Salt and Water Stresses Affecting Charcoal Rot Development in Fall-Planted Strawberry

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Charcoal Rot

- Disease caused by *Macrophomina phaseolina*
  - Soilborne fungal pathogen
  - Can survive in soil as microsclerotia for 2-15 years (Singh et al. 2023)

- Symptoms appear as:
  - Wilting of foliage
  - Collapse and eventual death of plant

Conducive Environment

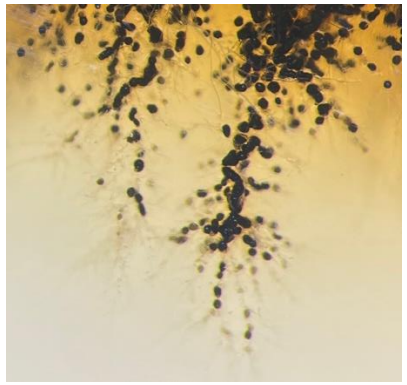
- *M. phaseolina* thrives in high temperatures (78-95˚F) and dry soil
- Can cause ≥80% plant mortality (Koike et al. 2013)

Disease Management

- No known fungicides are approved for use against *M. phaseolina*
- Current management focuses on:
  - Preplant fumigation (not as effective as methyl bromide)
  - Cultural controls
    - Crop rotation
    - Planting resistant cultivars (no complete resistance)
    - Reducing plant stress

Disease Triangle

Conducive Environment



Virulent Pathogen

Susceptible Host

Abiotic Stressors

- Past studies show *Macrophomina* infection usually occurs when plants are under severe stress (Goudarzi et al. 2011)
  - Stresses:
    - Drought, high salinity, and high temperatures
- Research specific to strawberry:
  - Low soil moisture increases charcoal rot mortality (Pedroncelli et al. 2025)
  - Little research exploring disease relationship with salinity

Research Question:

Which environmental stressor contributes most to charcoal rot disease development in strawberry?

Materials and Methods

- Field trial at Cal Poly San Luis Obispo
- Split plot design with 4 replications
  - 5 Treatments
  - 2 Cultivars:
    - ‘Sweet Ann’ and ‘Fronteras’
- Plants artificially inoculated
  - Using *Macrophomina phaseolina* cornmeal-sand inoculum

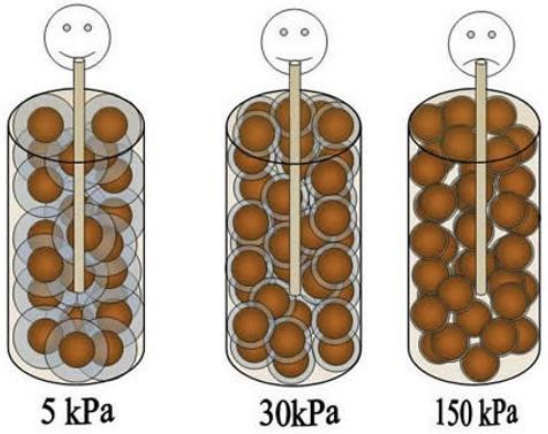
Treatments

- Standard/Control
- Drought Stress
- Chloride Stress
- Chloride × 2 Stress
- High ECw Stress

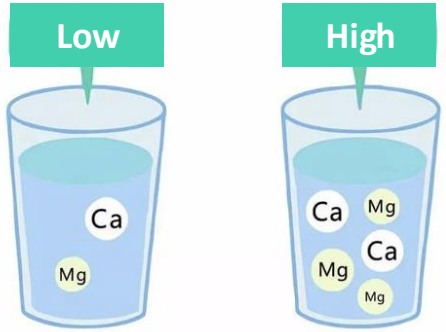
Materials and Methods

Treatment	Soil tension (kPa)	Added salts	EC_W (dS/m) 2024	EC_W (dS/m) 2025
Standard	10	-	0.68	0.70
Drought	60	-	0.68	0.70
Chloride	10	$CaCl_2$, $MgCl_2$, NaCl	1.12	1.36
Chloride × 2	10	($CaCl_2$, $MgCl_2$, NaCl) × 2	1.32	2.09
High EC_W	10	$MgSO_4$, Na_2SO_4, $MgCl_2$, NaCl	1.95	2.52

Soil tension: Measure of soil moisture content



EC_W: Electrical conductivity of irrigation water, a measure of salinity

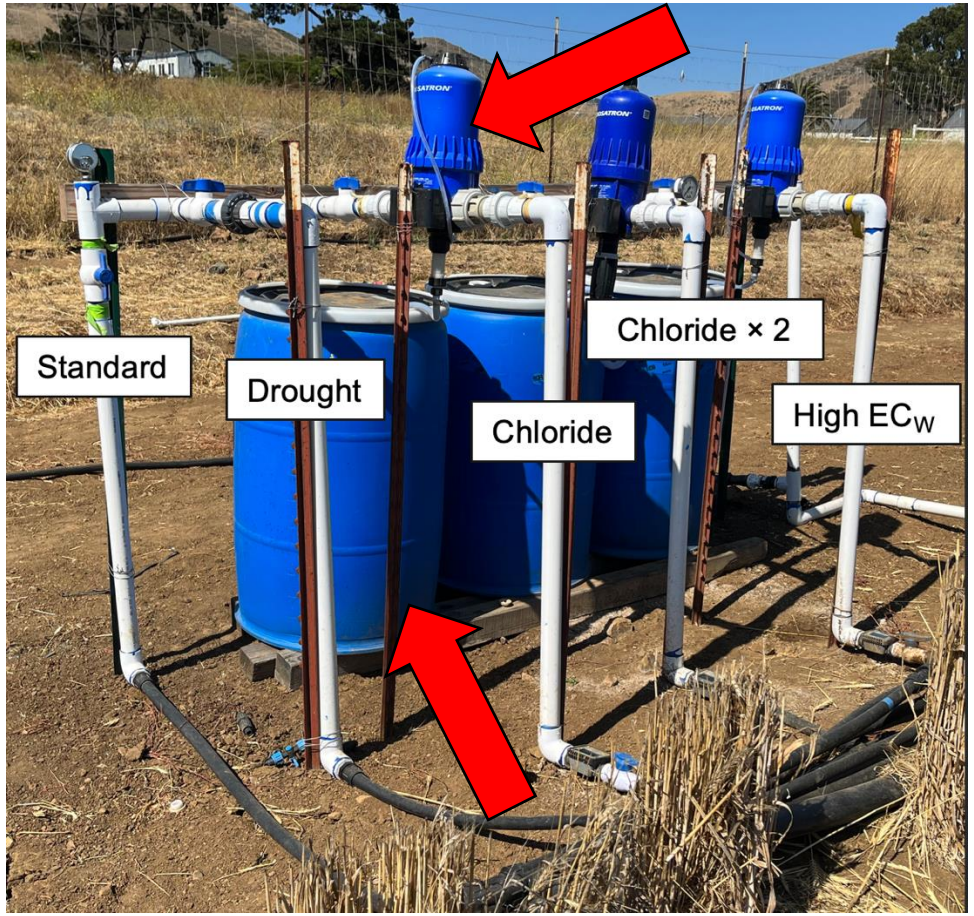


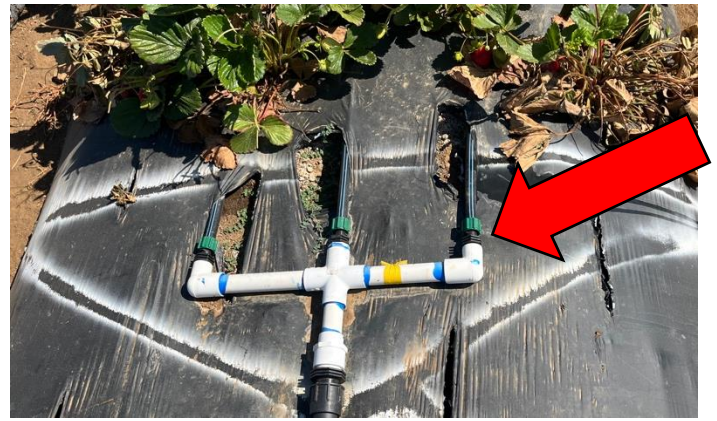
*Strawberries considered very sensitive to salinity with a threshold of 1 dS/m (Maas et al. 1977)

(Hortau, 2025)

Materials and Methods

- Each plot was connected to corresponding treatment via PVC pipes





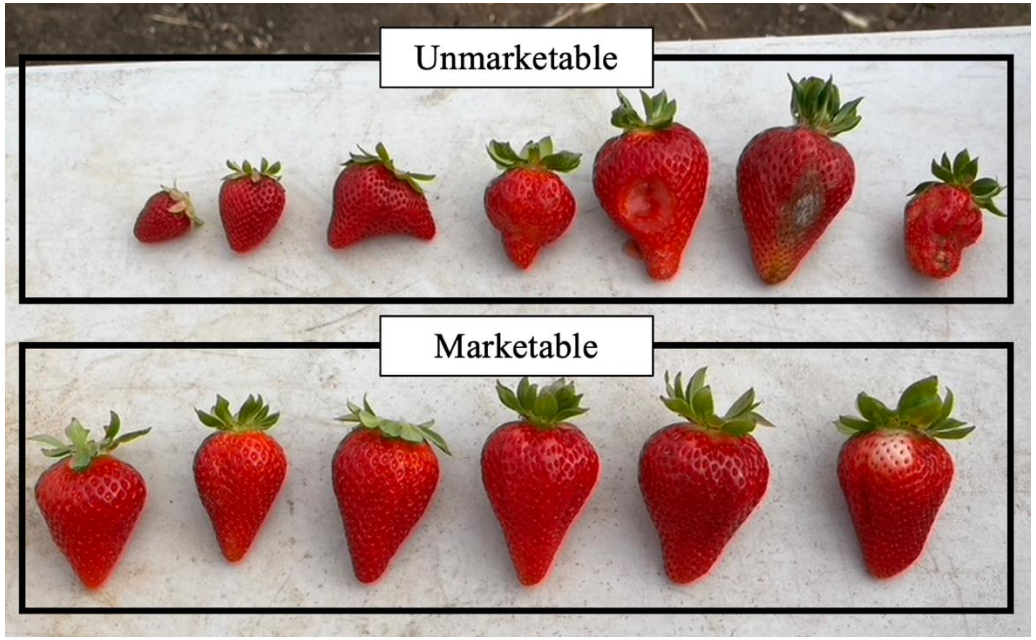
Materials and Methods

- Plant mortality
  - Tracked plant mortality throughout entire season
  - Process and plate plant material to confirm presence of *M. phaseolina*

- Assess correlation between stress type and cultivar to plant mortality rate
  - Two-way ANOVA to test for significance using JMP Pro 18

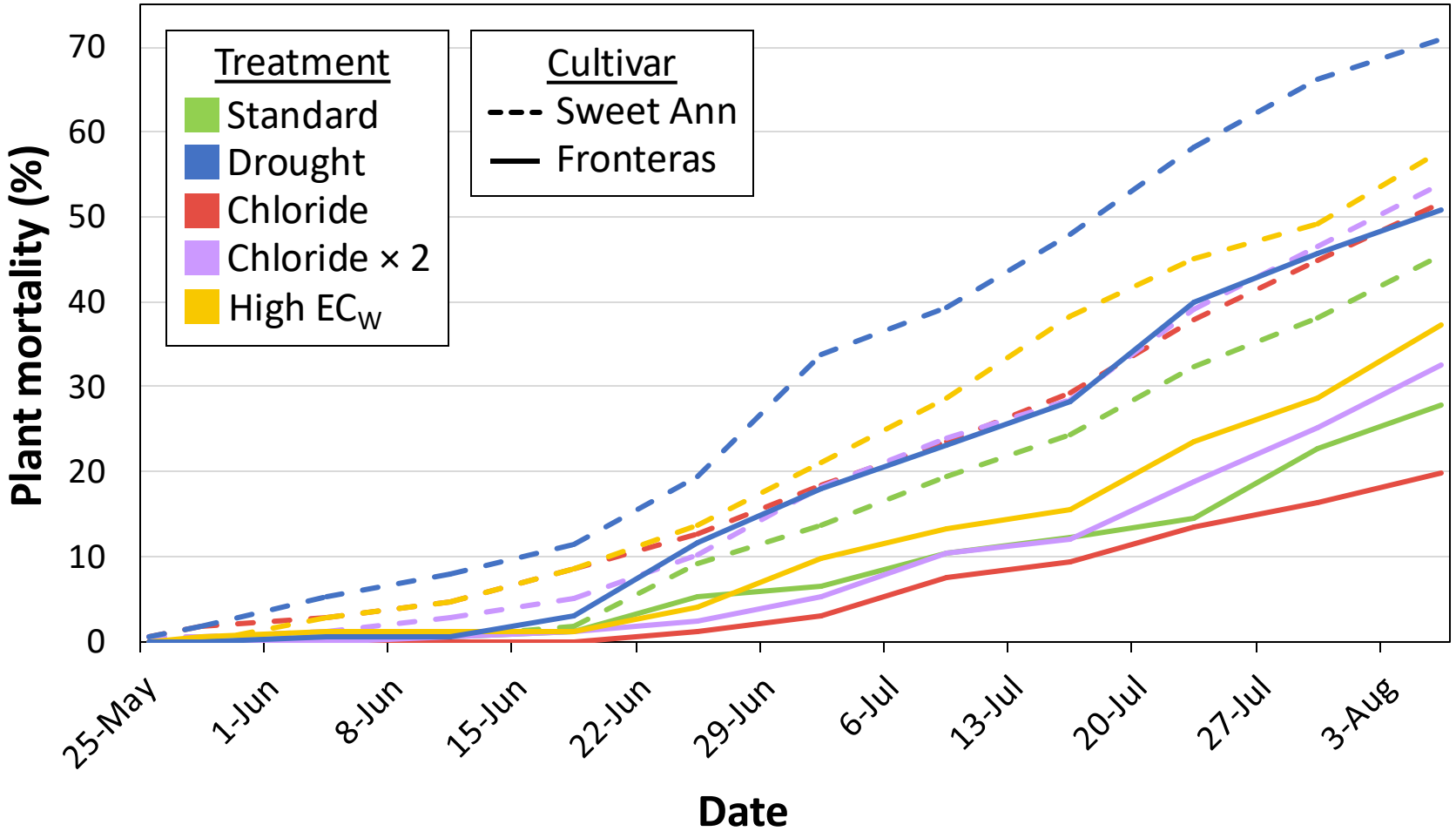
Materials and Methods

- Season long fruit yield (2025)
  - Ripe fruit harvested and weighed
  - Each fruit examined and categorized as marketable or unmarketable
    - Marketable fruit reweighed and % yield calculated



- Assess correlation between stress type and cultivar to fruit yield
  - Two-way ANOVA to test for significance using JMP Pro 18

Results: Mortality Rate 2024



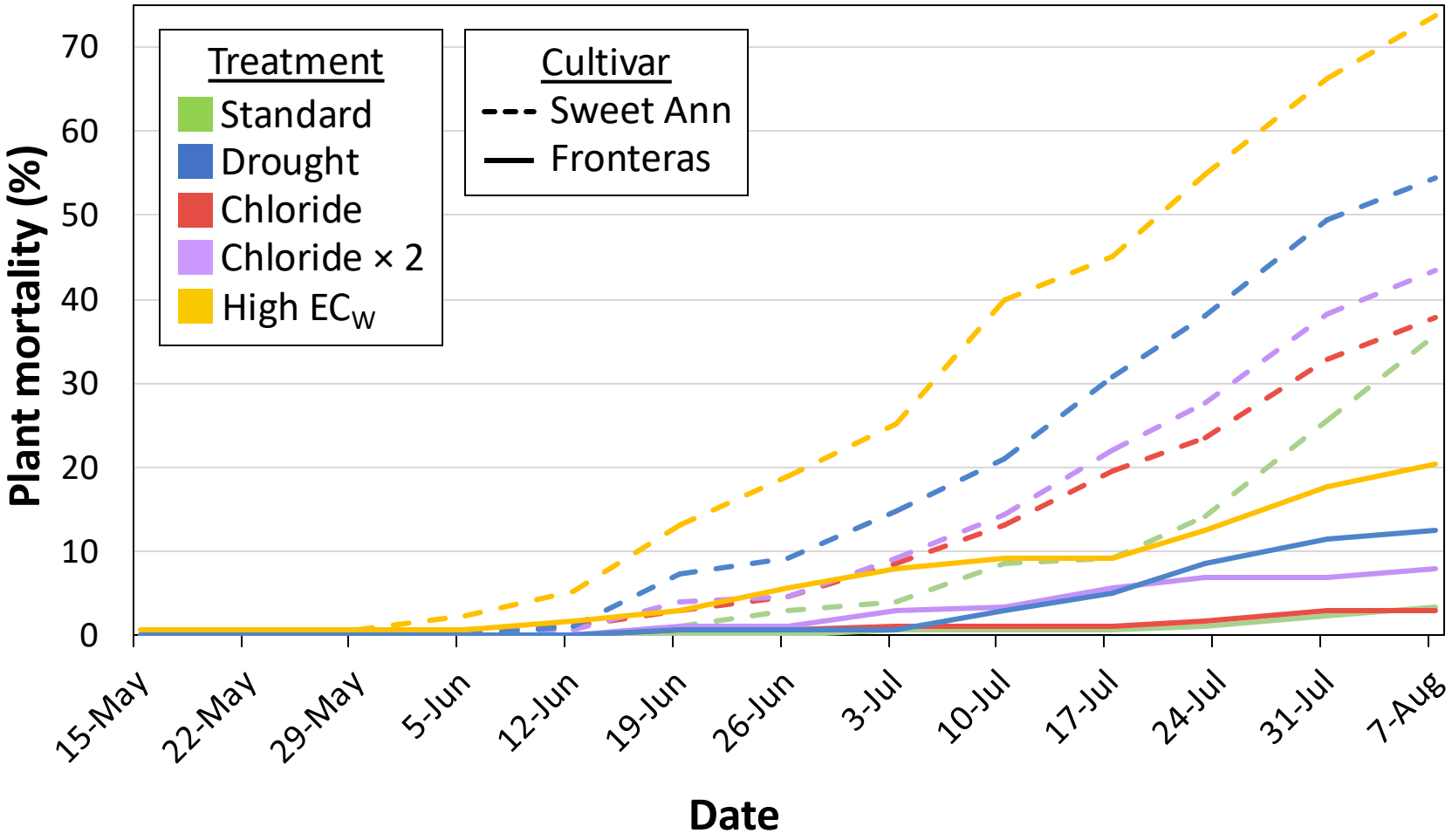
Two-way ANOVA Results:

Treatment: $P < 0.001$

Cultivar: $P < 0.001$

Interaction: $P = 0.61$

Results: Mortality Rate 2025



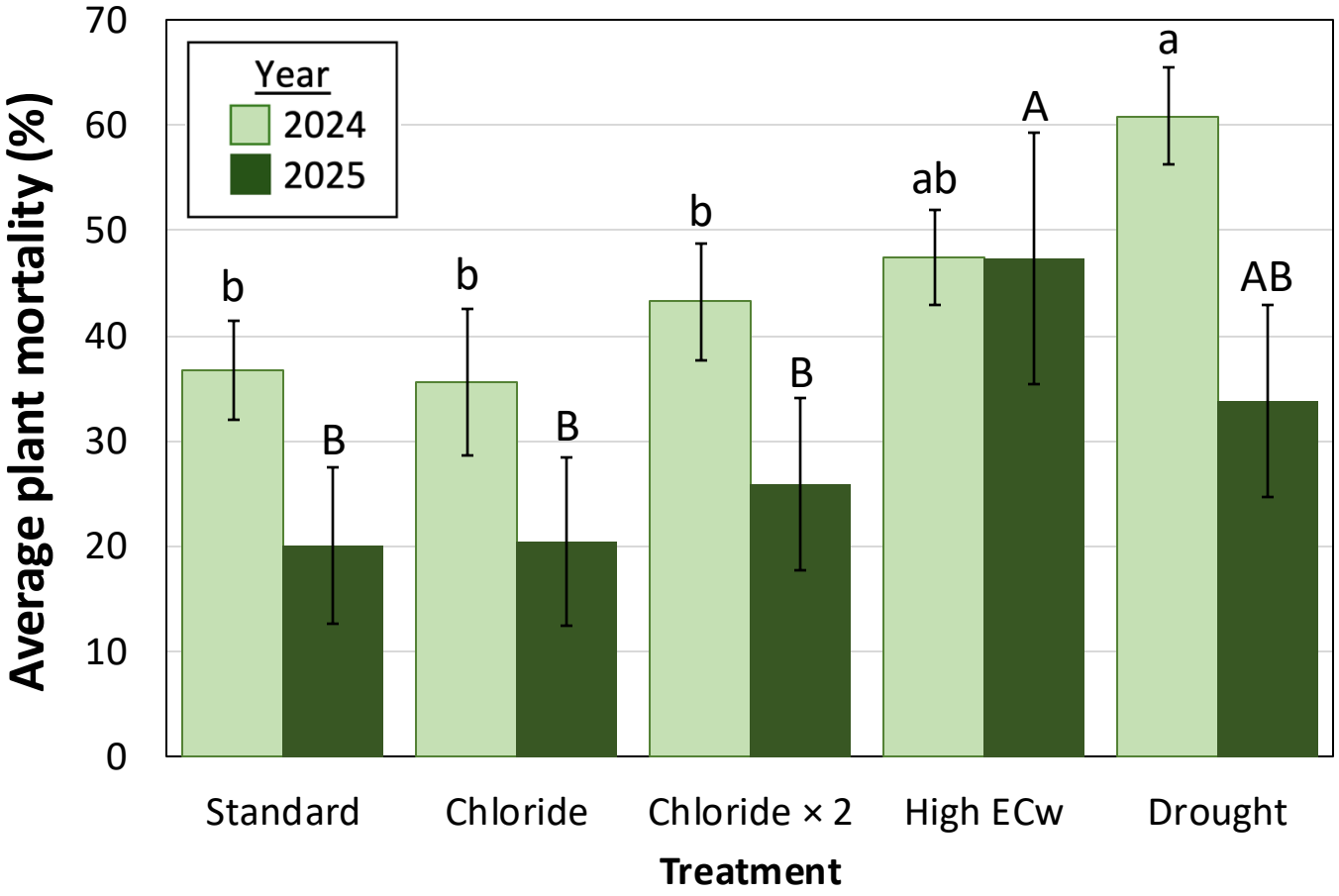
Two-way ANOVA Results:

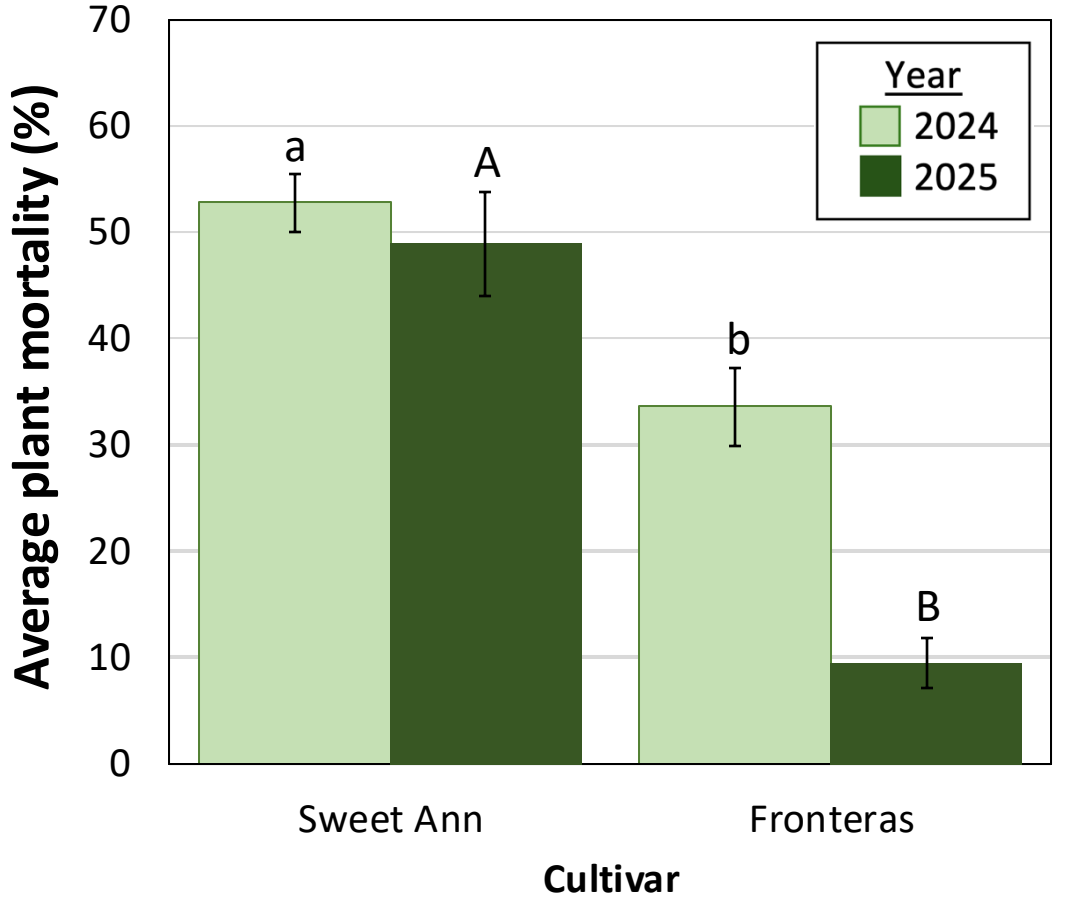
Treatment: $P = 0.0043$

Cultivar: $P < 0.001$

Interaction: $P = 0.62$

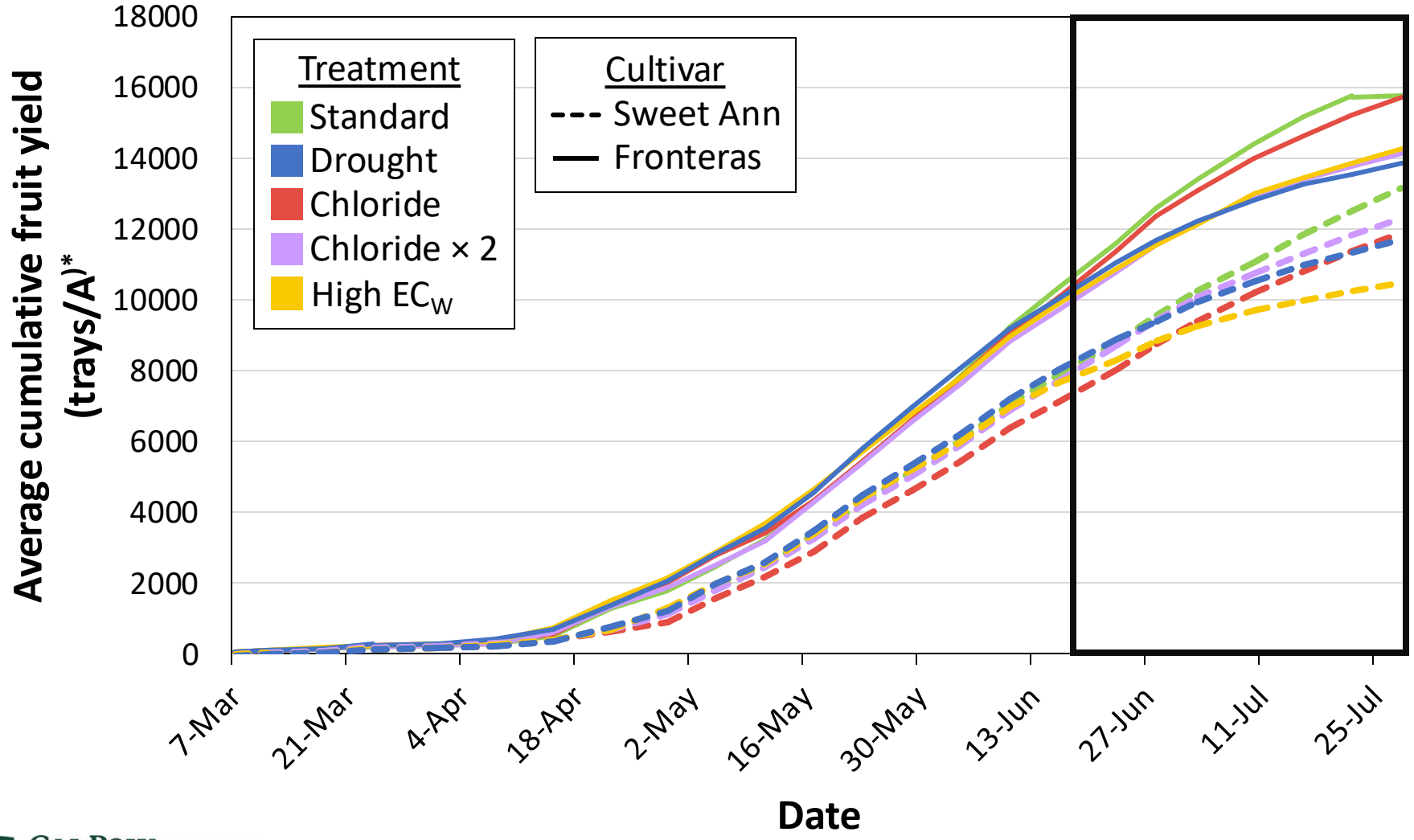
Results: Average Plant Morality





Values not connected by the same letter are significantly different ($P < 0.05$).

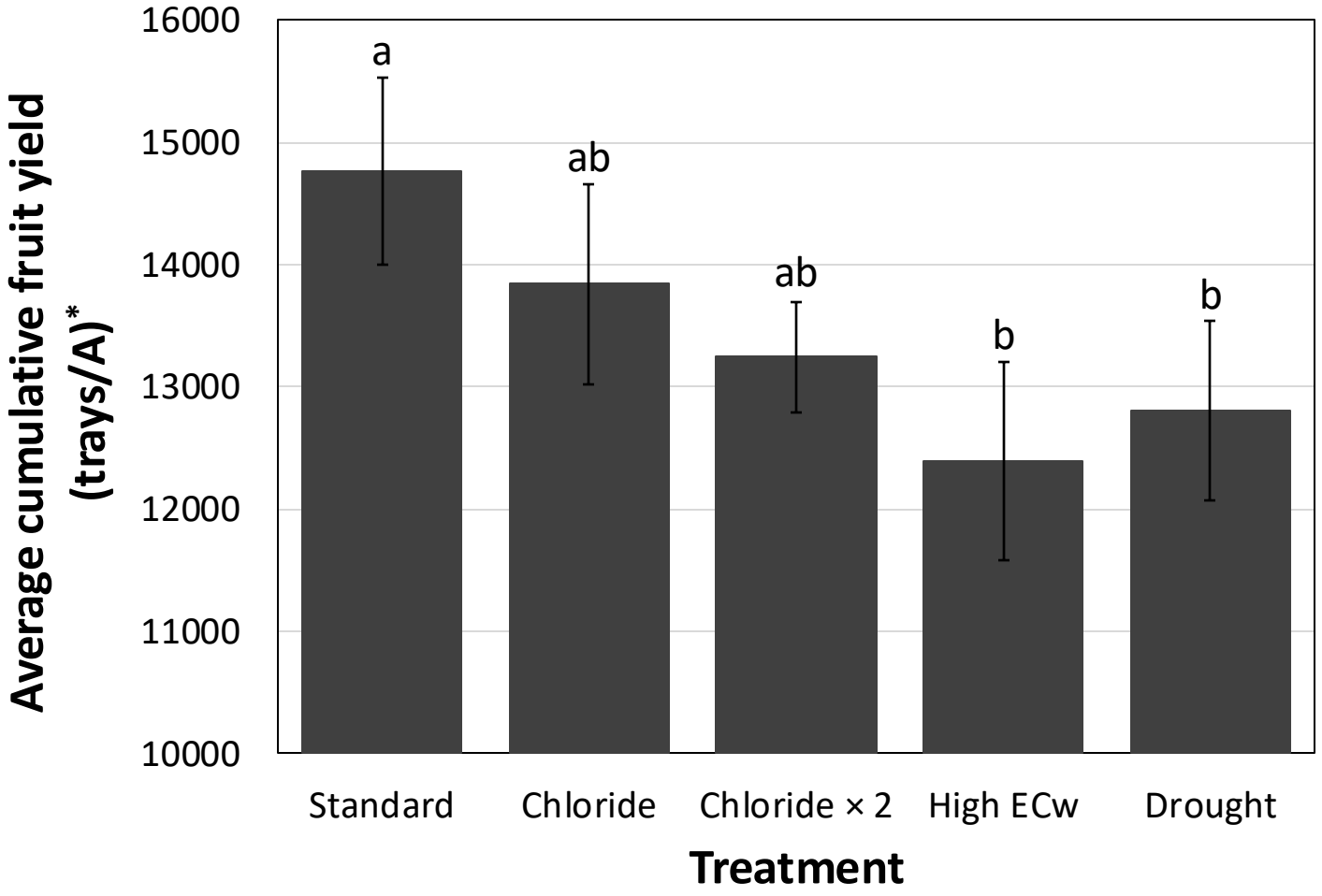
Results: Fruit Yield 2025

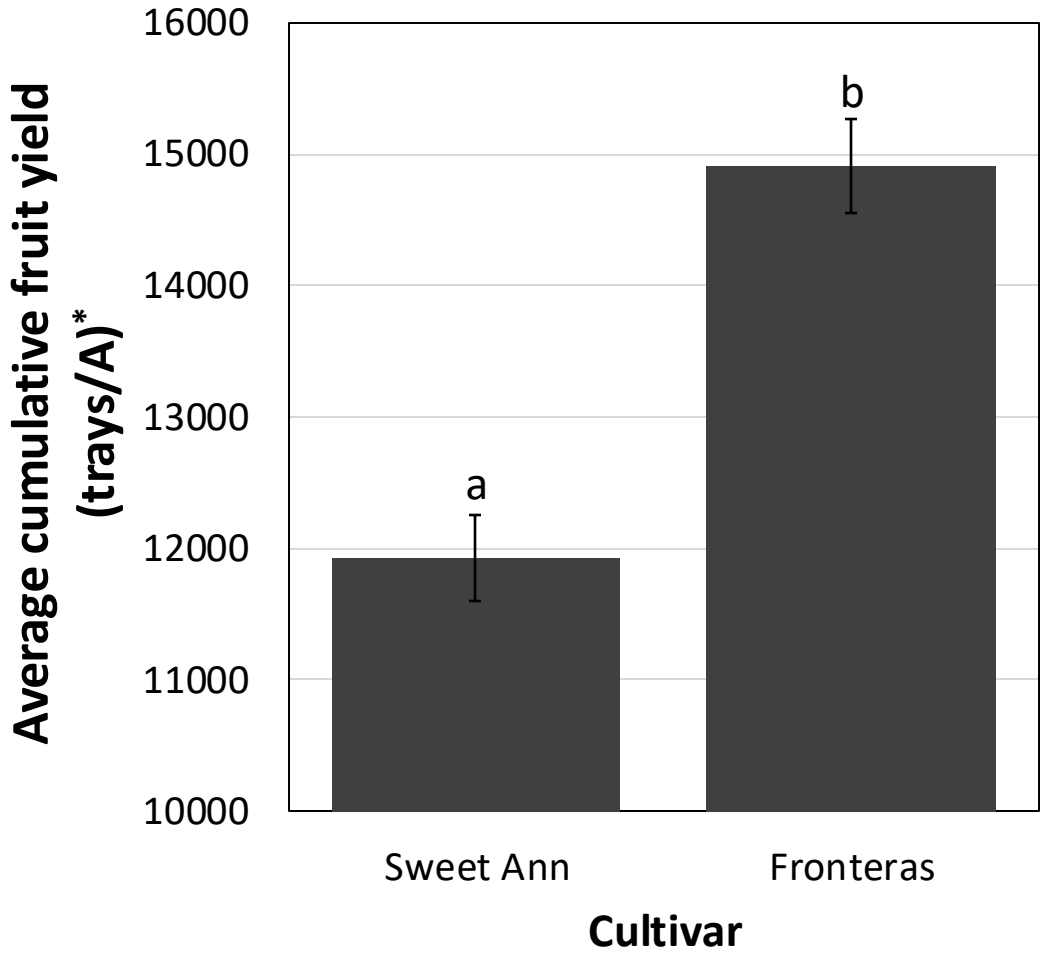


Begin to see separation between treatments during late-season

*Trays/A calculated assuming 8 lb/tray

Results: Fruit Yield 2025





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Discussion

- Charcoal rot severity can be significantly minimized using cultural management tools such as:
  - Maintain soil moisture within ideal ranges using tensiometers
  - Avoid poor-quality irrigation water
  - Planting disease-resistant cultivars

- Limitation:
  - Experiment does not account for salt accumulation in soil that would occur when using irrigation water with elevated salinity over multiple years

Acknowledgements

Funding: USDA, Specialty crop research initiative project 2022-51181-38328

Tensiometers:

Thank you to the Strawberry Center staff and students who helped with this project!

Strawberry Center Diagnostic Service

- Samples can be dropped off at the cooler located by Oleg's office

Too healthy

Too decayed

Just right

How to submit samples:

CAL POLY
Strawberry Center

Questions?

References

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