Modelling Seasonal Variations of Chlorophyll Fluorescence in Bamboo Leaves

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Why measuring chlorophyll fluorescence on bamboo?

- High yields (use for biomass production)

<table>
<thead>
<tr>
<th><em>Phyllostachys</em> species</th>
<th>Dry matter (tons / ha.year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan, Taiwan, China</td>
<td>14</td>
</tr>
<tr>
<td>Ireland</td>
<td>8</td>
</tr>
<tr>
<td>Belgium</td>
<td>9</td>
</tr>
</tbody>
</table>

- Stress?
  - In Europe (≠ environmental conditions)
  - Model performance of the leaves under these conditions
Chlorophyll fluorescence

- To measure “plant health”
- Light energy can either be:
  - used in the process of photosynthesis
  - lost through heat
  - lost though fluorescence

  => Measured by the Handy Pea
Chlorophyll fluorescence

Parameters frequently used:
TRo/RC, ABS/RC, Dio/RC, Eto/RC

=> Fv/Fm (=Tro/ABS)

= “How efficient is PSII”

• Value << 0.83 => STRESS!
Model development

- Morning - midday - afternoon
- 3 leaves / node
- Multiple nodes / culm
- ≠ culms each season

⇒ nested design (mixed model)

⇒ variance functions allowing for different standard deviations
Models

1. LINEAR MODEL
   Harmonic function often used to model temporal data

2. NONLINEAR MODEL
   Function based on measurements
Best model

NONLINEAR MODEL:
Function based on measurements
\( \Rightarrow \) Seasonal, diurnal and spatial variations

\[
Fv/Fm = \left[ \frac{a(\text{DOY}-d)^2}{b+(\text{DOY}-d)^2} \right] + c
\]

With DOY = day of the year
1. Seasonal variation

seasonal dip
in spring
2. Diurnal variation

Small but significant diurnal variation

![Graph showing diurnal variation with Fv/Fm on the y-axis and day of the year on the x-axis with lines for morning, midday, and afternoon data.](image)
3. Spatial variation

Performance: top leaves < bottom leaves
(sun-exposed) (shaded)

Graph showing Fv/Fm against day of the year with data points and two lines representing node 1 and node 9.
3. Spatial variation

Performance: top leaves (sun-exposed) < bottom leaves (shaded)
Excitation pressure hypothesis

- Light energy levels exceed potential of PS
- At low T => even under low light intensity
- Spatial variation?
  - High LAI (=8) => dense canopy limits light
  - In natural habitat: bamboo = understory
- Implications?
  - Better land use (yield of bamboo + overstory)
  - Inhibition PSII = ↓photosynthetic rate?
Future research

- Correlation PSII ~ photosynthetic rate
  \[ \Rightarrow \text{gas exchange measurements} \]
- Test hypothesis in controlled condition (growth chamber)
- Model can be used when comparing different environmental condition
  ex. polluted \( \leftrightarrow \) non polluted soils