Stem circumference changes of clone spruce trees in relation to air and soil parameters

Katarína Střelcová and Adriana Leštianska

Technical University in Zvolen, Forestry Faculty, Slovakia

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Introduction

- Long drought periods and abnormal precipitation amounts in short time periods are expected in the Central Europe as a consequence of air temperature increase and changes in the distribution of precipitation in time and space.

- The impact of drought on plants growth depends on duration and the intensity of the stress factors and the genetically determined capacity of species.

- Trees growing under deficient water supply respond by decreased level of stem growth (increment) in comparison to trees, which grow under sufficient soil moisture conditions.
Introduction

Transpiring plants do not use only the water absorbed by the roots but temporarily also that stored in the plant tissues. This is important for plants if they need to respond rapidly to changes in their transpiratory demands (Kozlowski et. al. 1991).

Zweifel and Häsl er (2001) reported, that internally stored water contributed to daily transpiration even in well-watered trees, indicating that stored water plays important role whenever water transport occurs within the tree by buffering extreme peaks of water consumption.
The contribution is aimed at evaluation of environmental conditions:

- precipitation
- air humidity
- soil moisture
- soil water potential

impact on stem circumference changes and the diameter increment of Norway spruce clones (*Picea abies* L. Karst).
Research plot localisation

North Slovakia – Region Kysuce
The investigated Norway spruce forest (Picea excelsa) was established through autovegetative reproduction in 1989.
Data and methods

- **Stem circumference changes**
  - 15 sample spruce trees were chosen for continual measurements (3 clones x 5 individuals)
  - Changes of stem circumference were measured using the digital dendrometer - DRL26,
  - Measurements were done during growing season 2008 and 2009
Data and methods

- **Meteorological parameters**
  - air temperature [° C],
  - global radiation [kWh.m-2]
  - air humidity [%]
  - daily precipitation was obtained from SHMI station – Turzovka (465 asl.).

Digital meteorological MINIKIN stations were used.

- **Soil parameters**
  - soil water potential [bar]
  - soil moisture [%]
  - were measured at two depths 10-15 cm and 25-30 cm.
  - To measure the soil water potential Microlog SP with gypsum blocks were applied.
## Results

### Climatic characteristics of vegetation period 2008

<table>
<thead>
<tr>
<th>Month</th>
<th>Precipitation</th>
<th>Air temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prec.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>[mm]</td>
<td>[%]</td>
</tr>
<tr>
<td>April</td>
<td>31,6</td>
<td>50</td>
</tr>
<tr>
<td>May</td>
<td>66,9</td>
<td>84</td>
</tr>
<tr>
<td>June</td>
<td>76,4</td>
<td>71</td>
</tr>
<tr>
<td>July</td>
<td>152,4</td>
<td>137</td>
</tr>
<tr>
<td>August</td>
<td>66,2</td>
<td>69</td>
</tr>
<tr>
<td>September</td>
<td>60,7</td>
<td>95</td>
</tr>
<tr>
<td><strong>Growing season 2008</strong></td>
<td>454,2</td>
<td>84</td>
</tr>
</tbody>
</table>

N[%] - percent of long-term average (1931-60)
Variation [°C] - variation from long-term average (1931-60)
PN [mm] - long-term average precipitation (1931-60 Turzovka)
TN [°C] - long-term average air temperature (1931-60 Čadca)

ssn – strong subnormal
n – normal
an – above-normal
The course of stem circumference changes and precipitation during growing season 2008
Results

The daily increment of sample spruce trees, precipitation and relative air humidity during growing season 2008
Daily increment of sample spruce trees and water potential values
Diurnal circumference changes of sample spruce tree, global radiation, temperature and relative humidity during the start of the vegetation period in May 2009.
Results

Results of variance analysis

On the basis of variance analysis there were no statistically significant differences in stem circumference changes among clones. Within monitored trees, higher individual differences in the intensity of the increment were found.

Results of regression analysis

<table>
<thead>
<tr>
<th>Dep. variable</th>
<th>increment</th>
<th>increment</th>
<th>increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent variable</td>
<td></td>
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<tr>
<td>precipit.</td>
<td>0.65</td>
<td>0.34</td>
<td>0.34</td>
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<tr>
<td>RAH</td>
<td>0.42</td>
<td>0.11</td>
<td>0.12</td>
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<tr>
<td>SWP</td>
<td></td>
<td></td>
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<td>Regression koef.</td>
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<tr>
<td>0.0001</td>
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<tr>
<td>Determination koef.</td>
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<tr>
<td>0.0001</td>
<td></td>
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<td>p</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0001</td>
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<td></td>
<td></td>
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<tr>
<td>F</td>
<td>14.211</td>
<td>24.711</td>
<td>26.481</td>
</tr>
</tbody>
</table>
Conclusions

- The diameter increment of monitored individuals began in the first half of May.

- Our results confirmed that intensity and increase in circumference is strongly influenced by precipitation.

- The stem circumference increase was observed always after precipitation and on the contrary in the period without precipitation, the circumference of stems decreased.

- The highest values of diameter increment were recorded in June (31.1 % from the yearly increment (YI)) and July (32.4 % from the YI). The drought period from the latter half of August to the first half of September caused stagnancy of diameter growth (August 9.7 % from the YI; September 3.4 % from the YI).
Conclusions

- On the basis of variance analysis we did not find out statistically significant differences in stem circumference changes among clones. Within monitored trees there were higher individual differences in the intensity of the increment.

- We used the regression analysis for the evaluation of the influence of precipitation, air humidity and soil water potential on the increment. We recorded a 42% dependency of increment changes on precipitation, 11% dependency on air humidity (RAH) and 12% dependency on soil water potential (SWP).

- The changes in stem circumference (diameter) not only respond to the growth processes occurring in creation of a new annual ring; they also reflect the water content in the stem tissues and the associated stem flow.
Thank you for attention!