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

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Note that this slide contains preliminary information, which the MPCA is using to guide the collection of additional study data. It is not appropriate to draw conclusions from the information prior to study completion.
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 NH₄, 0.1 µg/ml as NO₃)
- 0.4 µg/ml P as KH₂PO₄
- pH buffering to c. 6.5 best achieved with TRIS buffer rather than CaCO₃
- 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

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

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

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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$_2$SO$_4$
- Effects of sulfate concentrations analyzed with ANOVA

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Length of Mesoctyl from Seed

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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

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

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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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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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