2023 Pythium wilt of Lettuce Overview

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Pest Management Series, Dec 2023

USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

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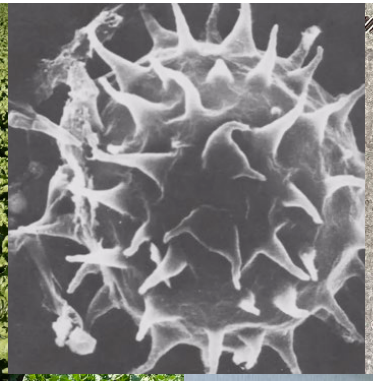
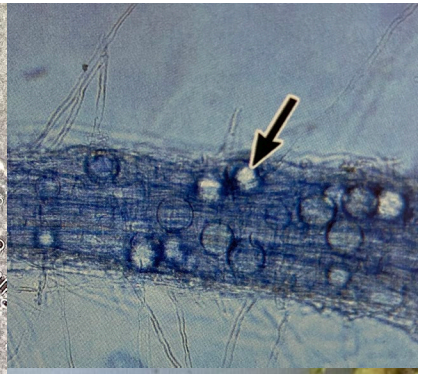
Pythium wilt of lettuce in CA

- *Pythium uncinulatum (Globisporangium uncinulatum)* previously reported in CA (1995)
- Secondary issue with losses up to 30%




Pythium wilt of lettuce: Symptoms

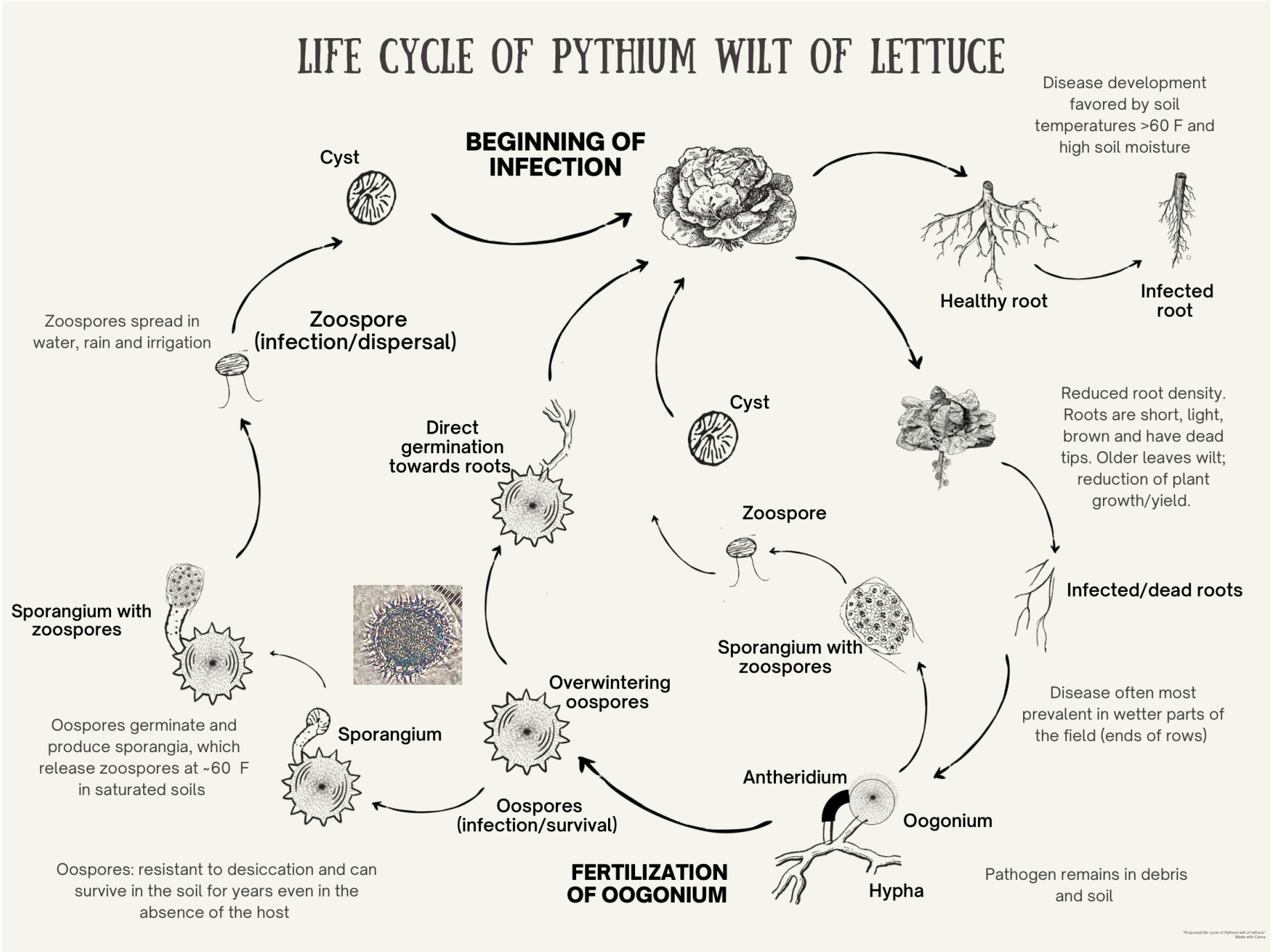
belowground

- Taproot t is misshapen, discolored, and lacking in secondary rootlets
- Water-soaked necrotic tissue
- External necrosis with no vascular discoloration (only in advanced infections)

aboveground

- Infected plants are smaller, than healthy adjacent plants
- Outer/older leaves are yellow and wilted
- Infected plants look “water-stressed”

LIFE CYCLE OF PYTHIUM WILT OF LETTUCE



Dundore-Arias & Smith, 2022

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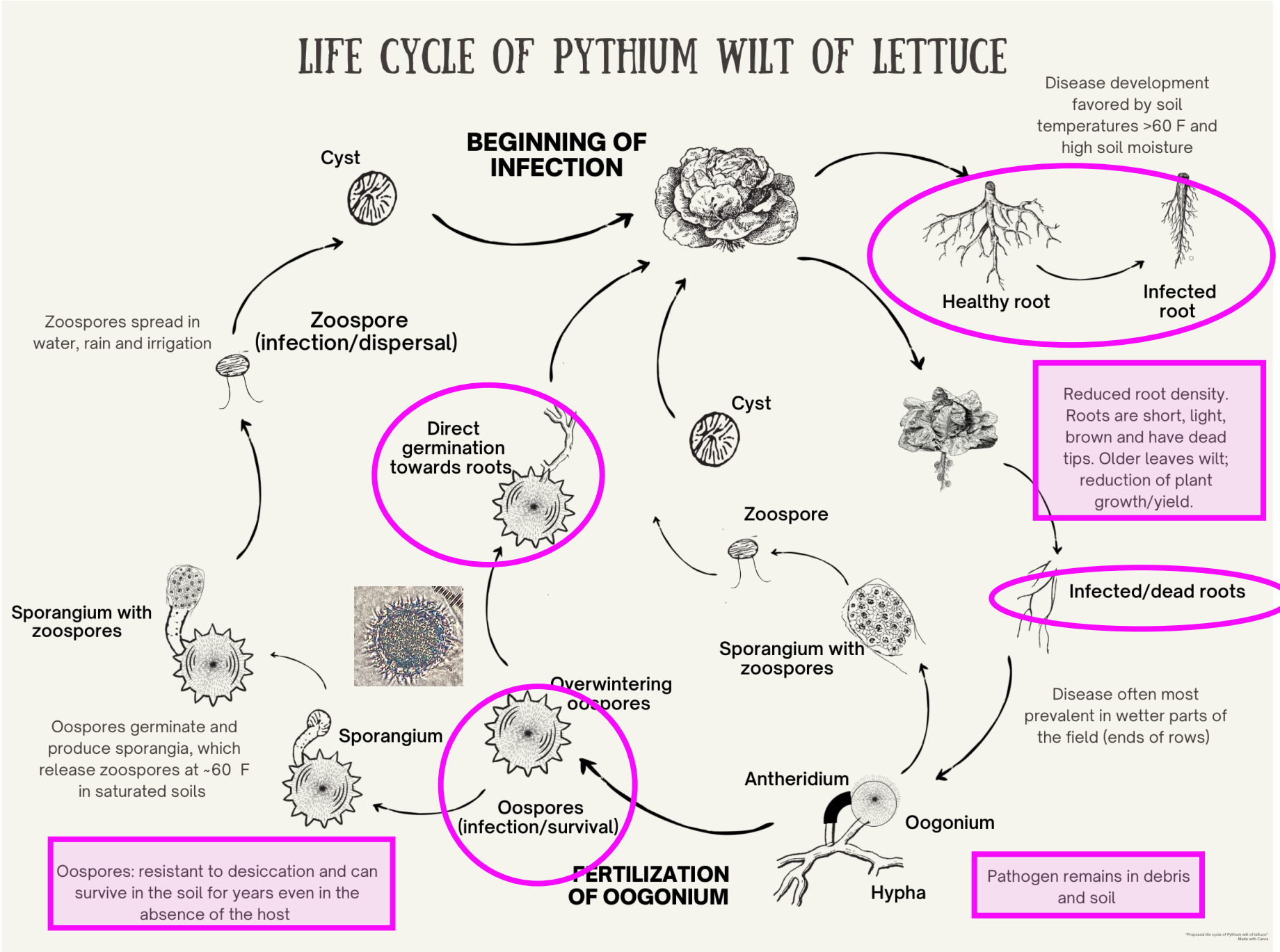

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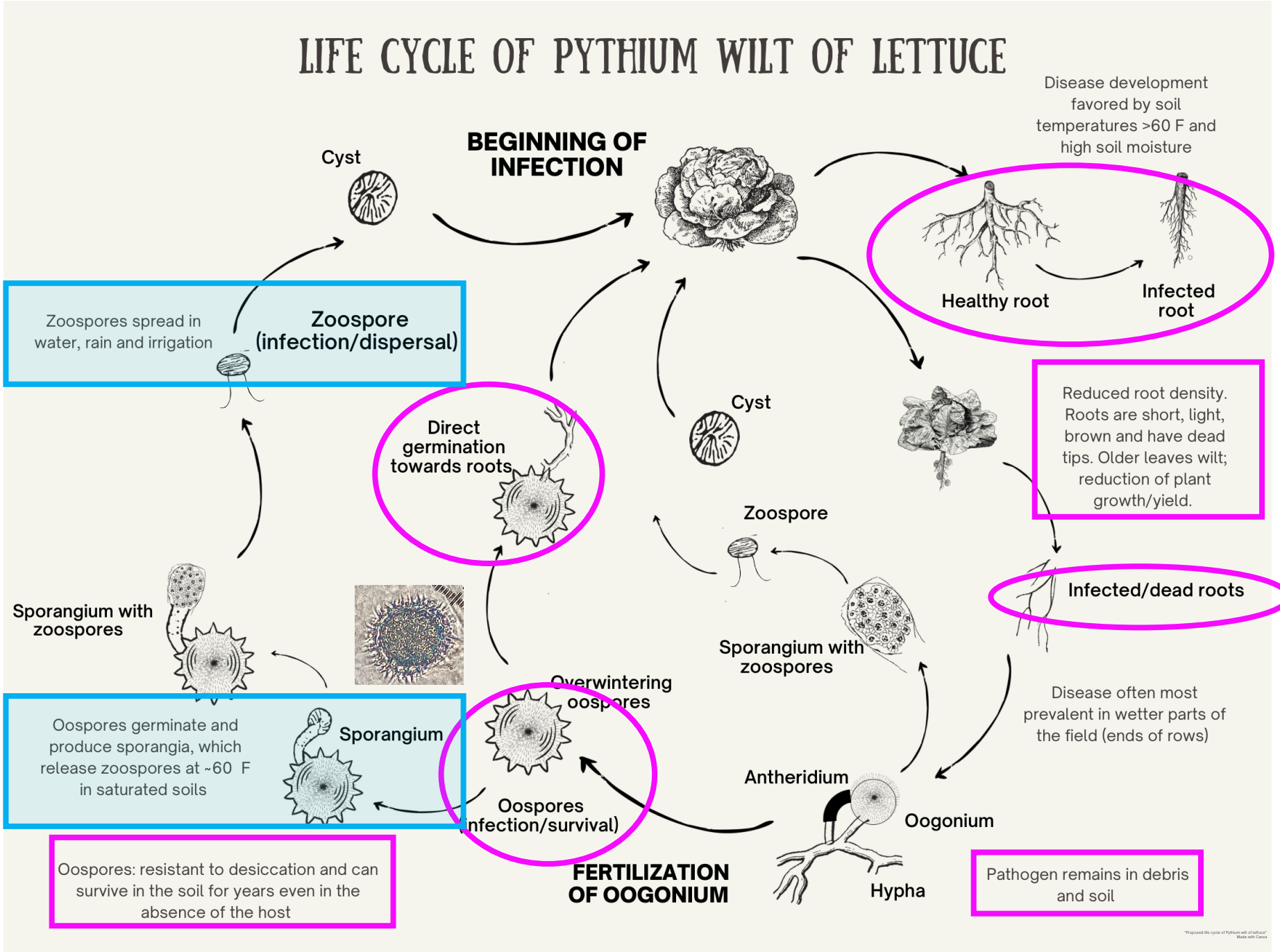
LIFE CYCLE OF PYTHIUM WILT OF LETTUCE



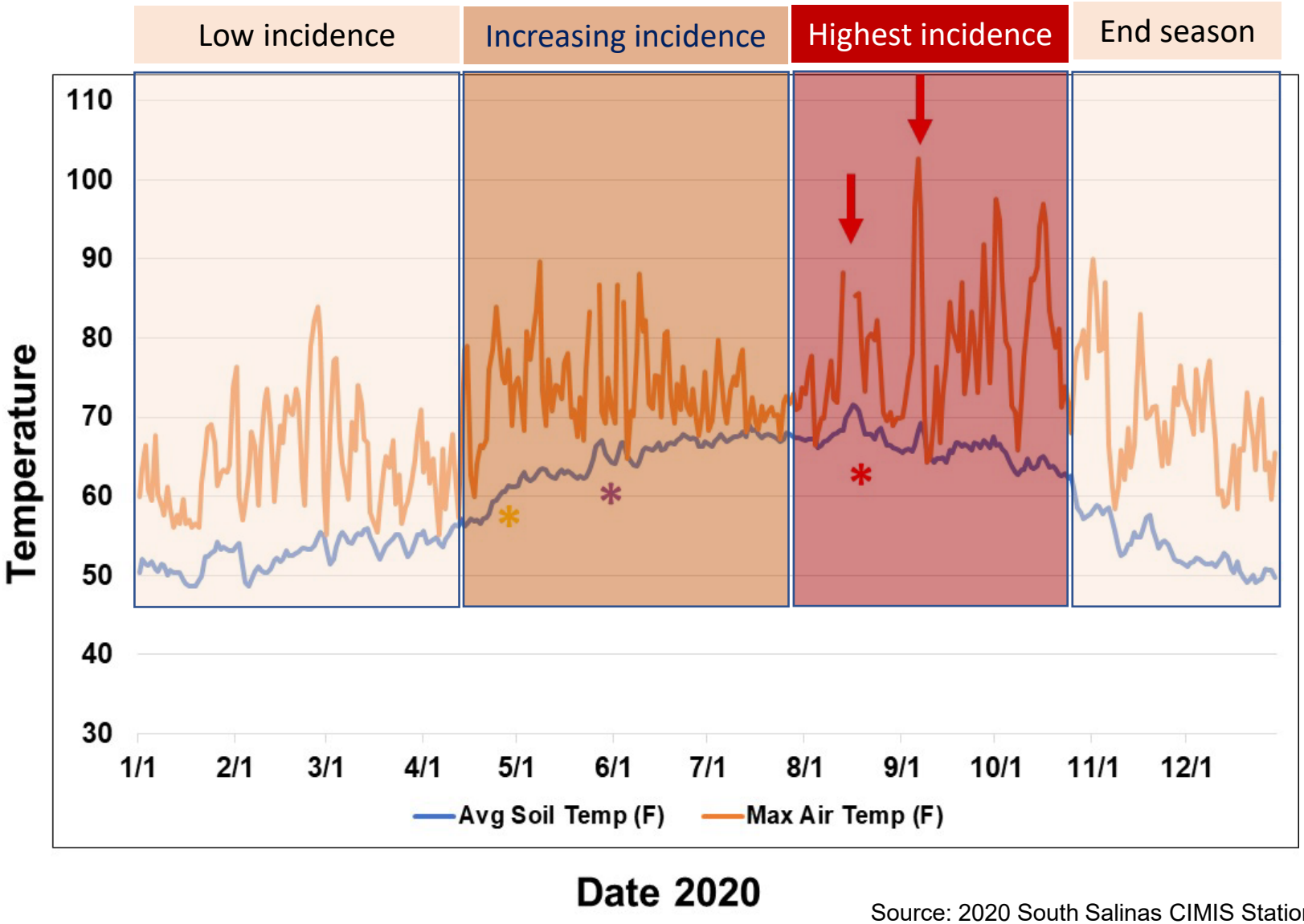
Dundore-Arias & Smith, 2022

Why now?

Changes in weather patterns (warmer years)?
Change in pathogen population?
Variety selection?
Confounding factors?

Changes in weather patterns (warmer years)?

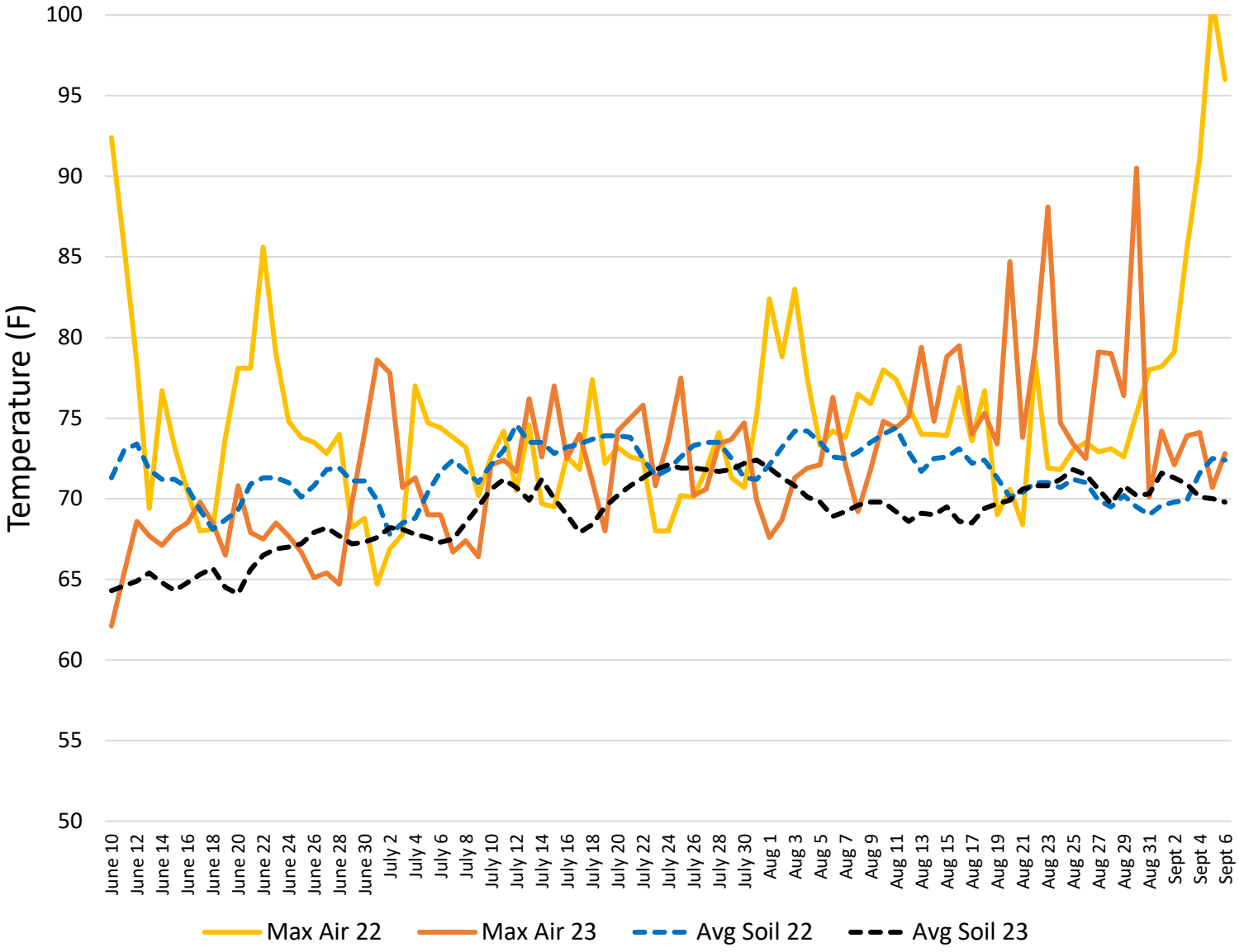
2020: Disease Incidence increased temperature increased



Source: 2020 South Salinas CIMIS Station (USDA Station)

2022 vs. 2023

Changes in weather patterns (warmer years)?



Temporal variability (within and across years) Influence plant stress and disease development

Source: 2022 & 2023 South Salinas CIMIS Station (USDA Station)

Changes in weather patterns (warmer years)?

What have we learned so far?

- **Warmer temps >>> Disease**

Stressed plants: 75F and above

- *P. uncinulatum* faster growth *in vitro* ~ 70F (higher for other Pythium spp.)

- **Soil temperature:**

60 – 70F = Pathogen growth and colonization

Symptoms may not be present until warmer soils and extended saturation occur

- **Air temperature:**

Symptom development: >80F (with rapid increase in disease severity)

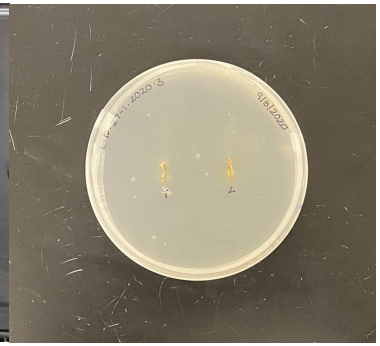
Increased irrigation could mascaraed symptoms but also enhance pathogen spread

Future work

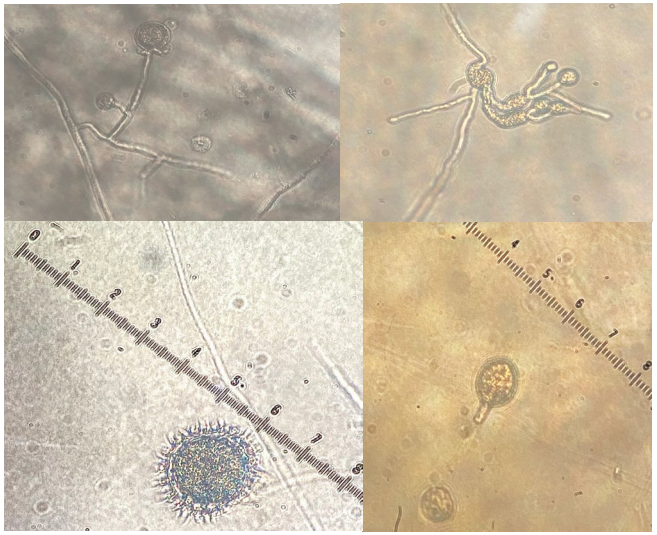
Growth chamber experiments

Understand the Genetic and Phenotypic Diversity of Pythium species from Lettuce Production Fields in CA

Karla Jasso



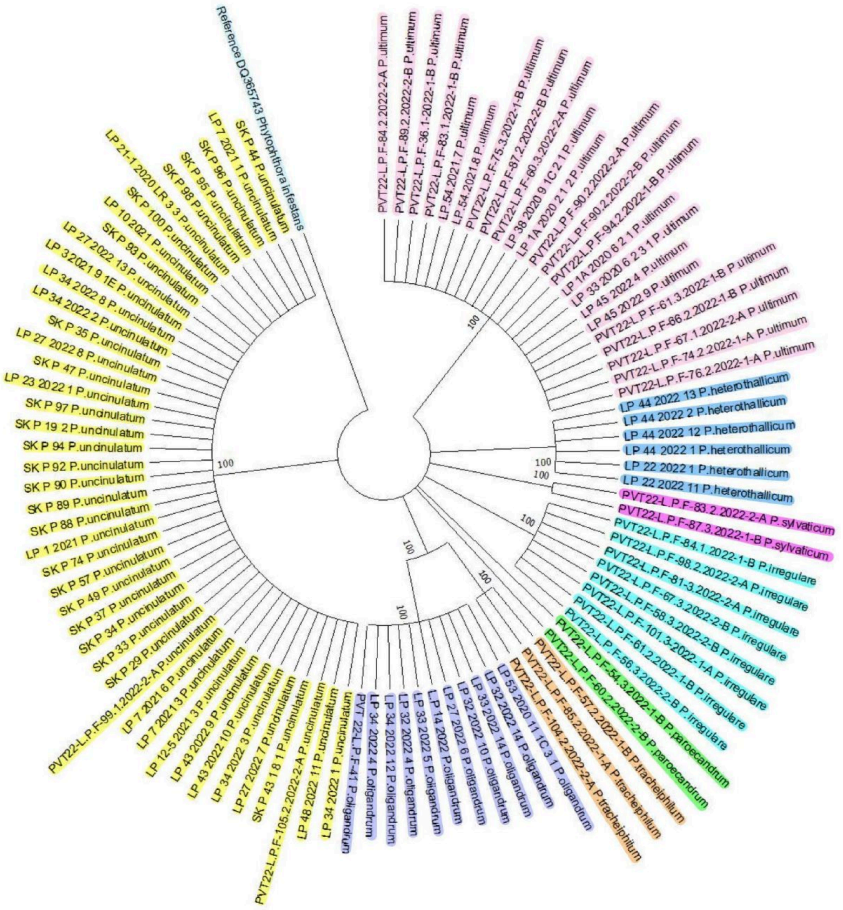
>250 pure culture isolates
2020-2022

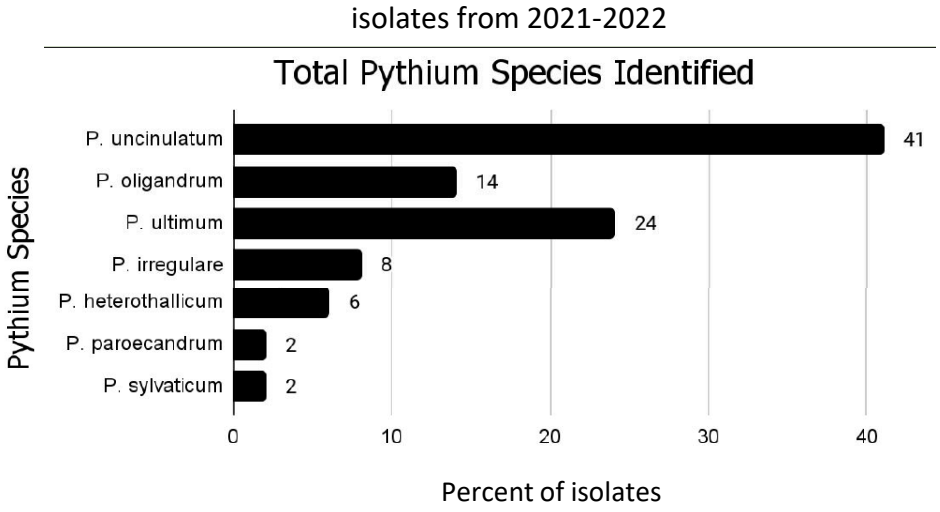


- Phenotypic and genetic characterization
- Identity confirmation
- Pathogenicity assessment

Molecular Identification of Pythium Species Associated with Pythium Wilt of Lettuce

Pat Broderick





- *P. uncinulatum* the main causal agent of Pythium wilt of lettuce
- Consistent high frequency of other *Pythium* spp. on infected roots
- Ongoing: Whole genome sequencing (in collaboration with Yuxin Bai, Michelmore Lab, UC Davis)

Molecular Identification of Pythium Species Associated with Pythium Wilt of Lettuce

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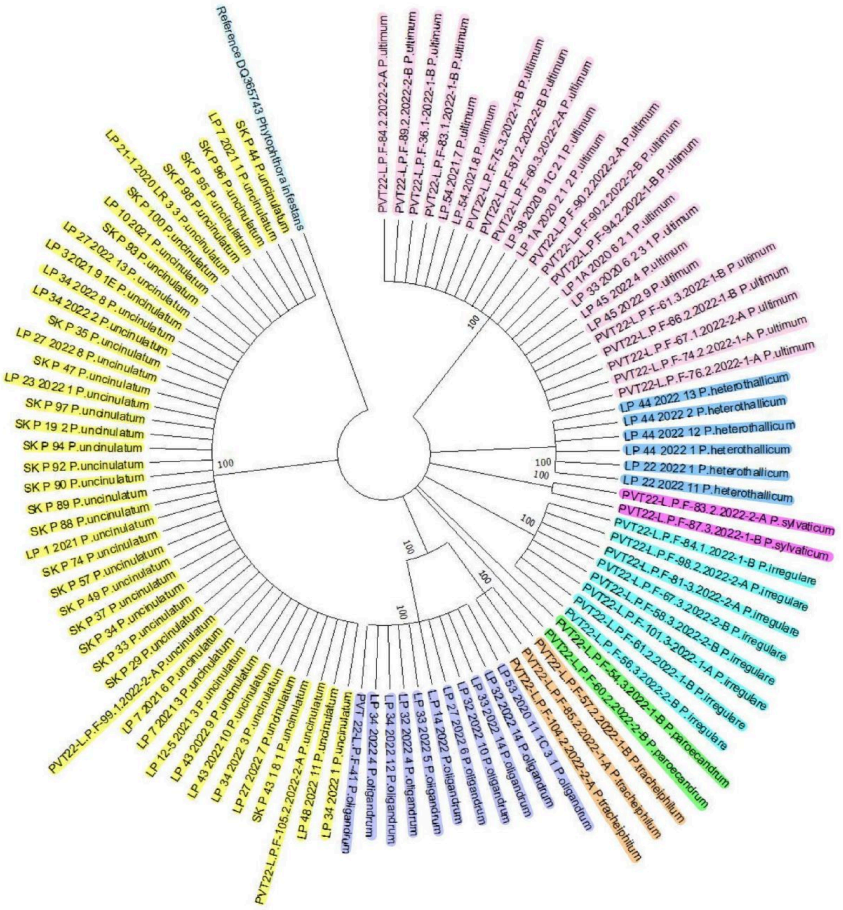

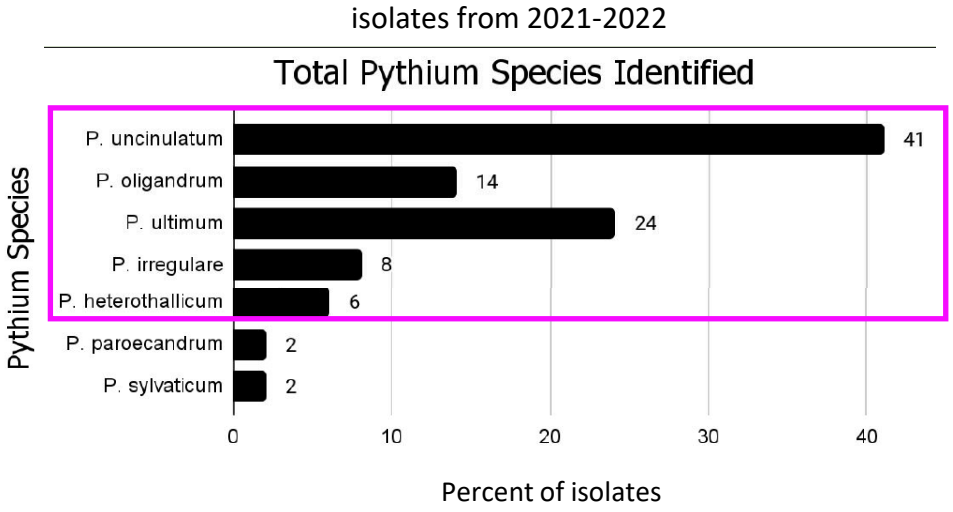

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Pythium species

- Soilborne pathogens and aggressive saprophytes
  - Can be found in soil, sand, pond and stream water and their sediments, and in the dead roots of previous crops

- Worldwide and wide host range: Multiple species of *Pythium*, not host-specific

- 300+ species have been described (most are not plant pathogens)

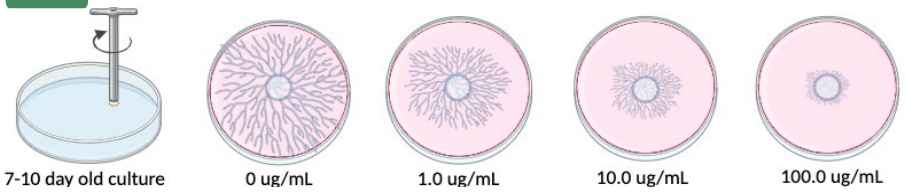
Pythium species	Reported row crop hosts
P. aphanidermatum	bean, beet, cabbage, carrot, cauliflower, cucumber, eggplant, lettuce, melon, onion, parsley, pea, pepper, potato, radish, spinach, sweet potato, tomato, watermelon
P. irregulare	asparagus, basil, bean, beet, Brussels sprouts, cabbage, carrot, cauliflower, celery, cilantro, cucumber, eggplant, endive, lettuce, melon, onion, parsley, pea, pepper, potato, radish, spinach, sweet potato, tomato, watermelon
P. mastophorum	celery, parsley
P. polymastum	broccoli, cabbage, cauliflower
P. sulcatum	carrot(infects other crops but causes few symptoms)
P. ultimum	bean, beet, Brussels sprouts, cabbage, carrot, cauliflower, celery, cilantro, cucumber, eggplant, endive, leek, lettuce, melon, onion, pea, pepper, potato, radish, spinach, sweet potato, tomato, watermelon
P. uncinulatum	lettuce
P. violae	carrot(infects other crops but causes few symptoms)

Source: Koike 2021

Experimental approach: Phenotypic characterization of *Pythium* spp. populations associated with Pythium wilt of lettuce in CA

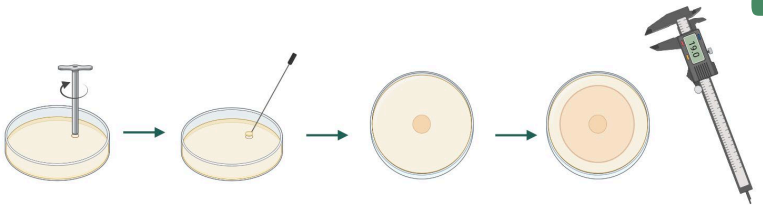
1

Mefenoxam sensitivity



2

Growth Assay



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Pathogenicity Assay

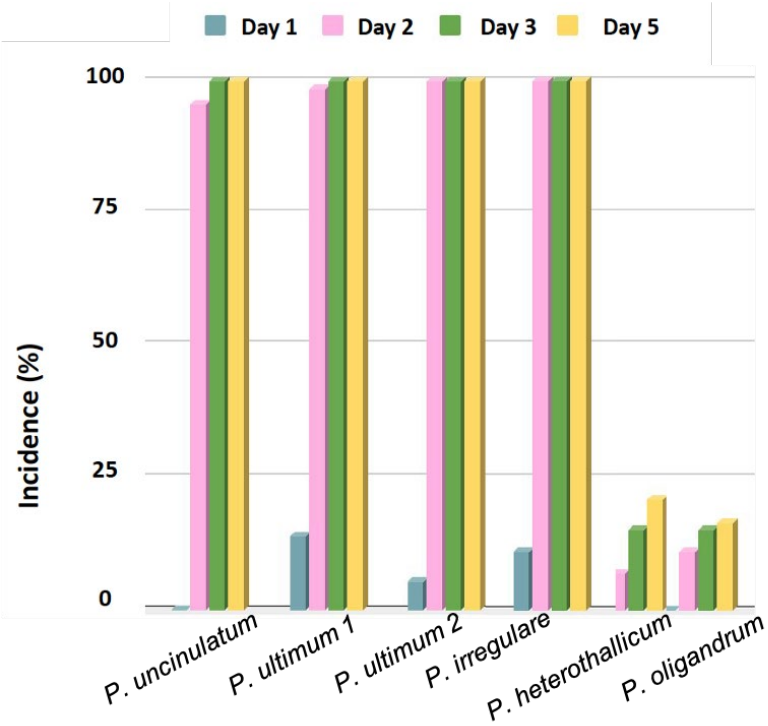
Control / healthy	Inoculated / wilted, root rot

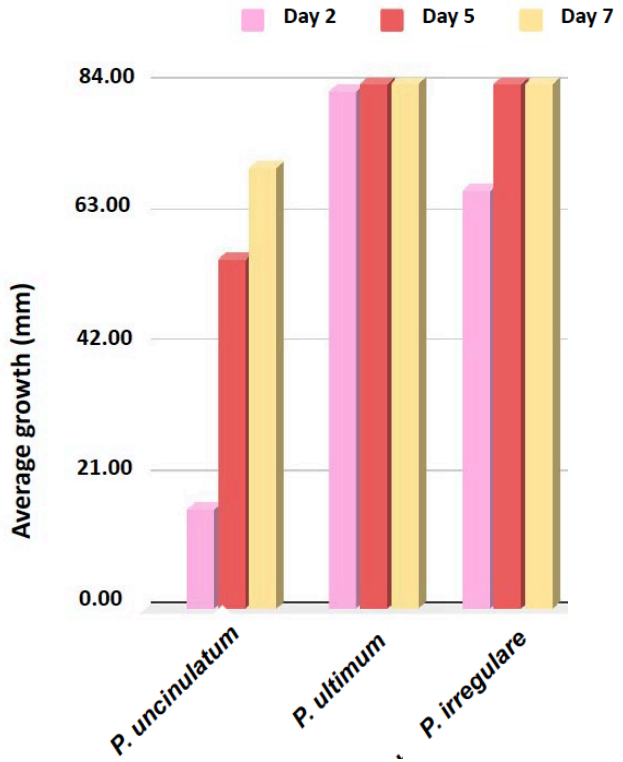
In vitro

In vivo

Characterization of *Pythium* species through Pathogenicity Testing

Joseph Garcia

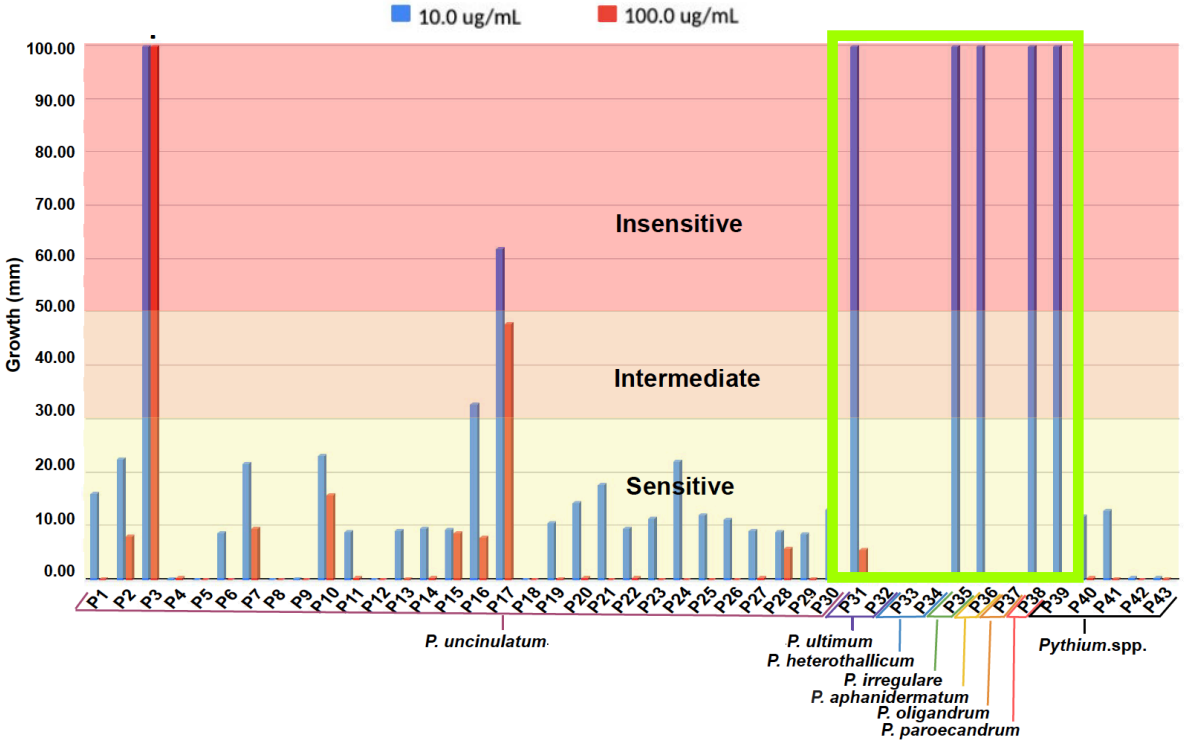




- *P. ultimum and P. irregulare* from lettuce roots were as aggressive as *P. uncinulatum* and caused severe wilting and death of lettuce seedlings (*in vitro)*
- Faster growth rate of *P. ultimum and P. irregulare* could contribute to early field infection

Characterization of *Pythium* species through Mefenoxam Sensitivity

Keeliah Keelan



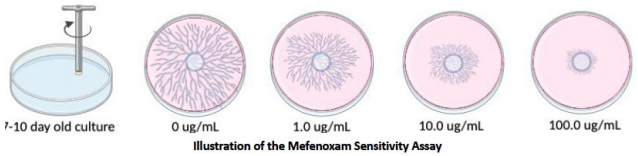


Illustration of the Mefenoxam Sensitivity Assay

- Most *Pythium* isolates, regardless of species were sensitive to mefenoxam
  Some exceptions particularly among non-uncinulatum *Pythium* species
- Presence of highly insensitive isolates suggests a moderate-to-high risk of resistance development to mefenoxam-based products (only registered alternative currently available)
- Ongoing: testing additional active ingredients

Variety selection?

Characterize Tolerance of Lettuce Cultivars to Pythium Wilt

Geovanni Espinoza

Richard Smith

No.	Variety	Type	Evaluation*	No.	Variety	Type	Evaluation*
1	Da Vince	Red multi leaf	5	18	Summer set	head	6
2	Extranet	Green	7	19	Republic	head	8
3	Expertise	Green	9	20	Rebel	head	8
4	91-02	Green	9	21	Somerset	head	4
5	91-01	Green	9	22	Republic	head	9
6	Asak Green	Green	1	23	New Castle	head	4
7	Xographi	light green	1	24	Lucky	head	6
8	90-57	Green	9.5	25	Salute	head	5
9	Frostex	Red	2	26	Steamboat	head	4
10	90-98	Red	2	27	ECS17-412	head	3
11	Bergmans	Green leaf	8	28	E900450.01E	head	3
12	Big Star	Green leaf	8	29	Senate	head	8
13	Infinity	Green multileaf	1	30	Liberate	head	6
14	Big Sur	Green leaf	8	31	PX1681	head	2
15	Star Struck	Green leaf	9	32	Lockwood	head	1
16	Numbered	Baby romaine	8	33	Tombstone	head	2
17	Regecey	head	2	34	Stage Coach	head	5

Variety Trial for Pythium Wilt Tolerance

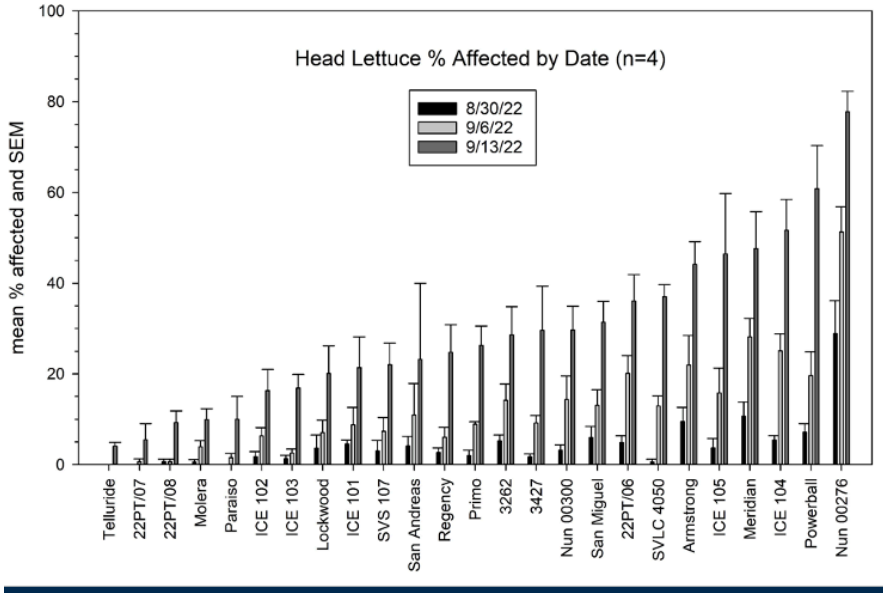
Alex Imperial *Tyler Barton*

Field evaluations

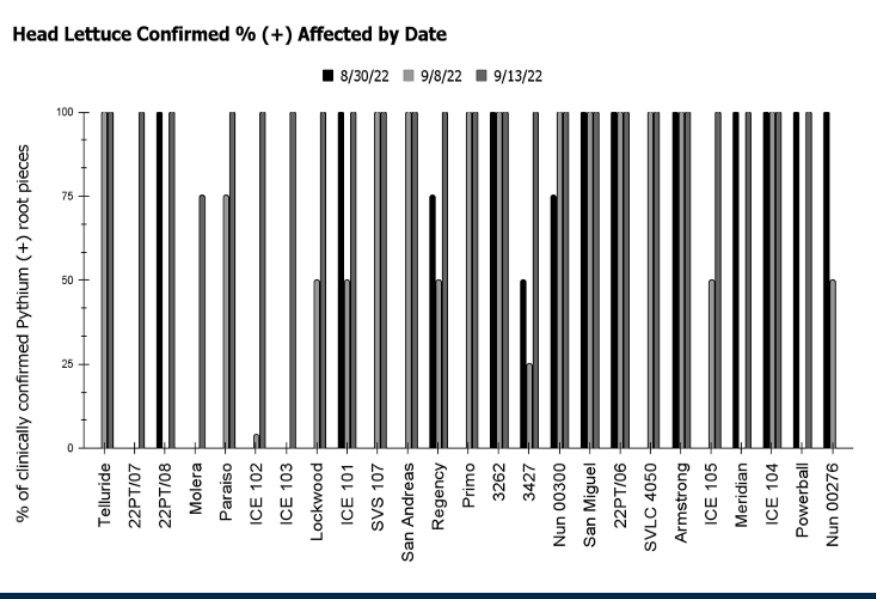
Root plating (confirmation)

Pathogen purification/identification

Foliar wilting



Confirmed root rot



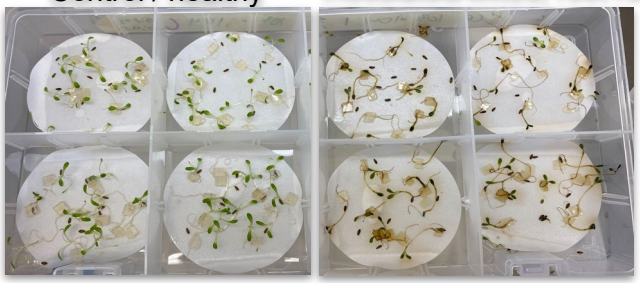
Variety Trial for Pythium Wilt Tolerance

Alex Imperial *Tyler Barton*

Field evaluations

Control / healthy

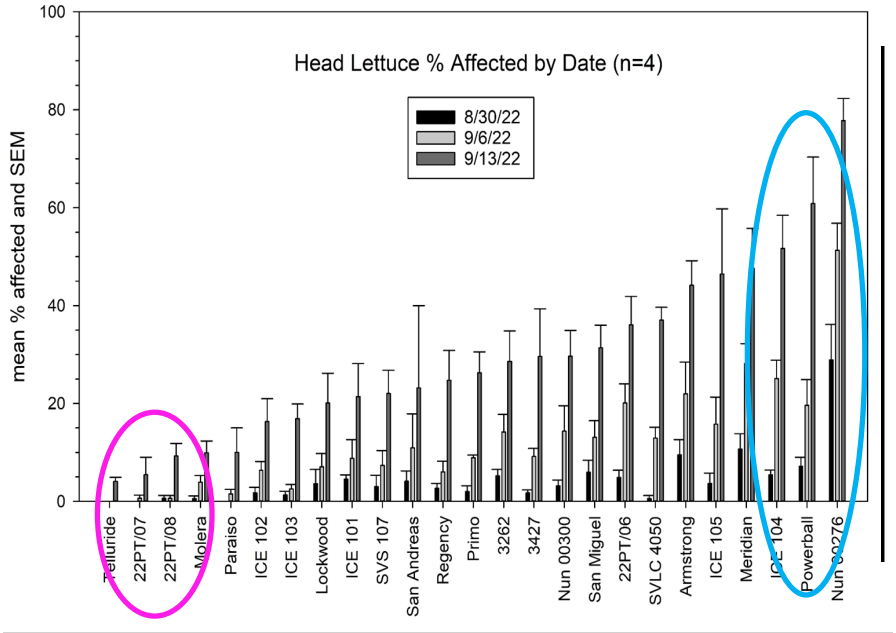
Inoculated/wilted, root rot

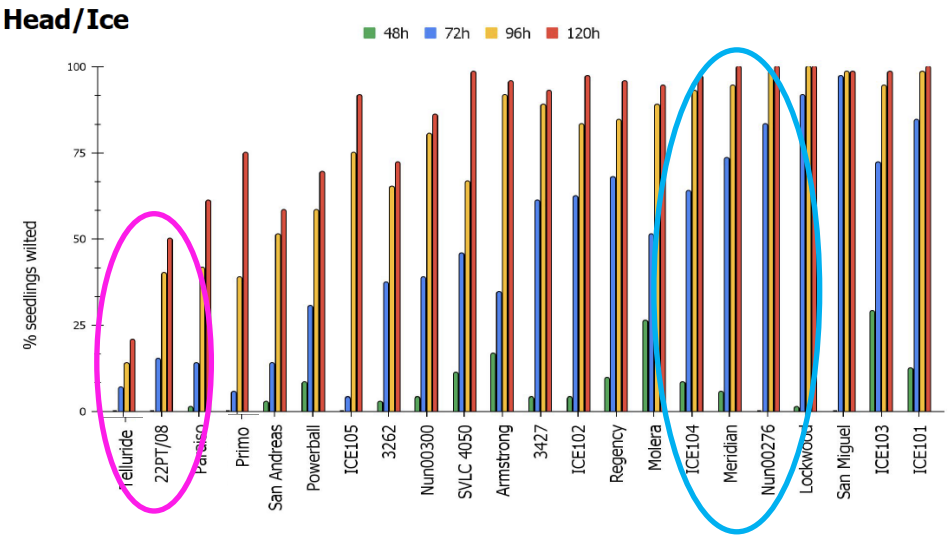


Field — *In vitro*

Consistency

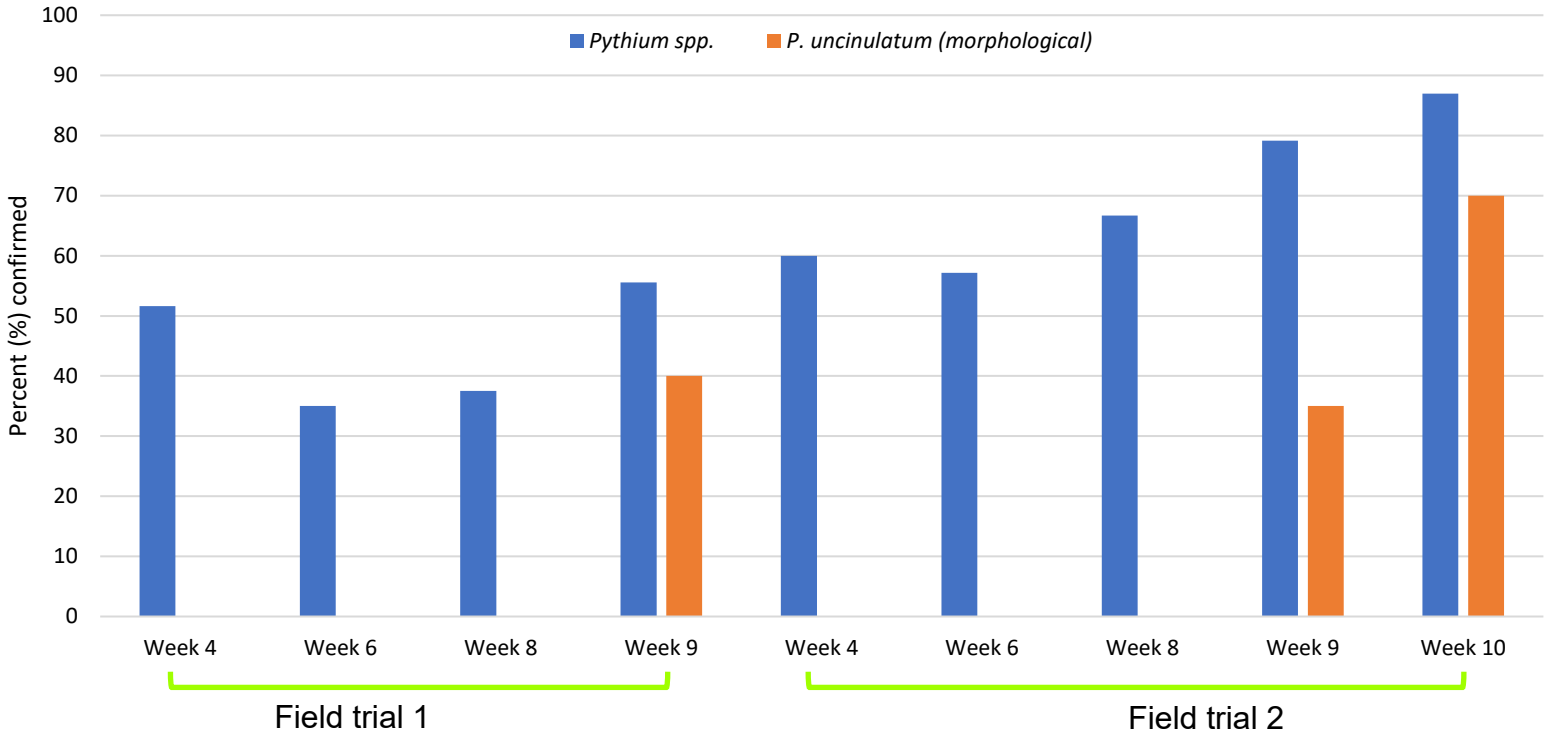
Robust evaluation of varieties





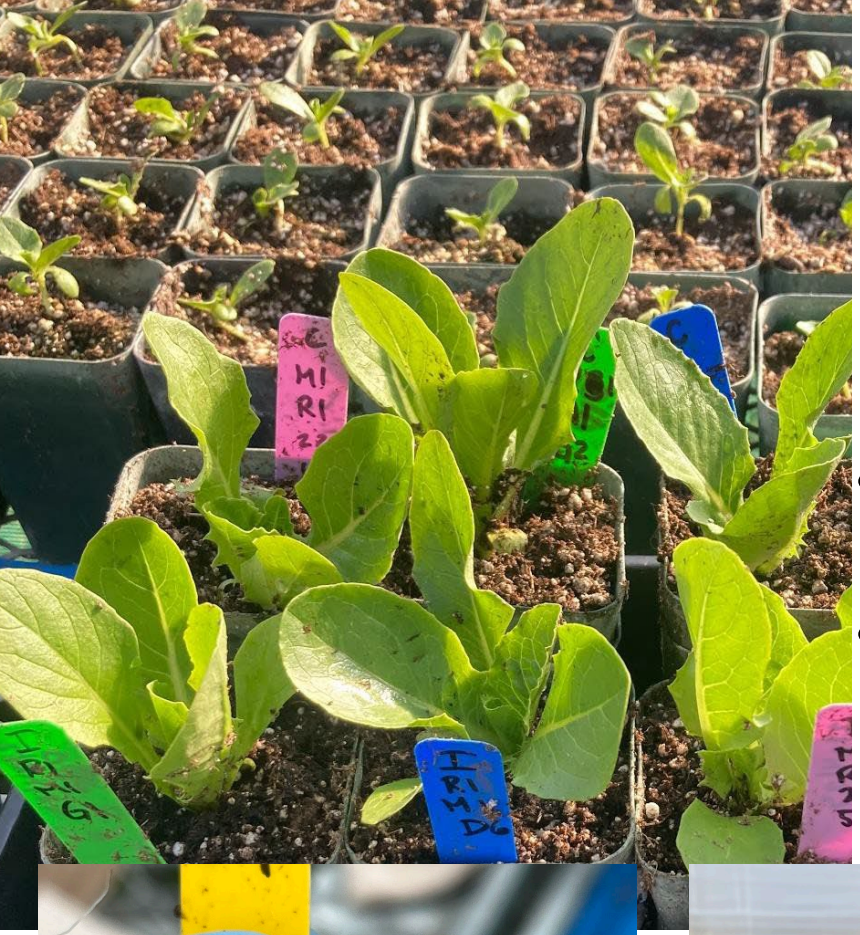
Variety Trial for Pythium Wilt Tolerance

UCCE-CSUMB team

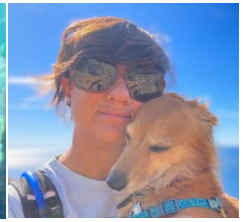


Overall observations:

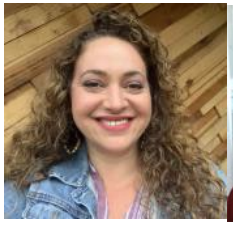
- Disease development varied across varieties
- By the last week of the trial, the vast majority of plants were infected with Pythium wilt
  - Some varieties showed disease tolerance
- Above-ground Pythium wilt symptoms were not accurate predictors of infection



Jasper Tao

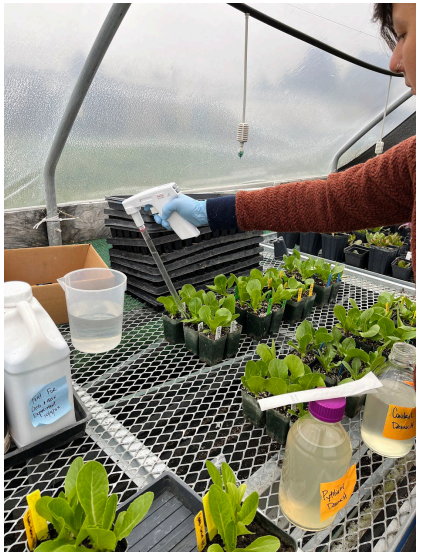


Alex Imperial



Kelley Richardson & Ivan Simko
USDA ARS, Salinas

- Evaluating breeding lettuce germplasm for resistance to *Pythium*
- Genetic markers (Michelmore, UC Davis)



Confounding factors?

Co-occurrence of INSV and Pythium Wilt diseases

Pythium wilt

+

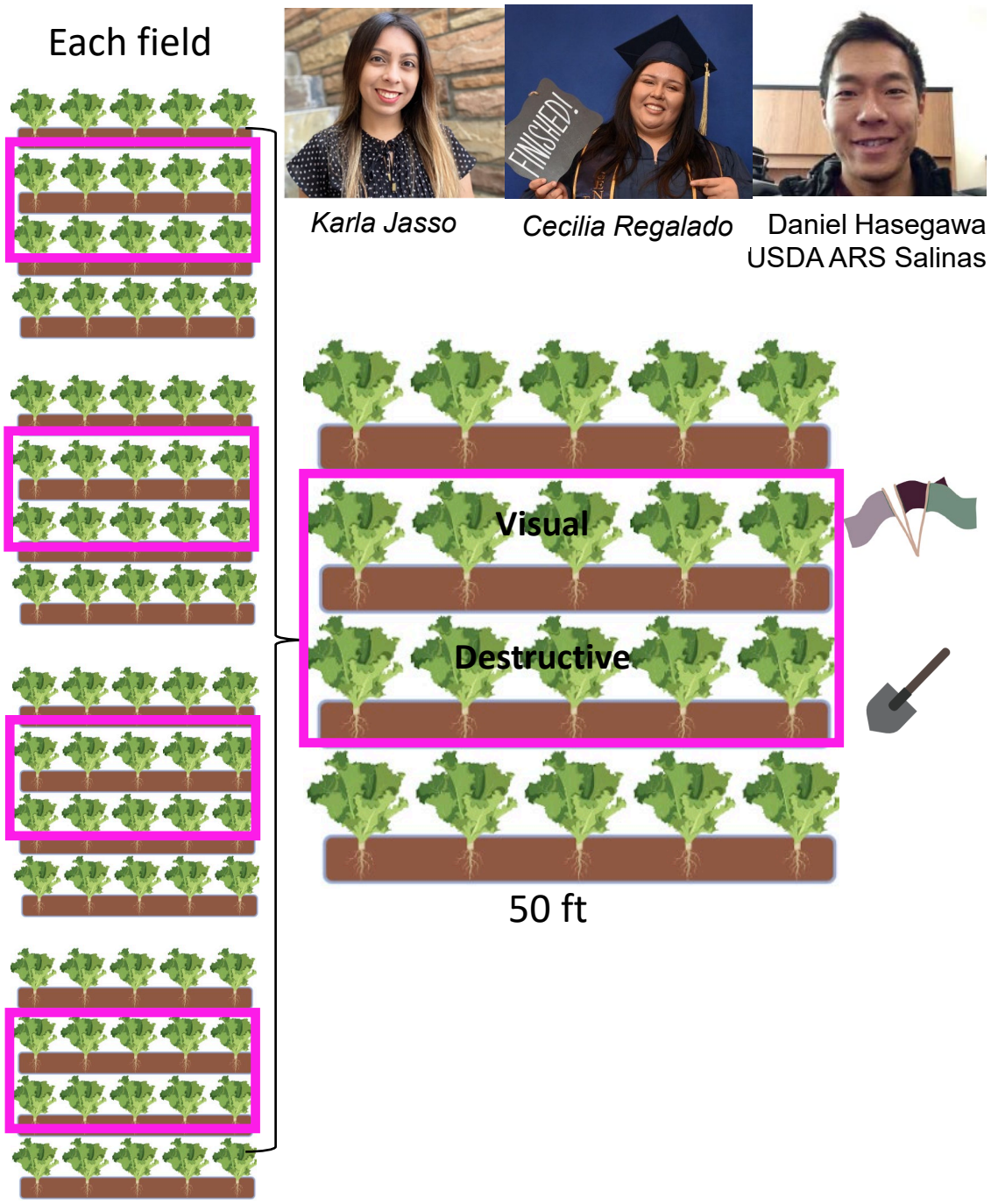
Impatiens Necrotic Spot Virus (INSV)

=

?

Methods

- **13 commercial fields evaluated** weekly from planting to harvest (total of 7-10 weeks)
- **Disease incidence assessment** (4 paired seedlines, 80-in* 50ft beds)
- **Visual: Foliar symptoms**
  - N=230 plants/field (same plants evaluated weekly)
  - INSV: leaf necrosis
  - Pythium Wilt: wilting of leaves
- **Destructive: Diagnostics**
  - N=20 plants/field collected weekly
  - INSV: TAS-ELISA (leaves + roots)
  - *Pythium* spp.: Culturing (roots)

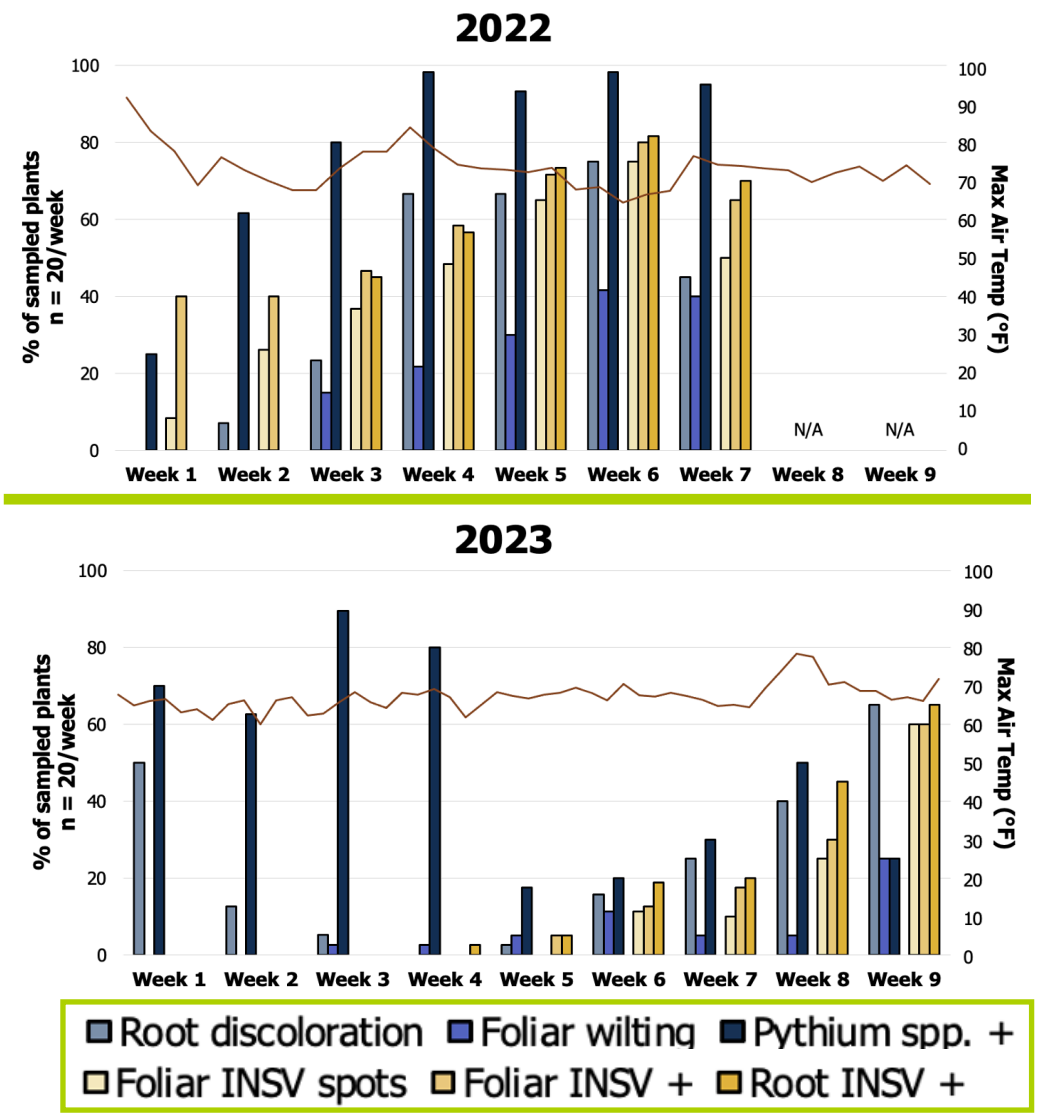


Karla Jasso

Cecilia Regalado

Daniel Hasegawa
USDA ARS Salinas

Timing of INSV and Pythium Wilt in commercial lettuce fields



Data from 8/13 fields

- Earlier and greater incidences in 2022
  - INSV seemed to accelerate Pythium wilt development
- Both pathogens detected in symptomatic/asymptomatic plants (foliar and root tissues)
- Pythium (INSV 2023) was frequently detected during the first 4 weeks suggesting early infection
- 2023 lower temp vs. 2022 impacted the incidence of both diseases
  - High temps impact INSV incidence, vector dispersal, and susceptibility and dispersal to *Pythium* (saturated soils)

Pythium wilt

Black root rot

Lettuce drop

Verticillium wilt

Fusarium wilt

Botrytis Crown Rot

When unsure, send a sample to a disease diagnostics clinic (CDFA, TriCal Diagnostics)

Conclusions

Changes in weather patterns

- Strong effect of temperature on plant health/stress
- Warmer temp >>> Greater disease incidence and severity

Changes in pathogen populations

- *P. uncinulatum* remains the main causal agent of Pythium wilt of lettuce
- Other *Pythium* spp. (alone and in combination) might contribute to high disease incidence and severity
  - Locally-adapted, widespread pathogens of commonly grown crops

Variety selection

- Promising tolerance shown by commercial varieties
  - Performance is context-dependent (temp, pathogen species, co-infection)

Confounding factors

- INSV accelerates Pythium wilt development
- Both pathogens detected in symptomatic/asymptomatic plants (foliar and root tissues)

Dundore-Arias Lab @CSUMB

Collaborators

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Alex Putman, UCR
Steve Koike, TriCal Diagnostics
Richard Michelmore, UC-Davis
PCAs and Growers
GSA INSV-Pythium Task Force

Funding

CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

CSU Agricultural Research Institute (ARI)

cdfa

FOUNDATION FOR FOOD & AGRICULTURE RESEARCH

USDA NIFA

NSF

U.S. DEPARTMENT OF ENERGY

Thank You!

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