Cryptic Invasion in a changed Climate -

Ecophysiology and Gene-expression of *Phragmites australis* from the US Gulf Coast

Franziska Eller & Hans Brix
• Cryptic invasion
  – European lineage is displacing native stands
  – Gulf Coast (GC) is a Hot Spot of *Phragmites* diversity

• Delta-type ➔ African/Mediterranean origin
• EU-type ➔ European invasive N-American population
• Investigation
  – Which of the two competing reed-types is ecophysiologically superior?
  
  • Salinity
  • Future climate

  – Are there differences in gene-expression of genes related to stress-response and photosynthesis?
• Experimental design

"Future climate" treatment (24/19°C; 700 ppm CO₂)

Ambient treatment (19/14°C; 385 ppm CO₂)
– 11 weeks of growth
– weekly measurement of growth parameters
– Gas-exchange: CO$_2$-response
  Light-response
Gene-expression analysis by RT-PCR

Primers designed by alignment of homologue gene sequences of Poaceae
– Genes of interest
  • rbcS – small subunit of Rubisco
  • Phosphoglycerate kinase
  • Phosphoribulokinase
  • Na\(^+\)/H\(^+\) antiporter
  • GPX – Glutathione peroxidase
  • MnSOD – Mn Superoxide dismutase

\[ \text{O}_2^- \xrightarrow{\text{MnSOD}} \text{H}_2\text{O}_2 \xrightarrow{\text{GPX}} \text{H}_2\text{O} \]
### Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Main factors</th>
<th>Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Genotype</td>
<td>Salt</td>
</tr>
<tr>
<td>Final biomass</td>
<td>0.4</td>
<td><strong>406.7</strong>*</td>
</tr>
<tr>
<td>Leaf dry mass</td>
<td>1.5</td>
<td><strong>77.7</strong>*</td>
</tr>
<tr>
<td>Stem dry mass</td>
<td>3.1</td>
<td><strong>36.1</strong>*</td>
</tr>
<tr>
<td>Leaf production rate</td>
<td>0.6</td>
<td><strong>66.1</strong>*</td>
</tr>
<tr>
<td>Shoot production rate</td>
<td>0.3</td>
<td>9.2**</td>
</tr>
<tr>
<td>Shoot elongation rate</td>
<td><strong>4.2</strong>*</td>
<td><strong>681.4</strong>*</td>
</tr>
<tr>
<td>Quantum yield</td>
<td>3.9</td>
<td>0.6</td>
</tr>
<tr>
<td>$P_{\text{max}}$</td>
<td><strong>4.8</strong>*</td>
<td>6.5*</td>
</tr>
<tr>
<td>Light compensation pt.</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Dark respiration</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Light saturation pt.</td>
<td>2.3</td>
<td><strong>9.0</strong></td>
</tr>
<tr>
<td>CO$_2$ compensation pt.</td>
<td>0.5</td>
<td><strong>11.7</strong></td>
</tr>
<tr>
<td>$V_{\text{cmax}}$ (carboxylation rate)</td>
<td><strong>5.5</strong>*</td>
<td><strong>2.1</strong></td>
</tr>
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<td>$V_{\text{cmax}}$ (carboxylation rate)</td>
<td><strong>5.5</strong>*</td>
<td><strong>0.0</strong></td>
</tr>
<tr>
<td>E (transpiration rate)</td>
<td>1.2</td>
<td><strong>38.5</strong>*</td>
</tr>
<tr>
<td>Water use efficiency</td>
<td>2.5</td>
<td><strong>9.5</strong></td>
</tr>
</tbody>
</table>
– Future climate enhanced growth & biomass
– Salt stress diminished growth **but:** less severe under future climate conditions
Shoot elongation rate – only significant difference between genotypes (growth)
\[ P_{\text{max}}, V_{\text{cmax}}, J: \text{only significant difference between genotypes (physiology)} \]
- **WUE (P_{max}/E):** high under salt stress
- **E (transpiration rate):** little salt impact in future climate
– no significant differences in gene expression

→ tendency

– Salt stress related genes:

- Up-regulation under salt stress, especially in future climate

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Orlando Florida, USA
General stress response (oxygen-scavenging enzymes)

Up-regulation under salt stress

- **MnSOD**

- **GPX**
– Calvin Cycle related genes:
– Down-regulation under salt-stress only in ambient climate
– Amelioration of salt stress under $[\text{CO}_2]$ and $\uparrow$ temperature:

• $\uparrow$ WUE, $\uparrow$ C-uptake
• $\uparrow$ assimilates for osmotic adjustment
• Osmotic adjustment by ion uptake
• Induction of specific salt stress genes in future climate (GPX)

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• **In conclusion**
  – Which of the two competing reed-types is ecophysiologically superior?

  • **Delta-type:** superior (SER) and few physiological traits
  • **Salinity:** unfavorable but not severely
  • **Future climate:** favors growth and withstanding salt stress

→ **Will the Delta-type outcompete the EU-type in the field?**
– Are there differences in gene-expression of genes related to stress-response and photosynthesis?

– Are those differences reflected in parameters?

• In “future climate + salt” treatment:
  – high transcript abundance
  – high photosynthesis
  – large biomass

→ Yes! (largely)
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