Speaker Schedule

California Processing Tomato Annual Research Meeting

December 3rd & 4th, 2025

Time	Limit (minutes)	Dec. 3, 2025: CTRI Annual Research Meeting - DRAFT Speaker Schedule	Presenter
1:00 PM	5	Welcome and Introductions	Zach Bagley
1:05 PM	30	Broomrape: Development of Long Term Management Options	Brad Hanson
1:35 PM	20	Broomrape: Equipment Sanitation - Science & Strategies (Zoom)	Cassandra Swett & Patricia Lazicki
1:55 PM	15	Broomrape: Development of Extension Tools in Support of Broomrape Management	Katie Ashley
2:10 PM	20	Disease MGMT: Integrated Management Strategies for Fusarium Stem Rot & Decline (FRD)	Myles Collinson
2:30 PM	15	Disease MGMT: Varietal Ranking and "Sunscreen" Protectants for FRD	Brenna Aegerter
2:45 PM	15	Disease MGMT: Disease Diagnostics (Zoom)	Cassandra Swett
3:00 PM	20	BREAK	
3:20 PM	20	Agronomic MGMT: AI-Based, Real-Time Nutrient and Stress Diagnosis Tool for Tomatoes	Alireza Pourreza
3:40 AM	15	Broomrape: Broomrape Detection - Remote Sensing	Alireza Pourreza
3:55 PM	20	Broomrape: Grower Owned & Operated In-Field Broomrape Detection System (Zoom)	Chris Laudando
4:15 PM	20	Broomrape: Targeting Strigolactone Receptors in Branched & Egyptian Broomrape	Marco Burger
4:35 PM	15	Broomrape: Identification of Soil Microbes that Disrupt Broomrape Seed Germination	Johan Leveau
4:50 PM	15	Agronomic MGMT: Exploring the Yield Gap Between “New” and “Old” Tomato Fields	Patricia Lazicki
5:05 PM	20	Agronomic MGMT: A Grower Directed Soil Health BMP Guide for Processing Tomatoes	Patricia Lazicki & Sutie Xu
5:25 PM		BREAK FOR EVENING - OPEN BAR @ CARBONIS	

Time	Limit (minutes)	Dec. 4, 2025: CTRI Annual Research Meeting - DRAFT Speaker Schedule	Presenter
9:00 AM	5	Welcome and Introductions	Zach Bagley
9:05 AM	15	Broomrape: Developing Tomato Lines Resistant to Branched Broomrape	Siobhan Brady
9:20 AM	15	Germplasm & Variety Development: Inducible Suberin for Improved Root Characteristics	Siobhan Brady
9:35 AM	15	Germplasm & Variety Development: C. M. Rick Tomato Genetic Resource Center	Vincent Colantonio
9:50 AM	20	Germplasm & Variety Development: Breeding for Heat Tolerance	Mark Johnson
10:10 AM	20	BREAK	
10:30 AM	20	Germplasm & Variety Development: Salt Stress Resilience (Zoom)	Greg Vogel
10:50 AM	20	Germplasm & Variety Development: Beyond Fusarium Wilt: Validating Gene-Edited Variants For Resistance Against Multiple Diseases Impacting Processing Tomato (Zoom)	Daniel Rodriguez-Leal
11:10 AM	20	Germplasm & Variety Development: Marker-Trait Association Study To Develop DNA Markers For RB-TSWV Resistance In Tomatoes (Zoom)	Reza Shekasteband
11:30 AM	25	Insect & Invertebrate MGMT: Evaluation of Management Programs for Consperse Stink Bug	Tom Turini
11:55 AM	20	Virus & Vector MGMT: Classification & Characterization of Non-Agricultural Beet Leafhopper Hotspots in the Coastal Foothills	Christian Nansen
12:15 PM		LUNCH - FREE FOR ATTENDEES & RESEARCHERS	

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California Processing Tomato Annual Research Meeting

December 3rd & 4th, 2025

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Annual Research Meeting 2025-2026

December 3rd & 4th, 2025

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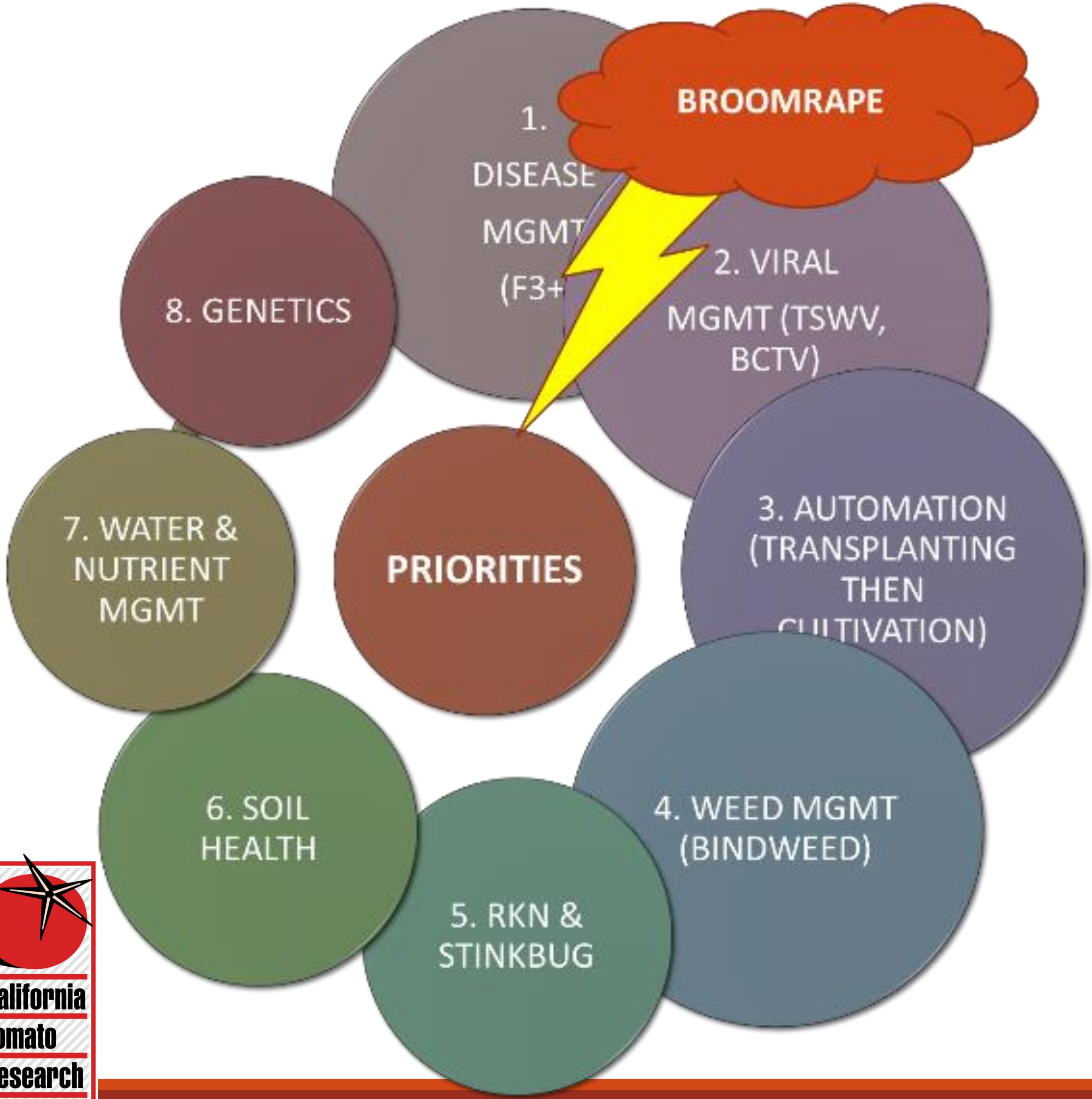

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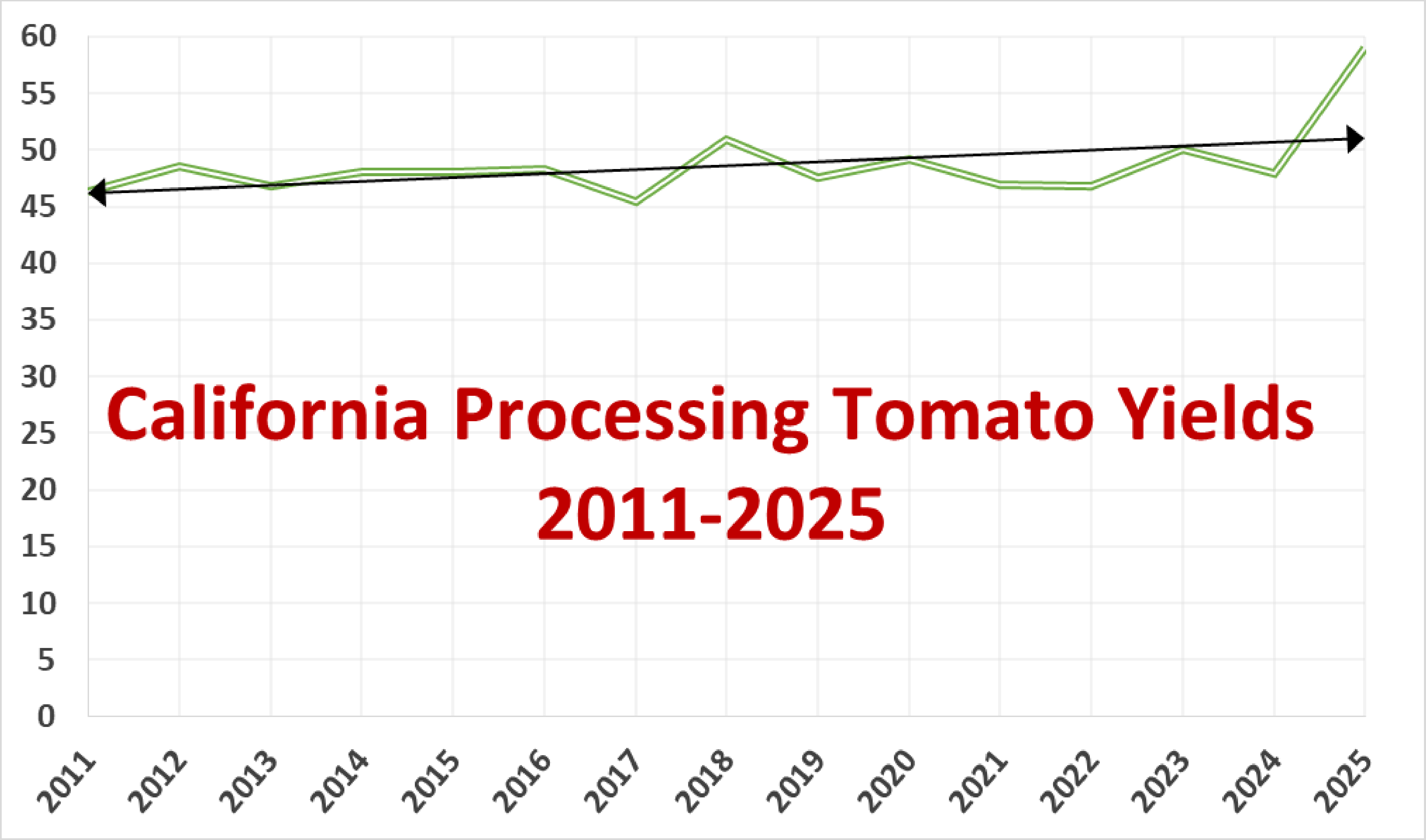

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CTRI-Funded Work: Highlighted 2025 Results

- Yield Gap Between “Old” & “New” Fields (Patricia Lazicki)
- Progress on Fusarium Stem Rot & Decline (FRD) Management (Cassandra Swett & Farm Advisors)
- Broomrape In-Field Management Updates (Brad Hanson and Cassandra Swett)
- In-Lab Molecule Discovery Stopped Broomrape Germination in the Lab – a first step (Martin Burger)
- Continued Stink Bug Trials Show Promise for New Chemistry Already in the Registration Pipeline

California Tomato Research Institute

Working Together for Greater Impact

California Tomato Research Institute

- CSU Ag Research Institute - Board of Governors
- UC CA&ES Dean Search - Industry Panelist
- CDFA Specialty Crop Block Grant - Technical Review Committee Panelist
- USDA IR-4 Project - Commodity Liaison Committee
- California Specialty Crops Council - Board Member
- USDA NP 304 5 Year Planning - Panelist
- FFAR Specialty Crop Convening - Panelist
- FIRA Ag Robotics Conference – Panel Organizer
- Western Growers Biologicals Summit – Panel Organizer

https://bit.ly/CTRI2024ExecutiveSummaries

https://bit.ly/CTRI-2025Projects

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Tomato Heinz Seed

BASF We create chemistry

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Broomrape management: ongoing field and lab work and cornerstone support project

- Brad Hanson, Pershang Hosseini, Rohith Vulchi, Arpan Bhusal (UC Davis)
- Patricia Lazicki, Matt Fatino (UCCE)

- Linked project: Swett equipment sanitation work
- Supported projects: Sinha, Brady, Burger, Pourreza, Davis/McCartney, Lefers/Tester
    - Salim Al-Babili, Muhammad Jamil (King Abdullah University of Science and Technology)

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Agriculture and Natural Resources

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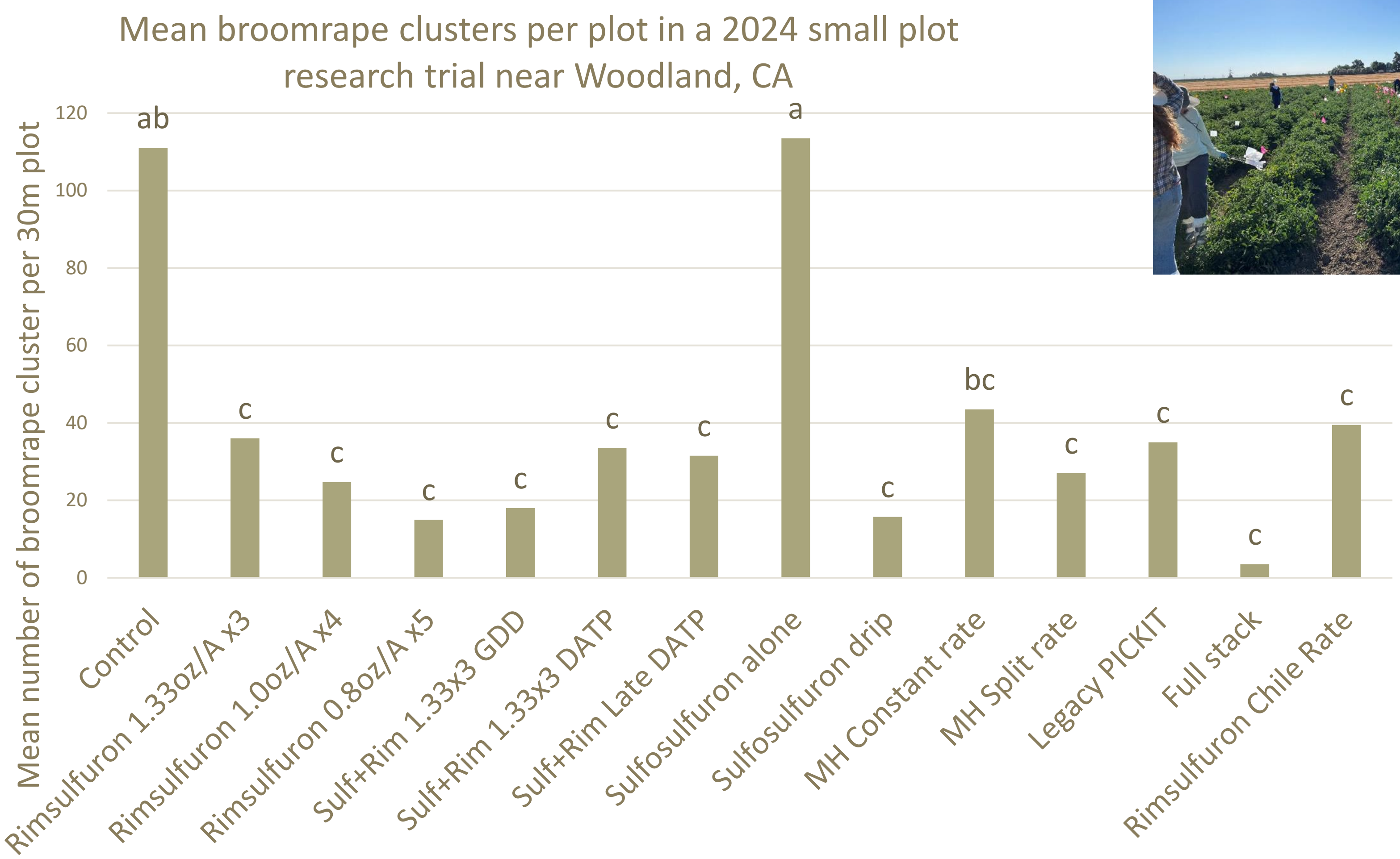
DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

CRTI 2026 preproposal / update
Winters, CA
12/03/25

- Since ~ 2020, about half my program's effort has been focused on broomrape in processing tomato
  - Fatino. MS, PhD, Postdoc. Left 2025
  - Hosseini. Postdoc. Leaving in 2026
  - Vulchi. Postdoc. Taking on field/lab responsibilities from Fatino and Hosseini
  - Bhusal. MS/PhD student. Project lead for MH work and supports other field and lab objectives

Recent progress

- 2025 California field experiments
  - Broomrape control experiment in Woodland
    - Chemigation treatments focused on rimsulfuron 24c label
    - Confirming evaluation of maleic hydrazide foliar programs
    - Planting date study
    - Coordinated industry replicated variety evaluation
  - Support for equipment sanitation work (Swett and Hanson)
- 2025 Contained Research Facility and non CRF greenhouse
  - Quaternary ammonia sanitizer dose response work (ongoing)
    - QAC products, interactions with soil and plant debris, surfactant
      - "tile trial", "mud ball trial"
    - Broomrape component of harvester sanitizer project (coordinated w Swett)
    - Modeling data generated and being analyzed
  - Supported collaborators with broomrape tissues, plants, seed and other samples (genetics and VOC projects primarily)
- Permitting: all UCD researchers working directly with broomrape continue to work under Hanson CDFA permits



- In most of our small plot research, rimsulfuron chemigation at US rates reduces broomrape emergence by ~70-86%
- However, in 2025 all treatments except MH performed poorly (not shown)
    - Need to understand what happened in the 2025 chemigation treatments
- MH was extremely effective in the 2025 “stacked” treatment
    - Working with manufacturer and IR4 to pursue MH further.

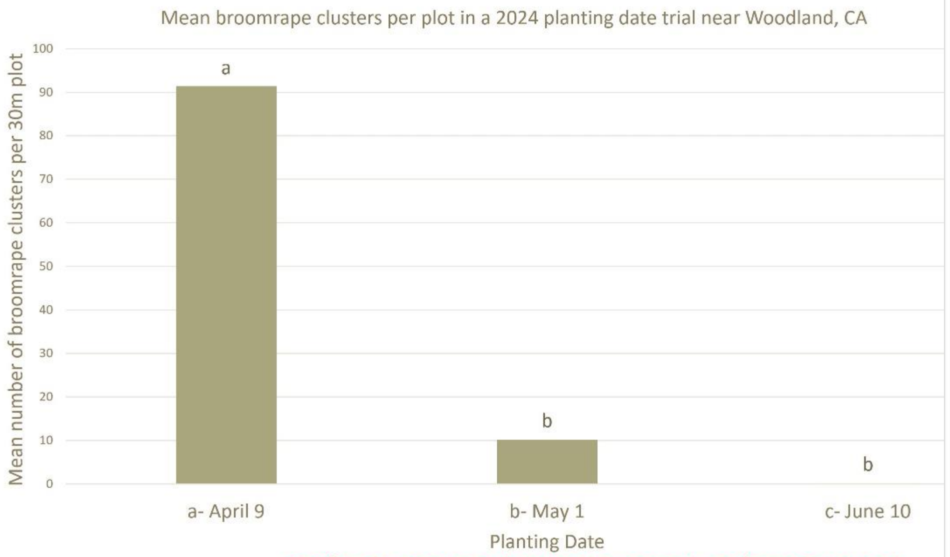
Table 2. Efficacy of different treatments using maleic hydrazide on broomrape emergence, Woodland, CA, 2025.

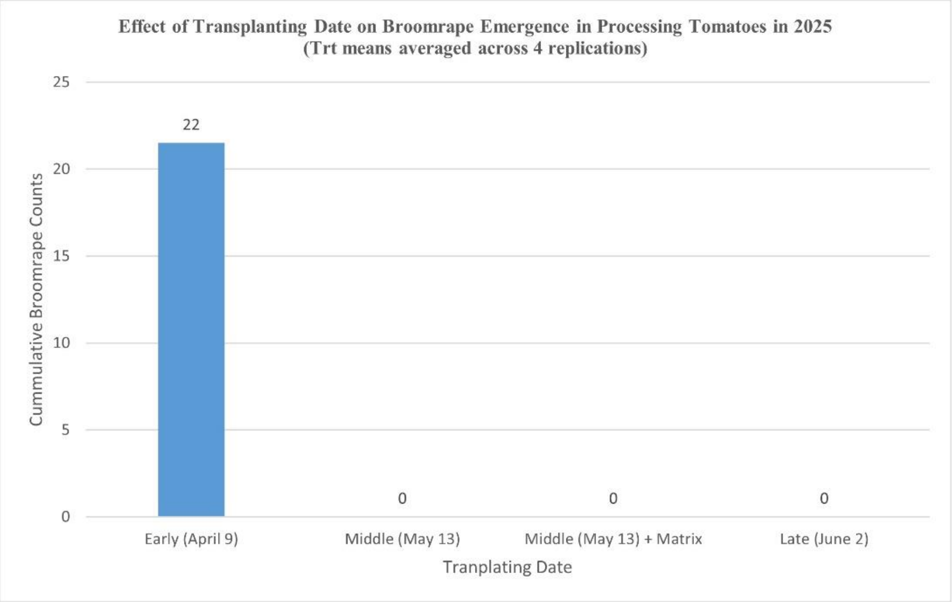
No.	Treatment	Cumulative broomrape counts per plot[i]	
		Trial 1	Trial 2
1	Untreated control	41.25 a[ii]	0.25 a
2	Matrix® (1.33 oz/A ×3)	33.25 a	0 a
3	Sprout-Stop® (28 fl oz/A ×6)	0.5 b	0 a
4	Sprout-Stop® (21 fl oz/A ×2 + 28 fl oz/A ×4)	0.25 b	0 a
5	Sprout-Stop® (32 fl oz/A ×6)	0.5 b	0 a
6	Sprout-Stop® (28 fl oz/A ×2 + 32 fl oz/A ×4)	0 b	0 a
7	Sprout-Stop® (28 fl oz/A ×8)	0 b	0 a
8	Outrider® (1.75 oz/A, PPI) + Matrix® (1.33 oz/A ×3) + Sprout-Stop® (32 fl oz/A ×6)	0.25 b	0 a
P value		0.0003	0.459

Trial 1 transplanted April 9, Trial 2 planted May 13

Bhusal and Hanson

2024 and 2025 planting date trials





- California planting date trial supportive of previous trial conducted in Chile; planting at-risk fields as late as feasible within the planting cycle may be of potential benefit

Fatino, Vulchi, Bhusal, and Hanson

Tomato variety screening

- Field
  - Thus far, no clear differences among commercial cultivars in larger scale demo or replicated plots
  - Have tested some research materials (cultivars and/or grafted); thus far, data have been negative or inconclusive due to planting date challenges
- Greenhouse
  - Two GH runs of top ~20 PTAB varieties
    - Minimal differences in total parasitism
  - Have some small studies with research materials ongoing in GH

CA host screening

- Small-scale in broomrape greenhouse
  - So far, 34 crops from 11 families evaluated
  - Double-cup system (1 Liter pots) and potting media with ~50 broomrape seed at planting/transplanting
  - Data are categorical (high/med/low/non) based on number of replicate pots with attachments or emergence observed

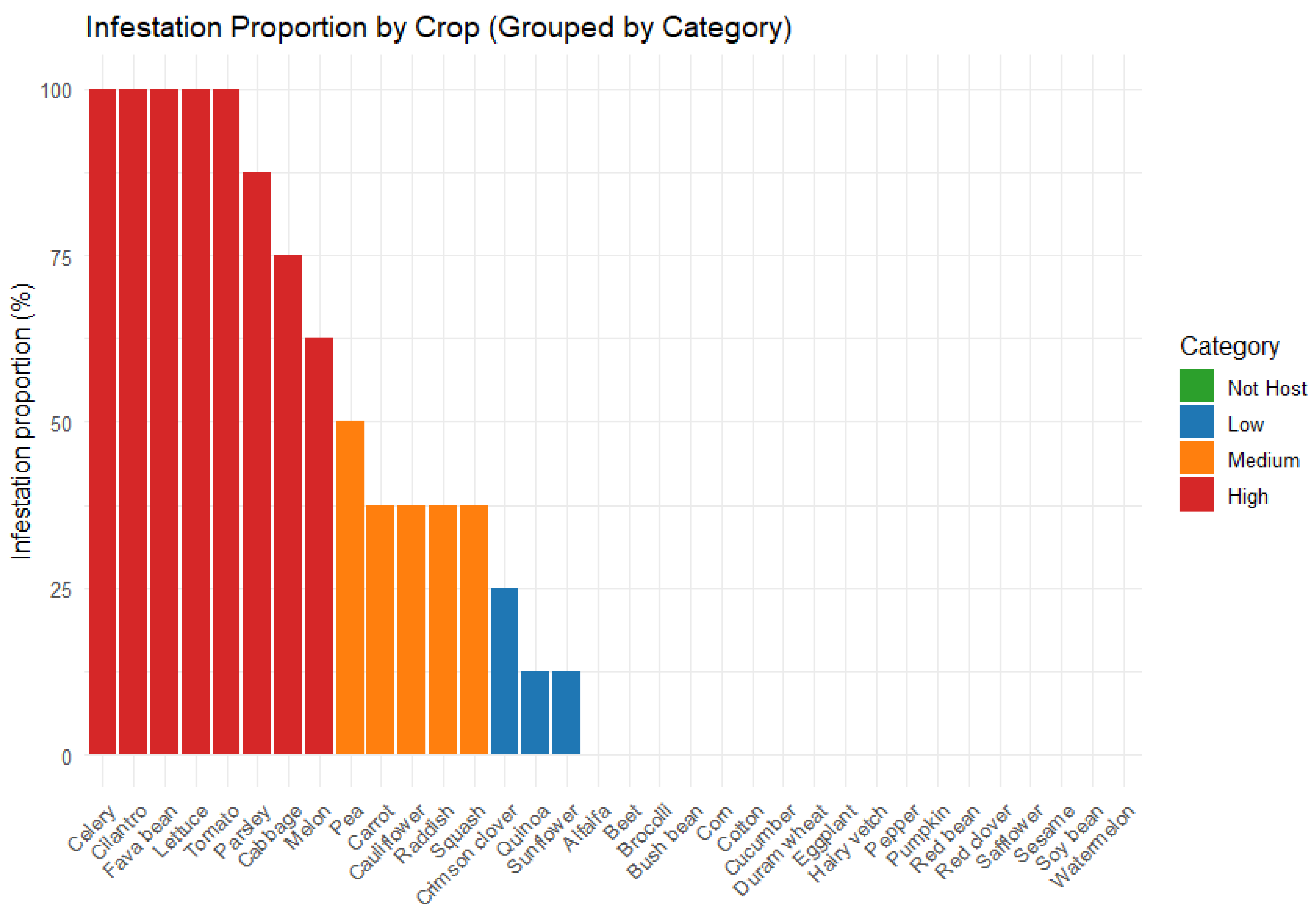


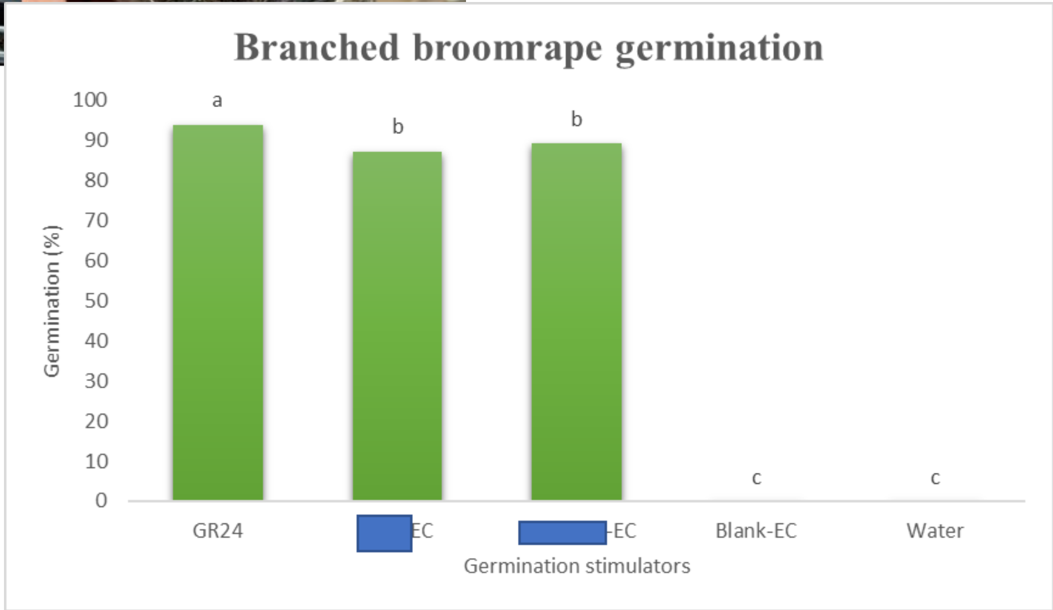
Figure 1. Infestation outcomes of 34 crops in host screening (8 replicates per crop). Number of crops classified based on infestation proportion: *Not Host* (0%), *Low* (1–25%), *Medium* (26–50%), and *High* (>50%).

Hosseini, Tang, and Hanson

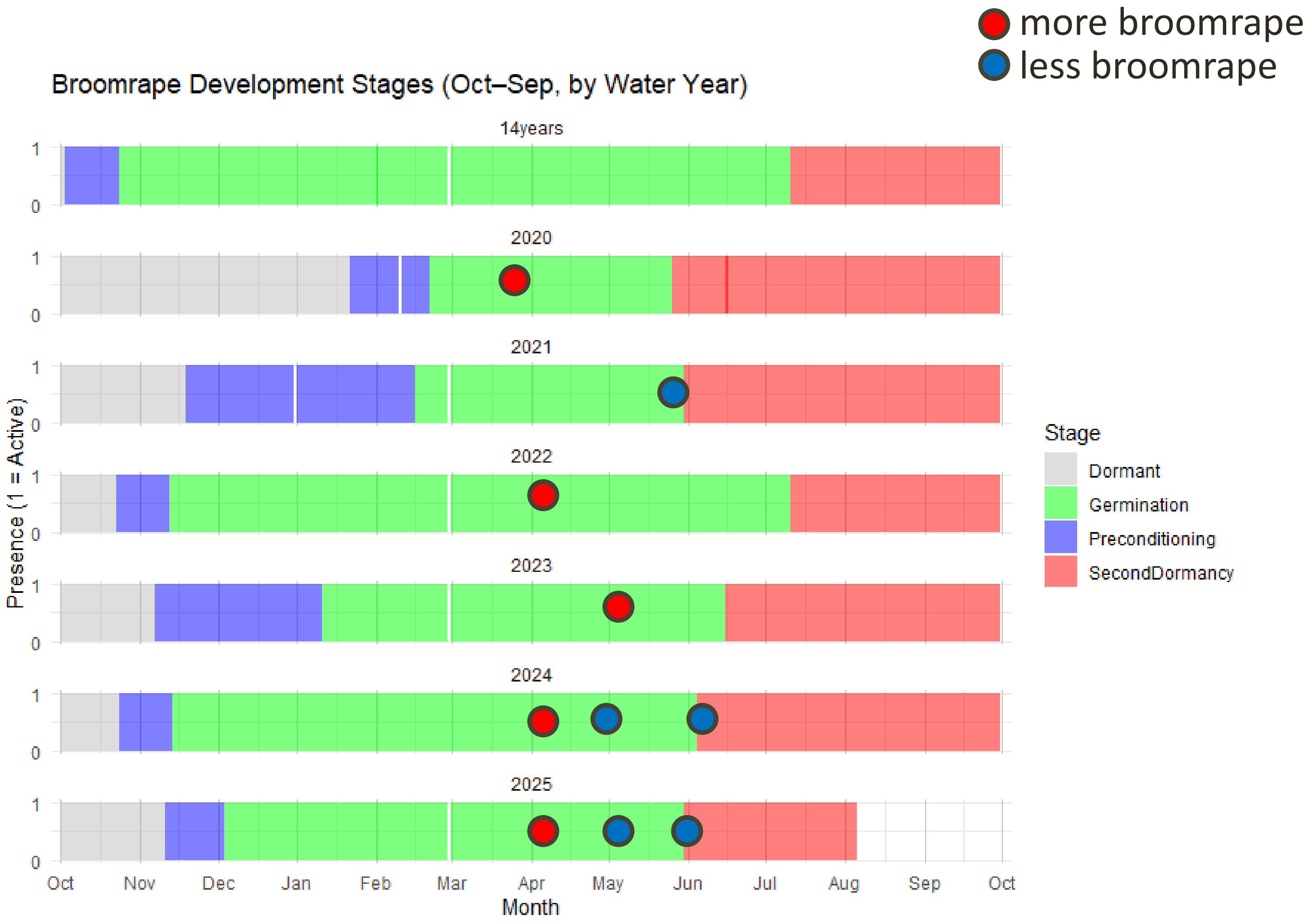
Germination stimulation studies

- Tested in field in 2025.
    - Inconclusive results due to planting date
    - Will regroup in 2026
- New GH and lab work underway

Collaborations with Striga researchers in Saudi Arabia (KAUST)



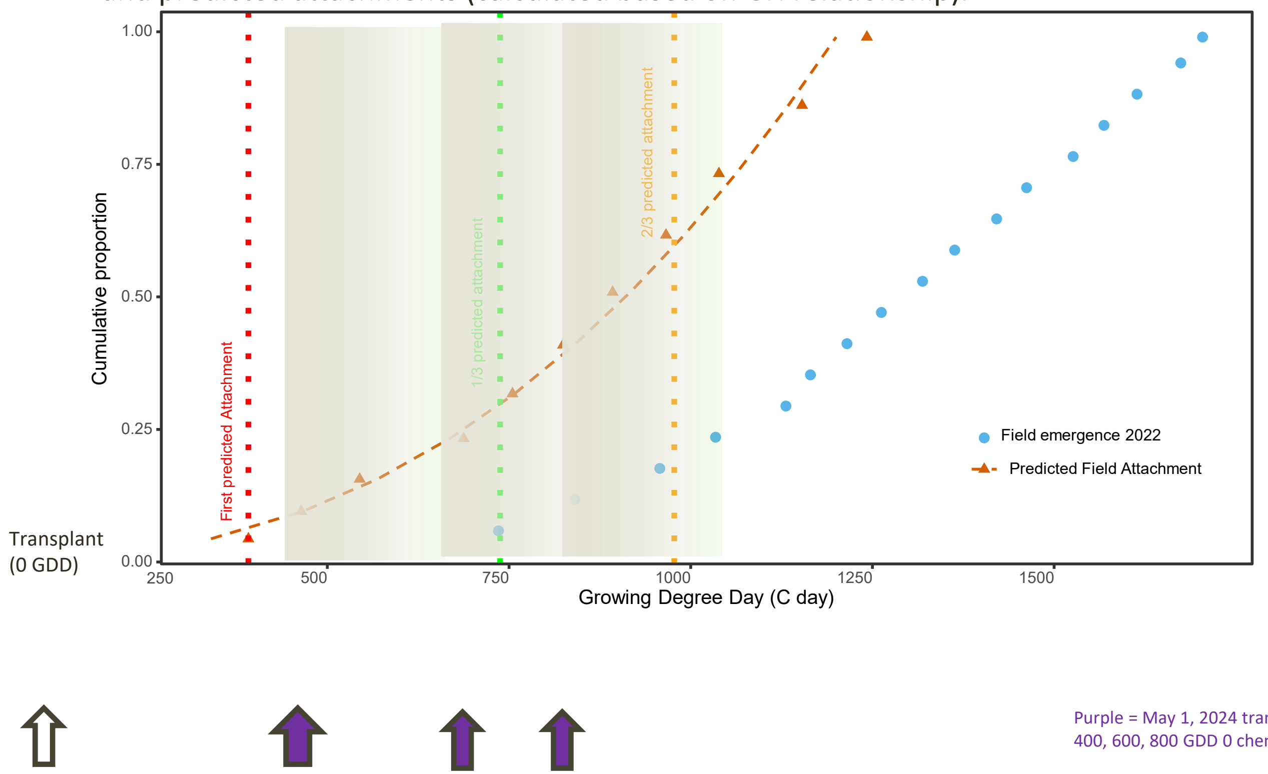
Explaining and predicting



Hosseini, Mesgaran, Hanson (analyses in process)

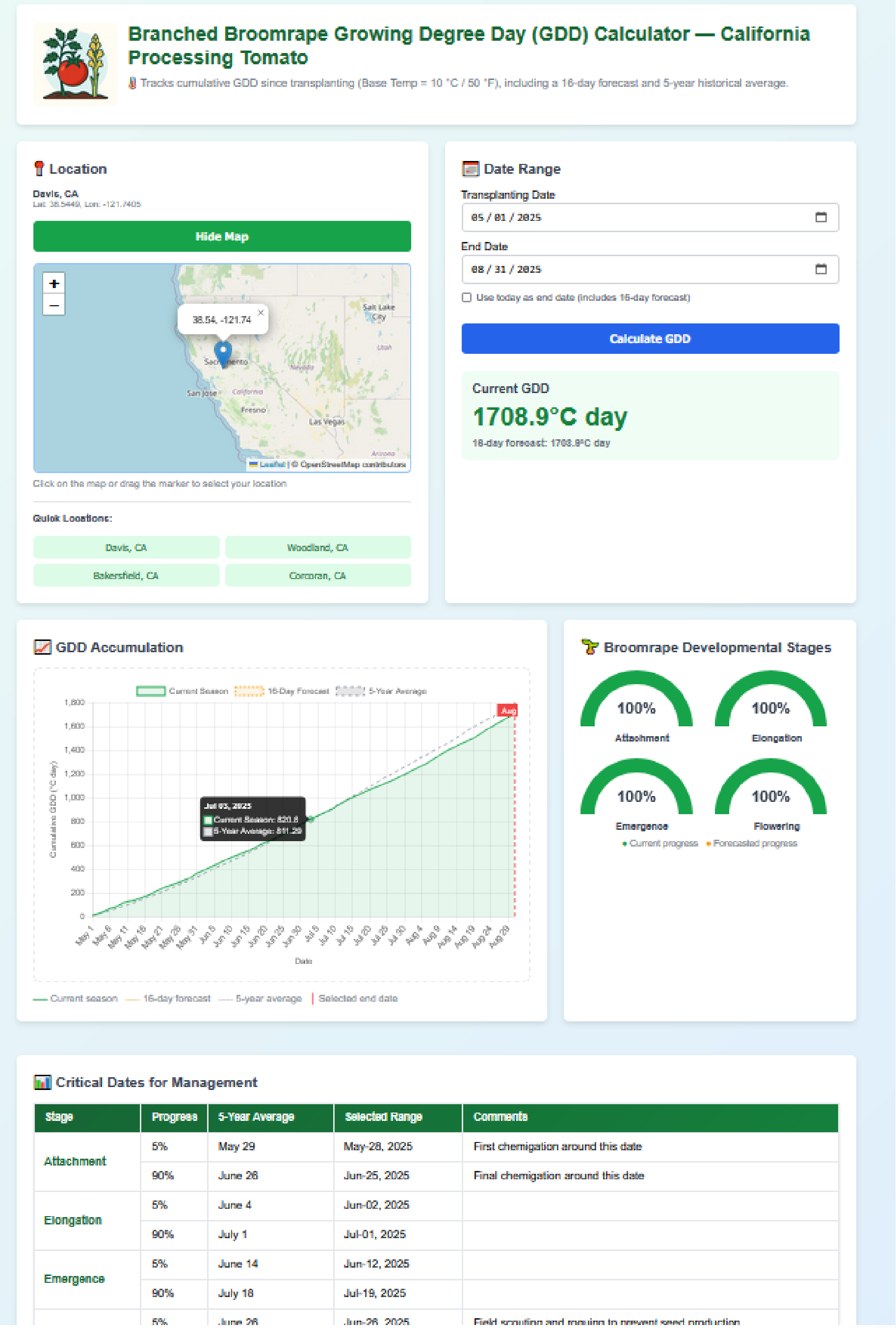
GH modeling to aid field predictions

Branched broomrape emergence in field (data from 2022)
and predicted attachments (calculated based on GH relationship).

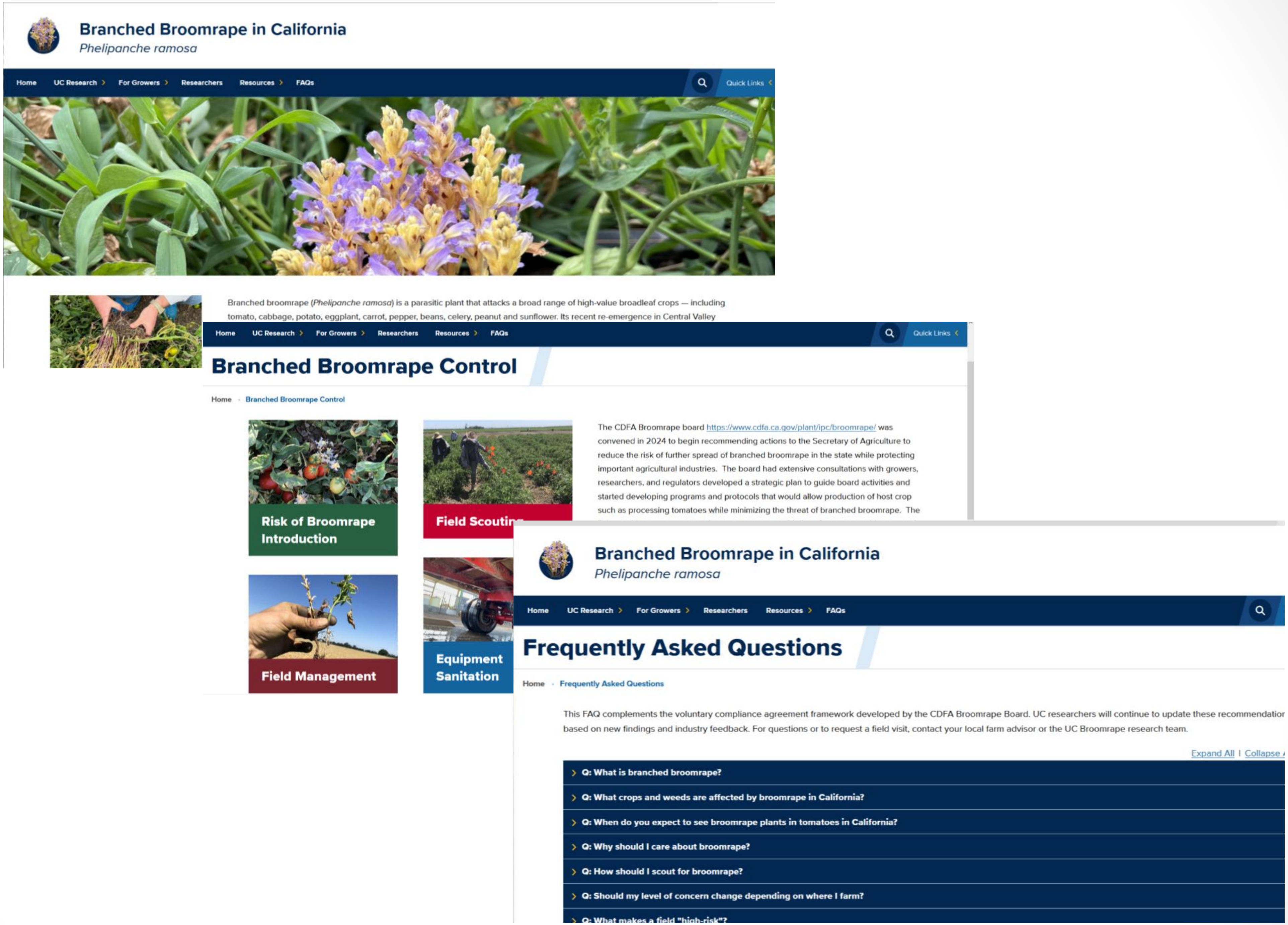


Purple = May 1, 2024 transplant
400, 600, 800 GDD 0 chem

- Mesgaran team developed 1st pass GDD calculator tool based on earlier GH work. Will validate during 2026



Site still in development, will be on UC broomrape website by spring



Branched Broomrape in California
Phelipanche ramosa
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Quick Links
Branched broomrape (Phelipanche ramosa) is a parasitic plant that attacks a broad range of high-value broadleaf crops — including tomato, cabbage, potato, eggplant, carrot, pepper, beans, celery, peanut and sunflower. Its recent re-emergence in Central Valley
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Branched Broomrape Control
Home · Branched Broomrape Control
Risk of Broomrape Introduction
Field Scouting
Field Management
Equipment Sanitation
The CDFA Broomrape board https://www.cdfa.ca.gov/plant/ipc/broomrape/ was convened in 2024 to begin recommending actions to the Secretary of Agriculture to reduce the risk of further spread of branched broomrape in the state while protecting important agricultural industries. The board had extensive consultations with growers, researchers, and regulators developed a strategic plan to guide board activities and started developing programs and protocols that would allow production of host crop such as processing tomatoes while minimizing the threat of branched broomrape. The
Branched Broomrape in California
Phelipanche ramosa
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Home · Frequently Asked Questions
This FAQ complements the voluntary compliance agreement framework developed by the CDFA Broomrape Board. UC researchers will continue to update these recommendatio based on new findings and industry feedback. For questions or to request a field visit, contact your local farm advisor or the UC Broomrape research team.
Expand All | Collapse
Q: What is branched broomrape?
Q: What crops and weeds are affected by broomrape in California?
Q: When do you expect to see broomrape plants in tomatoes in California?
Q: Why should I care about broomrape?
Q: How should I scout for broomrape?
Q: Should my level of concern change depending on where I farm?

2026 Objectives (field)

1. Further refine rimsulfuron treatment protocols and programs
2. Continue sulfosulfuron and imazosulfuron evaluations (broomrape and other weeds; PPI and chemigation)
3. Further evaluation of maleic hydrazide foliar programs
4. Repeat field evaluation of synthetic strigolactone germination stimulant (with KAUST)
5. Coordinate with breeding programs to evaluate a limited number of commercial and pre-commercial lines in the field
6. Initiate Egyptian broomrape evaluations
7. Develop fumigation trial for 2026 (Egypt/branched)

2025 Objectives (lab/GH)

1. Continue systematic screening of tomato cultivar sensitivity to broomrape parasitism
    1. Some partnerships with private sector
2. Complete initial evaluations of broomrape seed tolerance to flooding (Lazicki and Miyao suggestion)
3. Complete initial evaluations of the effects of N fertilizer on broomrape parasitism
4. Continue pilot studies of synthetic strigolactone as a preplant germination stimulant and scale to field (KAUST cooperators)
5. Broad support of other research projects who need broomrape seed, plants, permitted space, or CDFA permit to work under

Project fit in the bigger picture

- Swett/Hanson proposal funded by MBT program
  - Funded fall 2025 to summer 2027
- Linked CTRI proposals
  - Swett – equipment sanitation projects (QAC, engineering, industry collaborations (CTRI and CLFP aspects)
- Supported projects
  - Sinha and Brady – resistant tomato lines
  - Burger - strigolactone receptors
  - McCartney/Davis – VOC sensor for proximal/remote sensing
  - Lefers/Tester – grafted tomato vs broomrape

Acknowledgements:

- Hanson lab group, Swett lab group
- Funding from CTRI, CDFA-SCBG, CLFP, NIFA-MBT
- Grower and industry cooperators
    - Schreiner Bros., Viguie, PCP, other growers and processors
- Patricia Lazicki, Gene Miyao, Coby Goldwasser
- Mohsen Mesgaran

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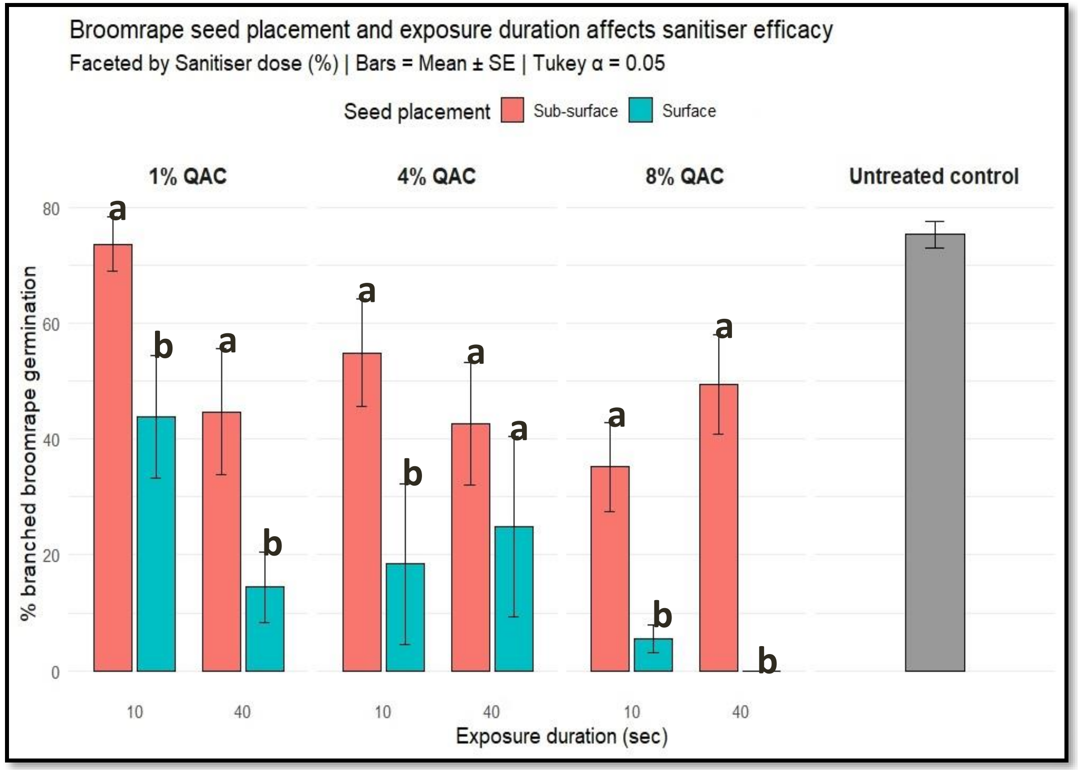
Questions

- How to get anonymous grower data on agronomic practices in infested and non-infested fields?
  - Meta data might reveal trends and management opportunities
- Need grower cooperators
  - 1-2 locations for large-plot demo with yield data
- How supportive is CTRI for the non-tomato crop work?
  - * in light of Egyptian broomrape report
- What does the board see as critical extension objectives related to broomrape chemical control and the equipment sanitation project?
  - These are likely to end up being a key part of compliance agreements

“The tile trial”

Experimental Setup in greenhouse near Davis

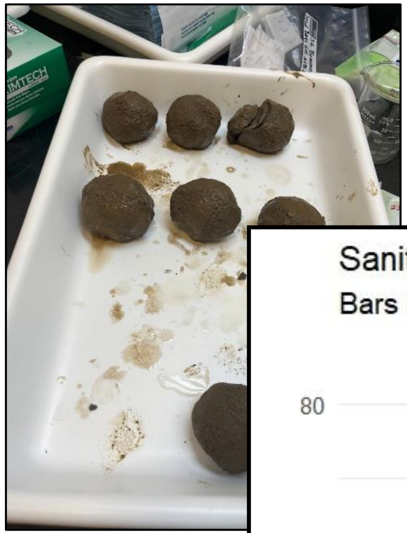
- Each pan has two broomrape seed bag in dried mud
  - 1-cm deep or on surface
  - Pans set vertically, then sprayed with QAC for 10 sec (runoff) or 40 sec (excess runoff) to mimic higher application volume
  - After drying, seed bag removed
  - Seed germ-tested



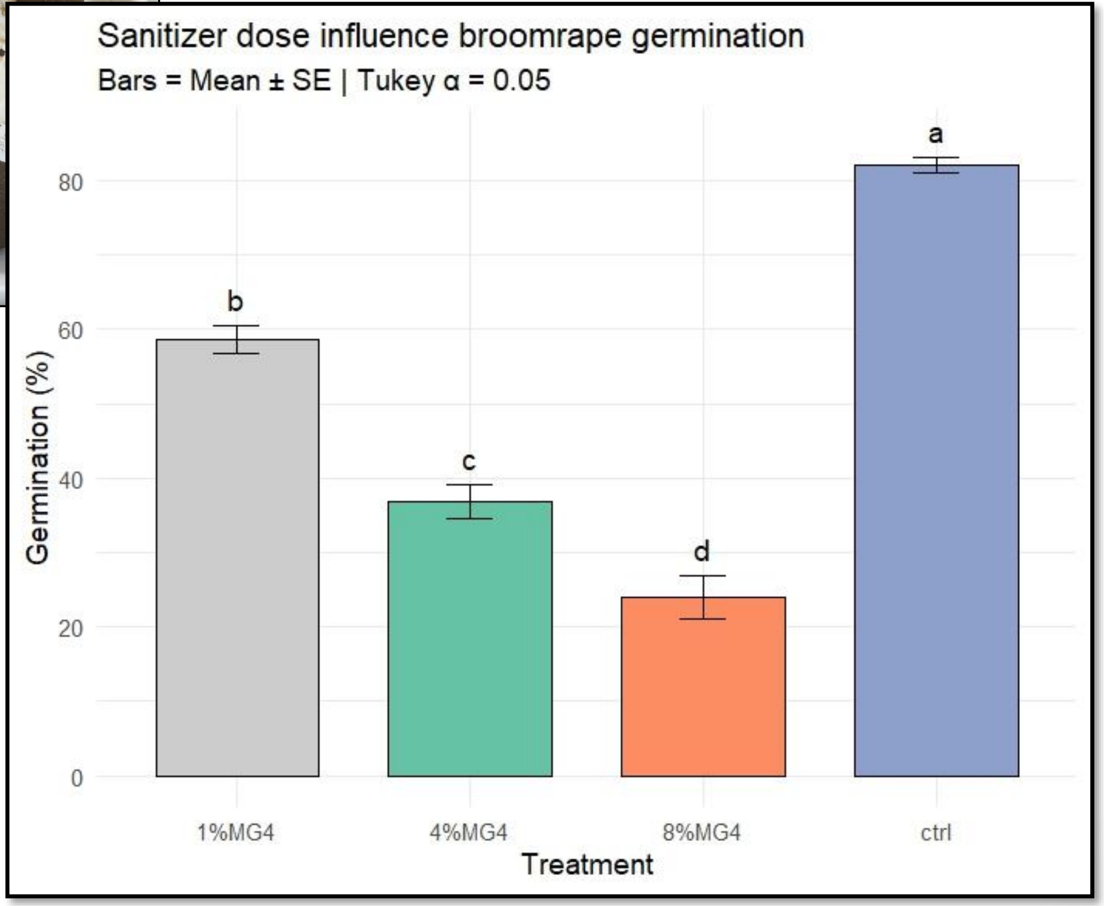
Hosseini, Vulchi, Hanson

Means were compared between seed placement factors for each dose X exposure duration combination.

The "mud ball" experiment



- Each mud ball has a broomrape seed bag at its core
  - Soaked in sanitizer for 1 min to saturate
  - Air dried, then seed bag removed
  - Seed germ-tested



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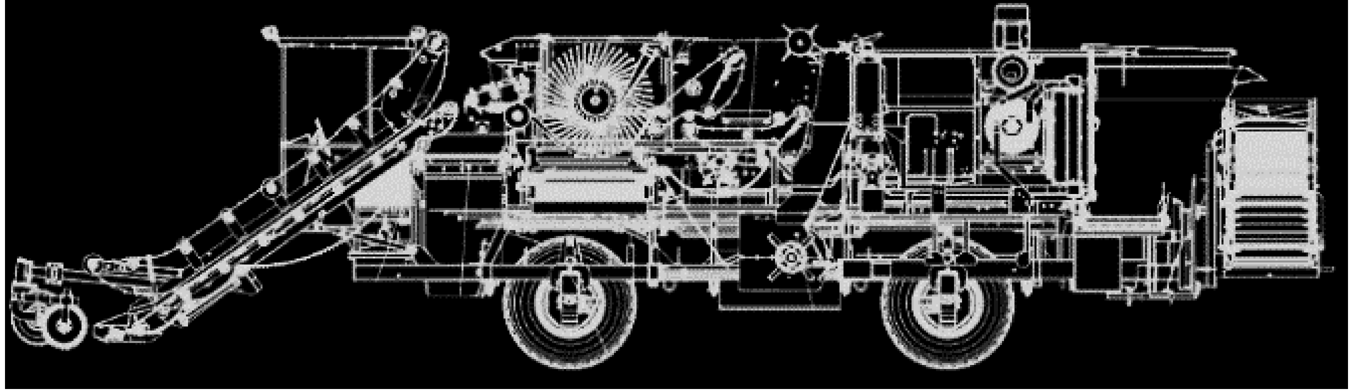


The Clean Machine: Transitioning to the new CDFA Broomrape Program Compliance Agreement

Cassandra Swett, Justine Beaulieu, Katie Ashley Brad Hanson, Pershang Hosseini, Patricia Lazicki, Dan Frank, Dave Viguie, Zach Bagley

Objectives from 2025/26

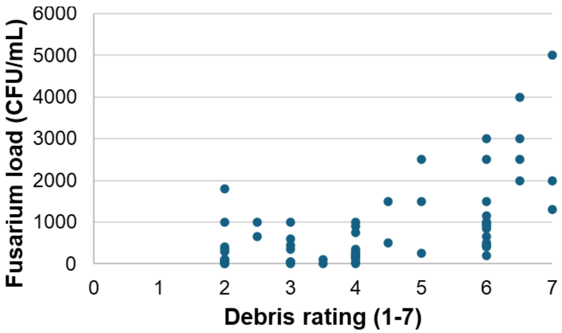
- **Objective 1. Evaluate risk and cleaning challenges associated with equipment type and time of year the equipment is used (Lazicki)**
- **Objective 2. Develop and beta test an installed harvester cleaning prototype (Lazicki, Frank)**
- **Objective 3. Develop protocols for a controlled study to examine efficacy of increased QAC concentration, increased volume and application in foam**
- **3.1. Soil pan protocol development**
- **3.2. Optimization of QACs in a debris environment: increased QAC concentration, increased volume of QAC application and application in foam**
- **Objective 4. Evaluate sanitizer efficacy against broomrape seed and other high impact diseases, analyze sanitizer trial data, and update sanitizer database**

Objective 1. Evaluate risk and cleaning challenges associated with equipment type and time of year the equipment is used (Lazicki)

- Parts pushing against soil = highest contaminant loads
- High contaminant loads only occurred at high debris loads
- Risk of high loads throughout spring tillage

Pescadero silty clay loam, moisture content=0.22 g/g; sampled April 2

Yolo/Capay silty clay loam; moisture content=0.15 g/g; sampled April 10

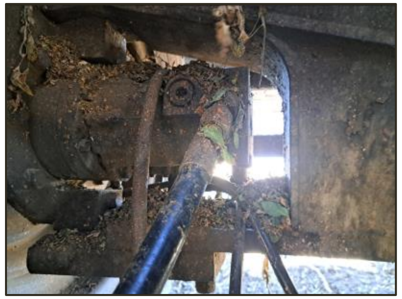


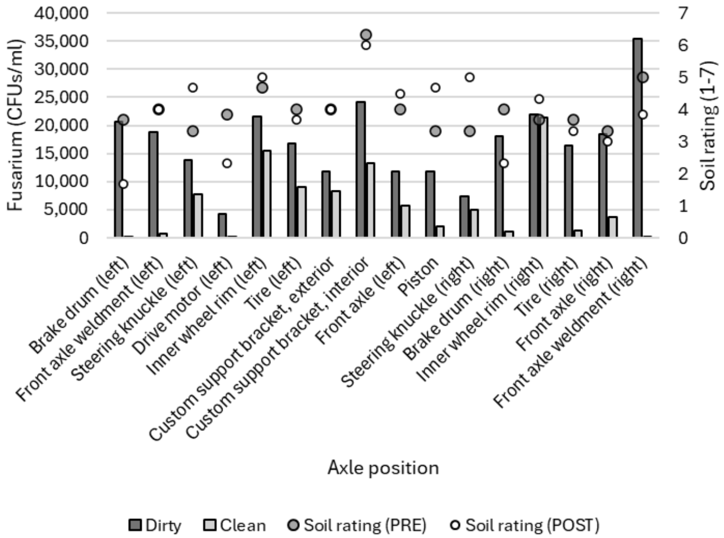
Objective 2. Develop and beta test an installed harvester cleaning prototype (Lazicki, Frank)

Lessons learned

- Design is robust, fairly easy to use
- Cost ~$700
- Generally reduces but doesn't eliminate inoculum
- Needs to be individually tailored for each machine, fairly narrow target area

Recommended use case: very specific problem areas





Objective 3. Develop protocols for a controlled study to examine efficacy of increased QAC concentration, increased volume and application in foam
3.1. Protocol development

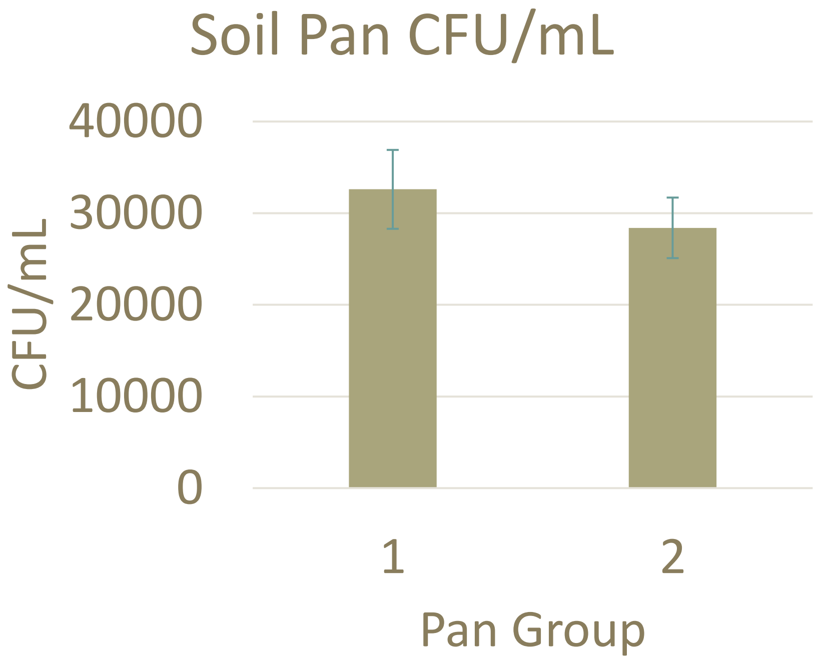
Broomrape seed protocol

- Developed basic pan preparation method and QAC application method
- Broomrape mud ball method- to overcome moisture penetration issues

Objective 3. Develop protocols for a controlled study to examine efficacy of increased QAC concentration, increased volume and application in foam
3.1. Soil pan protocol development

Infested soil protocol

- Developed a "mud flap" model system for soil debris loads – adapted thickness and soil type from broomrape seed study
- Generated replicated, consistent levels of infested soil



3.2. Optimization of QACs in a debris environment: increased QAC concentration and volume of application

Broomrape seed

Concentration

- 1% label rate of MG4 –quat vs. 4% and 8%

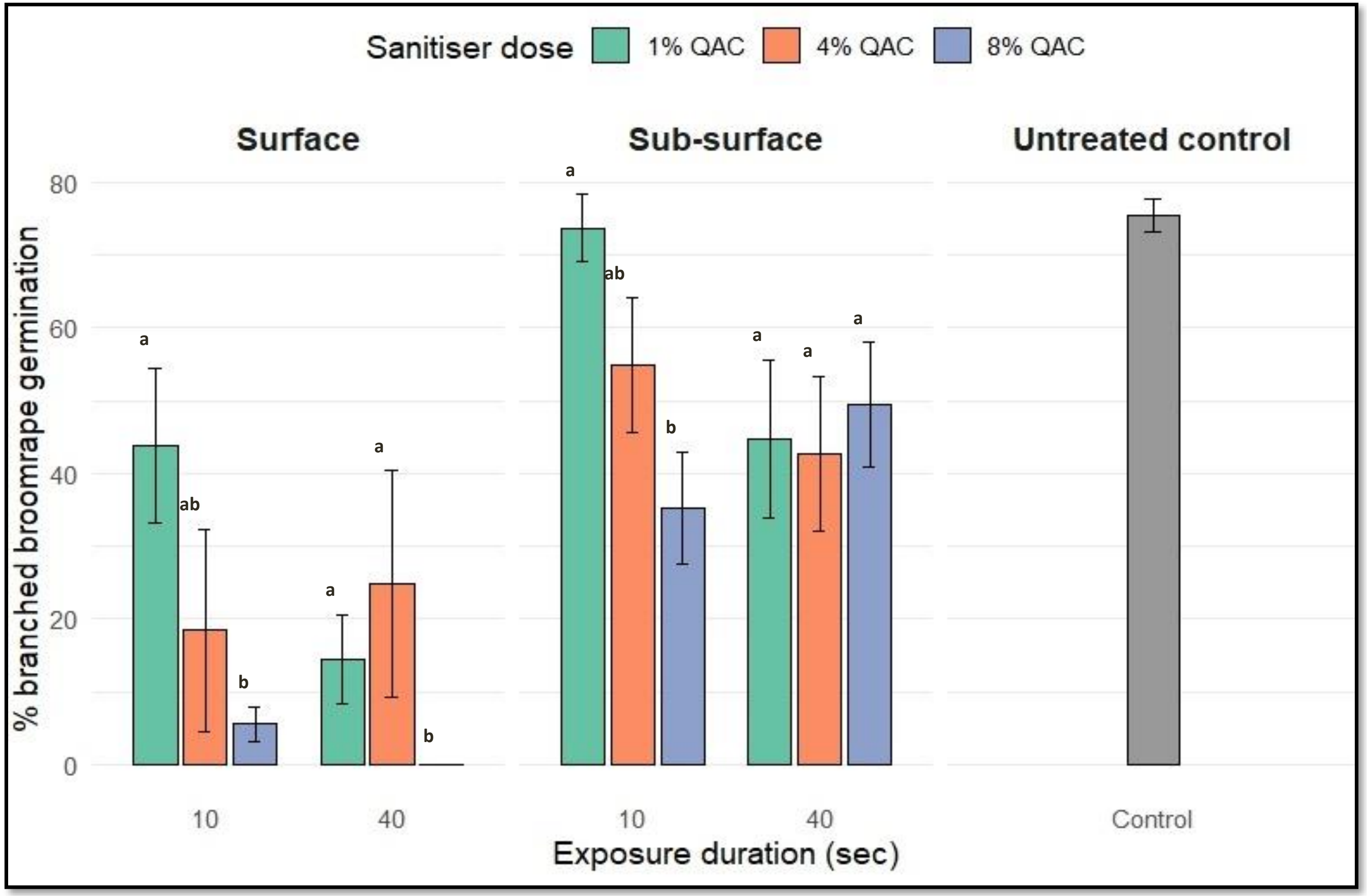
Volume / duration

- 10 sec and 40 sec application

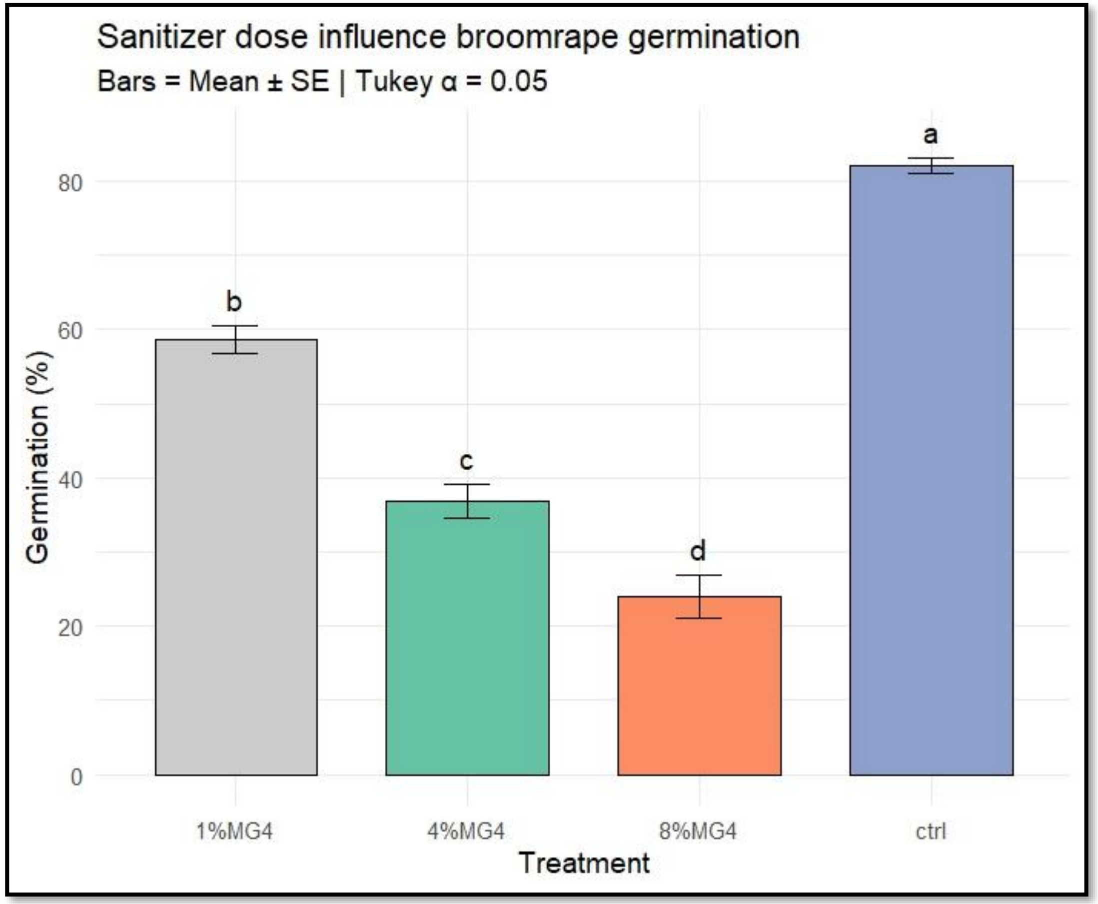
Evaluating effect on broomrape seeds on

- The soil surface
- Embedded in soil

Increasing QAC concentration and application volume / exposure duration



The “mud ball” experiment

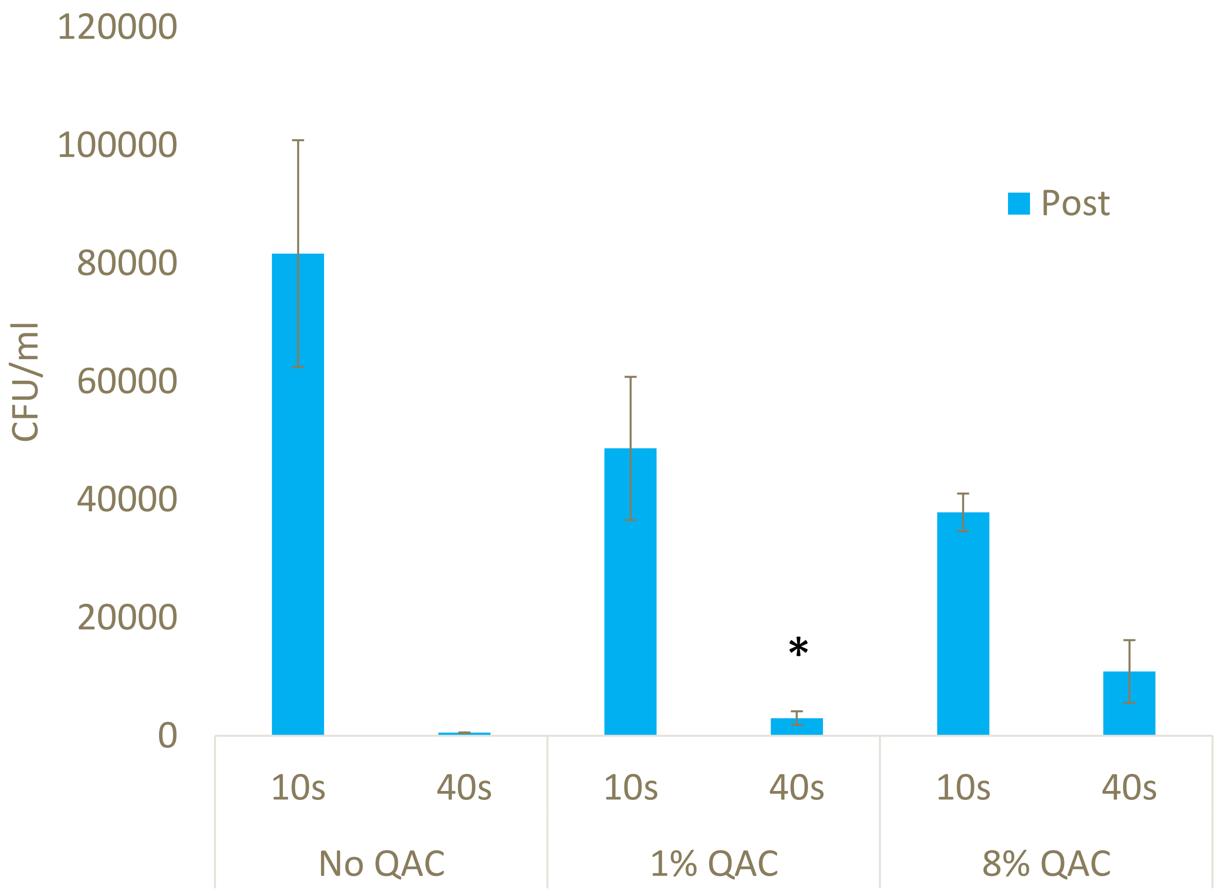


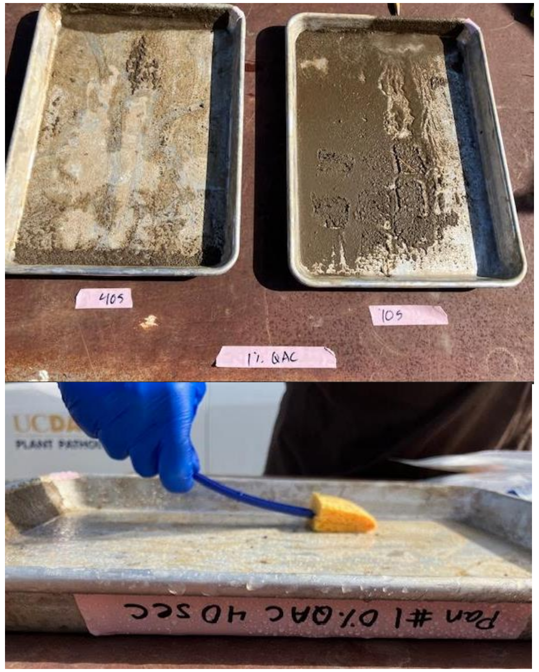
- Each mud ball has a broomrape seed bag at its core
  - Soaked in sanitizer for 1 min to saturate
  - Air dried, then seed bag removed
  - Seed germ-tested

Hosseini, Vulchi, Hanson

3.2. Optimization of QACs in a debris environment: increased QAC concentration and volume of application

Infested soil: combined physical and chemical effect





3.2. Optimization of QACs in a debris environment: increased QAC concentration, increased volume of QAC application and application in foam

- Underway: Repeated studies with infested soil pans
- Upcoming: Foam studies

Objective 4. Evaluate sanitizer efficacy against broomrape seed and other high impact diseases, analyze sanitizer trial data, and update sanitizer database

- Underway

Trade Name	Tested Conc.	Sanitizer type	Corrosive on metal	Managed Pathogens	Efficacy in presence of soil debris
Peracetic acid/Peroxyacetic acid (94865-2)	0.01% (100 ppm)	Oxidizer	Yes	None	TBD
MG 4-Quat (10324-117-9152)	1% (10,000 ppm)	Quaternary Ammonia	No	Branched broomrape, Fusarium wilt, bacterial canker	Low
Star San Acid Sanitizer (65001-1)	0.03% (300 ppm)	Organic Acid	Corrosive on soft metals	Fusarium wilt, bacterial canker	Moderate-low
Virkon S (71654-6)	1% (10,000 ppm)	Oxidizer	Corrosive on soft metals	Fusarium wilt, bacterial canker	Moderate-high
Jet-Ag	0.2-0.3% (2,000-3,000 ppm)	Oxidizer	Yes	TBD	TBD
Bleach (67619-32)		Oxidizer	Yes	TBD	Low

FY26/27
The Clean Machine: Transitioning best management practices and training resources for field equipment sanitation to be implemented and operationalized under the new CDFA compliance agreements

Principle Investigator: Cassandra Swett, Associate Professor of Cooperative Extension Plant Pathologist, Department of Plant Pathology, UC Davis, 530-752-337, clswett@ucdavis.edu

Co-PIs

- Patricia Lazicki, Vegetable crops advisor, Yolo, Solano and Sacramento County, Woodland, CA, palazicki@ucanr.edu
- Daniel Frank, Lecturer, Department of Biological and Agricultural Engineering, UC Davis, (530) 754-7905, dafrank@ucdavis.edu
- Katie Ashley Postdoctoral researcher, UC Davis Department of Plant Pathology, kjashley@ucdavis.edu
- Brad Hanson, Professor of Cooperative Extension, Weed Specialist, Department of Plant Sciences, UC Davis, (530) 752-8115, bhanson@ucdavis.edu

Collaborators:

- Dave Viguie, david@tvfarming.com
- Zach Bagley, CTRI Director, zach@tomatonet.org
- CDFA Broomrape Control Board Director Nick Condos
- Caren R Weintraub, Strategic Communication Director, crweintraub@ucdavis.edu
- Pacific Coast Producers, 1376 Lemen Ave, Woodland, CA 95776
- Los Gatos Tomato Products, 19800 W Gale Ave., Huron, CA 93234

FY 26/27 objectives

- **Objective 1. Expanding on basic principles of equipment sanitation (leads: Swett and Ashley)**
- **Objective 2. Enabling canneries to optimize efficacy of trailer wash stations (leads: Swett, Ashley, Frank, Hanson; Bagley-cannery coordination)**
- **Objective 3. Developing an adaptive toolkit to enable effective, low worker hazard in-field equipment cleaning (leads: Lazicki, Frank, Swett)**

Objective 1. Expanding on basic principles of equipment sanitation

- 1.1 Do cost effective, mist-based QAC application methods (used in wash stations) have utility in trailer wash stations and can increased misting duration (volume) improve efficacy?
- 1.1.1 Efficacy in the absence and presence of soil debris with standard application timing (3s)
- 1.1.2 Potential to improve efficacy as above with increased exposure duration (3, 5, 10, 30, 60s)

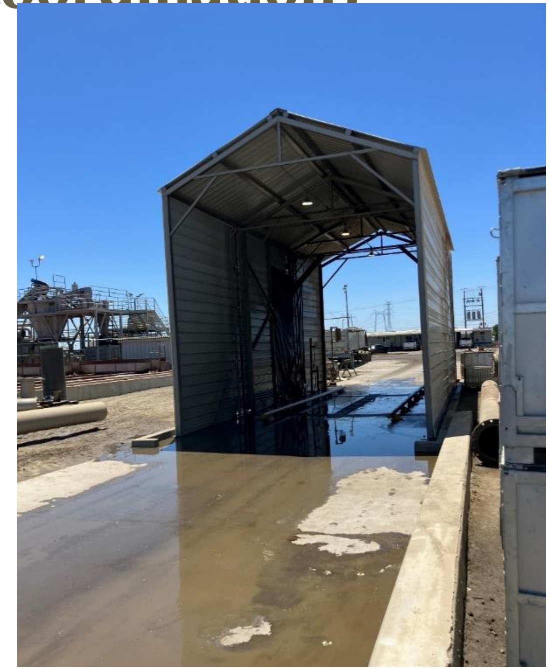
Objective 1. Expanding on basic principles of equipment sanitation

- 1.2 Understanding the relationship between debris thickness and QAC application method
- and establishing maximum tolerable debris loads over which QAC cannot work

- 1.3 Determining whether existing footwear cleaning methods should be included as part of guidelines for footwear cleaning
  - 8% QAC spray bottle application

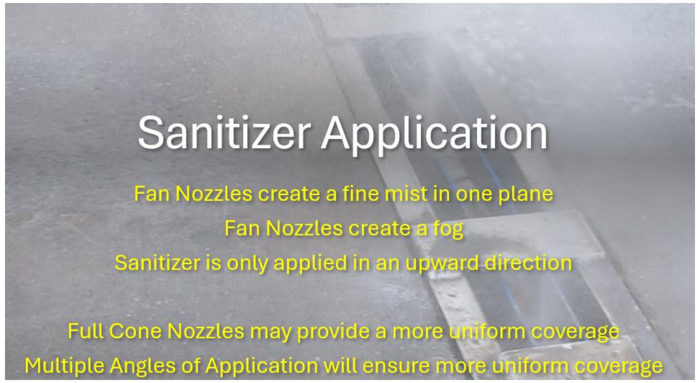
Objective 2. Enabling canneries to optimize efficacy of trailer wash stations (leads: Swett, Ashley, Frank, Hanson; Bagley-cannery coordination)

- **2.1 Developing cannery wash station guidelines based on post season optimization studies**
- 2.1.1 Efficacy of extending wash cycle duration (standard 3s vs 5, 10, 30, 45s).
- 2.1.2 Nozzle type optimization: inter-cannery comparisons to established optimal nozzle types and configurations.



Objective 2. Enabling canneries to optimize efficacy of trailer wash stations (leads: Swett, Ashley, Frank, Hanson; Bagley-cannery coordination)

- **2.2 Providing canneries with site-specific trailer wash station efficacy assessments and consultations in-season**
- 2.2.1 Virtual meeting to communicate basic guidelines to canneries (CDFA broomrape board host) (winter 2026).
- 2.2.2 On-site efficacy assessments of wash stations
- 2.2.3 Off-season consultations with canneries on results of efficacy assessment and ag engineer consultation

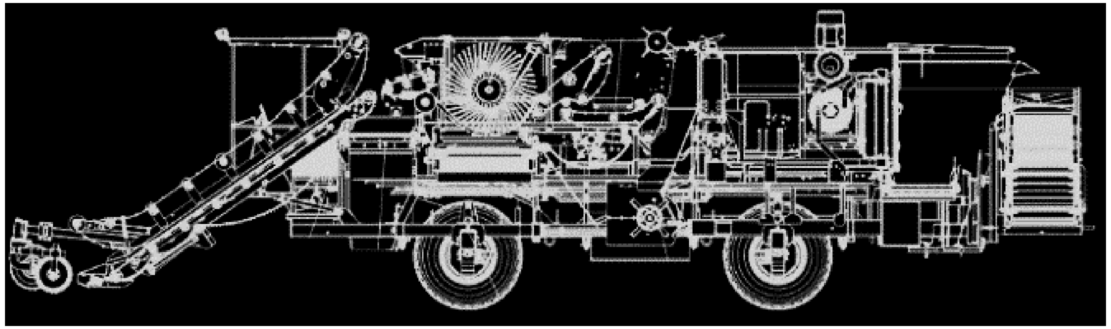


Objective 3. Developing an adaptive toolkit to enable effective, low worker hazard in-field equipment cleaning (leads: Lazicki, Frank, Swett)

- 3.1 Drive-over cleaning prototype system, with comparison of nozzle configurations (using infested tile system)
- 3.2 Wand system prototyping and efficacy evaluation
- 3.3 Prototype optimization workshop (Spanish field day with field workers)

Questions?

Cassandra Swett
clswett@ucdavis.edu



Team broomrape outreach: A one-year project to develop essential outreach support for broomrape management guidelines referenced in the CDFA compliance agreement

Cassandra Swett and Katie Ashley, UCD Dept. of Plant Pathology

Brad Hanson, UCD Dept of Plant Sciences

UC Davis Strategic Communications Office

Patricia Lazicki, UCANR

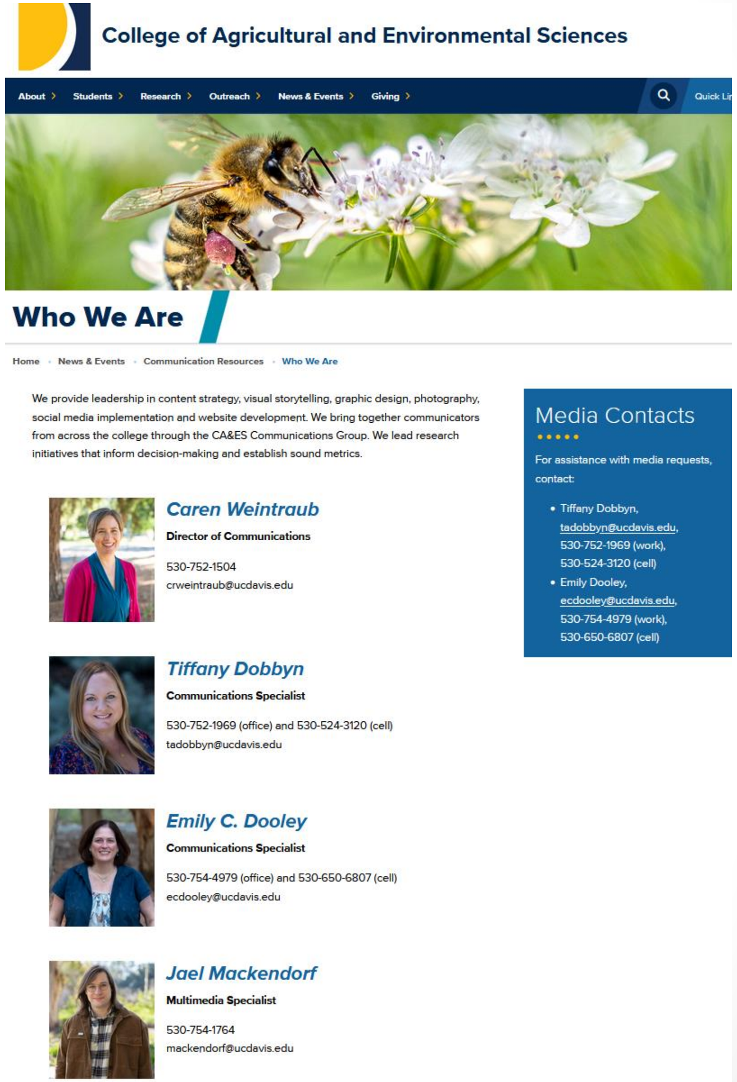
Daniel Frank, UCD Dept of Bio and Ag Engineering

Objectives proposed for FY2025/26-

FY25 proposal

The Clean Machine: Developing best management practices for mitigating the spread of branched broomrape and other high-profile soilborne pathogens

- Objective 5. Create outreach materials for stakeholders to enable rapid and effective adoption of methods to limit broomrape seed dispersal (Swett, Hanson, Lazicki, Bagley)
- Working with the UC Davis strategic communications office

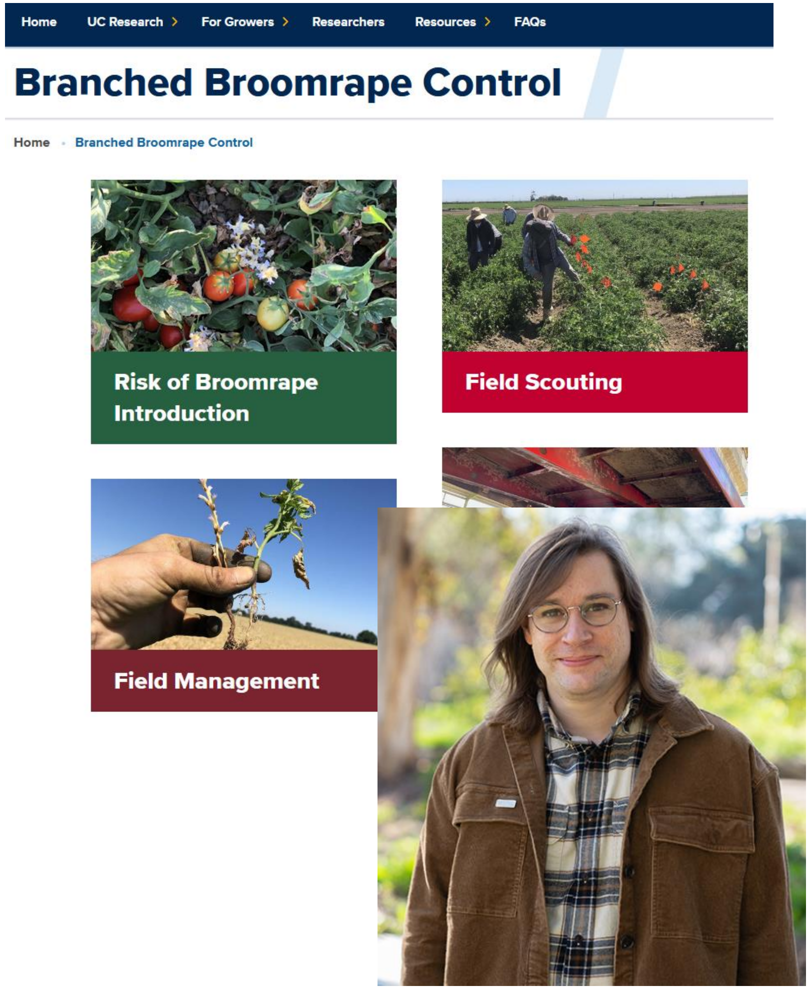


Objective 5. Create outreach materials for stakeholders to enable rapid and effective adoption of methods to limit broomrape seed dispersal

- Developed broomrape website to host all content relevant to the emerging compliance agreement
  - https://broomrape.sf.ucdavis.edu/
- Added BMP content for equipment cleaning

Objective 5. Create outreach materials for stakeholders to enable rapid and effective adoption of methods to limit broomrape seed dispersal

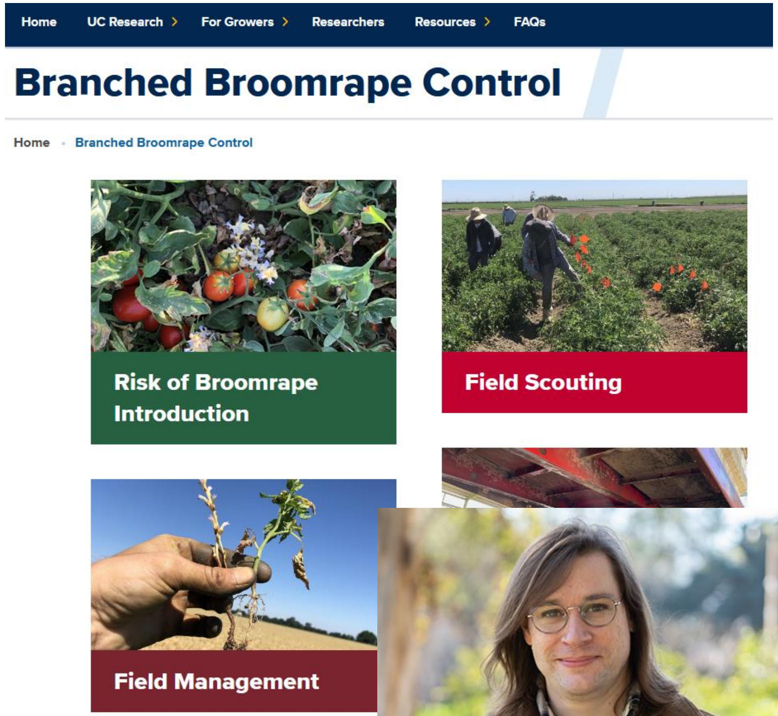
- Videography
  - Videography equipment
  - Videography training
  - Captured over 5 hrs video footage



Objective 5. Create outreach materials for stakeholders to enable rapid and effective adoption of methods to limit broomrape seed dispersal

Video development (Spanish and English)

- Introduction to broomrape—nearly completed
- Scouting for broomrape—in development
- Key considerations for equipment cleaning and methods for effective cleaning—in development



Objective 5. Create outreach materials for stakeholders to enable rapid and effective adoption of methods to limit broomrape seed dispersal

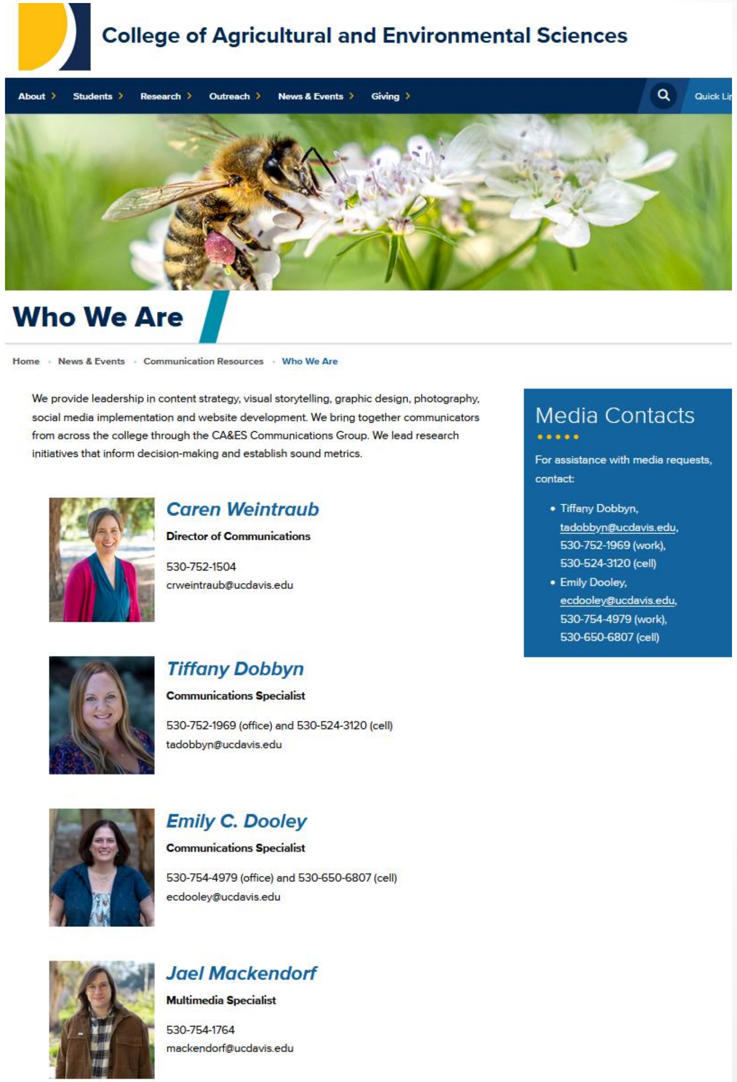
Trainings and consultations

- In service training—farm advisors—July 2025 update on broomrape regulations and new agreements
  - Z. Bagley, B. Hanson, C. Swett
- Trailer wash station consultations

2026/27

Team broomrape outreach: **A one-year project** to develop essential outreach support for broomrape management guidelines referenced in the CDFA compliance agreement

- →Encompasses all outreach efforts related to compliance agreement-referenced management guidelines
- →Work with Strategic communications office team: budget is primarily for them
- →Goal: have basic referenced management guidelines available by July 2026
  - →And create platforms that can be continuously updated by UC Davis outreach teams



Guidelines referenced in Compliance Agreement require background knowledge

- Broomrape biology and lifecycle:
  - Identification
  - Scouting
- Best management practices:
  - Plant destruction & rogueing
  - Field management program
  - Cleaning of equipment

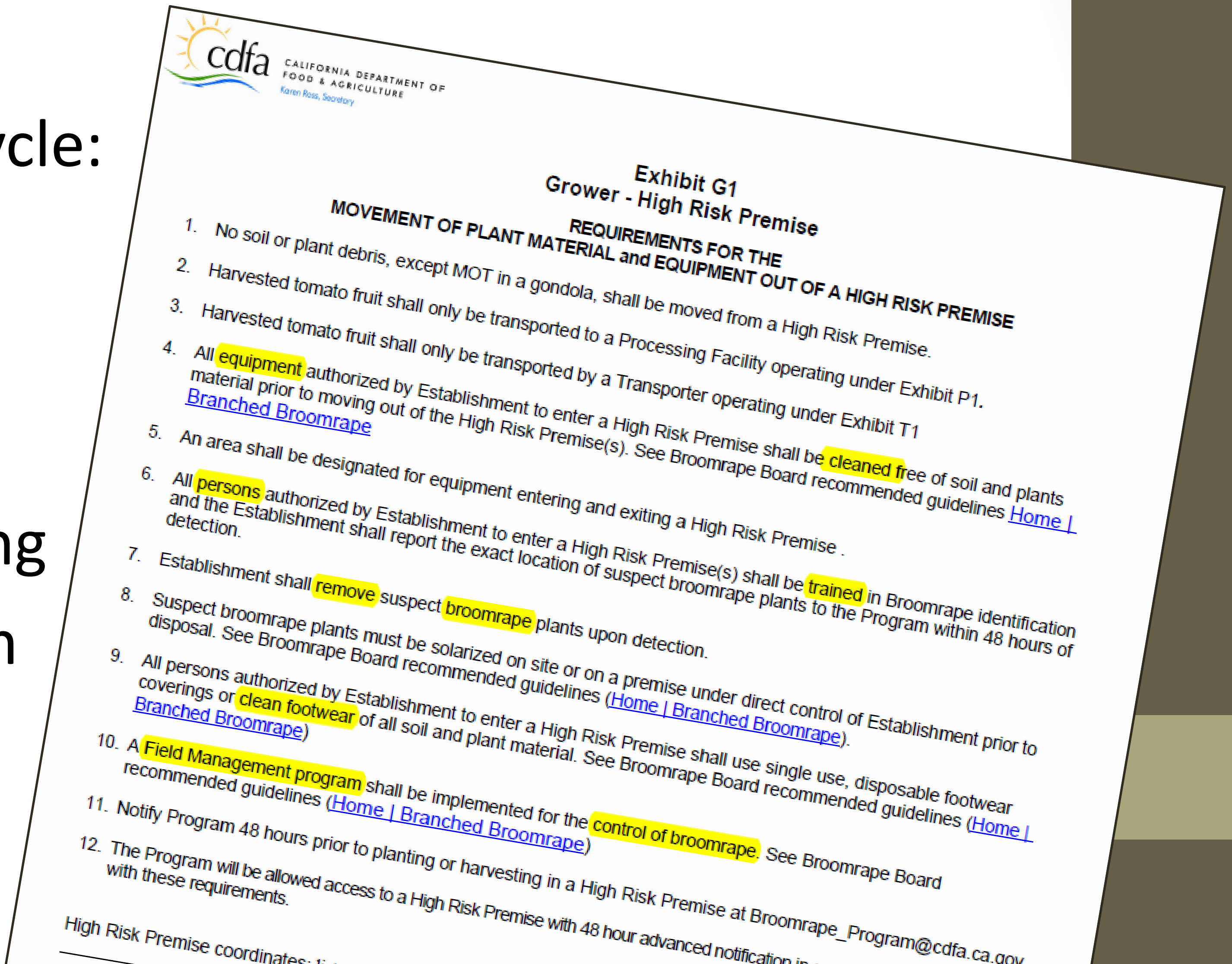

cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE
Karen Ross, Secretory

Exhibit G1
Grower - High Risk Premise

REQUIREMENTS FOR THE
MOVEMENT OF PLANT MATERIAL and EQUIPMENT OUT OF A HIGH RISK PREMISE

1. No soil or plant debris, except MOT in a gondola, shall be moved from a High Risk Premise.
2. Harvested tomato fruit shall only be transported to a Processing Facility operating under Exhibit P1.
3. Harvested tomato fruit shall only be transported by a Transporter operating under Exhibit T1
4. All equipment authorized by Establishment to enter a High Risk Premise shall be cleaned free of soil and plants material prior to moving out of the High Risk Premise(s). See Broomrape Board recommended guidelines Home | Branched Broomrape
5. An area shall be designated for equipment entering and exiting a High Risk Premise .
6. All persons authorized by Establishment to enter a High Risk Premise(s) shall be trained in Broomrape identification and the Establishment shall report the exact location of suspect broomrape plants to the Program within 48 hours of detection.
7. Establishment shall remove suspect broomrape plants upon detection.
8. Suspect broomrape plants must be solarized on site or on a premise under direct control of Establishment prior to disposal. See Broomrape Board recommended guidelines (Home | Branched Broomrape).
9. All persons authorized by Establishment to enter a High Risk Premise shall use single use, disposable footwear coverings or clean footwear of all soil and plant material. See Broomrape Board recommended guidelines (Home | Branched Broomrape)
10. A Field Management program shall be implemented for the control of broomrape. See Broomrape Board recommended guidelines (Home | Branched Broomrape)
11. Notify Program 48 hours prior to planting or harvesting in a High Risk Premise at Broomrape_Program@cdfa.ca.gov
12. The Program will be allowed access to a High Risk Premise with 48 hour advanced notification in ... with these requirements.

High Risk Premise coordinates: ...

Cleaning guidelines vary by risk and supply chain position

Non-infested Processing Tomato Field		
Sector	**What to clean**	**Exhibit**
Grower (G)	Harvesters	Exhibit G2
Transporter (T)	Trucks	Exhibit T2
Processor (P)	Trailers	Exhibit P2

High Risk Premise		
Sector	**What to clean**	**Exhibit**
Grower (G)	All equipment	Exhibit G1
Transporter (T)	Trucks	Exhibit T1
Processor (P)	Trailers	Exhibit P1

Many outreach needs and challenges: Referenced guidelines are being developed


CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

Exhibit G1
Grower - High Risk Premise

8. Suspect broomrape plants must be solarized ... disposal. See Broomrape Board recommended guidelines
9. All persons authorized by Establishment to enter a High Risk Premise shall use single use, disposable footwear coverings or clean footwear of all soil and plant material. See Broomrape Board recommended guidelines (Home | Branched Broomrape)
10. A Field Management program shall be implemented for the control of broomrape. See Broomrape Board recommended guidelines (Home | Branched Broomrape)
11. Notify Program 48 hours prior to planting or harvesting in a High Risk Premise at Broomrape_Program@cdfa.ca.gov.
12. The Program will be allowed access to a High Risk Premise with 48 hour advanced notification in order to verify compliance with these requirements.

High Risk Premise coordinates: list the county site ID coordinates of all separate High Risk Premises under control of Establishment

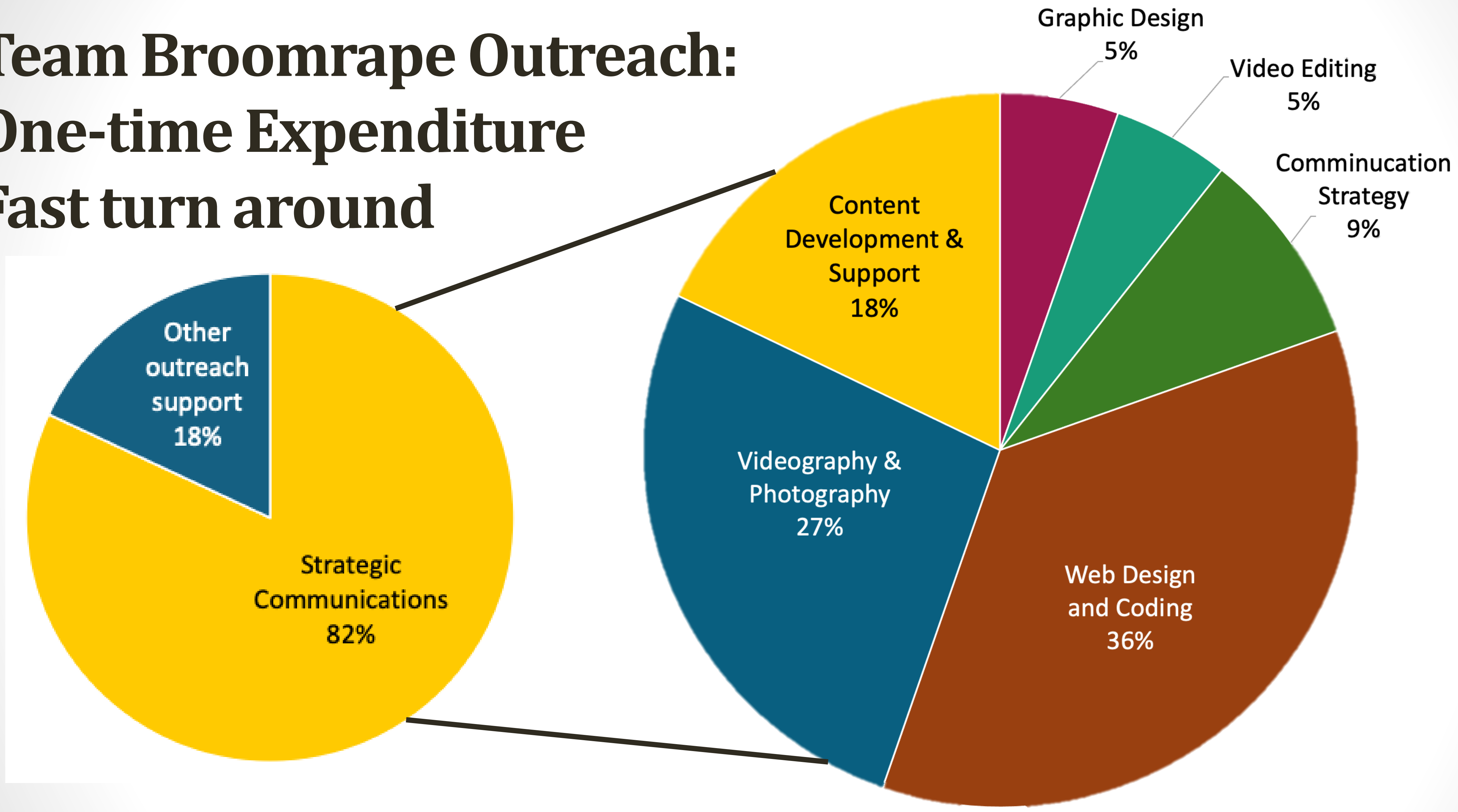
Signature Date

Printed name (Owner/Manager) Signature Date

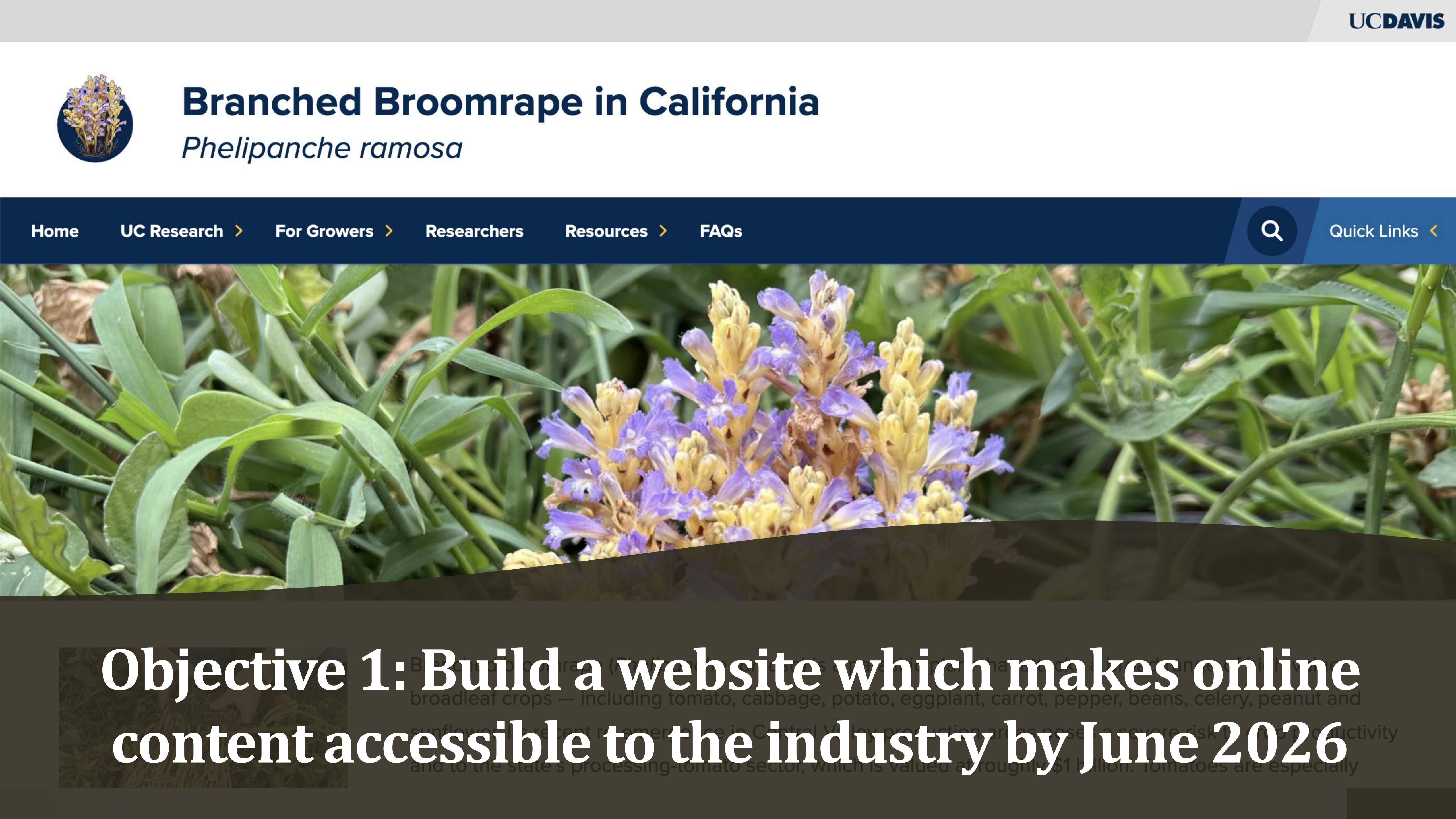
Page 1 of 1

Need for a single location with cohesive sets of recommendations

Team Broomrape Outreach: One-time Expenditure Fast turn around



Objective 1: Build a website which makes online content accessible to the industry by June 2026



Objective 1: Website & YouTube Channel

Website development

- Mapping
- Organization
- Inventory

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Karen Ross, Secretary

Exhibit G2
Grower: Non-Infested Processing Tomato Field

REQUIREMENTS FOR THE MOVEMENT OF HARVESTED TOMATO FRUIT and EQUIPMENT FROM A NON-INFESTED FIELD

1. Harvested tomato fruit from a non-infested field may only be transported to a processing facility operatin under Exhibit P2.
2. Harvested tomato fruit from a non-infested field may only be transported by a Transporter operating u Exhibit T2.
3. All persons authorized by Establishment to enter a non-infested processing tomato field shall be trained in broomrape identification and sanitation guidelines. See Broomrape Board recommended guidelines (Home | Branched Broomrape)
4. All suspect broomrape plants shall be brought to the attention of the Program within 48 hours of detec Establishment or persons authorized by Establishment to enter a non-infested processing tomato field.
5. All equipment authorized by Establishment to enter a non-infested processing tomato field shall be cleaned fr and plant material prior to being transported out of a Designated Zone (Designated Zone Map). See Broomrape recommended guidelines (Home | Branched Broomrape)
6. The Establishment shall verify that Processor and Transporter are on the list of Establishments under compliance agreement prior to harvest. See list of Establishments (link under construction).

Educational Need

Website Reference

Educational Need

Exhibit	Number	Summary	Information needed for UC Website	BRB Website referenced?
G1	10	Field management program shall be implimen	- IPM program details - Chemical, cultural, etc. practices	No
G1	11	Notify program 48 hours prior to planting or harve	Contacting the program details (Broomrape_Program@cdfa.ca.gov) "When to contact CDFA" page or FAQ - When to contact BRB page or FAQ	No
G2	3	Everyone authorized to enter non-infested premise trained in broomrape identification and sanitation guidelines	- Broomrape ID - Scouting and growing locations/plant biology/lifecycle - Cleaning for growers - Farm equipment sanitation	Yes
G2	4	Suspected broomrape growing location reported within 48 hours	- Broomrape ID - Scouting and growing locations/plant biology/lifecycle - Reporting protocol	No
G2	5	Equipment in non-infested premise shall be cleaned according to BRB recommendations prior to leaving DZ	- Farm equipment sanitation - Cleaning for growers - Designated Zone map	Yes

Website Reference

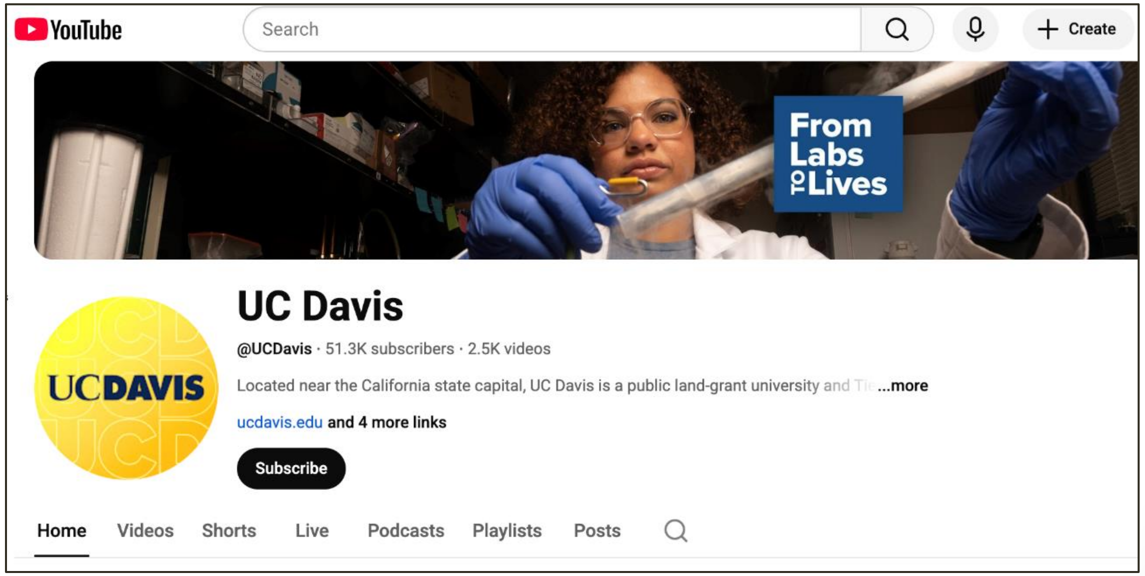
Objective 1: Website & YouTube Channel

Website development

- Mapping
- Organization
- Inventory

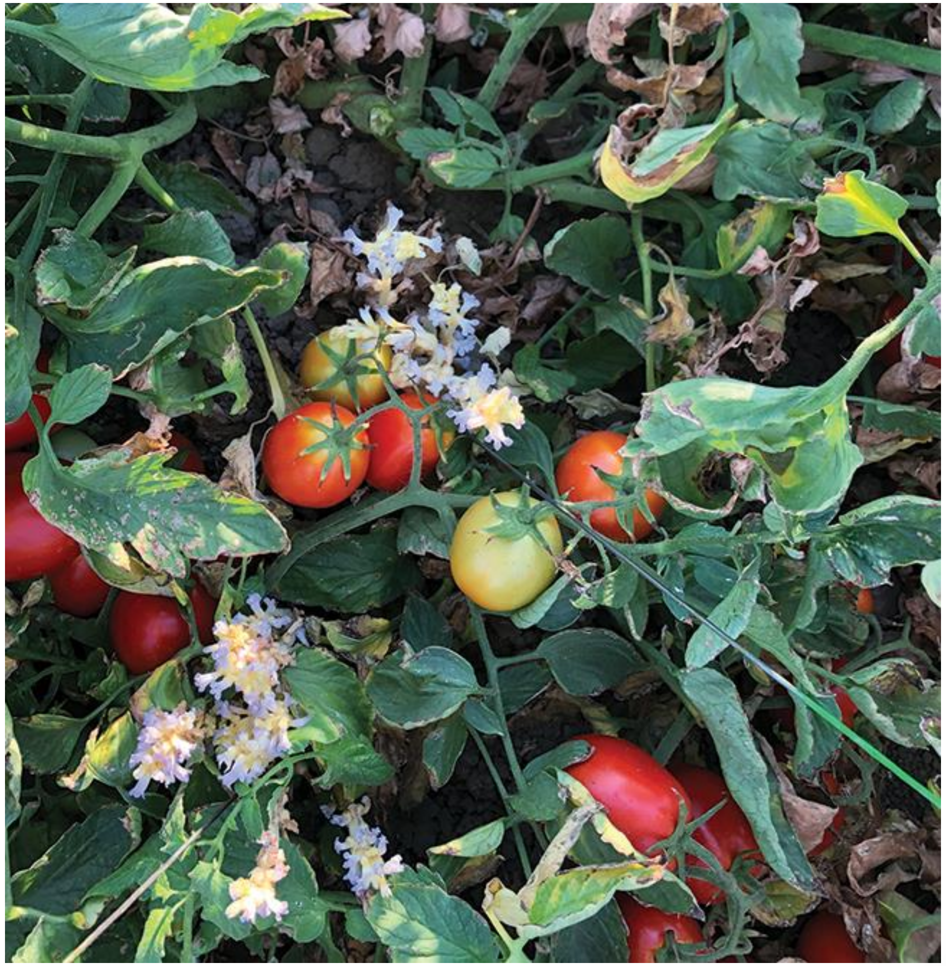
YouTube

- Create channel
- House videos
- Curate playlists



Objective 1: Website & YouTube Channel

- Who thinks they would use YouTube videos as training modules?
- Who thinks they will use other training resources?
- What are they?



Objective 2: Develop online content for actionable steps to meet compliance agreement exhibit stipulations

Objective 2: Develop online content

- Identifying and scouting for broomrape
- Developing/adapting cleaning:
  - In-field for growers and transporters
  - Wash stations for processors
- Implementing broomrape field management
- Navigating roles in the CDFA Compliance Agreement

Objective 2: Develop online content

- What is the best method of communication for content needs?
- What is the best way for us to evaluate our success (and needs) in communicating management information to the industry?
  - Should we consider having a focus group to give us feedback on the resources?

Objective 3. Traditional outreach support to help the broader grower-support community navigate the compliance agreement

Objective 3. Traditional outreach & grower-support assistance

- 3.1 Workshops:
  - County Ag commissioner deputies
  - County Ag commissioner biologists
  - Farm advisors
- 3.2 Trainings:
  - Broomrape scouting and management
  - Equipment cleaning methods
- 3.3 Other required training materials (train the trainer)

Objective 3. Traditional outreach & grower-support assistance

- Who do you envision will be the "Trainer" for your operation
  - Should we be providing directed training to other sectors of the grower support system, like PCAs?
- Are there other outreach efforts that you would find helpful, not detailed here?

Developing integrated management guidelines for Fusarium stem rot and decline (FRD, previously ‘F. falciforme’) and co-occurring diseases

Project Leader: Dr. Cassandra Swett
Co PI: Myles Collinson
UC Davis, Department of Plant Pathology

Cooperative Extension Co PI:
Brenna Aegerter, Tom Turini, Patricia Lazicki, Zheng Wang

Collaborators:
Ag Seeds, TS&L Seed Company

Fusarium Stem Rot and Decline (FRD)

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii

Fusarium Foot Rot

Fusarium falciforme ss

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii

At the start of this project, we could not differentiate between these three species and so they were all referred to as *Fusarium falciforme* or just 'Falciforme'

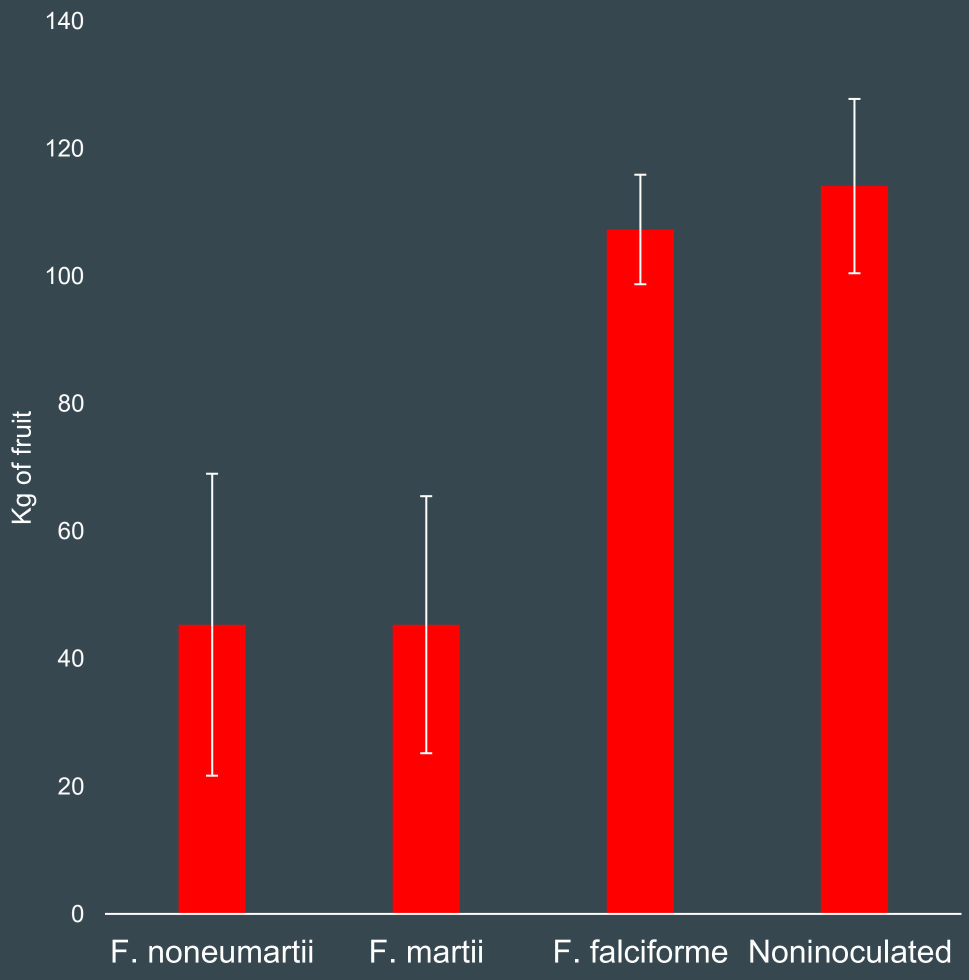
Fusarium Foot Rot

Fusarium falciforme ss

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii



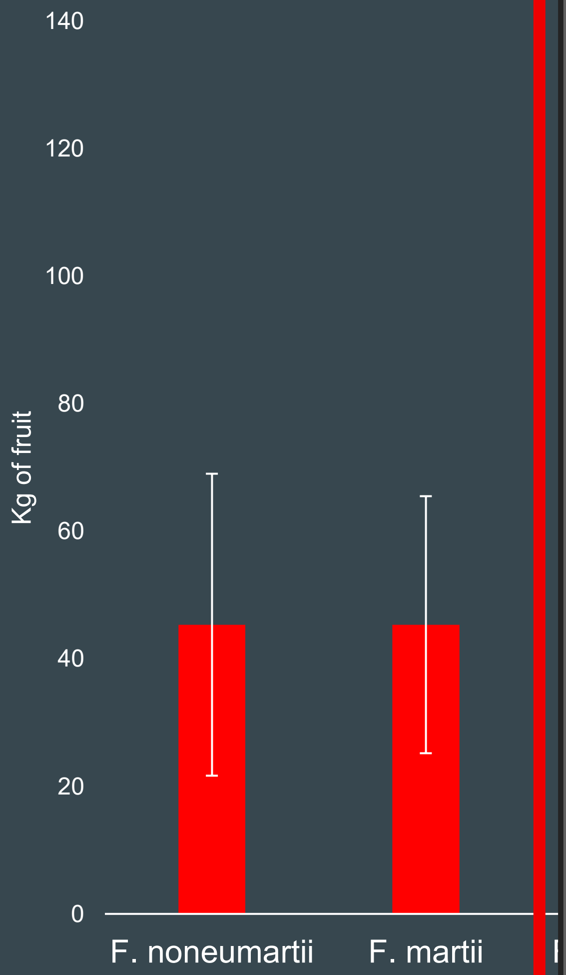
Fusarium Foot Rot

Fusarium falciforme ss

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii



Fusarium Stem Rot and Decline (FRD): Economically important disease with few management tools

Fusarium Stem Rot and Decline (FRD)

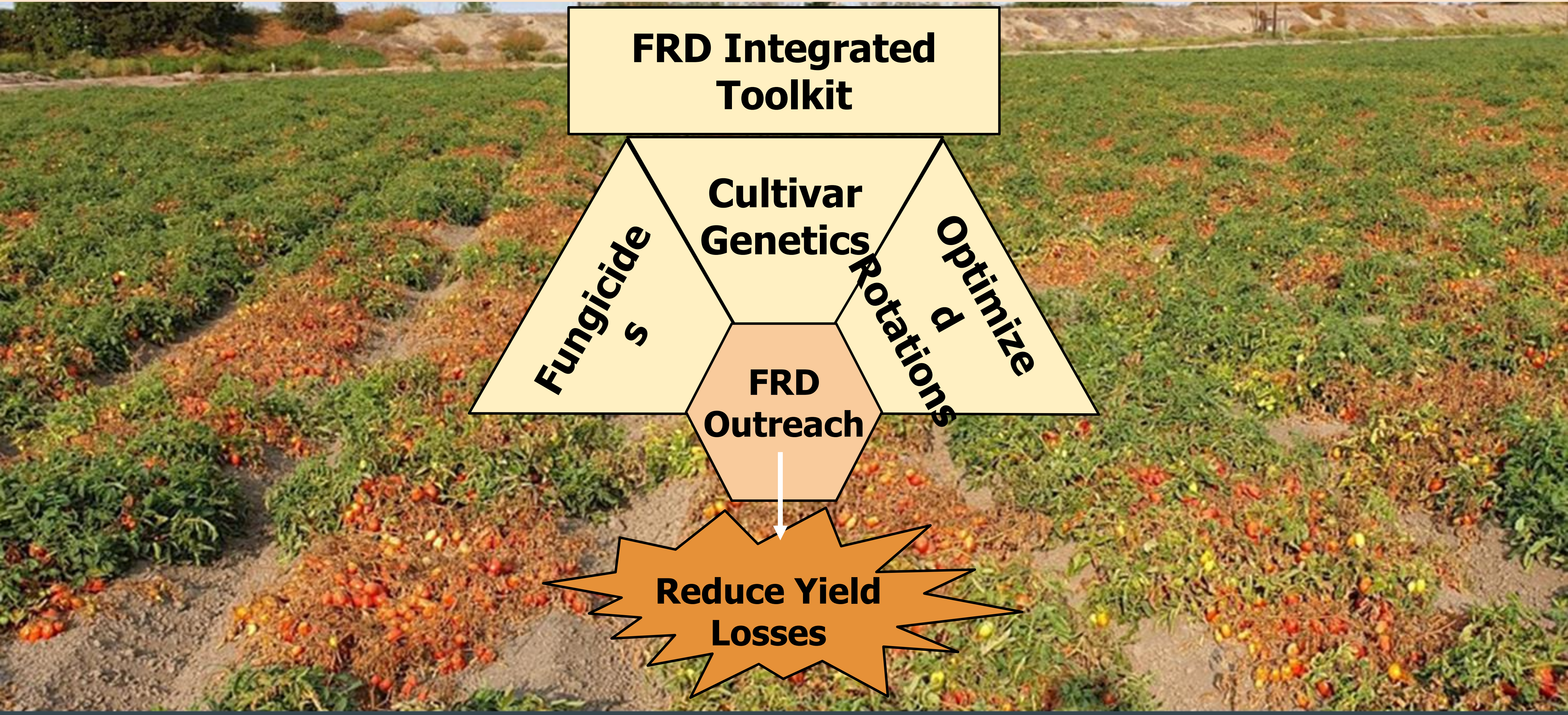
Fusarium martii

Fusarium no umartii

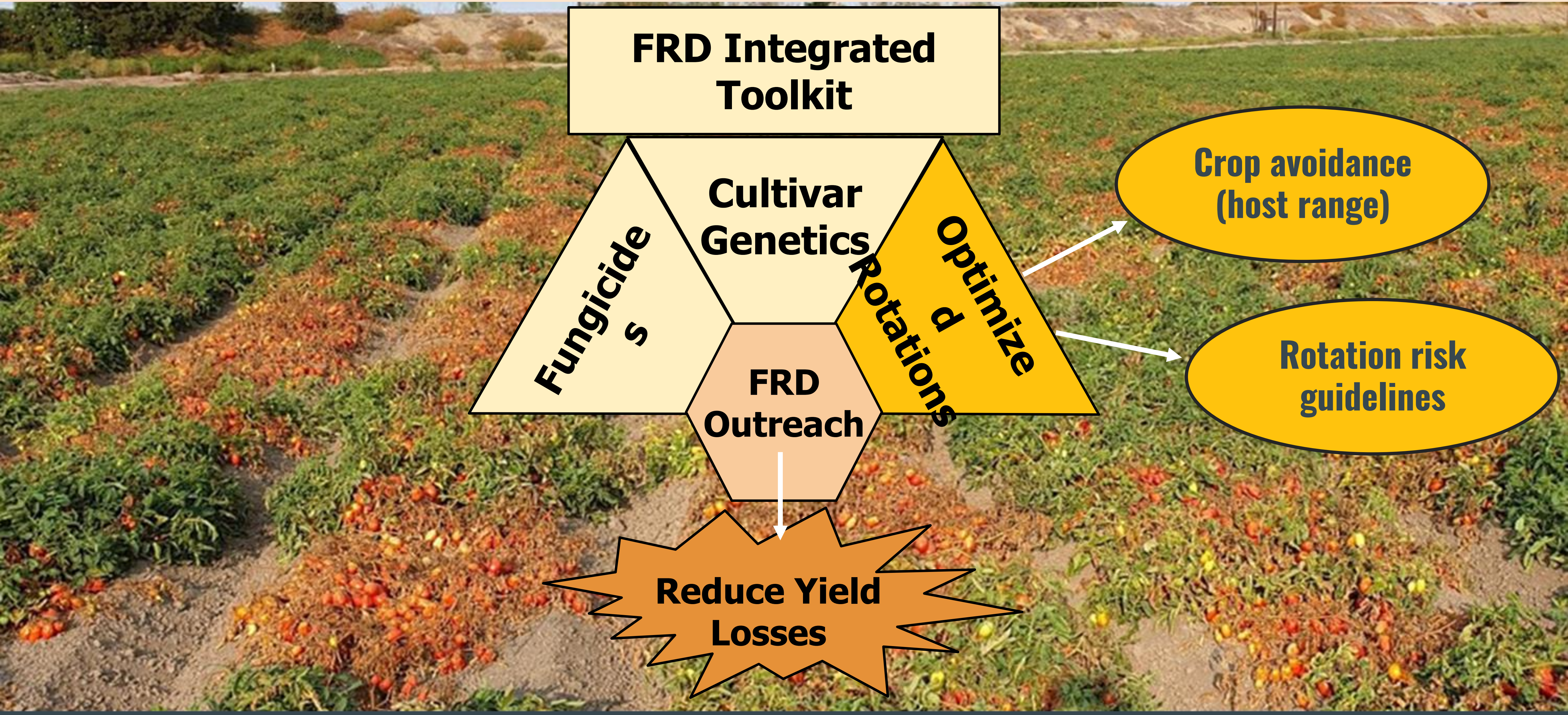
QUESTIONS?

rium Stem Rot and
Decline (FRD):
mically important
se with few
management tools

Main Goal: Develop and effective integrated toolkit for FRD in processing tomato

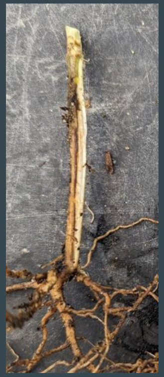


Main Goal: Develop and effective integrated toolkit for FRD in processing tomato



Developing crop avoidance and rotation guidelines: 2021-2025

- Crop avoidance → Host Range
  - Greenhouse trials
    - Inoculate crops, rate for symptom development
    - Compare to tomato (+) and mock inoculated (-)
    - Isolate from symptomatic plants to confirm pathogen presence
  - Field trials
    - Infested field trials, rate for symptom development
    - Compare to tomato (+) in summer trials only
    - Isolate from symptomatic plants to confirm pathogen presence



Developing crop avoidance and rotation guidelines: 2021-2025

- Rotation studies
    - Warm season rotation trials
        - 3 summers: tomato - summer crops - back to tomato
        - Compare treatments to tomato rotation (+) and chemical fallow (-)
    - Cool season rotation trials
        - 2 summers: toamto - winter cash/cover crops - back to tomato
        - Compare treatments to chemical fallow (-) (can't grow tomato over winter)
    - Commercial rotation studies

2026 Project Goals

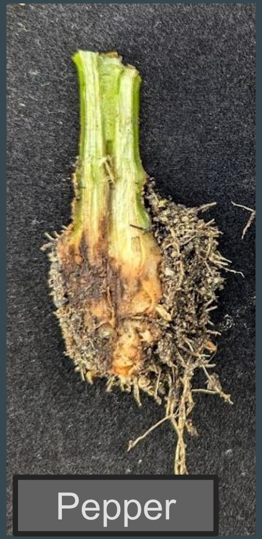
- **Objective 1. Host range and crop rotation studies.**
  - **1.1 *F. noneumartii* host range studies – field-based host range, economic impacts, asymptomatic, combined analyses**
  - **1.2 FRD crop rotation-based management studies – rotation with alfalfa, combined analyses, commercial rotation**
  - **1.3 Connecting rotation crop effects on FRD risk with impacts on pathogen loads in soil and other potential soil physiochemical traits**. – soil qPCR work, biomass and nitrogen analyses
- **Objective 2. Commercial cultivar trials.**
- **Objective 3. Fruit protection management in fields with FRD-driven decline.**
- **Objective 4. Outreach.**

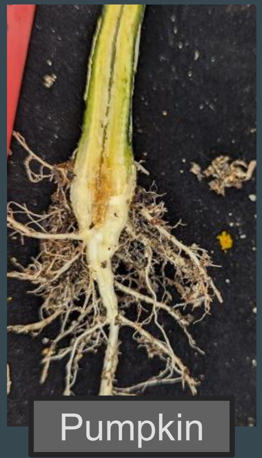
FRD Management: 2021-2025 CTRI host range/rotation Projects

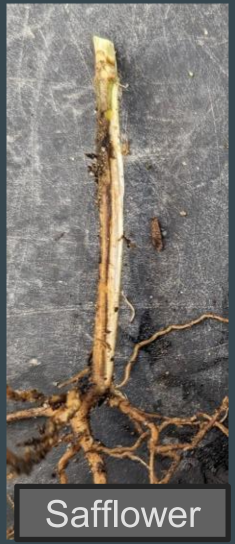
Warm season crops

Crop	Host status	
	GH	Field
hemp	NH*	?
kidney bean	NH	?
melon	NH	NH
pepper	H	H
potato	H	?
pumpkin	H	?
rice	NH	-
safflower	H	H
sunflower	H	H
sweet potato	NH	?
corn	NH	NH
cotton	NH	NH
garbanzo	?	H

NH = Non-Host
H = Host







FRD Management: 2021-2025 CTRI host range/rotation Projects

Warm season crops

Crop	Host status		Economic impact	
	GH	Field	GH	Field
hemp	NH	?	no	?
kidney bean	NH	?	no	?
melon	NH	NH	no	?
pepper	H	H	no	?
potato	H	?	yes	?
pumpkin	H	?	no	?
rice	NH	-	no	?
safflower	H	H	yes	?
sunflower	H	H	yes	?
sweet potato	NH	?	no	?
corn	NH	NH	no	?
cotton	NH	NH	no	?
garbanzo	?	H	-	?

NH = Non-Host
H = Host

FRD Management: 2021-2025 CTRI host range/rotation Projects

Warm season crops

Crop	Host status		Economic impact		Rotation risk	
	GH	Field	GH	Field	Disease	Inoculum
hemp	NH	?	no	?	-	?
kidney bean	NH	?	no	?	-	?
melon	NH	NH	no	?	L/MR	?
pepper	H	H	no	?	M/HR	?
potato	H	?	yes	?	-	?
pumpkin	H	?	no	?	-	?
rice	NH	-	no	?	-	?
safflower	H	H	yes	?	HR	?
sunflower	H	H	yes	?	HR	?
sweet potato	NH	?	no	?	-	?
corn	NH	NH	no	?	L/MR	?
cotton	NH	NH	no	?	L/MR	?
garbanzo	?	H	-	?	M/HR	?

NH = Non-Host
H = Host

LR = Low Risk
MR = Moderate Risk
HR = High Risk
(risk based on fallow comparison)

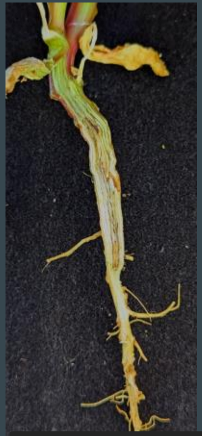
FRD Management: 2021-2025 CTRI host range/rotation Projects

Cool season crops

Crop	Host status	
	GH	Field
alfalfa	NH	NH
barley	NH	-
cabbage	NH	NH
carrot	H	NH
cilantro	H	NH
fava	NH	NH
garlic	NH	NH
onion	NH	NH
parsley	NH	NH
spinach	H	NH
vetch	NH	NH
wheat	NH	NH
mustard	?	NH
lettuce	H	NH
broccoli	NH	NH

NH = Non-Host
H = Host


Cilantro


Spinach


Carrot

FRD Management: 2021-2025 CTRI host range/rotation Projects

Cool season crops

Crop	Host status		Economic impact	
	GH	Field	GH	Field
alfalfa	NH	NH	no	?
barley	NH	-	no	?
cabbage	NH	NH	no	?
carrot	H	NH	yes	?
cilantro	H	NH	yes	?
fava	NH	NH	no	?
garlic	NH	NH	no	?
onion	NH	NH	no	?
parsley	NH	NH	no	?
spinach	H	NH	no	?
vetch	NH	NH	no	?
wheat	NH	NH	no	?
mustard	?	NH	no	?
lettuce	H	NH	no	?
broccoli	NH	NH	no	?

NH = Non-Host
H = Host

FRD Management: 2021-2025 CTRI host range/rotation Projects

Cool season crops

Crop	Host status		Economic impact		Rotation risk	
	GH	Field	GH	Field	Disease	Inoculum
alfalfa	NH	NH	no	?	HR	?
barley	NH	-	no	?	-	?
cabbage	NH	NH	no	?	-	?
carrot	H	NH	yes	?	MR	?
cilantro	H	NH	yes	?	LR	?
fava	NH	NH	no	?	LR	?
garlic	NH	NH	no	?	LR	?
onion	NH	NH	no	?	HR	?
parsley	NH	NH	no	?	HR	?
spinach	H	NH	no	?	L/MR	?
vetch	NH	NH	no	?	MR	?
wheat	NH	NH	no	?	MR	?
mustard	?	NH	no	?	LR	?
lettuce	H	NH	no	?	M/HR	?
broccoli	NH	NH	no	?	MR	?

NH = Non-Host
H = Host

LR = Low Risk
MR = Moderate Risk
HR = High Risk
(risk based on fallow comparison)

FRD Management 2026 Proposal: Putting it all together/filling gaps

Warm season crops

Gaps: ?

NH = Non-Host
H = Host

LR = Low Risk
MR = Moderate Risk
HR = High Risk
(risk based on fallow comparison)

Crop	Host status		Economic impact		Rotation risk	
	GH	Field	GH	Field	Disease	Inoculum
hemp	NH	?	no	?	-	?
kidney bean	NH	?	no	?	-	?
melon	NH	NH	no	?	L/MR	?
pepper	H	H	no	?	M/HR	?
potato	H	?	yes	?	-	?
pumpkin	H	?	no	?	-	?
rice	NH	-	no	?	-	?
safflower	H	H	yes	?	HR	?
sunflower	H	H	yes	?	HR	?
sweet potato	NH	?	no	?	-	?
corn	NH	NH	no	?	L/MR	?
cotton	NH	NH	no	?	L/MR	?
garbanzo	?	H	-	?	M/HR	?

FRD Management 2026 Proposal: Putting it all together/filling gaps

Cool season crops

Gaps: ?

Unreplicated: X

NH = Non-Host
H = Host

LR = Low Risk
MR = Moderate Risk
HR = High Risk
(risk based on fallow comparison)

Crop	Host status		Economic impact		Rotation risk	
	GH	Field	GH	Field	Disease	Inoculum
alfalfa	NH	NH	no	?	HR	?
barley	NH	-	no	?	-	?
cabbage	NH	NH	no	?	-	?
carrot	H	NH	yes	?	MR	?
cilantro	H	NH	yes	?	LR	?
fava	NH	NH	no	?	LR	?
garlic	NH	NH	no	?	LR	?
onion	NH	NH	no	?	HR	?
parsley	NH	NH	no	?	HR	?
spinach	H	NH	no	?	L/MR	?
vetch	NH	NH	no	?	MR	?
wheat	NH	NH	no	?	MR	?
mustard	?	NH	no	?	LR	?
lettuce	H	NH	no	?	M/HR	?
broccoli	NH	NH	no	?	MR	?

FY2026: Host range final work

- Complete unreplicated trials for select crops in greenhouse
  - (garbanzo, mustard)

- Complete unreplicated trials for select crops in field in both cool (winter) and warm (spring summer) conditions for optimal fungal growth
  - (alfalfa, carrot, cabbage, onion, garlic, parsley)

- Determine economic impact of *F. noneumartii* in select crops based on greenhouse trials
  - (potato, cilantro, carrot)

FY2026: Study soil to understand crop rotation risk and inoculum

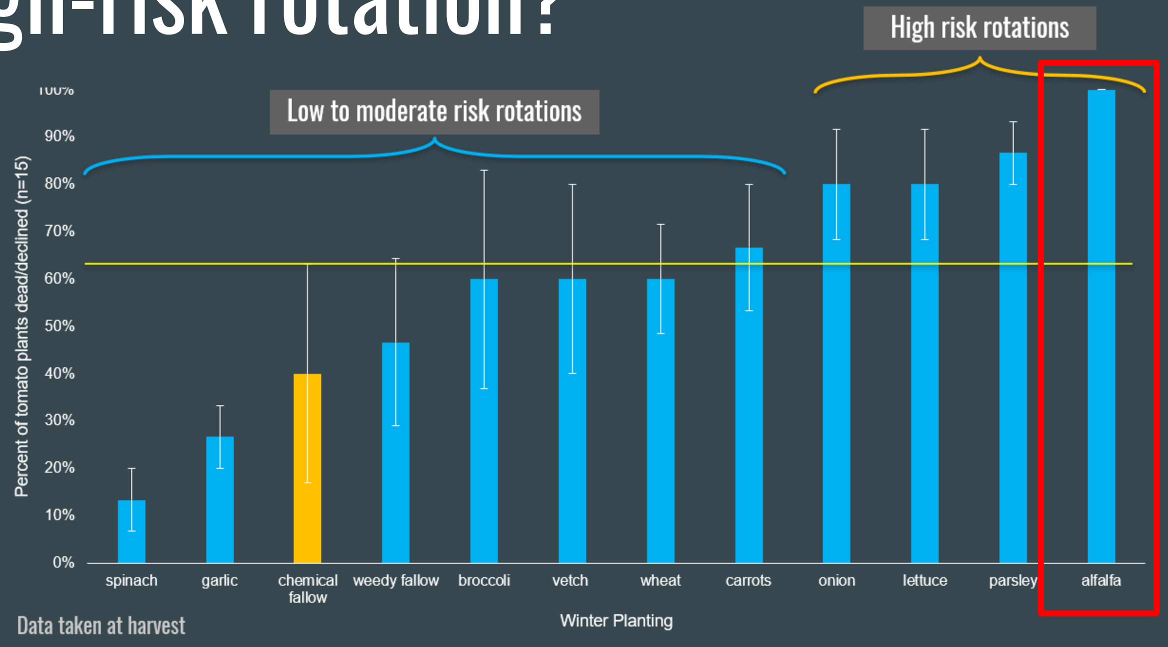
- Collected 600+ soil samples for all trials combined
    - 3 soil samples / treatment
- We have just validated new FN1 diagnostic marker
- Adapt this to a qPCR soil test
- Calibrate *F. noneumartii* qPCR assay to quantify inoculum loads

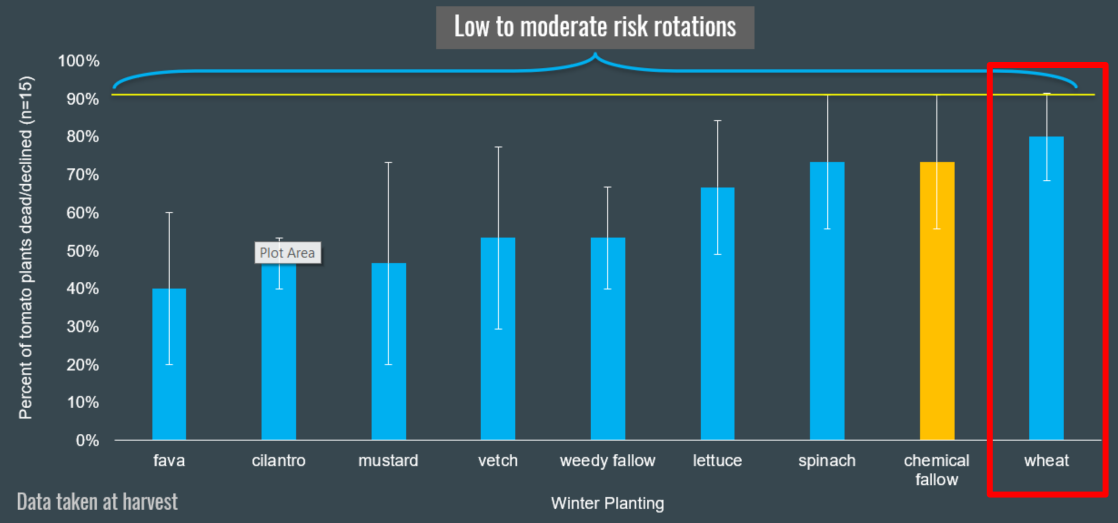
- Utilize inoculum load data as another metric to measure rotation risk, insight into long terms inoculum impacts

What makes a particular crop a high-risk rotation?

- Some crops did not develop symptoms in host range trials but are moderate/high risk rotations
- Could these crops be increasing inoculum another way?
    - Alfalfa -> nitrogen fixer
    - Wheat -> high biomass

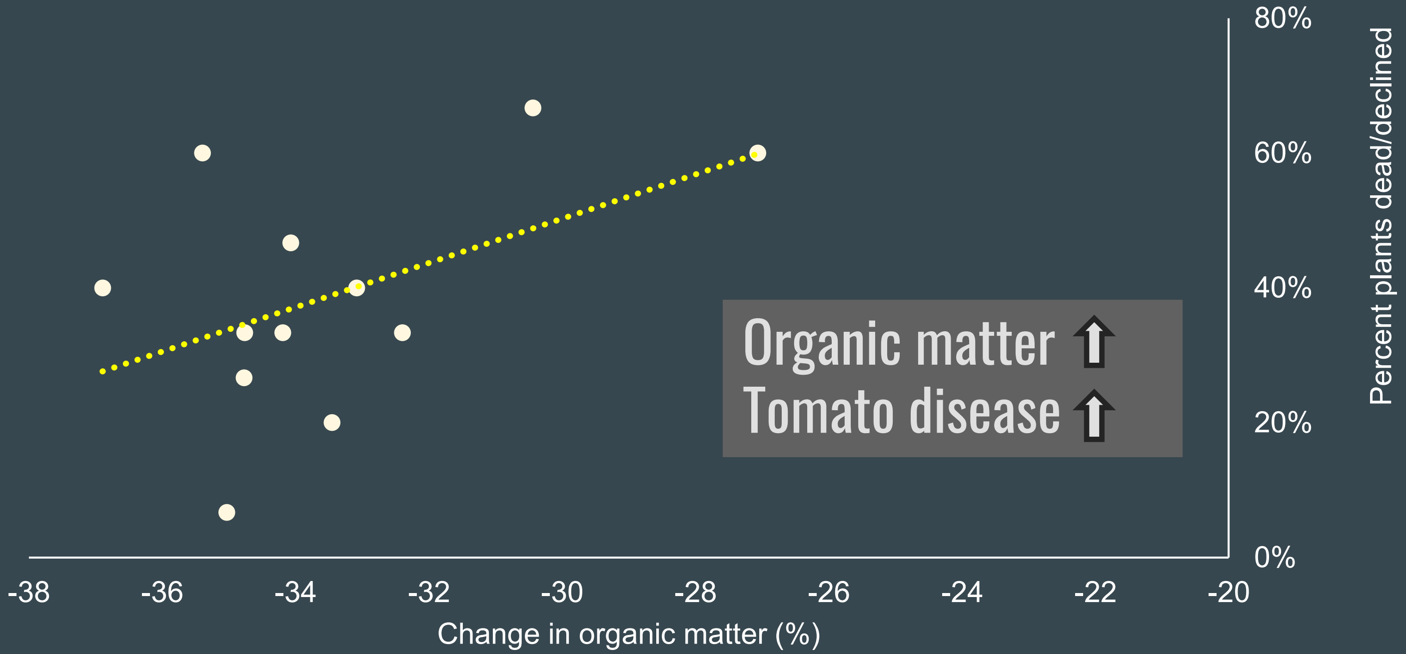
- Could these non-hosts actually be asymptomatically colonized hosts?





FY2026: Rotation Risk – Organic matter and soil nitrogen

- Measure organic matter and nitrogen in saved soil, corelate to tomato disease levels and inoculum loads and develop predictive metrics for rotation risk in untested crops
- 2025: evaluated mustard (high organic matter) and fava (high N); started alfalfa trial (high N)



2022-2023 winter rotation trial, pre harvest

FY2026: Rotation Risk – Asymptomatic colonization

- Test crops that did not develop symptoms in host range trials (deemed ‘non-hosts) to determine if they are asymptomatically colonized by *F. noneumartii*
- Correlate any asymptomatic colonization with disease levels in tomato (data from 2021-2025 rotation trials) and soil inoculum loads (qPCR)





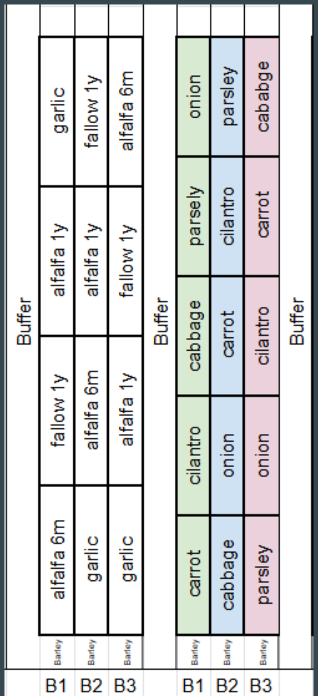
FY2026: Final rotation studies

- Complete cool season rotation studies of unreplicated crops (alfalfa, carrot, cilantro, cabbage, parsley, onion, garlic)
    - Include a 6- and 12-month planting of alfalfa

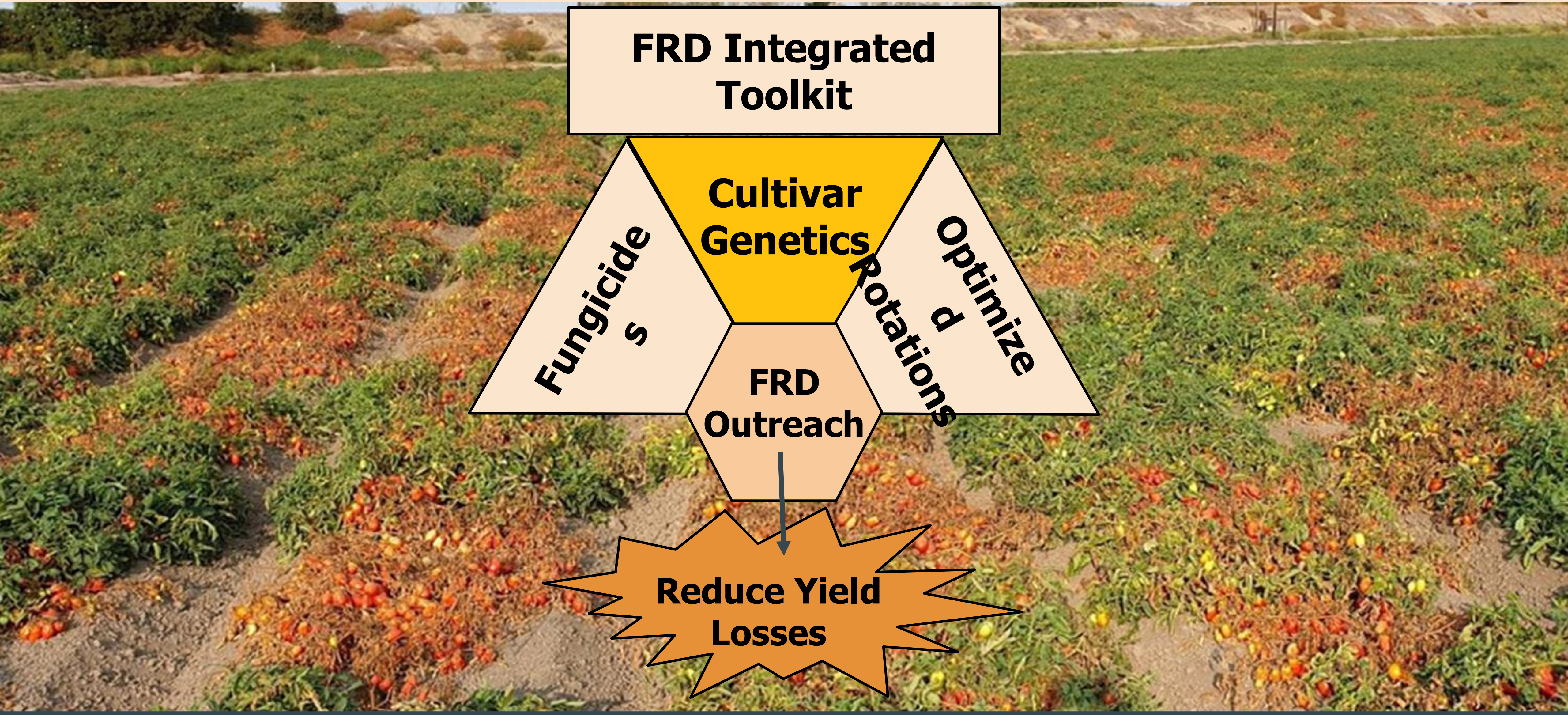
- Continue to track and evaluate commercial rotation trials

- Develop predictive risk guidelines for crops under FRD pressure
    - Organic matter, soil nitrogen
    - Crop host status, crop taxonomic family
    - Asymptomatic colonization

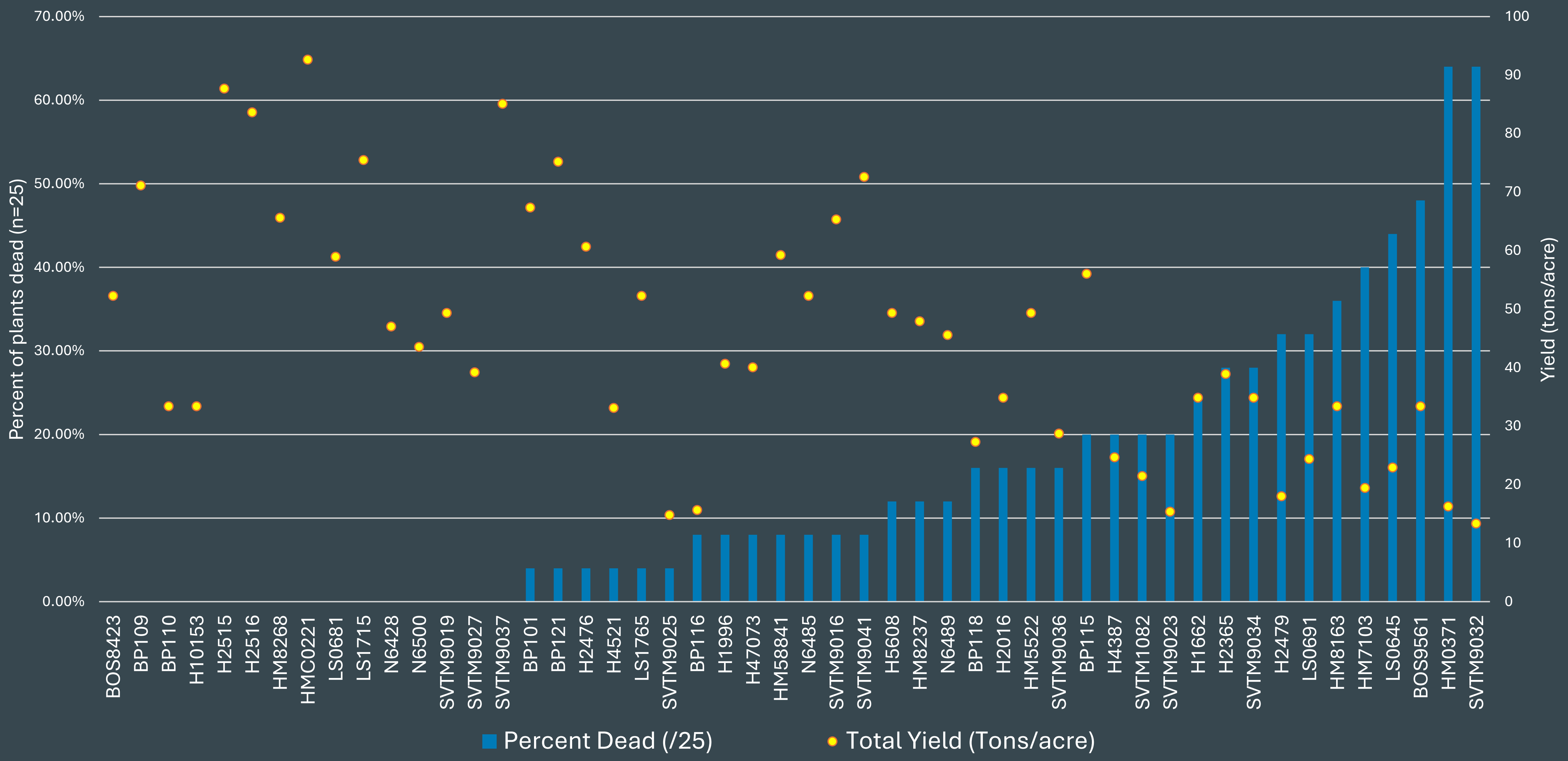
- Combine and complete analysis of 5 years of rotation trials



Main Goal: Develop and effective integrated toolkit for FRD in processing tomato



Cultivar resistance screening- 2025 UCD/Ag Seeds trial



2026: UC Davis cultivar trials

Early varieties trial- in development with AgSeeds

	Variety	Normalized yield	% dead 6 weeks pre harvest	Category
1	HM0317	0.360036	64.00%	Highly Susceptible
2	SVTM9027	0.867944	0.00%	Highly Resistant
3	SVTM9032	0.295744	64.00%	Highly Susceptible + S check
4	HM7103	0.430757	40.00%	Highly Susceptible
5	LS0691	0.540054	32.00%	Highly Susceptible
6	BP115	1.240838	20.00%	Moderately Susceptible
7	BP118	0.604346	16.00%	Moderately Susceptible
8	H2479	0.398611	32.00%	Highly Susceptible

2026: UC Davis cultivar trials

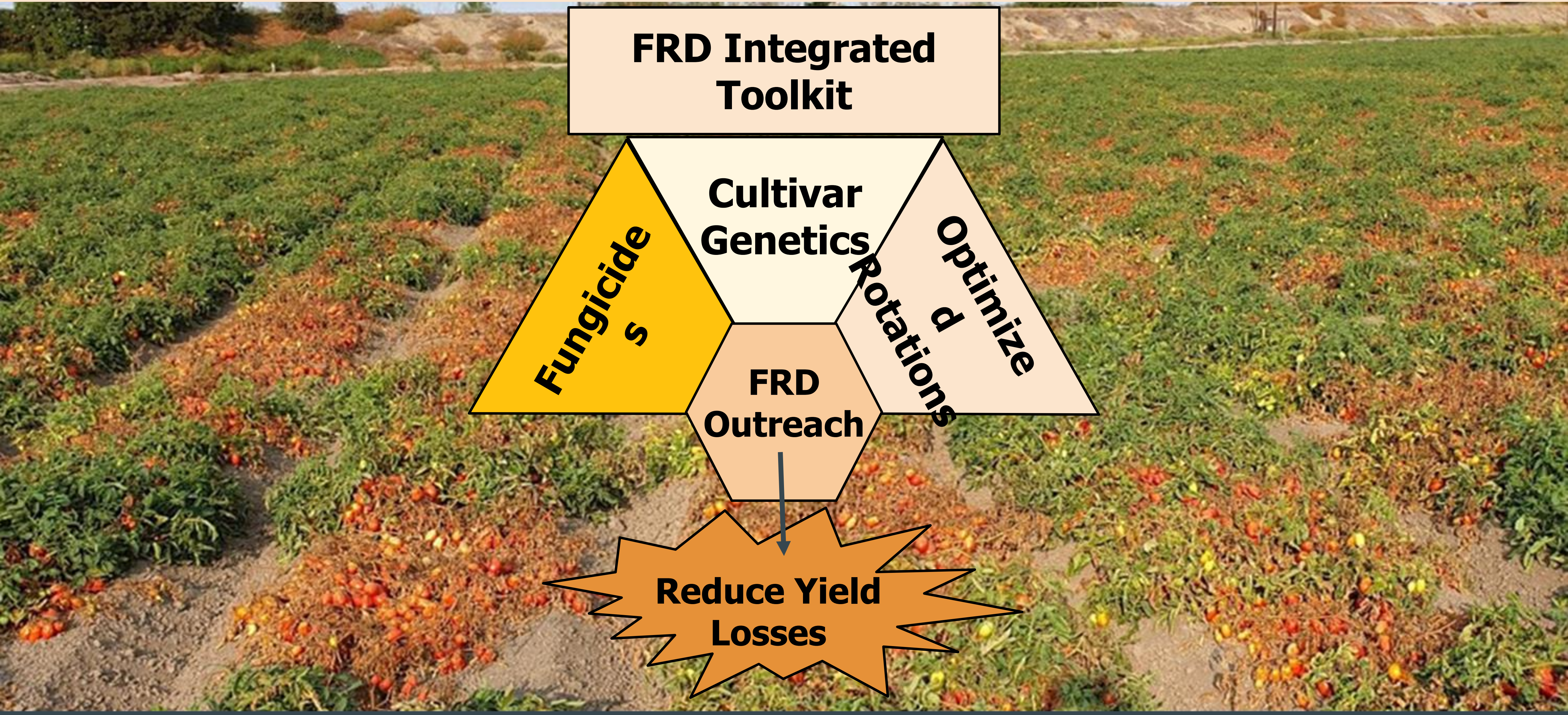
Standard late varieties trial- in development with AgSeeds

	Variety	Normalized yield	% dead 6 weeks pre harvest	Category
1	BP109	1.575158	0.00%	Highly Resistant
2	BP110	0.73936	0.00%	Highly Resistant
3	H10153	0.73936	0.00%	Highly Resistant
4	H2515	1.941623	0.00%	Highly Resistant
5	H2516	1.851614	0.00%	Highly Resistant
6	HM8268	1.453002	0.00%	Highly Resistant
7	HMC0221	2.050919	0.00%	Highly Resistant; top yielder
8	LS1715	1.671596	0.00%	Highly Resistant
9	N6500	0.964382	0.00%	Highly Resistant
10	NB6500	nd		nd
11	HM58841			late R checks
12	H1996			late R checks
13	N6428			late R checks
14				late S check

2026: UC Davis support to AgSeeds/ANR cultivar trials

- Diagnostics for 5 northern and 3 central valley trials

Main Goal: Develop and effective integrated toolkit for FRD in processing tomato



Fruit Protection – Kaolin clay trials

Support to trials – diagnostics for three field studies

FRD outreach

2026: Further develop and disseminate reports

- UC IPM pest note
- Plant Disease Management Reports (2023,2024 trials)
- Disseminating information in diverse venues

Questions for us?

- How should we use information from cultivar or chemical trials where other diseases are present?
- What metrics are you using to determine crop rotation risk? What are limitations in using these metrics?
- How did you choose the crops to test in your host range/rotation studies?
- Is crop residue management important for FRD? What is the importance of organic matter in the FRD system?

Questions to the board

- Would it be useful to you if, in future years, we transfer the qPCR-based soil testing tool to diagnostic labs, so you can determine the FRD risk level of your fields prior to planting tomato?
- What format would you find most useful for the dissemination of FRD management guidelines? (CE presentations, websites, printed materials etc)
- What guides your decision on whether to use a chemical management tool? Specifically, for FRD?
- When/how far in advance do growers choose what crops to rotate with and/or what cultivars to plant? Do FRD diagnoses in-season inform selection of tomato cultivars or rotation crops?

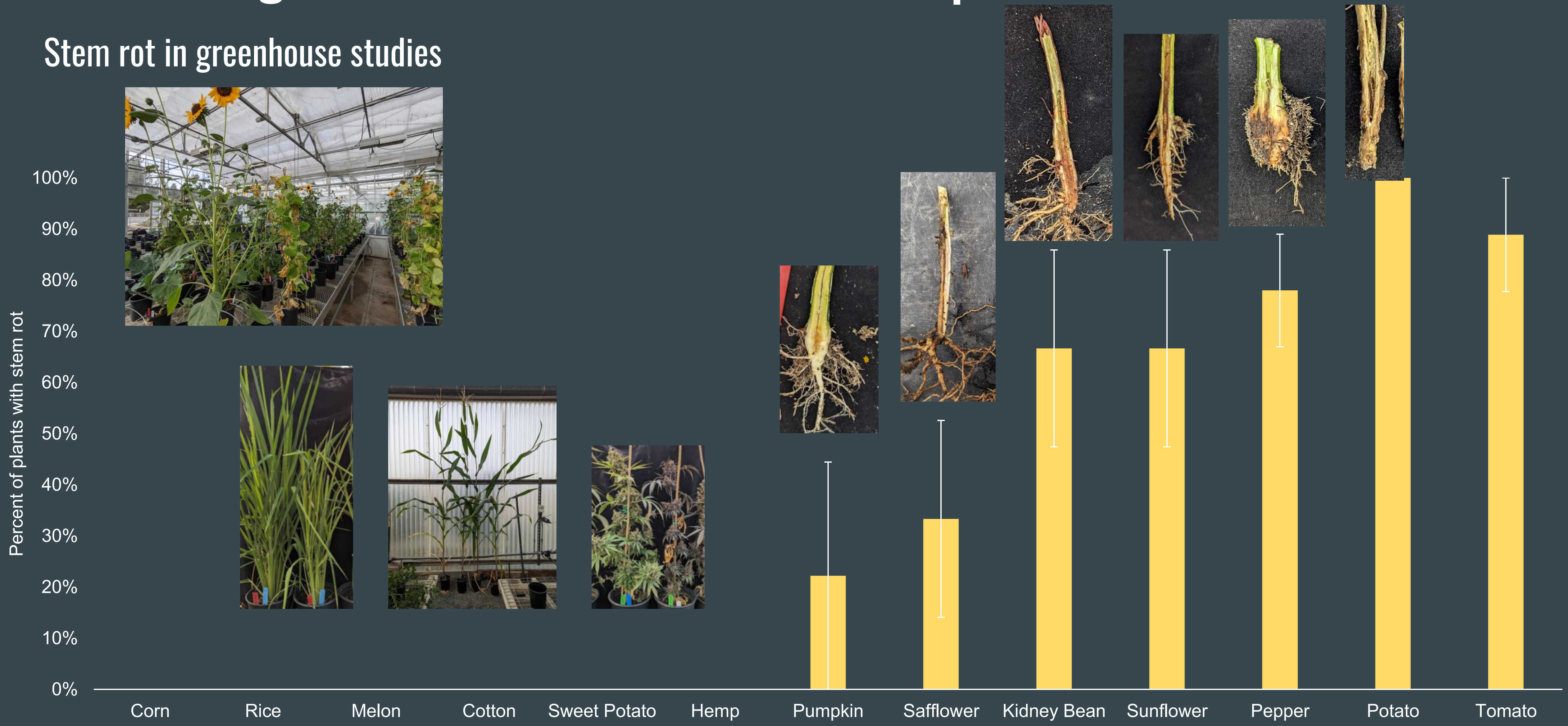
Questions to the board

- Specifically for winter cover crops, which are not widely used, what added value would be needed to justify use? Weed suppression? Nutrient benefits? Other?
- Past work on irrigation indicates that reducing irrigation inputs late season causes FRD to blow up, but we don’t have specific guidelines on how irrigation reductions should be managed if FRD is present. Would this kind of information be useful in the future?
- Are there other directions we should be thinking about for managing FRD or other soil borne pathogens?

Supplemental Data Slides

Host Range Studies in warm season crops – *F. noneumartii*

Stem rot in greenhouse studies

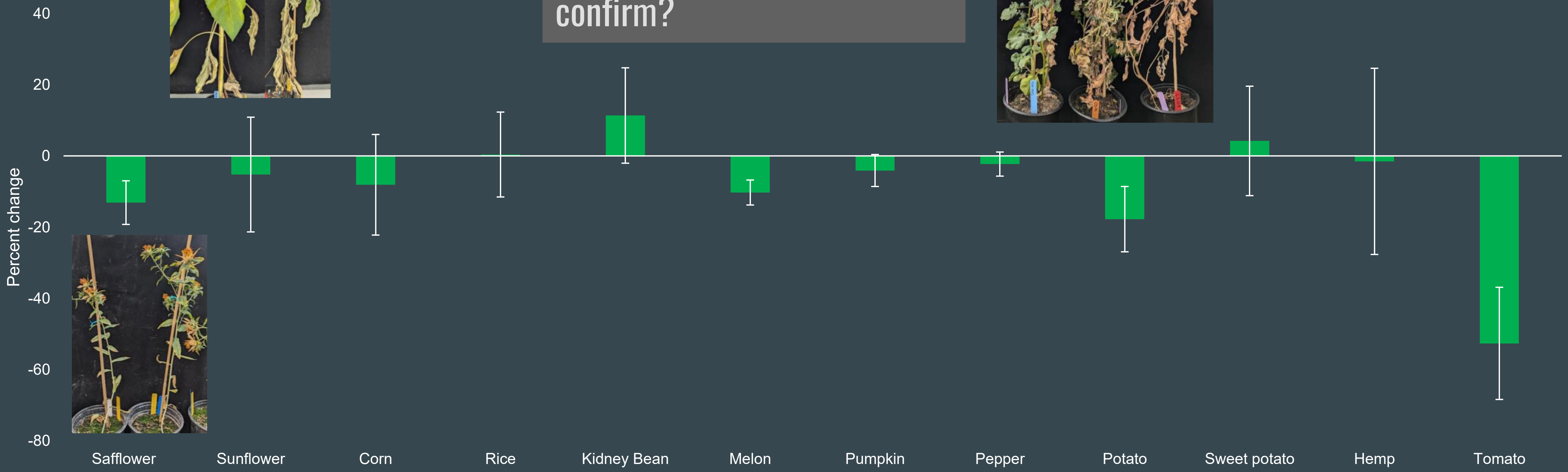


F. noneumartii recovered from all symptomatic crops

Host Range Studies in warm season crops – *F. noneumartii*

Change in biomass (inoculated vs mock inoculated

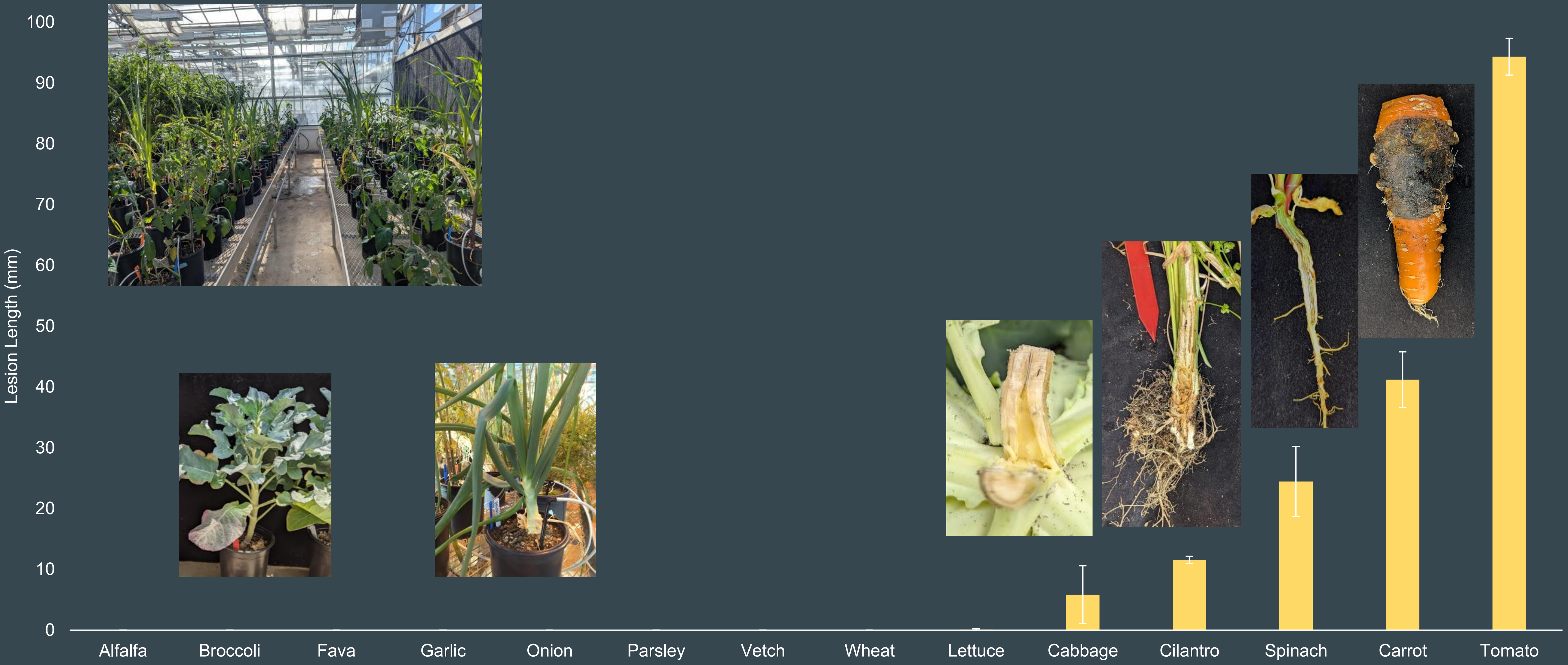
Potential economic impact in potato in greenhouse
→ Test in field conditions to confirm?



F. noneumartii recovered from all symptomatic crops

Host Range Studies in cool season crops – *F. noneumartii*

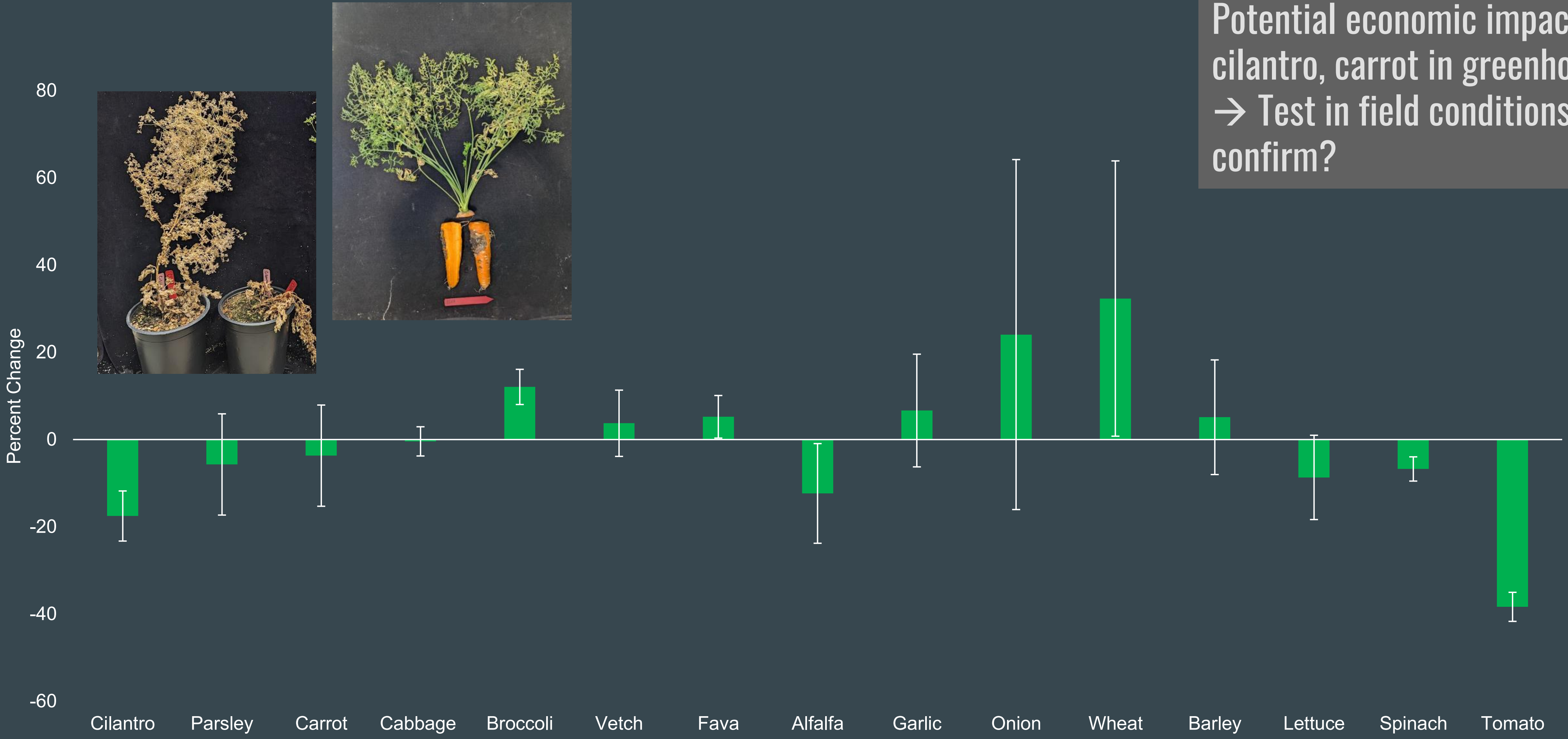
Stem rot in greenhouse trials



F. noneumartii recovered from all symptomatic crops

Host Range Studies in cool season crops – *F. noneumartii*

Change in biomass (inoculated vs mock inoculated)

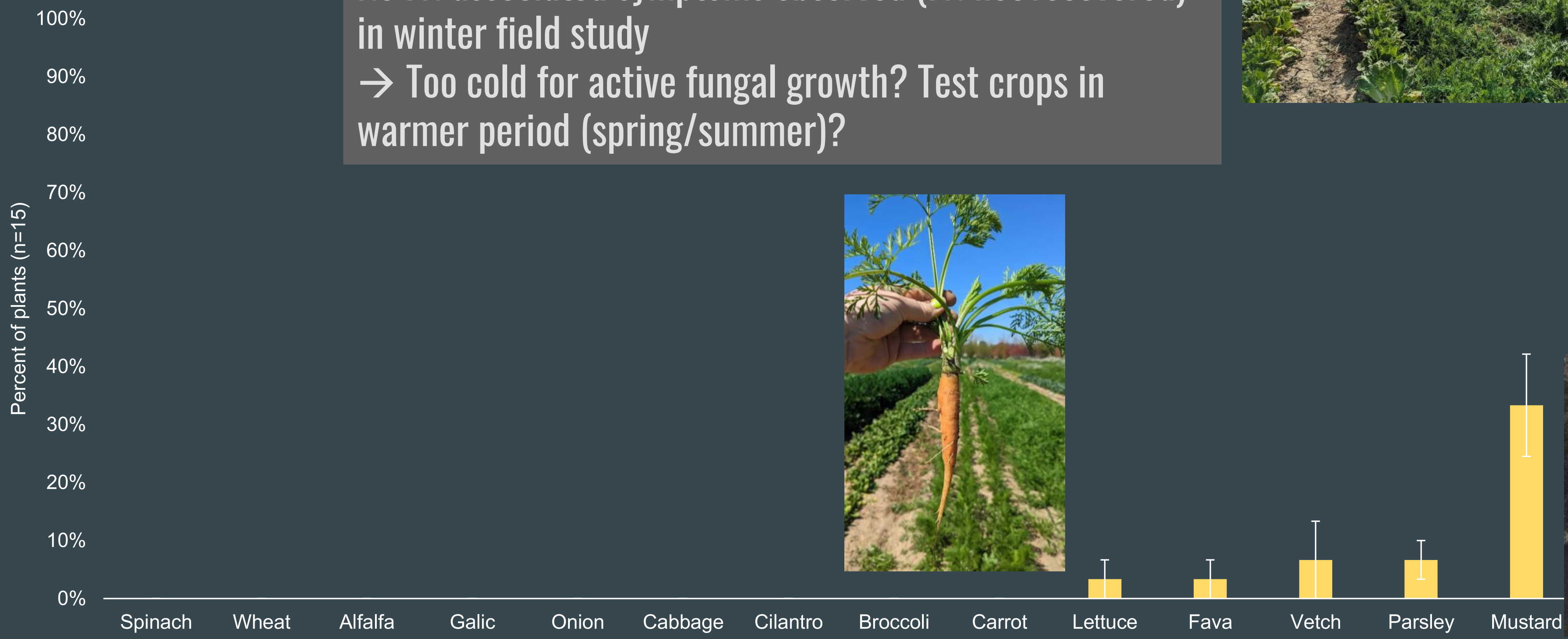


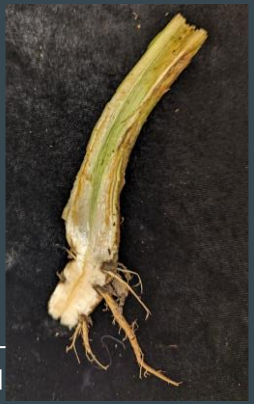
Potential economic impact in cilantro, carrot in greenhouse → Test in field conditions to confirm?

Host Range Studies – *F. noneumartii* Field studies

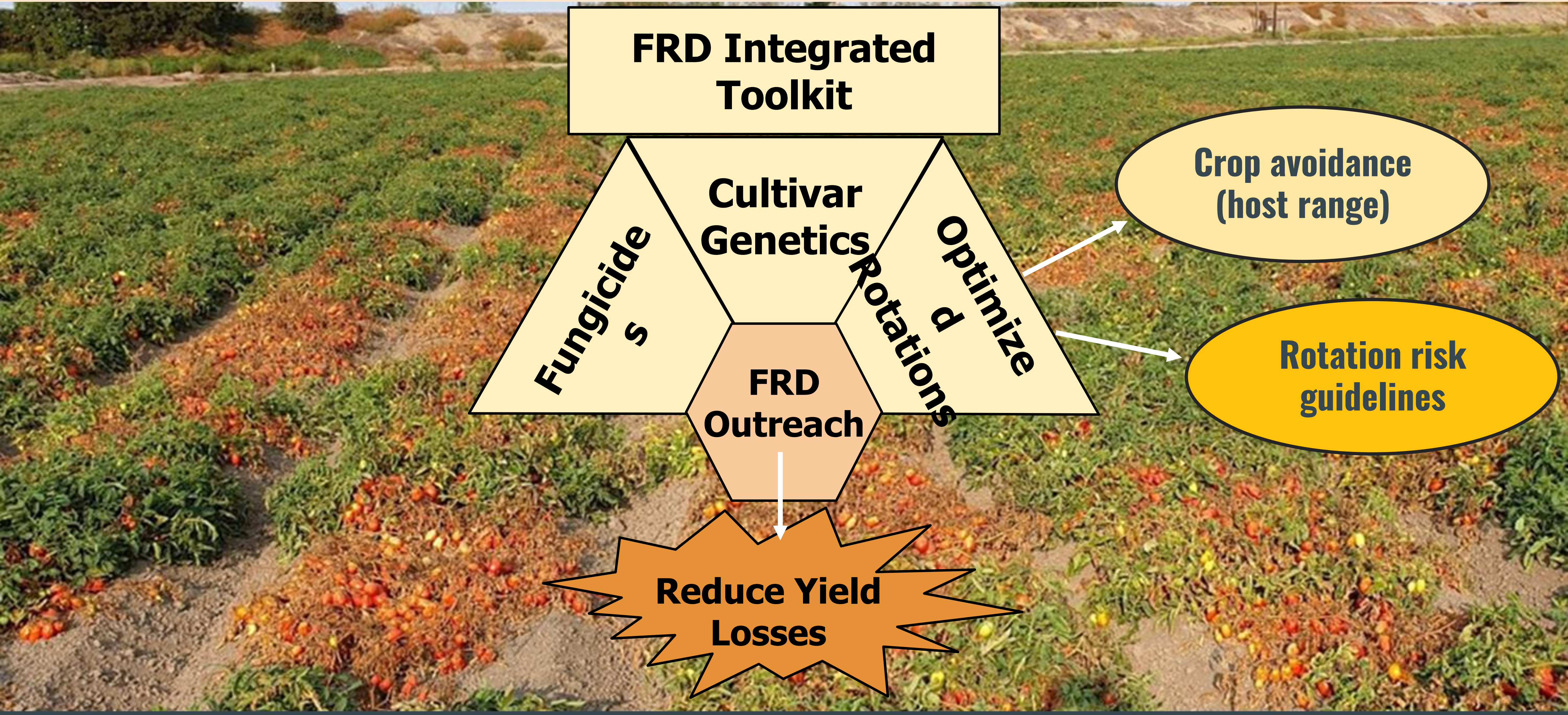
Stem rot in field studies

No FN associated symptoms observed (FN not recovered) in winter field study
→ Too cold for active fungal growth? Test crops in warmer period (spring/summer)?

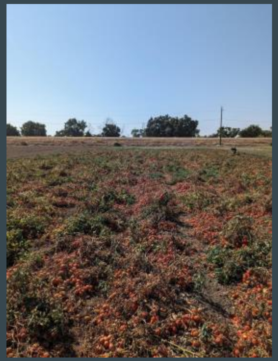




Main Goal: Develop and effective integrated toolkit for FRD in processing tomato

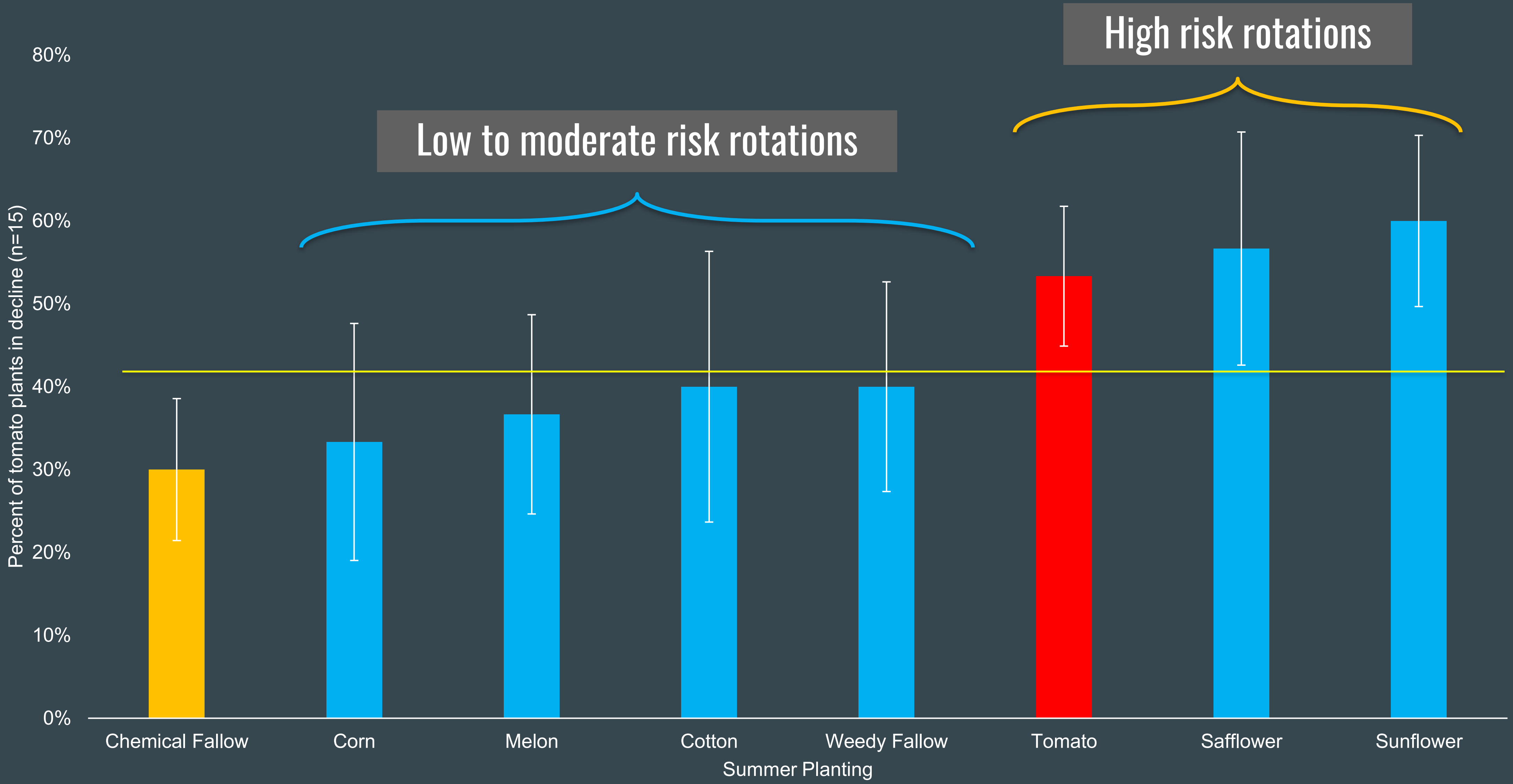


Rotation Studies – Warm season (2021-2023)

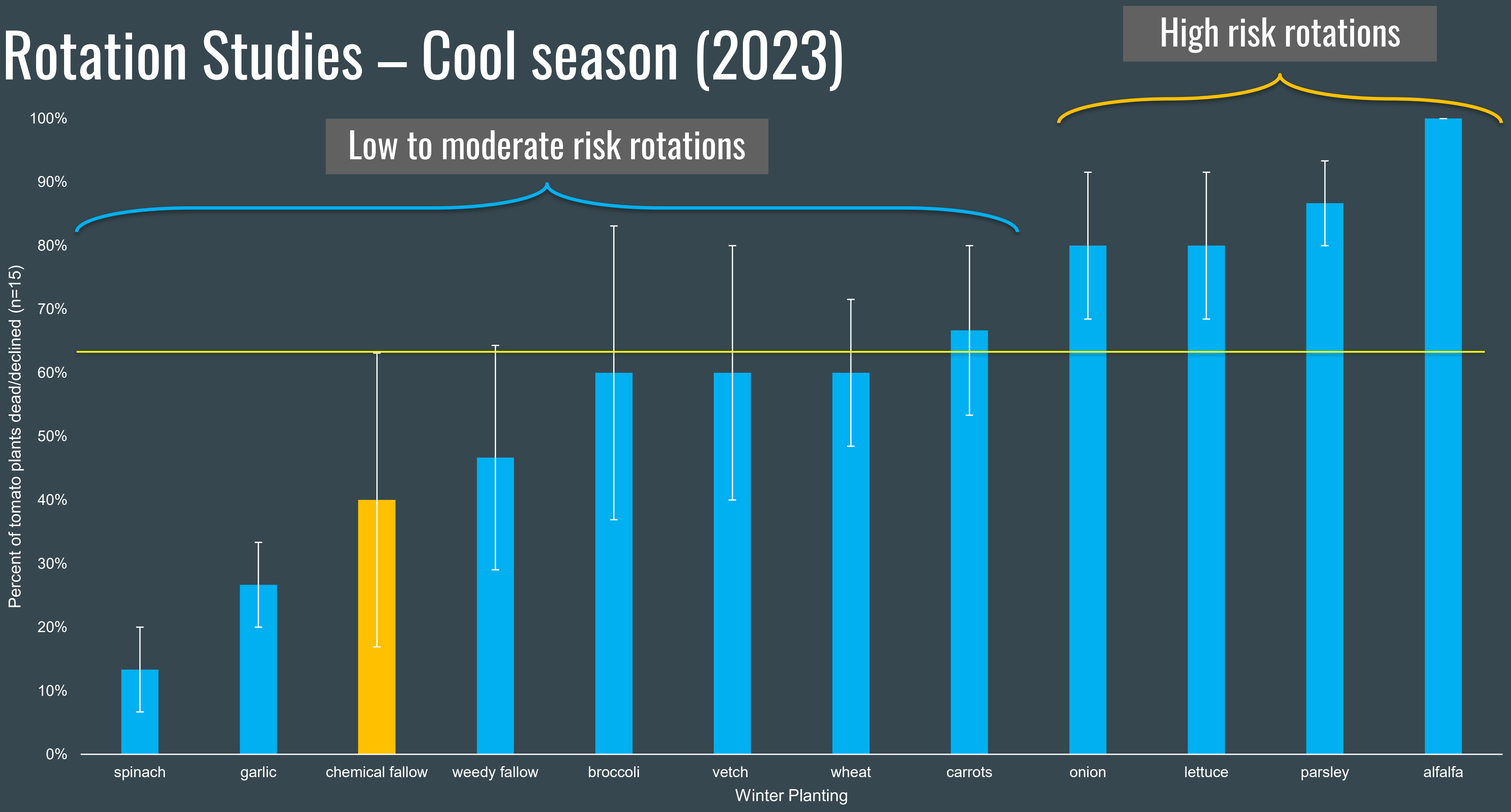


Data taken pre harvest

Averaged across the two years we ran this etrial

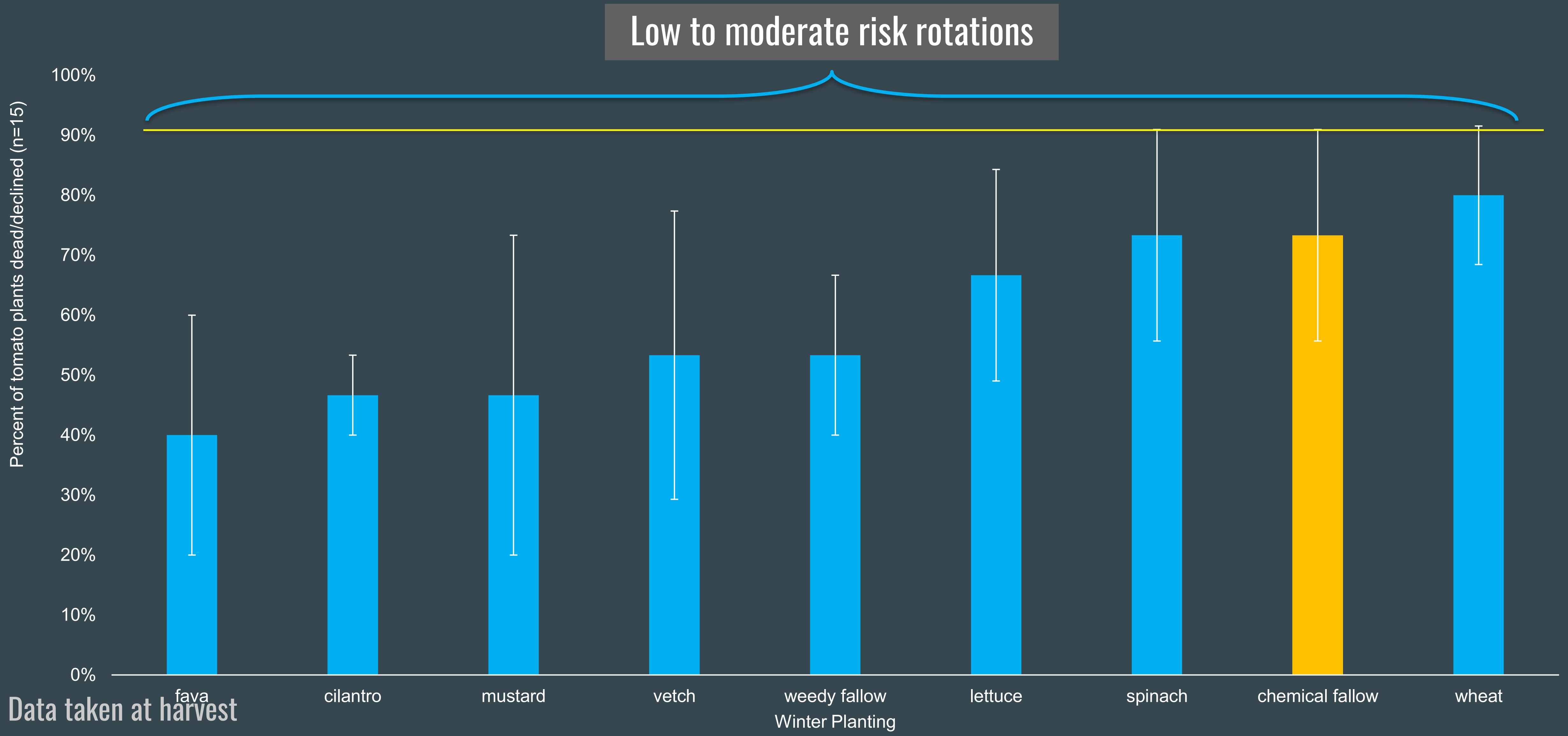


Rotation Studies – Cool season (2023)



Data taken at harvest

Rotation Studies – Cool season (2024)

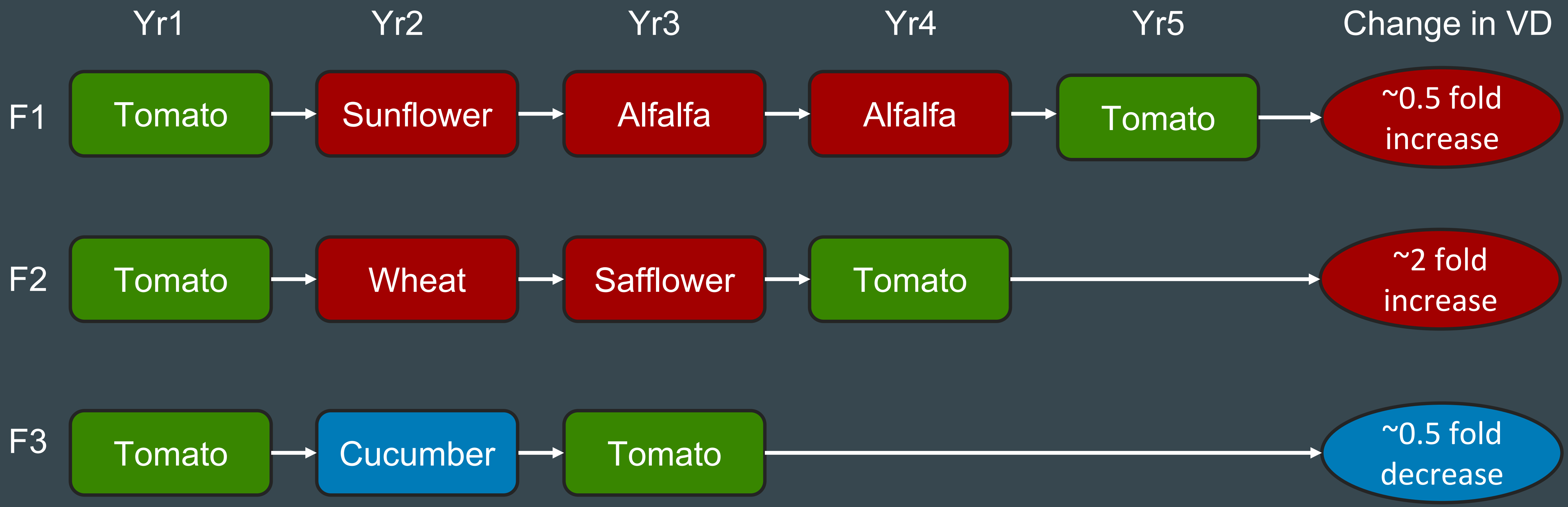


Data taken at harvest

Multi-year rotations in commercial

High Disease Risk Rotation

Low Disease Risk Rotation



Multi-year rotations in commercial – FY2026

High Disease Risk Rotation

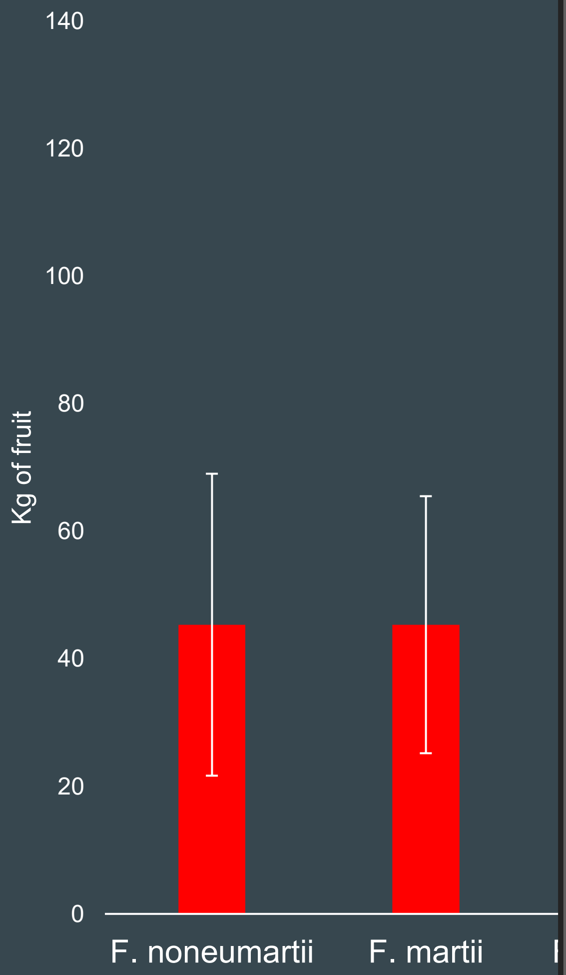
Low Disease Risk Rotation

	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8
F1	Tomato →	Sunflower →	Alfalfa →	Alfalfa →	Tomato →	Corn →	Corn →	?
F2	Tomato →	Tomato →	Wheat →	Safflower →	Tomato →	Wheat →	?	
F3	Tomato →	Cucumber →	Tomato →	Tomato →	Wheat →	?		

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii

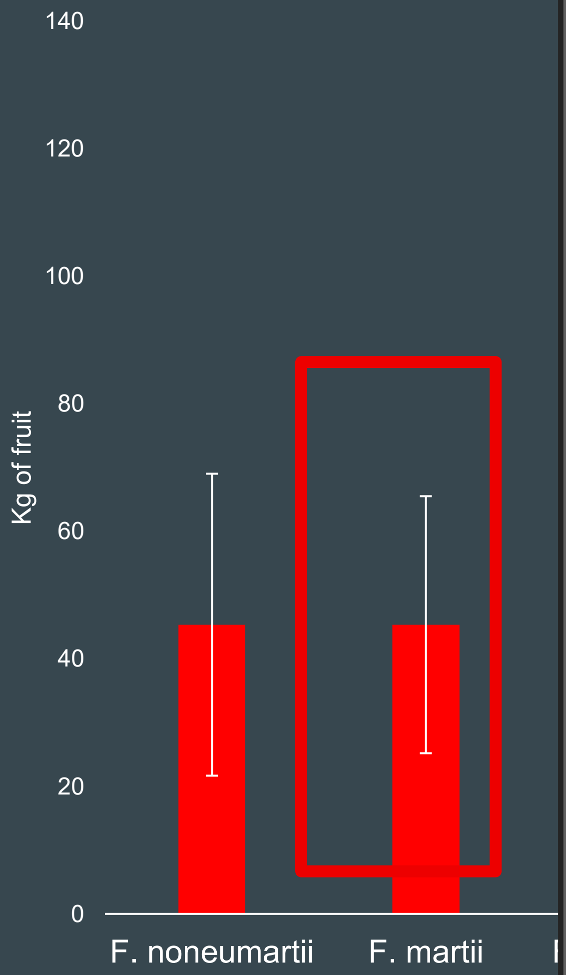


Fusarium Stem Rot and Decline (FRD): Economically important disease with few management tools

Fusarium Stem Rot and Decline (FRD)

Fusarium martii

Fusarium noneumartii

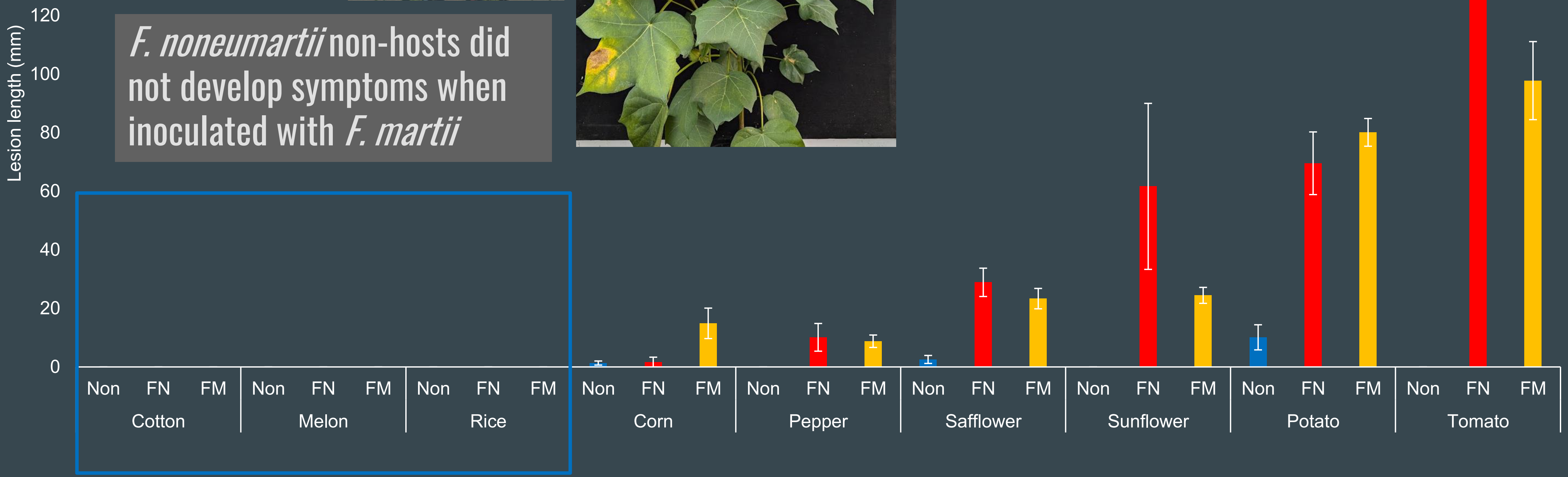


Both *F. noneumartii* and *F. martii* are management targets

<u>Need co-management guidelines</u>

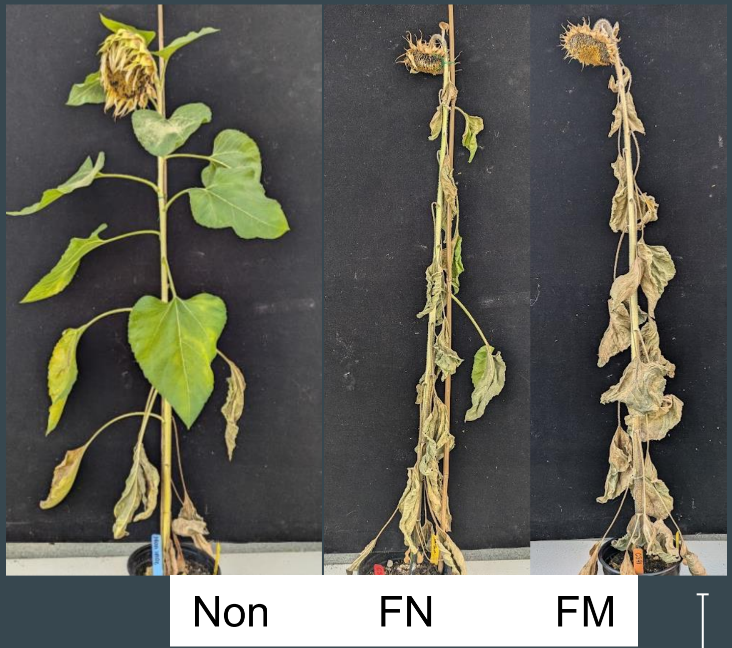
2025 Host Range Studies – *F. martii*
Warm season

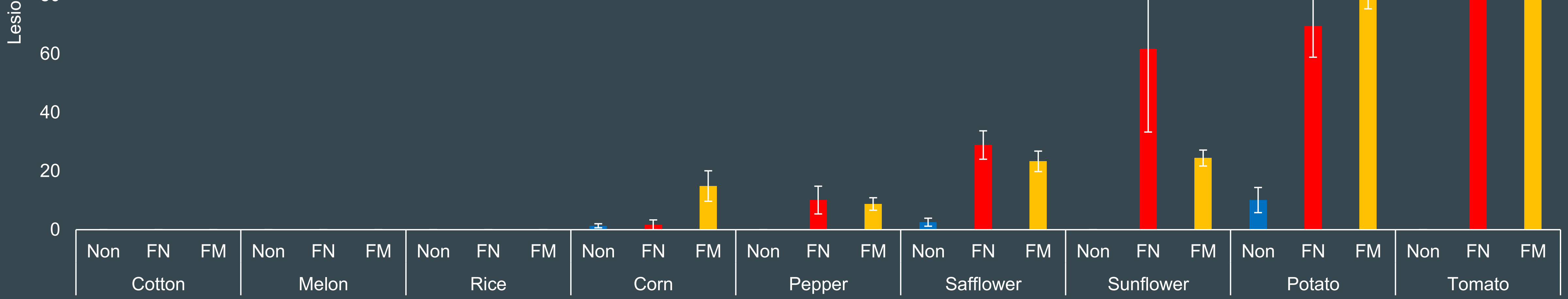
F. noneumartii non-hosts did not develop symptoms when inoculated with *F. martii*



2025 Host Range Studies – *F. martii*
Warm season

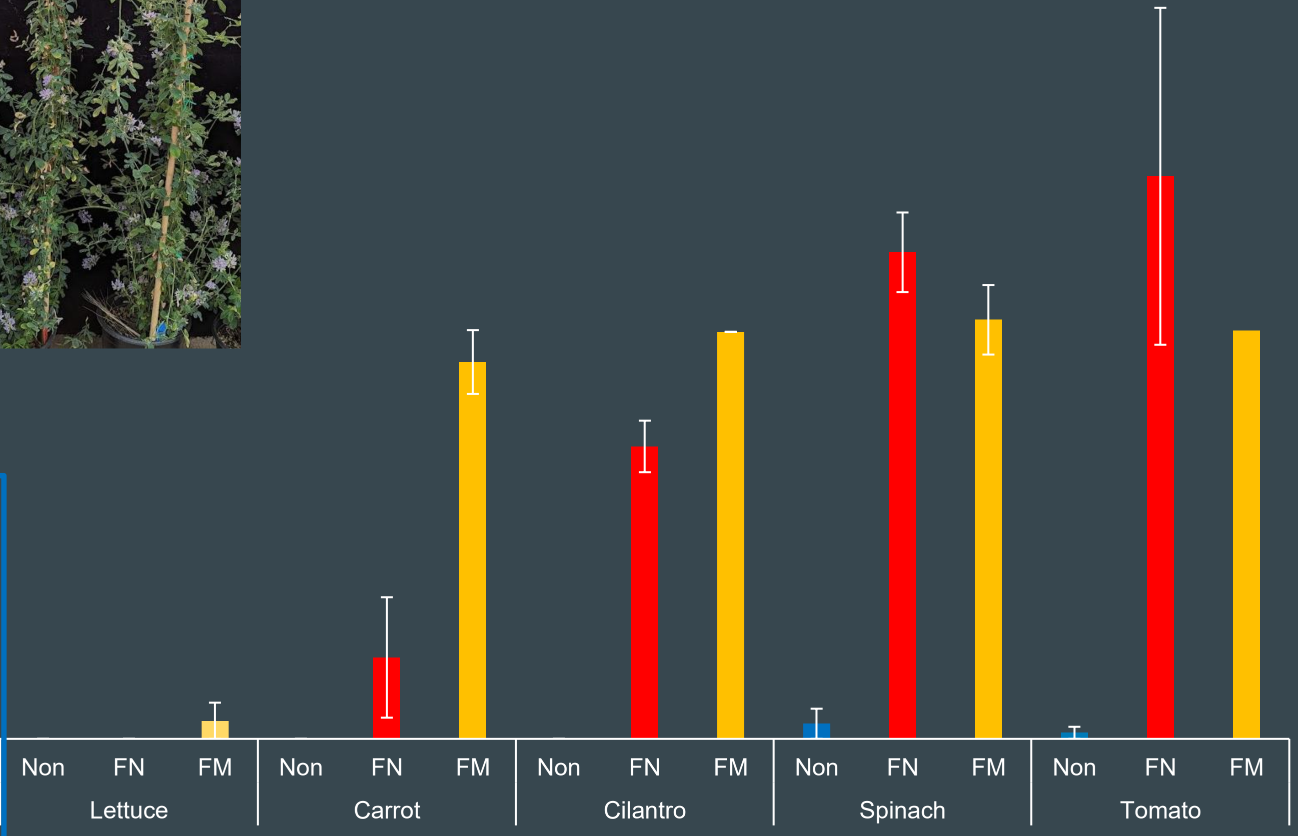
F. noneumartii hosts developed symptoms of similar or less severity when inoculated with *F. martii*





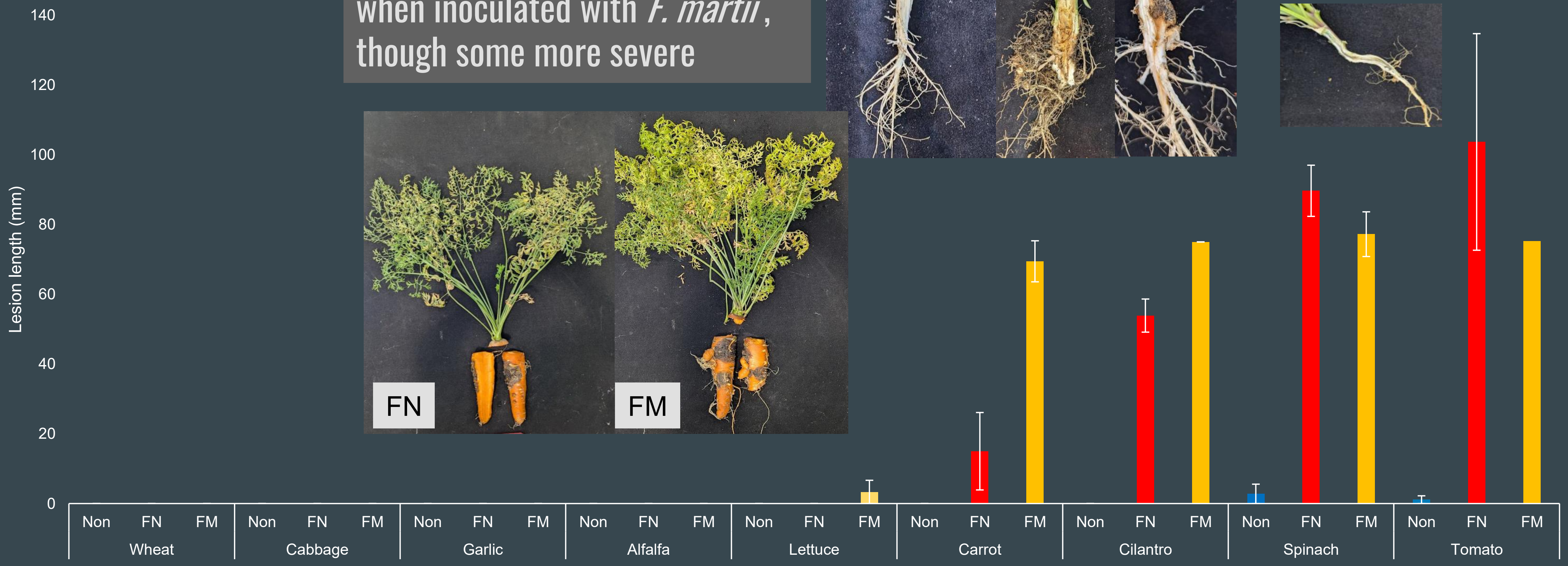
2025 Host Range Studies – *F. martii*
Cool season

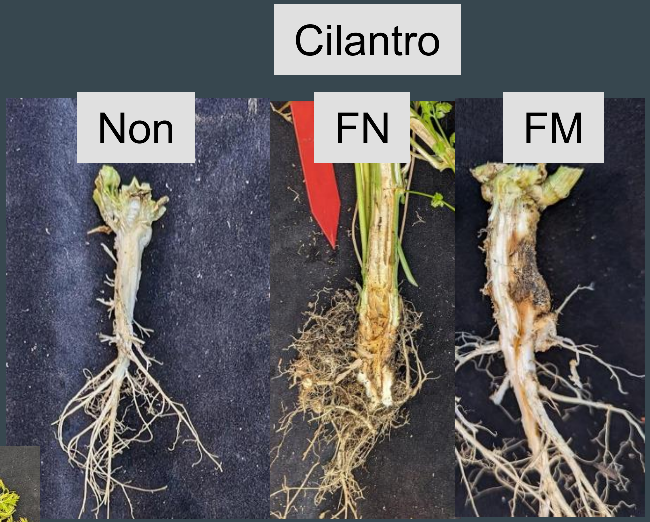
F. noneumartii non-hosts did not develop symptoms when inoculated with *F. martii*

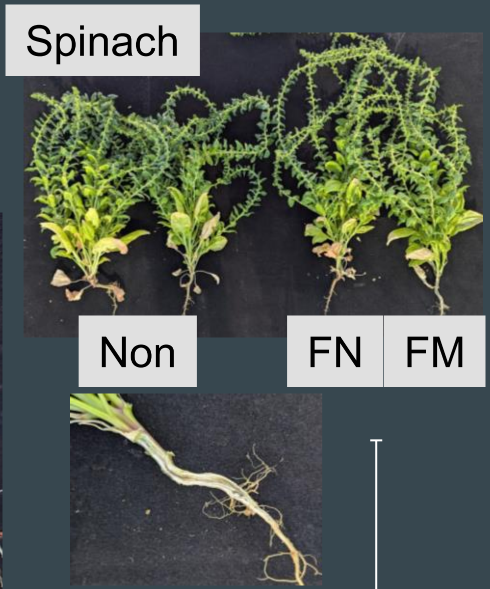


2025 Host Range Studies – *F. martii*
Cool season

F. noneumartii hosts developed symptoms of similar severity when inoculated with *F. martii*, though some more severe

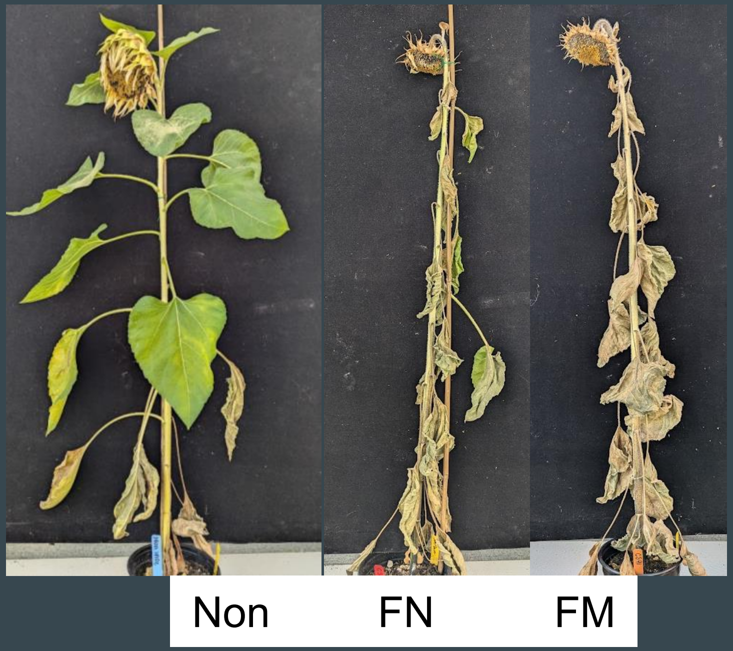






Next steps-*F. martii* management-2026

- Host range appears consistent for FN and FM – can be co-managed with the same suppressive crops, same crop avoidance guidelines
- Integrate results into UC IPM Pest note – together with cultivar- based management work



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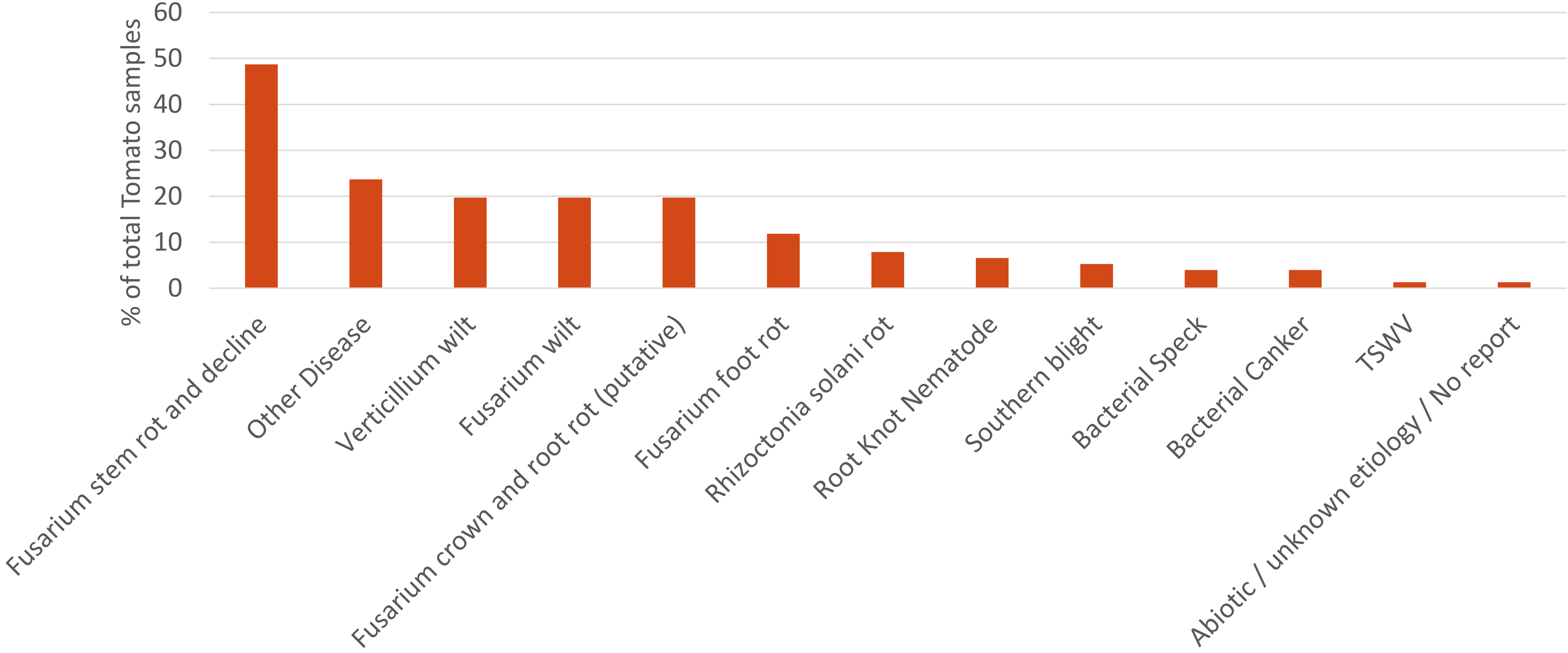
Ever a moving target: Disease diagnosis, new pathogen monitoring, and outreach support to the California processing tomato industry

CALIFORNIA TOMATO RESEARCH INSTITUTE – FY26/27

CASSANDRA SWETT

UC DAVIS, DEPT. OF PLANT PATHOLOGY

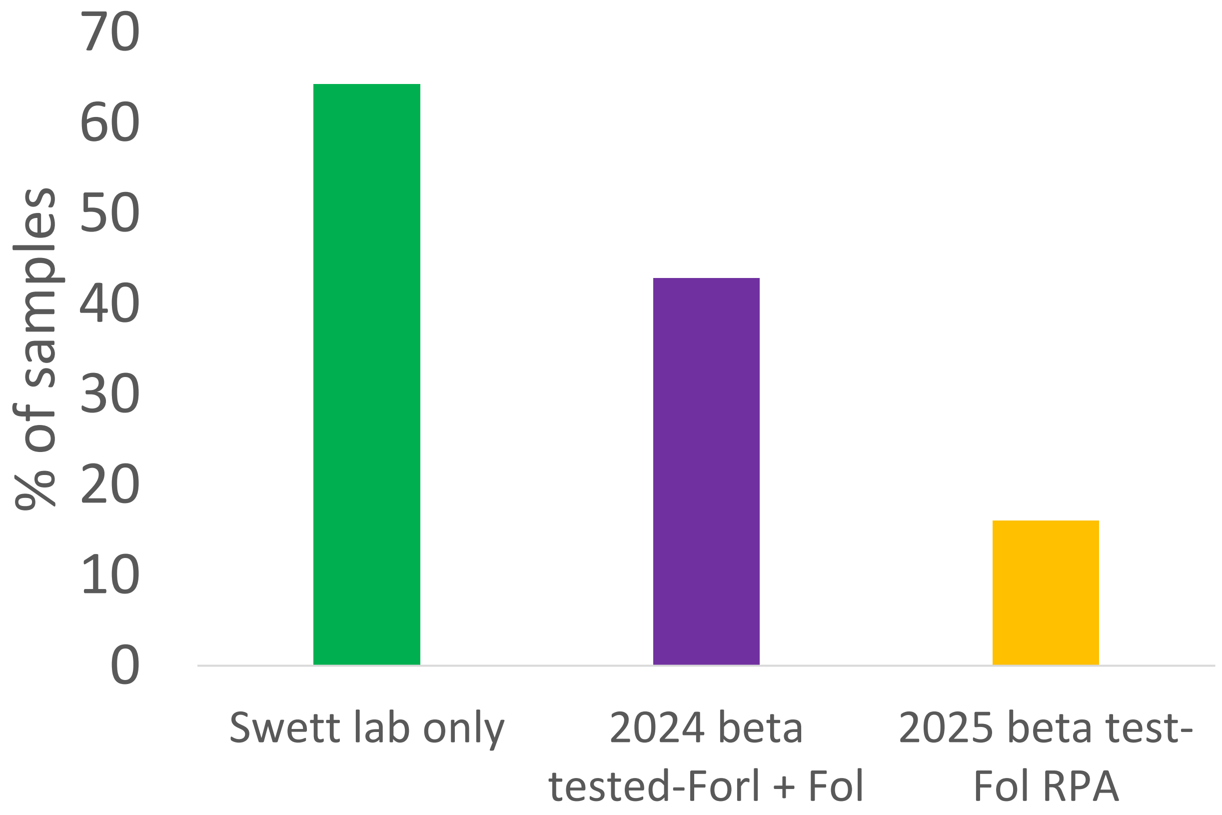
Diagnostics to support management of diverse diseases 2025 diagnoses – pathogen monitoring and decision support



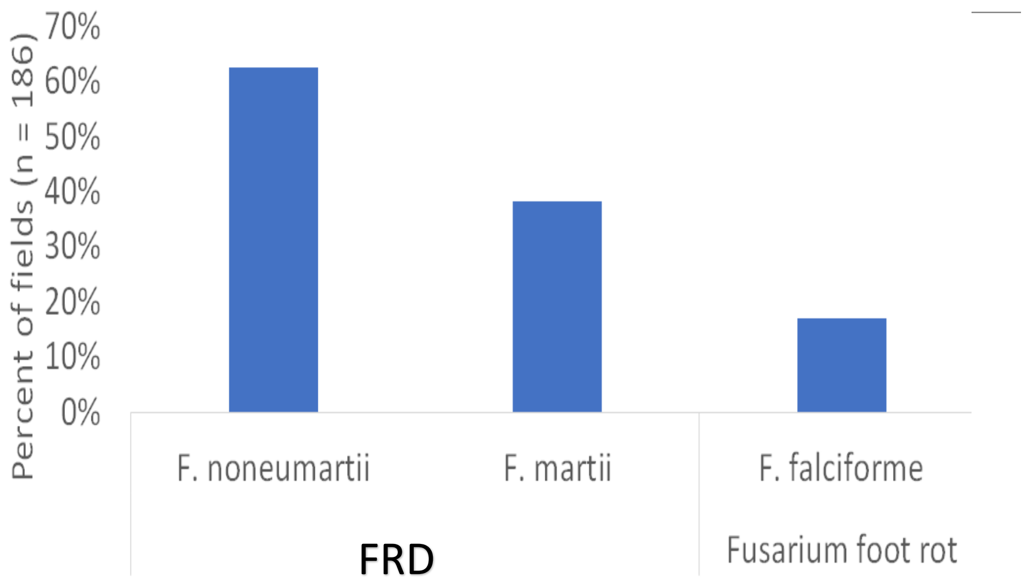
Use of specialized diagnostic tools

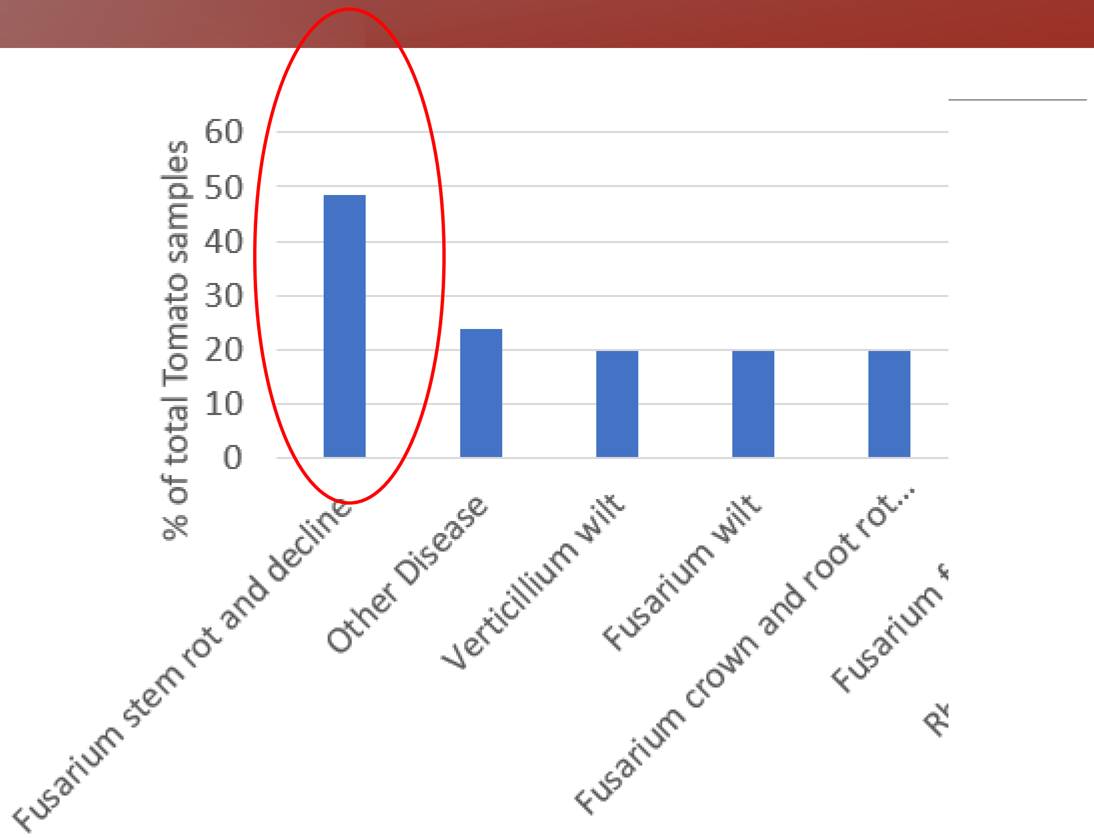
FY25/26

- Improving speed of diagnosis
- RPA for Fusarium wilt
    - Screened against Fol and non targets-confirm efficacy
    - Beta testing – tissue stored; testing underway



FY26/27: Use of specialized diagnostic tools-improving diagnosis of FRD





There are two diseases of processing tomato caused by members of the F. solani species complex

Fusarium Solani Species Complex (FSSC)

Fusarium Stem Rot and Decline (FRD)

Fusarium noneumartii

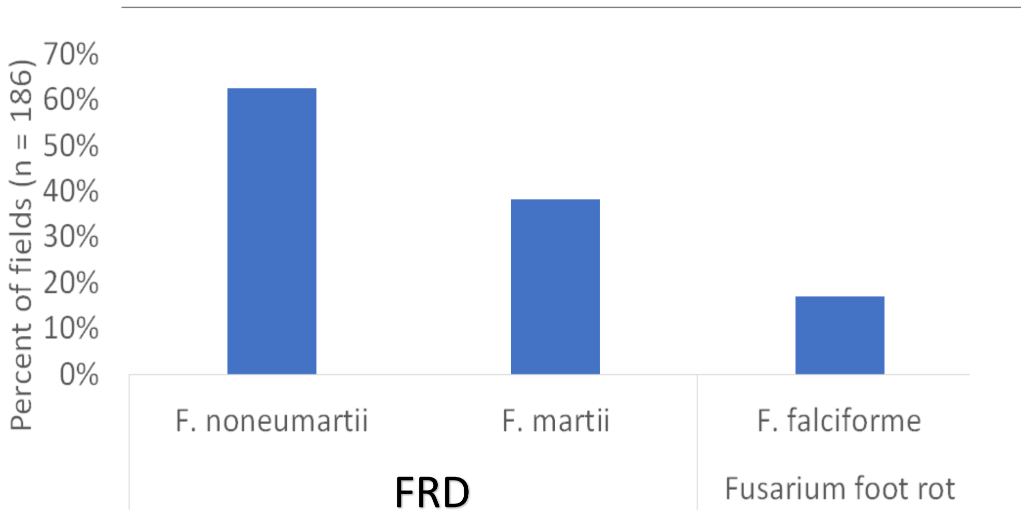
Fusarium martii

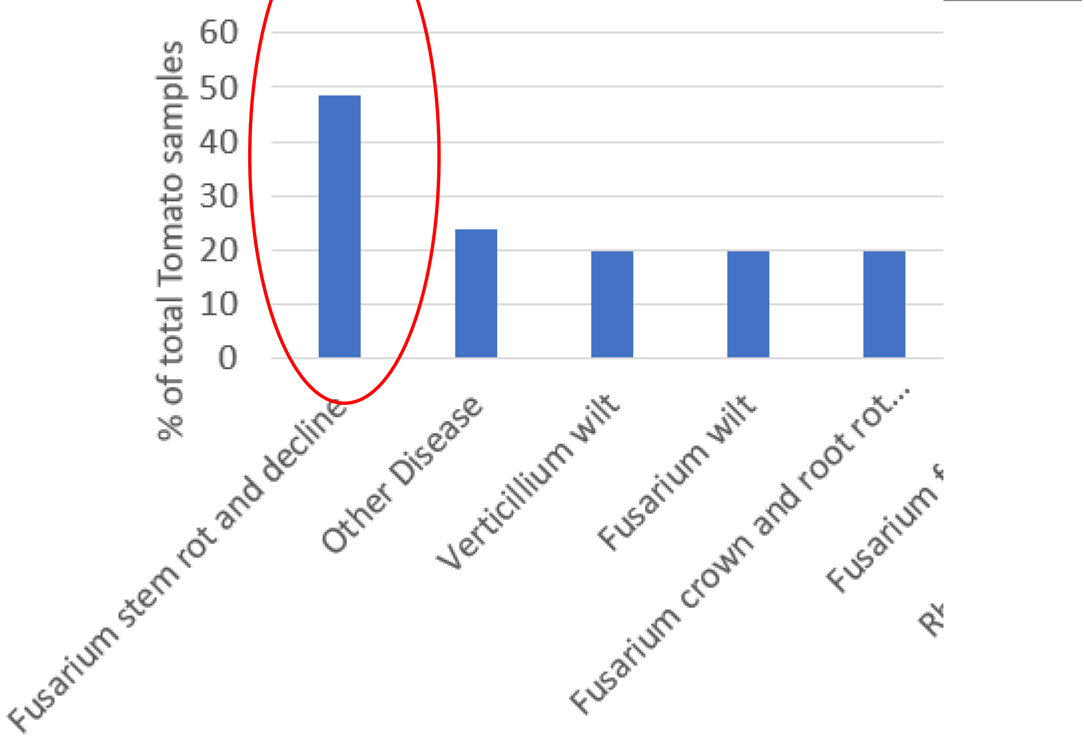
Previously referred to as *Fusarium falciforme*

Fusarium Foot Rot

Fusarium falciforme sensu strico

FY26/27: Use of specialized diagnostic tools-improving diagnosis of FRD





2026

- New FRD diagnostic tool testing
- F. noneumartii: FN1 beta testing
- F. martii: development of diagnostic region

use the 40+ genome pipeline generated for *F. martii* and related species (using support from DPR) to identify a diagnostic marker for *F. martii*

Monitoring for resistance breaking
Fusarium wilt in resistant (F3) cultivars = race 4?

2017-2023

33 F3 fields with Fol

Non RB

2024

4 F3 fields with Fol detected

None were RB

2025

5 F3 isolates where Fol was detected

In testing…

No fields (percent)							
Year	Total	Fol R1	Fol R2	Fol R3	Fol R4	Forl	Non-Path
2017	2	0	0	2 (100%)	0	0	0
2018	11	0	0	11 (100%)	0	0	0
2019	0	0	0	0	0	0	0
2020	2	0	0	2 (100%)	0	0	0
2021	2	0	0	2 (100%)	0	0	0
2022	3	0	0	3 (100%)	0	0	0
2023	9	0	0	3	0	2	4
2024	4	0	0	3	0	0	1
Total	33	0	0	26 (79%)	0	2 (6%)	5 (15%)
2025	5				TBD		

Spreading the word on the phenomenon of Fol race3 causing disease in F3 cultivars

To help reduce false reporting of Fol race 4 worldwide

frontiers | Frontiers in Plant Science

TYPE Original Research
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Check for updates

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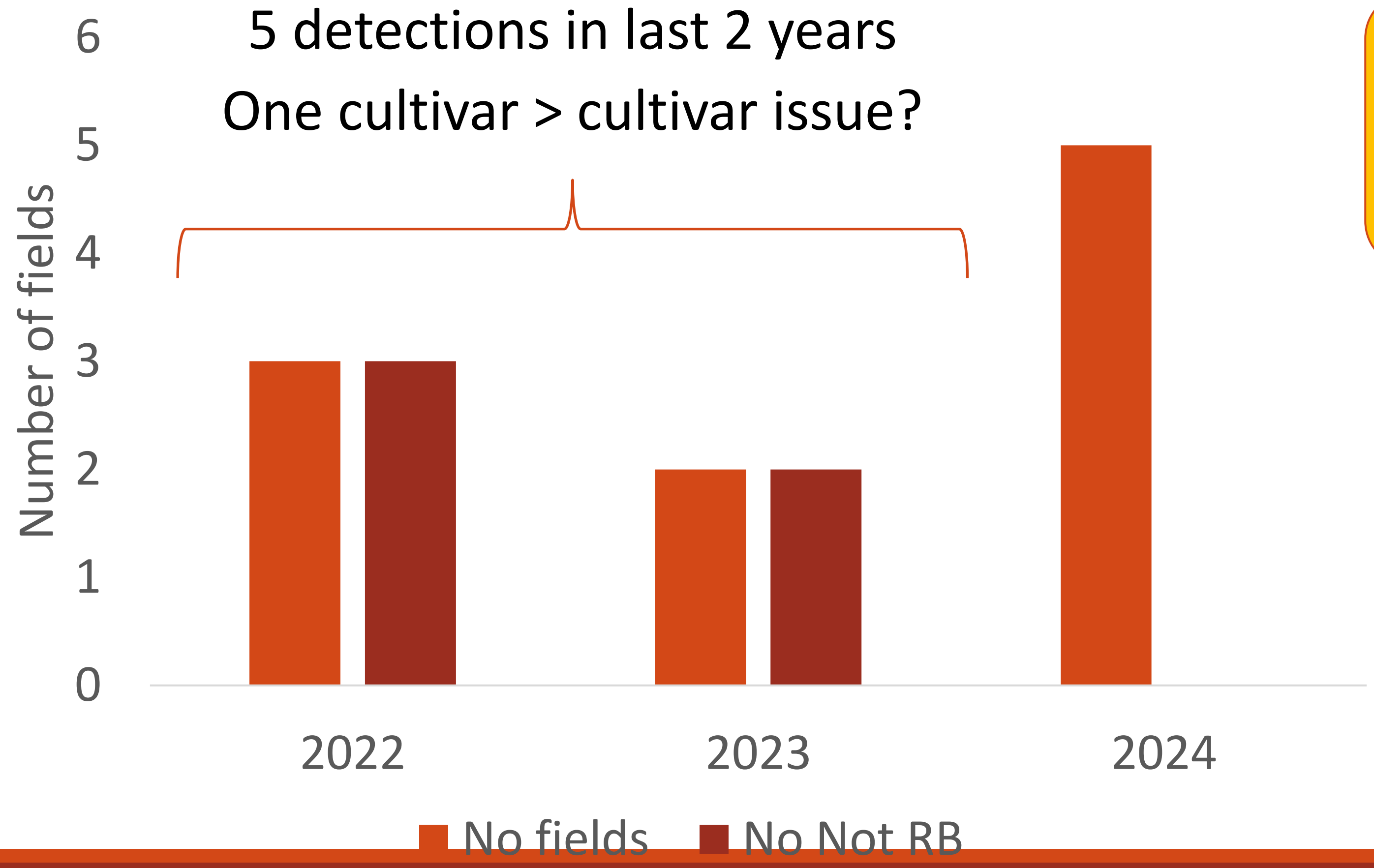
Monitoring for a new *I3* resistance gene-breaking race of *F. oxysporum* f. sp. *lycopersici* (Fusarium wilt) in California processing tomatoes following recent widespread adoption of resistant (F3) cultivars: Challenges with race 3 and 4 differentiation methods

Cassandra L. Swett*, Johanna Del Castillo Múnera, Elizabeth Hellman, Erin Helpio, Megan Gastelum, Elver Lopez Raymundo, Heather Johnson, Rino Oguchi, Aimee Hopkins, Justine Beaulieu and Fernando Rodriguez

Fusarium crown and root rot in resistant (Fr) cultivars

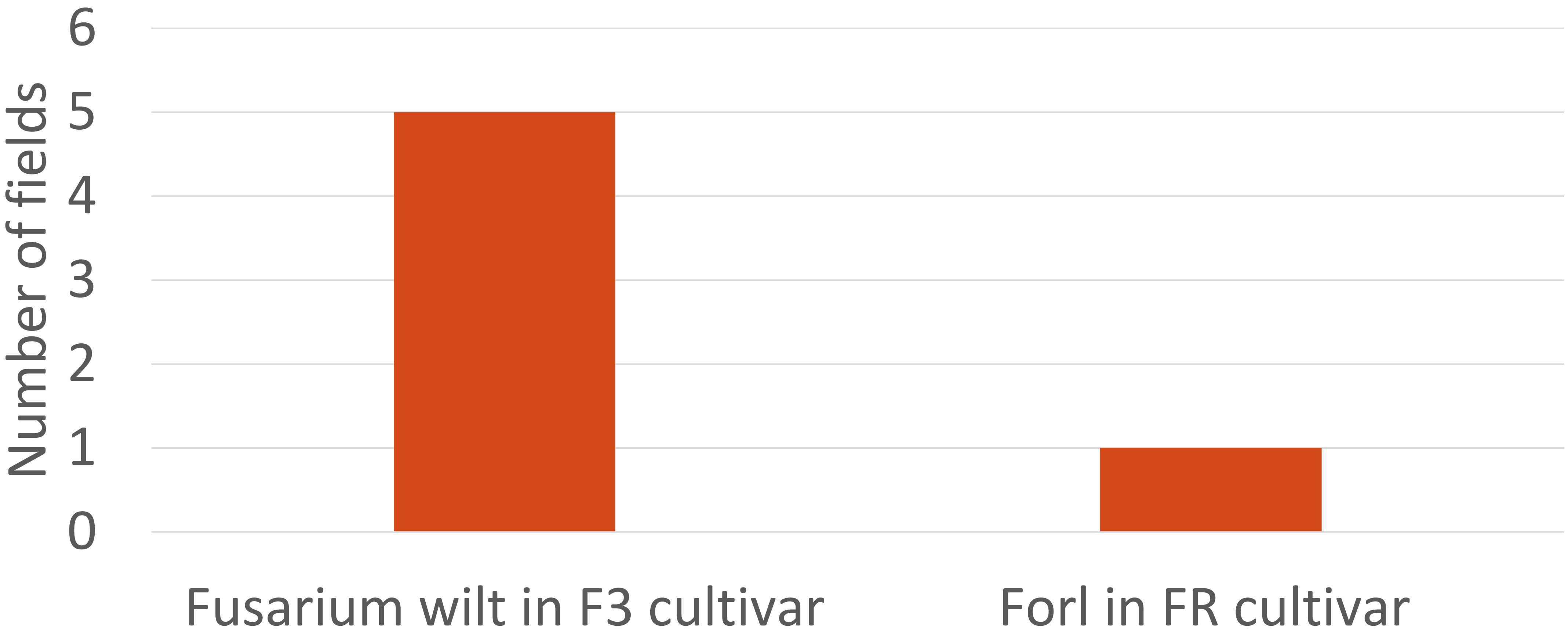


FY 25/26:

5 detections this year to test

All non-pathogens

FY 25/26: Potential resistance-breaking detections in 2025
FY 26/27: Identify these isolates and continue to monitor



The Swett lab culture collection is derived diagnostic samples = Core component of tomato research statewide

- ~1400 isolates from tomato
- ~20 different tomato pathogens
  - Includes putatively new pathogens saved for pathogenicity testing
- ~200 historical isolates (1980s, 1990s, 2000s) from tomato
- Provide isolates to ~15-20 researchers annually

Use information in field days, laboratory workshops and in-service trainings: highlight diagnostic challenges, management strategies, etc

FY 25/26

In service field day

Cultivar plot trial: FRD

Winter grower meetings

FY 26/27

Vegetable disease field day-open to the industry

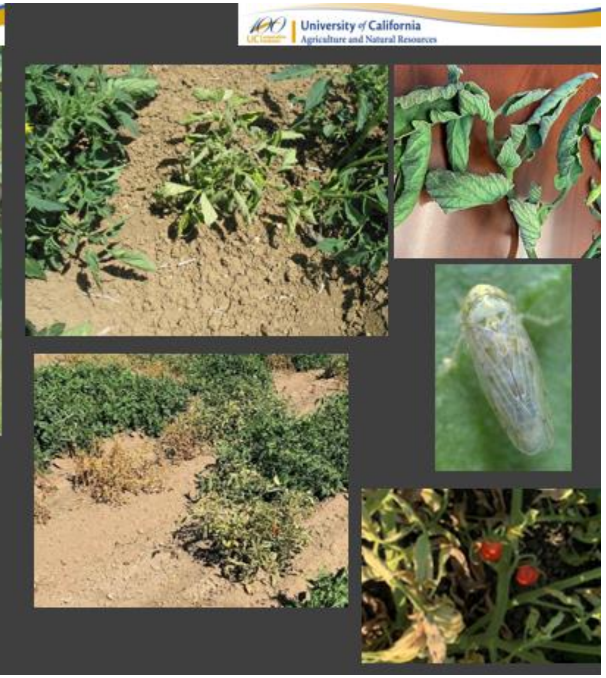
Winter grower meetings

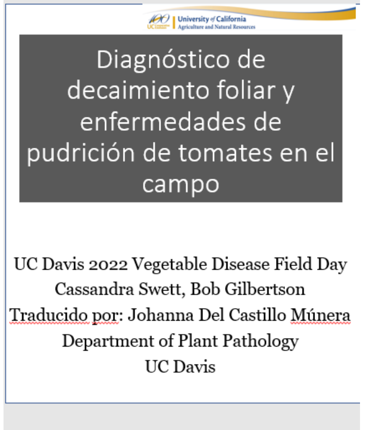
Outreach materials

FY 25/26

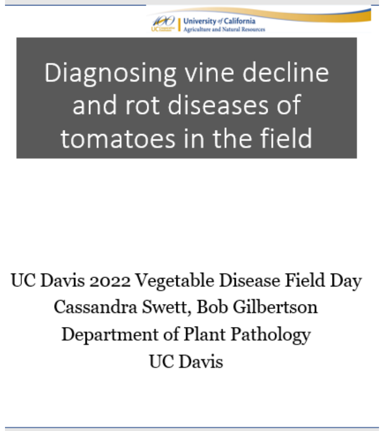
Fusarium wilt ANR 8000 series article
-submitted, in review

Tomato disease diagnostic field guide
-submitted, reviewed, in revision




Diagnóstico de decaimiento foliar y enfermedades de pudrición de tomates en el campo

UC Davis 2022 Vegetable Disease Field Day
Cassandra Swett, Bob Gilbertson
Traducido por: Johanna Del Castillo Múnera
Department of Plant Pathology
UC Davis


Diagnosing vine decline and rot diseases of tomatoes in the field

UC Davis 2022 Vegetable Disease Field Day
Cassandra Swett, Bob Gilbertson
Department of Plant Pathology
UC Davis

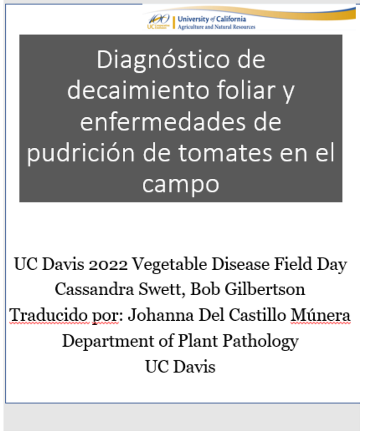
Outreach materials

FY 26/27 – complete publication

Fusarium wilt ANR 8000 series article
-revisions

Tomato disease diagnostic field guide
-revisions

-UC IPM disease section edits


Diagnóstico de decaimiento foliar y enfermedades de pudrición de tomates en el campo

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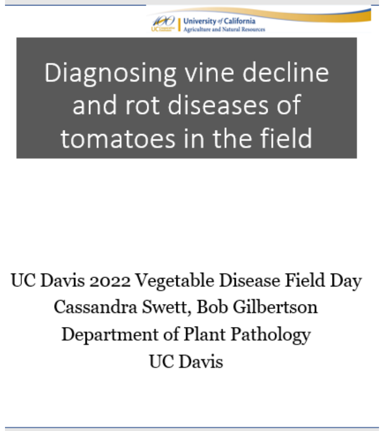
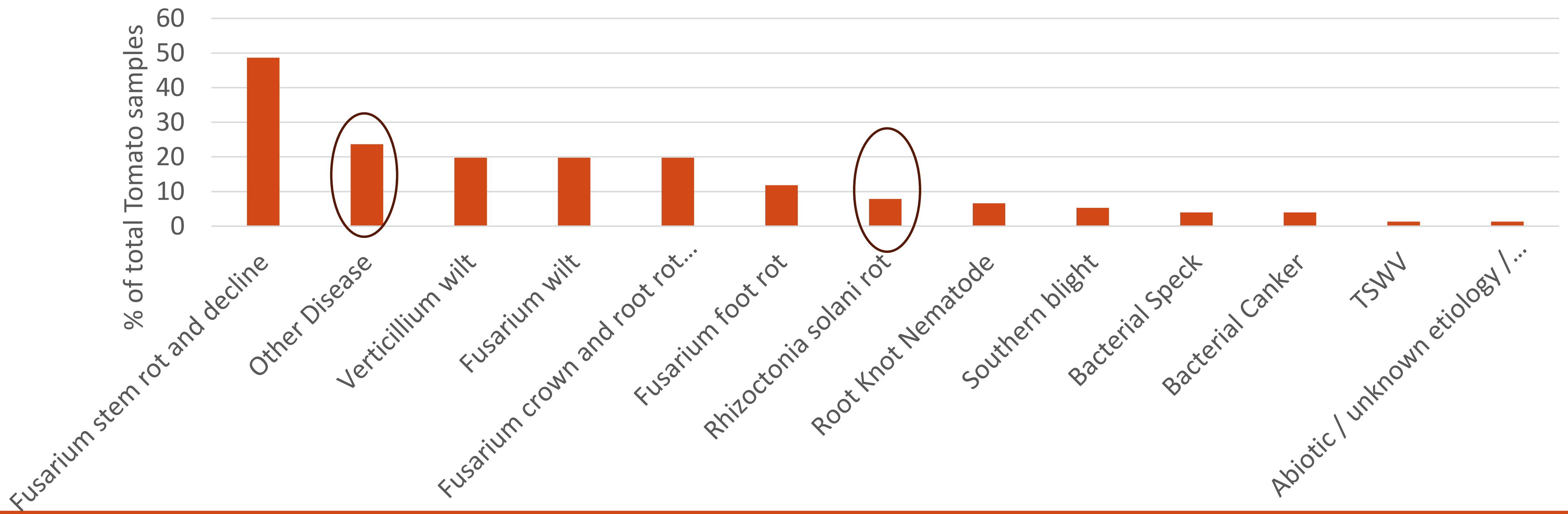

Diagnosing vine decline and rot diseases of tomatoes in the field

UC Davis 2022 Vegetable Disease Field Day
Cassandra Swett, Bob Gilbertson
Department of Plant Pathology
UC Davis

Questions from the board?

Are there emerging diseases we should be thinking about?

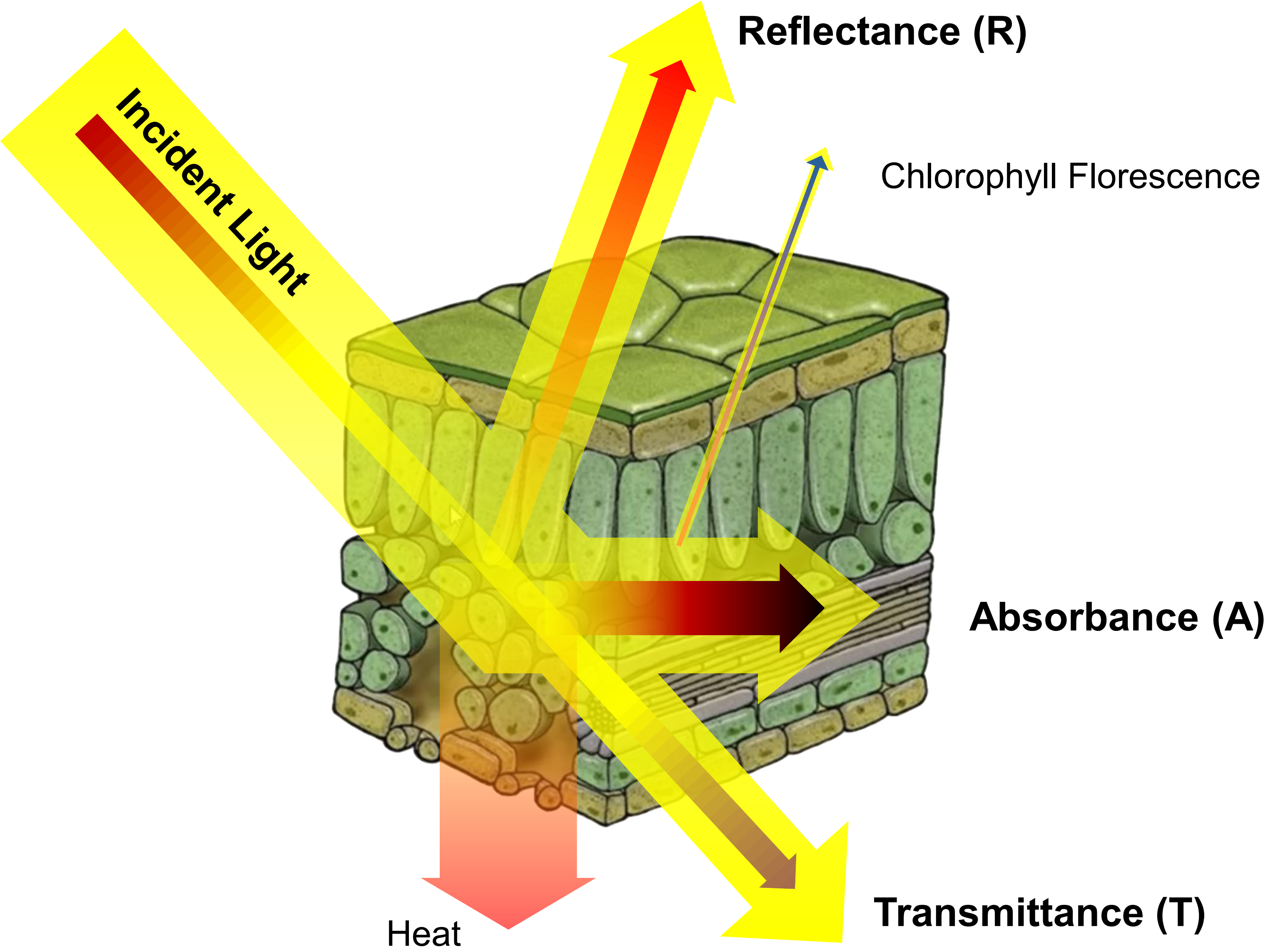
What should we be doing (if anything) with the root rot associated group?



AI-Based, Real-Time Nutrient and Stress Diagnosis Tool for Tomatoes

Alireza Pourreza
Associate Professor of Extension
UC Davis – UC ANR

Digital Ag
UC DAVIS


Incident Light
Reflectance (R)
Chlorophyll Florescence
Absorbance (A)
Transmittance (T)
Heat

Radiative Transfer Modeling

Radiative transfer modeling (RTM) is a widely used technique for understanding and predicting the interactions between electromagnetic radiation and matter in various applications, including agriculture. One of the most used RTM models in vegetation remote sensing is the PROSPECT model, which simulates leaf optical properties and has been used for various applications. Below is an RTM simulator based on the prospect model (developed by Damian Oswald):

Practical Demonstration of the Prospect Model Inversion

☑ Show model predictions ☐ Show MSE ☐ Estimate alpha

Leaf structure parameter: 2 (range 0.5–3.5)

Chlorophyll content: 0 (range 0–80)

Carotenoid content: 0 (range 0–15)

Anthocyain content: 0 (range 0–10)

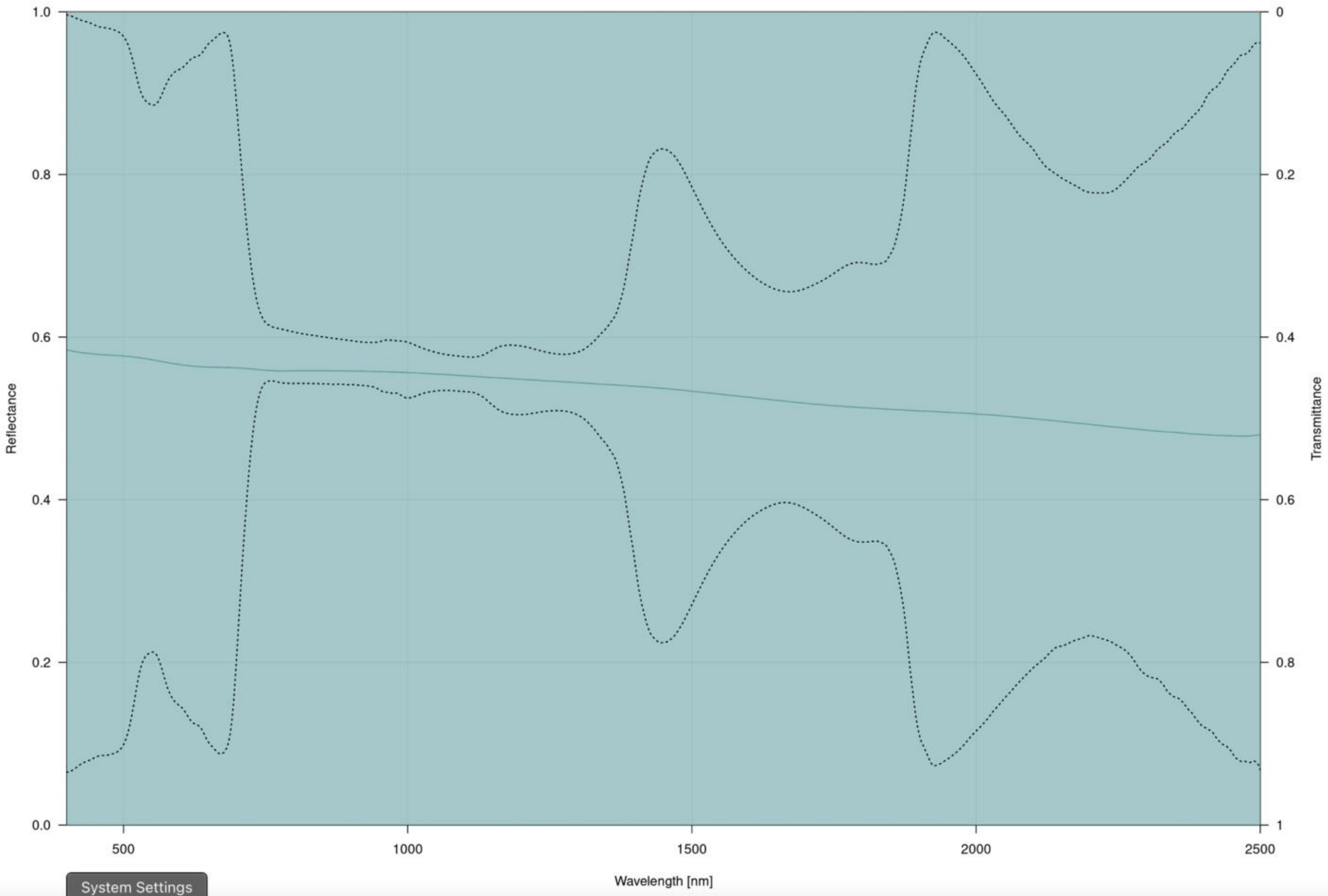
Equivalent water thickness: 0 (range 0–0.02)

Protein content: 0 (range 0–0.005)

Carbon-based (non-protein) content: 0 (range 0–0.01)

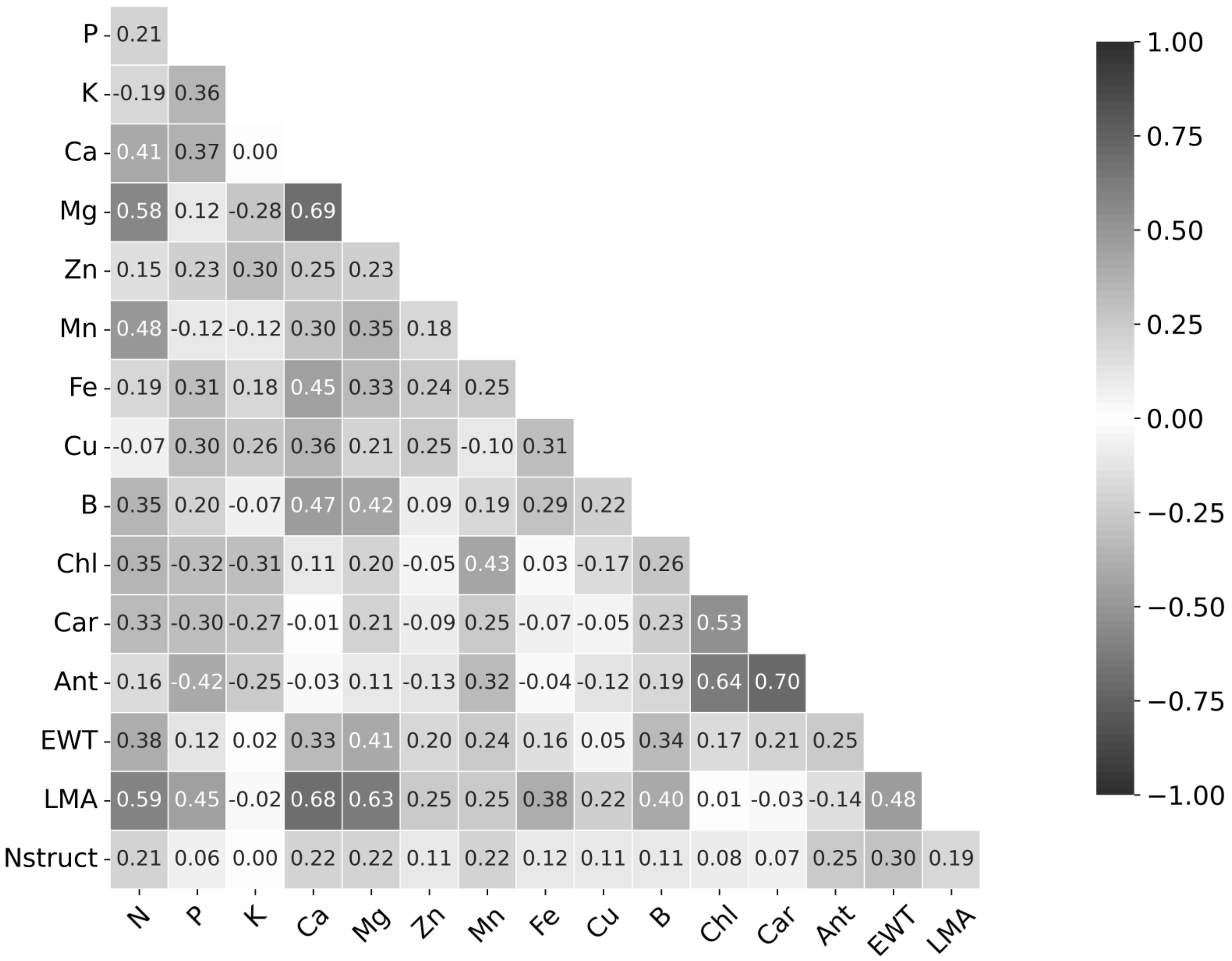
Solid angle for incident light at surface of leaf: 40 (range 10–90)

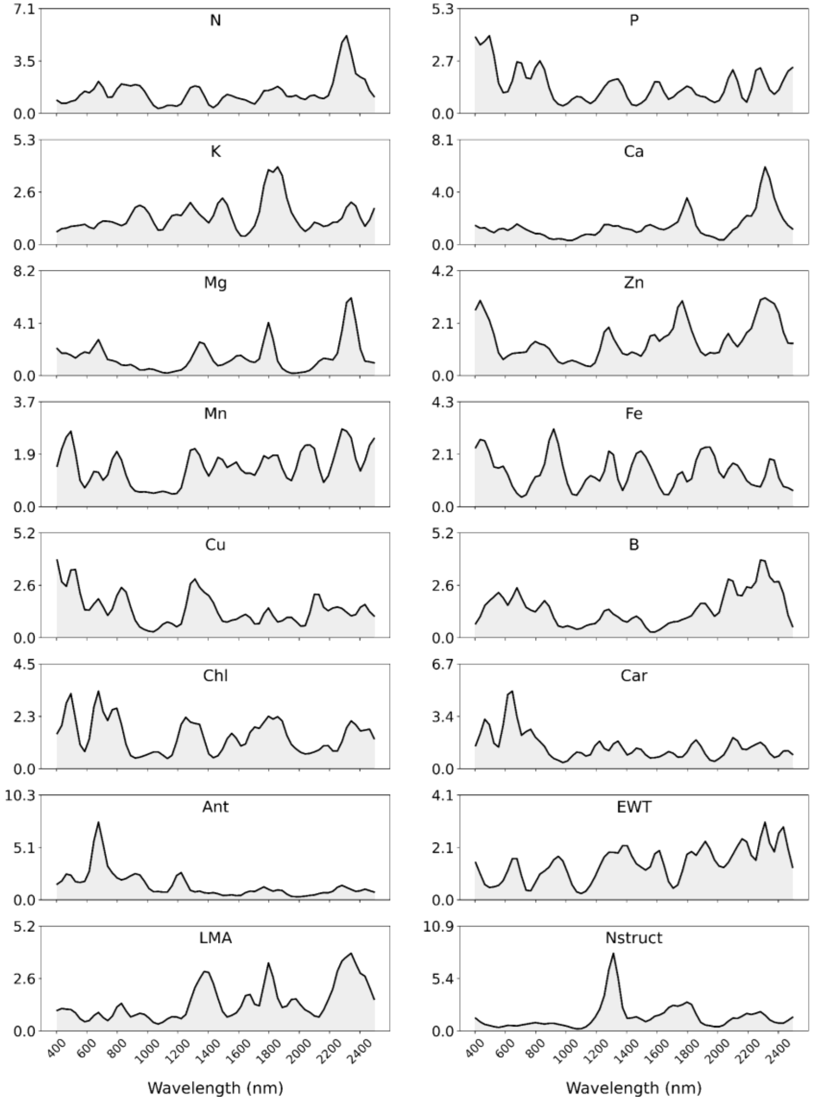
Optimize the parameters | Reset parameters | New observation

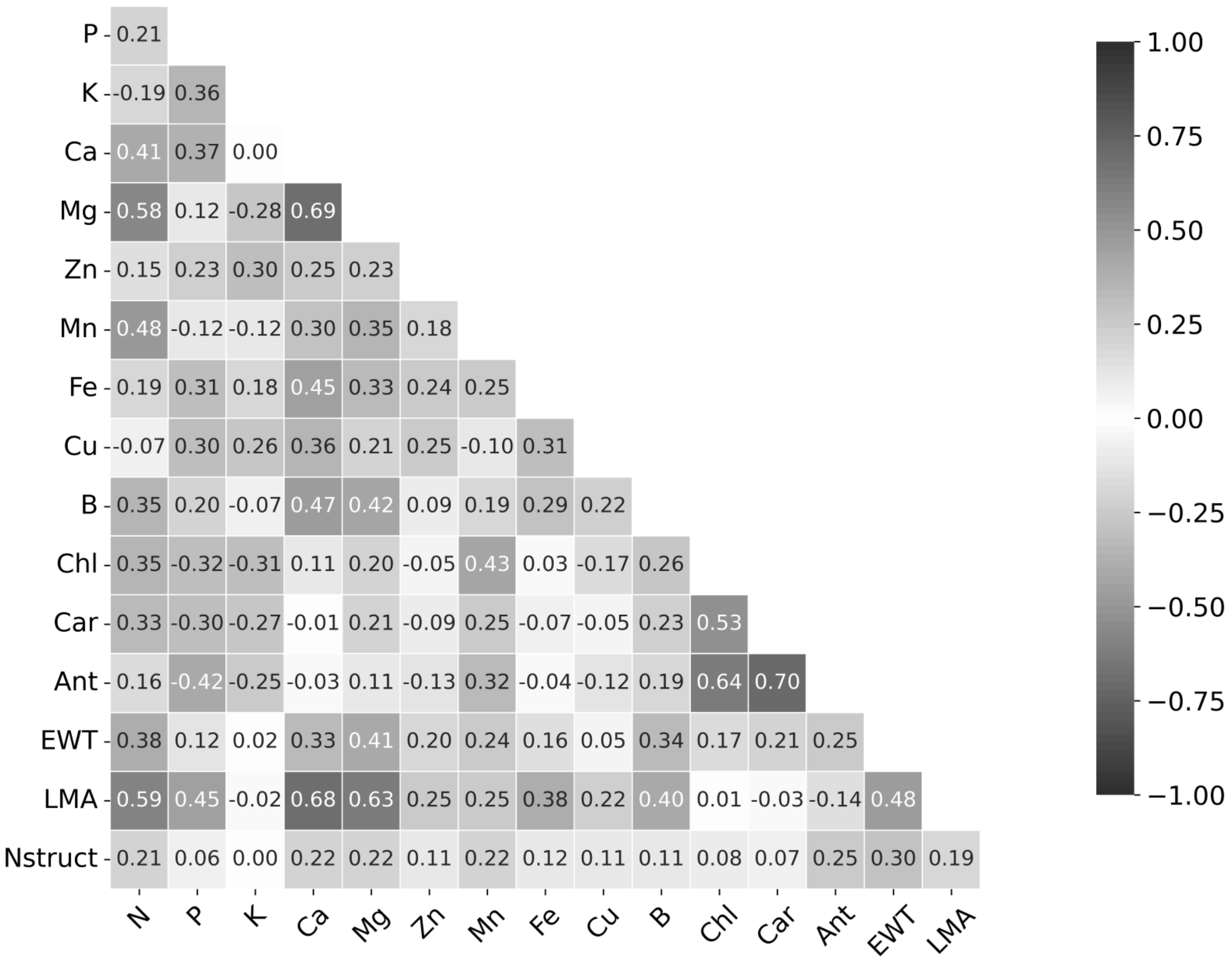


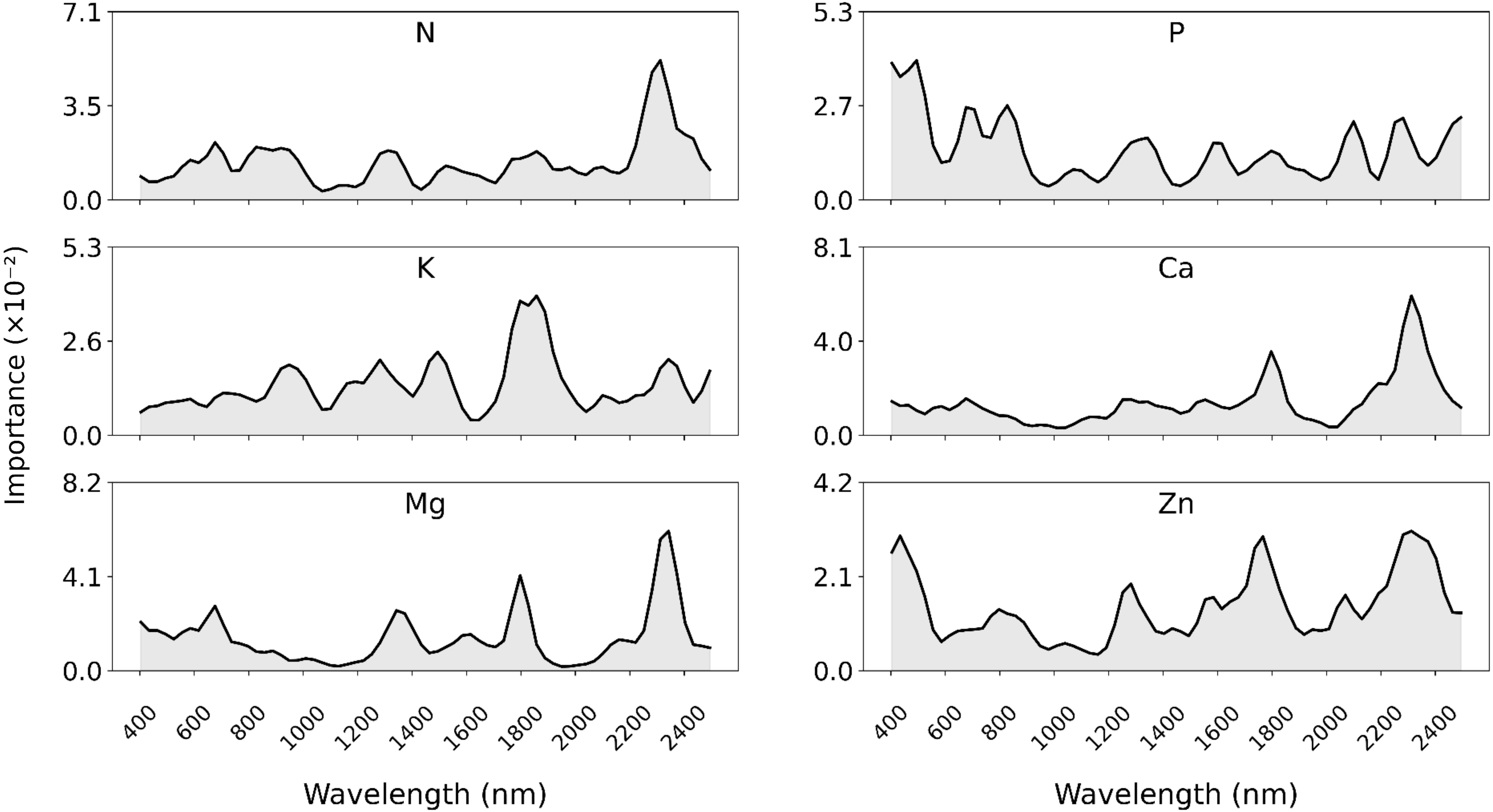
System Settings

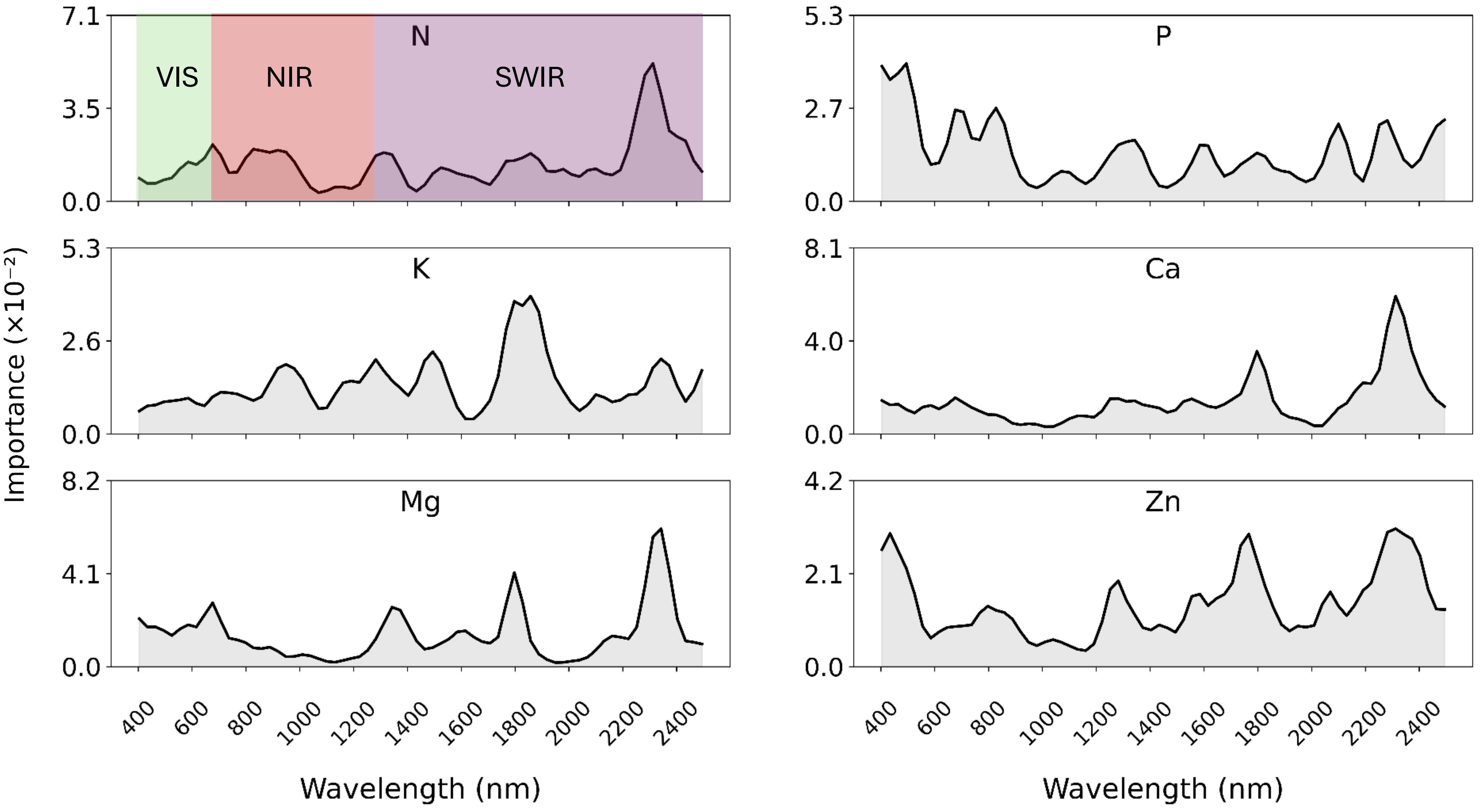
Modeling for Leaf Traits + Nutrition



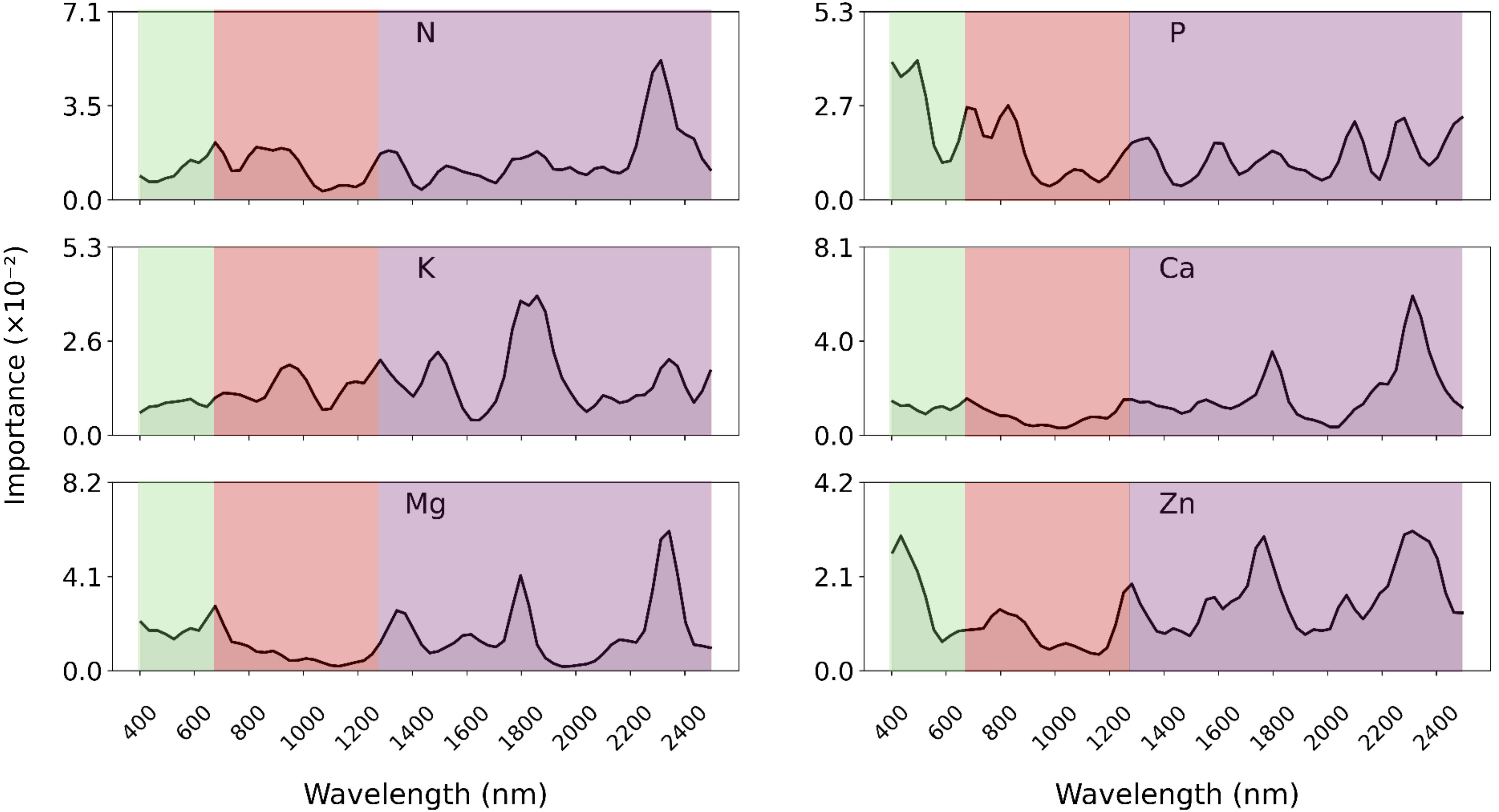

N
P
K
Ca
Mg
Zn
Mn
Fe
Cu
B
Chl
Car
Ant
EWT
LMA
Nstruct
Wavelength (nm)
Wavelength (nm)


P 0.21
K -0.19 0.36
Ca 0.41 0.37 0.00
Mg 0.58 0.12 -0.28 0.69
Zn 0.15 0.23 0.30 0.25 0.23
Mn 0.48 -0.12 -0.12 0.30 0.35 0.18
Fe 0.19 0.31 0.18 0.45 0.33 0.24 0.25
Cu -0.07 0.30 0.26 0.36 0.21 0.25 -0.10 0.31
B 0.35 0.20 -0.07 0.47 0.42 0.09 0.19 0.29 0.22
Chl 0.35 -0.32 -0.31 0.11 0.20 -0.05 0.43 0.03 -0.17 0.26
Car 0.33 -0.30 -0.27 -0.01 0.21 -0.09 0.25 -0.07 -0.05 0.23 0.53
Ant 0.16 -0.42 -0.25 -0.03 0.11 -0.13 0.32 -0.04 -0.12 0.19 0.64 0.70
EWT 0.38 0.12 0.02 0.33 0.41 0.20 0.24 0.16 0.05 0.34 0.17 0.21 0.25
LMA 0.59 0.45 -0.02 0.68 0.63 0.25 0.25 0.38 0.22 0.40 0.01 -0.03 -0.14 0.48
Nstruct 0.21 0.06 0.00 0.22 0.22 0.11 0.22 0.12 0.11 0.11 0.08 0.07 0.25 0.30 0.19
N P K Ca Mg Zn Mn Fe Cu B Chl Car Ant EWT LMA

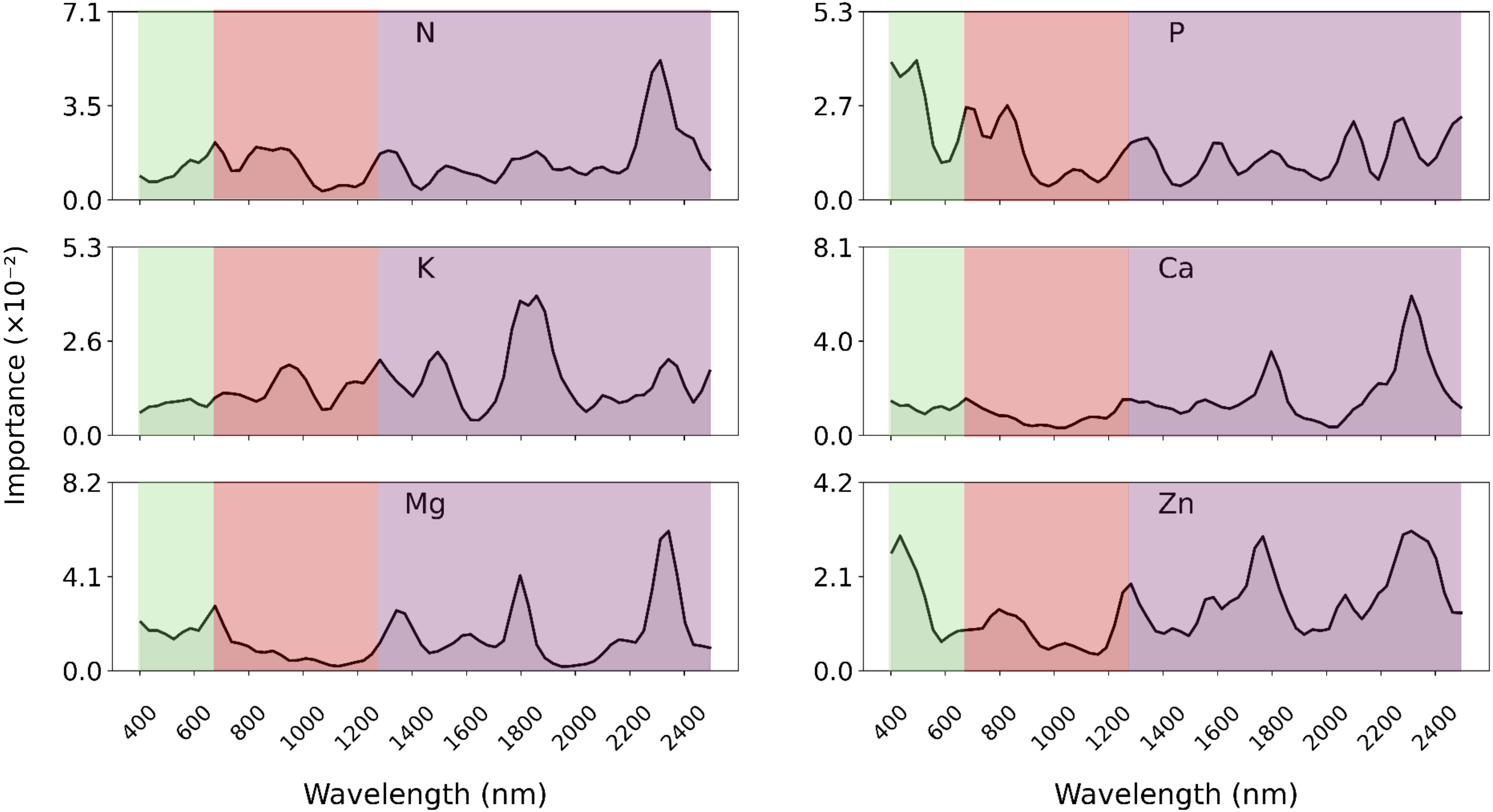

N
P
K
Ca
Mg
Zn
7.1
3.5
0.0
5.3
2.7
0.0
5.3
2.6
0.0
8.1
4.0
0.0
8.2
4.1
0.0
4.2
2.1
0.0
400 600 800 1000 1200 1400 1600 1800 2000 2200 2400
Importance (×10⁻²)
Wavelength (nm)
Wavelength (nm)



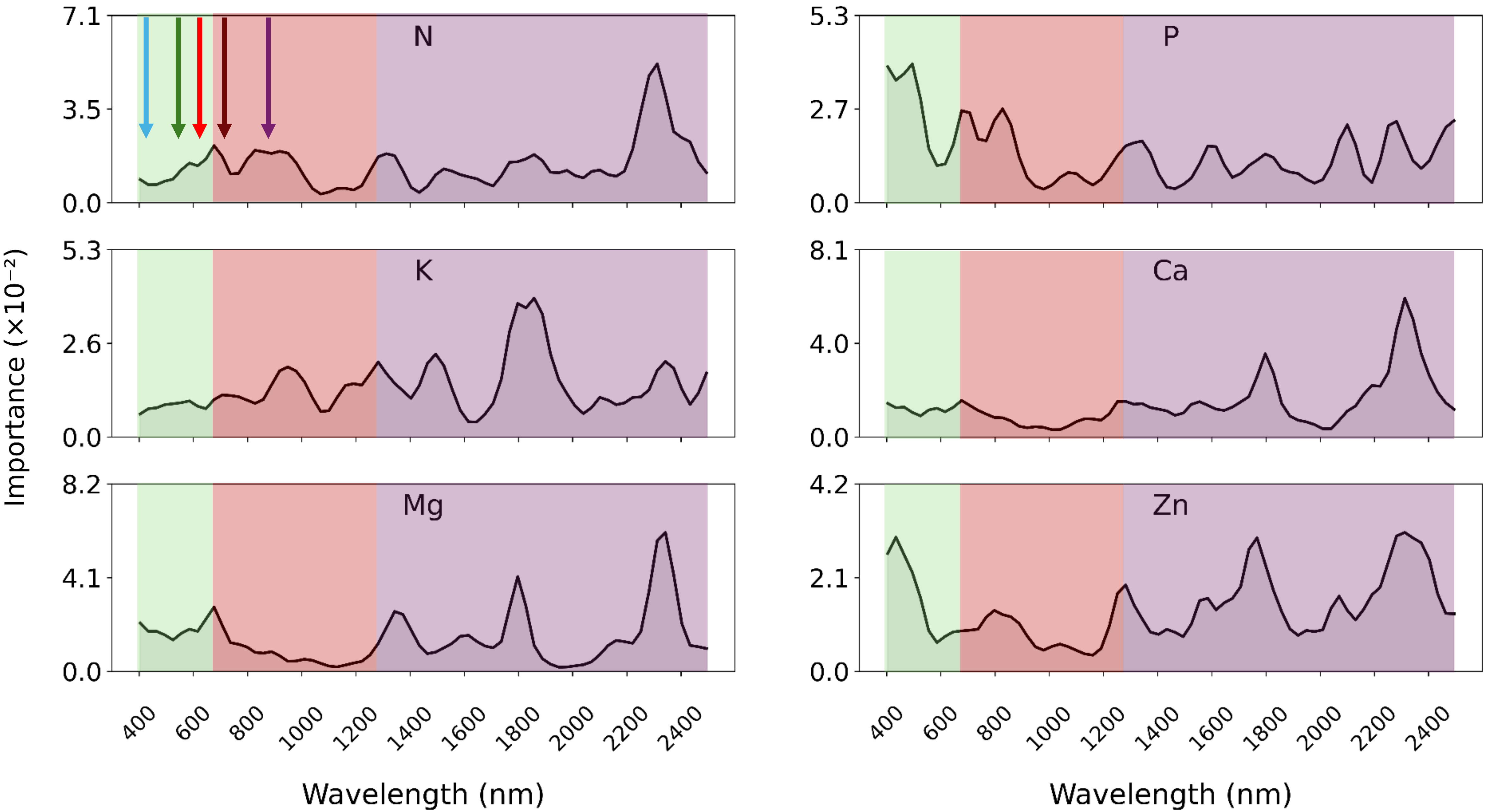
N
VIS
NIR
SWIR
P
K
Ca
Mg
Zn
7.1
3.5
0.0
5.3
2.7
0.0
5.3
2.6
0.0
8.1
4.0
0.0
8.2
4.1
0.0
4.2
2.1
0.0
Importance (×10⁻²)
400 600 800 1000 1200 1400 1600 1800 2000 2200 2400
Wavelength (nm)
Wavelength (nm)



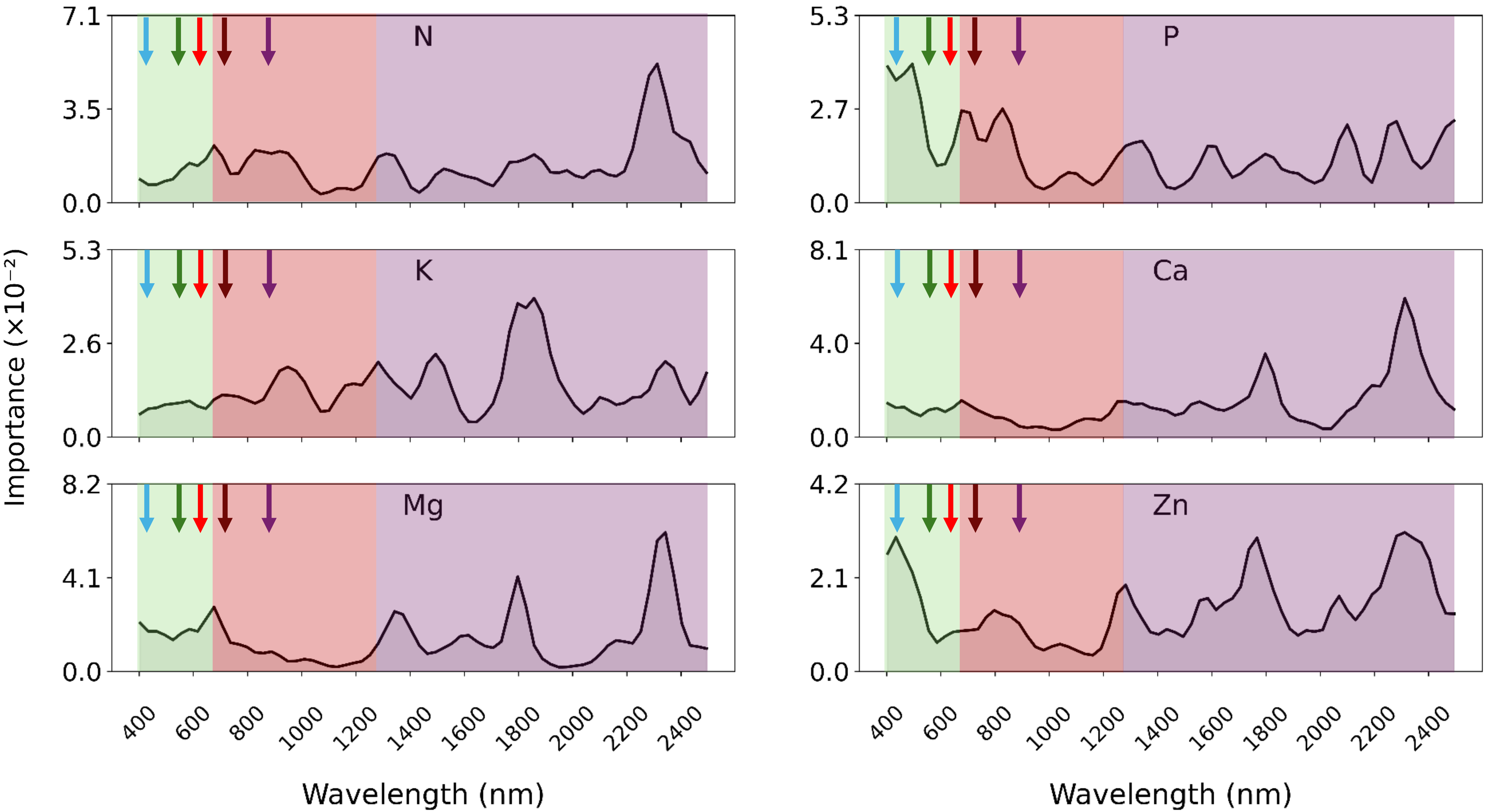
Importance (×10⁻²)
N
P
K
Ca
Mg
Zn
7.1
3.5
0.0
5.3
2.7
0.0
5.3
2.6
0.0
8.1
4.0
0.0
8.2
4.1
0.0
4.2
2.1
0.0
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Wavelength (nm)
Wavelength (nm)



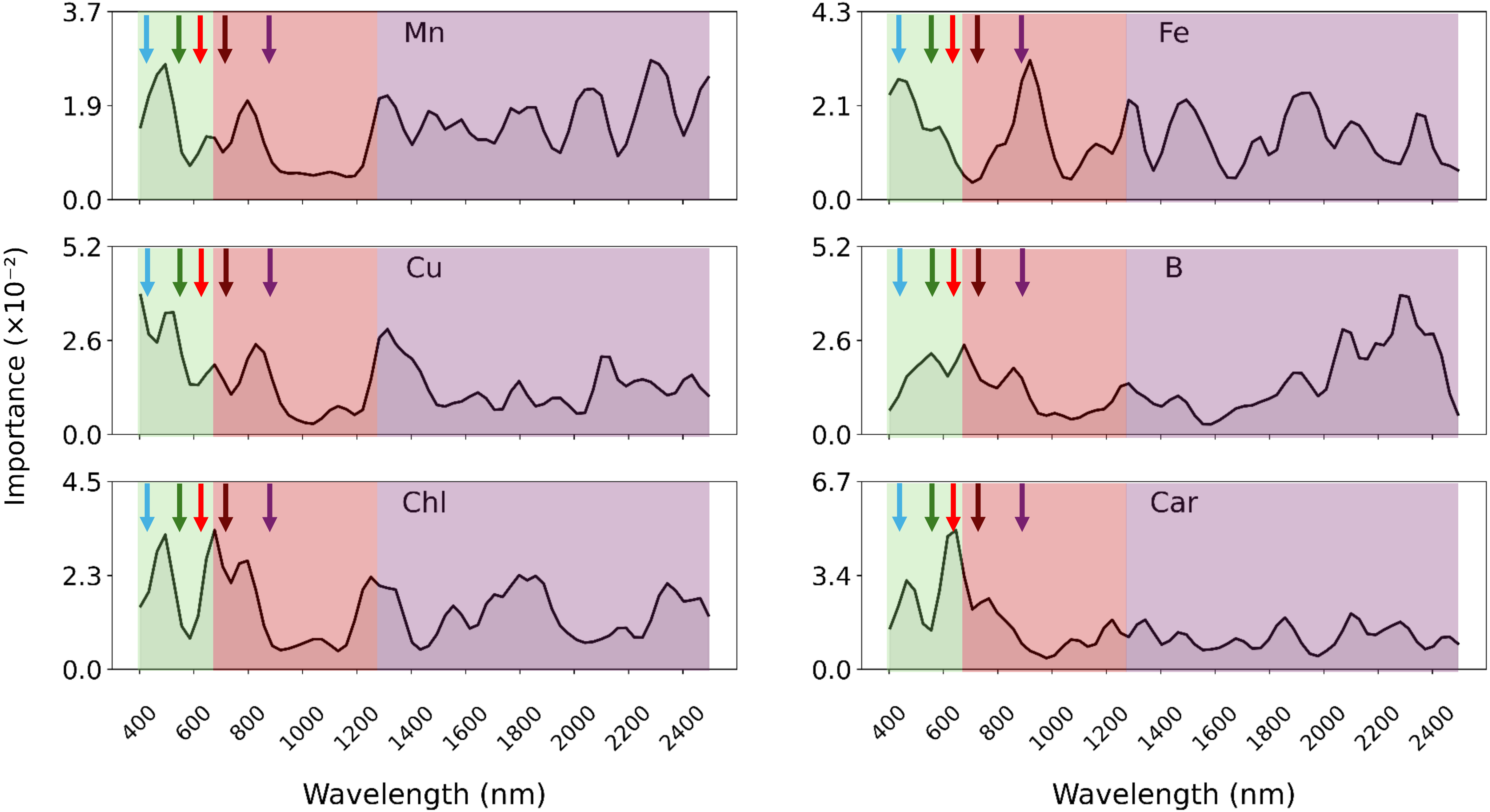
N
P
K
Ca
Mg
Zn
7.1
3.5
0.0
5.3
2.7
0.0
5.3
2.6
0.0
8.1
4.0
0.0
8.2
4.1
0.0
4.2
2.1
0.0
Importance (×10⁻²)
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Wavelength (nm)
Wavelength (nm)



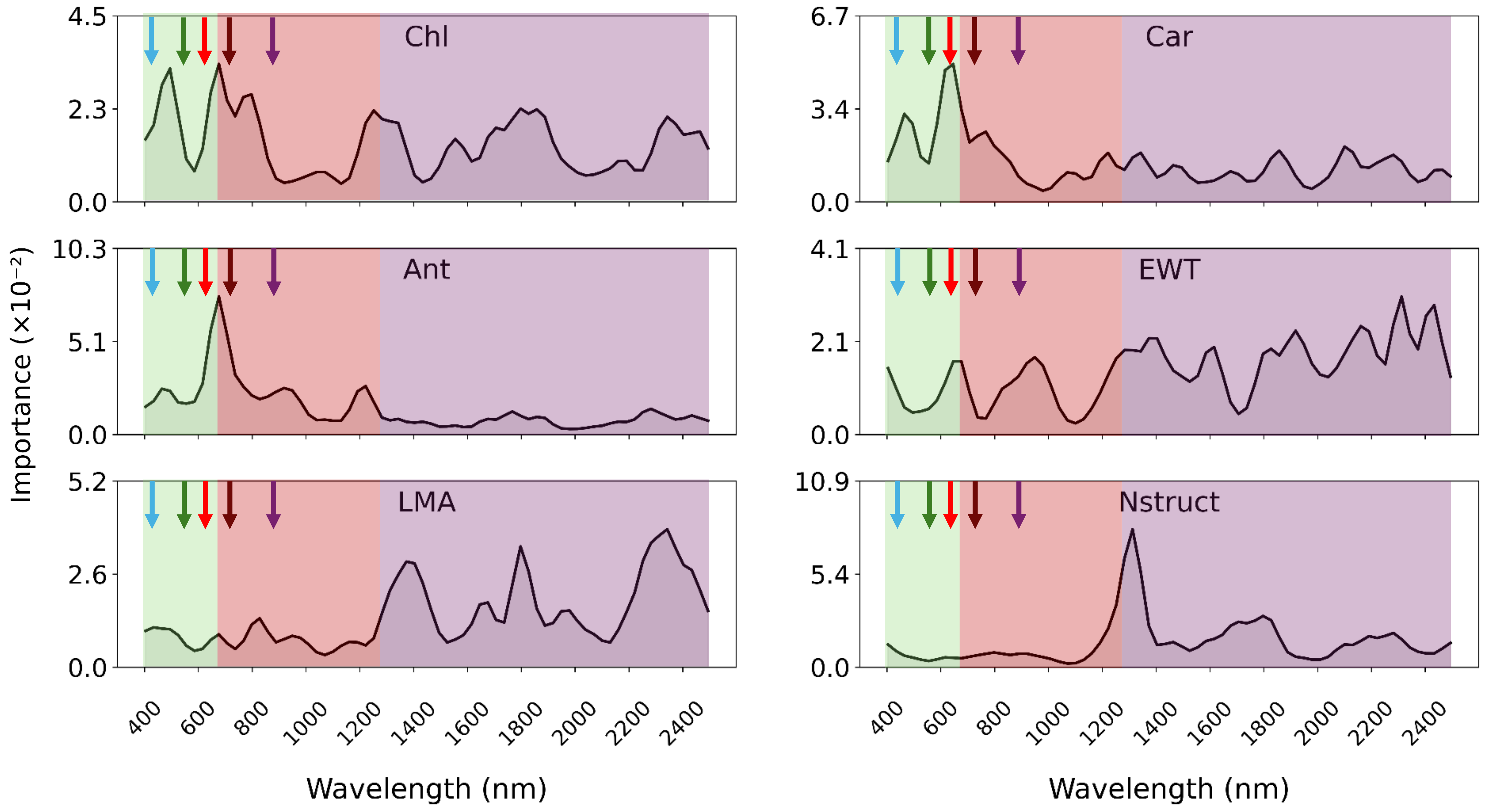
N
P
K
Ca
Mg
Zn
7.1
3.5
0.0
5.3
2.7
0.0
5.3
2.6
0.0
8.1
4.0
0.0
8.2
4.1
0.0
4.2
2.1
0.0
Importance (×10⁻²)
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Wavelength (nm)
Wavelength (nm)



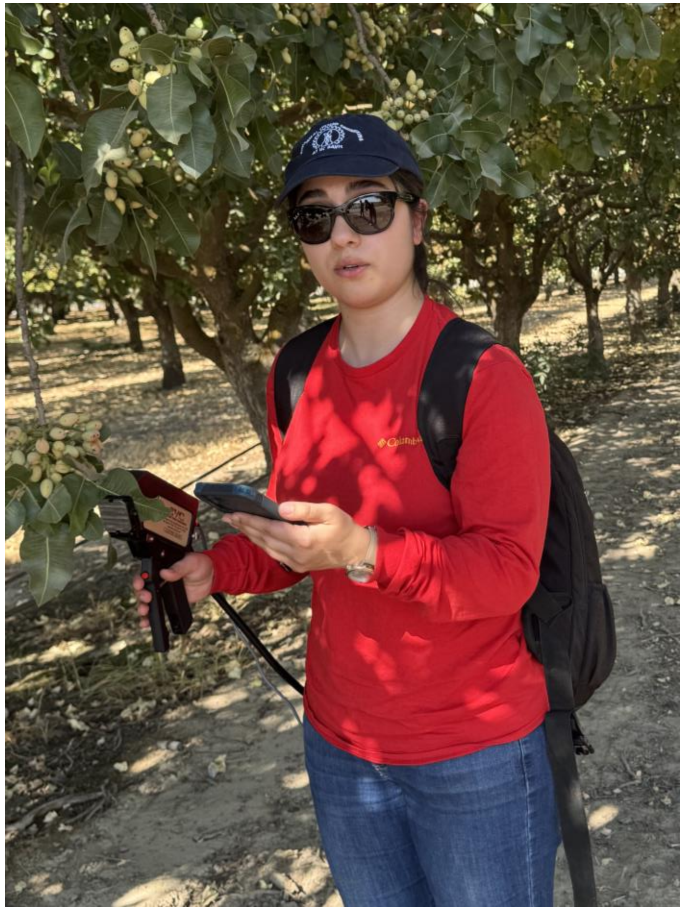
Importance (×10⁻²)
N
7.1
3.5
0.0
P
5.3
2.7
0.0
K
5.3
2.6
0.0
Ca
8.1
4.0
0.0
Mg
8.2
4.1
0.0
Zn
4.2
2.1
0.0
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Wavelength (nm)
Wavelength (nm)



Mn
Fe
Cu
B
Chl
Car
Importance (×10⁻²)
3.7
1.9
0.0
4.3
2.1
5.2
2.6
4.5
2.3
6.7
3.4
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Wavelength (nm)



Chl
Car
Ant
EWT
LMA
Nstruct
Importance (×10⁻²)
4.5
2.3
0.0
6.7
3.4
10.3
5.1
4.1
2.1
5.2
2.6
10.9
5.4
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Wavelength (nm)

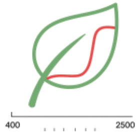


Parastoo Farajpoor, PHD Candidate

DATA Collection

Leaf spectral measurement

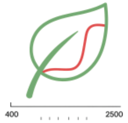
Mechanistic Forward

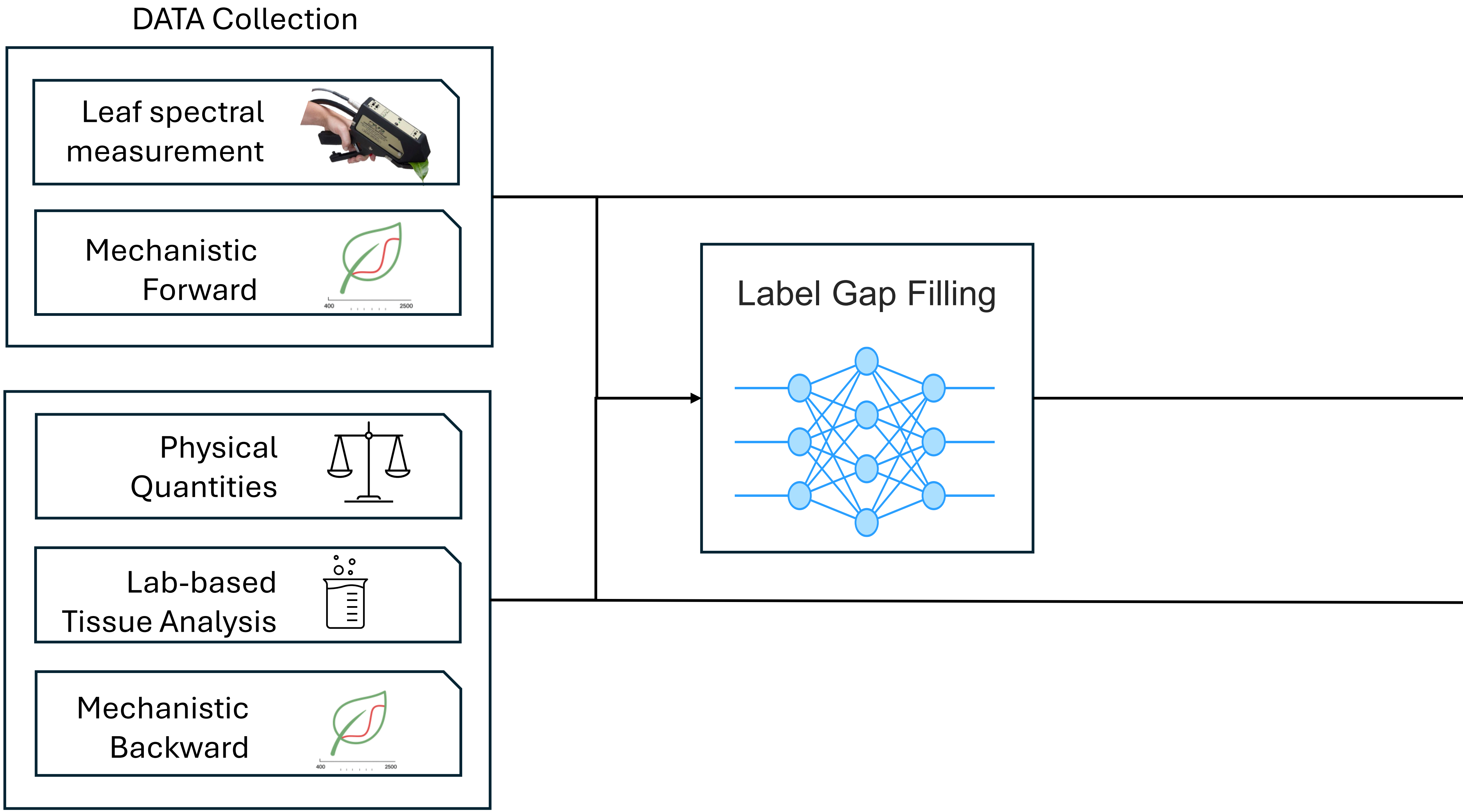


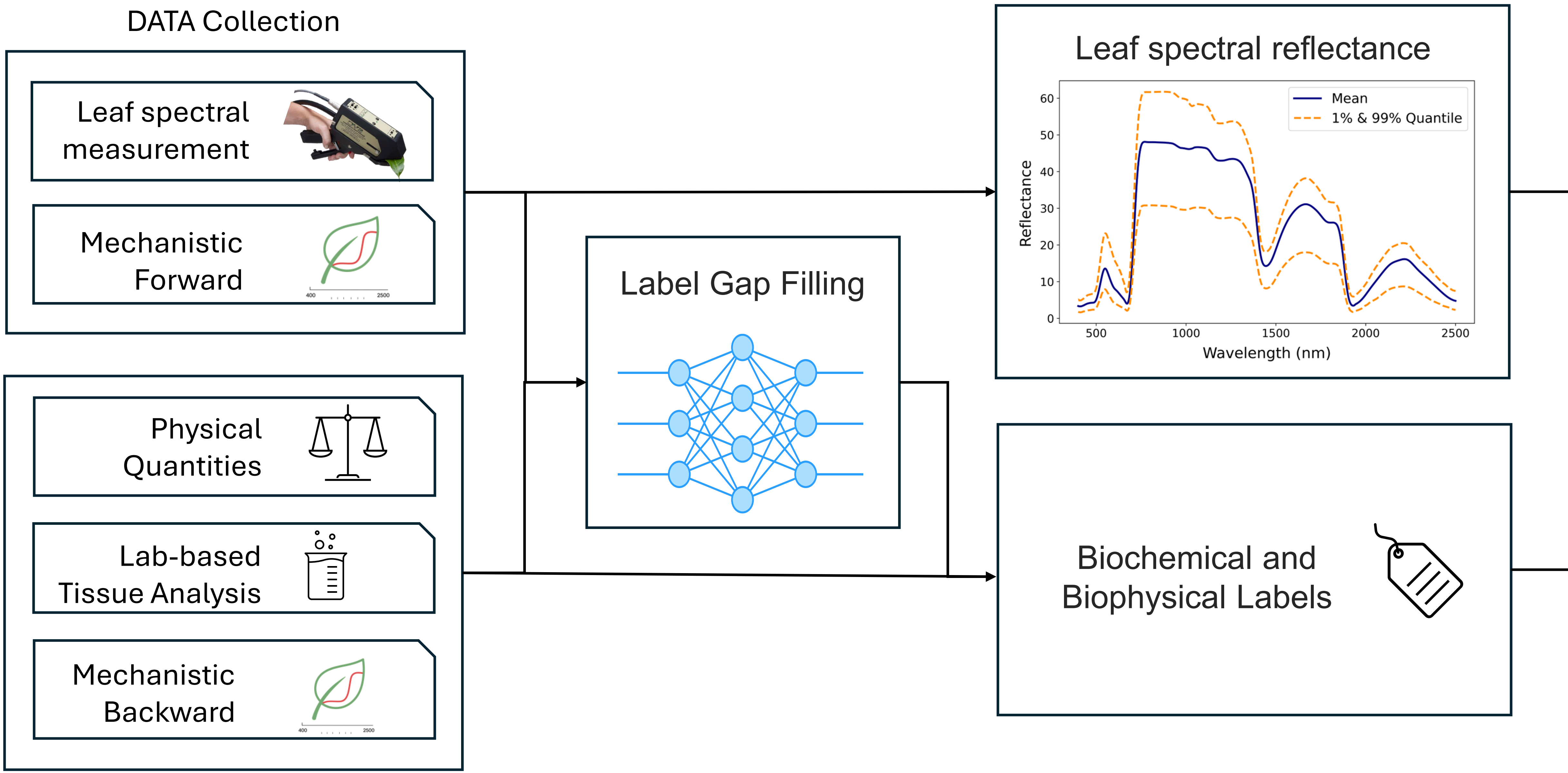
Physical Quantities

Lab-based Tissue Analysis

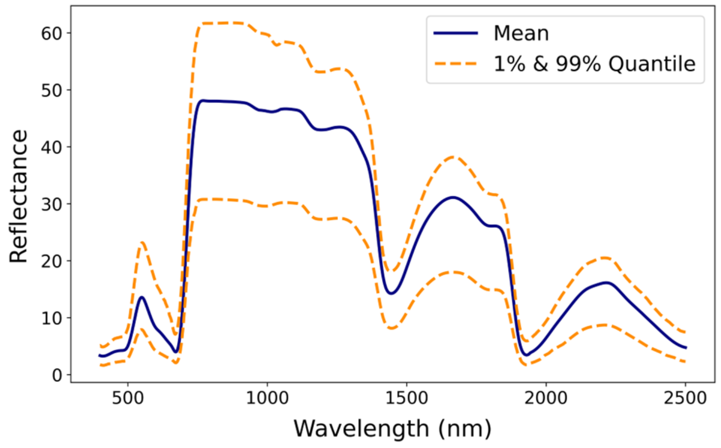
Mechanistic Backward



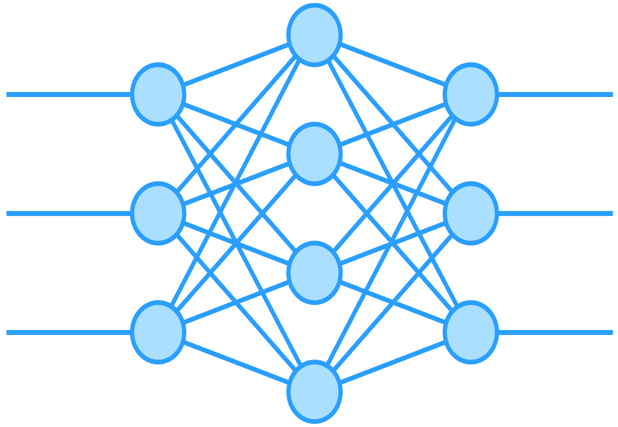

DATA Collection
Leaf spectral measurement
Mechanistic Forward
Physical Quantities
Lab-based Tissue Analysis
Mechanistic Backward
Label Gap Filling


DATA Collection
Leaf spectral measurement
Mechanistic Forward
400
2500
Physical Quantities
Lab-based Tissue Analysis
Mechanistic Backward
400
2500
Label Gap Filling
Leaf spectral reflectance
Mean
1% & 99% Quantile
Reflectance
0
10
20
30
40
50
60
500
1000
1500
2000
2500
Wavelength (nm)
Biochemical and Biophysical Labels

Leaf spectral reflectance

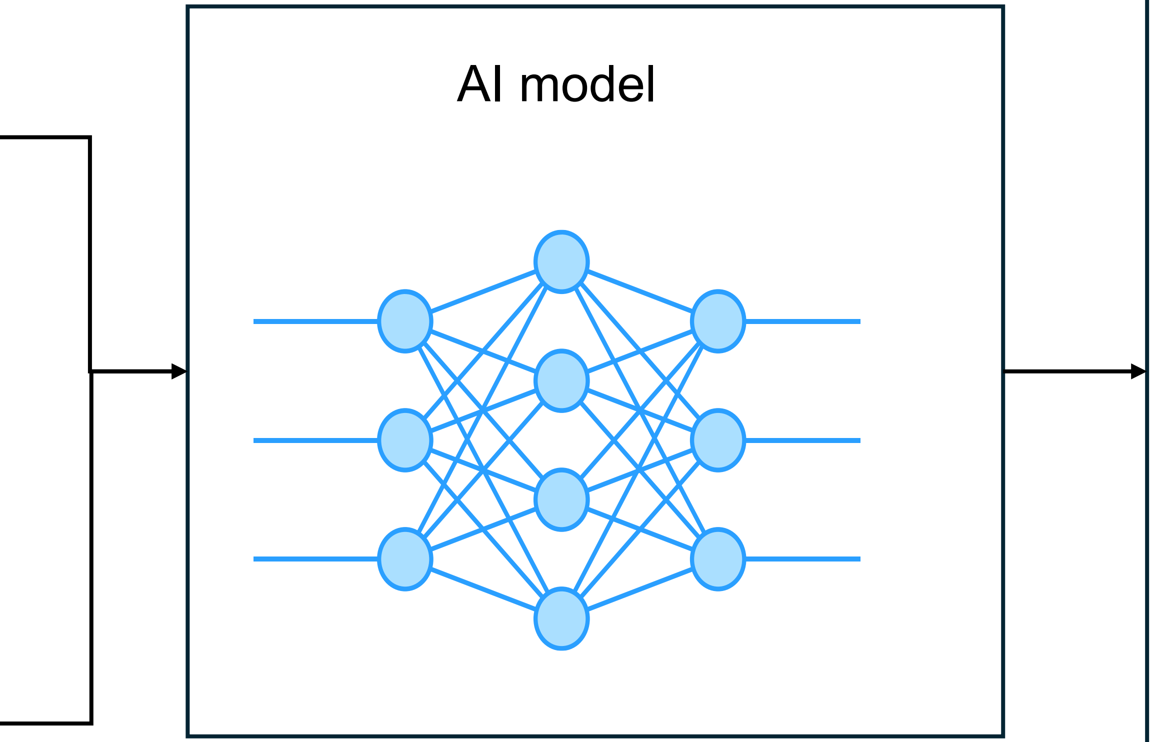


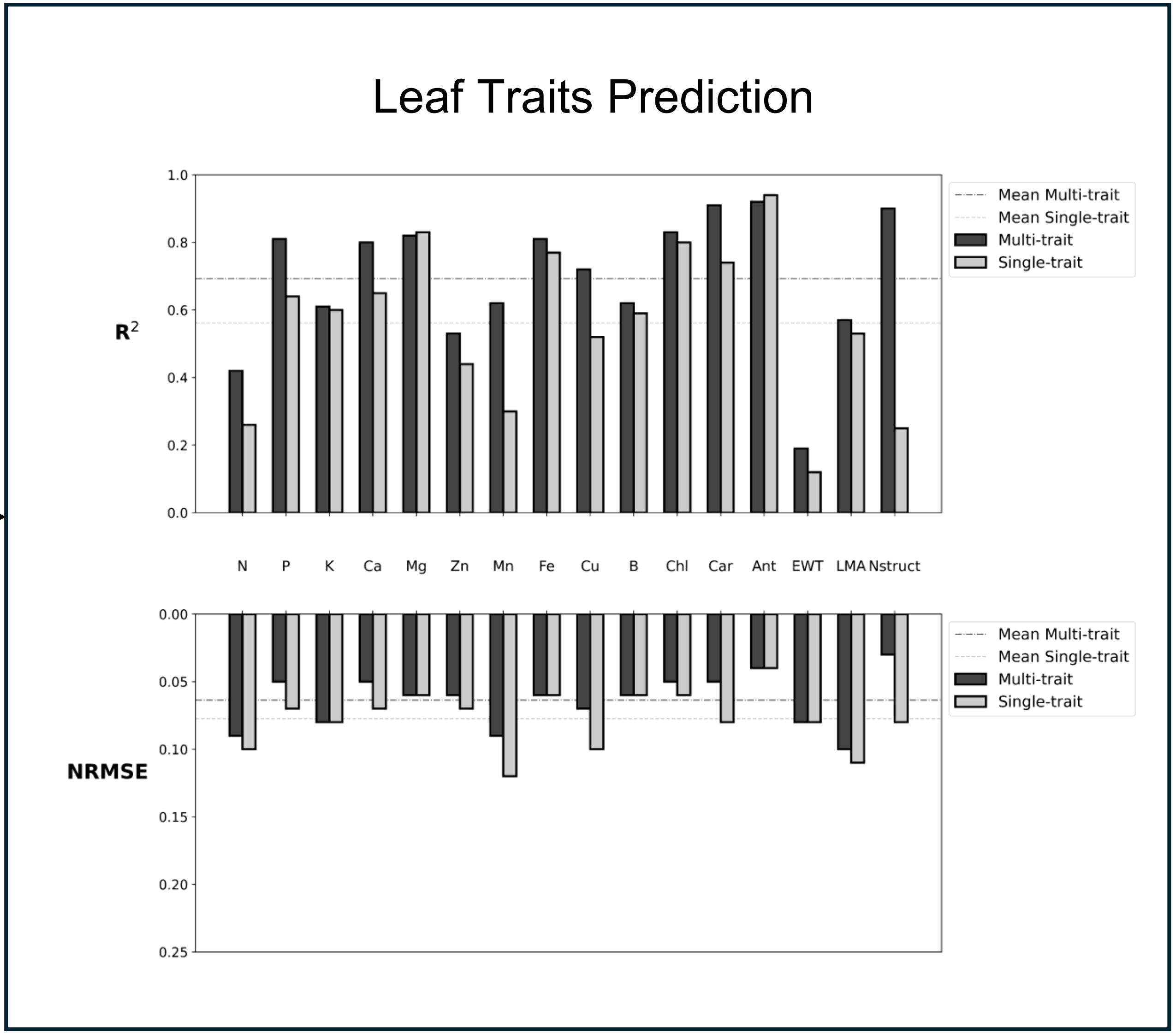
AI model



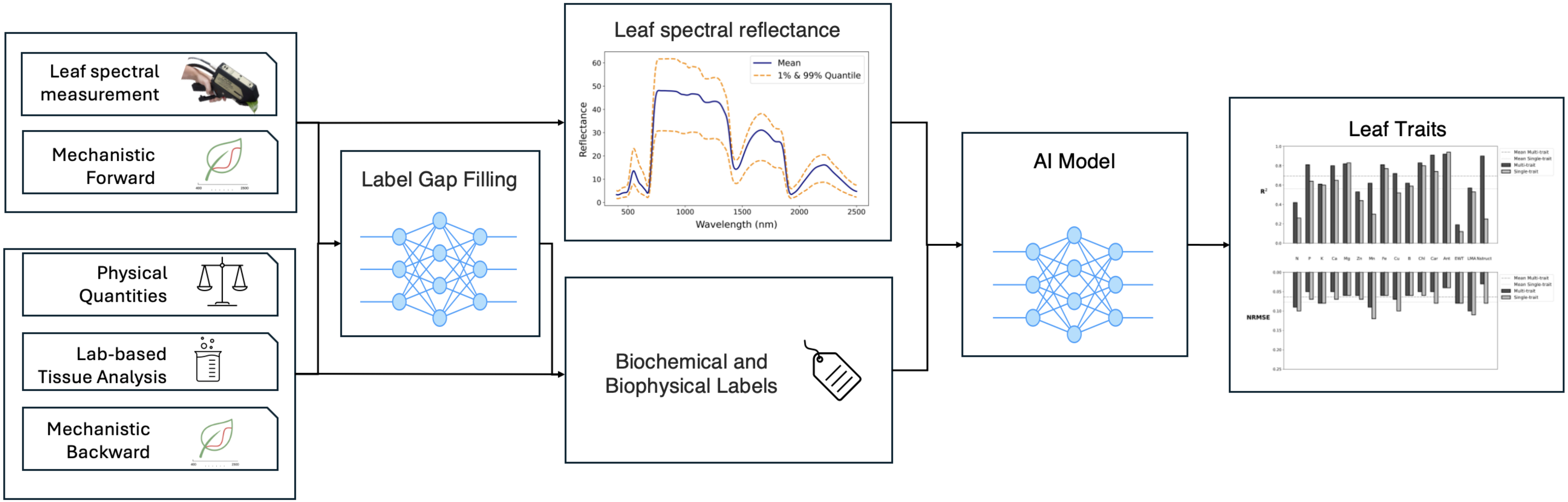
Biochemical and Biophysical Labels

Cured Training set

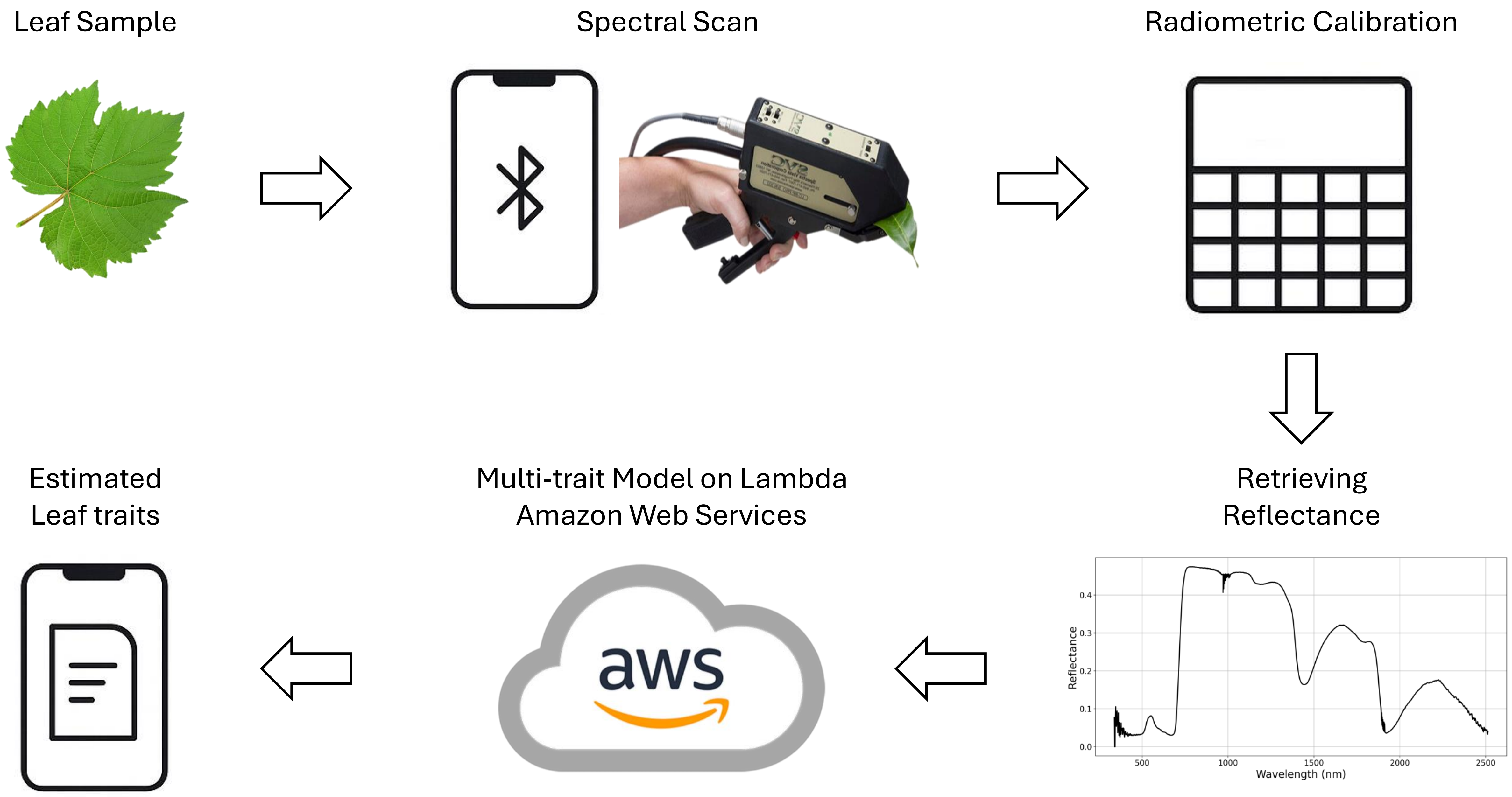

AI model


Leaf Traits Prediction
R²
NRMSE
N
P
K
Ca
Mg
Zn
Mn
Fe
Cu
B
Chl
Car
Ant
EWT
LMA
Nstruct
Mean Multi-trait
Mean Single-trait
Multi-trait
Single-trait

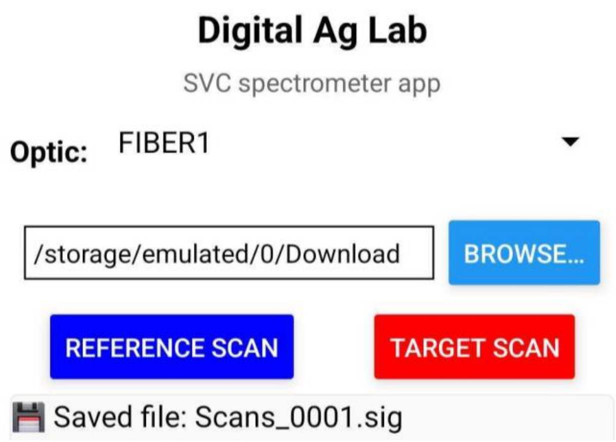
AI: Hybrid Modeling



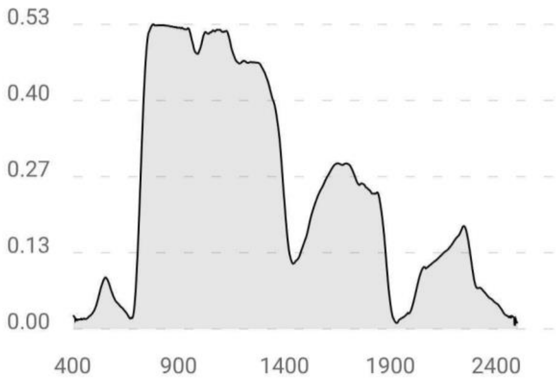
Mobile Application



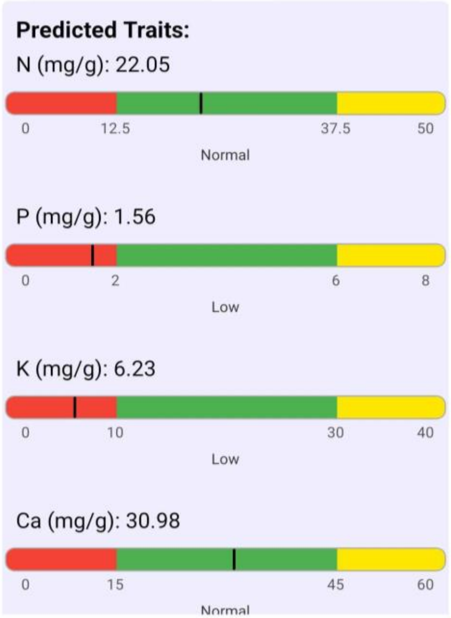
Mobile Application



- Selecting optic
- Setting up the path for saving spectral data
- Scanning panel or leaf
- Name of the saved file



- Reflectance plot



- 16 traits estimated by multi-trait model on AWS

Model input & output

Input

X_1: spectral features from multispectral image (250 features total)

X_2: cosine of Zenith angle

Output

y: array of 17 biochemical traits & LAI (Leaf Area Index, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Zinc, Manganese, Iron, Copper, Boron, Chlorophyll, Carotenoids, Anthocyanins, Equivalent Water Thickness, Leaf Mass per Area, N_{struct})

AI-Based, Real-Time Nutrient and Stress Diagnosis Tool for Tomatoes

College of Agricultural and Environmental Sciences

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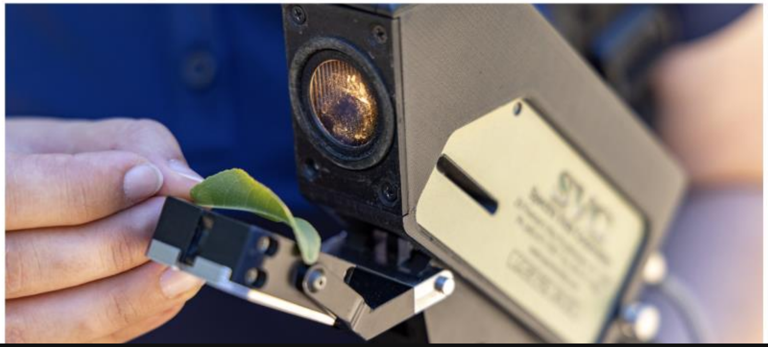

People

Alireza Pourreza
Associate Cooperative Extensio

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Leaf Spectrometry App Predicts Nutrition and Stressors

by Emily Dooley | September 24, 2025

ving farmers to make

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UC Davis Develops AI Powered Leaf Monitor for Real Time Crop Health

The app provides data on leaf nutrition and structural traits in just five seconds, enabling rapid assessment in the field

By Vaishali Mehta | 25 September 2025 | A+A-

Image Credit: University of California, Davis

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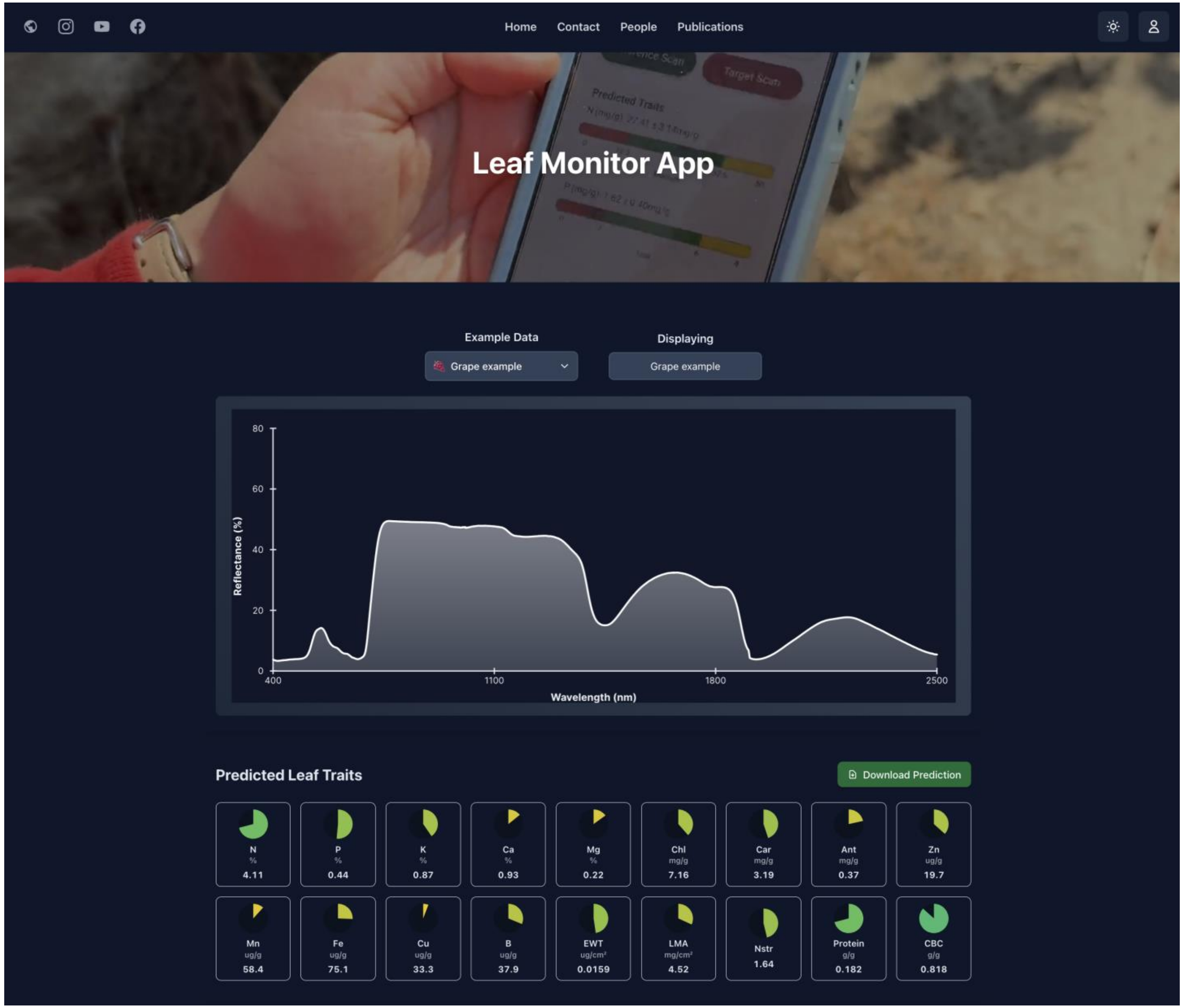
Empowering Sustainable Agriculture with AI-Powered Leaf Nutrient Sensing on AWS

by Parastoo Farajpoor and Dr. Alireza Pourreza | on 21 NOV 2025 | in Agriculture, Artificial Intelligence, Compute, Research | Permalink | Share

The Challenge of Nutrient Management in Agriculture

Web Application



Proposed activities

- **March–April 2026:** Sensor calibration and algorithm adaptation for tomato leaves; finalize field sites and cooperative growers.
- **May–August 2026:** Conduct intensive field sampling across Sacramento and San Joaquin valleys; collect paired spectral scans and lab analyses of tomato leaves to train nutrient models; begin small exploratory spectral monitoring for early stress signals related to broomrape, Fusarium stem rot and decline, and Beet curly top virus (BCTV).
- **June–September 2026:** Develop and refine machine-learning models for nutrient estimation and stress classification; hold mid-season demonstration for growers to gather feedback.
- **August–December 2026:** Validate nutrient models across multiple fields and cultivars; release beta version of the Leaf Monitor App tailored for tomatoes; present preliminary findings at the CTRI Annual Research Meeting.
- **January–February 2027:** Finalize model and interface improvements; prepare large-scale extension materials; plan full deployment for the following season: submit final report and deliverables.

Amount of funding requested:

$39,500 (no indirect/overhead charges).

Thank you!

Alireza Pourreza

digitalaglab.com
digitalag.ucdavis.edu

Broomrape Monitoring Tool

Development, test, and implementation

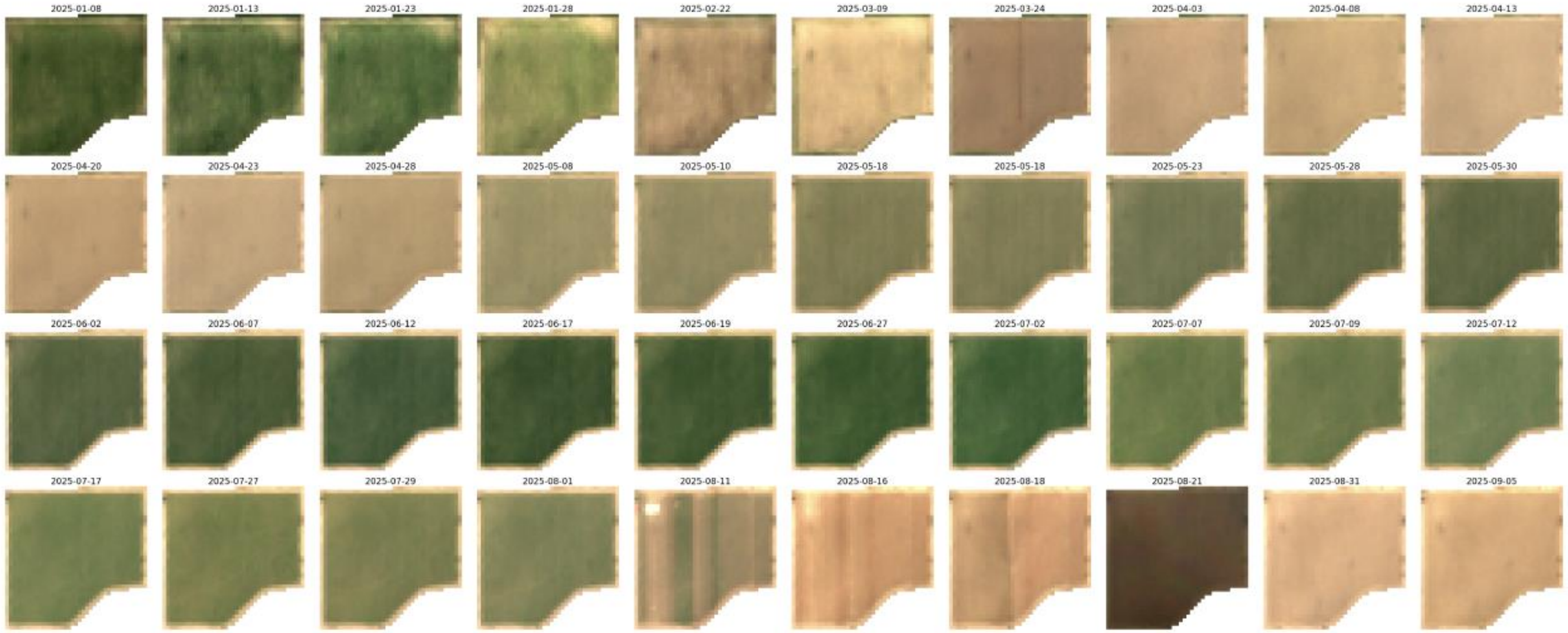
Alireza Pourreza

Kobin.com

Objective 1

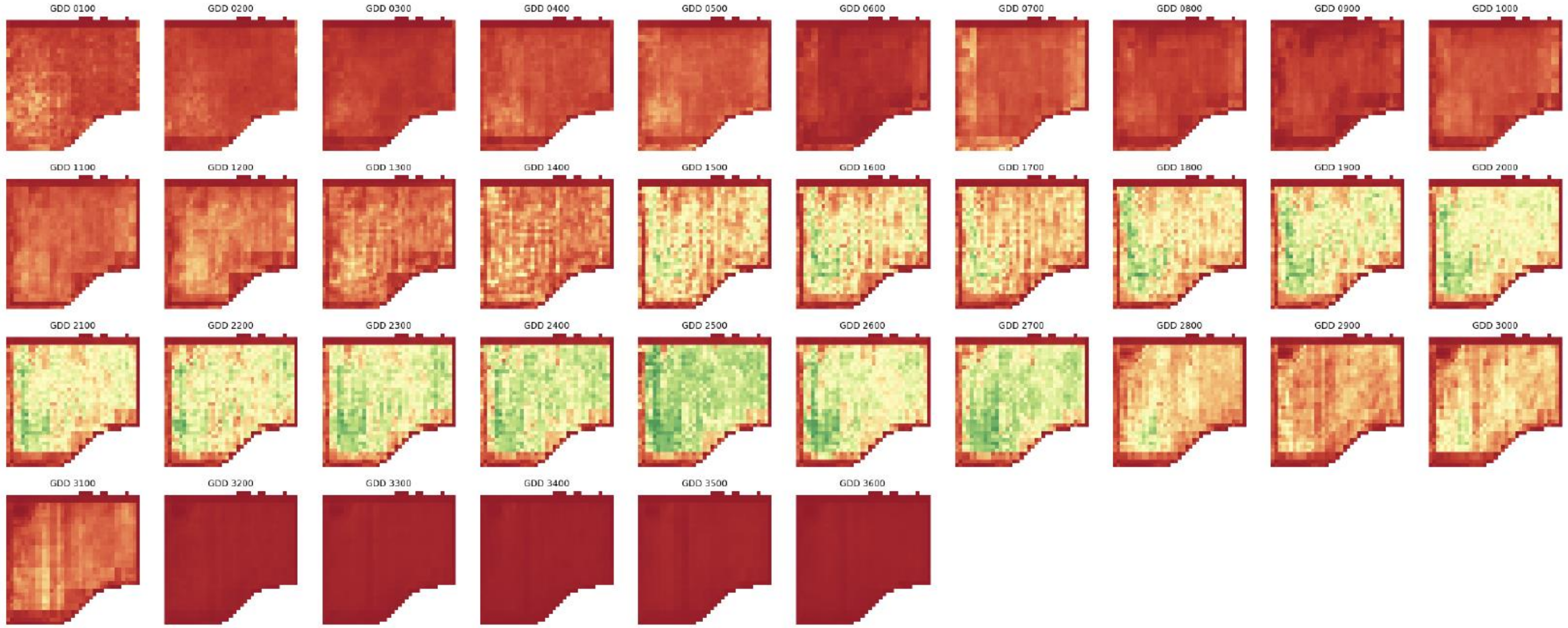
Develop satellite based remote sensing technique for monitoring broomrape in tomato fields

Input: timeseries satellite imagery



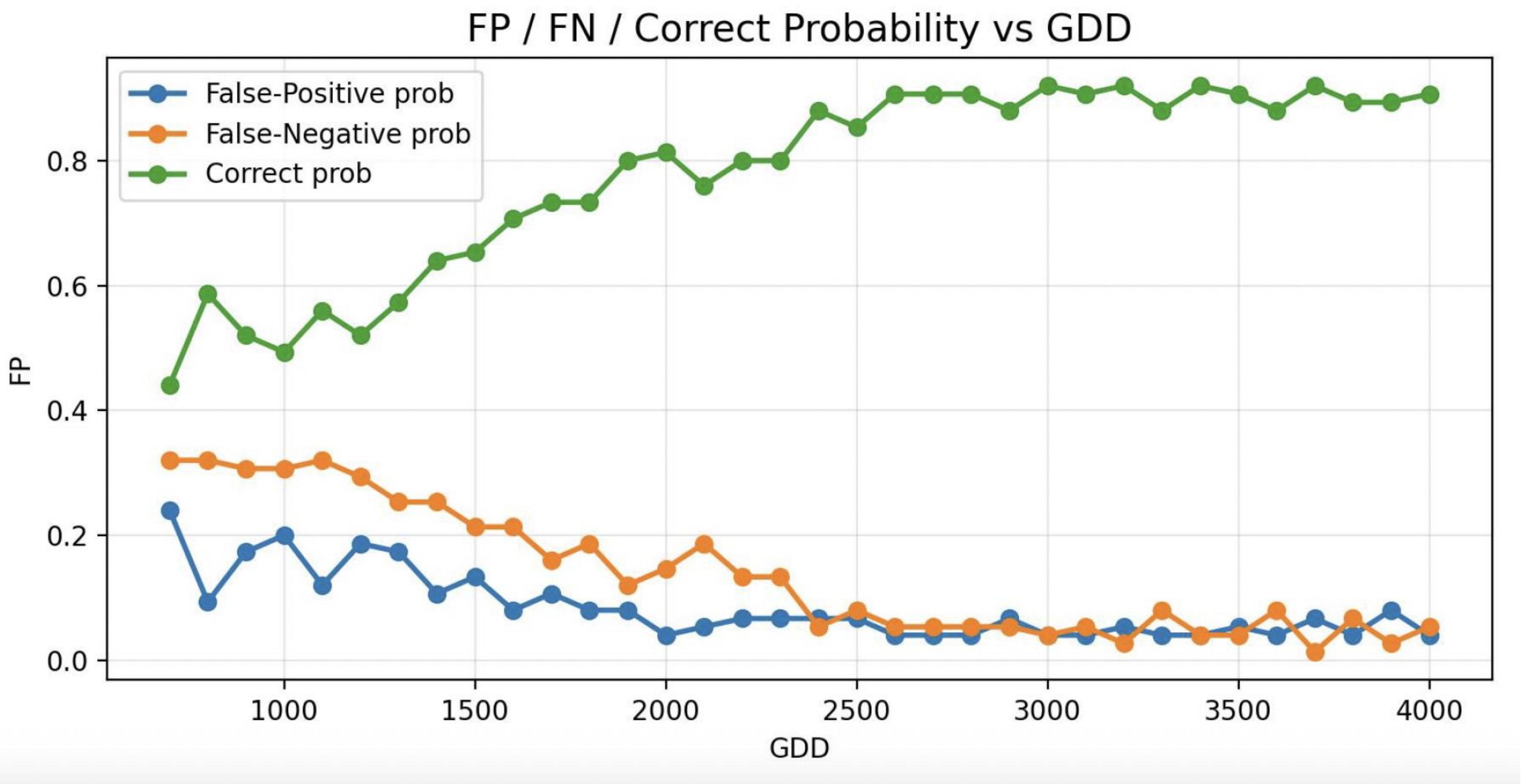
Objective 1

Output: a broomrape infestation probability map generated based on an integrated analysis of all satellite imagery since the transplant time.



Objective 1

Accuracy metrics



Objective 2 – Blind test

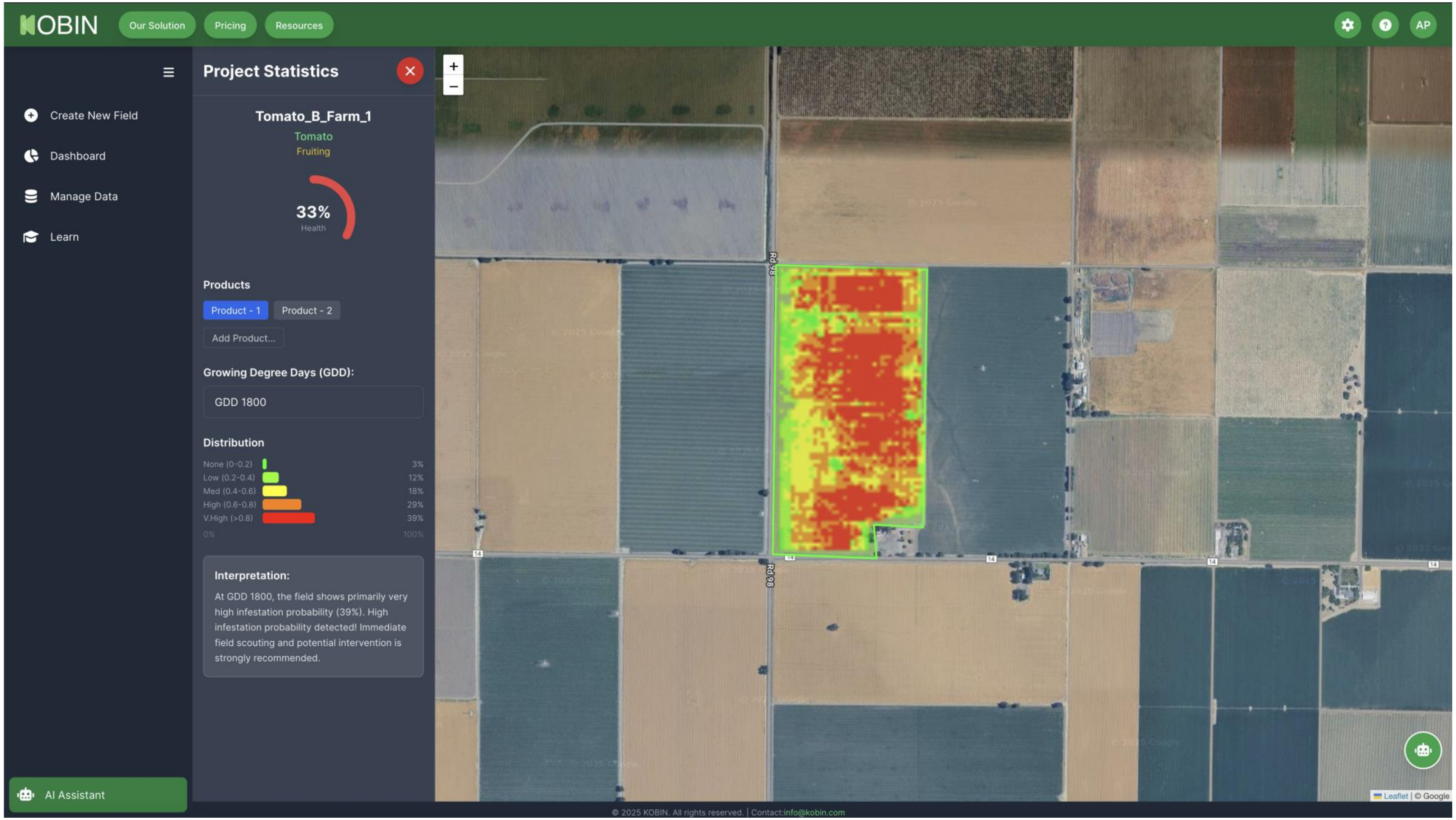
- The model has been tested on 42 tomato farms in Yolo county in 2025

Predicted

Actual		Infested	Non-infested
	Infested	13	3
	Non-infested	4	22

Accuracy: 83%
False Negative probability: 7%
False Positive Probability: 10%

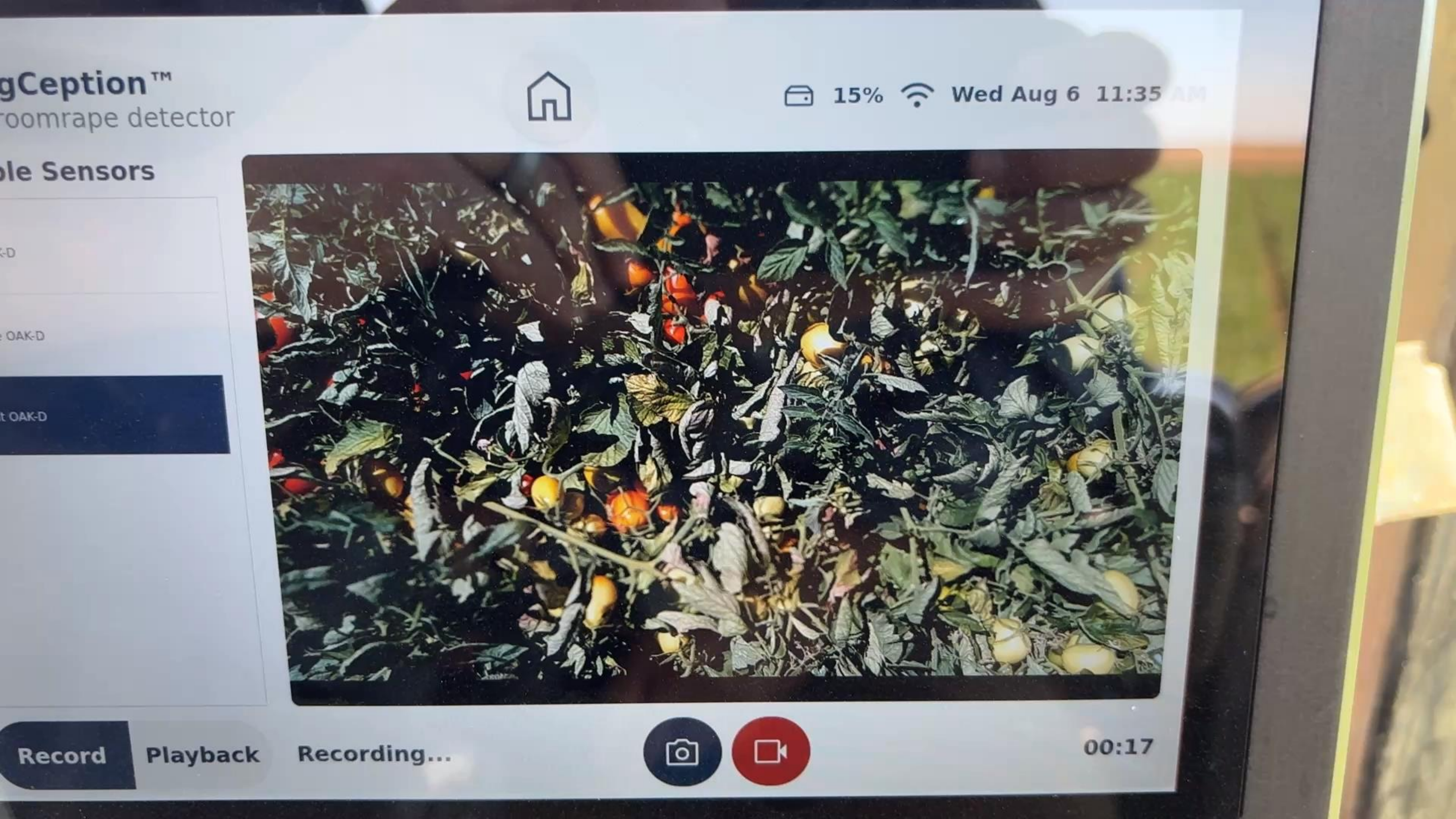
Objective 3 - Implementation



Grower Owned & Operated In-Field Broomrape Detection System

California Processing Tomato Annual Research Meeting

December 3rd, 2025


gCeption™
roomrape detector
ble Sensors
OAK-D
t OAK-D
15%
Wed Aug 6 11:35
Record
Playback
Recording...
00:17

Summary

- Application Hardware, GPS, Front/Back End Complete
- 5 Site Visits to Barrios Farms & CTRI Research Plot
- Experimented with **Fixed** vs. Autofocus
- Collected Images of Overhead View & Alternate Views
- Growth Stages (Mostly Later Stage Tomatoes & Broomrape)
- Lighting Conditions (9am – 2pm daylight with Autoexposure)
- Total Data Collected Exceeds 8Gb
- Training Instances

  - Total Training Images: 2,101

  - Total Validation Images: 293

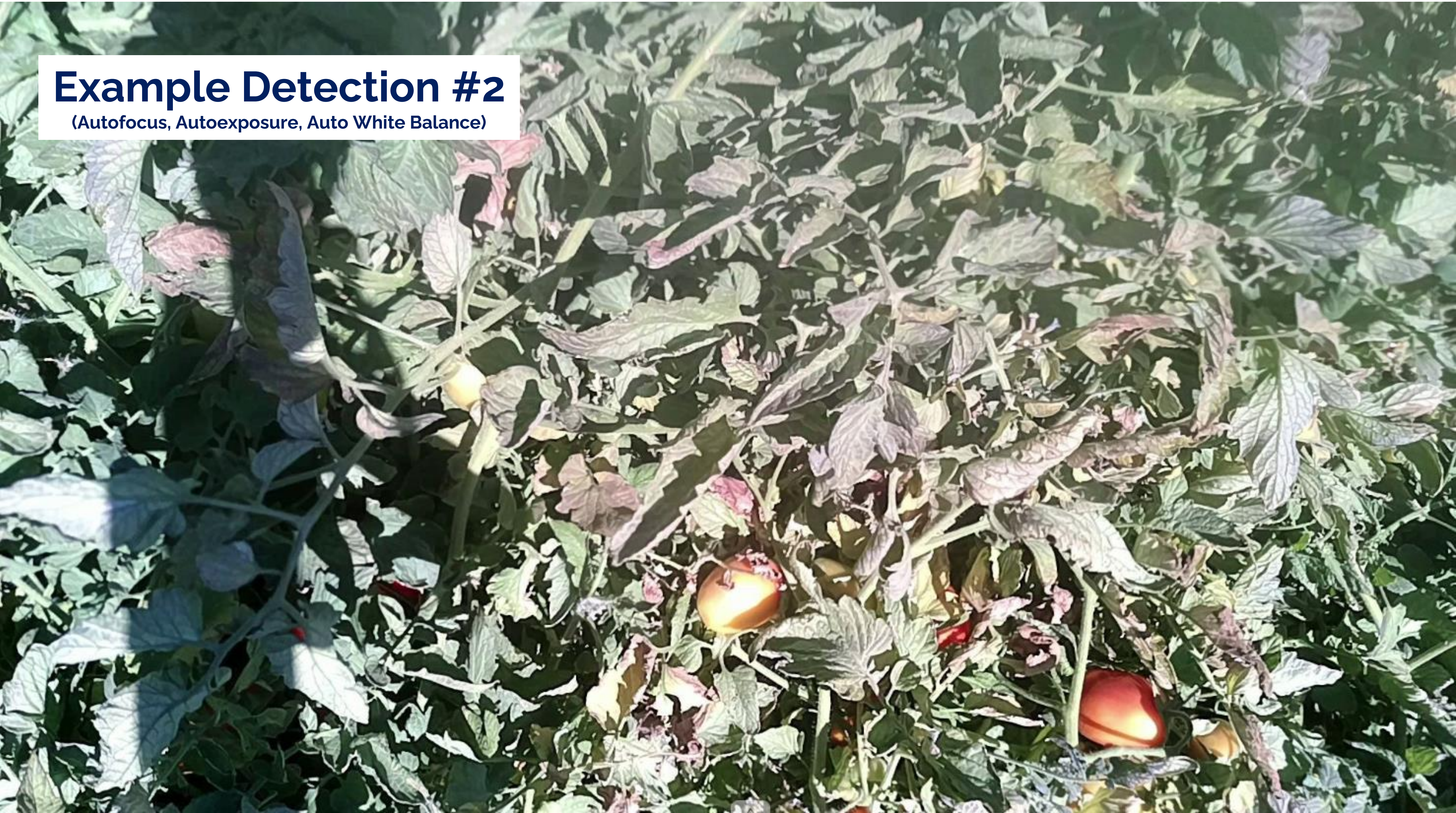
  - Total Test Images: 285
- **Image Count**
- POC Location Services Map Complete!

Example Detection #1

(Autofocus, Autoexposure, Auto White Balance)

Example Detection #2

(Autofocus, Autoexposure, Auto White Balance)




Example "Ideal"
Image Capture
(Autofocus, Autoexposure, Auto White Balance)

Example Occlusion & Shadow Image Capture

(Autofocus, Autoexposure, Auto White Balance)

Desiccated Broomrape Examples

Note the autofocus variance

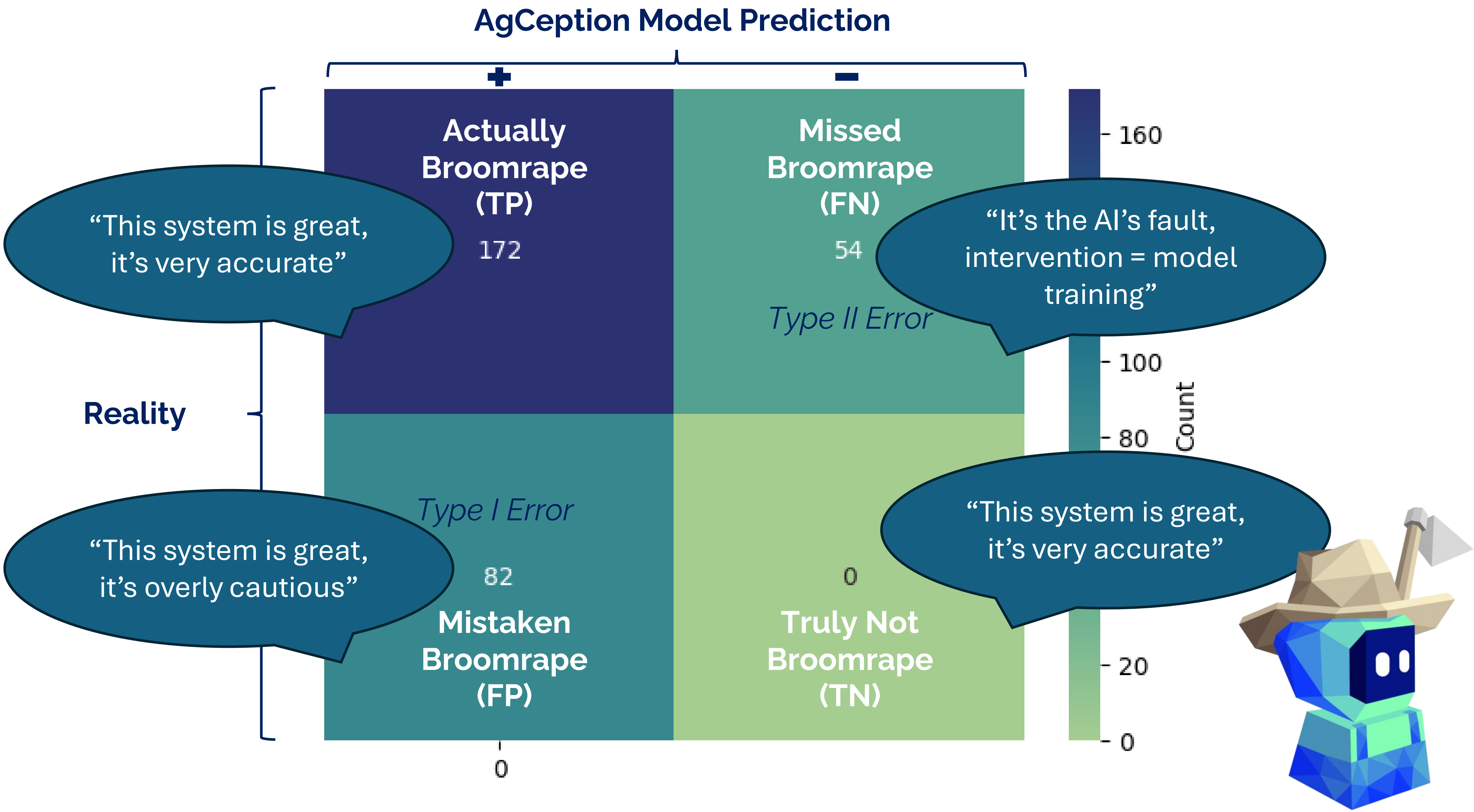
Small Instance Broomrape

Note the autofocus variance

Autofocus w/Late Growth Stage Tomatoes

Autofocus w/Late Growth Stage Tomatoes

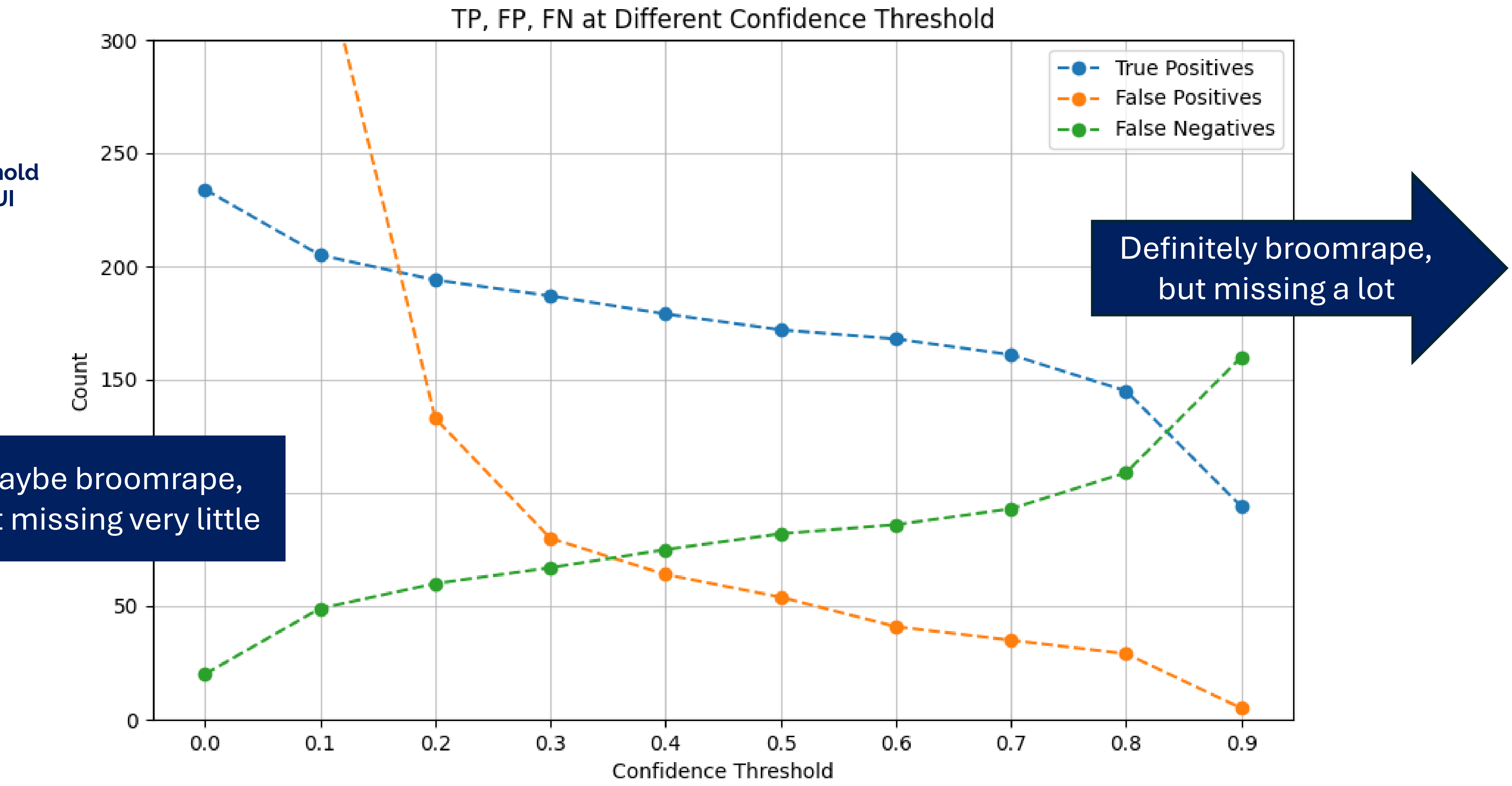
AgCeption Model Performance – Confusion Matrix



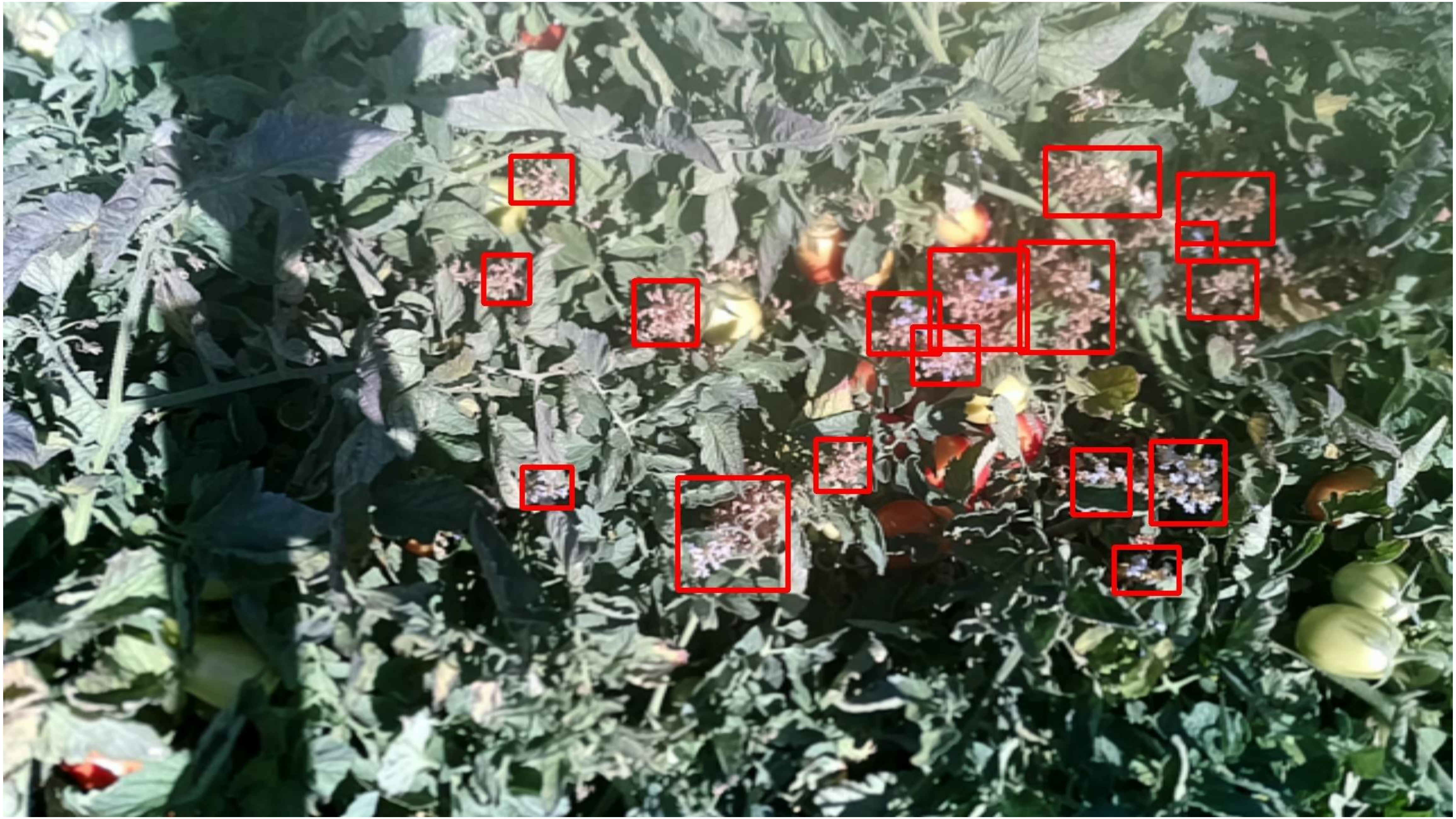
Confidence Thresholding & Farmer Optionality

Further Development Discussion

Confidence Threshold Adjustment via UI



AI Model Performance – Test Image Detections



AI Model Performance – Test Image Detections

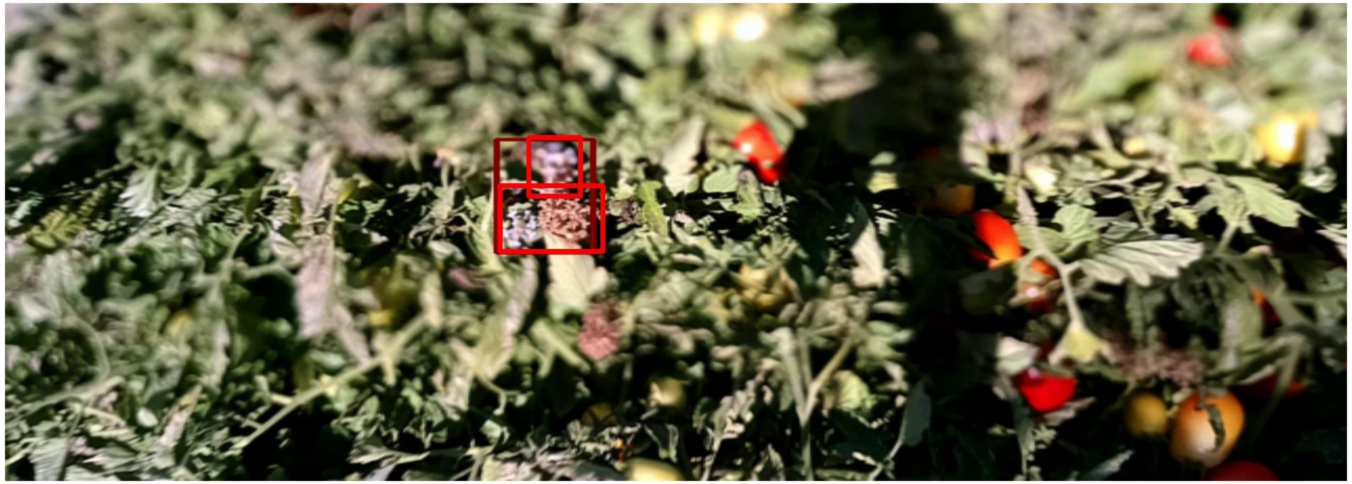
AI Model Performance – Test Image Detections

Split Instances

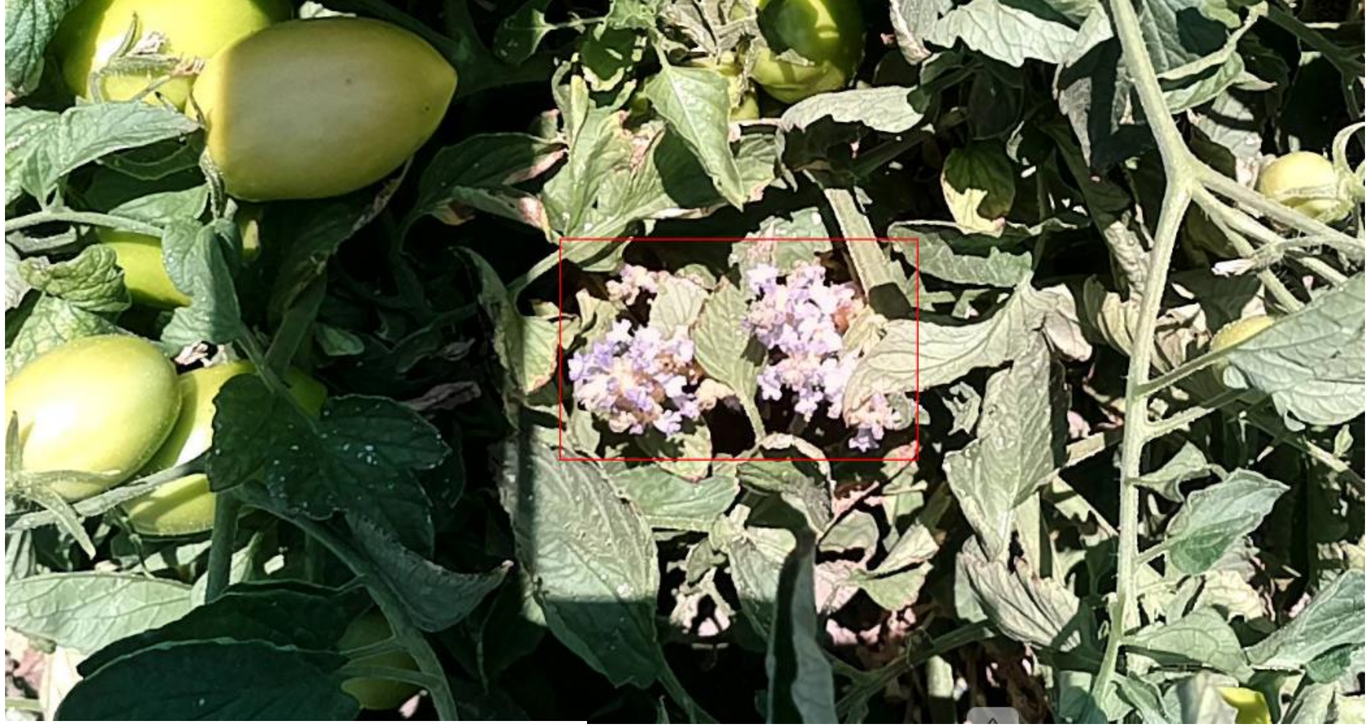
Dark Red = Labels

Light Red = Predictions

Consideration: Class purity vs. giving contradictory signals to the network



Alternative Views w/Mid-Growth Stage Tomatoes



Fixed Focus Single Plant Line FOV

Note this is ideal config. for detection

POC Map w/Location Services

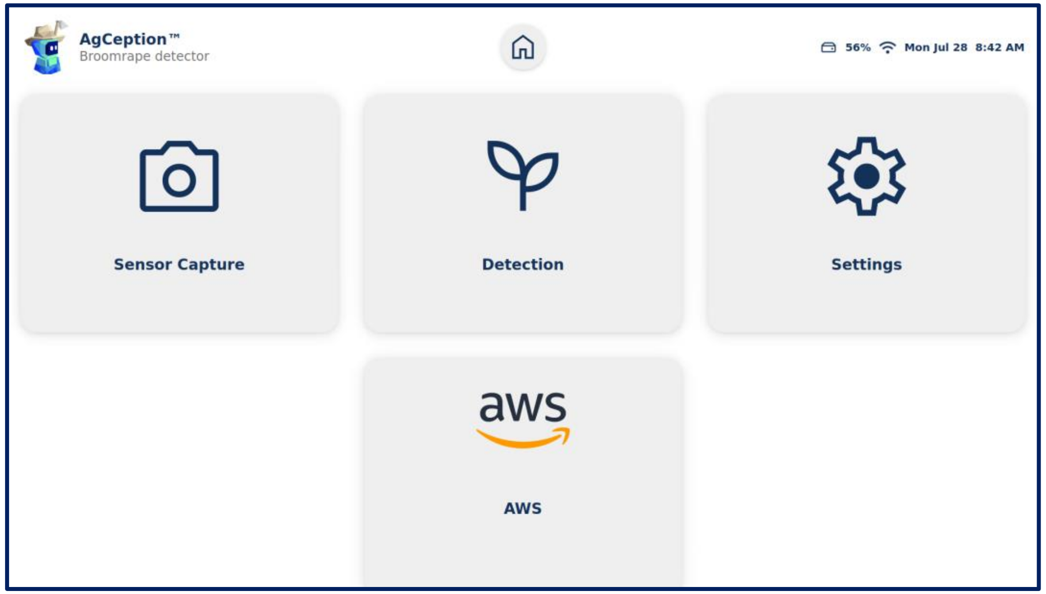
Created via CSV export data

https://broomrape-heatmap.vercel.app/

Early 2026 Engineering Tasks

1. AgCeption Semi-Automated ML Pipeline UI Model & Software Update (i.e., Growers can independently collect, upload, & update)
2. Swap sensors to Fixed Focus / Global Shutter Variant
3. Early broomrape data collection + focus on class purity for 2026 commercial model

Home Screen UI



Run Screen UI

Data Collection Screen UI

AWS Pipeline Screen UI

Optional Engineering

- Adjust Mounting Arms up by 12" (i.e., weld vertical arm above horizontal extension arm)
- Procure & Test OAK-D PoW Wide FOV Sensor

Further Development Focus

1. Model sensitivity adjustment via UI (more/less discerning = more/less FP. *Farmers choice!*)
2. Analyze contradicting annotations. I.e., investigate class purity & multi-class model (desiccated vs. early broomrape = 2 classes, or occluded, non-occluded, early, desiccated = 4 classes vs. current single class)
3. Ongoing data capture of tomato & broomrape growth stages via AWS pipeline (CTRI/Barrios + L&A, multiple systems)
4. FOV & Mounting Height Trade
    A. Amiga capture height is ideal for early detection → higher resolution → higher fidelity/ROI model. But only captures a single plant line. To get "very best" image, we'd require either:
        i. More sensors (higher BOM, more optimization for real-time performance) E.g., 1 sensor per plant line = 6 sensors per kit)
        ii. Wide FOV lensing w/image distortion correction via OAK-D PoE W
    B. Keep existing sensors (higher mounting height) and implement sliding window, et al. technique(s) to retain higher resolution
    C. Keep existing sensors (higher mounting height) and live with reduced resolution
5. Currently capturing both plant lines, but require higher sensor mounting location to capture 100% of bed
6. Desiccated broomrape vs. early stage (i.e., pre-seed broomrape)
7. Occlusion strategy (annotate key broomrape features vs. annotate occluded broomrape)
8. False positives (morning glory, blooms, desiccated leaves, shadows)
9. False negatives (missed detections, impure training data)
10. Reduce splits for higher fidelity instance counts
11. If desired, GPS RTK and/or additional location services map functions/dedicated iOS/Android app
12. If desired, data analytics (e.g., fruit counts, harvest timing/yield estimation, soil occlusion/growth rate, etc.)
13. If desired, new models (e.g., invasive weeds, animal feces, plant vigor, diseases/viruses, etc.)

False Positives (Type 1 Error) Hypotheses

1. **Desiccated → class impurity**
2. Broomrape 'trumpet' annotations → class impurity
3. Outlier scene (e.g., bare dirt, shadows) → Undertrained model

False Positives (Type 1 Error) Hypotheses

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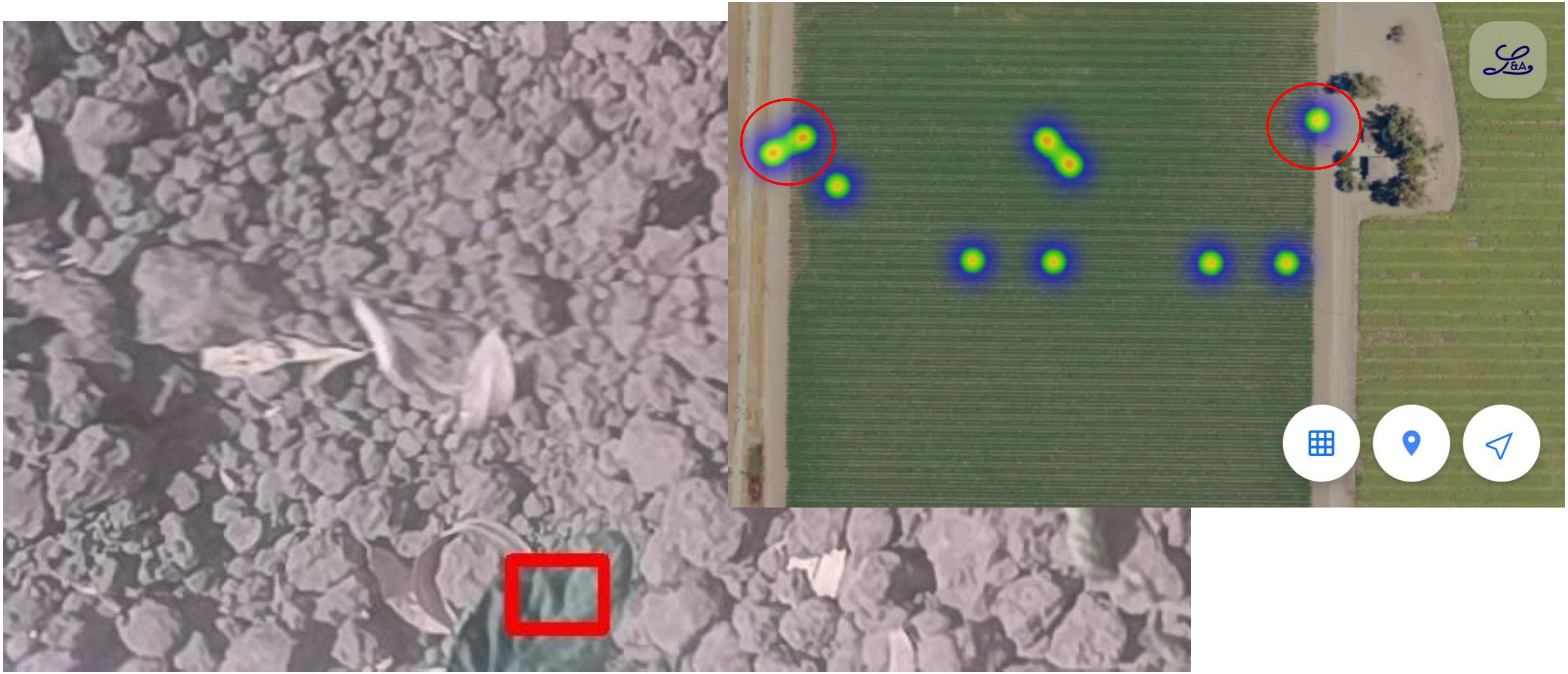
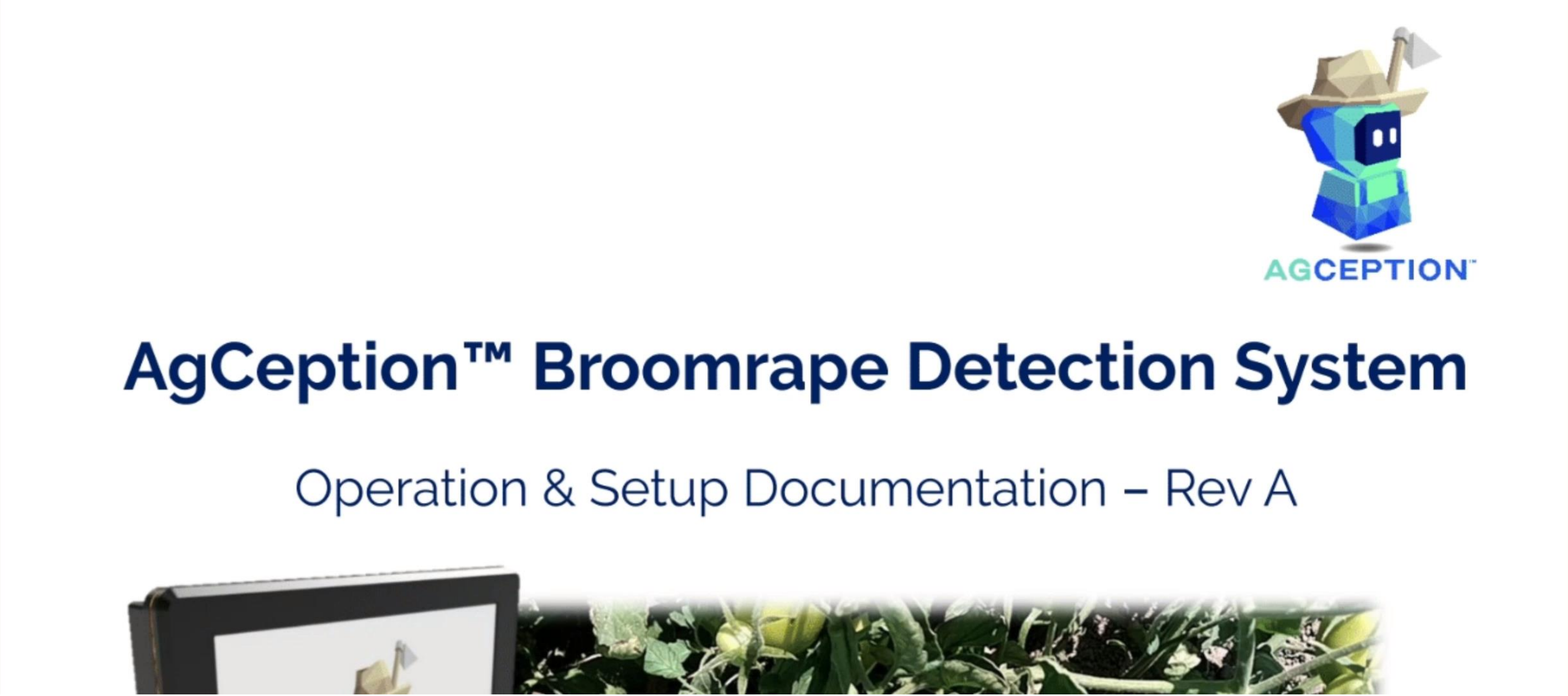


- 3-80" Retrofit System Cost (1X HMI + 3X Sensors + Wire Harness + Mounting Brackets): **$14,500**
- **20% Revenue Share to CTRI** (*Retrofit System Hardware Only*, i.e., $2,900 per system)
- Annual AgCeption license fee per system after the first 10 systems: **$2,500 per system**

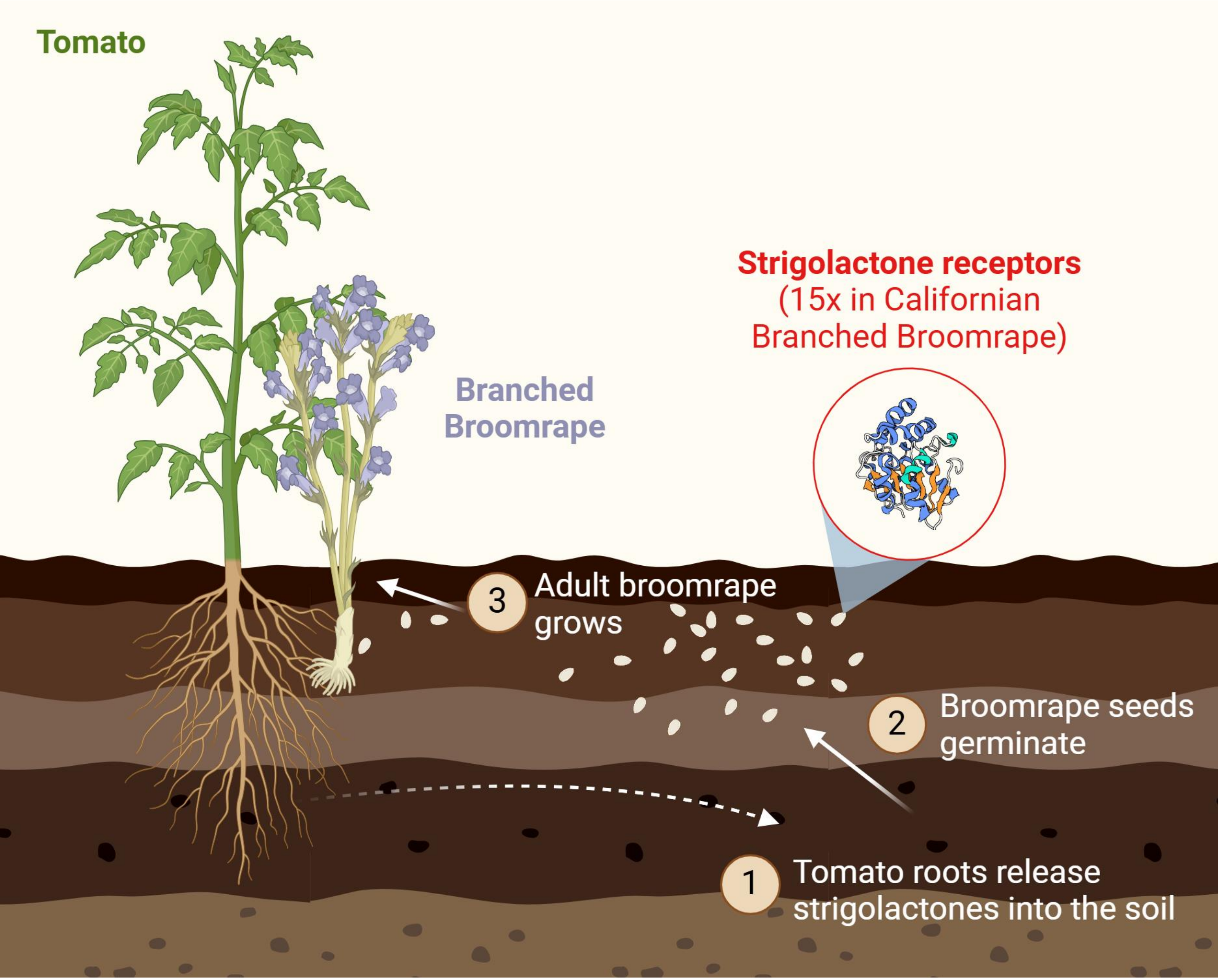


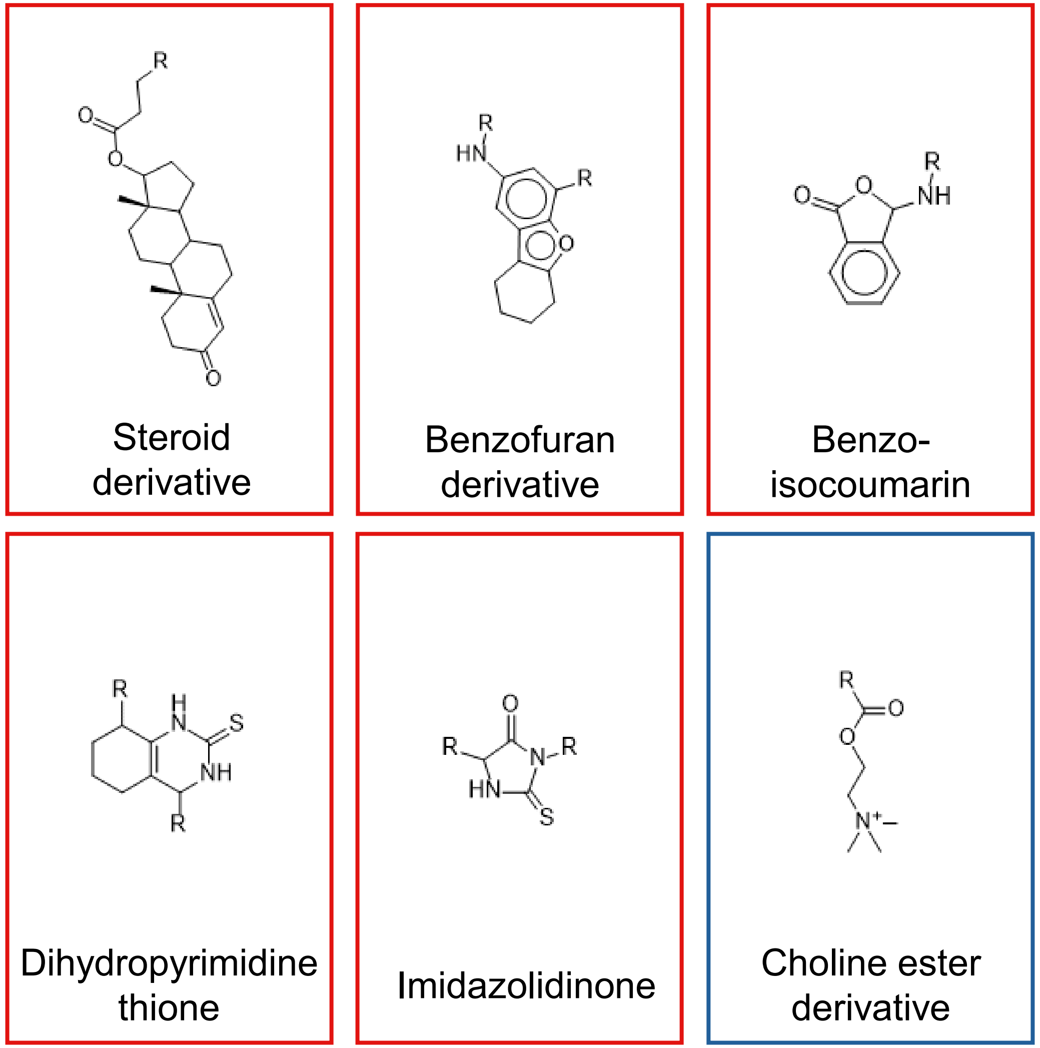
AGCEPTION

AgCeption™ Broomrape Detection System

Operation & Setup Documentation – Rev A

2025: Finding chemicals that interfere with Branched Broomrape germination





Inhibitors
Activator

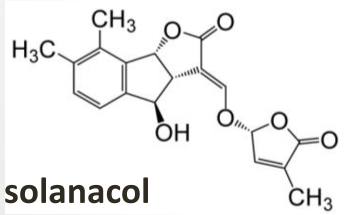
Marco Burger – Salk Institute, San Diego

2026: Get chemicals soil ready and expand on Egyptian Broomrape

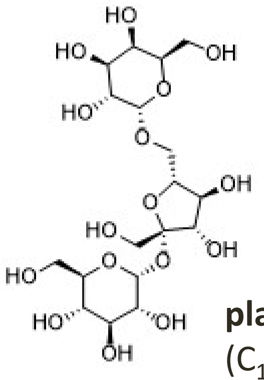
1. Branched Broomrape germination inhibitors	2. Egyptian Broomrape	3. PCR detection
• Get derivatives	• Sequence local population	• Use genomic data
• Test on receptors	• Run same screen	• Identify species markers
• Test germination in soil	• Platform ready, low risk	• Detect seeds in soil
• 4-5 starting points	• Doubles value of library	• Minimal extra cost

Identification of Soil Microbes That Disrupt Broomrape Seed Germination

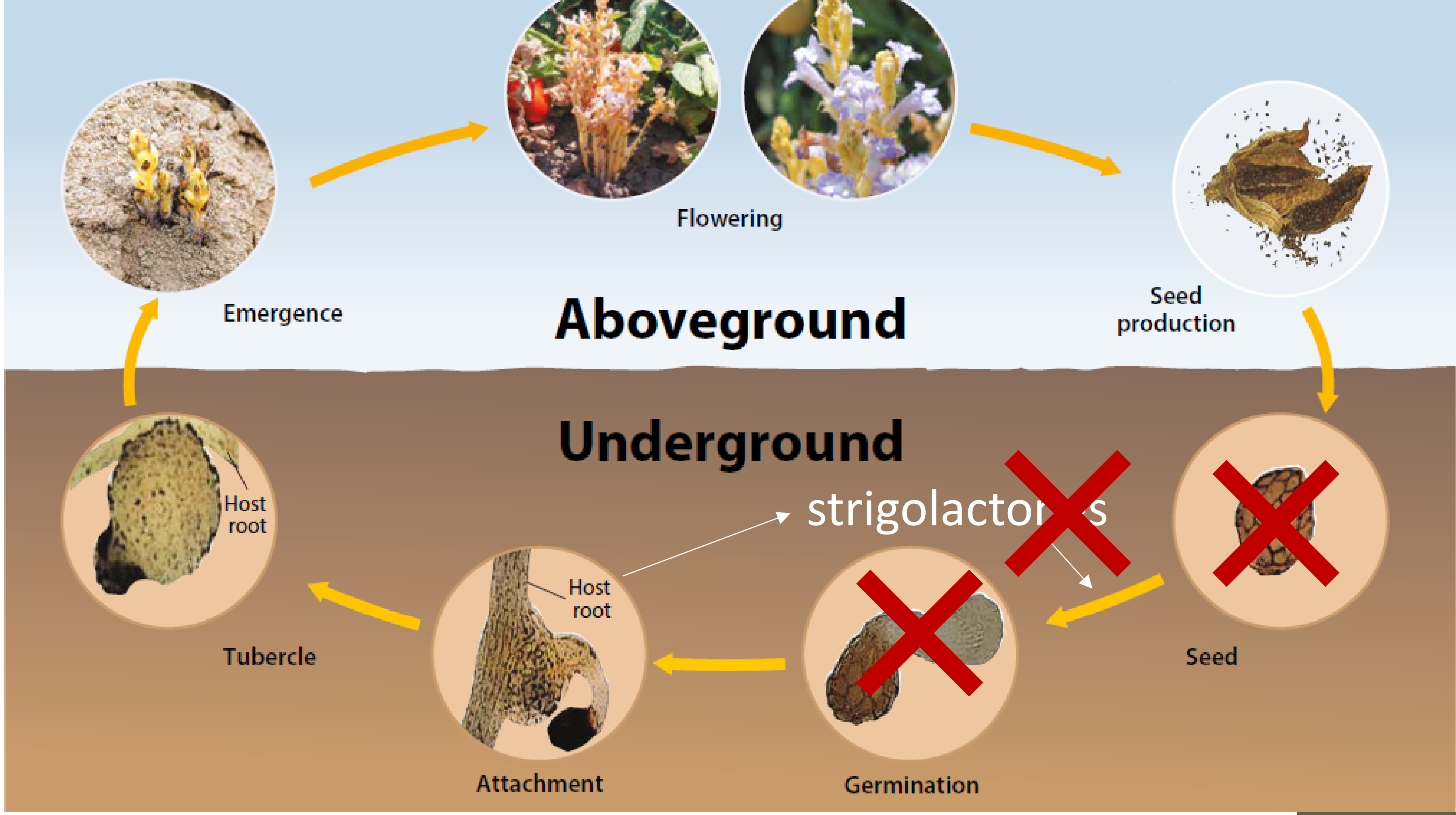
Johan Leveau
Professor of Plant Pathology
(530) 752-5046 (office)
(530) 574-4946 (cell)
jleveau@ucdavis.edu



solanacol
($C_{19}H_{18}O_6$)



planteose
($C_{18}H_{32}O_{16}$)



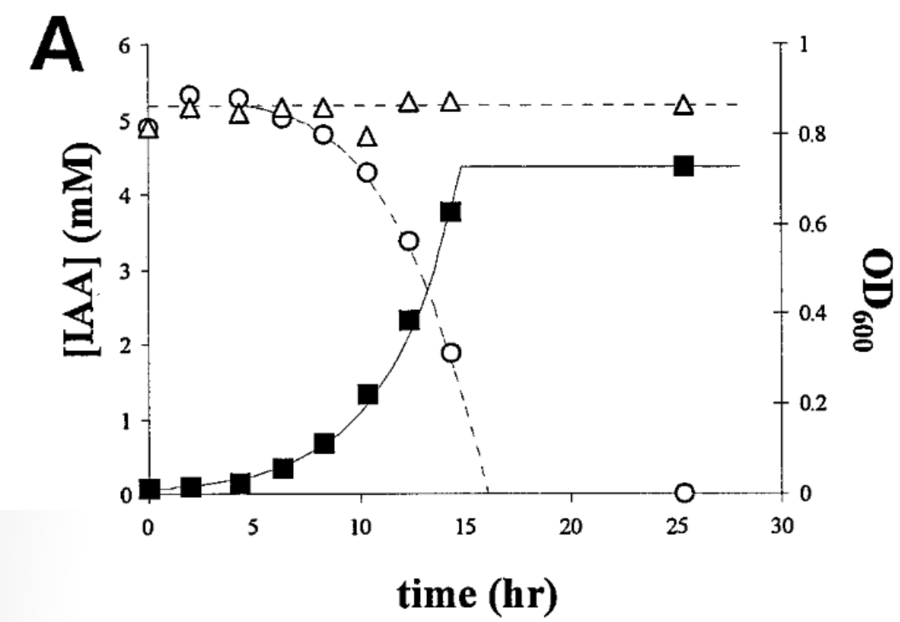
From: Osipitan et al, 2021

untapped potential of soil microbiota (bacteria and fungi) to disrupt the life cycle of branched broomrape

Hypotheses

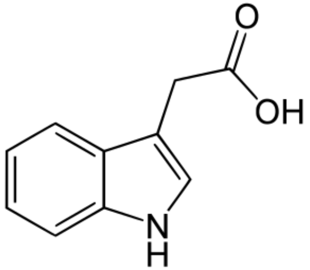
There are microbes that use strigolactones as food.

There are microbes that use broomrape seeds as food.



Utilization of the Plant Hormone Indole-3-Acetic Acid for Growth by *Pseudomonas putida* Strain 1290†

Johan H. J. Leveau[1,2]* and Steven E. Lindow[2]

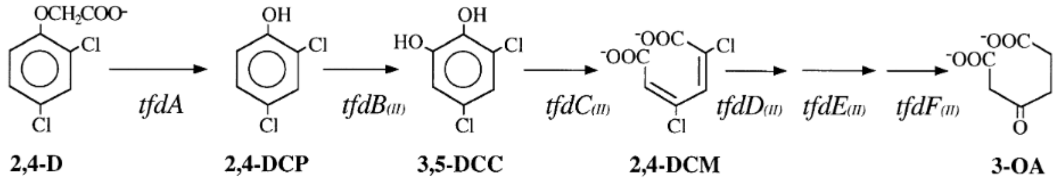


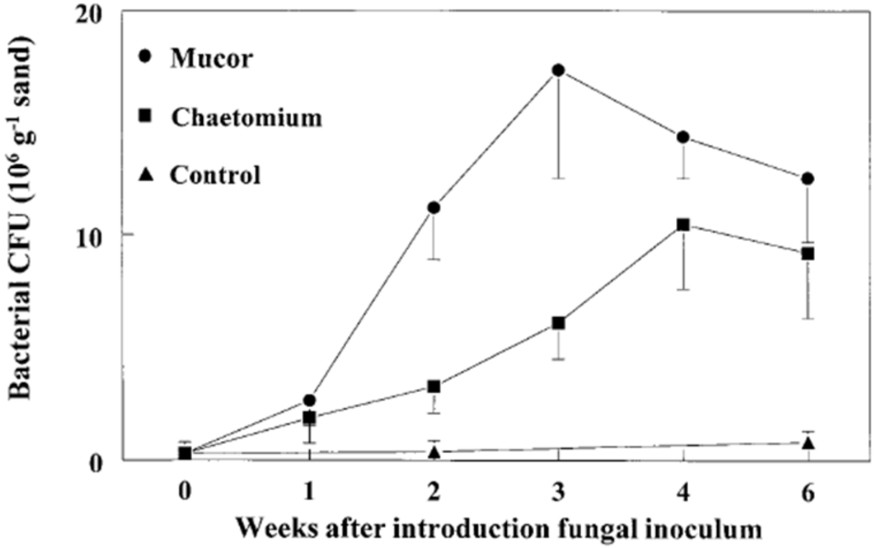
Bacterial mycophagy: definition and diagnosis of a unique bacterial–fungal interaction

Johan H. J. Leveau[1] and Gail M. Preston[2]

Dynamics of multigene expression during catabolic adaptation of *Ralstonia eutropha* JMP134 (pJP4) to the herbicide 2,4-dichlorophenoxyacetate

Johan H. J. Leveau,† Franziska König, Hanspeter Füchslin, Christoph Werlen Jan Roelof van der Meer*





Hypotheses

There are microbes that use strigolactones as food.

There are microbes that use broomrape seeds as food.

Identification of Soil Microbes That Disrupt Broomrape Seed Germination

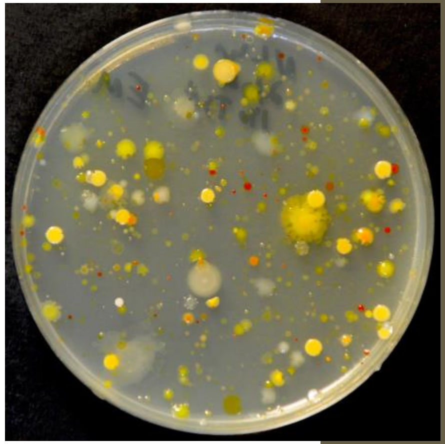
soil samples from seed-infested field

soil slurries

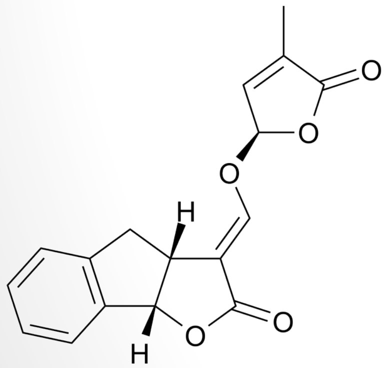
enrichment culture containing GR24 as sole source of carbon

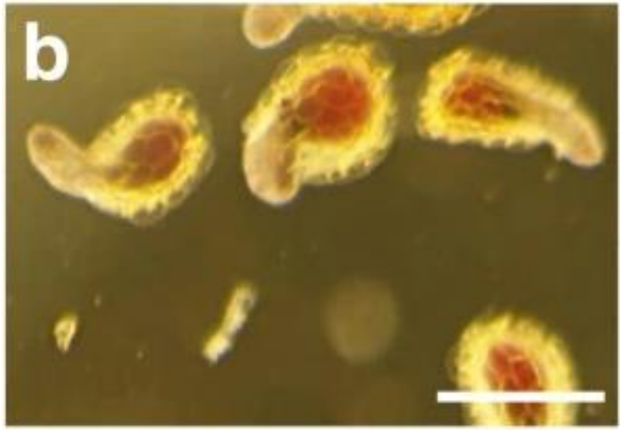
enrichment culture containing broomrape seeds plus GR24

enrichment culture containing broomrape seeds as sole source of carbon

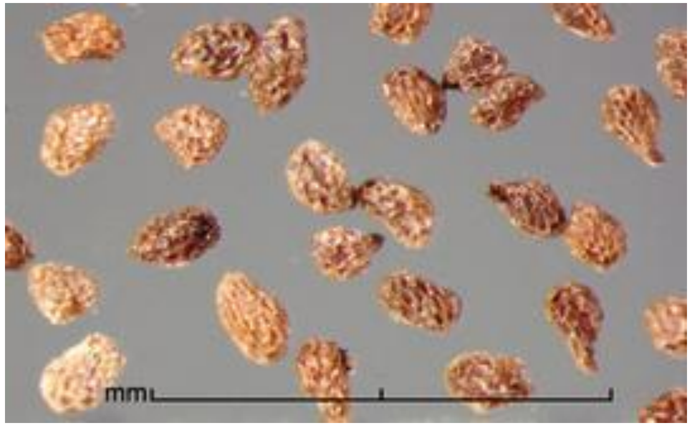


screen for ability to induce seed germination





https://doi.org/10.1186/1746-4811-9-32

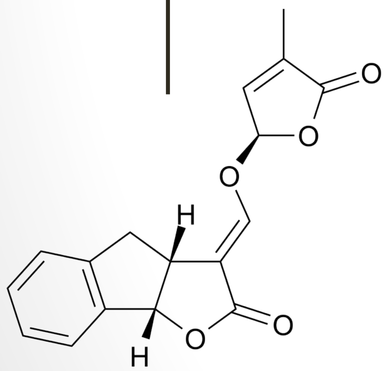


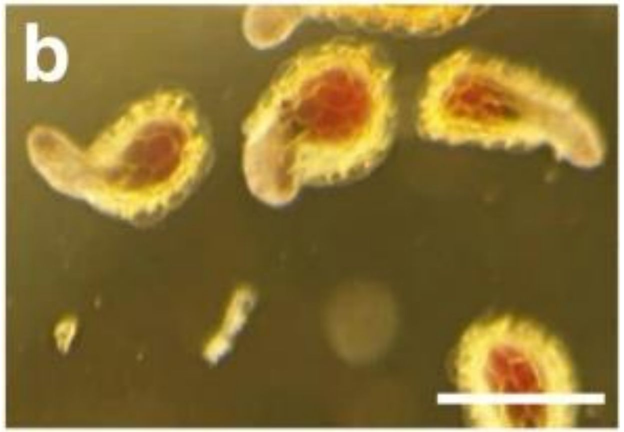
https://idtools.org/fnwd/index.cfm?packageID=1097&entityID=2631

plan for year 2: test under greenhouse/field conditions:
Can these strains "bioremediate" broomrape seed-infested soils?
Can these strains protect tomato plants from broomrape "infection"?
Can these strains "confuse" broomrape seeds into germinating?

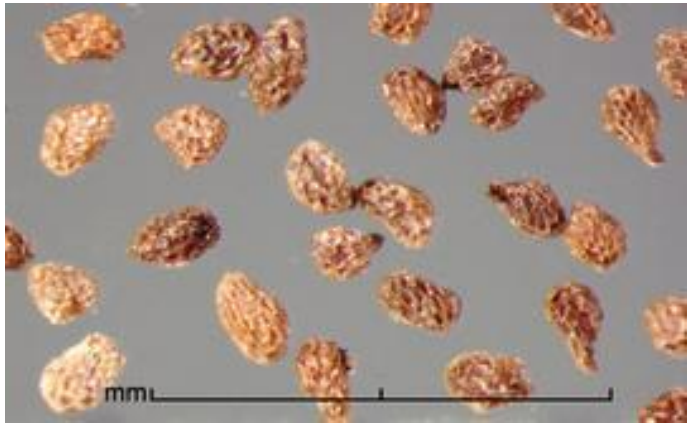
deliverable year 1

bacterial/fungal strains that grow at the expense of GR24	bacterial/fungal strains that grow at the expense of germinating broomrape seeds	bacterial/fungal strains that grow at the expense of broomrape seeds	bacterial/fungal strains that induce broomrape seed germination





https://doi.org/10.1186/1746-4811-9-32



https://idtools.org/fnwd/index.cfm?packageID=1097&entityID=2631

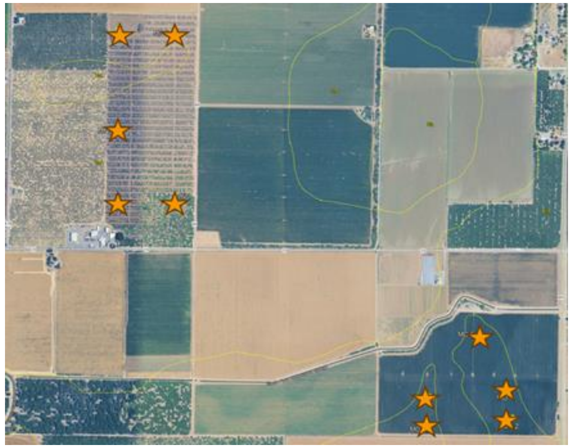
"OLD" VS "NEW" FIELDS: EXPLORING CAUSAL FACTORS FOR THE YIELD GAP

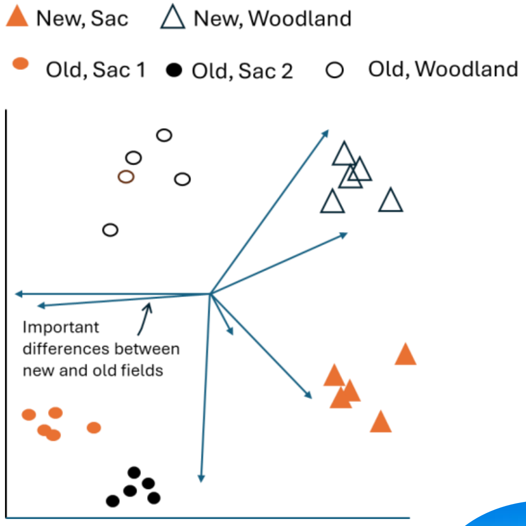
Patricia Lazicki
UCCE Vegetable Crops Advisor
Yolo, Solano & Sacramento counties
palazicki@ucanr.edu; 530-219-5198

California Tomato Research Institute

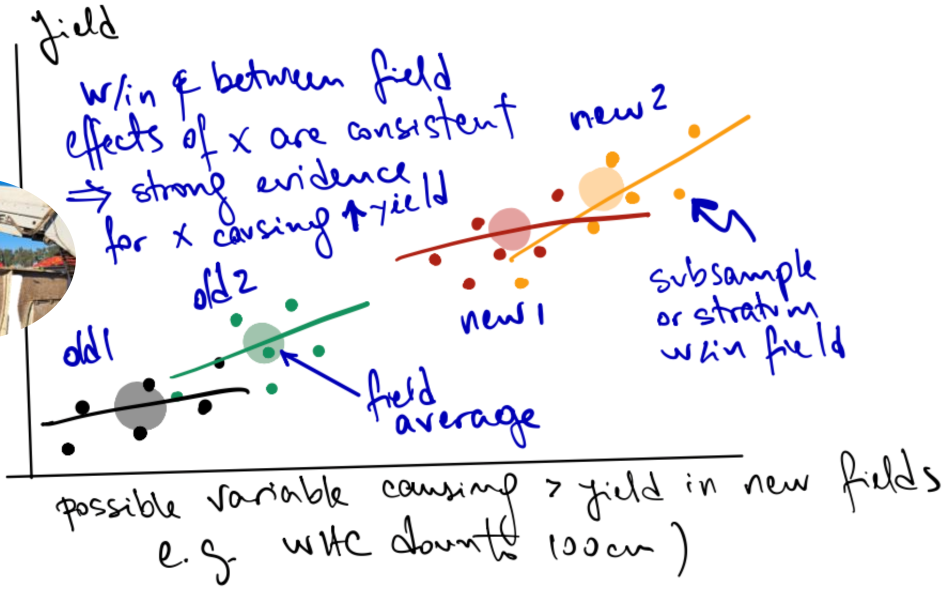
UC Cooperative Extension
University of California
Agriculture & Natural Resources

Questions:

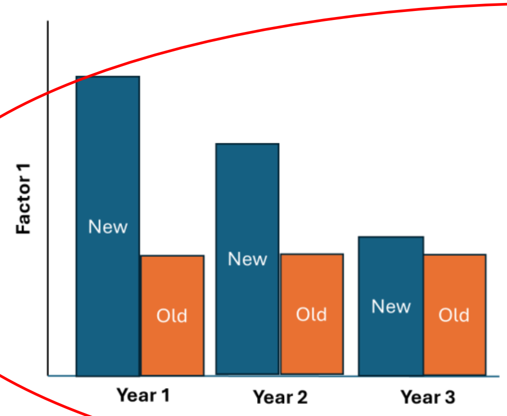




"What factors look most different between old and new fields?"



"What factors positively correlate with yields?"



"What factors start to look more alike over time?" (proposed for 2026)

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2025 EXPERIMENT

- 3 field pairs (row-crop vs walnut), 5 locations per field
- Match:
  - Soil type
  - Variety
  - Approximate planting time (Late March/ early April)

Location	Soil type	Old/New	Variety	Yield (t/a)*	Brix
Madison	Tehama loam (light surface soil, clay layer)	Old	SVTM 9027	65.6	5.68
		New	SVTM 9027	**76.5**	5.3
Winters	Brentwood silty clay loam (heavier soil, clay layer)	Old	HM 58841	80.5	5.33
		New	HM 58841	**88.5**	4.81
Zamora	Yolo silt loam (medium texture, no subsurface layer)	Old	HM 0371	79.8	5.05
		New	HM 0371	**101.6**	5.13

*Yield average from 5 200-ft plots machine-harvested into GT cart

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- Measure biological, physical, chemical indicators

Factor Type	Analyses	Timing (1st year)
Biological	Greenhouse assays; sterilized vs unsterilized soils	Planting
	Nematode communities	Planting
	Microbial communitiy structure (PLFA)	Planting
	Declined plants, pathogen identities	Pre-harvest
	Microbial communities (DNA)	Planting
Physical	Bulk density (0-6", 6-12" , 12-18", 18-24")	Early season
	Aggregate size distribution	Planting
	Moisture content (center vs edge, 0-24")	Midseason
	Soil pit, root distribution (observational, only)	Mid - late season
Chemical	Basic fertility	Planting
	Nutrient distributions (center vs edge, 0-24")	Midseason
	Leaf nutrients	Midseason
	Carbon fractions & enzyme analyses	Planting

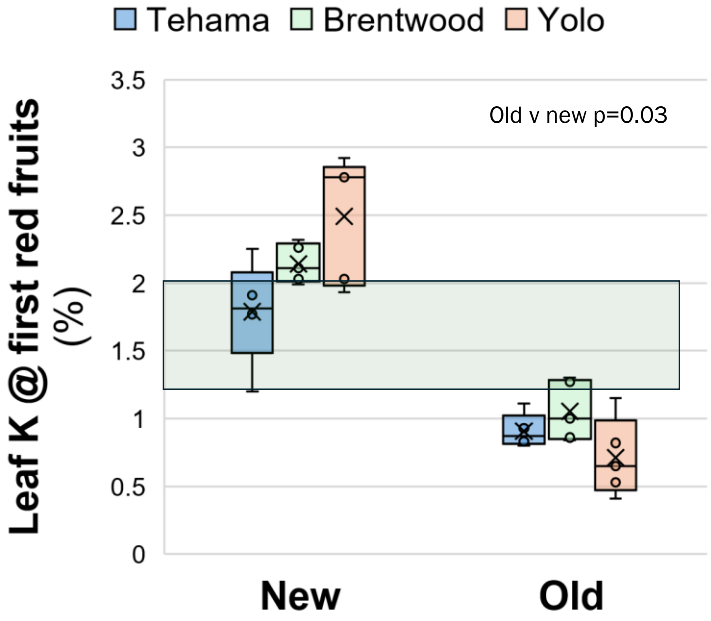
“WHAT LOOKS DIFFERENT?”

- Nutrition
- Compaction
- Disease

HIGH POTASSIUM IN 'NEW'

Rectangle = sufficiency threshold

Soil at planting (0-12")



Young mature leaf @ first red fruits

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Yolo silt loam "Old", pre-harvest
(8/1; 127 DAP)

Yolo silt loam "New", pre-harvest
(8/30; 148 DAP)

(Also consistently different between old & new: available phosphorus, available magnesium, leaf copper)

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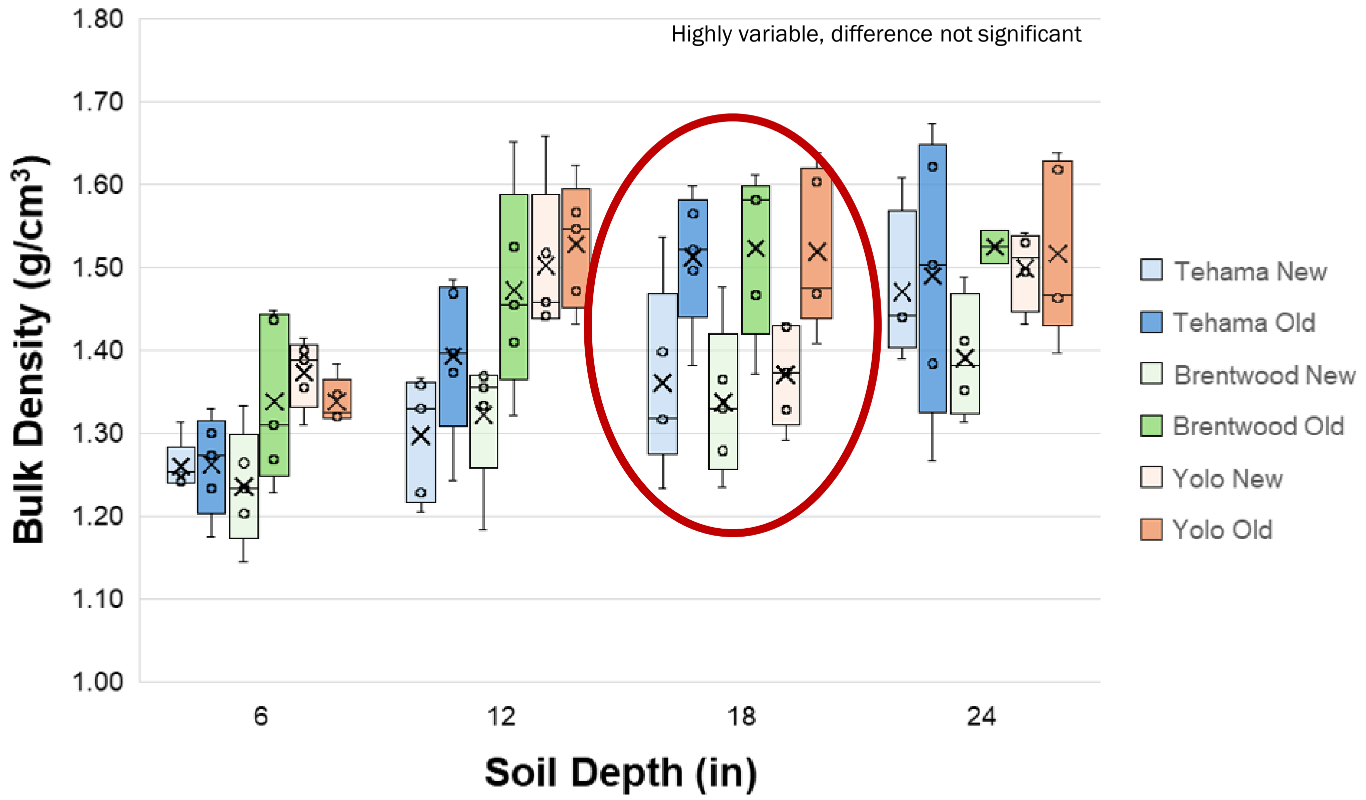
Agriculture & Natural Resources

SUBSURFACE COMPACTION



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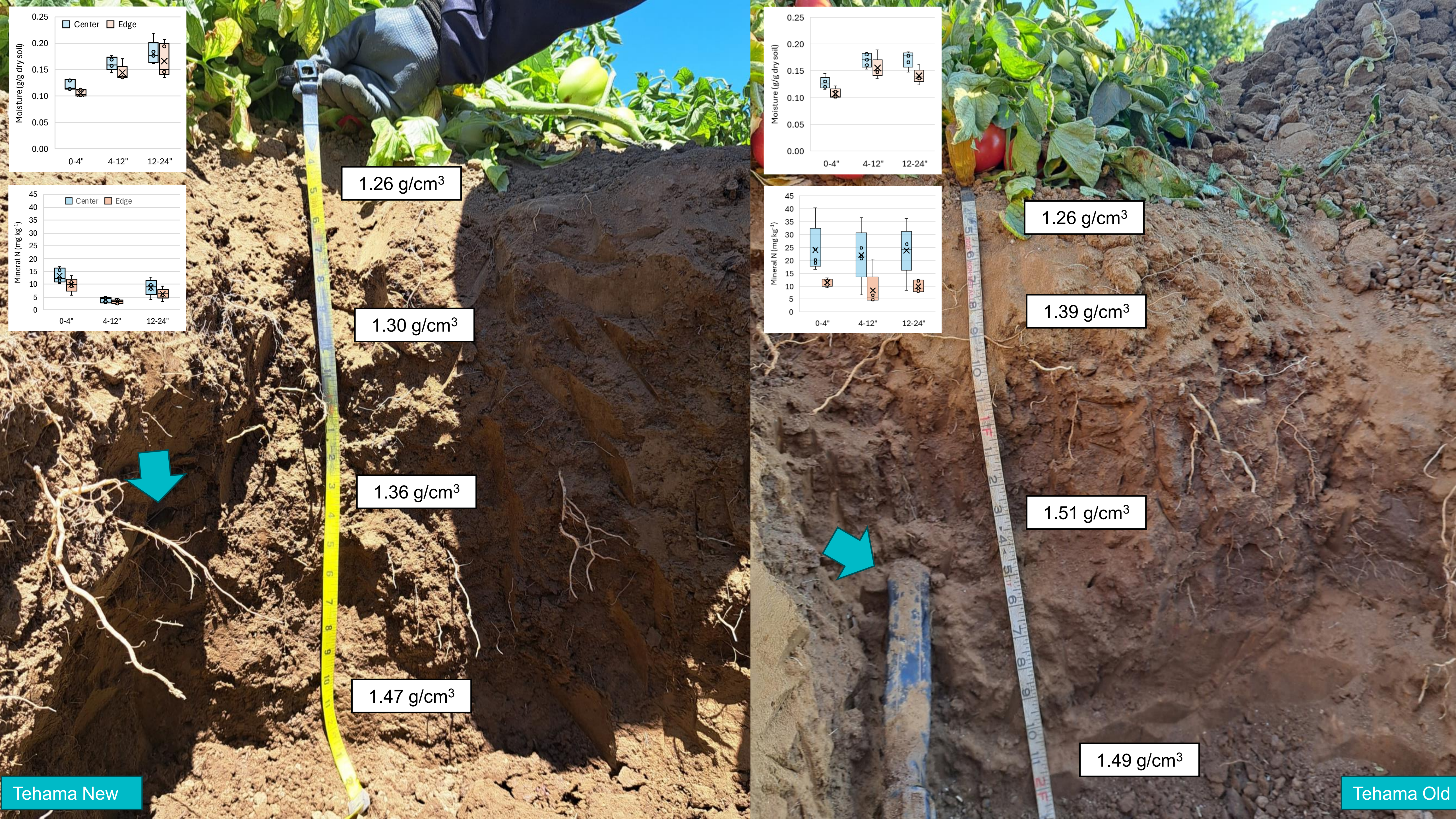
Brentwood silty clay loam “Old”

Bulk density=
1.52 g/cm^3

Brentwood silty clay loam “New”

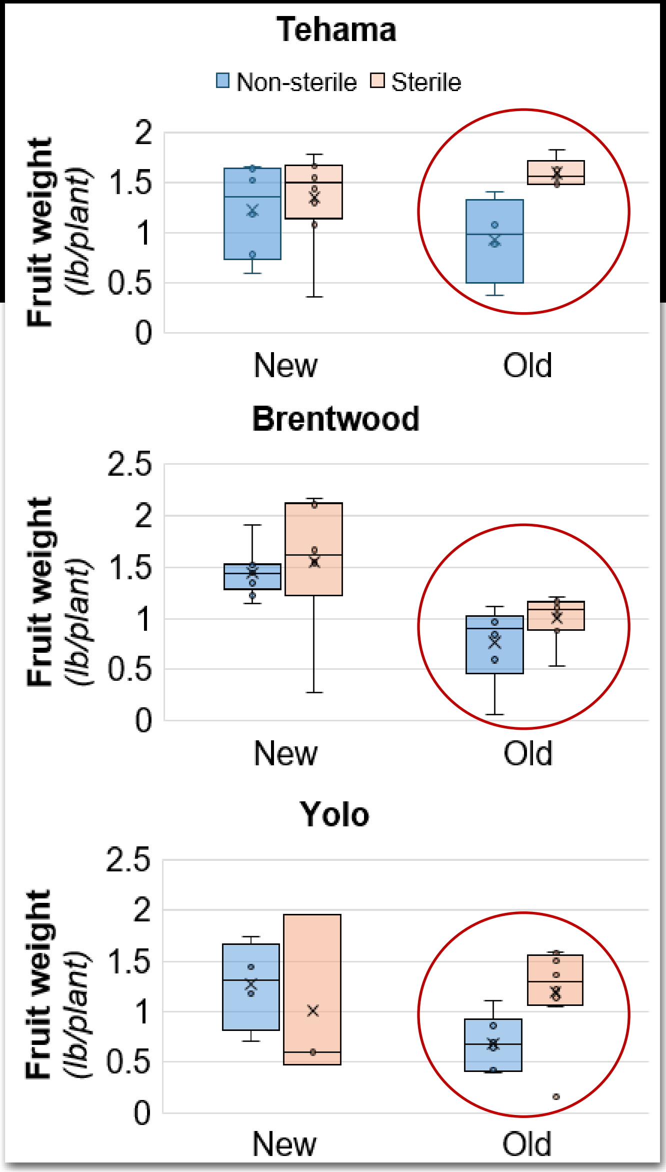
Bulk density=
1.34 g/cm^3

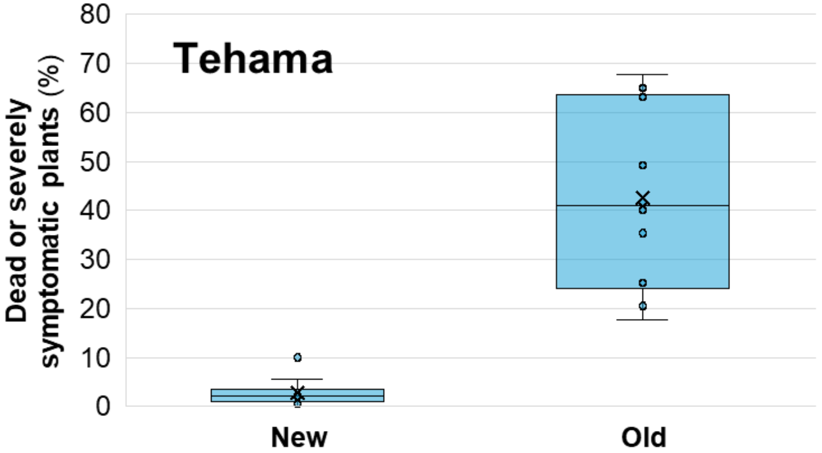

Moisture (g/g dry soil)
Center
Edge
0-4"
4-12"
12-24"
Mineral N (mg kg⁻¹)
1.26 g/cm3
1.30 g/cm3
1.36 g/cm3
1.47 g/cm3
Tehama New
1.26 g/cm3
1.39 g/cm3
1.51 g/cm3
1.49 g/cm3
Tehama Old

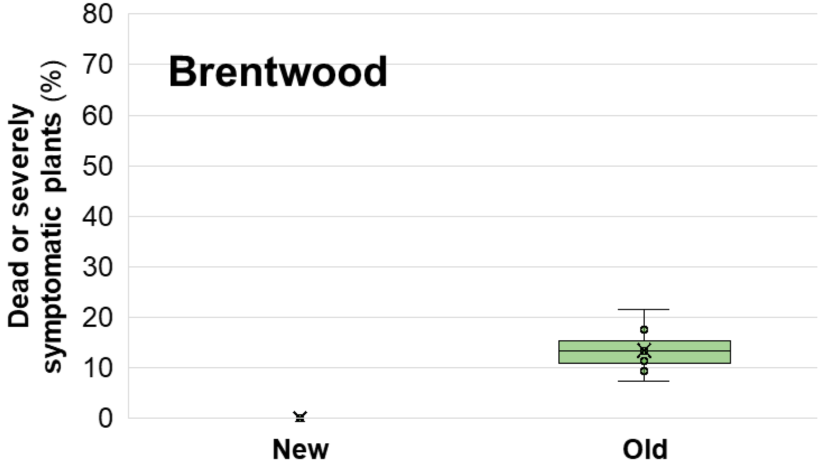
DISEASE

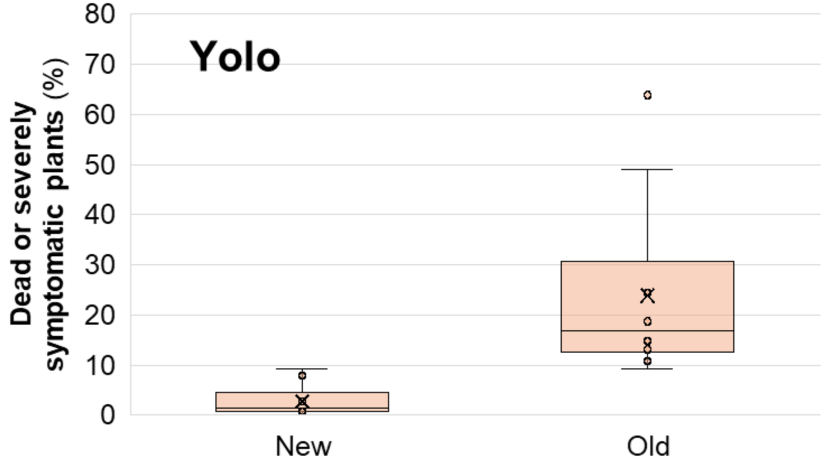
Hypothesis:

Sterilized soils will outyield non-sterilized soils in “old” fields, but not “new” ones









Fusarium stem rot & decline (FRD); F. foot rot

FRD; southern blight

SVTM 9027

No disease

Fusarium wilt (F2); southern blight

HM 58841

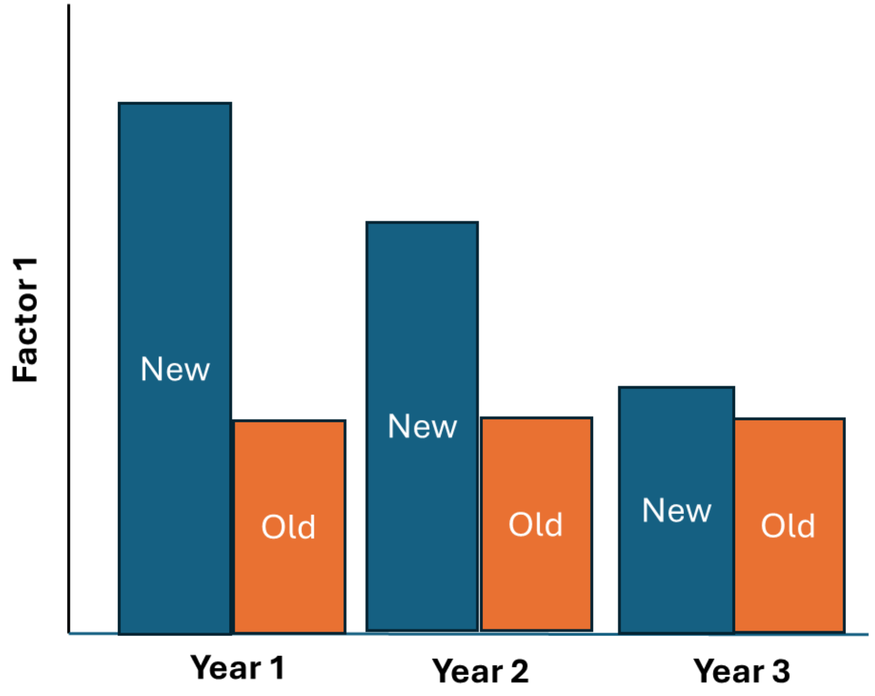
Rhizoctonia; charcoal rot

FRD; Verticillium wilt

HM 0371

PROPOSED NEXT STEPS: 2026

- Measure change over time (2025 “New” fields)
- Confirm by considering more new-old field pairs
  - “New” from row crops— Russell Ranch?
  - Drip tape vs tomato legacy-- new drip tape in “old” fields?
  - Better moisture/ stress monitoring-- “Gradient” system?



Acknowledgements

Hosting

- **Blake Harlan & Chris McAlister** (Harlan Family Ranch)
- **Bruce Rominger** (Rominger Brothers Farms)
- **Tim Beeman & Toshi Aoki** (Bullseye Farms)
- **Colin Muller** (M Three Ranches)
- **Planting & harvest crews!!**

Donation of plants

- **Kevin Winn & Scott Picanso** (TS&L)

Field help, analytics & use of lab space

- **Jorge Rodrigues** (UC Davis Professor of Soil Ecology) & Lab
- **Daniel Geisseler** (UC Davis CE Specialist in Nutrient Management)
- **Sutie Xu** (UC Davis CE Specialist in Soil Health)
- **Cassandra Swett** (UC Davis CE Specialist in Plant Pathology)
- **Amanda Hodson** (UC Davis Professor of Nematology)
- **Eric Haddix** (UC Davis Vegetable Crops Facility)
- **Indiana Waterman, Mat Talton & UCCE colleagues** for harvest help (!!)

California Tomato Research Institute for funding

QUESTIONS?

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Leveraging CTRI-funded climate-smart research to produce a best management practices guide for processing tomato growers

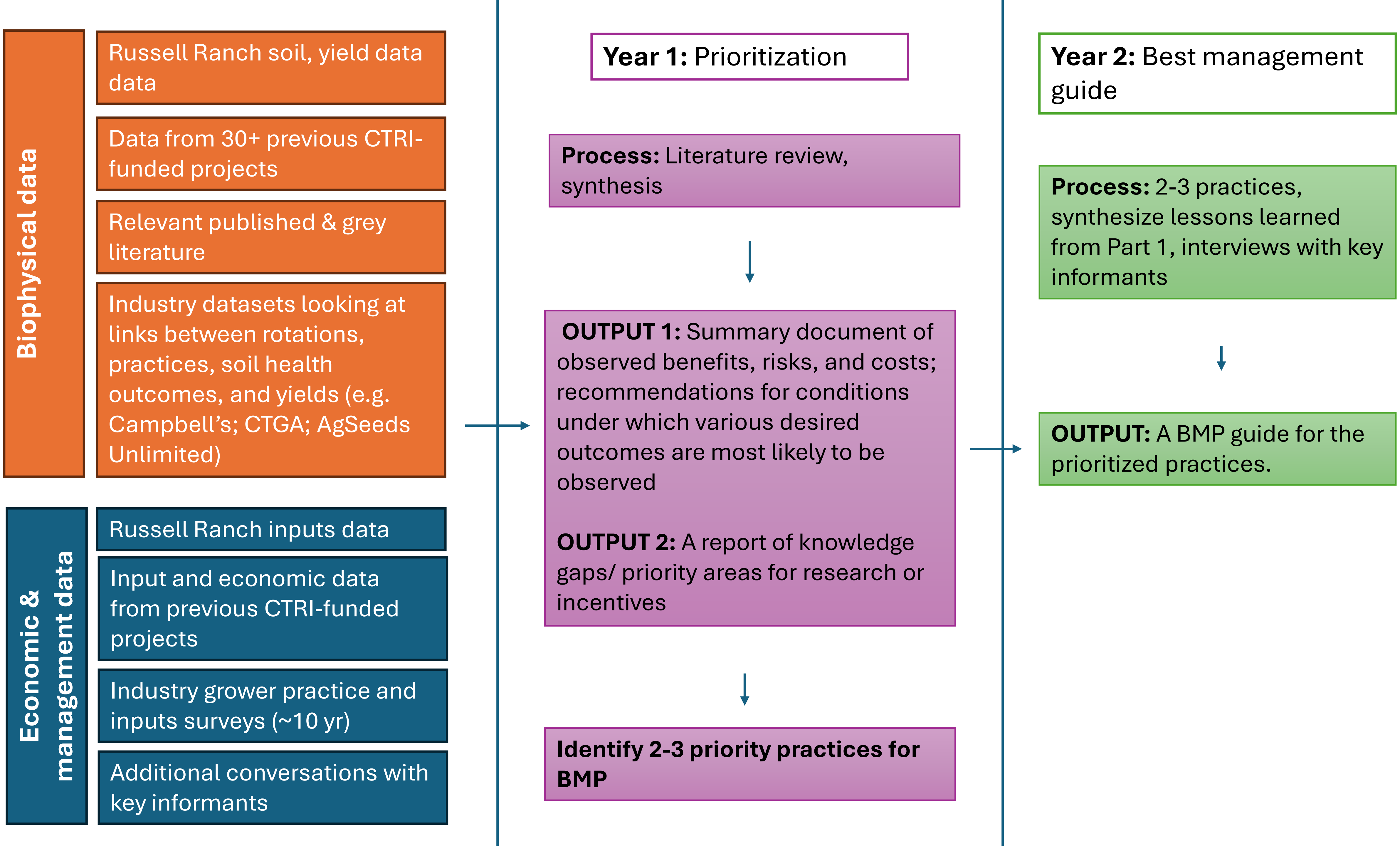
Patricia Lazicki (UCCE Vegetable Crops Advisor)

Sutie Xu (UCCE Specialist in Soil Health)

Sarah Light & Mandeep Singh (UCCE Agronomy Crops Advisors)

Margaret Lloyd (UCCE Organic & Small Farms Advisor)

Amelie Gaudin (Professor, UC Davis)



Biophysical data
Russell Ranch soil, yield data data
Data from 30+ previous CTRI-funded projects
Relevant published & grey literature
Industry datasets looking at links between rotations, practices, soil health outcomes, and yields (e.g. Campbell's; CTGA; AgSeeds Unlimited)
Economic & management data
Russell Ranch inputs data
Input and economic data from previous CTRI-funded projects
Industry grower practice and inputs surveys (~10 yr)
Additional conversations with key informants
Year 1: Prioritization
Process: Literature review, synthesis
OUTPUT 1: Summary document of observed benefits, risks, and costs; recommendations for conditions under which various desired outcomes are most likely to be observed
OUTPUT 2: A report of knowledge gaps/ priority areas for research or incentives
Identify 2-3 priority practices for BMP
Year 2: Best management guide
Process: 2-3 practices, synthesize lessons learned from Part 1, interviews with key informants
OUTPUT: A BMP guide for the prioritized practices.

Questions for discussion

1. We would like to sharpen our focus so that whatever we create will be directly useful to CTRI members.
   a. *Who do you think the main end-users would be?*
   b. *In what ways would you foresee the products of this project would be used?*
   c. *In what physical form do you see the products of this work being most accessible to end users (e.g. pdf living online? Physical book? Interactive website? Other?)*

2. Does the board have a preference as to whether we also consider CTRI-funded projects on water and nutrient management practices in Phase 1 of this project?

3. Other questions for us? (E.g. Methodology? Sources? Additional funding sources? Need for new data? Needs from industry?)

Thank you to our generous meeting sponsors!

BAYER

BHN Seed Hybrid Tomato

ENZA ZADEN

Tomato Heinz Seed

BASF We create chemistry

nunhems

Ac-Planta

Kula Bio

TOWING

BENE SEEDS

HM CLAUSE

Drexel

NORFOLK HEALTHY PRODUCE

EFPOLYMER

lark seeds international

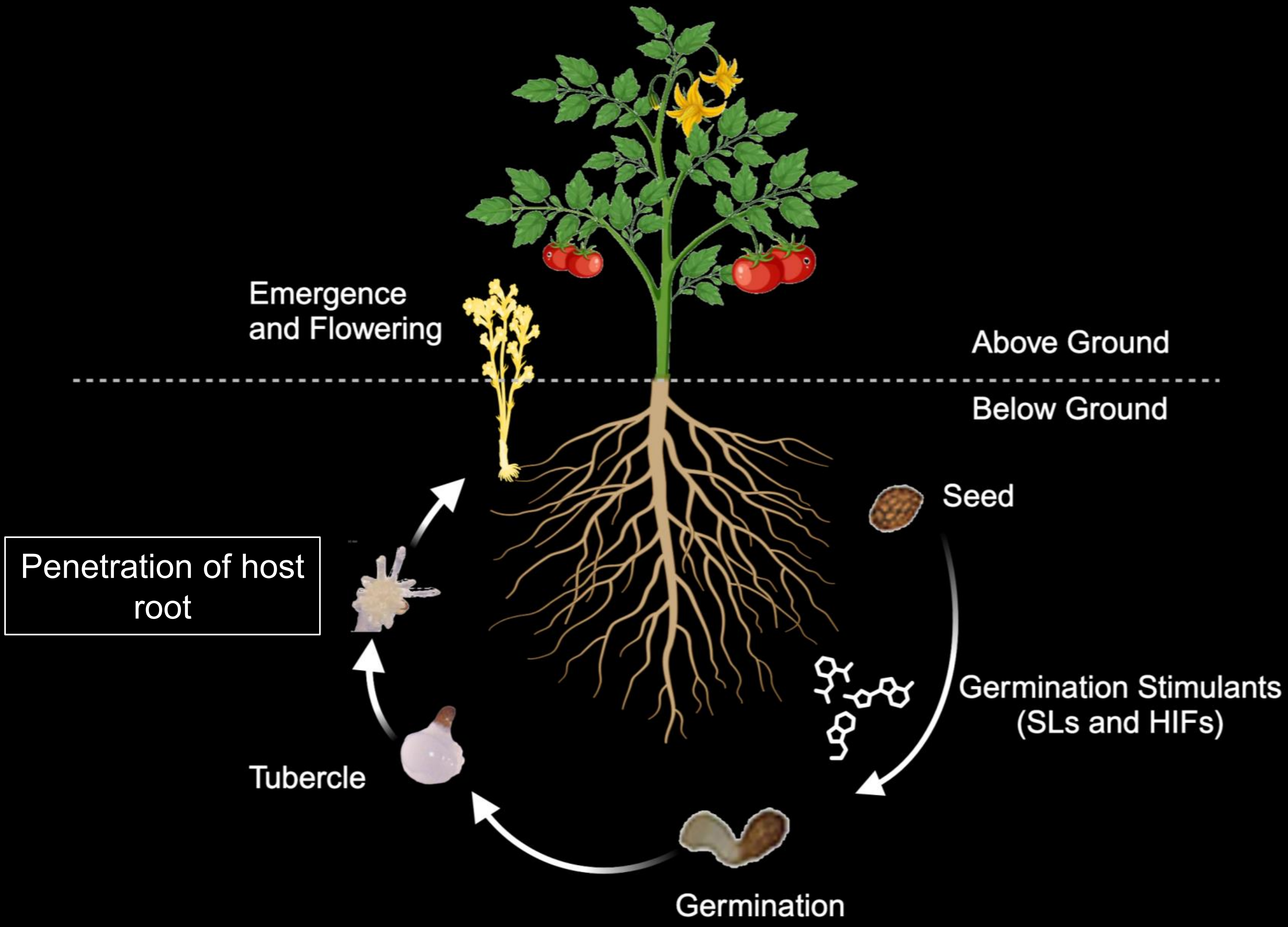
syngenta

Genetic Engineering for Resistance to Branched Broomrape in Tomato

University of California, Davis
Labs of Neelima Sinha, Siobhan Brady
Mona Gouran, Mily Ron, Summer deClarin, Melvin Martinez

What is Branched Broomrape?

Branched Broomrape Life Cycle

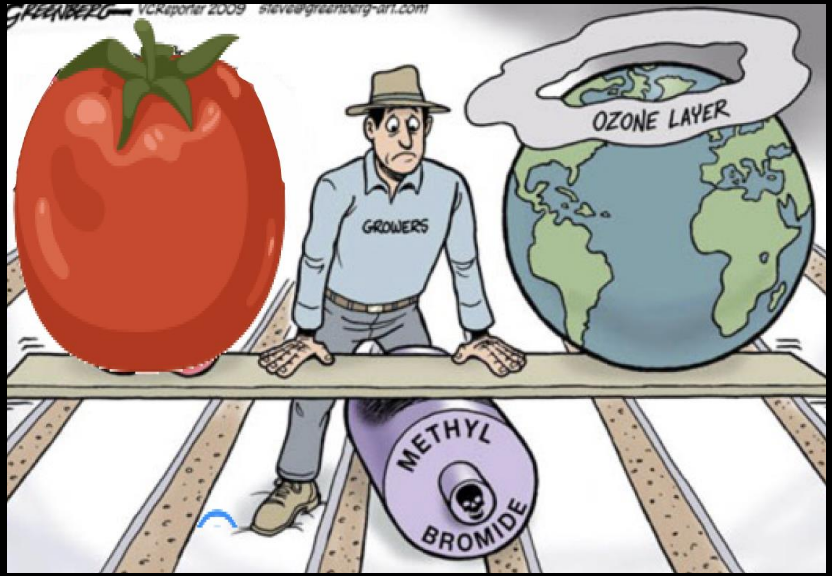


Project Goals

Using genetics and genomics, identify candidate resistance genes

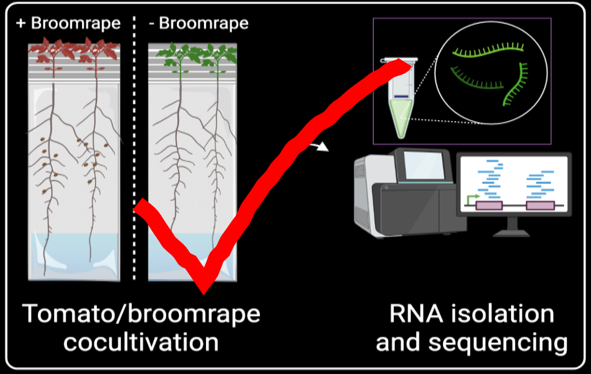
Focus on penetration of branched broomrape through the root

Engineer resistance to branched broomrape

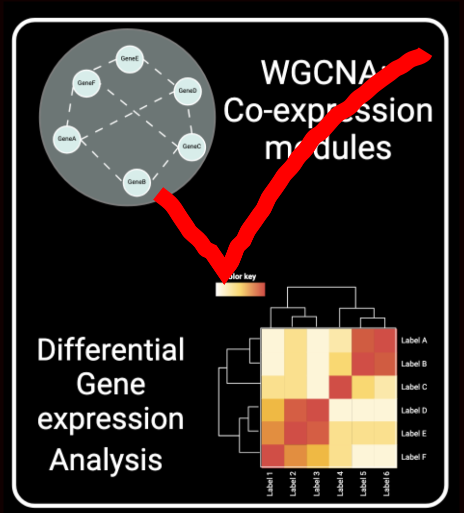


Past Accomplishments Years 1-3

Aim 01 Characterizing gene expression in tomato post-infection

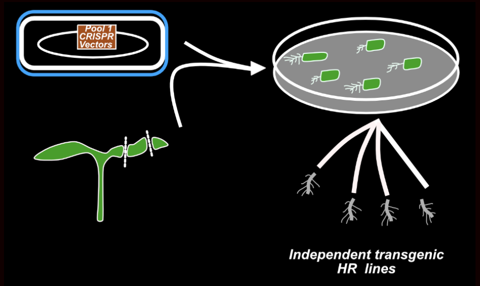


Aim 02 Identify candidate genes for CRISPR editing



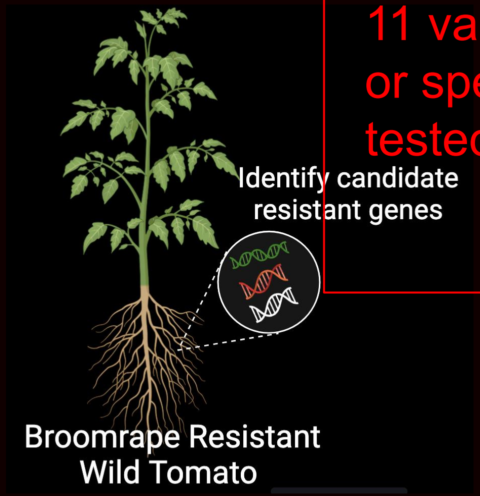
Aim 03 CRISPR mutagenesis and resistance screening in tomato hairy roots

100 genes targeted and confirmed
40 genes tested/testing
(CTRI, CDFA, FFAR)

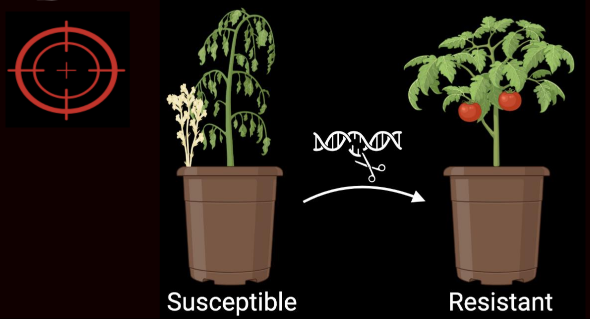


Aim 04 Harnessing Natural Variation in Wild Tomato Species for Broomrape Resistance

11 varieties or species tested

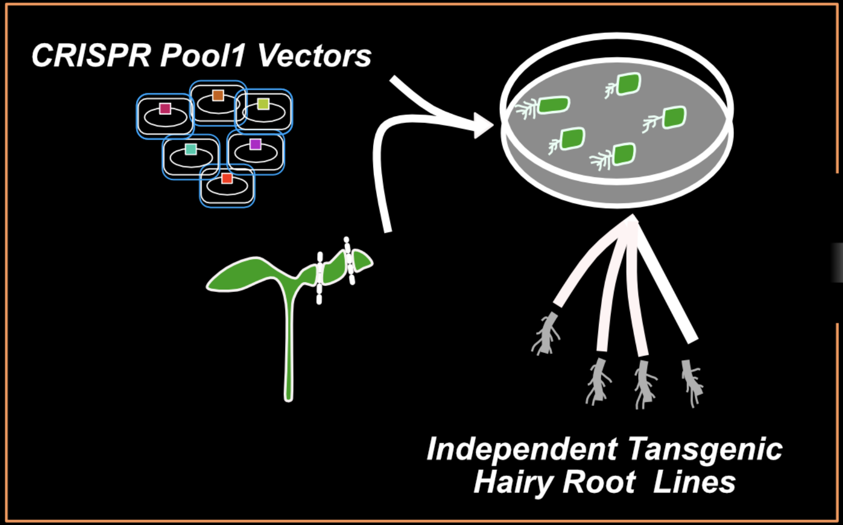


Aim 05 CRISPR edited stable broomrape resistant tomato lines



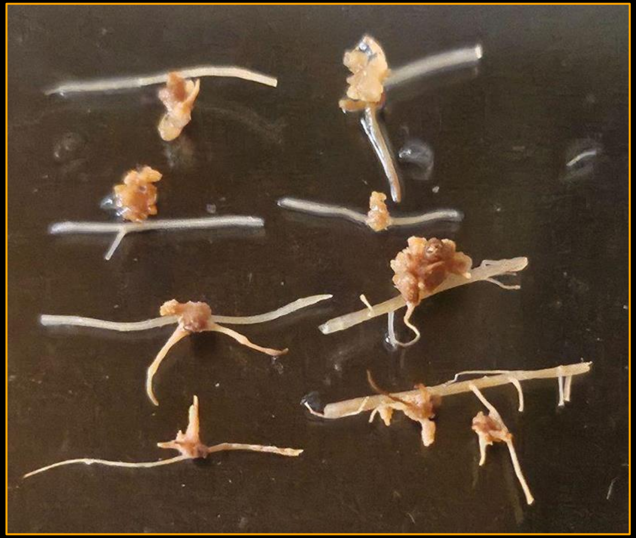
3 CRISPR Mutagenesis in Tomato Hairy Roots and Testing in Composite Plants

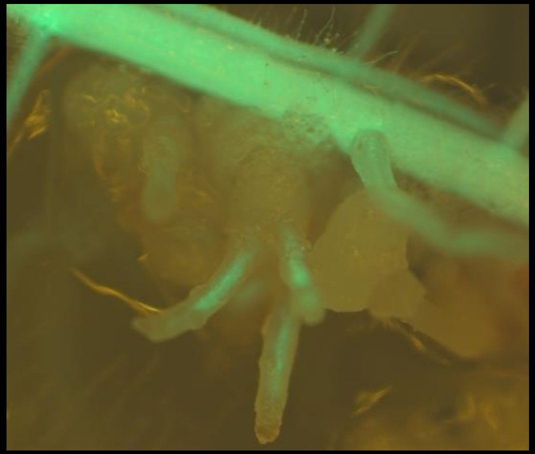
Tomato Hairy Root Transformation



Composite Plant

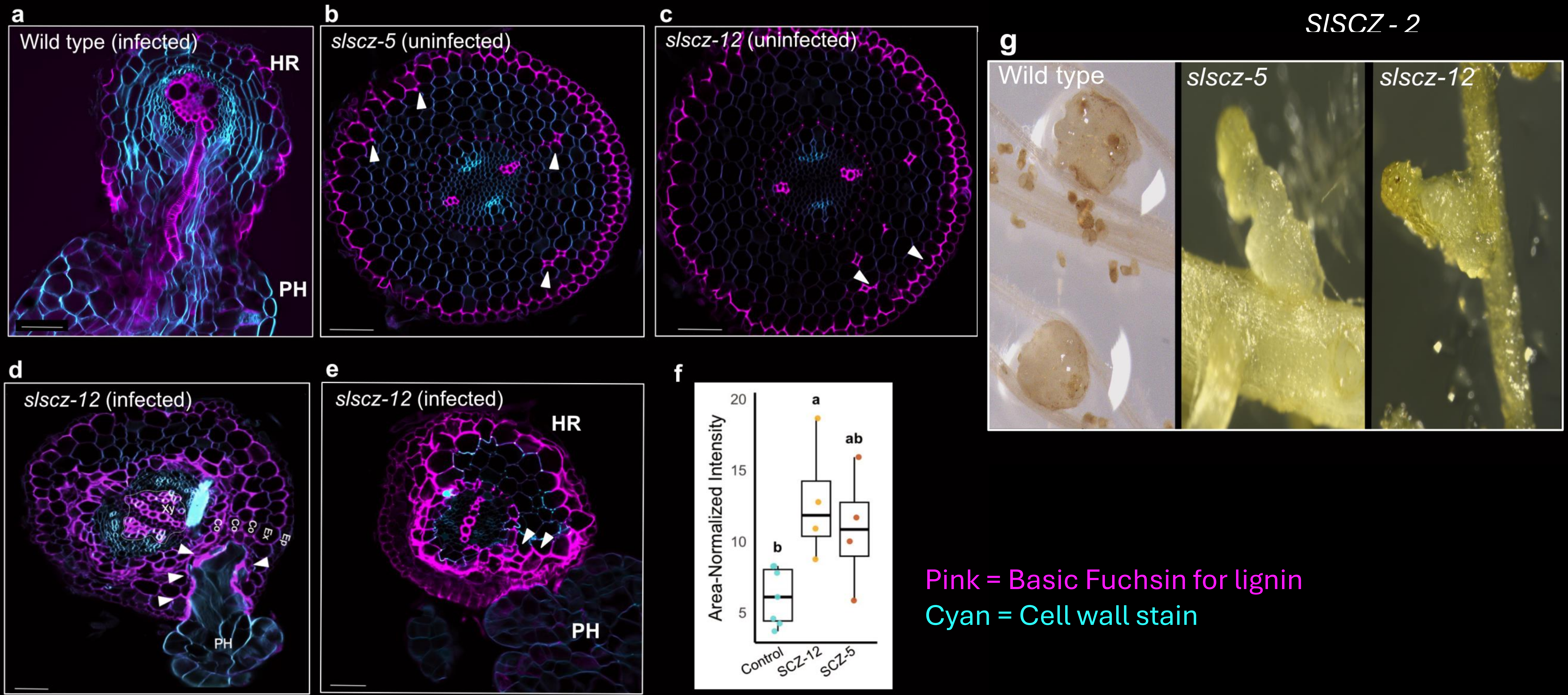
Segment of infected root





GFP Taken Up into Branched Broomrape (successful transformation + infection)
COUNT INFECTION #

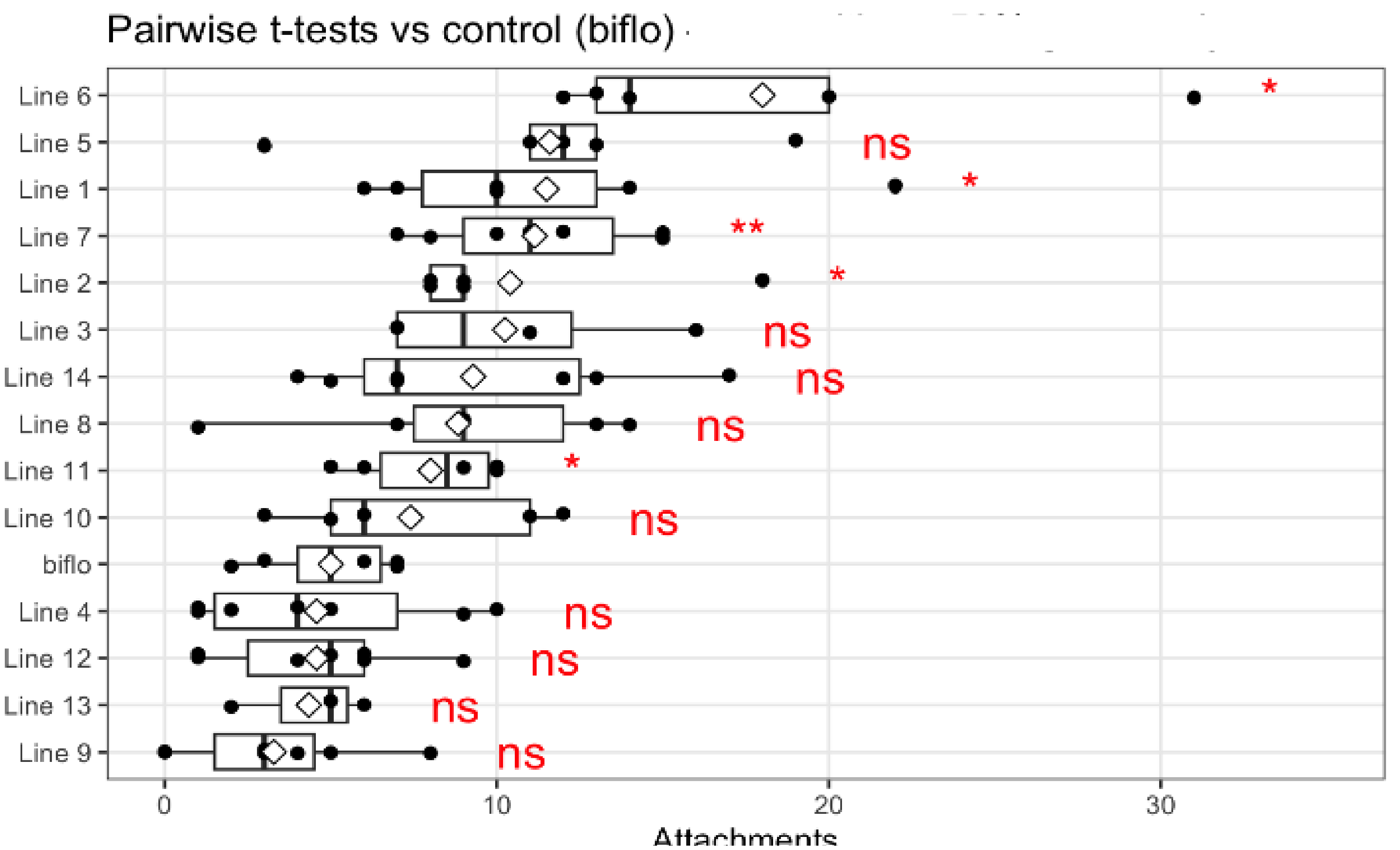
3 Enhanced Lignin Deposition in CRISPR-Edited Hairy Roots for Broomrape



Pink = Basic Fuchsin for lignin
Cyan = Cell wall stain

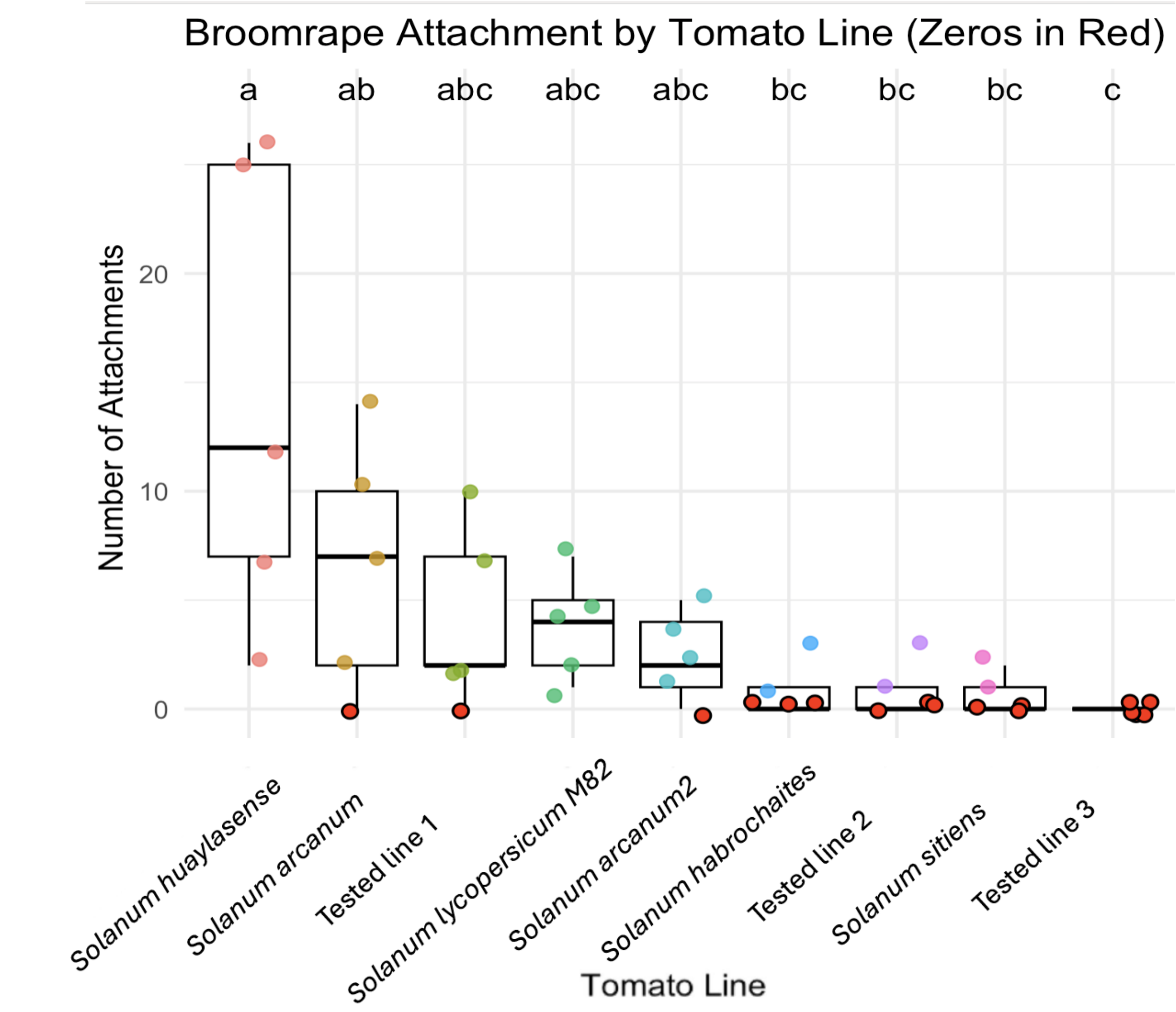
3

Past Aims and Accomplishments (approach is working!)



Broomrape attachments on composite plants with transgenic edited hairy roots compared to controls with biflo expressing roots – genes edited in lines significantly different from control are marked.

4 Variation in Susceptibility of Wild Tomato Species to Broomrape



Goals for 2026

1. Screen 15 Wild Tomato Species and Cultivars for Resistance Genes:
- Lines selected for their reported resistance to other root pathogens
- Testing in 10-week-old plants
- Identify genomic region of interest in introgression or crosses to do so
- RNAseq experiments/genomic if needed to identify candidate resistant-genes

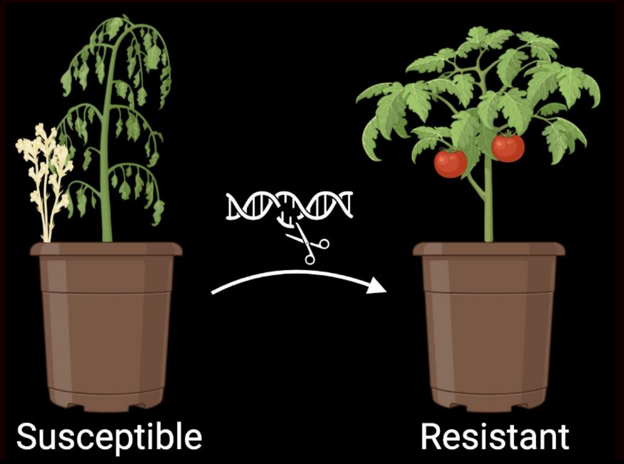
2. Analyze mature CRISPR-edited tomato plants for resistance testing:
- Resistance in mutations at 22 single genes and up to 30 gene combinations

3. Stable lines:
- Stably edited lines for up to 5 genes at the UC Davis Plant Transformation Facility.
- Select edited non-transgenic lines by the end of 2026.

Questions for You

- Ideal processing tomato cultivar to introduce resistance into (maximize applicability while still enabling publication)?
- Value in explaining or work to industry partner? Who and how?
- In field, how do you measure resistance?
- In field, what are your strategies for control?

CRISPR edited stable broomrape resistant tomato lines



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BAYER

BHNSeed Hybrid Tomato

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TOMATO Heinz SEED

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BENE SEEDS

HM • CLAUSE

Drexel

NORFOLK HEALTHY PRODUCE

EFPOLYMER

lark seeds international

syngenta

Inducible Suberin for Tomato Drought Tolerance

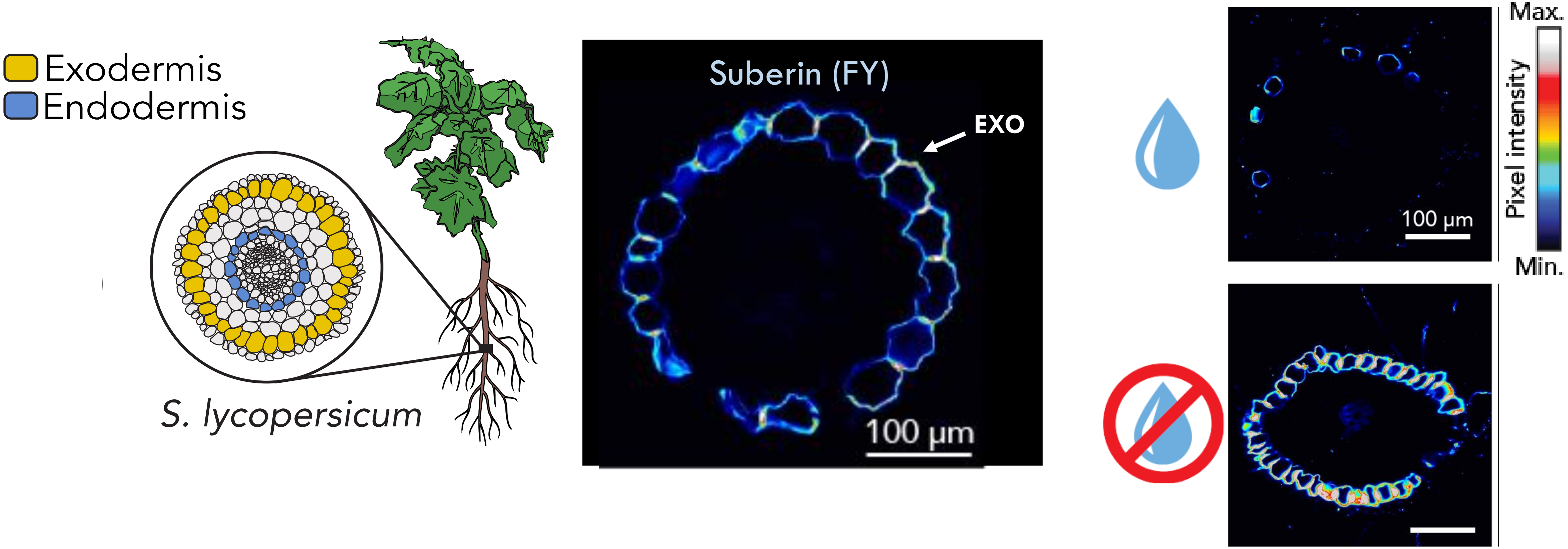
Professor Siobhan Brady, PhD
Alex Cantó-Pastor, PhD
Kevin Morimoto
Kordi Kokott
Adele Nemer
Barbara Blanco-Ulate
HM Clause – Shantel Martinez

BAYER
NSF
California Tomato Research Institute
hhmi
UC DAVIS
UNIVERSITY OF CALIFORNIA

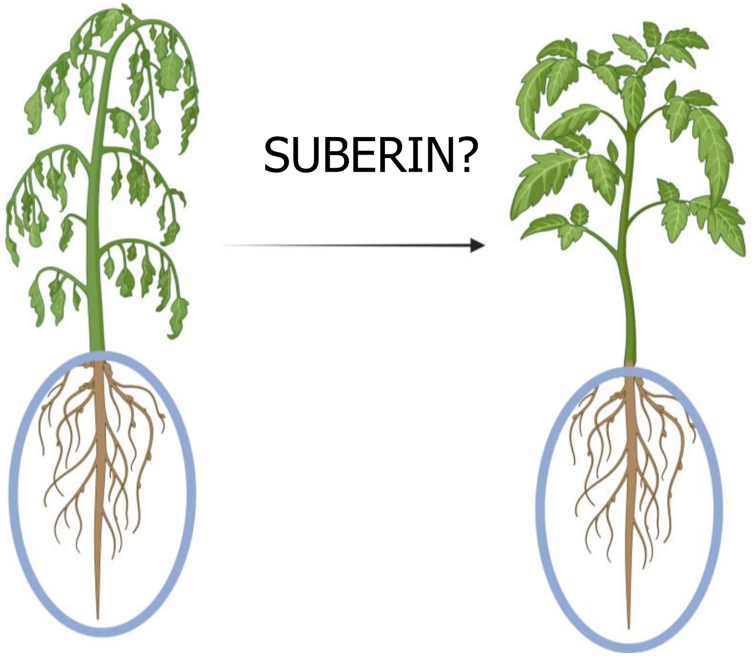
What is suberin and why is it important?

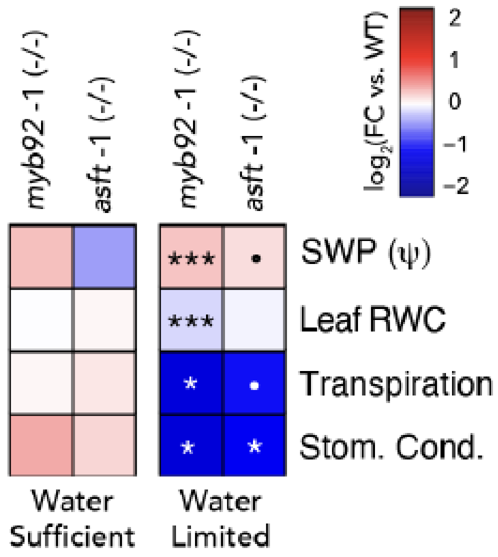
- Waxy biopolymer, found in cork
- Correlated with drought tolerance (Arabidopsis) and pathogen resistance (soybean)
- A target for many multi-million dollar initiatives to increase carbon content in the soil, and improve drought tolerance in multiple crop species (corn, rice, soy)
- Tomato: Increasing threat of water deficit
- Tomato: Water uptake by plant roots in sub-surface irrigation is dependent on proximity to drip lines

Tomato is Different: Exodermis Suberin Production



Tomato: What happens if you don’t have suberin in drought conditions?



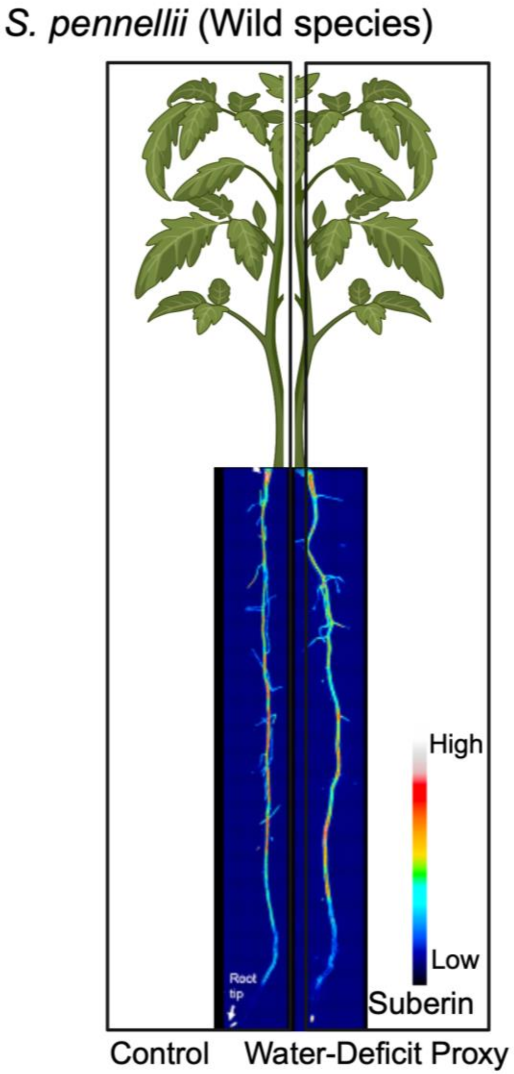


Plants are more sensitive to drought.

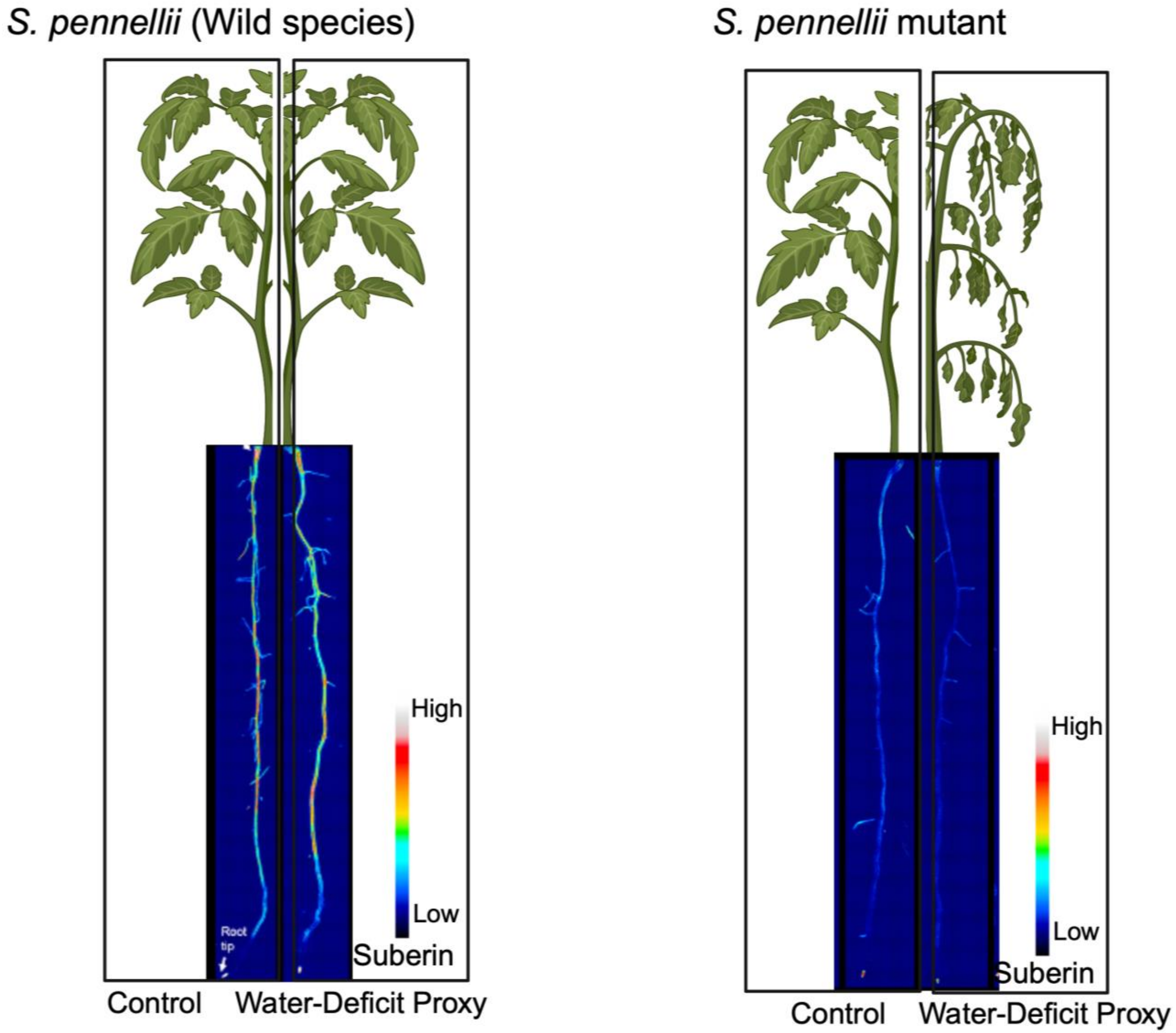
Exodermal suberin controls the drought response

(Cantó-Pastor et al., 2024)

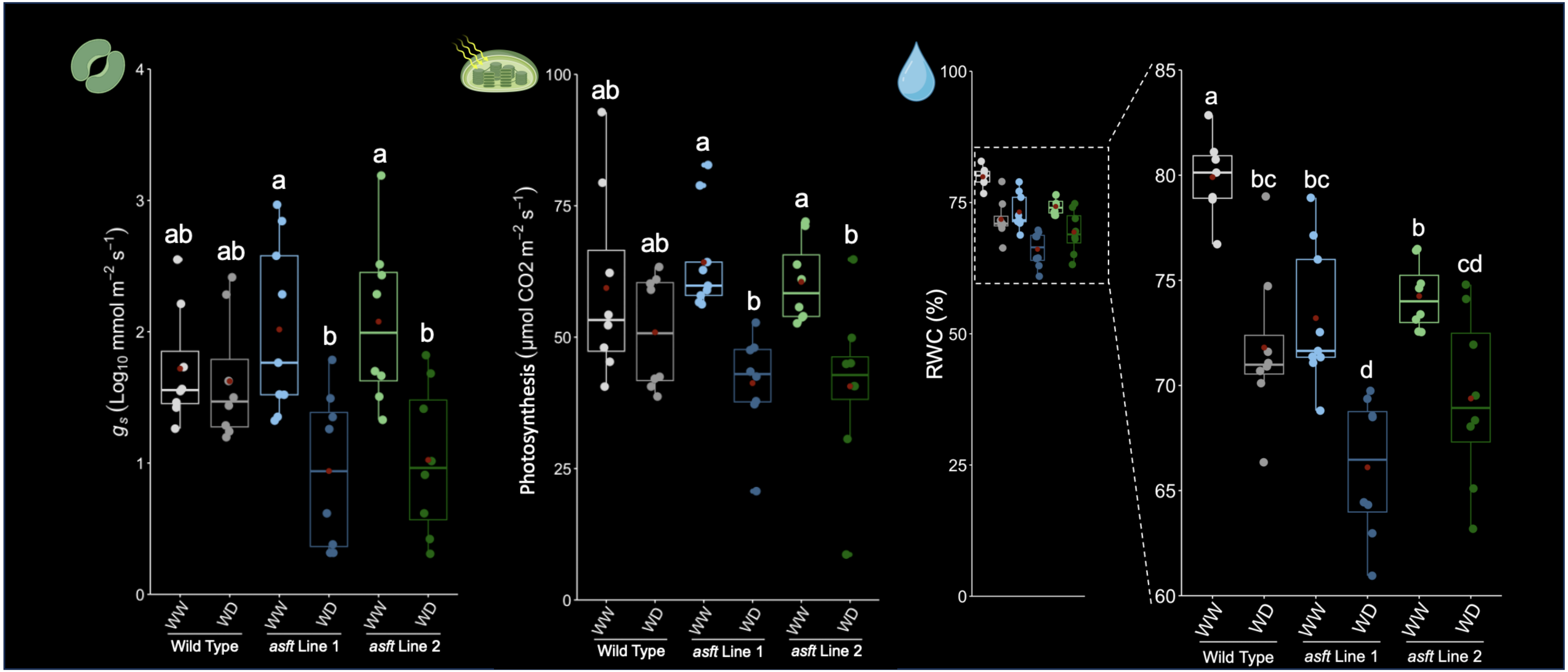
Wild drought tolerant species: What happens if you don’t have suberin in drought conditions?



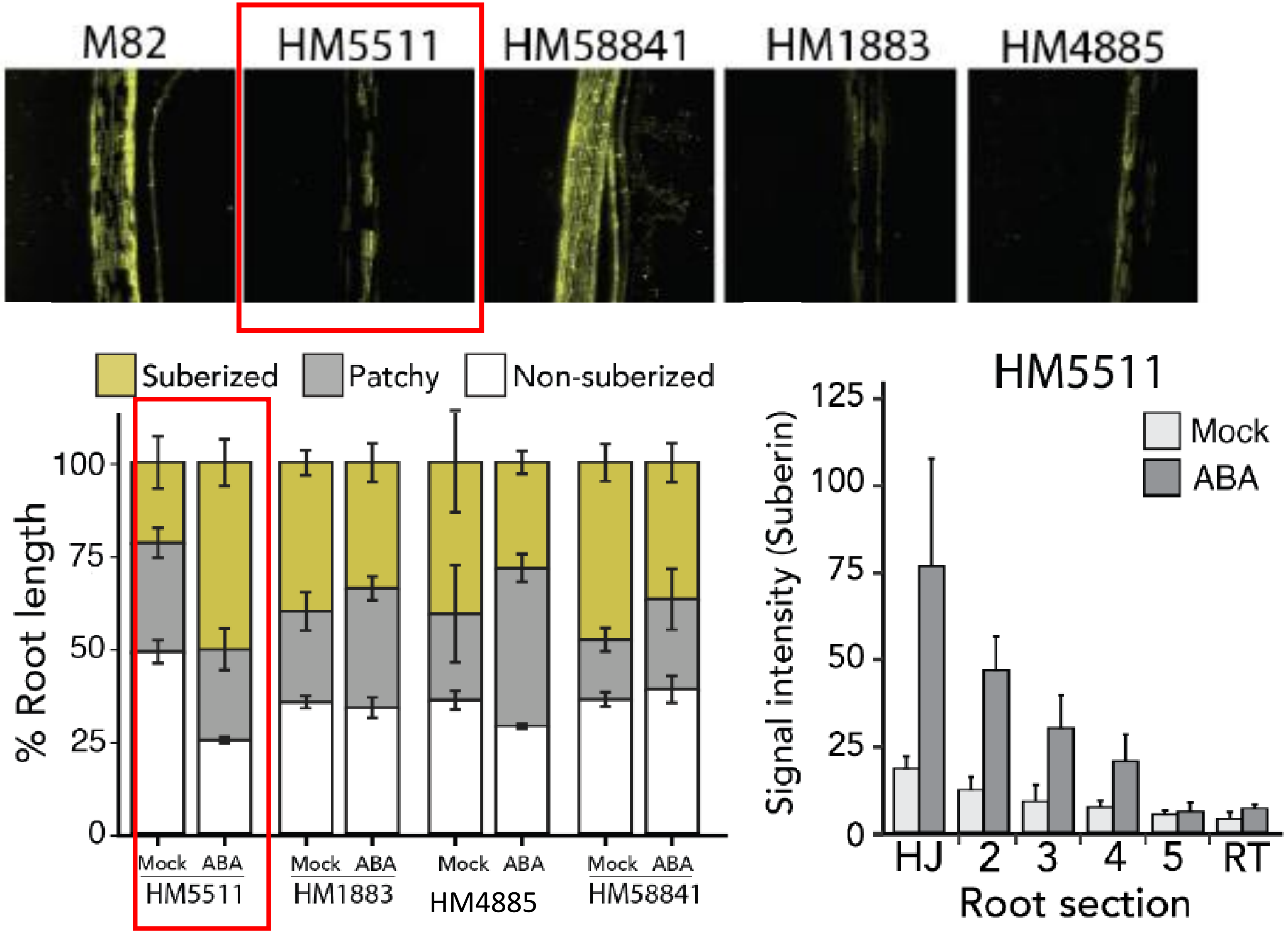
Wild drought tolerant species: What happens if you don't have suberin in drought conditions?



Suberin is responsible for drought tolerance in wild species



Commercial Processing Varieties have Variable Suberin Levels



- Consult with HM Clause
- Choose HM5511 as germplasm to transform
- Can we max out suberin in drought conditions?

Make lines with increased and inducible suberin

- Takes 1.5-2 years to generate
- Only one of the four strategies worked
- Growth penalty in the three other strategies
- Generate hybrid
- Test parent and hybrid
- Parent A; HM5511-like

Greenhouse Experiment to Test Yield and Fruit Parameters

- 90 plants
- Included HM5511 as a control
- Plants grown for ~2.7 months in well watered conditions, and then 62.5% reduction of water; first harvest at ~1.5 months of drought treatment
- Four harvests to collect enough material for fruit yield count, and assessing dry root and shoot weight
- Dry root and shoot weight measurements remain to be determined (still drying)

Parent A Morphology

Drought

Water

Control

Drought

Water

Inducible Suberin

Parent A Summary

Trait	Parent A (-) W vs. D	Parent A (+) W vs. D
Total Yield	—	—
Shoot Fresh Weight	↓	↓
Fruit Fresh Weight	—	↓
Firmness	—	—
Lightness (*L**)	—	—
Yellowness (*b**)	—	—
Redness (*a**)	—	↑
a:b** ratio	↑	↑
Hue	↓	↓
Chroma	—	↑
Color Index	—	↑
Total Soluble Solids	↑	↑

Key	
Increase	↑
No Change	—
Decrease	↓

Increased redness

More vivid

HM5511-Like Morphology

Drought

Water

Control

Drought

Water

Inducible Suberin

HM5511-Like Summary

Trait	HM5511-Like (C) W vs. D	HM5511-Like (IS) W vs. D
Total Yield	—	—
Shoot Fresh Weight	↓	↓
Fruit Fresh Weight	↓	↓
Firmness	—	—
Lightness (*L**)	—	—
Yellowness (*b**)	—	—
Redness (*a**)	↑	—
*a**:*b** ratio	↑	—
Hue	↓	—
Chroma	↑	—
Color Index	—	—
Total Soluble Solids	↑	↑

Key	
Increase	↑
No Change	—
Decrease	↓

C = Control
IS – Induced Suberin

Takeaway: how does inducible suberin production change yield/fruit parameters in water deficit

- Parent A: No change in fruit yield in lines with and without suberin in water deficit, fruit fresh weight penalty when suberin is induced; similar increase in total soluble solids
- Parent A: Lines with suberin only have increased fruit redness, vivid color and color index upon water deficit

- HM5511-Like: Lines with and without suberin have no change in total fruit yield, and both lines have decreases in shoot and fruit fresh weight upon water deficit
- HM5511-Like: Increases in fruit redness and vividness; and decrease in hue are lost in the hybrid with suberin upon water deficit

Caveats

- This is a greenhouse experiment with irrigation coming from the top of the soil, not representative of field conditions
- We chose to make our line in a background that already has increased suberin in drought conditions. There may be different results if this was put in a line that had low suberin in both well watered and water deficit conditions

Questions for YOU!

- What processing tomato metrics do you look at when assessing if improvement in a line in water deficit is worth investing in? Is it just yield? Is color important?
- What is an acceptable reduction in plant growth and seed production?

Is this observation worth pursuing in the field?

Siobhan M. Brady
Alex Cantó-Pastor
Kevin Morimoto

Brady lab members

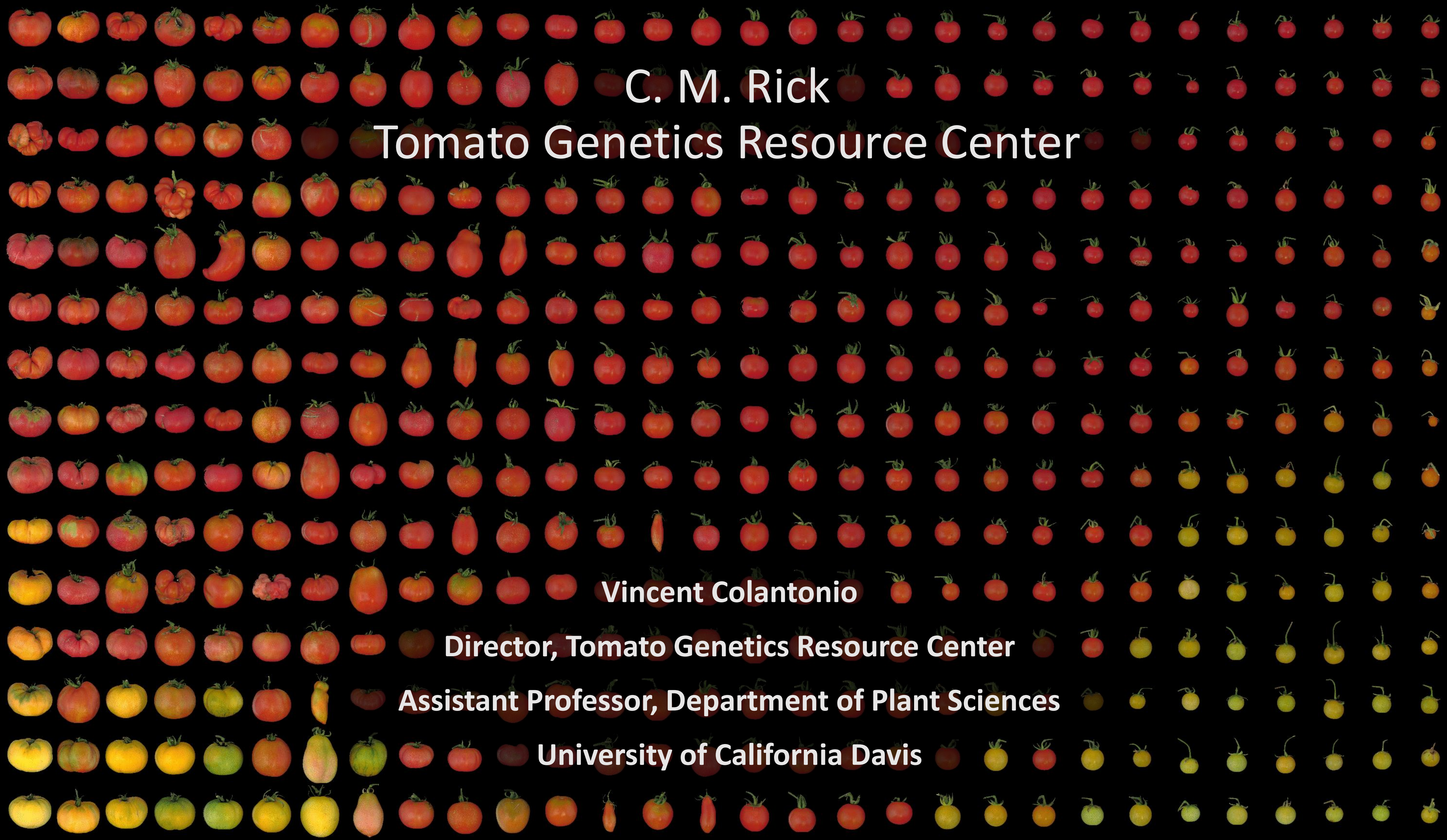
Undergraduates:
He Yang, Aaron Wright,
Emma Desany, Kevin Morimoto,
Kordelia Kokott, Adele Nemer

Collaborators:
HM Clause: Sukhpreet Sandu, Shantel Martinez, Chad Kramer, Kebede Muleta, & Vincent Asiago

Bayer: Alessandra Frizzi

UC Davis: Neelima Sinha, Brad Hanson & Shahid Siddique

Thank you Zach and CTRI!



C. M. Rick
Tomato Genetics Resource Center

Vincent Colantonio

Director, Tomato Genetics Resource Center

Assistant Professor, Department of Plant Sciences

University of California Davis

Wild Tomatoes

S. cheesmaniae

S. peruvianum

S. chilense

S. habrochaites

S. galapagense

S. ochranthum

S. huaylasense

S. sitiens

Wild tomato traits on the farm

Jointless pedicel for mechanical harvest

S. cheesmaniae

Resistance to Root-knot Nematode

S. peruvianum

Resistance to Fusarium Race 3

S. pennellii

C.M. Rick Tomato Genetics Resource Center

Core Objectives

- **Maintain germplasm**
  - >4500 accessions
- **Distribute seed**
  - >5000 seed packets per year
- **Expand the collection**
  - Resurrect historical seed lots
- **Catalog and characterize deeper into the collection**

Research Program

- **Prebreed wild tomato traits into processing cultivars**

S. ochranthum

S. peruvianum

Thank You!

California Tomato Research Institute

C.M. Rick

TGRC

Tomato Genetics Resource Center

TGRC Endowment

UC DAVIS
DEPARTMENT OF PLANT SCIENCES
College of Agricultural and Environmental Sciences

USDA
Agricultural Research Service

MORNING STAR
Excellence Through Commitment

<u>TGRC Team</u>

- **Roger Chetelat**
- **Xiaoqiong Qin**
- **Matt Valle**
- Mercury Komjak
- Jesse Martinelli
- Han Jeon

Matt Valle

Xiaoqiong Qin

Roger Chetelat

Thermotolerant pollen performance to enhance yield

Mark Johnson
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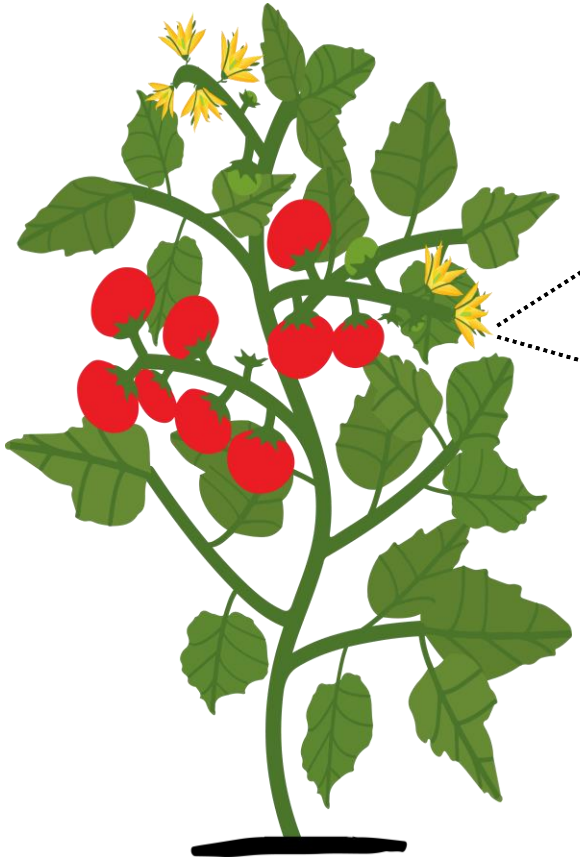
BROWN
MCB

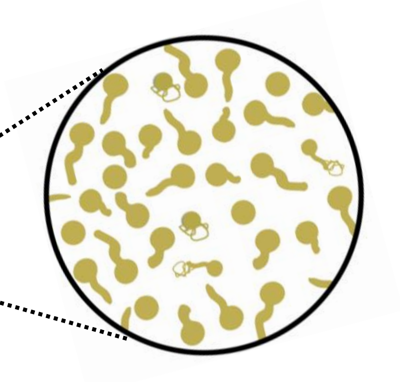
California
Tomato
Research
Institute

California Processing Tomato Annual Research Meeting

December 3rd & 4th, 2025

Thermotolerant pollen performance to enhance yield



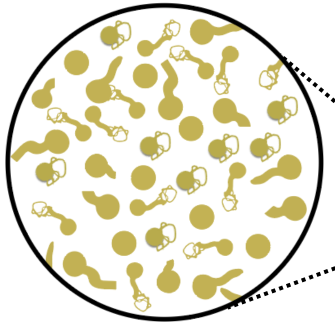


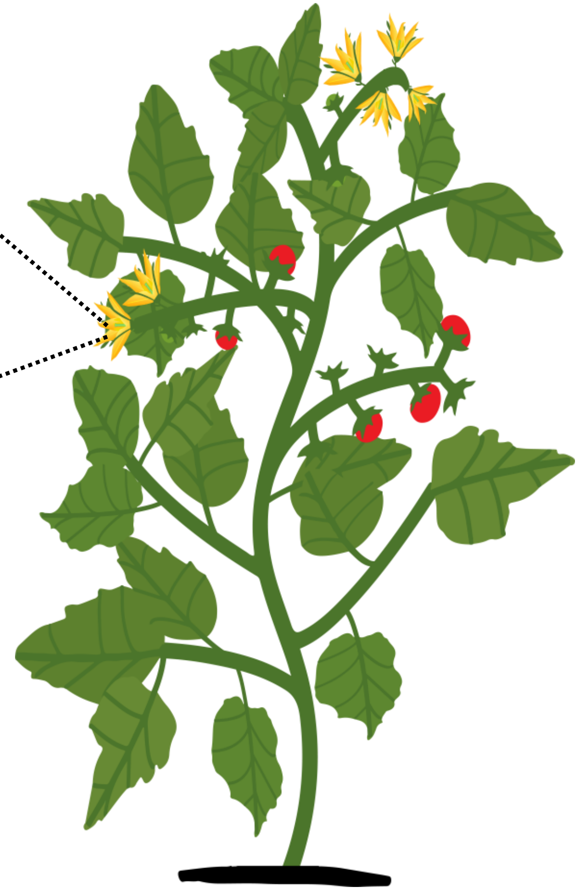
Good growing season (2025)

2025: Days and nights were cooler than average. Yields rose 10–20%.

What do you need to achieve 2025-like performance in hotter seasons?

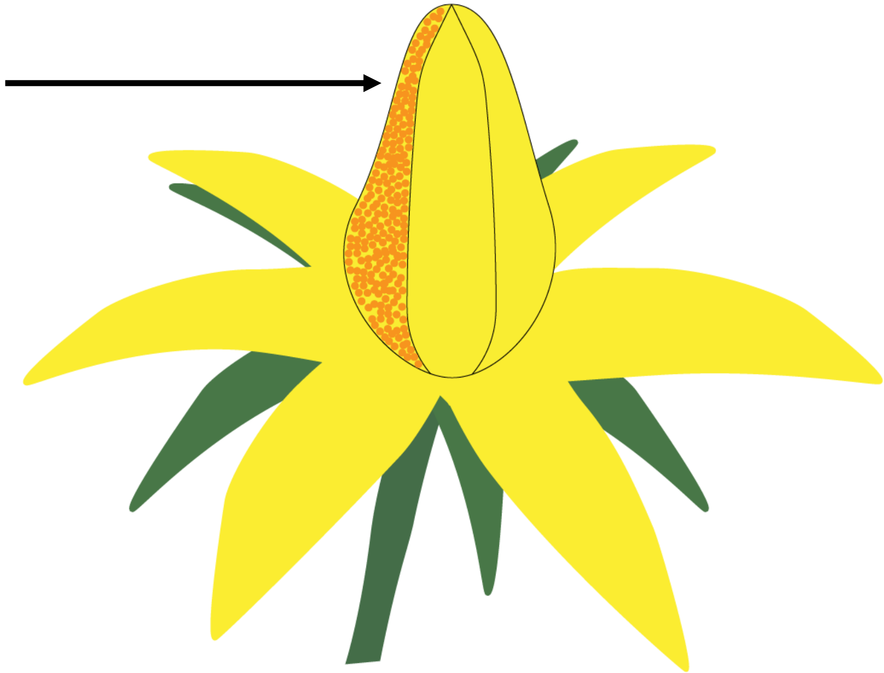
Even modest yield protection via thermotolerant varieties will produce significant returns on investment.





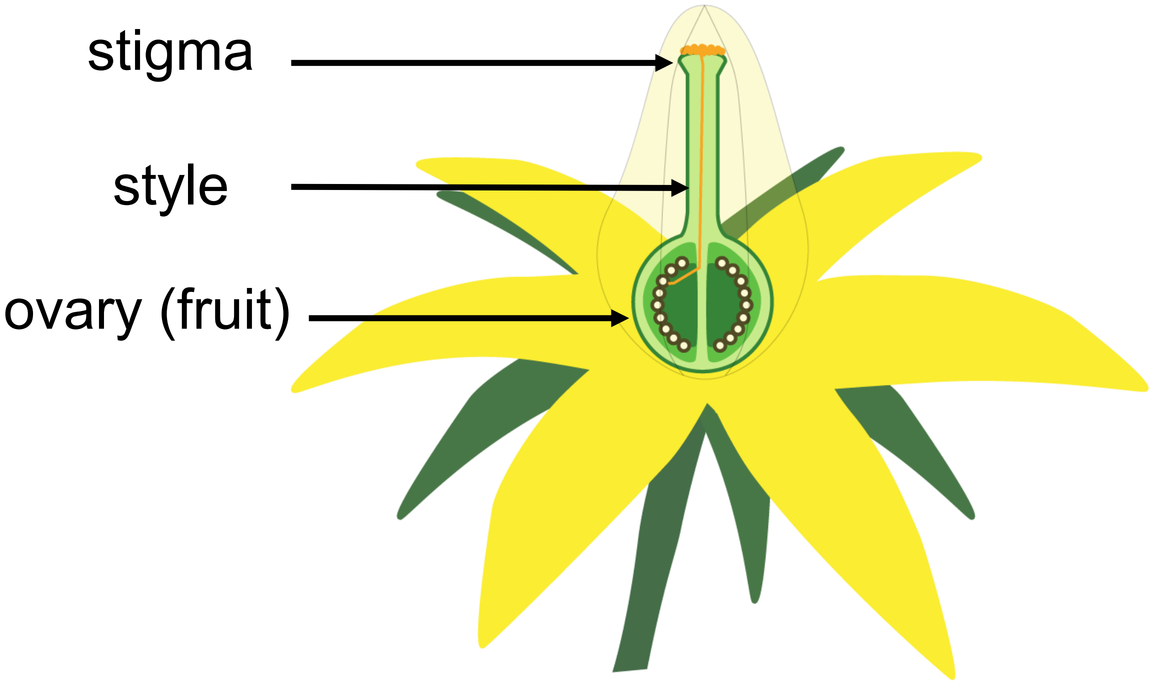
Heat wave(s) during pollination

the tomato flower

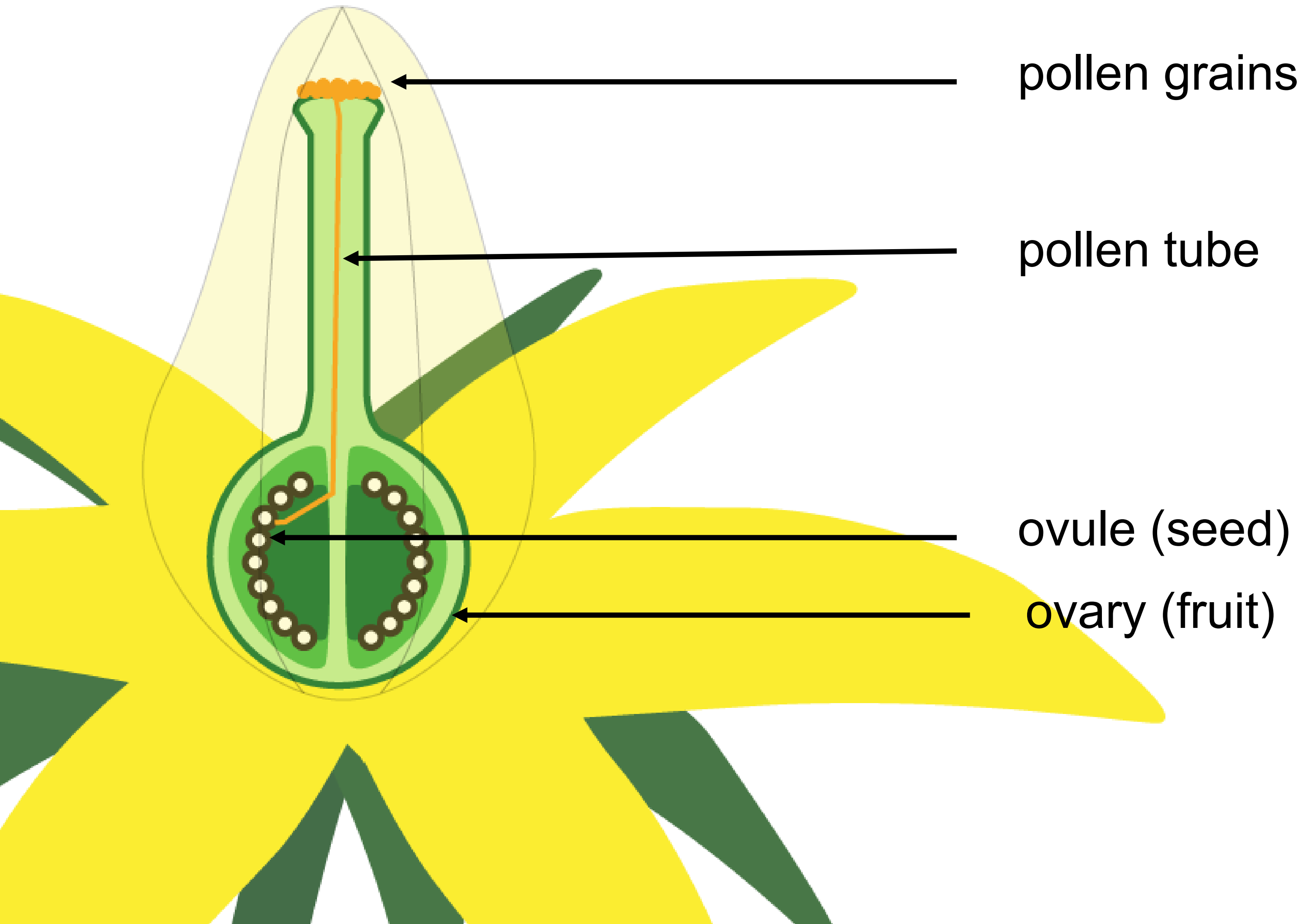


10s of thousands of pollen grains develop in the anther

the tomato flower



Pollen lands on the stigma and each one extends a pollen tube to an ovule



For full fertilization and fruit production, dozens of individual pollen tubes must deliver sperm to ovules

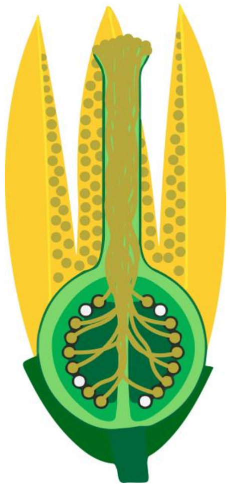
What is your current understanding of the reproductive performance of varieties in production?

What is the relationship between between seed # and fruit weight? What is the minimum # of seeds required to initiate fruit production?

How does high temperature affect the fraction of flowers that set fruit?

How does high temperature affect the amount of pollen made by each flower?

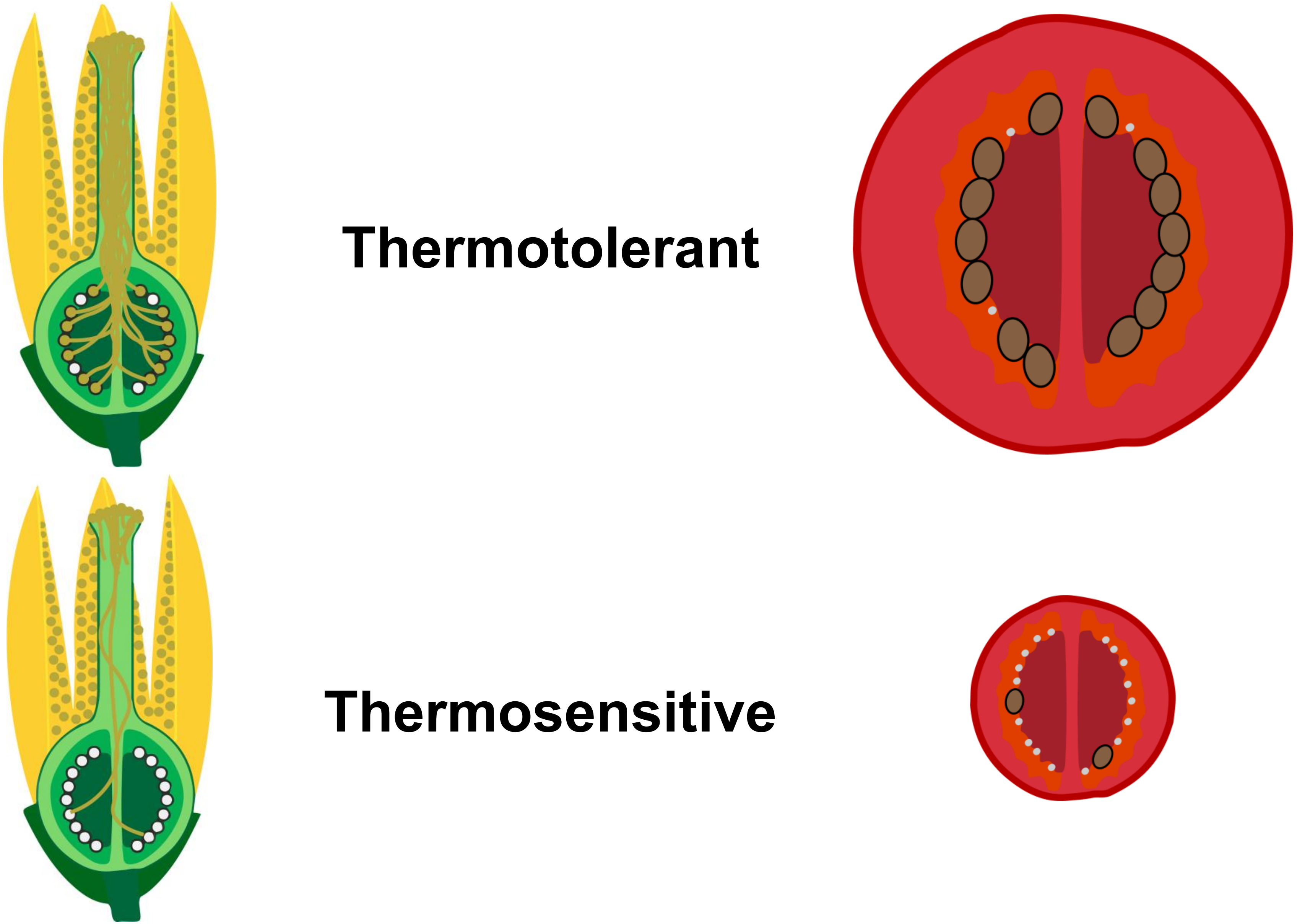
How does pollen performance vary across the cultivars you have in production?



Hypotheses:

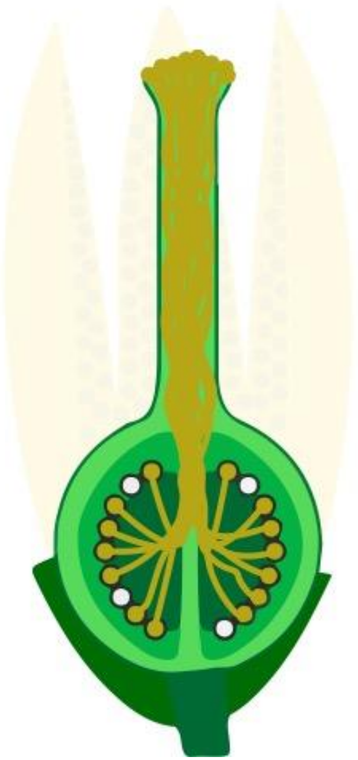
The pollen tube growth phase is critical for crop production under heat stress

Varieties of tomato that maintain fruit set at high temperature have **thermotolerant** pollen tube growth


Thermotolerant
Thermosensitive

High temperature only during pollen tube growth phase reduces Heinz fruit weight

25°C (77°F) or 37°C (98°F)
for 12 hours



Ouonkap et al 2024 - https://doi.org/10.1016/j.cub.2024.10.025

Kelsey Pryze; Palanivelu Lab, University of Arizona

High temperature only during pollen tube growth phase reduces Heinz fruit weight

25°C (77°F) or 37°C (98°F)
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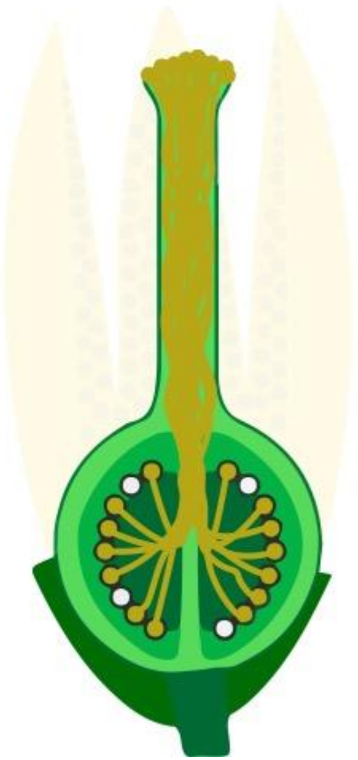
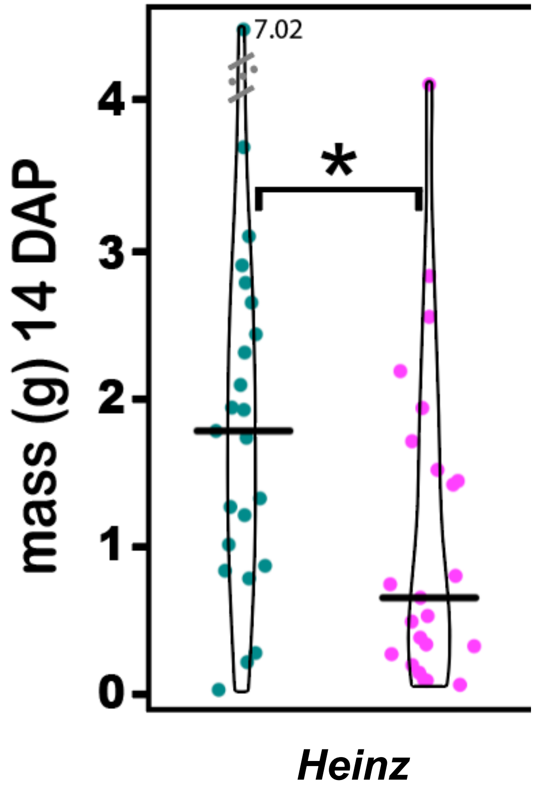
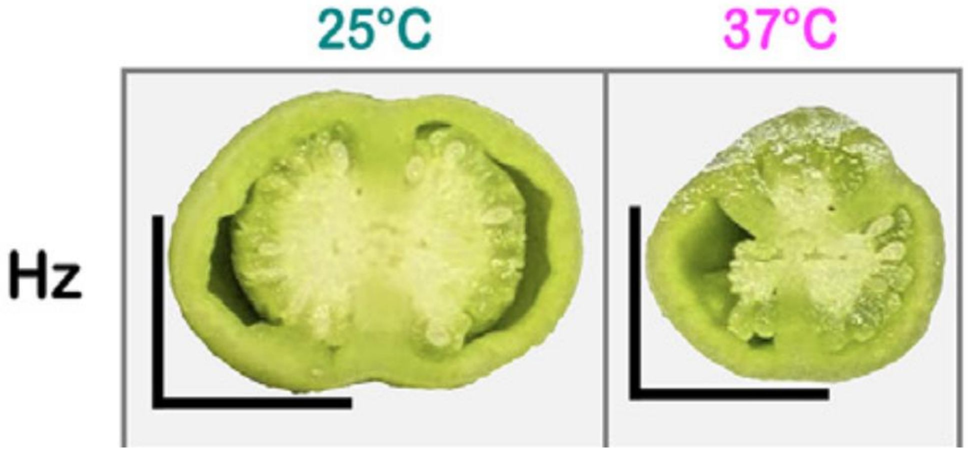






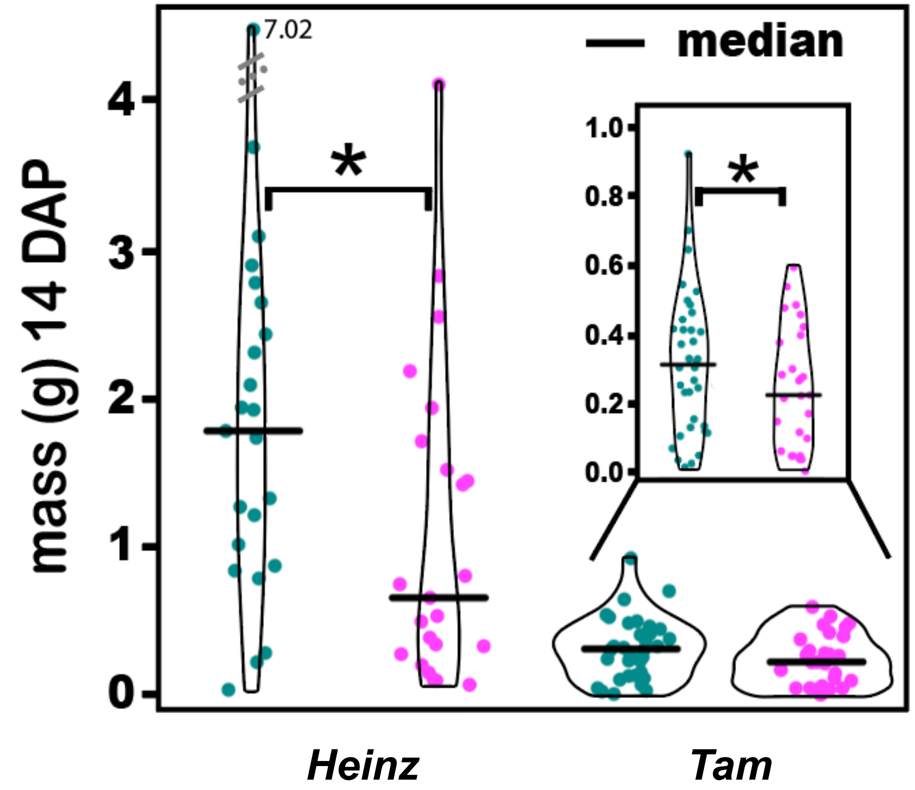
analysis of fruit weight and seed set **2 weeks after hand pollination; fruits are not mature;** bar = 1 cm

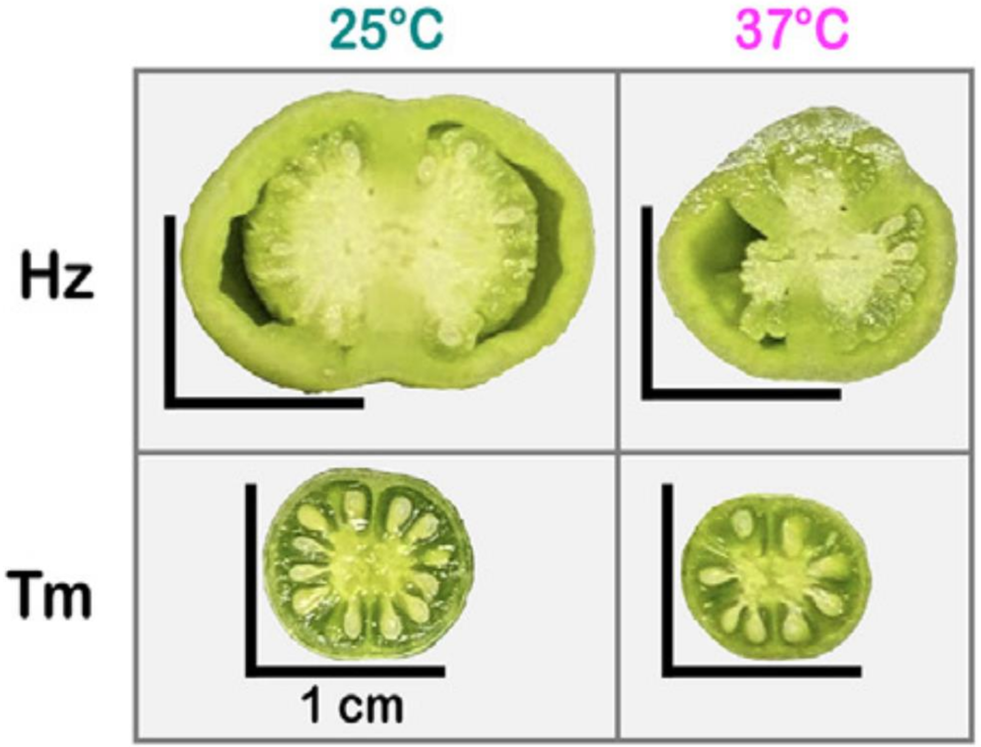
Ouonkap et al 2024 - https://doi.org/10.1016/j.cub.2024.10.025

Kelsey Pryze; Palanivelu Lab, University of Arizona

High temperature only during pollen tube growth phase reduces Heinz fruit weight; Tamaulipas is Thermotolerant

25°C (77°F) or 37°C (98°F)
for 12 hours



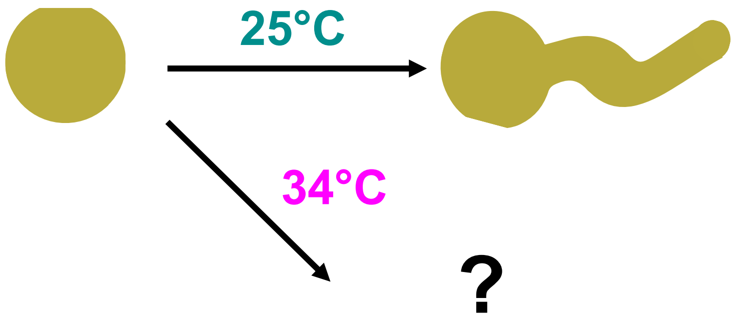


analysis of fruit weight and seed set **2 weeks after hand pollination; fruits are not mature;** bar = 1 cm

Ouonkap et al 2024 - https://doi.org/10.1016/j.cub.2024.10.025

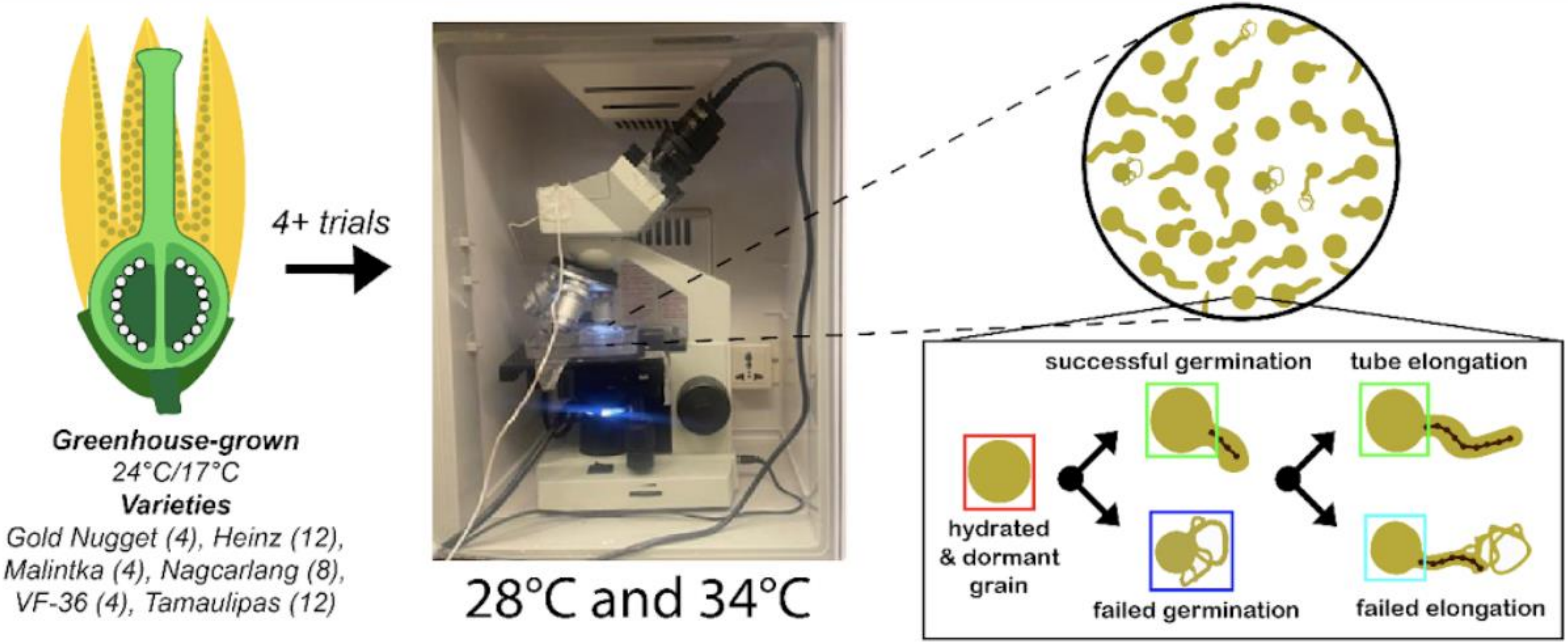
Kelsey Pryze; Palanivelu Lab, University of Arizona

How does temperature affect pollen performance?



How do thermotolerant varieties maintain pollen tube growth under temperatures stress?

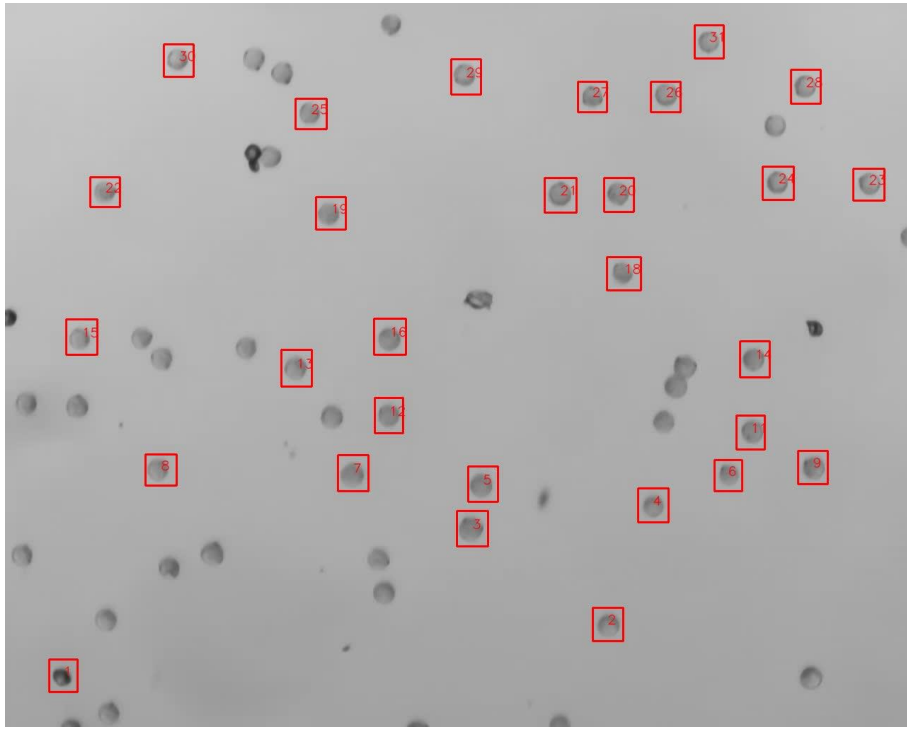
Live imaging of the cellular response to heat stress

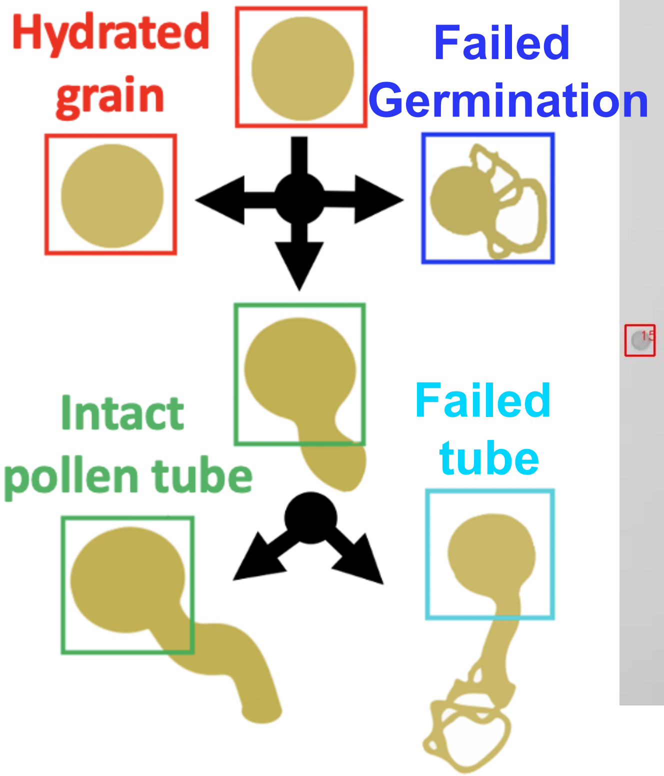


Ouonkap et al., 2025 doi: 10.1007/s00497-025-00526-0

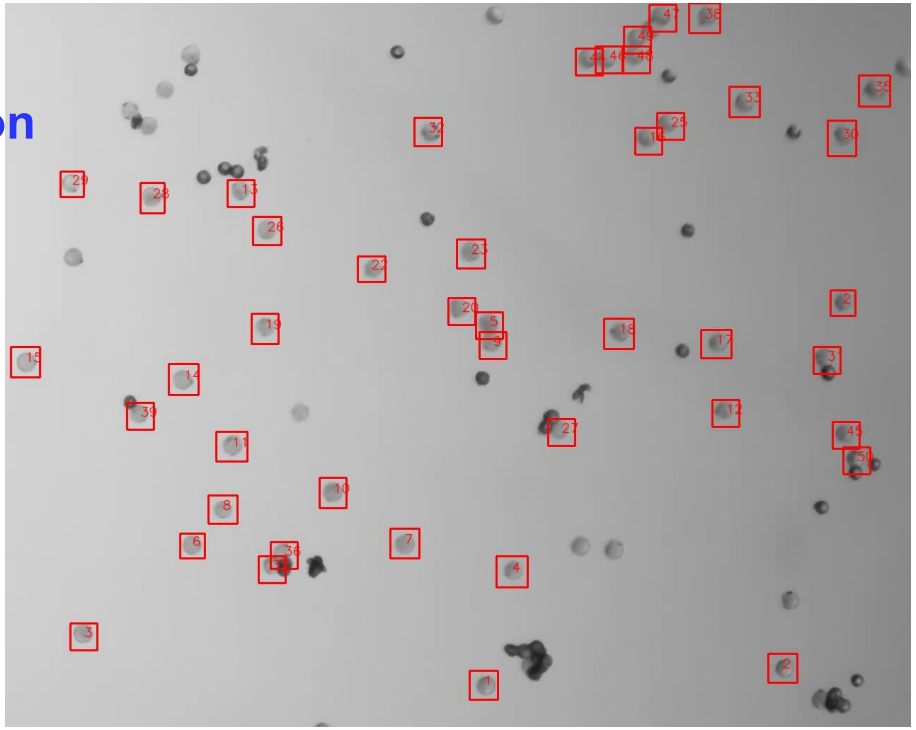
Live imaging of the cellular response to heat stress

T.S Heinz, 28°C, (82°F)





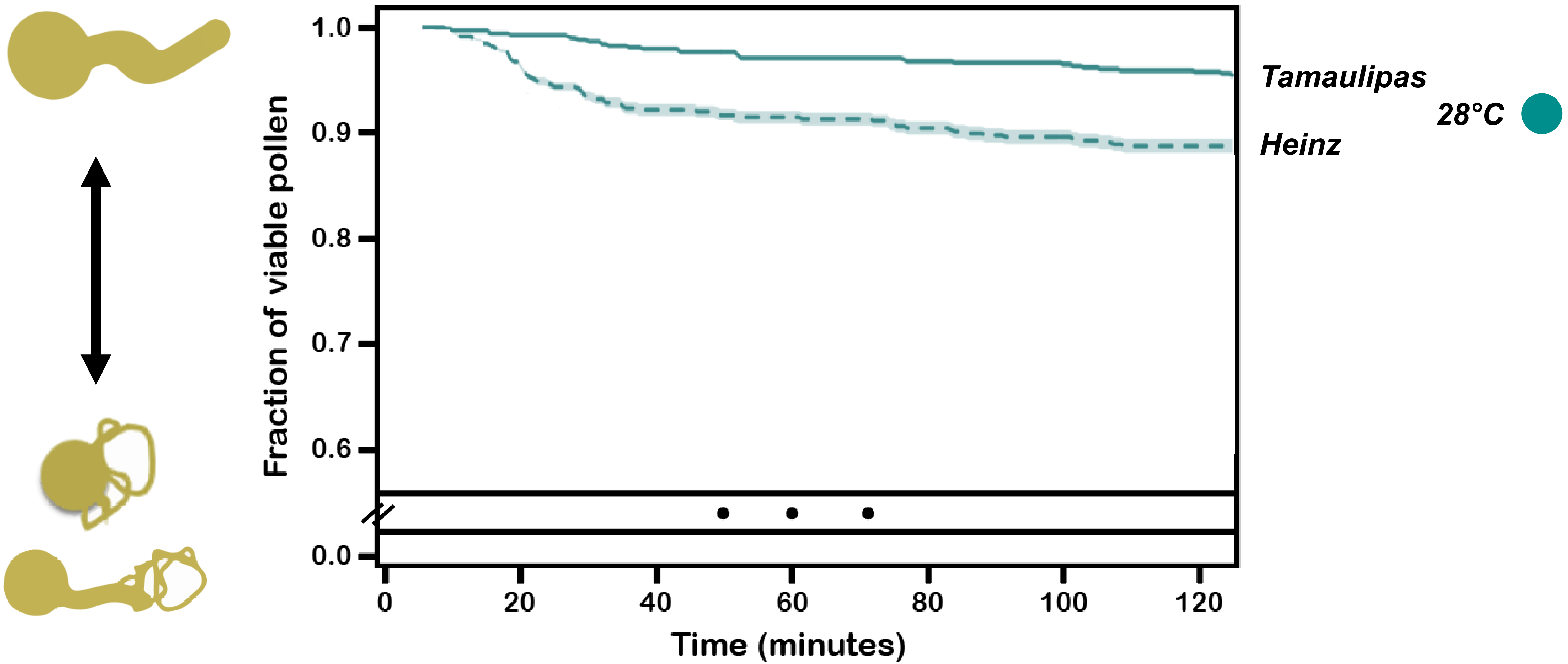
T.S Heinz, 34°C (93 °F)



Ouonkap et al., 2025 doi: 10.1007/s00497-025-00526-0

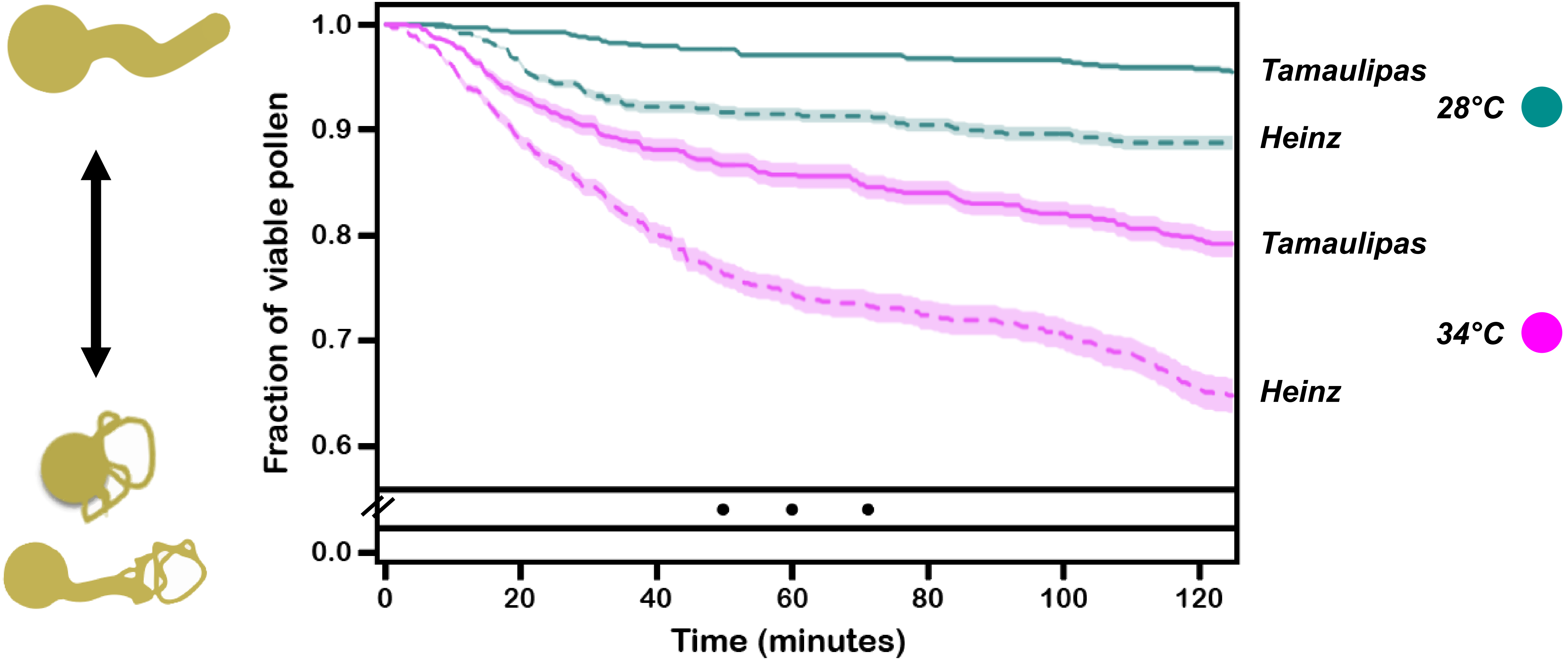
Althiab Almasaud, Ouonkap et al., https://doi.org/10.1101/2025.10.25.684177

High temperature makes Heinz pollen tubes burst; Tamaulipas is Thermotolerant



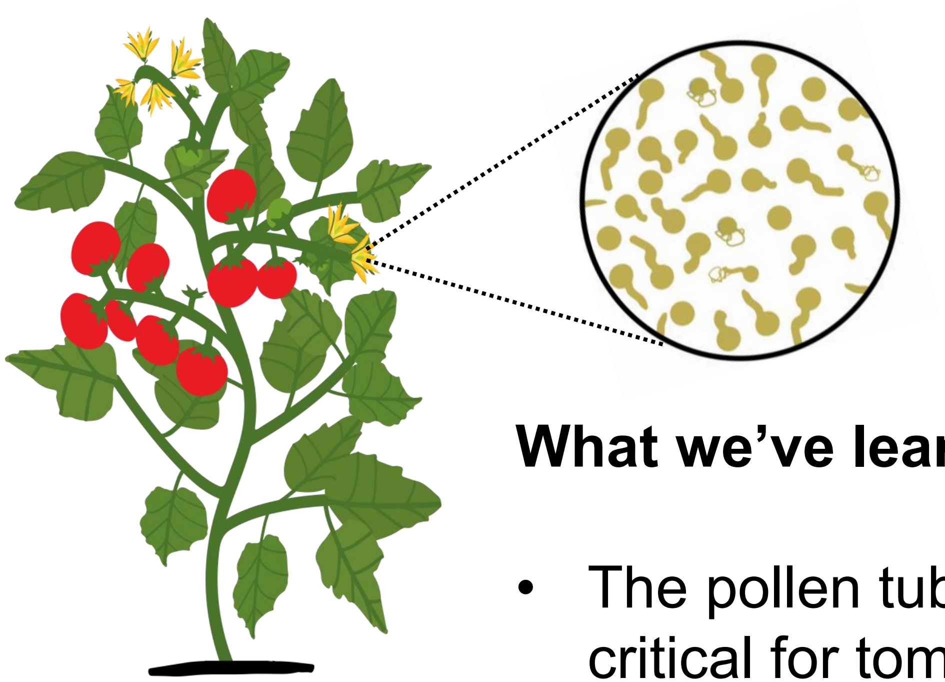
Althiab Almasaud, Ouonkap et al., https://doi.org/10.1101/2025.10.25.684177

High temperature makes Heinz pollen tubes burst; Tamaulipas is Thermotolerant

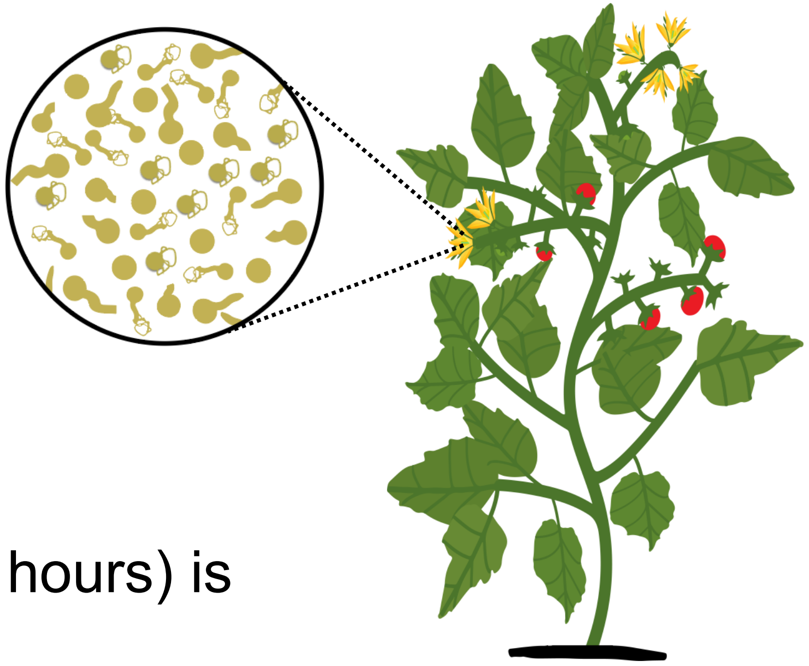


Althiab Almasaud, Ouonkap et al., https://doi.org/10.1101/2025.10.25.684177

Pollen performance for tomato yield



Good growing season



Heat wave during pollination

What we've learned:

- The pollen tube growth phase (only ~10 hours) is critical for tomato yield
- Varieties like Tamaulipas that set fruit at high temperature have thermotolerant pollen tube growth
- Molecular pathways controlling pollen tube cell wall integrity are important and can be modified to achieve thermotolerance

What information/resources would be most helpful?

- Genetic variants/QTLs
- Transgenes/mutations that confer thermotolerance
- Small molecules that induce thermotolerance

Are you interested in collaborating to learn more about gene variants that drive thermotolerance in your commercial varieties?

Genomics of Thermotolerant Tomato Reproduction

BROWN

Mark Johnson
Genetic variation in pollen tube response to HS
Postdoc:
Dr. Rasha Althiab Almasaud
Graduate Student:
Dr. Sorel V. Yimga Ouonkap
Staff:
Sherry Warner
Undergraduates:
Ben Styler
Atticus Henry
Celia Johnson
Cassandra Travis
Yahir Oseguera
Bryce Okihiro
Maddie Pittigher
Jiaying Hou

WAKE FOREST UNIVERSITY

Gloria Muday
Flavonols enhance thermotolerance
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Dr. M. Foteh Ali
Dr. Anthony Postiglione
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Nina Bravo-Chan
Nicholas Majkut
Undergraduates:
Eric Wang
Stacy Hahn
Ashley Lockwood
Keyi Huang
Colleen Roark

THE OHIO STATE UNIVERSITY

James Pease
SolaVar – A database of tomato genetic variation
Postdoc:
Dr. Andria Harkey

KU LEUVEN

Joelle Muhlemann
Flavonol production during pollen development
Graduate Student:
Hana Daryanavard

THE UNIVERSITY OF ARIZONA

Ravi Palanivelu
Pollen-Pistil RNA-seq Genetic Variation in HS response
Postdoc:
Dr. Cedar Warman
Graduate Students:
Emma Jong
Kelsey Pryze
Calvin Perkins

Steven Smith

UNIVERSITY OF NORTH CAROLINA CHARLOTTE

Ann Loraine/Rob Reed
Bioinformatics/IGB
Dr. Nowlan Freese
Graduate Students:
Molly Davis
Varnika Mittal

Pollen Genetics Lab
@Brown University

Critical funding from: NSF USDA NIFA

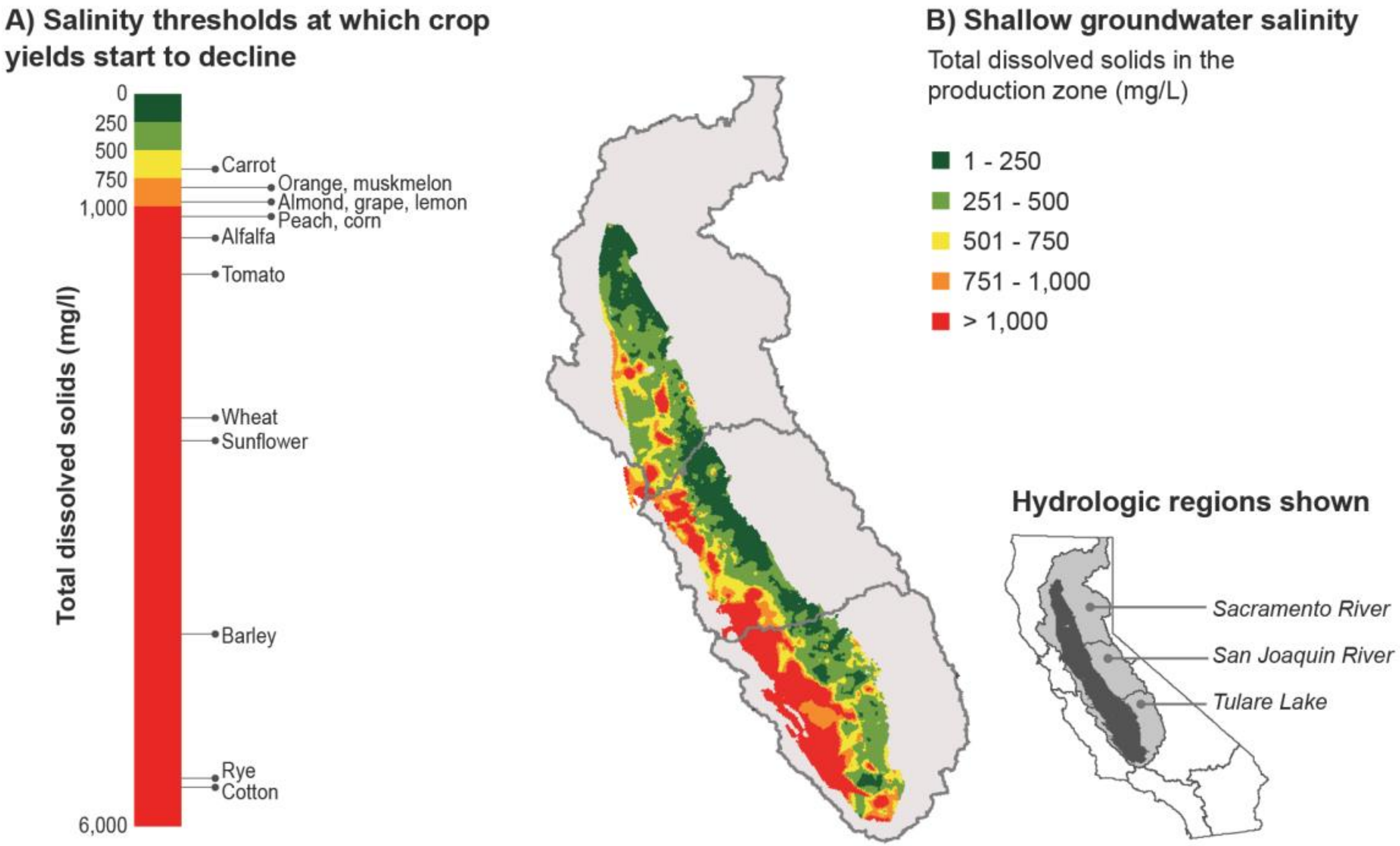
Leveraging germplasm resources for genetic discovery and deployment of salt stress resilience

GREG VOGEL

CTRI ANNUAL RESEARCH MEETING

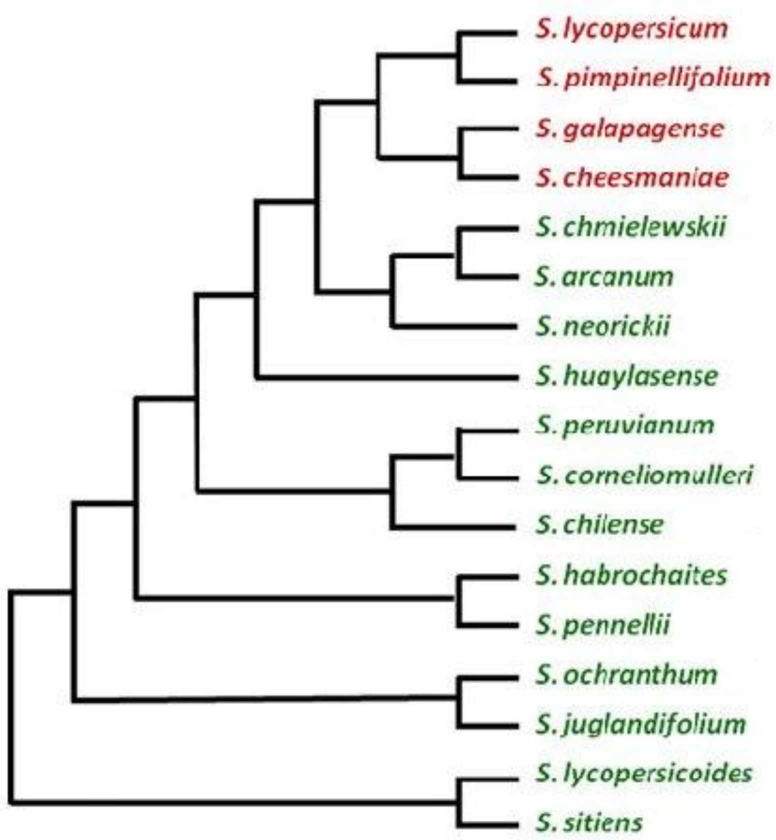
DECEMBER 4, 2025

Salinity stress depresses processing tomato yield



Ellen et al., 2019. Public Policy Institute of California 100

Wild relatives are the source of many commercially important traits in tomato breeding



Adapted from Bedinger et al., 2011.
Sex Plant Reprod 24: 171–187

Solanum sitiens possesses remarkable adaptation to an extremely harsh environment

Adapted from Chetelat et al., 2009. Euphytica 167: 77-93

Main project goals

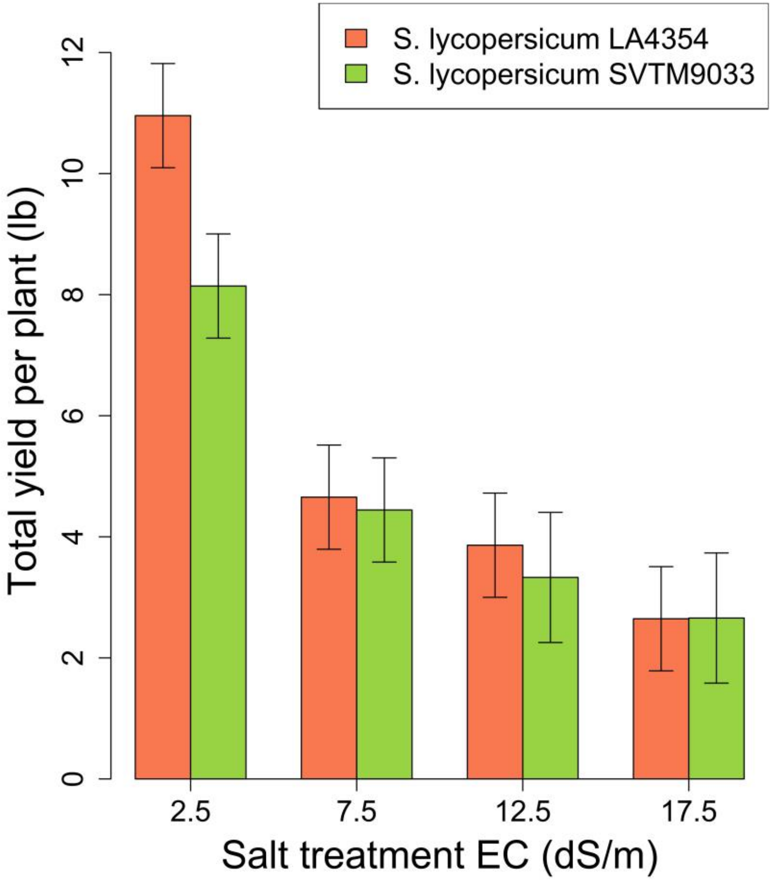
Discover, isolate, and validate salt tolerance loci from *S. sitiens* for development of breeder-ready salt stress resilience donor lines.

Year 1: Protocol development and salt tolerance gene discovery

Year 2: Validate salt tolerance gene(s) and begin crossing into processing tomato

Year 3: Cross gene(s) into processing tomato for field trialing and distribution

Year 1 Accomplishments

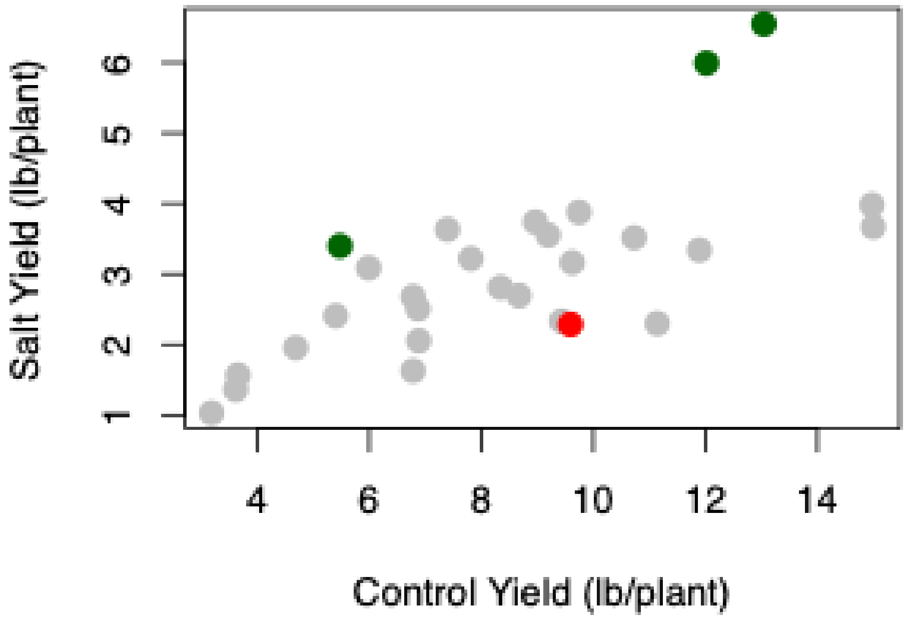


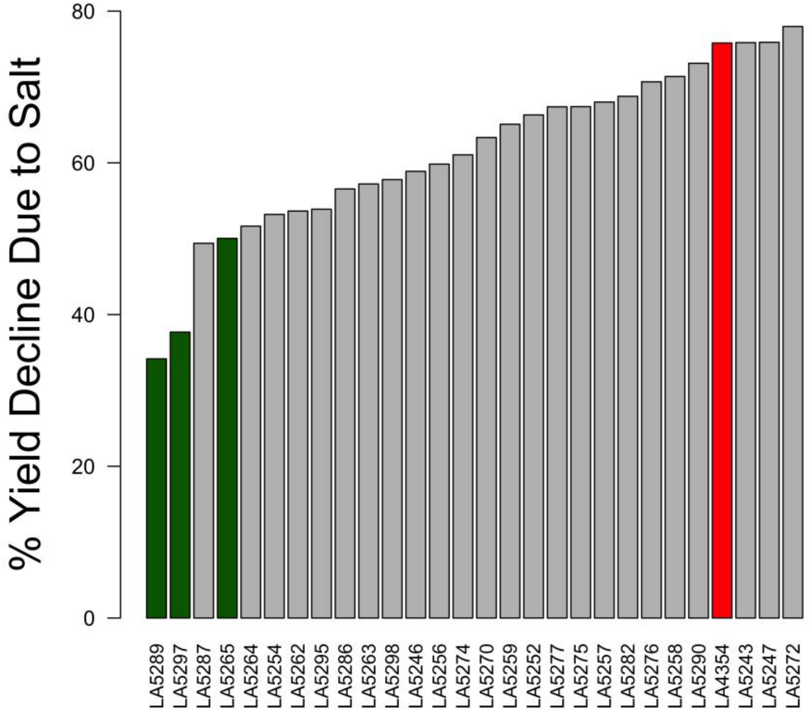
Seed increase of introgression lines

Salt stress dosage-response curves

First replicate of salt stress screen of introgression lines

Year 2: Completion of salt stress screen and identification of three promising introgressions





- **Red** = Tomato (recurrent parent)
- **Green** = Top Introgression Line
- **Gray** = Introgression Line

*We have identified three introgressions that result in a 35-50% yield penalty under 10 dS/m EC compared to a 75% yield penalty for tomato. Two of these introgressions show higher yield to tomato parent under both control **and** salt treatments.*

Ongoing work

- Validating the top 3 introgressions in both homozygous and heterozygous condition in follow-up greenhouse experiment
- Di-introgression lines to evaluate combined salt stress resistance
- Development of segregating populations for fine-mapping

Plan for Year 3 – Line development to move testing from greenhouse to field

Backcross best 1-2 introgressions to processing tomato background in order to enable field testing

Simultaneously conduct fine-mapping to develop reduced-introgression lines with less *S. sitiens* DNA

Potential pitfalls

- Plan to move forward dependent on validation of introgression effects (experiment will conclude 12/22)
- Multiple generations of backcrossing are needed but we will use embryo rescue (speed breeding) and marker-assisted background selection to speed up process
- We may see recombination suppression but we will evaluate large populations to identify recombinants

Questions

How can we best collaborate with partners on the ground in California to test these lines in fields with history of salt stress?

Are there fields that can be reliably expected to experience salt stress or is this highly dependent on weather conditions, management outcomes, etc?

What magnitude of yield penalty for a salt stress-resilient variety would be considered a "win"?

When would seed be needed for potential trials in 2027?

California Tomato Research Institute

Cornell CALS
College of Agriculture and Life Sciences

Cornell tomato and eggplant lab

Acknowledgements

- Howard Rice: experimental design, experimental execution, data collection
- Diana Mulder: molecular markers, experimental design, data analysis

Thank you to our generous meeting sponsors!

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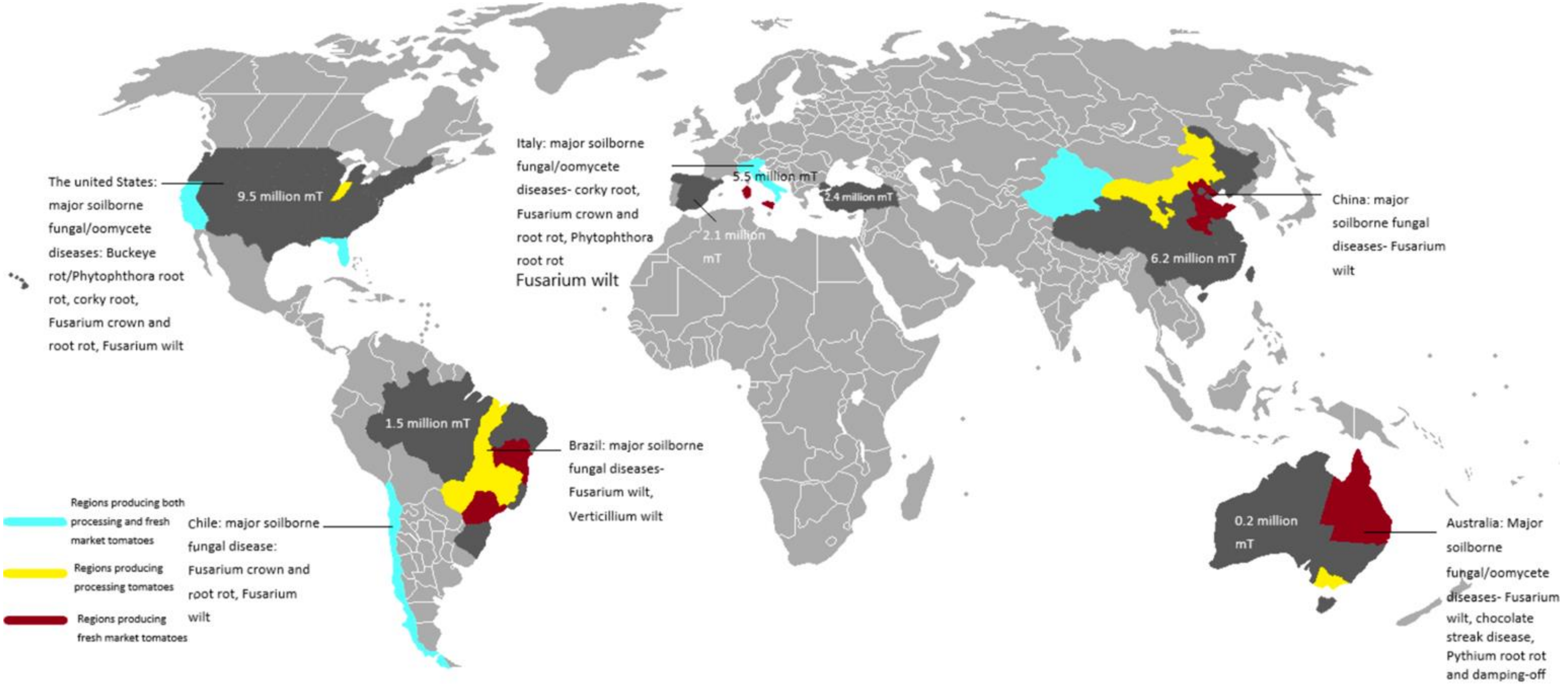
Beyond Fusarium wilt: Validating gene-edited variants for resistance against multiple diseases impacting processing tomato production.

PI: Daniel Rodriguez-Leal, PhD
CoPI: Nidhi Rawat
University of Maryland, College Park.

Due to its global distribution, tomatoes are susceptible to multiple pathogens

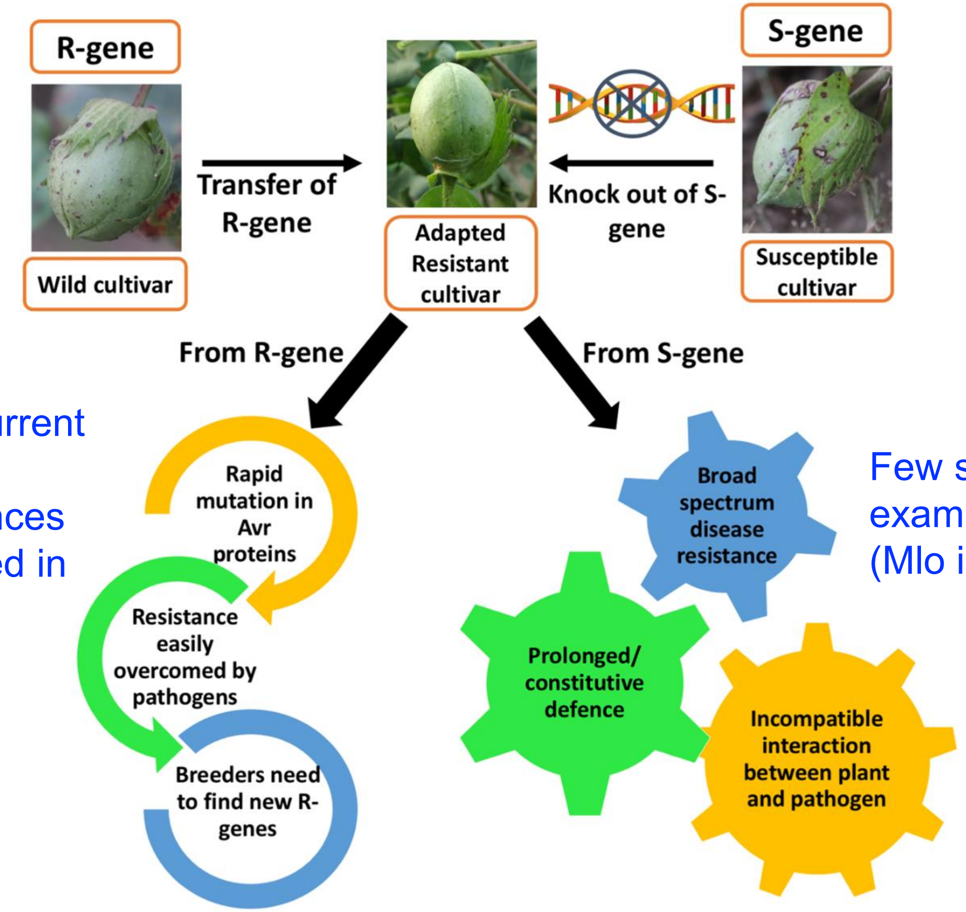


Ma et al., 2023. Microorganisms.

Fungal pathogens are a common threat to the tomato industry and most biotic resistances are race-specific and short-lived

Fusarium wilt (*Fusarium oxysporum f.sp. lycopersici*)

Gray mold (*Botrytis cinerea*)



Most current genetic resistances deployed in crops

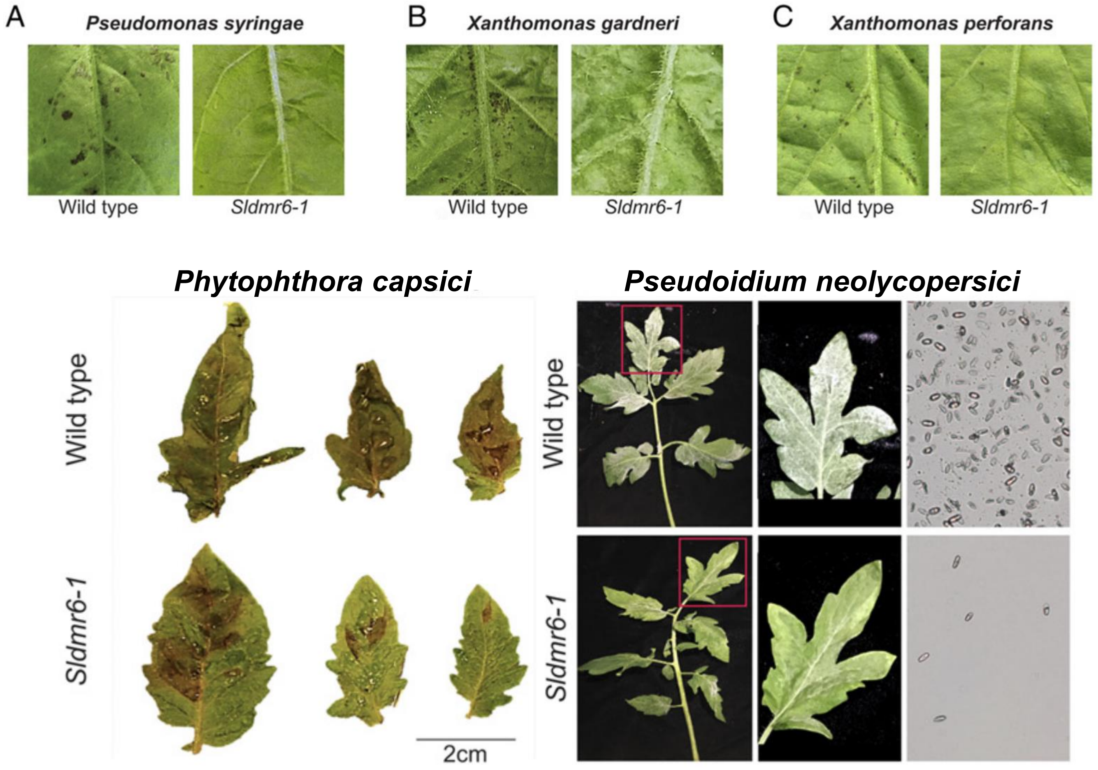
Few successful examples available (Mlo in barley)

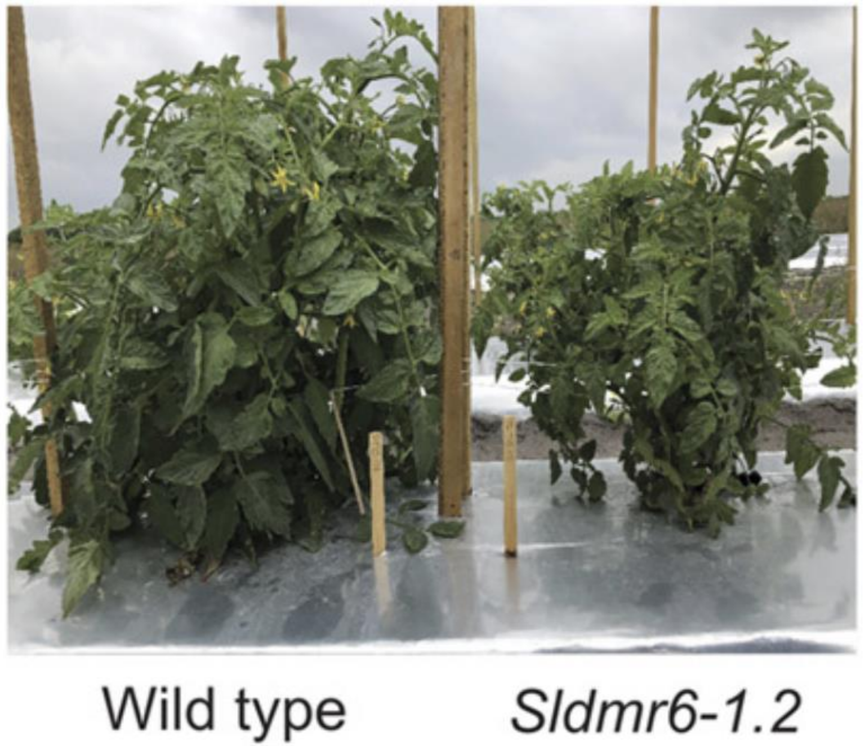
Our research group is interested in designing broad and durable disease resistance for the processing tomato industry using conventional and biotech approaches

Bishnoi et al., 2023. Func & Int Gen. Ma et al., 2023. Microorganisms.

DMR6 gene is a susceptibility gene with potential for engineering disease resistance

Despite knockout *dmr6* lines are resistant to multiple pathogens,
they also exhibit pleiotropic effects (reduced stature, decrease fruit weight)

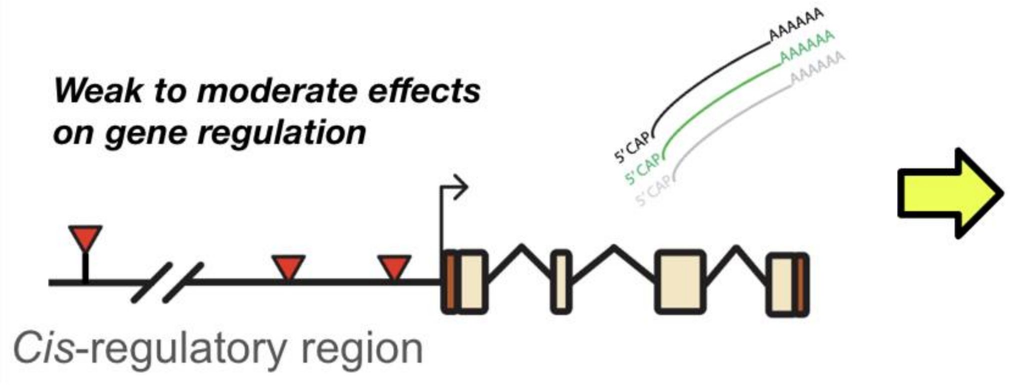


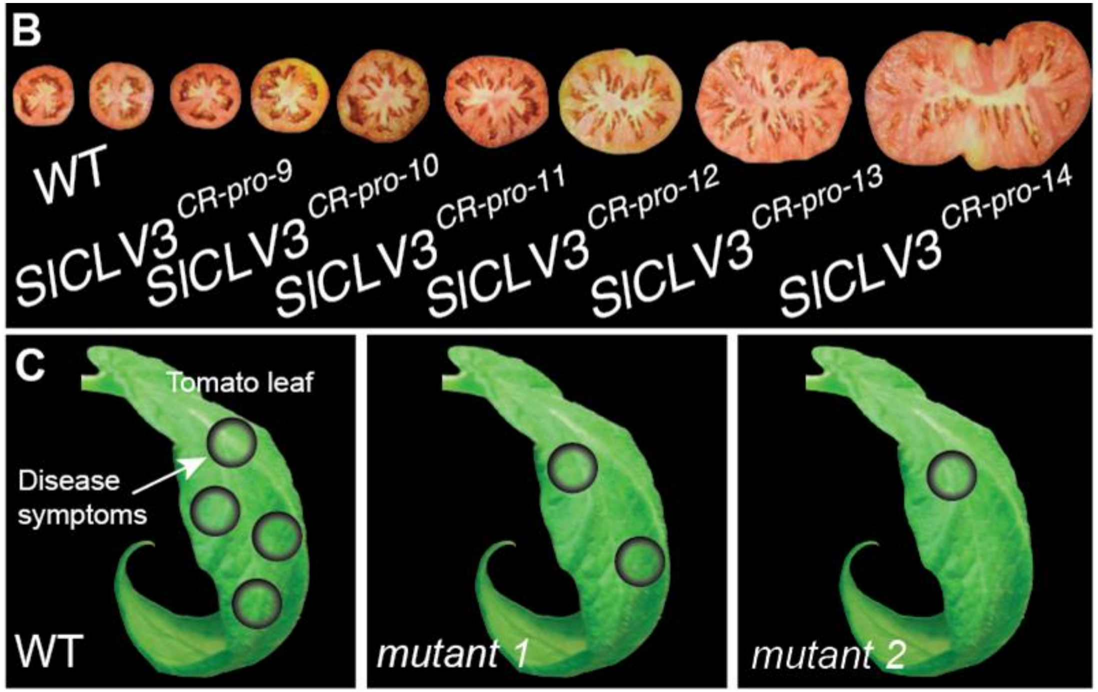


Knockout mutations may be too strong and penalize agronomic performance!

CTRI 2025-funded project:
POC: Using Genome Editing to modulate *Susceptibility* genes* against *Fusarium*!

**S* genes are used by pathogens for successful infection and disease. Resistance by *S* genes is a recessive trait!



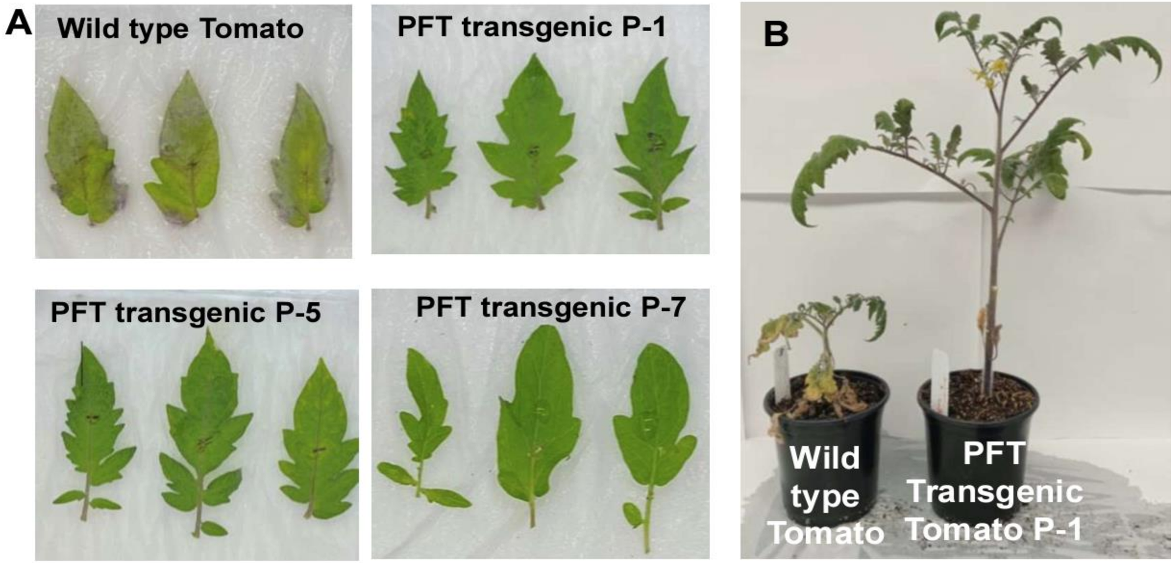


Expected outcomes:

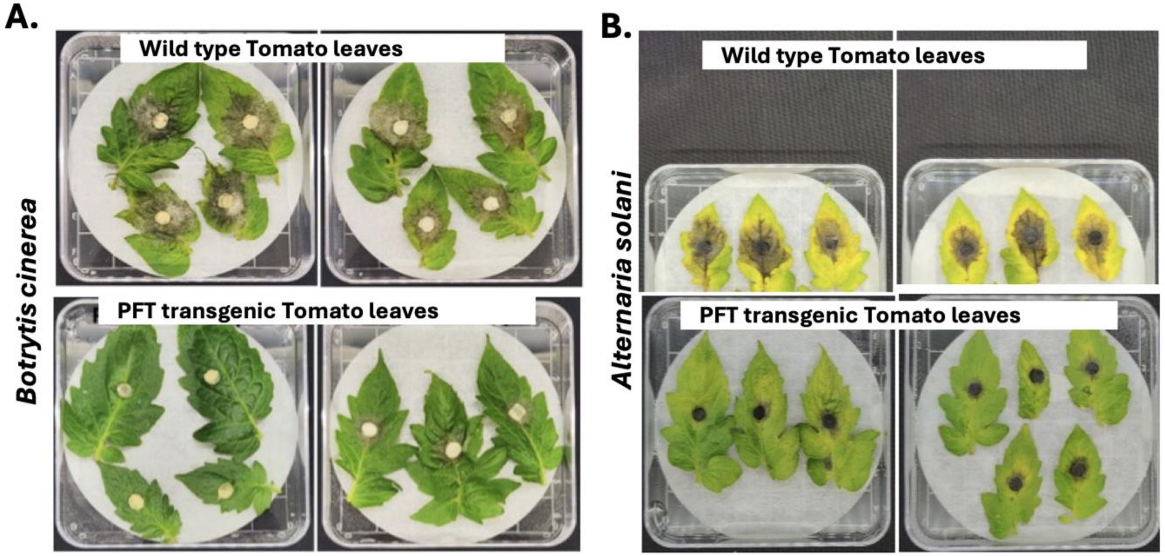
- Mid-to-high resistance to **<u>all races</u>** of *Fusarium oxysporum*.
- Potential resistance against other *Fusarium* spp.
- No alterations in other agronomic traits.
- Improving line development by introducing resistance for future emerging races!
- Reducing yield losses from disease pressure.

Previous results from CTRI 2025-2026 Grant

We developed *in planta* validated protocols to assess disease severity for fusarium wilt



We developed leaf detach assays for assessments of *Botrytis* and *Alternaria* infection in tomato

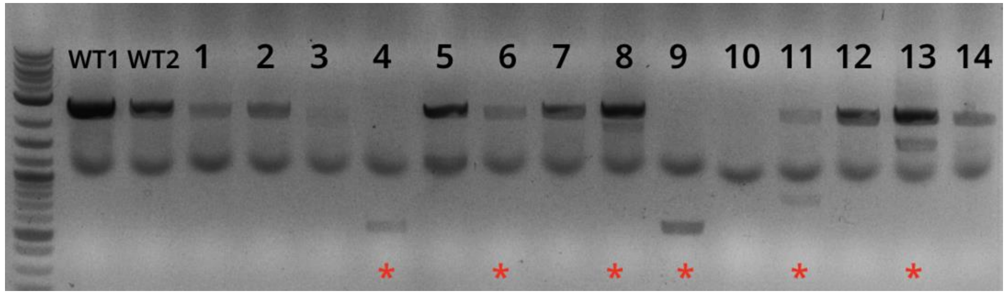


CTRI support and funding was relevant for securing funding from USDA BRAG program ($650,000 for 4 years to work in disease resistance against Fusarium wilt in tomato)

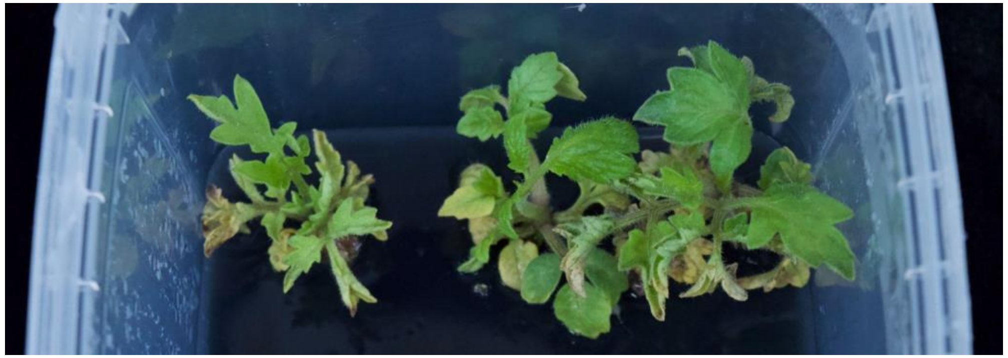
Previous results from CTRI 2025-2026 Grant

We developed edited plants targeting the promoter of the gene *DMR6.1*

PCR of target region showing edits



Regenerated seedlings ready for transplanting



Pending and proposed work for 2025-2026 (if funded again by CTRI):

- Evaluating edited plants carrying *dmr6pro* mutations (Q1-Q3 2026).

- Testing stable edited lines against *Verticillium dahliae* (Verticillium wilt) , *Xanthomonas campestris* (bacterial spot), *Pseudomonas syringae* (bacterial speck) and *Alternaria solani* (early blight).

We have pending applications to USDA NIFA A1141 using these results.

Questions to CTRI Board

- Is there an interest from California growers in trialing genome edited materials?
- Is there an interest in developing a consortium to develop a program to implement genome editing for crop improvement?

Our goal is to design broad and durable disease resistance against major pathogens affecting processing tomato (soilborne and foliar diseases).

We have an interest in releasing new traits, but still need to work with industry partners to work on relevant traits and establish potential licensing/regulatory support.

Gene editing is still not widely adopted by companies/industry due to regulatory, IP and commercial challenges. But most agree is a relevant tool and the future for targeted design of traits for breeding.

Collaboration among multiple partners (Universities, Seed companies and growers) could allow for an easier path to commercialize gene-edited traits (by spreading the risk and costs of developing these traits).

Thank you to our generous meeting sponsors!

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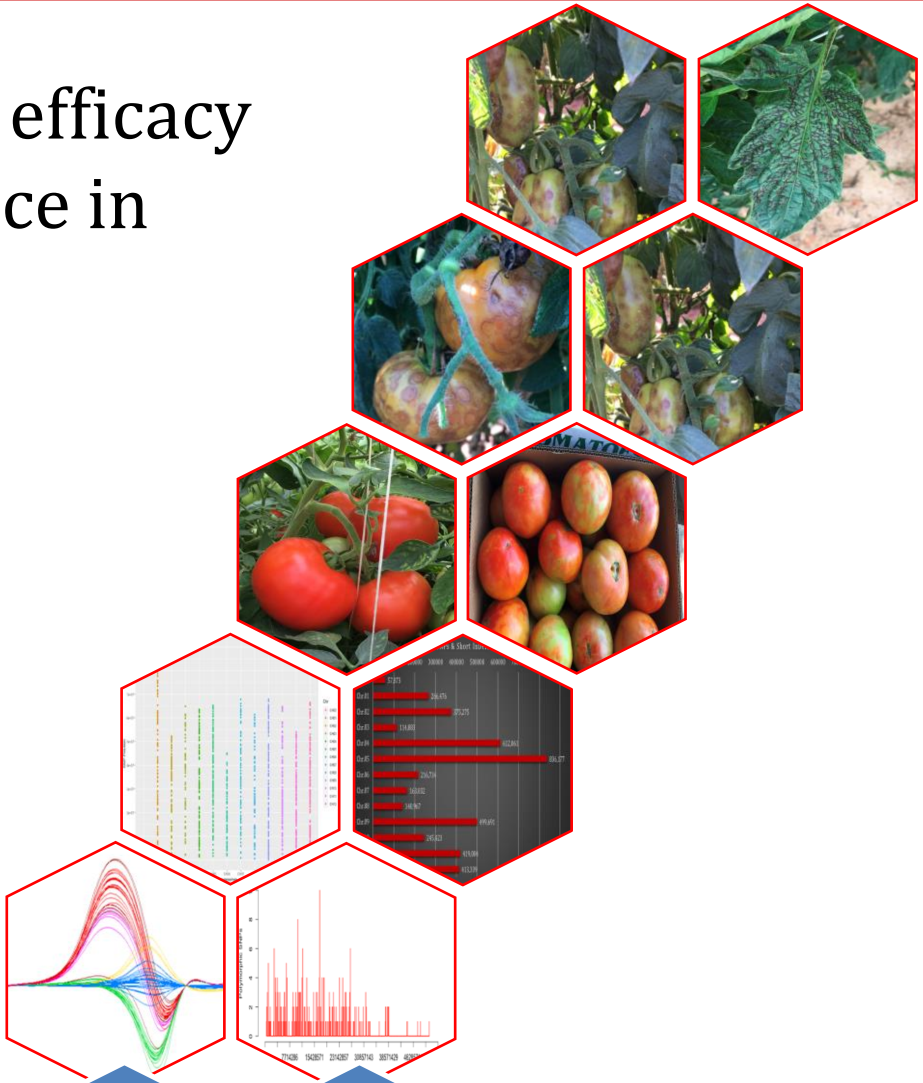
NC STATE UNIVERSITY

Marker-trait association study to confirm the efficacy of the DNA markers for RB-TSWV resistance in processing tomatoes

Reza Shekasteband
Dorith Rotenberg
Anna E. Whitfield
Thomas Turini



Marker-trait association study to confirm the efficacy of the DNA markers for RB-TSWV resistance in processing tomatoes

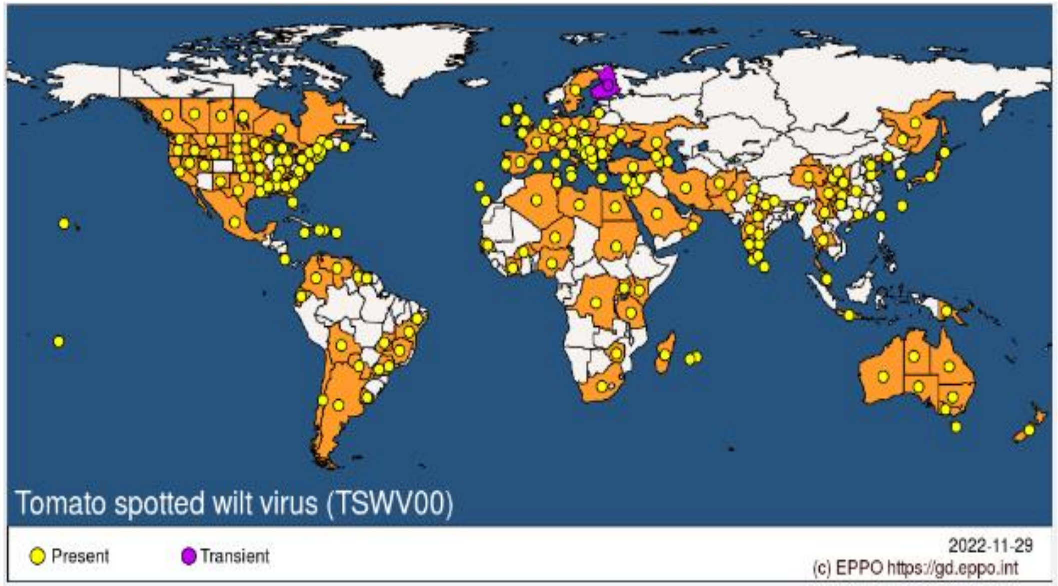
Tomato Spotted Wilt

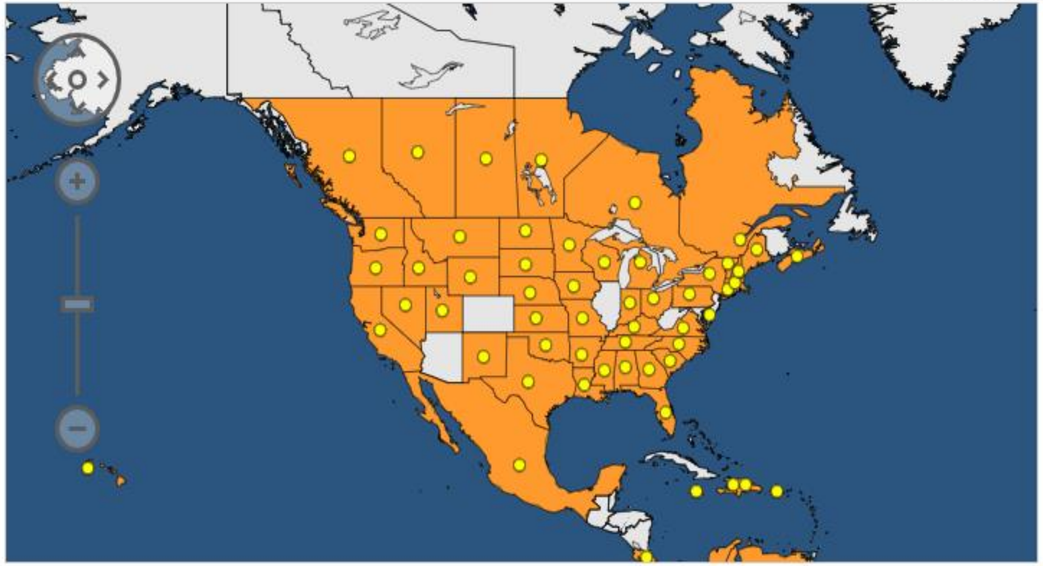
Widespread and Destructive Disease

- ✓ Thrips are the vectors
- ✓ Limited success with pesticides
- ✓ Limited success with cultural practices
- ✓ Success with genetic engineering

  Public acceptance!?

- ✓ Natural Resistance





Natural Resistances Exist in Wild Tomato Accession

- ✓ *S. pimpinellifolium* (Samuel et al., 1930)
- ✓ *S. peruvianum** (Wenholz, 1939)
- ✓ *S. habrochaites* (Costa, 1944)
- ✓ *S. chilense* (Iizuka et al., 1993)
- ✓ *S. pennellii* (Kumar et al., 1993)

S. peruvianum* **Sw-5 was derived from (1986)

Pre-breeding and germplasm screening

Identification of a new source of resistance
(TSW-07)

Genetic studies:

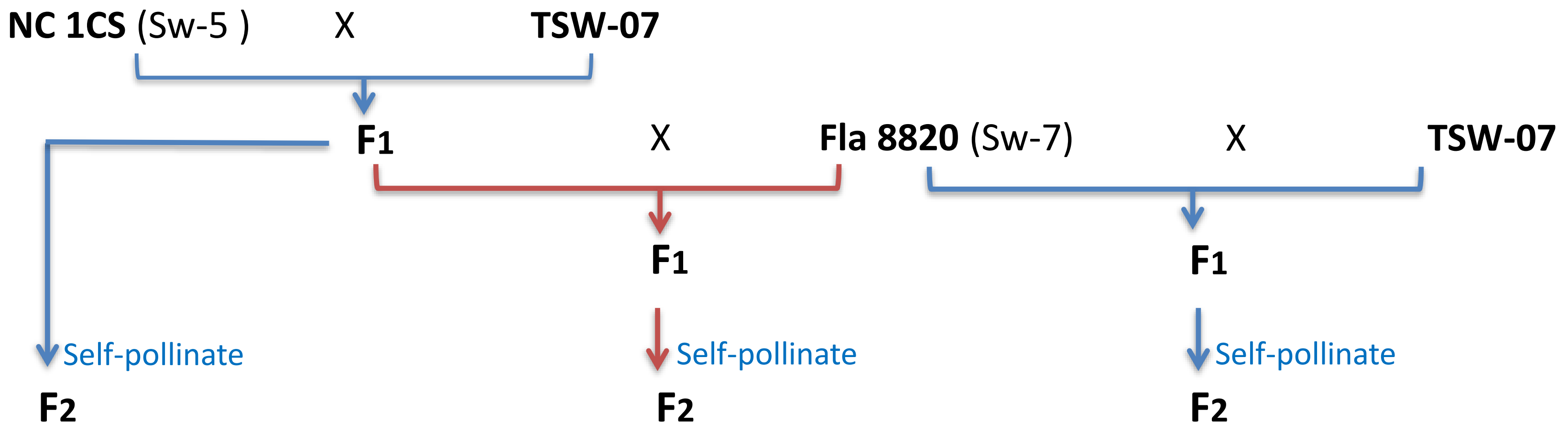
- ✓ Map the resistance on the tomato genome
- ✓ DNA marker development for **MAS**
- ✓ Identify the resistance gene/s

Breeding process:

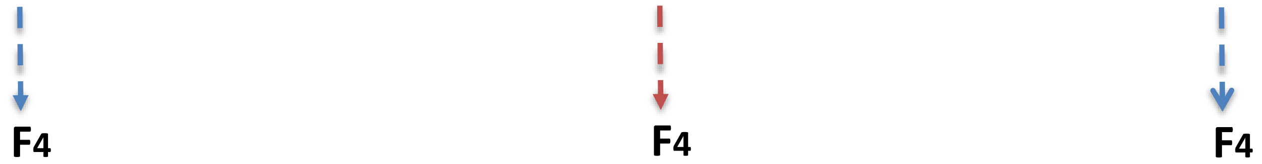
- ✓ Improve the horticultural performance
- ✓ Incorporate the R gene/s into elite cultivars by **MAS**
- ✓ Combine the new resistance with the **Sw-5b gene**

New parental lines and F1 hybrids that exhibit resistance to RB-TSWV.

Marker-resistance association in field trial (2024)



Three F2 populations were genotyped and selected based on genotypic combinations of Sw-5 and Sw-7 genes and <u>two</u> DNA markers specific to the TSW-07 tomato line

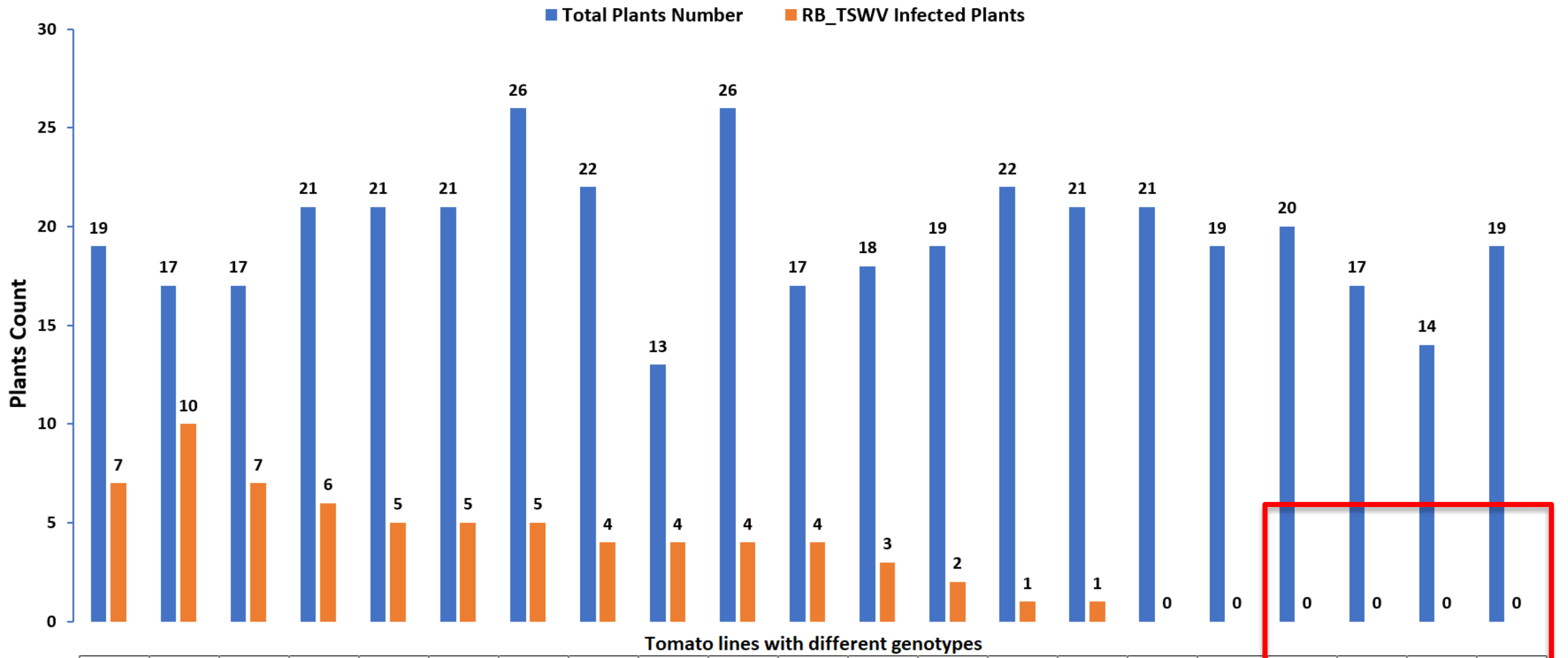


Tomato lines with different genotypes

DNA markers / Lines	UC-21	UC-20	UC-05	UC-06	UC-08	UC-17	UC-01	UC-02	UC-09	UC-13	UC-14	UC-10	UC-11	UC-15	UC-16	UC-03	UC-19	UC-04	UC-07	UC-12	UC-18
NC-TSW10	-/-	-/-	+/-	-/-	-/-	-/-	-/-	-/-	-/-	+/-	-/-	-/-	-/-	+/-	-/-	-/-	+/-	+/+	+/+	+/+	+/+
NC-TSW11	-/-	+/+	+/+	+/+	+/+	+/+	-/-	.	.	+/+	+/+	.	.	+/+	+/+	-/-	+/+	+/+	+/+	+/+	+/+
Sw-5	-/-	-/-	-/-	-/-	-/-	+/+	+/+	-/-	-/-	+/+	+/+	-/-	-/-	+/+	+/+	-/-	-/-	-/-	-/-	+/+	-/-
Sw-7	-/-	-/-	+/+	+/+	-/-	+/-	-/-	+/+	+/+	-/-	-/-	+/-	+/+	+/+	+/+	+/+	-/-	+/+	-/-	-/-	-/-

-/-	Homozygous Susceptible
+/-	Heterozygous
+/+	Homozygous Resistant

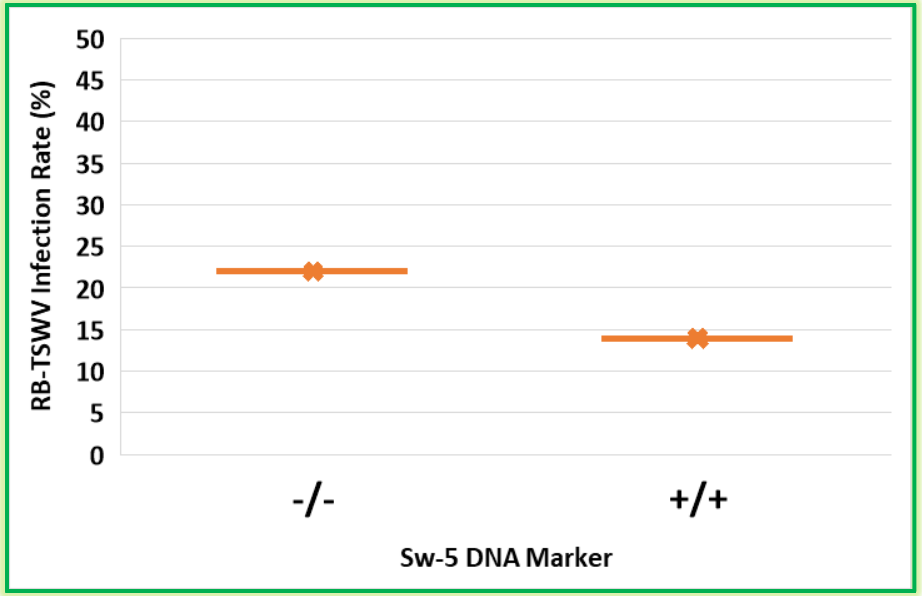
RB-TSWV disease incidence in a replicated on-farm trial, Fresno County, CA (2024)

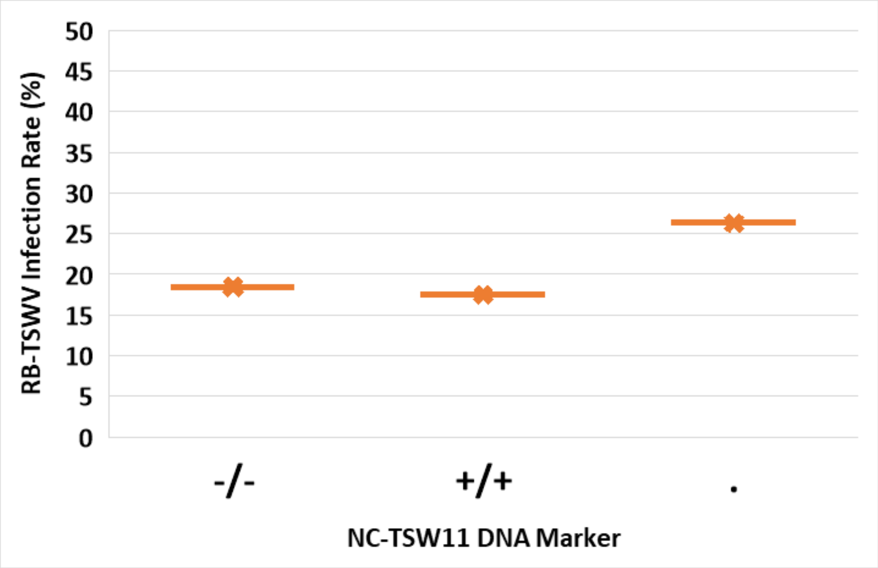


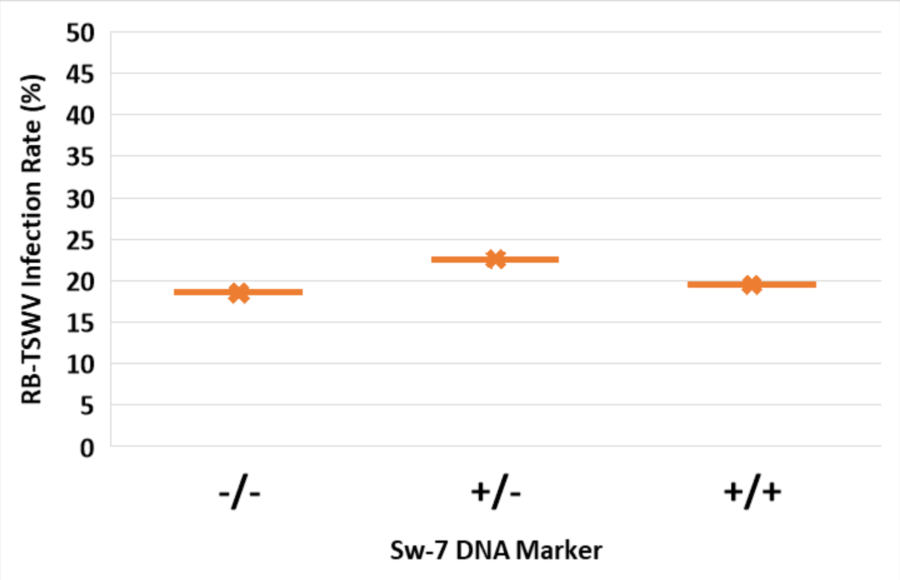
DNA markers / Lines	UC-21	UC-20	UC-05	UC-06	UC-08	UC-17	UC-01	UC-02	UC-09	UC-13	UC-14	UC-10	UC-11	UC-15	UC-16	UC-03	UC-19	UC-04	UC-07	UC-12	UC-18
NC-TSW10	-/-	-/-	+/-	-/-	-/-	-/-	-/-	-/-	-/-	+/-	-/-	-/-	-/-	+/-	-/-	-/-	+/-	+/+	+/+	+/+	+/+
NC-TSW11	-/-	+/+	+/+	+/+	+/+	+/+	-/-	.	.	+/+	+/+	.	.	+/+	+/+	-/-	+/+	+/+	+/+	+/+	+/+
Sw-5	-/-	-/-	-/-	-/-	-/-	+/+	+/+	-/-	-/-	+/+	+/+	-/-	-/-	+/+	+/+	-/-	-/-	-/-	-/-	+/+	-/-
Sw-7	-/-	-/-	+/+	+/+	-/-	+/-	-/-	+/+	+/+	-/-	-/-	+/-	+/+	+/+	+/+	+/+	-/-	+/+	-/-	-/-	-/-

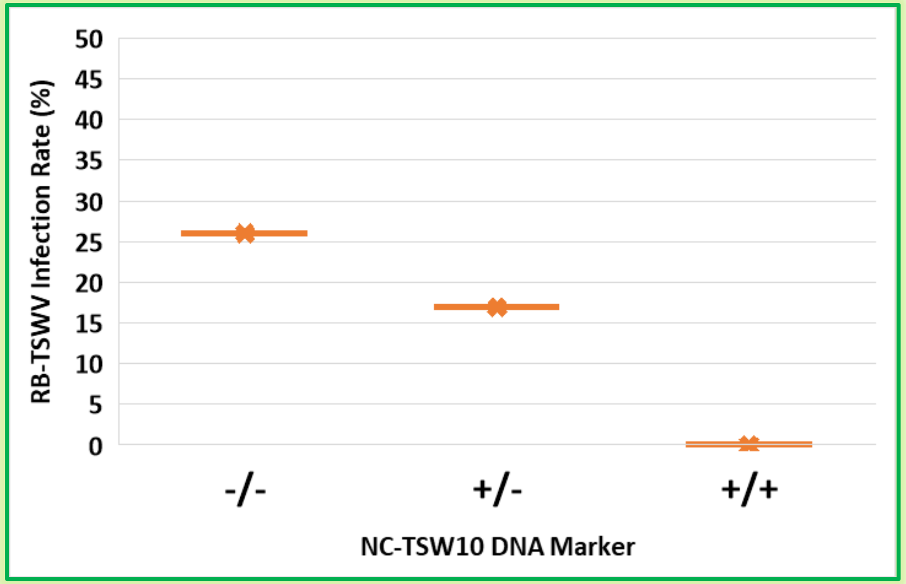
-/-	Homozygous Susceptible
+/-	Heterozygous
+/+	Homozygous Resistant

NC-TSW10 DNA Marker is highly associated with RB-TSWV resistance derived from TSW-07









Homozygous for DNA markers:

NC-TSW10-1
NC-TSW10-2
NC-TSW11
SW-5b
Sw-7

Homozygous for DNA markers:

NC-TSW10-1
NC-TSW10-2
NC-TSW11
SW-5b

The following objectives are proposed for this research:

1. **Improve the horticultural performance of the lines** derived from TSW-07 (with the *Sw-5b* gene in the background), using MAS

2. Develop RB-resistant **near-isogenic lines with the minimum introgression size** during the marker-assisted backcrossing process

3. Validate the efficacy of the marker-resistance association and horticultural performance **in greenhouse and field trials in California and North Carolina**

Marker-assisted Backcrossing in 2025

NC 1CS (Sw-5) X **TSW-07**

F1

Used **MAS** to select lines homozygous for **Sw-5b, NC-TSW10, and NC-TSW11)** seedlings

F4 X **NC Plum line** (Sw-5b +)

$\mathbf{F_1}$ X **NC Plum line** (Sw-5b +)

MAS $\mathbf{F_1BC_1}$

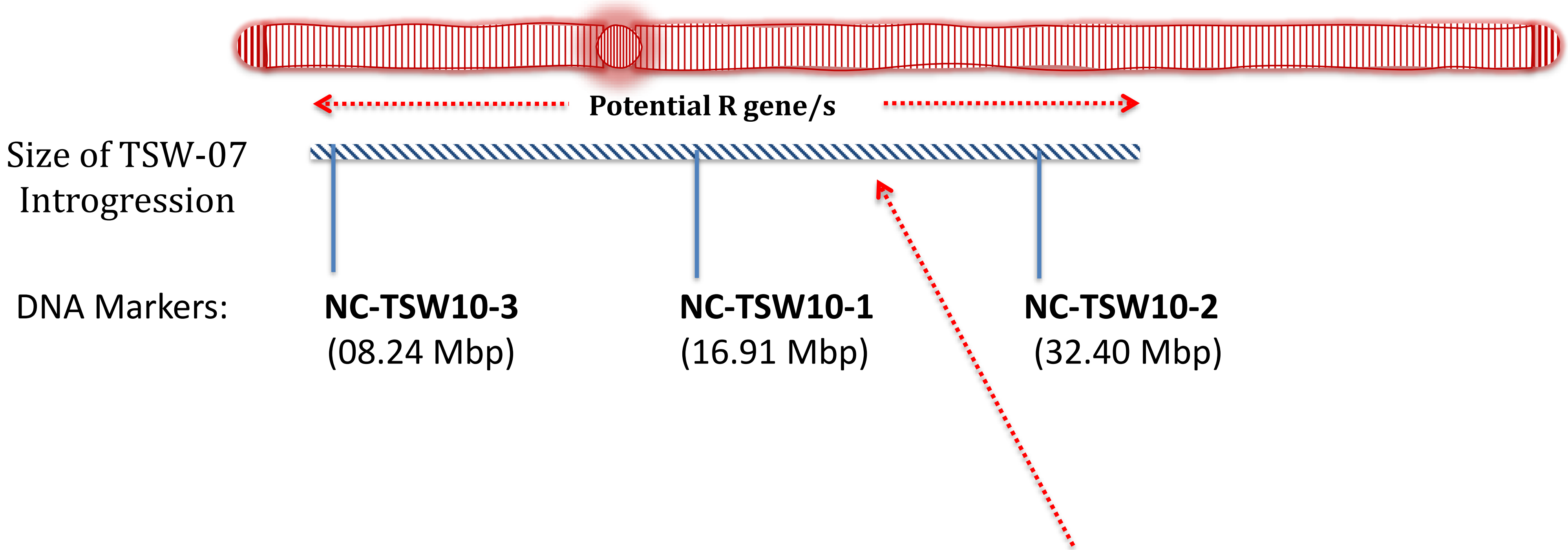
F3

Short to elongated plum lines with:

- ✓ **NC-TSW10-1, -2, & -3 DNA markers**
- ✓ ***Sw-5b* gene**
- ✓ *I*, *I2*, and *I3* genes
- ✓ *Ve* gene
- ✓ Jointless pedicel
- ✓ Og Crimson

Seeds for test crosses and disease evaluations are available through an MTA agreement with NCSU

Chromosome harboring the potential RB-TSWV resistance loci



Recombination events have been identified and selected by MAS during the backcross process

Existing breeding lines with processing tomato characteristics
(***no RB-TSWV resistance yet***)

As part of our collaboration with CTRI, we have emphasized horticultural traits important to processing tomatoes in our disease-resistance projects.

Next steps during this project in 2025:

1. Confirmation of the **genetic map and efficacy of the DNA markers** during this project
2. Third round of marker-assisted backcrosses to **improve the horticultural performance** of the lines
3. Evaluate the **resistance in a greenhouse with different RB-TSWV virus variants**.
4. Processing tomato types **breeding lines carrying the NC-TSW10 markers** will be available for public and private breeding programs
5. Disease evaluation in research fields **in California and North Carolina**

Greenhouse disease evaluation is still a challenge!

Acknowledgment

Mountain Horticultural Crops R & E Center

Funding Agencies

California Tomato Research Institute

NC Specialty Crop Block Grant Program

Supported by The NC Department of Agriculture & Consumer Services and Funded by the United States Department of Agriculture's Agricultural Marketing Service

North Carolina Tomato Growers Association

Questions?

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Evaluation of Management Programs for Consperse Stink Bug

Tom Turini
University of California
Vegetable Crops Advisor
Fresno County

UNIVERSITY OF CALIFORNIA
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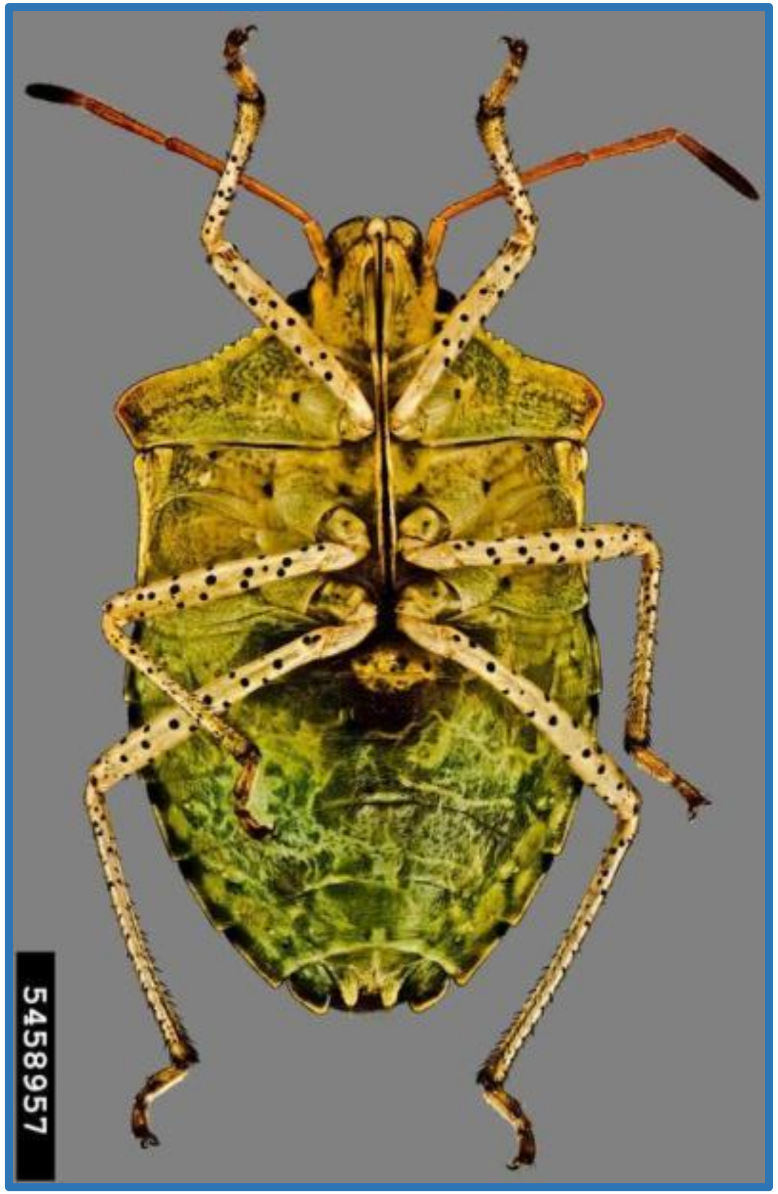
Advanced stages of rot in field with high stink bug population densities

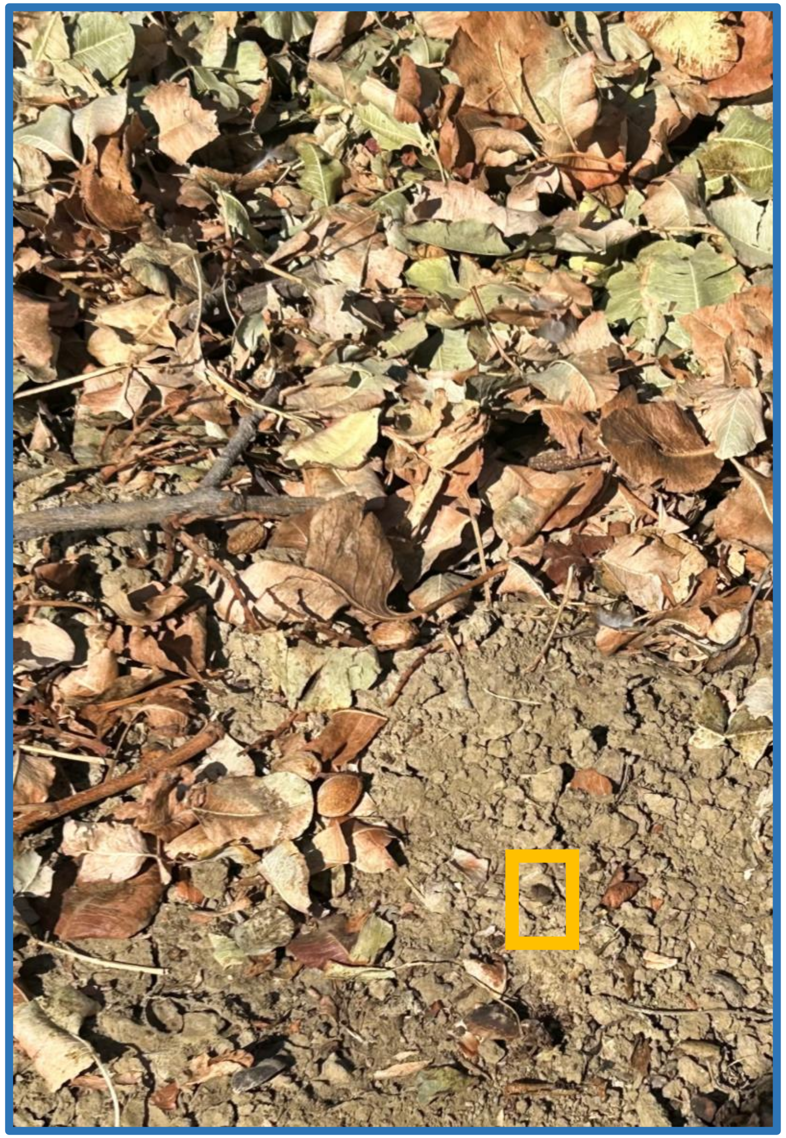
Consperse stink bug is consistently associated with fruit damage



Consperse stink bug: Euschistus conspersus

Consperse stink bug life cycle

Overwinter



Consperse stink bug overwinter under leaf litter or other cover

Insecticides Evaluated (2014-2024)

Not all are currently registered for use as trialed

IRAC #*	Trade name	Common name	
1A	Lannate	methomyl	
1B	Dibrom 8E	naled	
1B	Dimethoate	dimethoate	
3A	Danitol	fenpopathrin	
3A	Warrior II	lambda-cyhalothrin	
3A	Danitol	fenpropathrin	
3A + 4A	Brigadier	bifenthrin + imidicloprid	
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam	
3A + 4A	Leverage	beta-cyfluthrin + imidicloprid	
4A	Assail	acetamiprid	
4A	Venom	dinotefuron	
4A+ 15	Cormoran	acetamiprid + novaluron	
4C	Sequoia	sulfoxaflor	
4D	Sivanto	flupyradifurone	
7C	Knack	pyriproxyfen	Juvenile hormone rec. mod
9C	Beleaf	flonicamid	Chordotonal organ nicotinamidase
15	Rimon	novaluron	Benzoyl urea’s
21A	Torac	tolfenpyrad	Mitochndrl Cmplx I, ETI
28	Exirel	cyantraniliprole	Diamides

* IRAC# mode of action as assigned by the Insecticide Resistance Action Committee

Insecticides Evaluated (2014-2024)

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1A	Lannate	methomyl	
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3A	Warrior II	lambda-cyhalothrin	
3A	Danitol	fenpropathrin	
3A + 4A	Brigadier	bifenthrin + imidicloprid	
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam	
3A + 4A	Leverage	beta-cyfluthrin + imidicloprid	
4A	Assail	acetamiprid	
4A	Venom	dinotefuron	
4A+ 15	Cormoran	acetamiprid + novaluron	
4C	Sequoia	sulfoxaflor	
4D	Sivanto	flupyradifurone	
7C	Knack	pyriproxyfen	Juvenile hormone rec. mod
9C	Beleaf	flonicamid	Chordotonal organ nicotinamidase
15	Rimon	novaluron	Benzoyl urea's
21A	Torac	tolfenpyrad	Mitochndrl Cmplx I, ETI
28	Exirel	cyantraniliprole	Diamides

* IRAC# mode of action as assigned by the Insecticide Resistance Action Committee

Key Takeaways from the 2025 CTRI-Funded Research

- Plinazolin (an insecticide that recently received federal registration) significantly reduced stink bug densities and fruit damage.

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Adult Consperse stink bug counts, 2025

Treatment	28 Aug	22 Sep
Plinazolin 200SC 4.1 fl oz foliar	7.25	1.75
Venom 6.0 oz drip irrigation injected	16.25	6.75
Celite 35 lbs dust	10.25	9.25
Dimethoate 1 pt, Warrior II 1.92 fl oz, Danitol 10.67 fl oz and Assail 70WP 1.7 oz foliar	16.00	11.50
Sivanto Prime 28 fl oz foliar	12.25	12.50
Untreated control	15.25	21.25
LSD (P=0.05)	NS	8.411

HM8237 planted on 2 Jun. Sivanto Prime was applied on 21 Aug, all other treatments were applied on 21 Aug and 9 Sep. All treatments applied to foliage were in the equivalent of 50 gal of water with 0.02% DyneAmic.

Insecticide influence on fruit quality

Treatments[z]	Red	Green	Sunburn	Rot total	Rot not specified	Rot stink bug
Plinazolin 200SC 4.1 fl oz foliar	69.2	12.1	0.1	18.6	8.8	9.8
Dimethoate 1 pt, Warrior II 1.92 fl oz, Danitol 10.67 fl oz and Assail 70WP 1.7 oz foliar	63.4	13.7	1.0	21.9	6.5	15.4
Sivanto Prime 28 fl oz foliar	44.2	17.6	0.5	37.7	10.5	27.1
Celite 35 lbs dust	37.3	14.3	0.6	47.7	15.6	32.2
Venom 6.0 oz drip irrigation injected	40.4	14.5	1.1	43.9	5.9	38.0
Untreated control	27.1	17.3	0.5	55.1	9.7	45.4
LSD (P=0.05)	20.932	NS	NS	18.568	NS	16.113

HM8237 planted on 2 Jun. Sivanto Prime was applied on 21 Aug, all other treatments were applied on 21 Aug and 9 Sep. All treatments applied to foliage were in the equivalent of 50 gal of water with 0.02% DyneAmic.

Insecticides Evaluated

Not all are currently registered for use as trialed

IRAC #*	Trade name	Common name	
1A	Lannate	methomyl	
1B	Dibrom 8E	naled	
1B	Dimethoate	dimethoate	
3A	Danitol	fenpopathrin	
3A	Warrior II	lambda-cyhalothrin	
3A	Danitol	fenpropathrin	
3A + 4A	Brigadier	bifenthrin + imidicloprid	
3A + 4A	Endigo ZCX	lambda-cyhalothrin + thiamethoxam	
3A + 4A	Leverage	beta-cyfluthrin + imidicloprid	
4A	Assail	acetamiprid	
4A	Venom	dinotefuron	
4A+ 15	Cormoran	acetamiprid + novaluron	
4C	Sequoia	sulfoxaflor	
4D	Sivanto	flupyradifurone	
7C	Knack	pyriproxyfen	Juvenile hormone rec. mod
9C	Beleaf	flonicamid	Chordotonal organ nicotinamidase
15	Rimon	novaluron	Benzoyl urea
21A	Torac	tolfenpyrad	Mitochndrl Cmplx I, ETI
28	Exirel	cyantraniliprole	Diamides
30	Plinazolin	isocycloseram	
UNM	Celite	diatomaceous earth	

* IRAC# mode of action as assigned by the Insecticide Resistance Action Committee 2025

Key Takeaways from the 2025 CTRI-Funded Research

- The electrostatic sprayer did not improve control under the conditions of the study.

HM8237 planted 2 Jun
Application dates: 20 Aug, 11 Sep
Tank Mix: Dimethoate 1 pt + Warrior II 1.92 fl oz + Danitol 10.67 fl oz and Assail 70WP 1.7 oz + DyneAmic 0.25%

Standard conventional sprayer
40 gallons per acre
30 psi
Three Teejet 8003VS nozzles

Electrostatic (OnTarget Spray Systems, Watsonville**)**
20 gallons per acre

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Sprayer performance: stink bug Density/Fruit quality

Consperse stink bug adults in the canopy and on soil in 4 ft length of 1 side of a bed

Treatments	29 Aug	23 Sep
Conventional	13.7	8.5
Electrostatic	12.2	11.5
Untreated	16.0	16.7

Treatments	Red	Green	Sunburn	Rot total	Rot not specified	Rot stink bug
Conventional	44.9	21.3	0.7	19.5	13.6 b	33.1 b
Electrostatic	40.1	22.8	1.6	12.6	23.0 a	35.6 ab
Untreated	30.9	27.6	0.5	19.5	21.5 ab	41.0 a

On 17 Oct even row feet of each plot were hand-harvested, a sub-sample of 22-28 lbs was collected and sorted into categories; red, green, sunburn, rot of unknown cause, and rot due to stink bug feeding was recorded.

Proposed 2026 Research

- Insecticide efficacy comparison
- Sprayer technology evaluation
- Trap crop optimization

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Insecticide Comparison

Plinazolin 200SC 4.1 fl oz foliar
Dimethoate 400 1 pt, Warrior II 1.92 fl oz, Danitol 10.67 fl oz and Assail 70WP 1.7 oz foliar (commercial standard)
Sivanto Prime 28 fl oz foliar one application
Celite 35 lbs dust
Celite 35 lbs as a foliar spray
Venom 6.0 oz drip irrigation injected
Avaunt 3.6 oz foliar
Sefina 14 fl oz foliar
Untreated control

Unless otherwise stated, all foliar treatment will be applied at first detection of Consperse stink bug and 14 to 21 days after the first applications or 70 and 90 days-post plant. 50 gal/acre with 0.25% DyneAmic.

Sprayer Evaluation

Common variety planted late-season
Application dates: two applications ca. 70 and 90 days post plant
Tank Mix: Dimethoate 1 pt + Warrior II 1.92 fl oz + Danitol 10.67 fl oz and Assail 70WP 1.7 oz + DyneAmic 0.25%

Standard conventional sprayer
40 gallons per acre
30 psi
Three Teejet 8003VS nozzles

Electrostatic (OnTarget Spray Systems, Watsonville**)**
40 gallons per acre

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Trap crop optimization

Trap Crops (main-plot) Planted Jan & Mar
1. safflower
2. wheat or other small grain,
3. rappini or another smaller brassica
4. low-density black mustard

Insecticide treatment(sub-plot)
a. Acephate 90WDG 1.1 lb, Warrior II 1.92 fl oz, Danitol 10.67 fl oz and Assail 70WP 1.7 oz foliar (commercial standard)b.
b. Untreated

½ of each main-plot will be treated when stink bug densities reach 3 stink bug per 10 sweeps. At 21- to 28-day intervals, densities of stink bugs will be recorded and each captured will be identified to species.

I	4b	3a	2a	1b	35’
	4a	3b	2b	1a	35’
II	2b	1b	4a	3b	35’
	2a	1a	4b	3a	35’
III	1a	4b	2a	3a	35’
	1b	4a	2b	3b	35’
IV	2a	3a	1b	4b	35’
	2b	3b	1a	4a	35’
Rep	12’	12’	12’	12’	

Discussion

- Variety suggestions?
- Comparing susceptibility of commercial varieties to Consperse stink bug feeding damage.
- Evaluate the role of plant nutrition in stink bug feeding damage.
- Interest in evaluation of high-volume insecticide applications in tomato with high label rates of surfactants to increase canopy penetration.
- Interest in laboratory assays of sensitivity of Consperse stink bug to pyrethroids, neonicotinoids, indoxacarb and other insecticides of interest.
- Use of synthetic Consperse stink bug aggregation pheromones (Alphascent Lures) in conjunction with sheets of yellow sticky material to reduce population densities.

Acknowledgements

- California Tomato Research Institute
- Fresno Consultants and Growers

- Scott Schmidt
- Chris Coelho
- Jared Overmyer
- UC West Side Research and Extension Center staff

- Industry
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  - FMC
  - Syngenta
  - OnTarget Spray Systems

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Thank you

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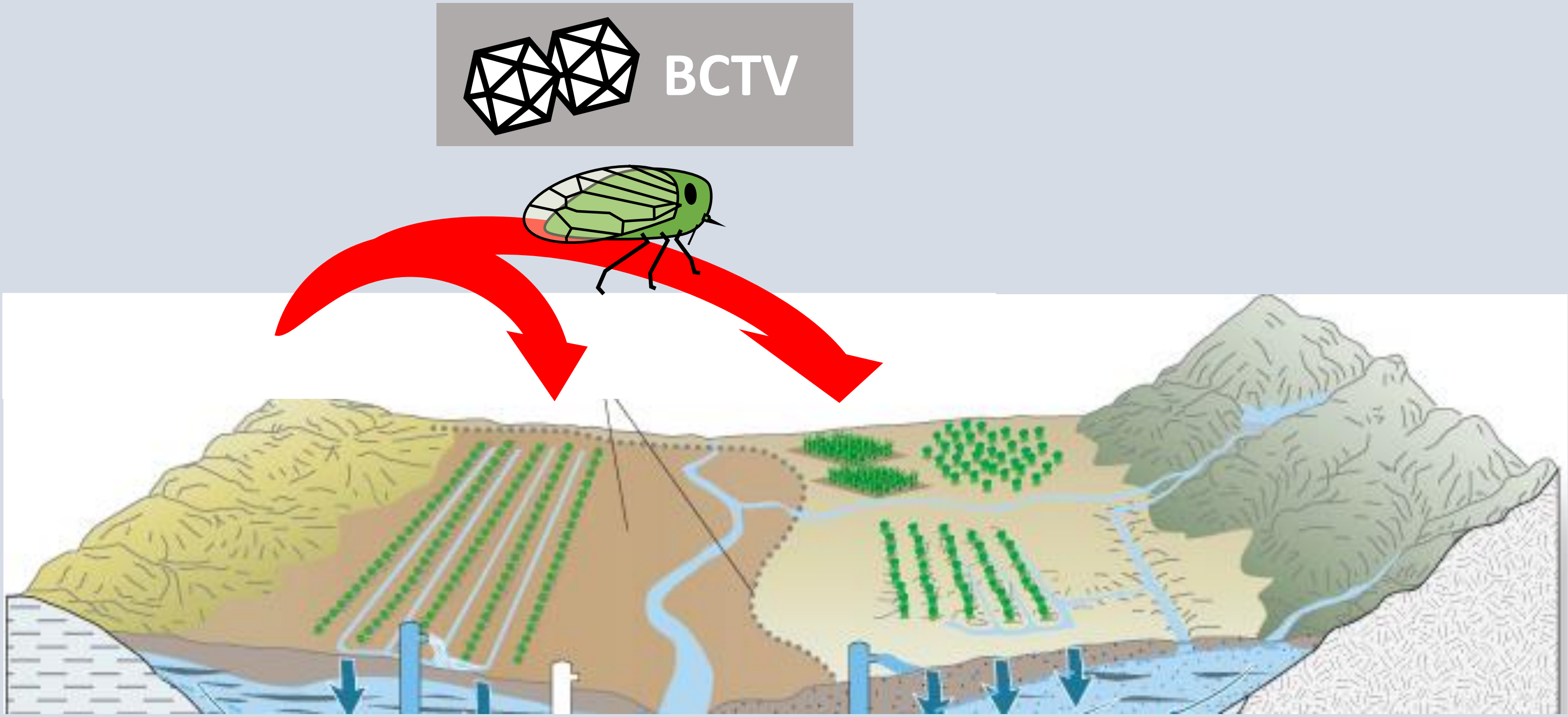
Virus & Vector MGMT: Classification & Characterization of Non-Agricultural Beet Leafhopper Hotspots in the Coastal Foothills



Proposal basics

- New proposal (Year 1 budget) = $58,000
- PI Christian Nansen (UC Davis and Spectral Analytix)
- Co-PI Jorge Angeles (Weed science advisor in Tulare, Kings and Fresno counties)
- Unique and innovative integration of GIS and weed expertise

Proposal basics

Project objectives

- Compilation of freely available satellite imagery and meteorological data
- Classification of satellite image pixels into meaningful BCTV vegetation types
- Ground truthing
- Integration of climatic data (temperature and precipitation)
- Associate key non-agricultural hosts of both beet leafhoppers and BCTV with vegetation types
- Develop a user-friendly website
- Outreach and dissemination.

What we have accomplished

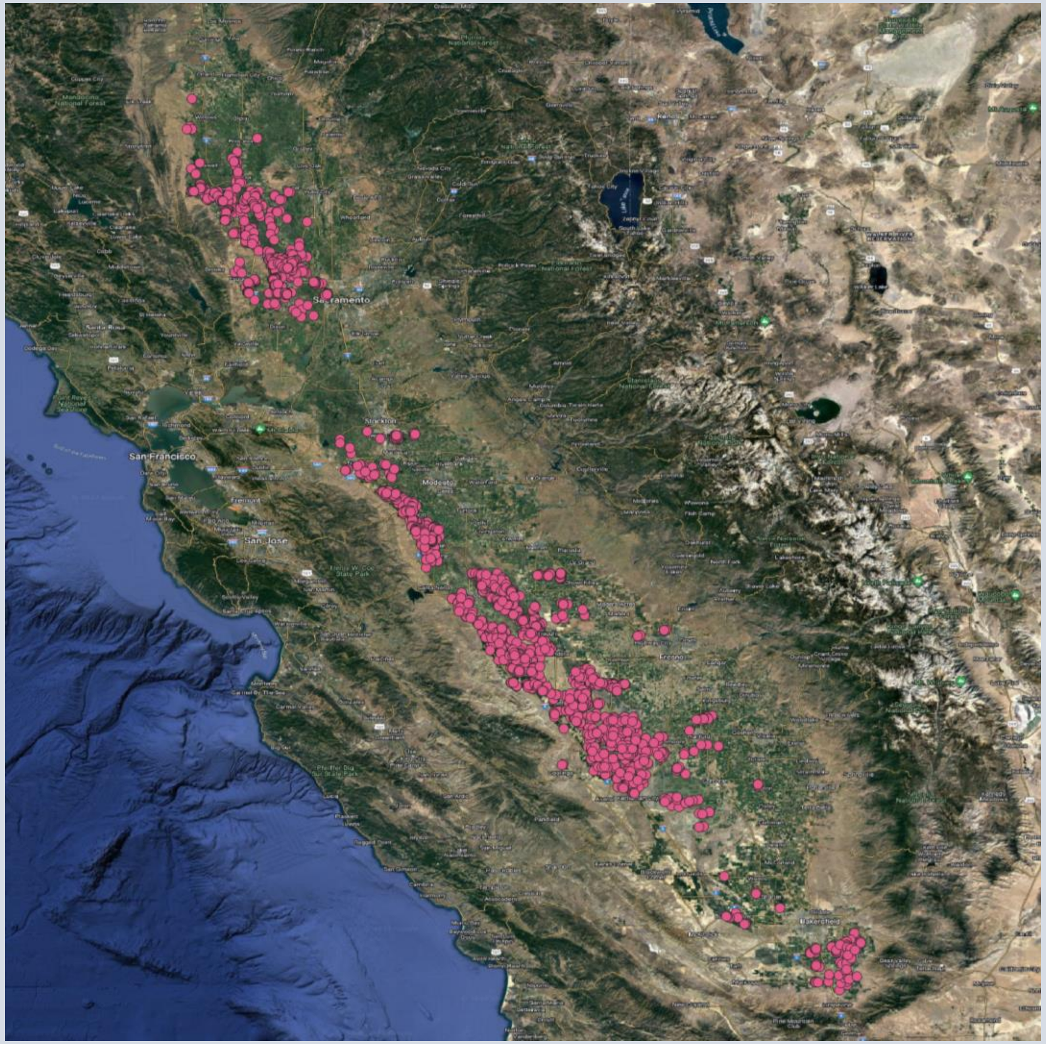
Journal of Pest Science
https://doi.org/10.1007/s10340-024-01771-4

ORIGINAL PAPER

Check for updates

Timing matters: remotely sensed vegetation greenness can predict insect vector migration and therefore outbreaks of curly top disease

Hyoseok Lee[1,4] · William M. Wintermantel[2] · John T. Trumble[3] · Christian Nansen[1]



- BCTV symptom survey from 2013 to 2022 in tomato fields (≈ 2,200 observations)
- Clear trend of late planting increasing risk of BCTV

What we have accomplished

Journal of Pest Science
https://doi.org/10.1007/s10340-024-01771-4

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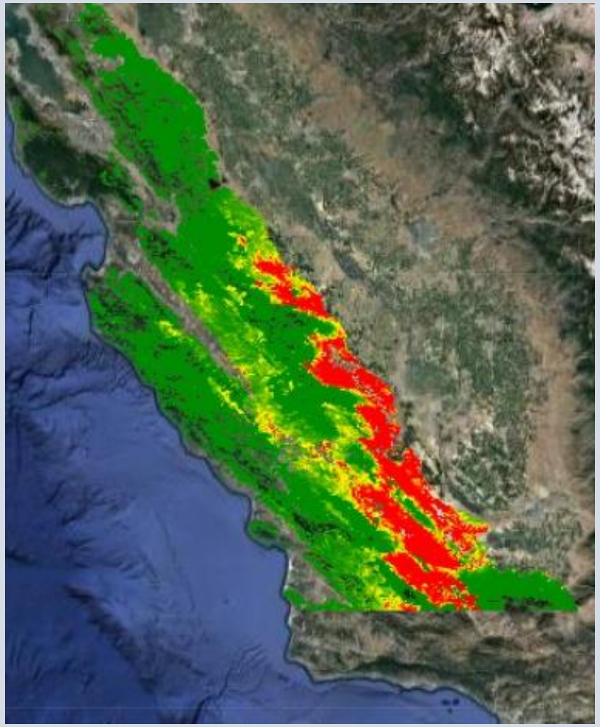
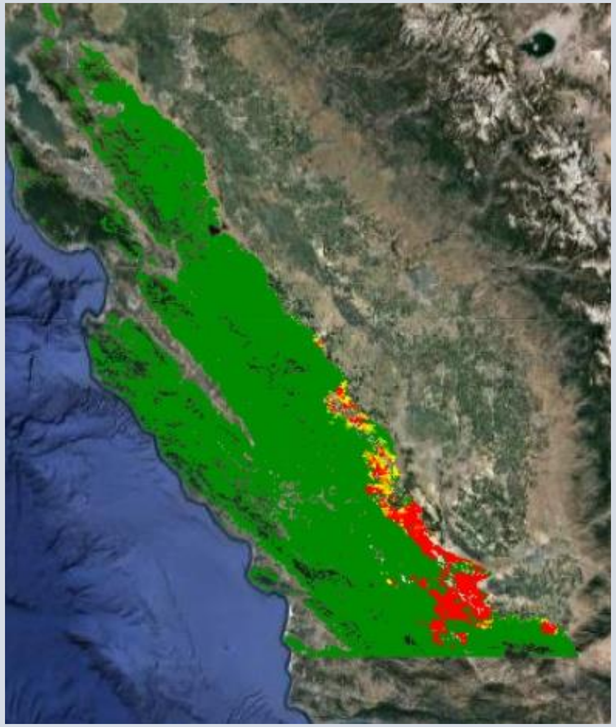
2013

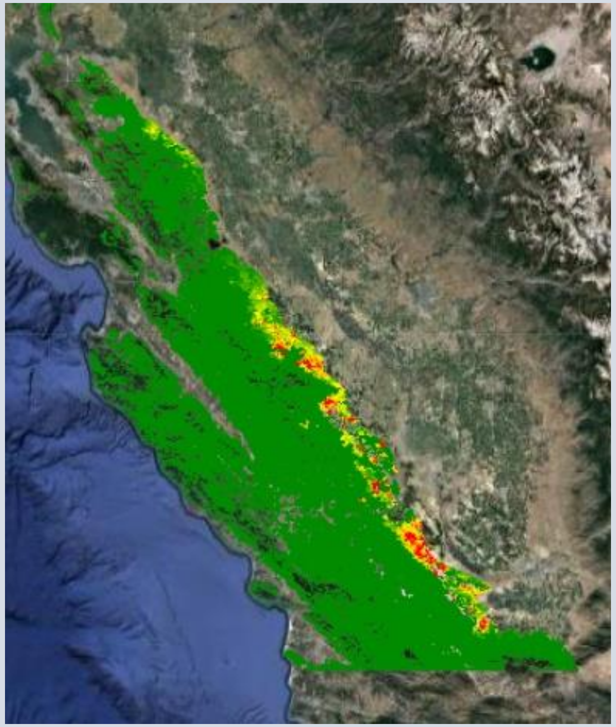


2018

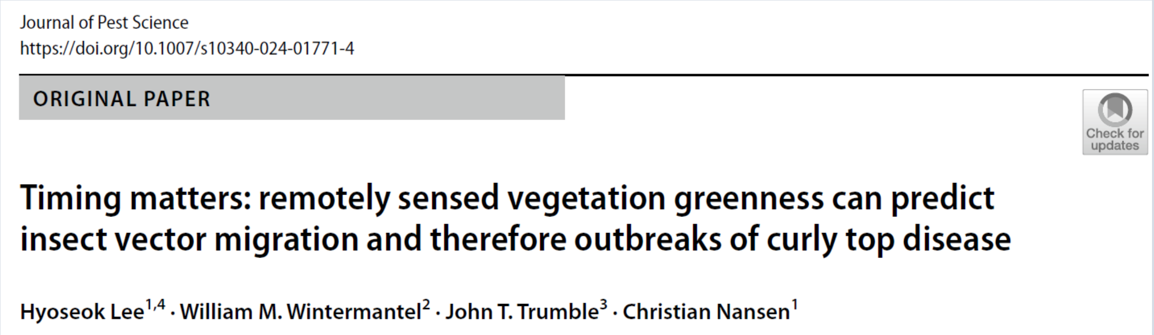


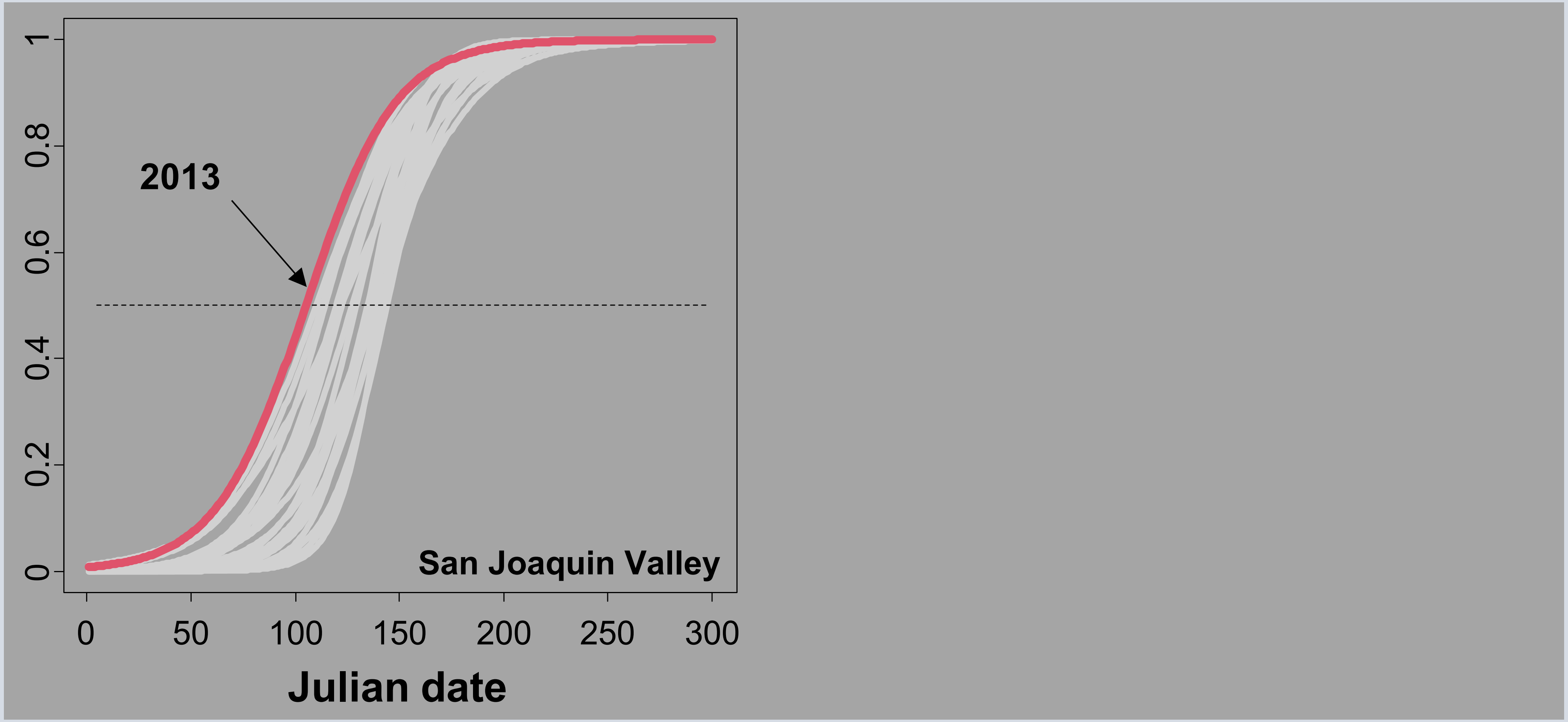
2019

2020



What we have accomplished





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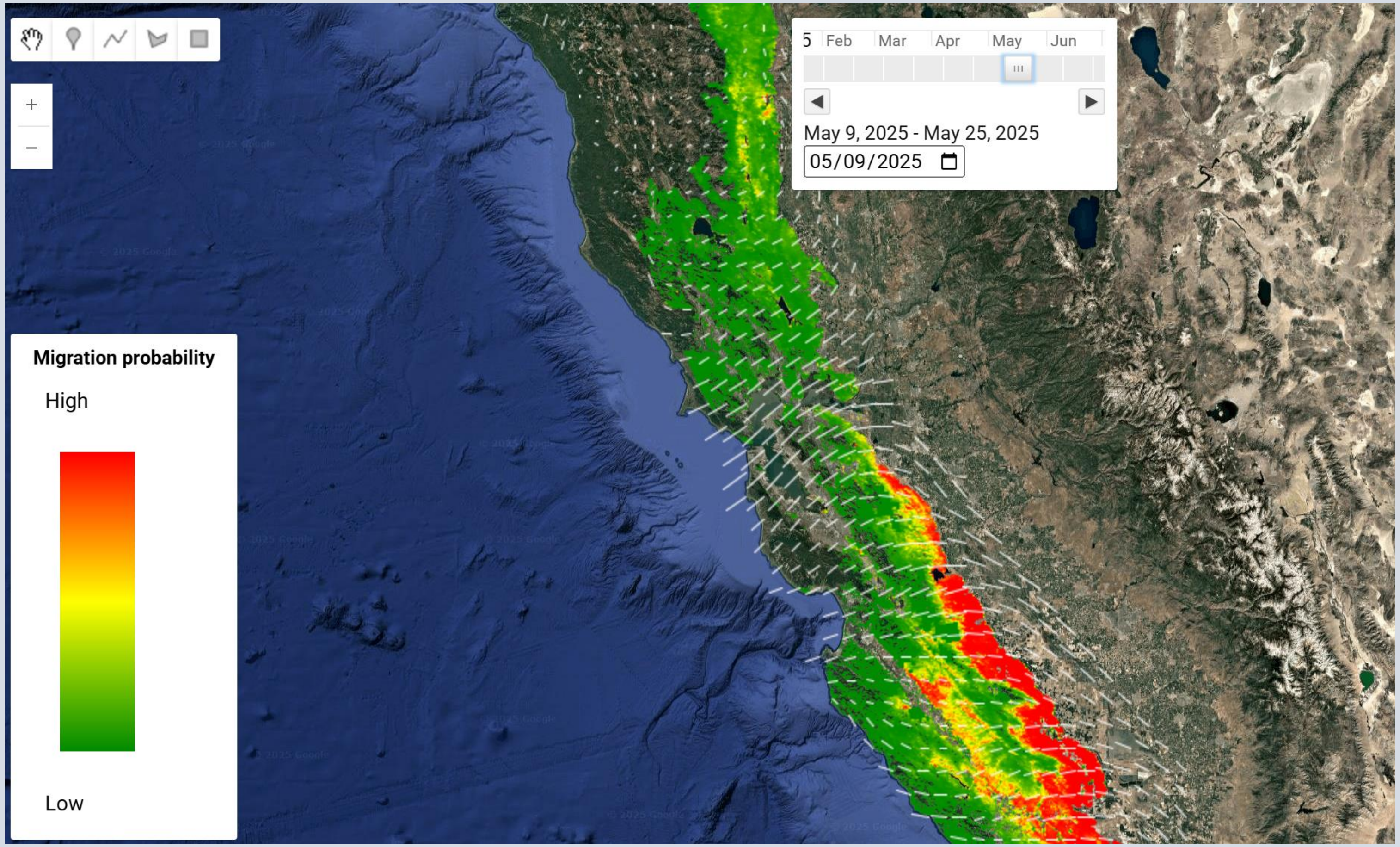

The vegetational challenge

The California coastal foothills or “Central California Coast Range”

Vegetation Type	Biotope	Key Species
Oak Woodland	Foothills, mid-elevations	Coast live oak, blue oak, toyon, buckeye
Chaparral	Hot, dry slopes	Chamise, manzanita, ceanothus
Coastal Sage Scrub	Lower, drier coastal areas	CA sagebrush, black sage, buckwheat
Grassland	Valleys, foothills	Wild oats, bromes, purple needlegrass
Redwood Forest	Fog-influenced north & Big Sur	Coast redwood, Douglas-fir
Riparian Woodland	Creeks & rivers	Sycamore, cottonwood, willow
Serpentine Communities	Serpentine outcrops	Numerous endemic shrubs & grasses

17,840 square miles = 11,420,000 acres

The vegetational challenge

The California coastal foothills or
“Central California Coast Range”

- California has 6,200–6,500 plant species
- The larger California Floristic Province (CFP = Central Valley, the Sierra Nevada, and Transverse/Peninsular Ranges) has about 3,500 plant species
- Nearly 61% of CFP species are endemic.

17,840 square miles = 11,420,000 acres

BCTV and host plants

- BCTV often infects weeds — including non-native or introduced species
- BCTV has a host range of more than 300 plant species from 44 plant families.
- Non-crop hosts include: filaree (*Erodium spp*.), peppergrass, and mustards, buckhorn plantain (*Plantago lanceolata*).
- No publicly available survey or peer-reviewed study that enumerates BCTV-susceptible species.

Discussion points

- Ideal features of a user-friendly website?
- How could a website be used and made meaningful to tomato producers?
- Ways website could be used in CTRI-BCTVCP-CDFA collaborations?

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