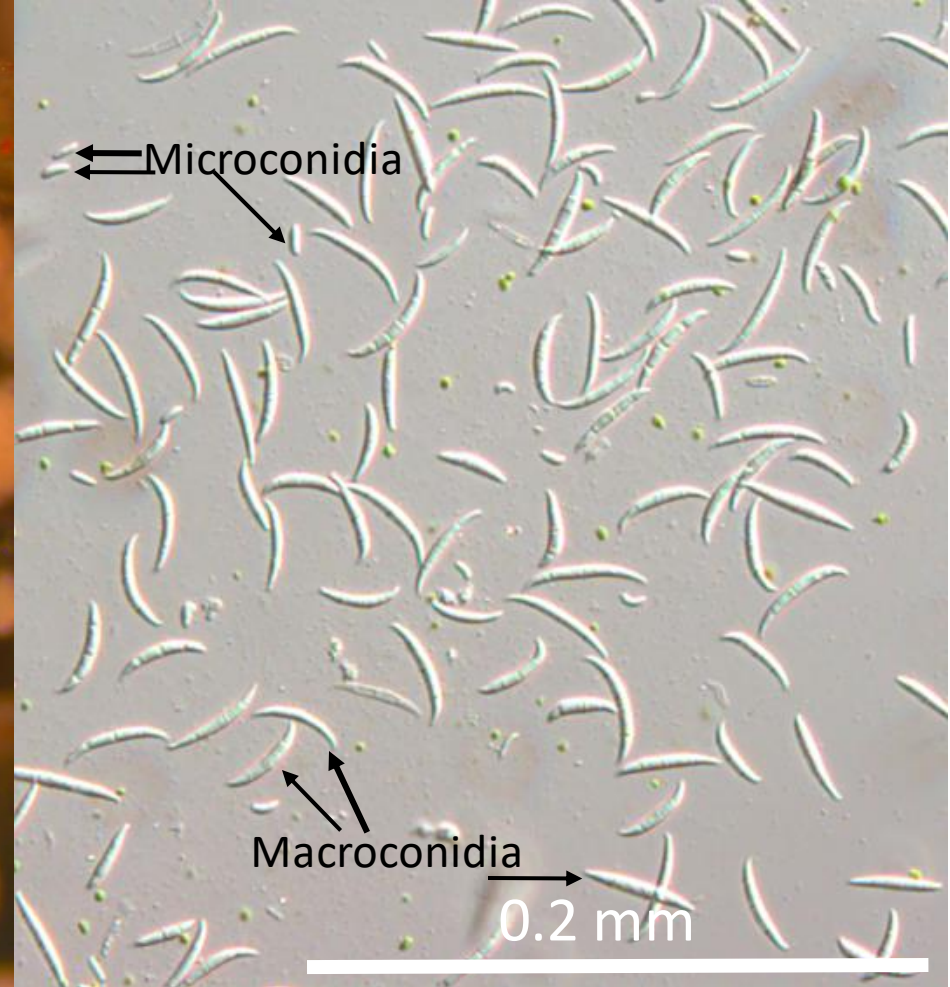
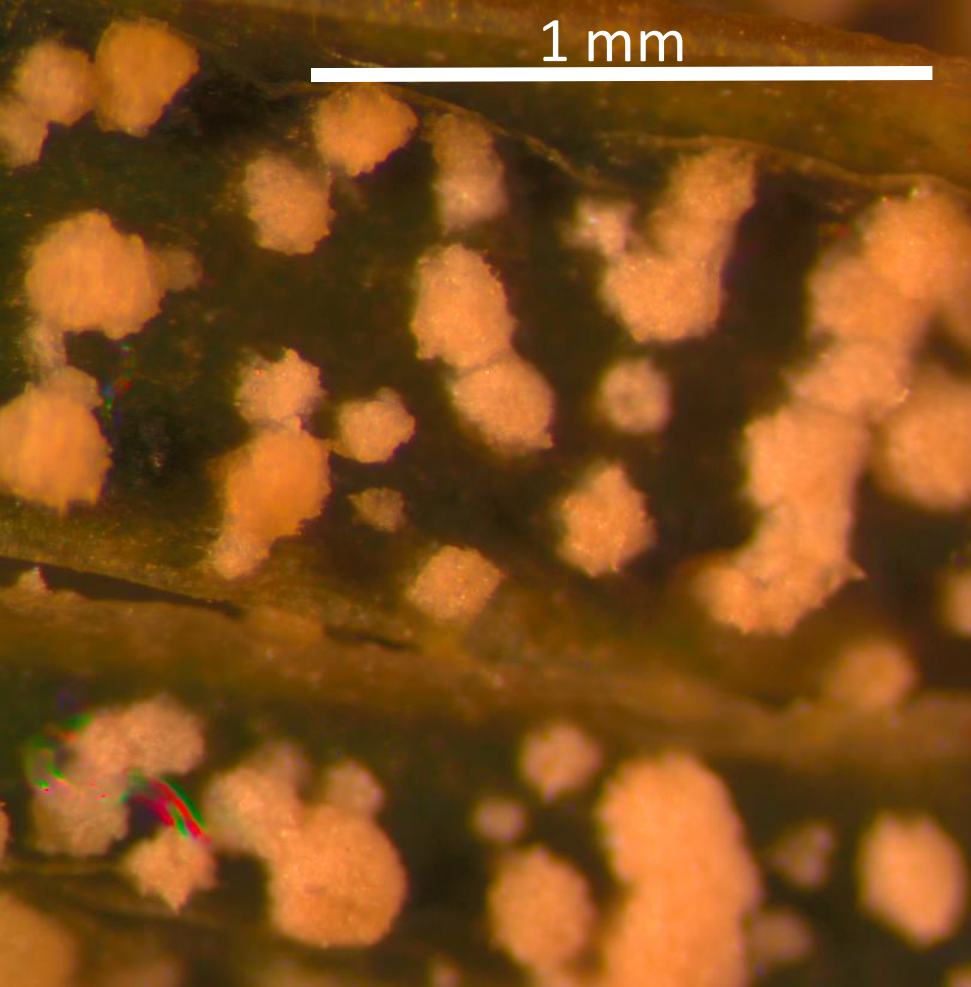
“Classic” yellows & stunting from *Foa* race 2



Vascular discoloration with both *Foa* races 2 and 4



Suckering from *Foa* race 4



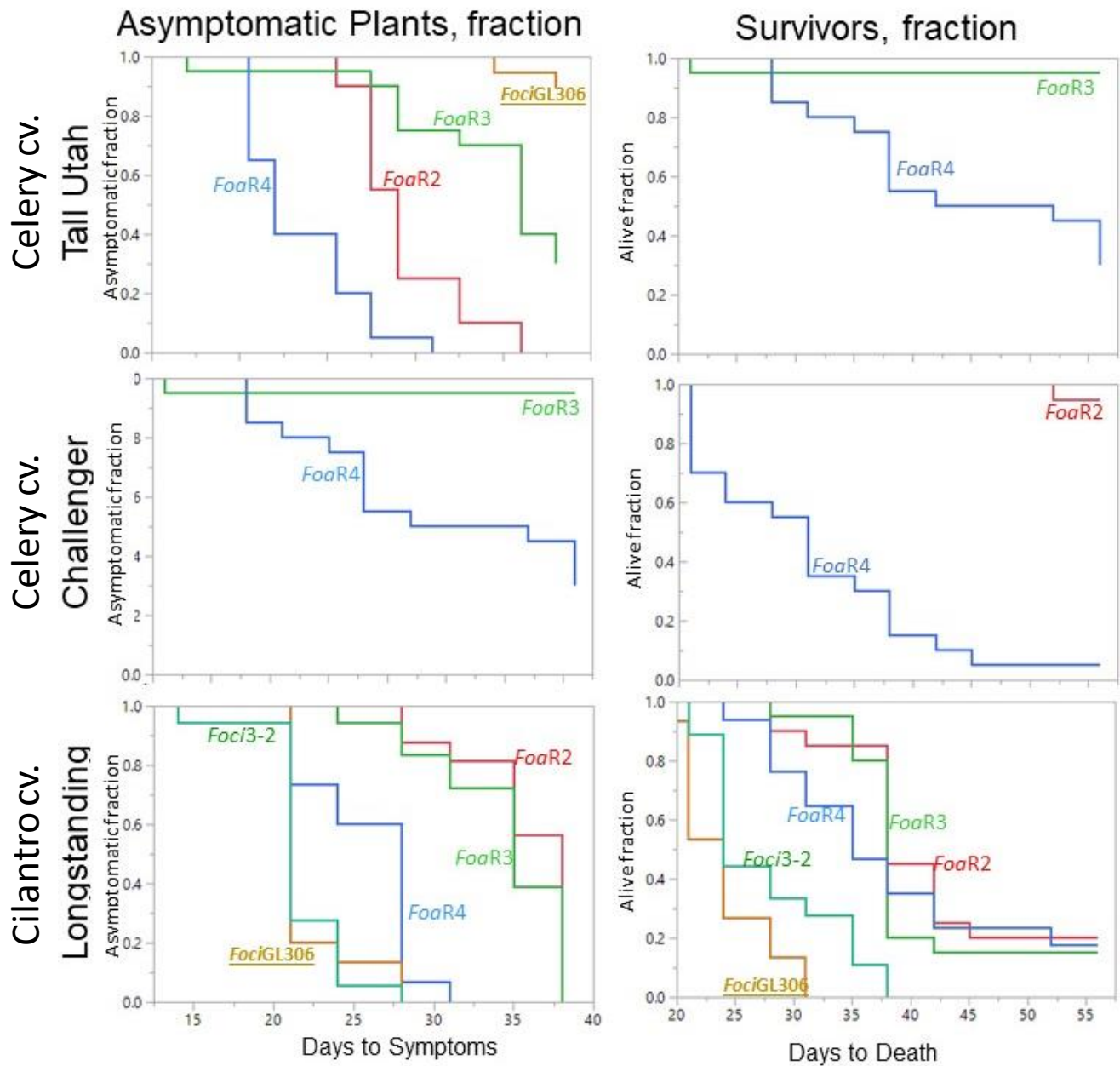
Masses of *Foa* race 4 conidia

Foa race 4 can sporulate in the field in very moist conditions

A complete loss of cilantro due to *F. oxysporum* f. sp. *corianderii*, Aug. 2018
in a field with little rotation



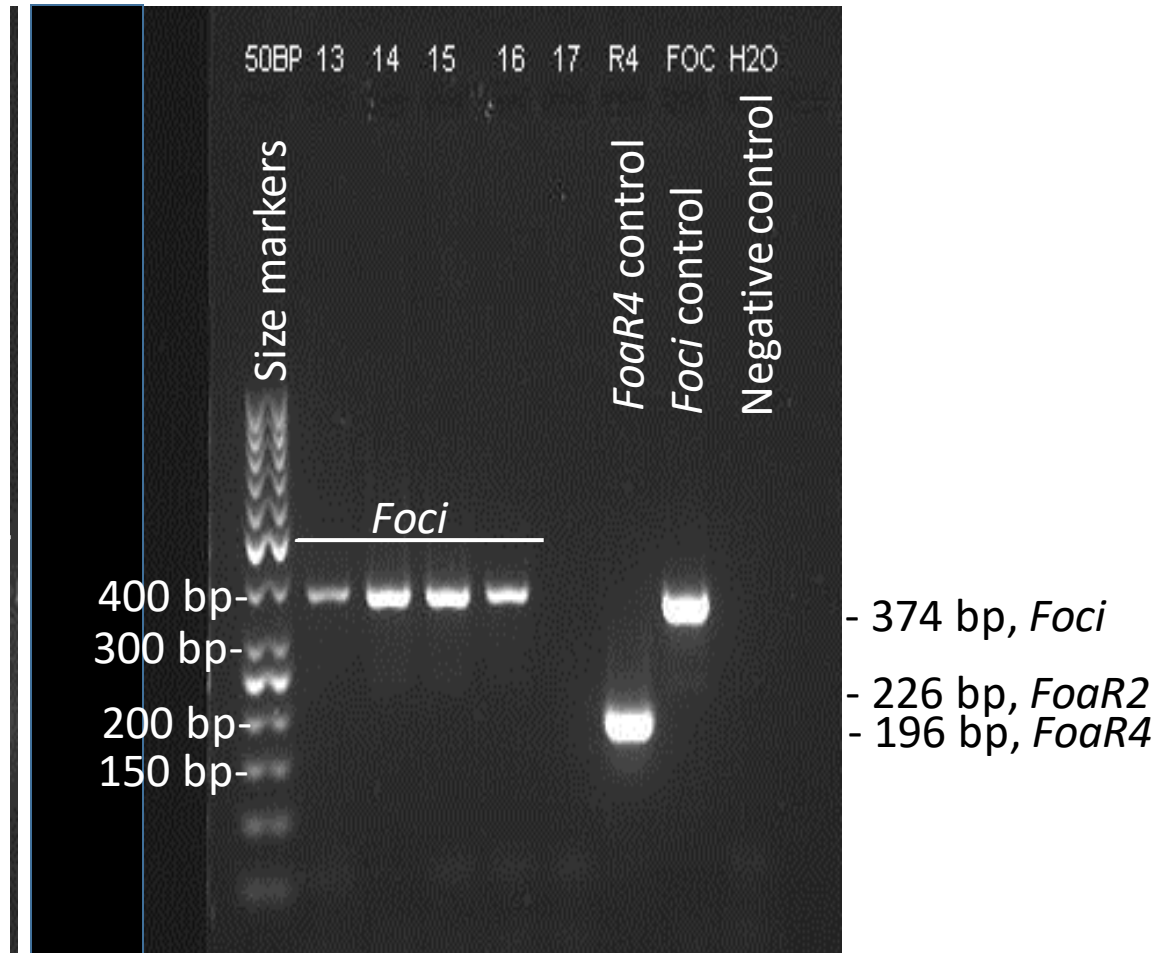
From Oleg Daugovich



Direct diagnosis of plant (crown) tissue

- We have molecular markers and can differentiate between the three strains in a couple of days
- Contact lepstein@ucdavis.edu for instructions on collecting either celery or cilantro
- We have a project from the Hansen Trust to use PCR to quantify inoculum of the strains from soil

A multiplex PCR for *F. oxysporum* f. sp. *apii* race 2 (*FoaR2*, not shown), *Foa* race 4 (*FoaR4*), and *F. oxysporum* f. sp. *coriandrii* (*Foci*) that can be run on either crown tissue or from fungal culture.



Spread of *Foa* race 4 in Ventura Co.: from 1 field in 2011 to more than 38 fields in 2019



Foa race 4 is now present in King City, Monterey Co.

Humans and agricultural operations are so good to *Foa* and *Foci*!!

We provide transportation from an infested field to an uninfested field in celery debris



We provide so much of their favorite foods!

cv. Challenger

cv. Sonora

Foa race 2

Foa race 4

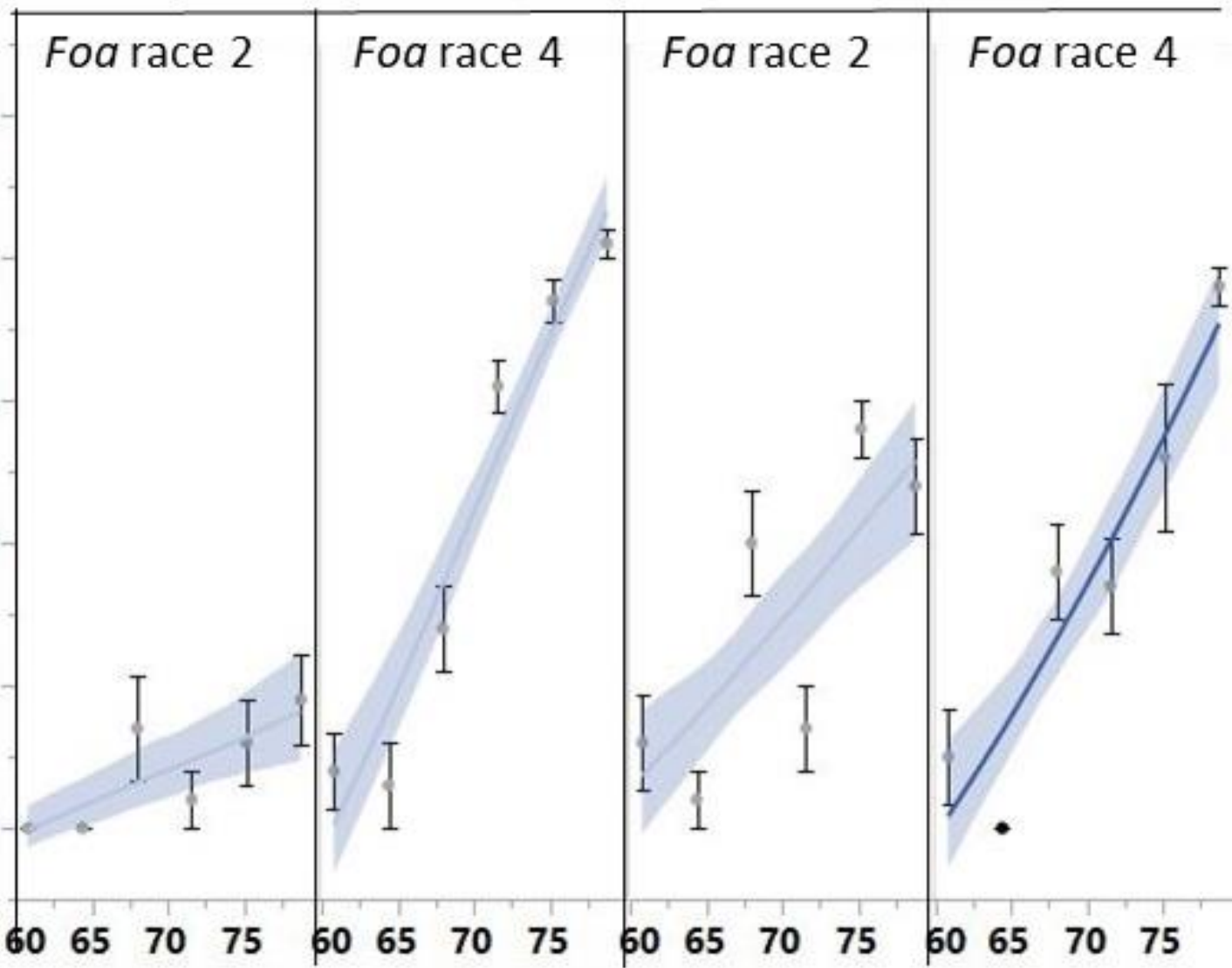
Foa race 2

Foa race 4

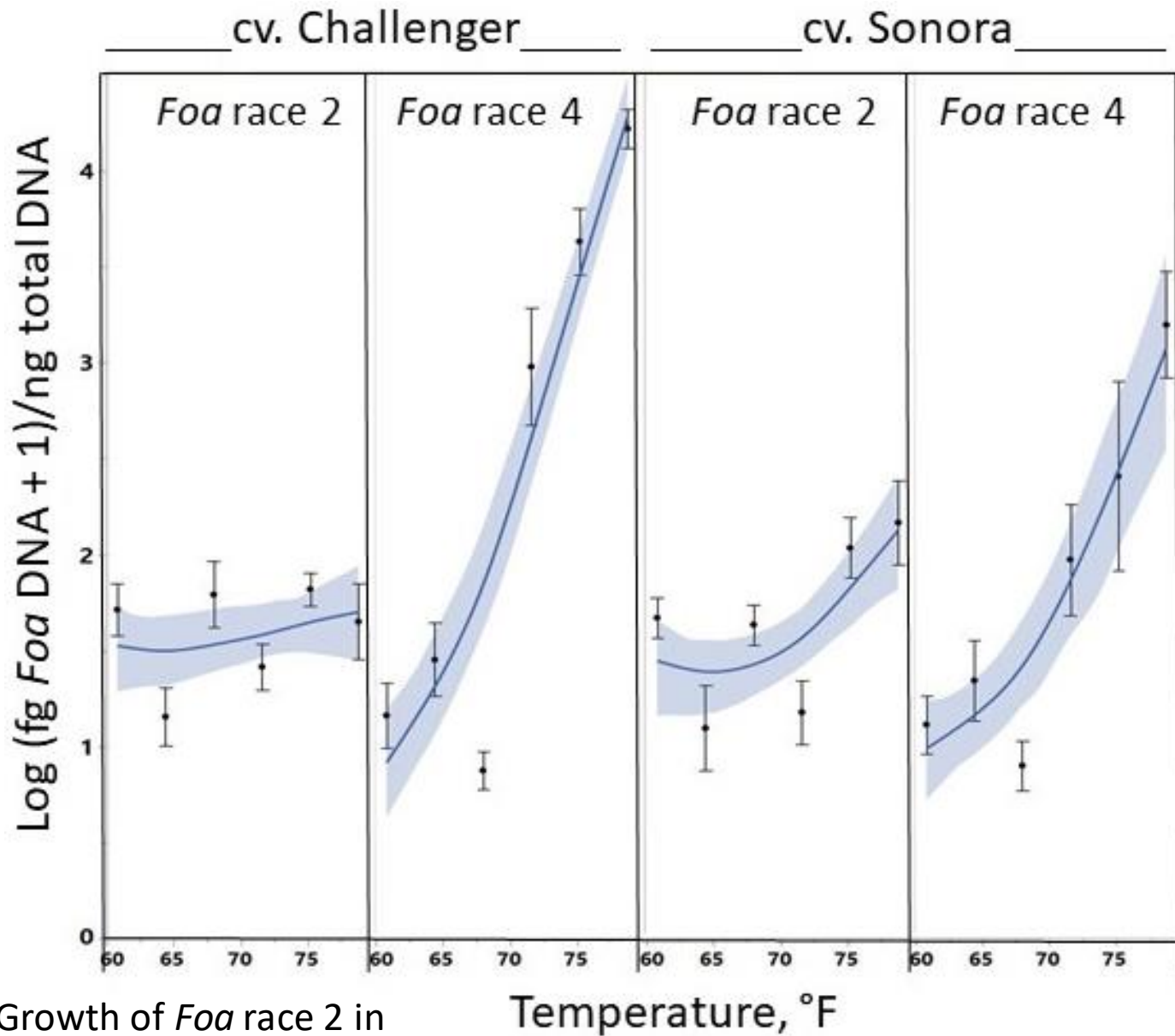
Vascular discoloration score

5
4
3
2
1
0

Temperature, °F



Concentration of fungus on a logarithmic scale



72 °F and above stimulate growth of *Foa* race 4;

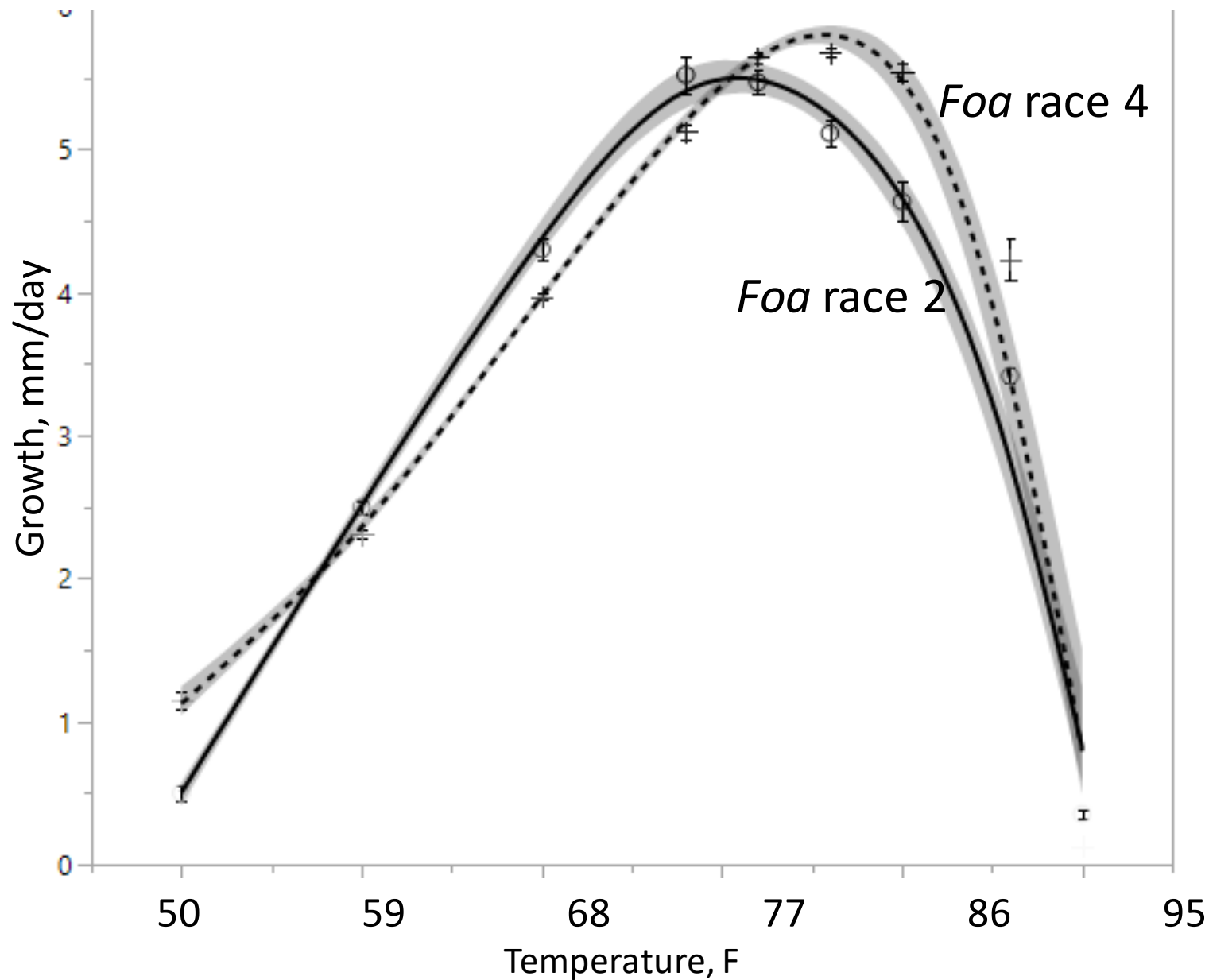
68 °F and below do not appear to stimulate *Foa* race 4.

Foa race 4 grows *in planta* > 10X more than *Foa* race 2.

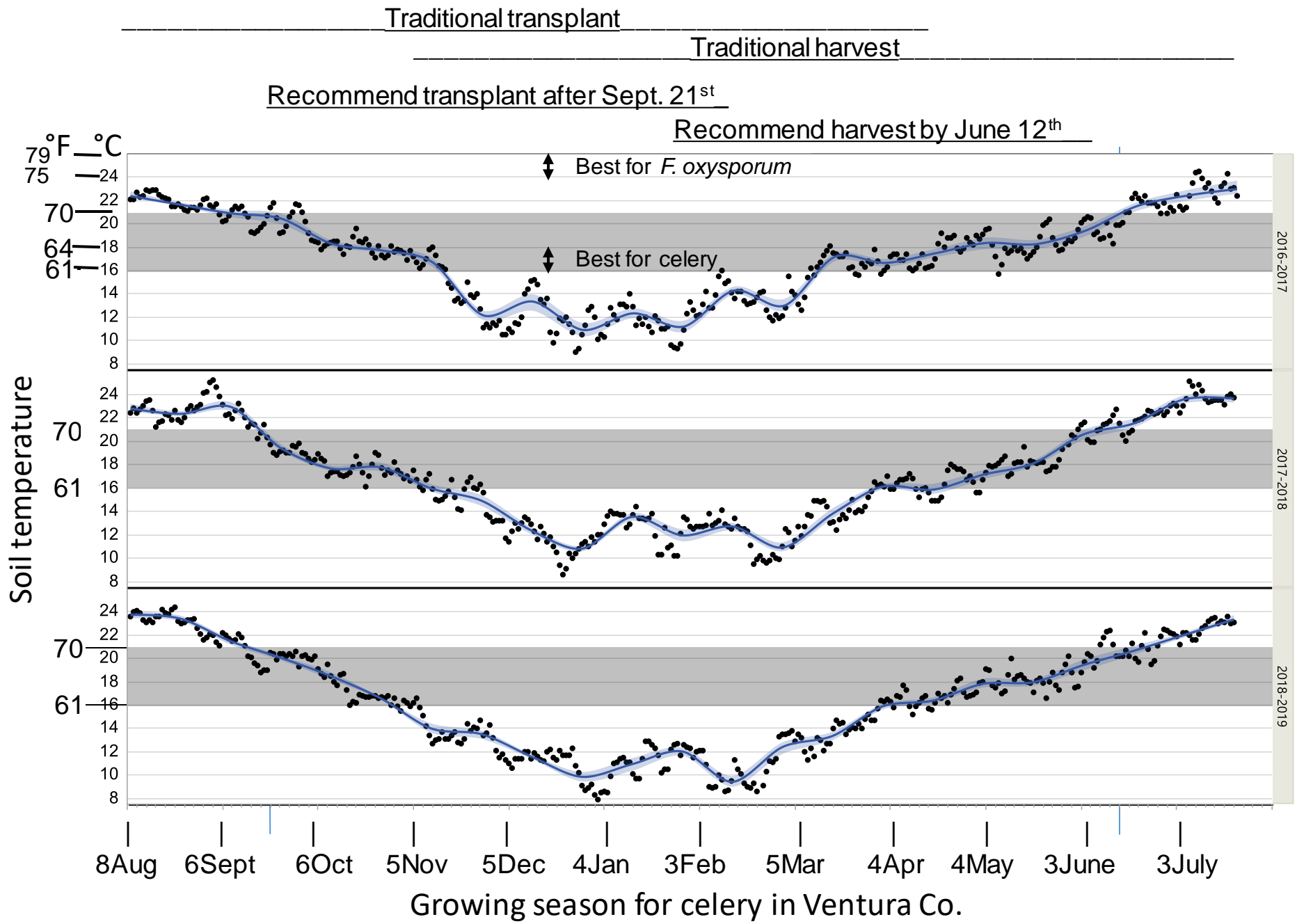
Growth of *Foa* race 2 in the tolerant cv. Challenger is relatively unaffected by temperature.

Growth of *Foa* race 2 is stimulated in cv. Sonora at 75 °F and above, but not to the extent that *Foa* race 4 is stimulated.

Effect of temperature on the growth of *Foa* race 2 and race 4 in celery extract

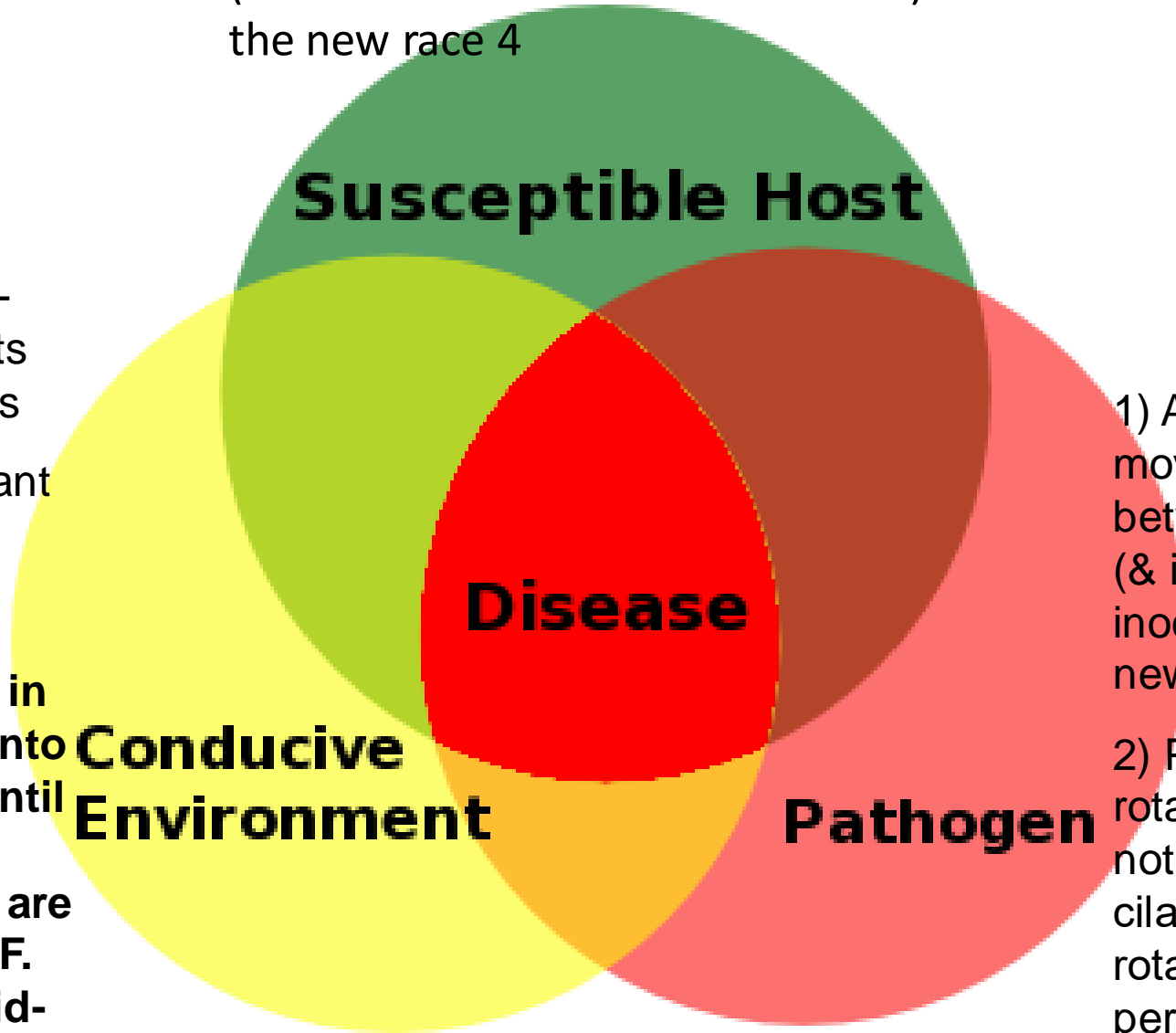


Soil temperatures in Camarillo from 8 August to mid-July for the last three years



Know whether you have the old race 2 (for which there are tolerant hosts) or the new race 4

- 1) Control root-chewing insects and nematodes
- 2) Minimize plant stress
- 3) **Avoid transplanting in August (and into September) until average soil temperatures are less than 70 °F. Harvest by mid-June (sooner is better).**



- 1) Avoid moving soil between fields (& introducing inoculum into new fields)
- 2) Practice rotation (and not to cilantro)...but... rotation isn't a perfect method of control.



We have selected one celeriac accession (A0134) from the UCD celery germplasm collection for breeding for tolerance to Foa race 4



An example of an F2 from the 76-21 family seven-weeks post-transplant in the field trial in *Foa* race 4-infested soil. The family has good resistance/tolerance to *Foa* race 4 and promising celery characteristics.

Selection and breeding for Foa race 4 tolerance in celery

A0134 celeriac (Foa race 4 tolerant) x Challenger celery (Foa race 2 tolerant)

F1 - selected in greenhouse (GH) for resistance/tolerance to Foa race 4

F2 - selected in GH for resistance/tolerance to Foa race 4 → Field (Foa race 4)-testing of selected families

F2 individuals with celery phenotypes selected & retested in GH

We are preparing F3 and will be GH-test and field testing them

We plan to release breeding line(s) as soon as we have "fixed" the genes for resistance, and have molecular markers for those genes.