Effect of Salinity and Water Stresses on Macrophomina Development in Strawberry Production

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Drought and Salinity Stress

- Causes osmotic stress → hindering plants ability to uptake water
- Effect on plants:
  - Reduced plant growth
  - Decreased yield
  - Reduced fruit size

Examples of salinity symptoms:

Abiotic Stresses

- Past studies show Macrophomina infection usually occurs when plants are under severe stress (Goudarzi et al. 2011)
  - Stresses:
    - Drought
    - High salinity
    - High temperatures
- Not sufficient research for strawberries

Research Question:

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

Macrophomina Root Rot

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

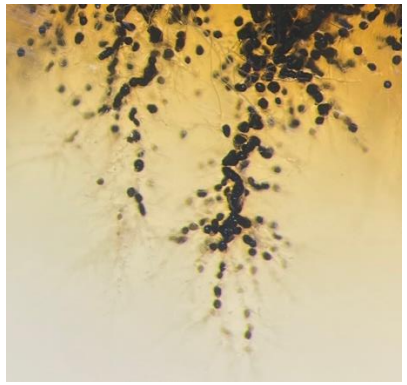
- Symptoms appear as:
  - Wilting of foliage
  - Collapse and eventual death of plant

Conducive Environment

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

Disease Triangle

Conducive Environment

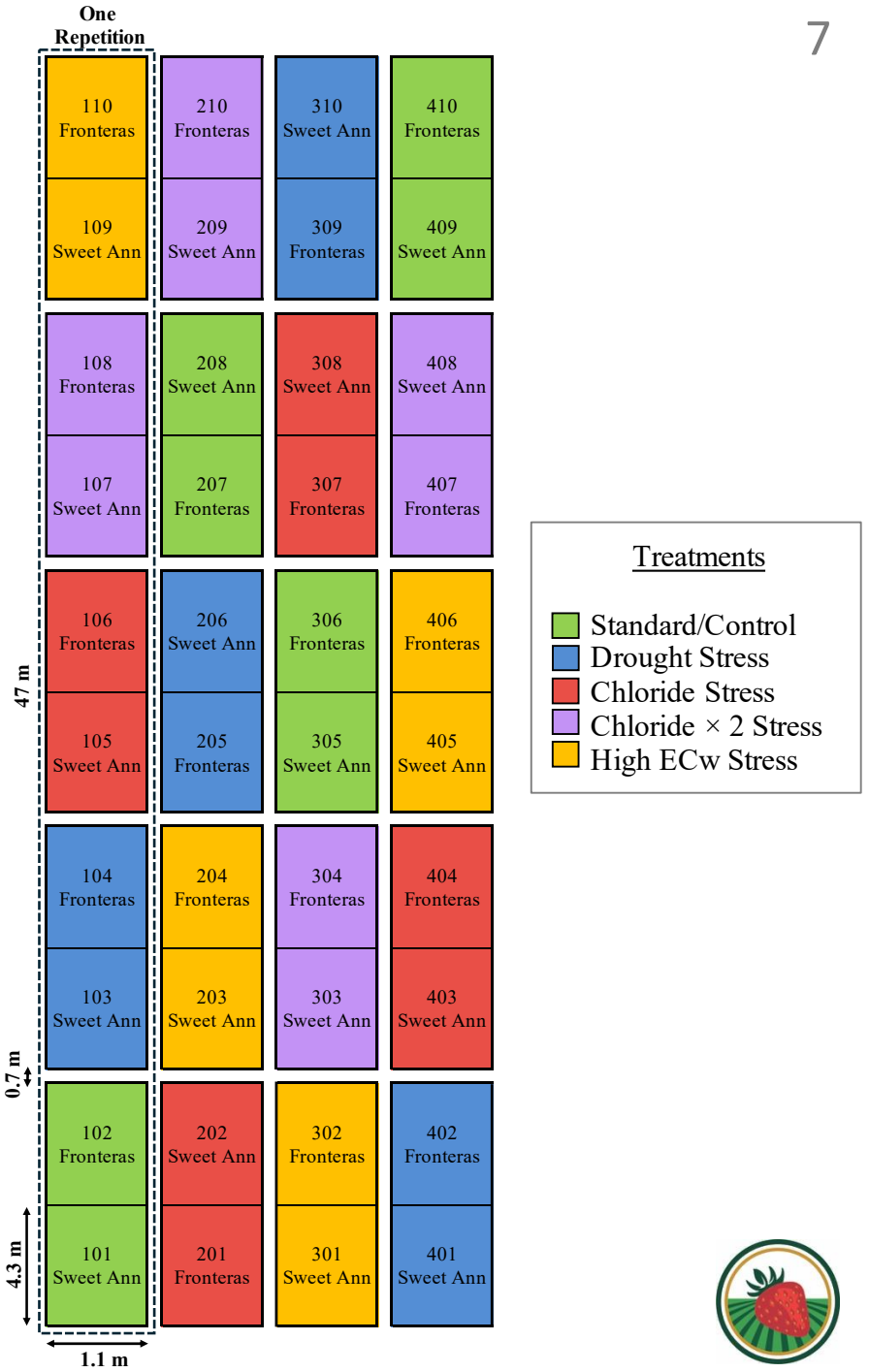


Virulent Pathogen

Susceptible Host

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



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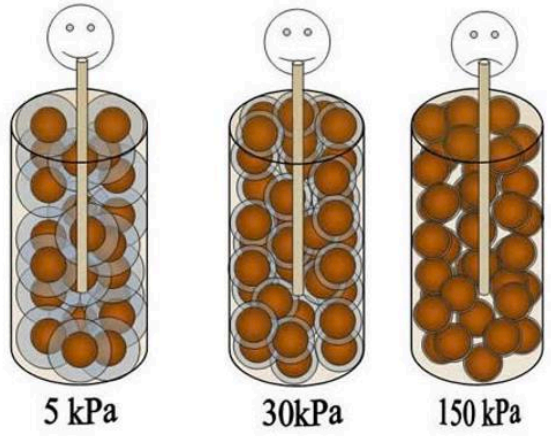
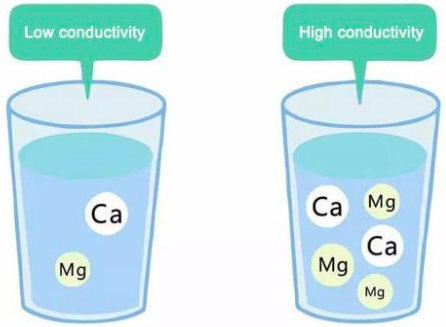
Materials and Methods

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



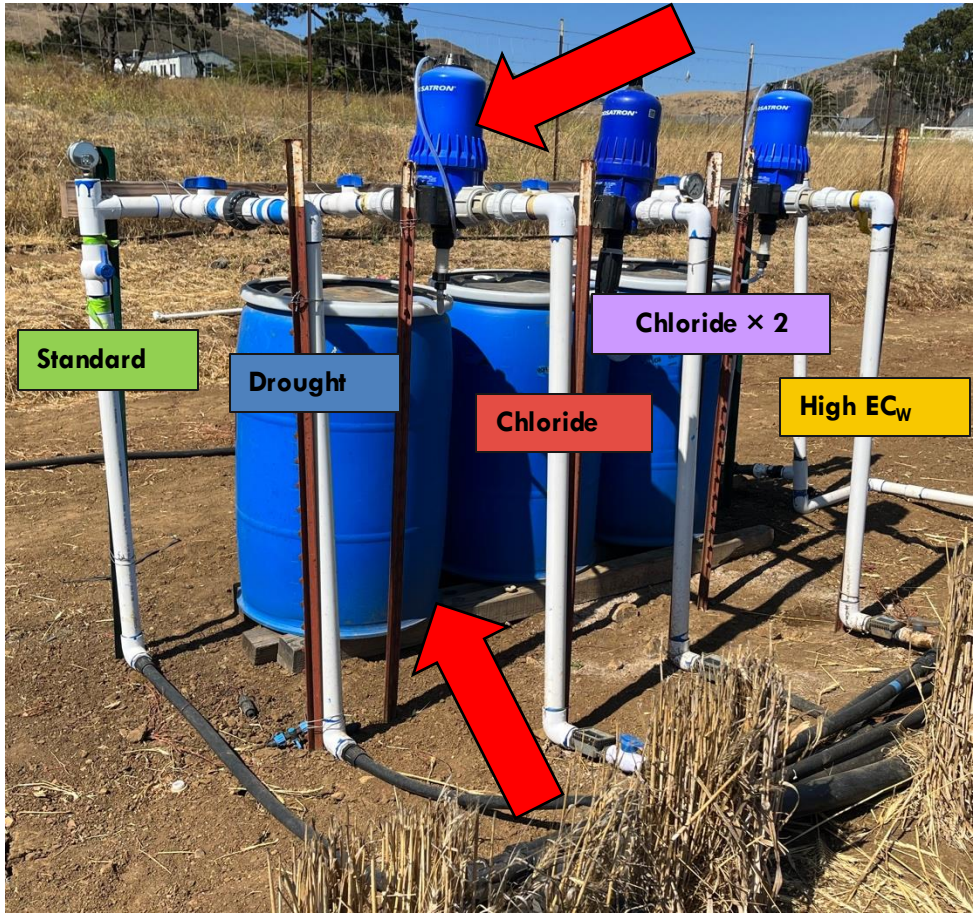
EC_W: Electrical conductivity of irrigation water, a measure of salinity



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

Materials and Methods

- Each plot was connected to corresponding treatment via PVC pipes



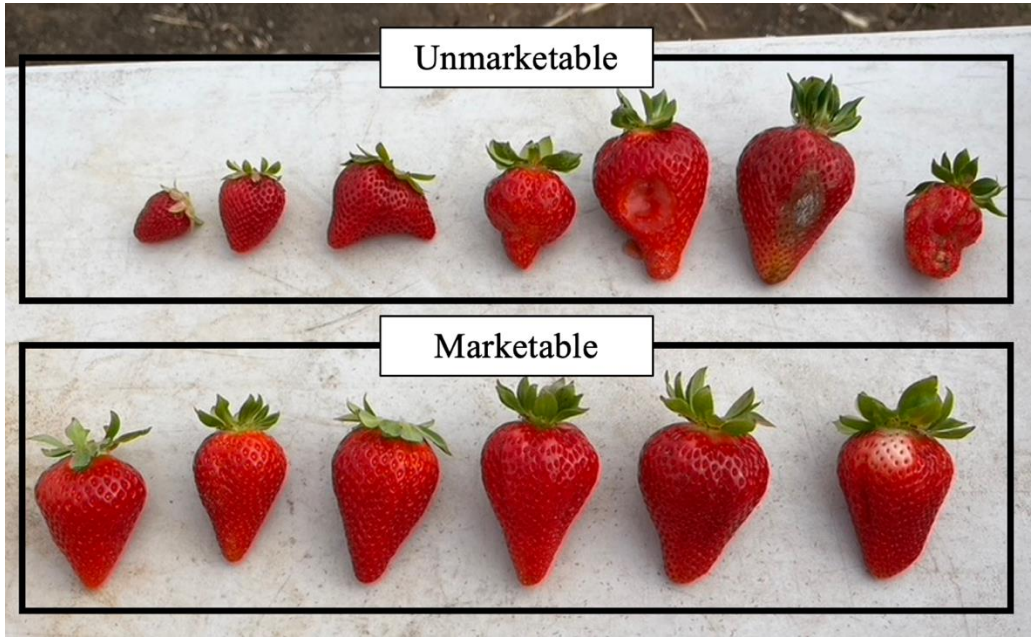
Materials and Methods

- 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

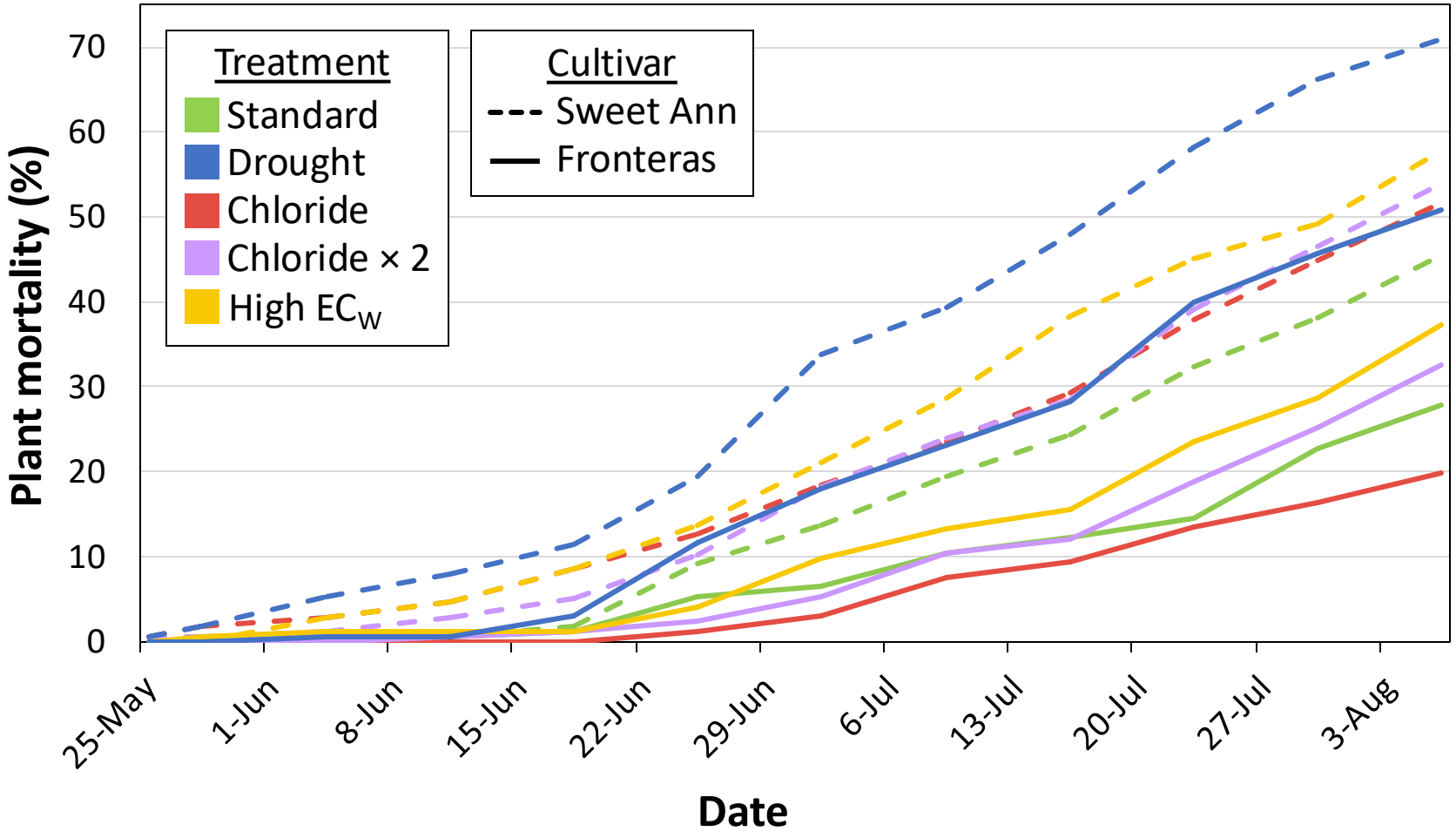
Materials and Methods

- 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



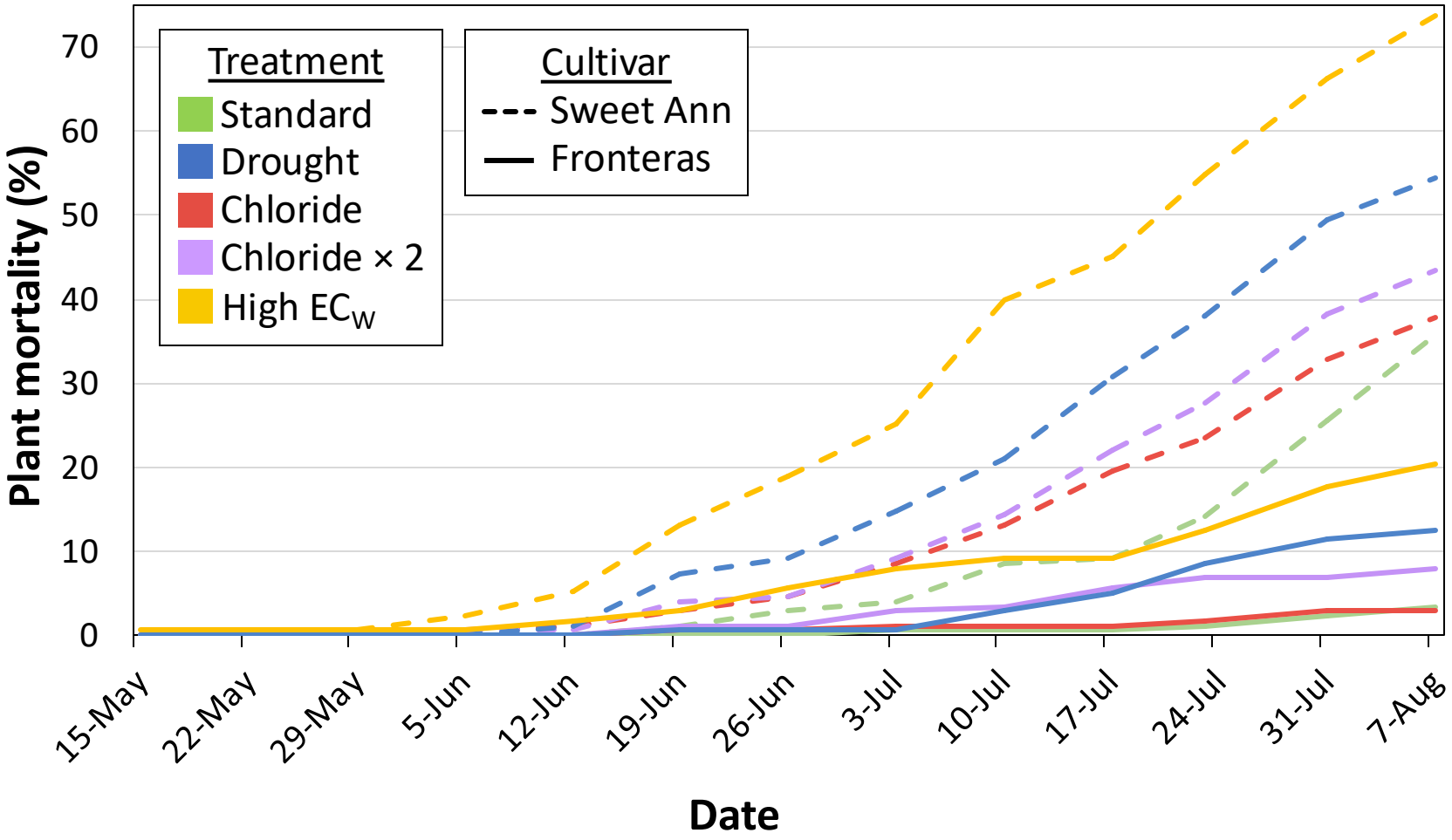
Two-way ANOVA Results:

Treatment: $P < 0.001$

Cultivar: $P < 0.001$

Interaction: $P = 0.61$

Results: Mortality Rate 2025



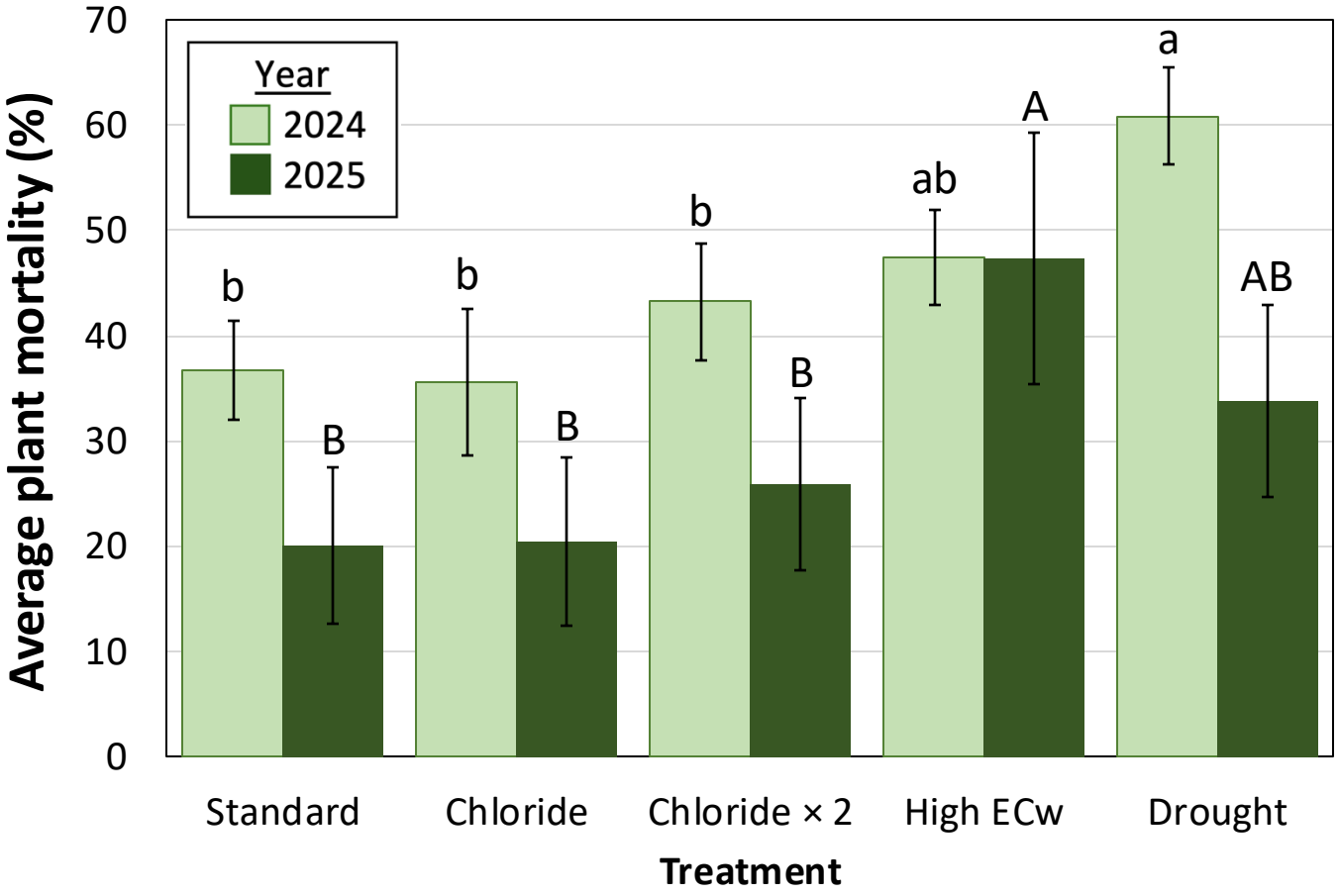
Two-way ANOVA Results:

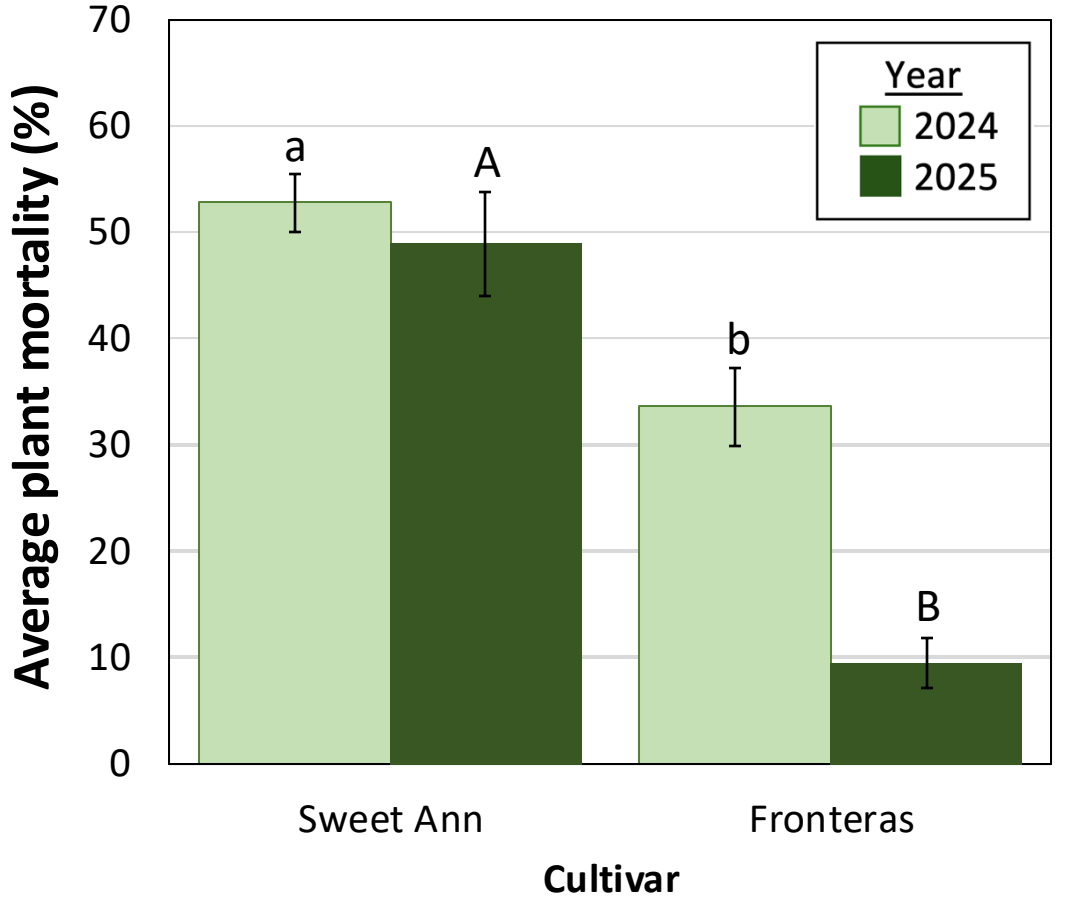
Treatment: $P = 0.0043$

Cultivar: $P < 0.001$

Interaction: $P = 0.62$

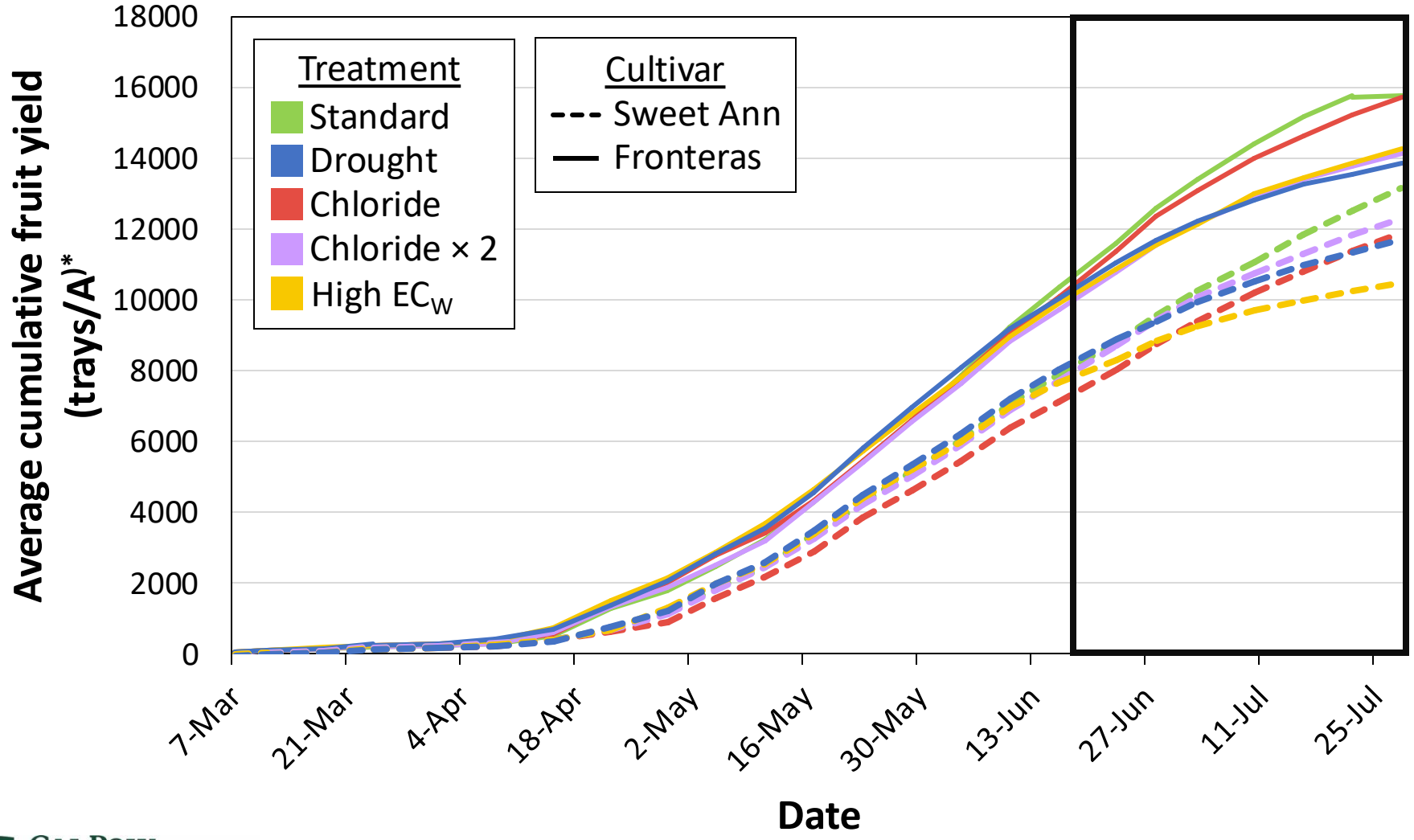
Results: Average Plant Morality





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

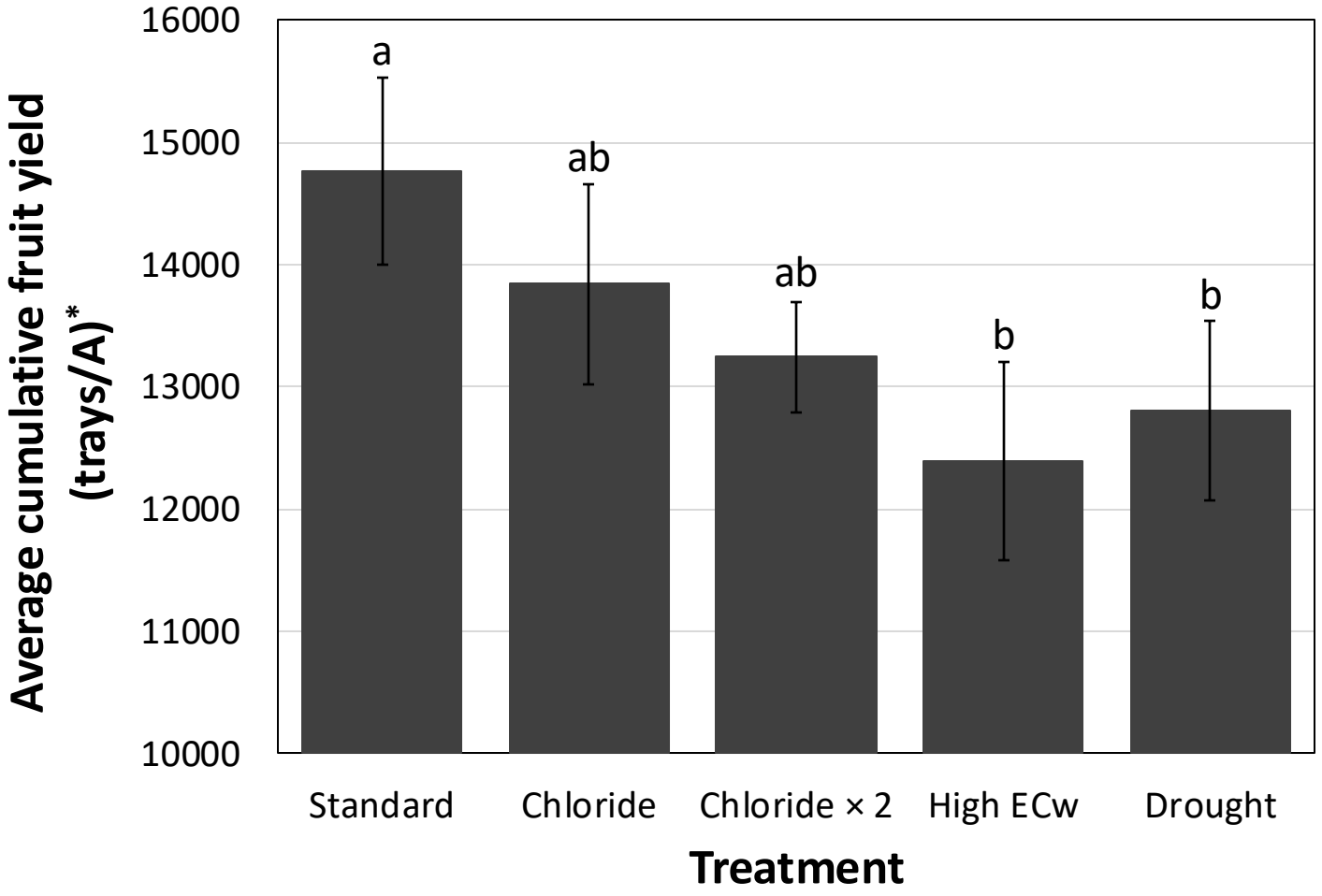
Results: Fruit Yield 2025

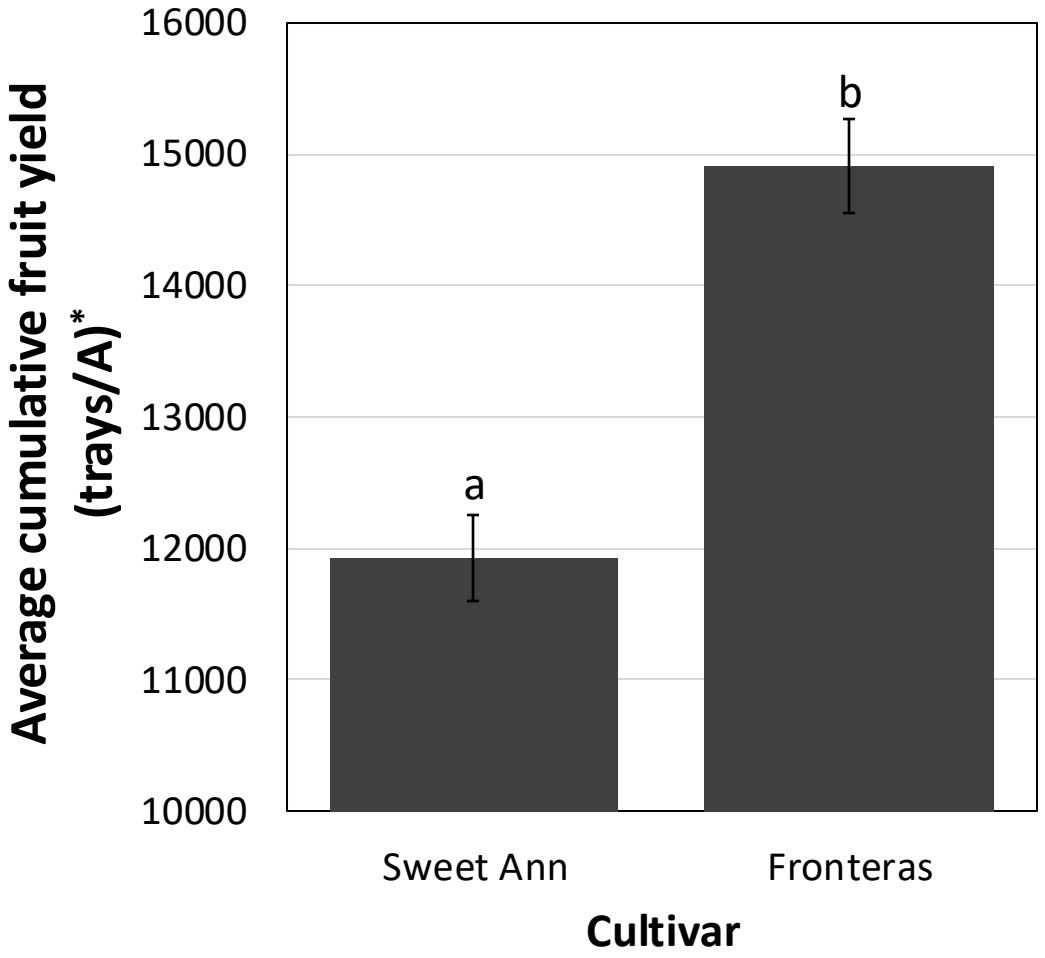


Begin to see separation between treatments during late-season

*Trays/A calculated assuming 8 lb/tray

Results: Fruit Yield 2025





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*Trays/A calculated assuming 8 lb/tray

Discussion

- Macrophomina disease 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

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Questions?

References

California Department of Food and Agriculture. 2023. Annual report on price posting for processing strawberries. https://www.cdfa.ca.gov/mkt/mkt/documents/annual_reports/2023_price_posting_report_with_appendices.pdf

Goudarzi, A., Banihashemi, Z., and Maftoun, M. 2011. Effect of salt and water stress on root infection by *Macrophomina phaseolina* and ion composition in shoot in sorghum. Iran. J. Plant Path. 3:69-83.

Koike, S. T. 2008. Crown rot of strawberry caused by *Macrophomina phaseolina* in California. Plant Dis. 8:1253.

Koike, S. T., and Bolda, M. 2013. Charcoal rot of strawberry: Increasing problem in California. ANR Blogs. ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=11043.

Maas, E. V. and Hoffman, G. J. 1977. Crop tolerance current assessment. J. Irrig. Drain. Div. 103:115-134.

Singh, S., Prashad, H., and Gautam, H. 2023. Management of *Macrophomina phaseolina* by cultural practices. Pages 241-247 in: *Macrophomina phaseolina*: Ecology, Pathology and Management. P. Kumar and R. C. Dubey eds. Academic Press, London, U.K.