Hydroponic Studies on Effects of Sulfate on Wild Rice Growth and Development

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CLEAN WATER LAND & LEGACY AMENDMENT

wq-s6-42l

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Objectives

- Develop methods for hydroponic experiments on wild rice seed germination, early post germination growth, and seedling growth
- Conduct range-finder tests for potential responses of wild rice germination and growth to sulfate concentrations

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Optimum solution for wild rice growth

- 1/5 strength Hoagland's solution for Ca, Mg, K, etc.
- 1.1 µg/g N (1.0 µg/g as NH_4, 0.1 µg/ml as NO_3)
- 0.4 µg/ml P as KH_2PO_4
- pH buffering to c. 6.5 best achieved with TRIS buffer rather than $CaCO_3$
- with TRIS buffer solutions need to be exchanged every 3-4 days depending on pH
- Once pH falls by 0.5 units, we exchange solutions

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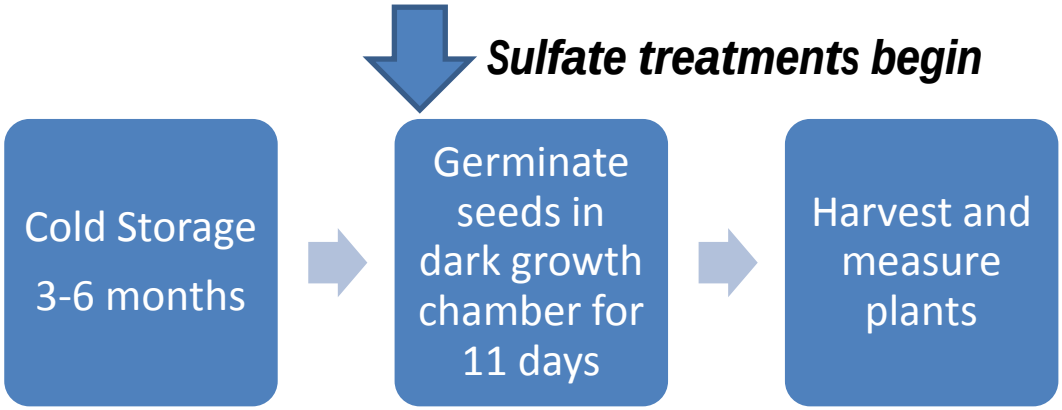
Comparison of solutions for hydroponic culture

Nutrient	Ours	Li et al. (2009)	Full strength Hoagland's Solution	Malvick & Percich (1993)	Yoshida's Solution
Mg	0.4 mM 9.7 ppm	1mM 24 ppm	2 mM 48 ppm	0.5 mM 12 ppm	1.65 mM 40 ppm
Ca	1 mM 40 ppm	2.5 mM 100 ppm	5 mM 200 ppm	1 mM 40 ppm	1 mM 40 ppm
K	1 mM 39 ppm	2.5 mM 100 ppm	6 mM 235 ppm	1.5 mM 59 ppm	1 mM 40 ppm
N	0.16 mM 2.2 ppm	0.4 mM 5.6 ppm	15 mM 210 ppm	3.62 mM 51 ppm	2.9 mM 40 ppm
P	0.013 mM 0.4 ug/ml	0.3 mM 9.3 ppm	1 mM 31 ppm	0.12 mM 3.7 ppm	0.32 mM 10 ppm

Balance of micronutrients are similar with Si, Fe-EDTA added to our solution.

Seed Germination Experiments

- 50 seeds of an average mass of 26 mg in each 450 ml Mason jar
- 3 replicate jars per sulfate concentration
- Germination trials conducted with deionized water buffered with $CaCO_3$ and with TRIS at 20˚ C
- Sulfate concentrations of 0, 10, 50, 100, 400, and 1600 ppm SO_4 as $MgSO_4$ and Na_2SO_4
- Effects of sulfate concentrations analyzed with ANOVA



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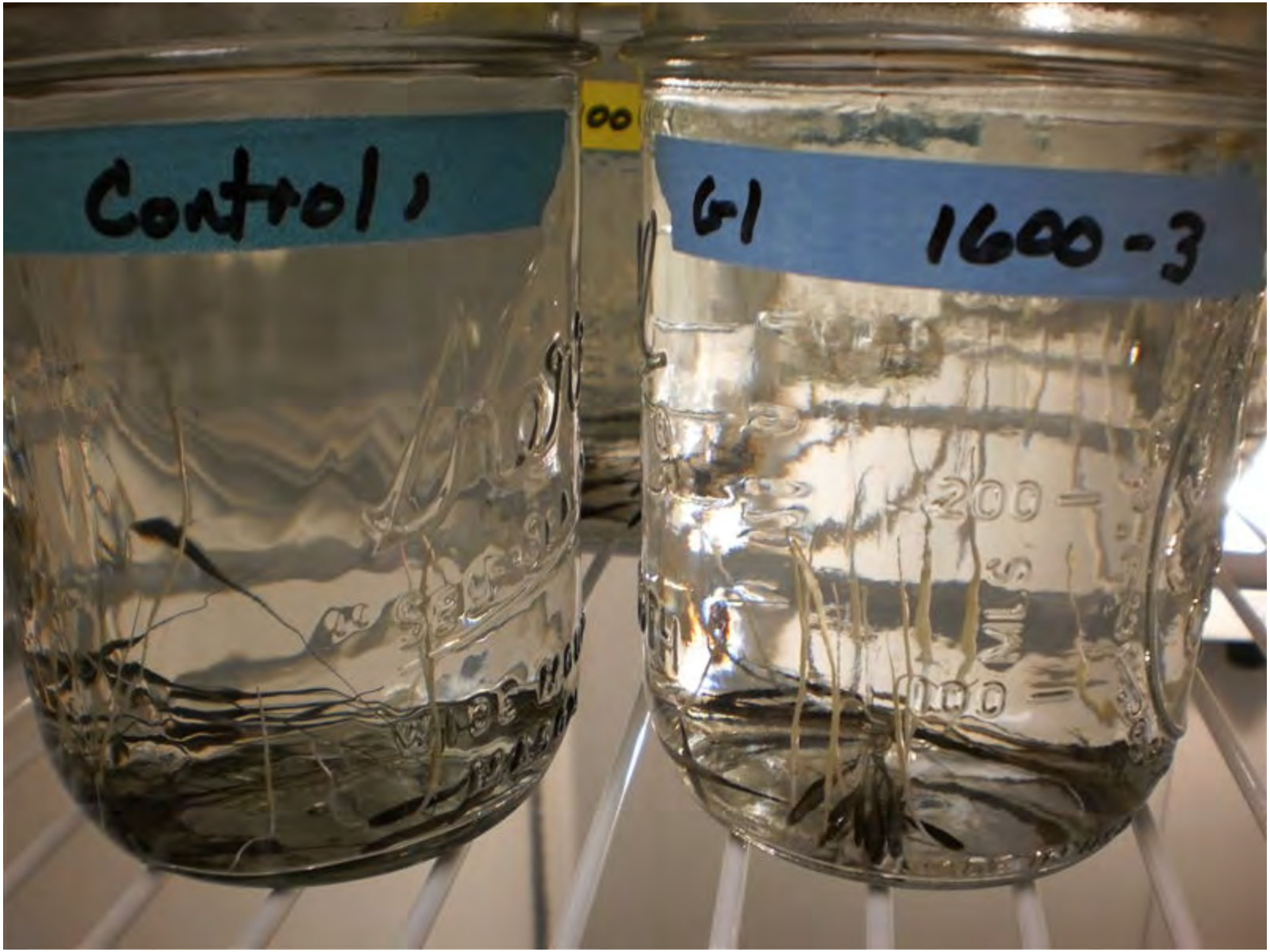

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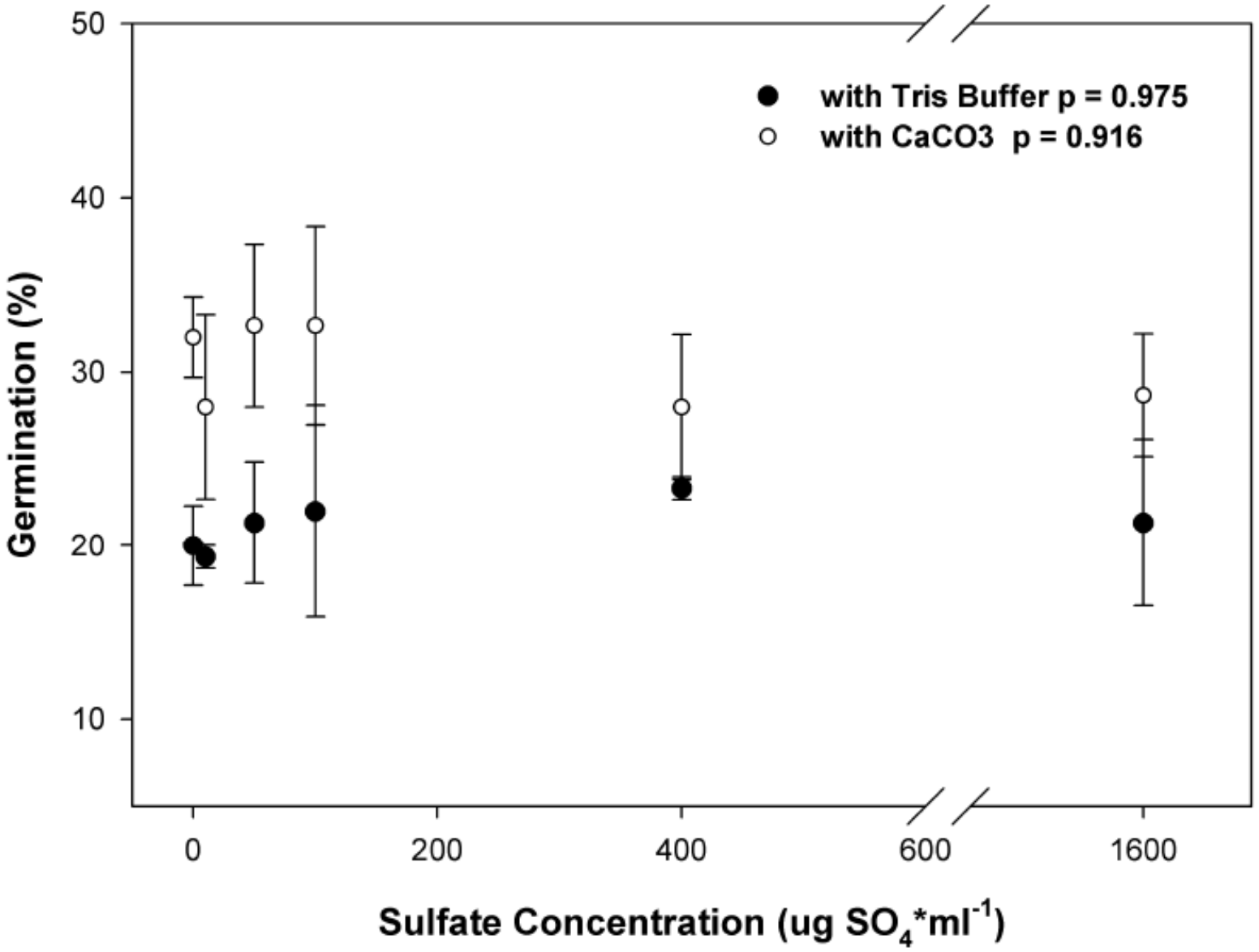

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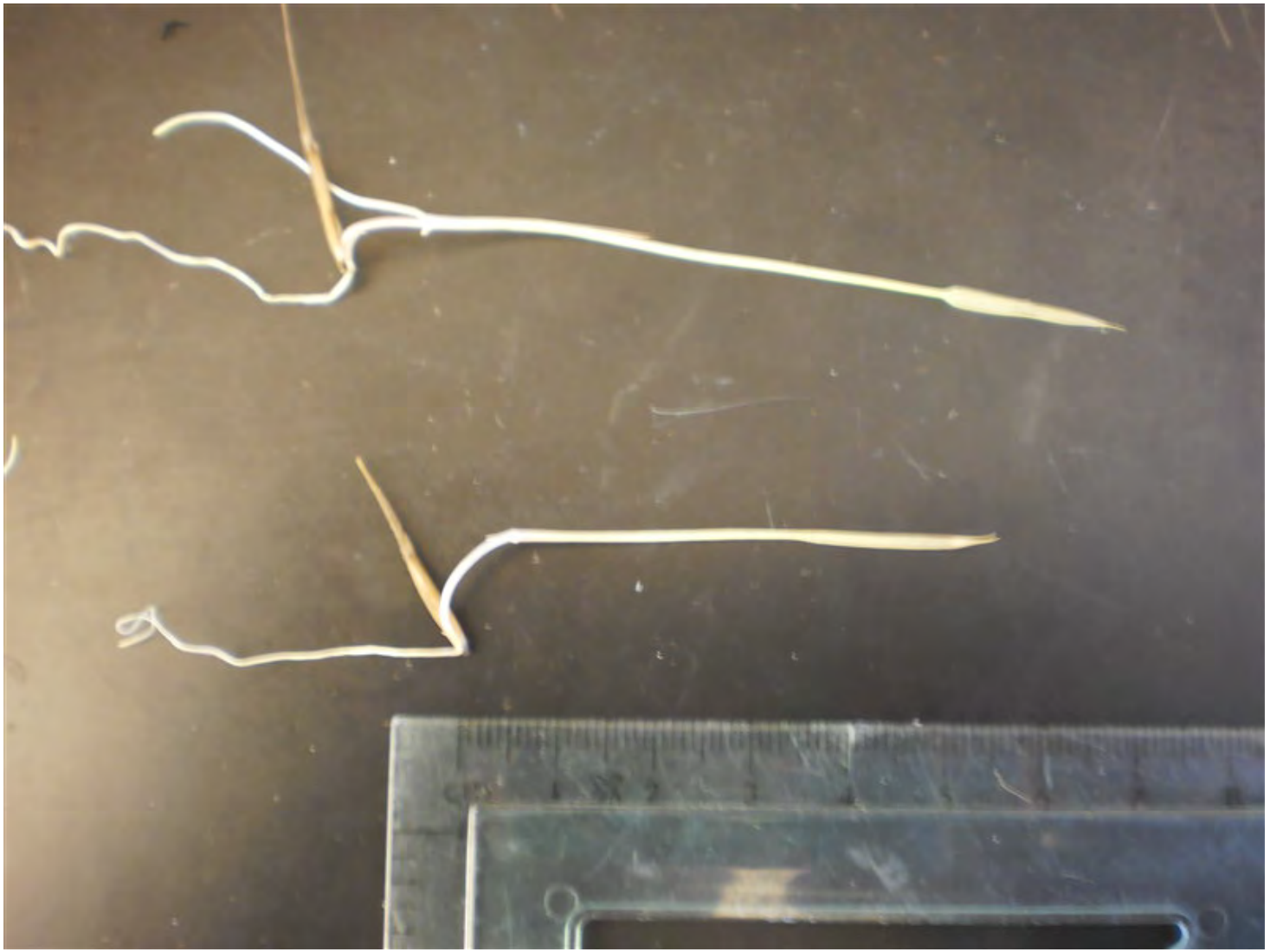
Length of Mesoctyl from Seed



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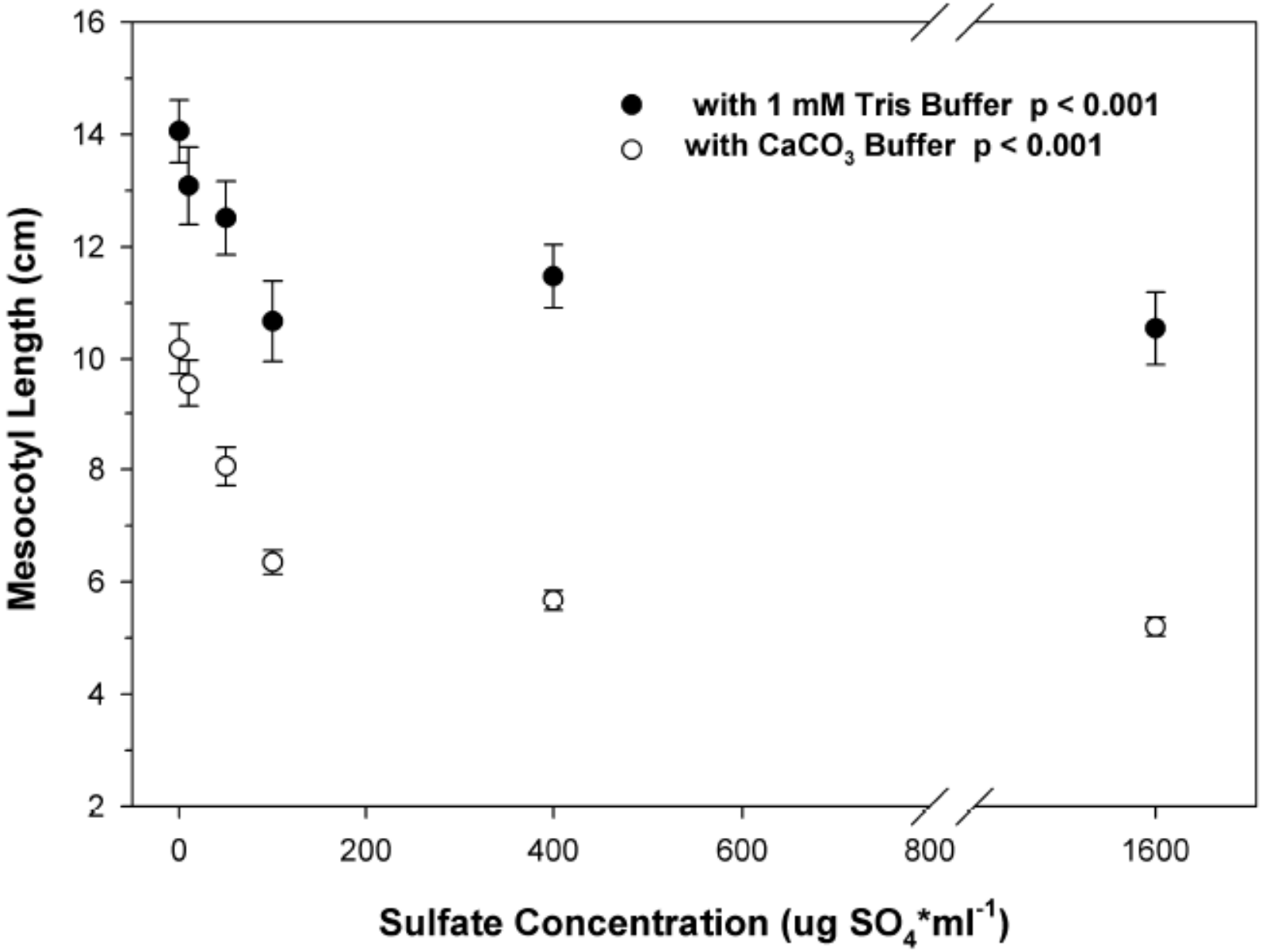

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Early Post-germination Trials

- Used seeds which have been cold stratified for 12 weeks
- Seeds placed in water in growth chamber without added sulfate
- Early seedlings with 1-2 cm of shoot length selected
- Optimum Hoagland's solution
- 20 replicates per sulfate treatment

Sulfate treatments begin

Cold Storage 3-6 months → Germinate seeds for 3-4 days → Choose seeds with 1-2 cm mesocotyl; place into Kimax tubes → Grow in light/dark cycle in growth chambers for 11 days → Harvest and measure plants

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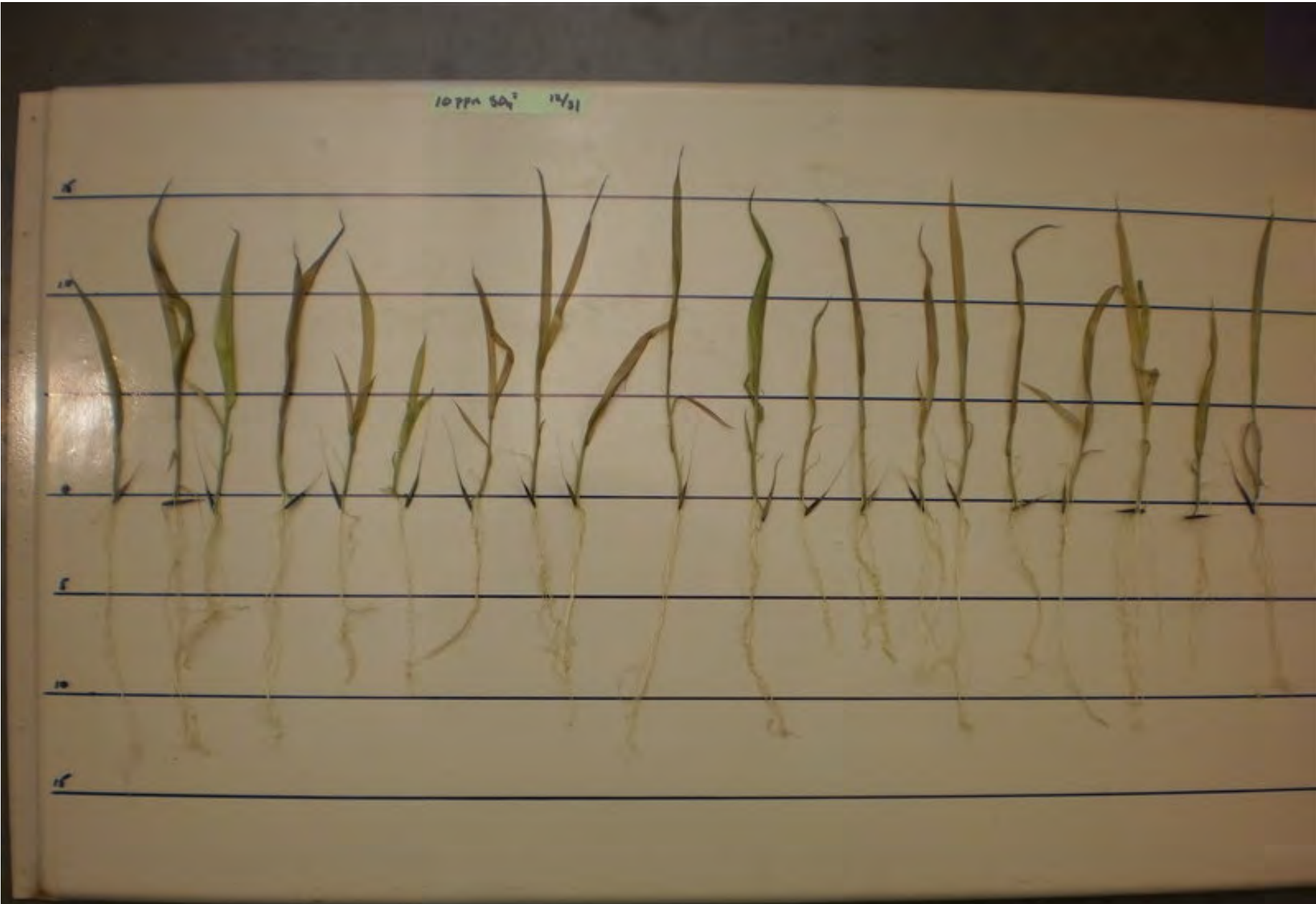

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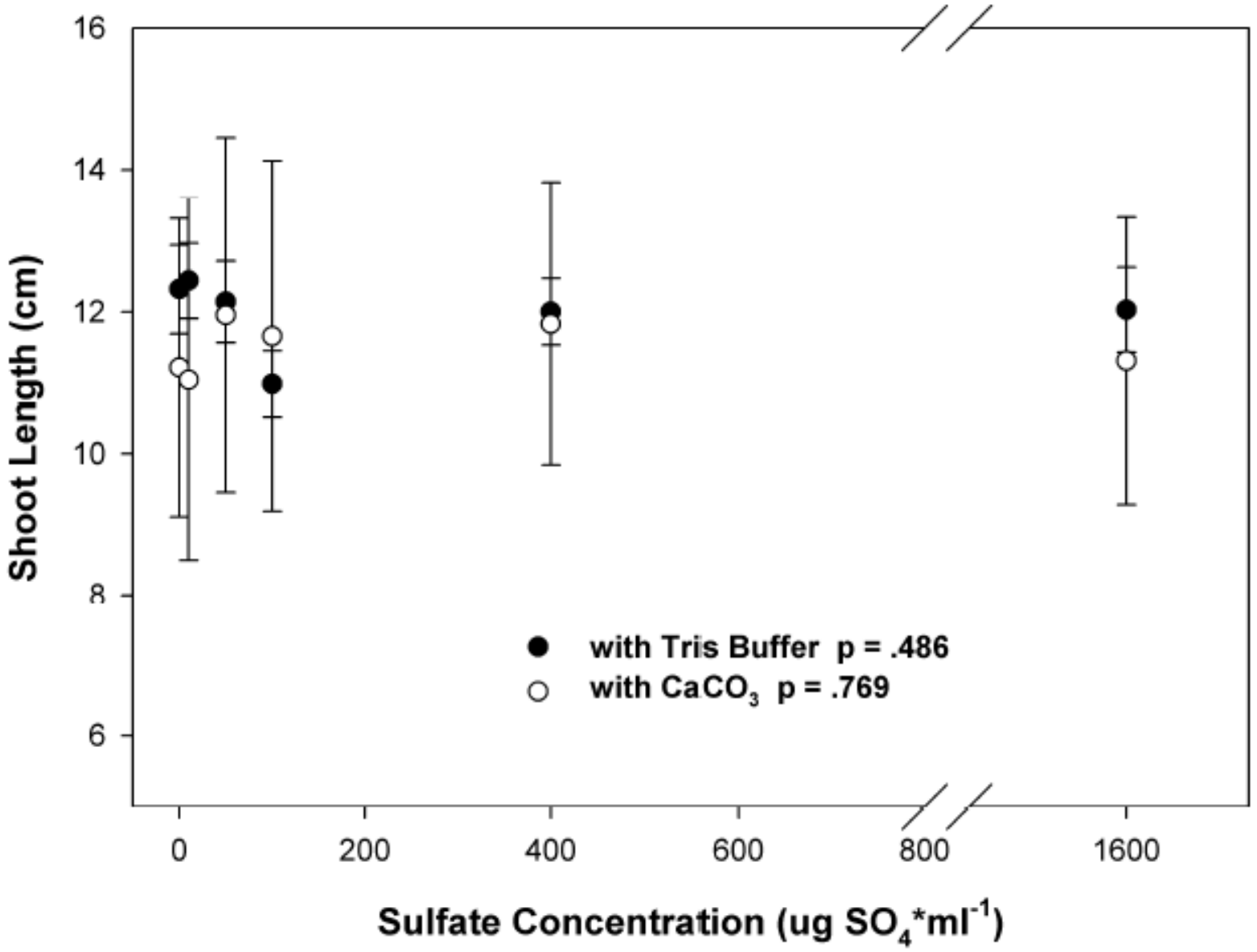

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Hydroponic Method for Seedling Growth

- 1 pint Mason jars with machined lid for probes and plant
- Can be kept aerobic or anaerobic
- Best method is to start plants in jar as seeds and grow to seedling stage rather than transplant from greenhouse

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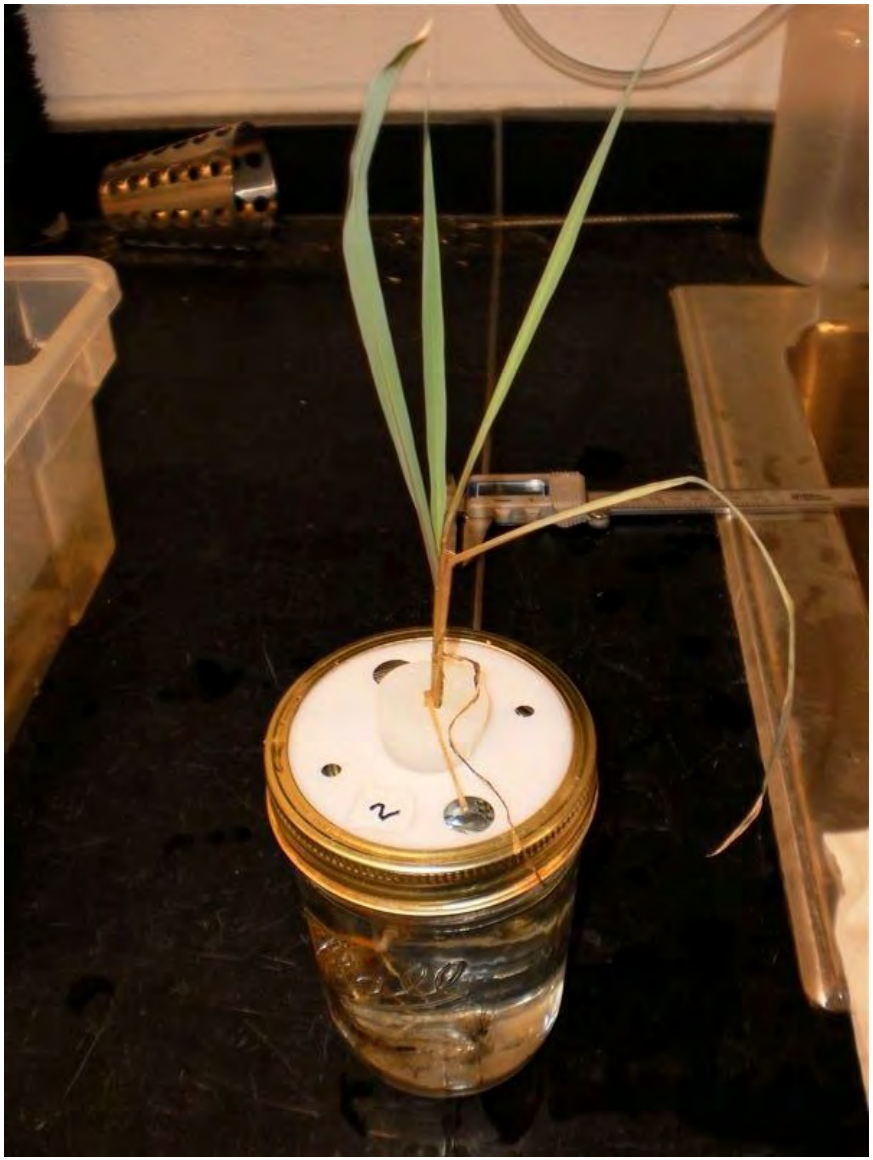

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Possible Future Experiments

- Determine if differences in mesocotyl growth are compounded or disappear as plants continue to grow
- Determine if differences in mesocotyl growth affect rate and timing of emergence of seedling from sediment
- Transition to sulfide experiments

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