# EVALUATION OF SOME PHYSIOLOGICAL PARAMETERS OF *ALNUS GLUTINOSA* (L.) GAERTN. IN CONTAINER NURSERY PRODUCTION

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## ABSTRACT

The leaf area ratio (LAR, total leaf area / dry weight of plants), chlorophyll content and stomatal conductance of leaves in container nursery production of *Alnus glutinosa* (L.) Gaertn was examined. The effects of 4 container substrates: peat-based RKS II, RKS II + TerraCottem (hydroabsorbent), Sand + TerraCottem, Bark + TerraCottem were compared. The control plants were grown on open field, in the soil. Relative chlorophyll contents and stomatal conductances were measured 6 times per year, and the yearly average and the yearly fluctuation of them were examined. Each parameter can show differences between the treatments. The stomatal conductance was characterized by high yearly fluctuation, for this it is offered several times to carry out the measurements.

## INTRODUCTION

Container growing technology is becoming very popular in nursery production nowadays. The objective of the reported experiment was to evaluate the effect of four substrates on the model plant *Alnus glutinosa* (L.) Gaertn, which has special climatic and soil demand, preferring moist habitats (Koblížek, 2000; Horáček, 2007).

In the sale of nursery products the most important properties of plants are the root neck diameter and the height (based on it can be categorized the plants as the standards). For this reason, the external view properties are examined traditionally. The physiological parameters can demonstrate the momentary growth and condition of the plants. Usually these examinations (leaf hydraulic conductance, number of leaf stomata per $mm^2$ or per leaves, relative chlorophyll content, etc.), which are available as the practical aspect, can help to observe the abiotic stress responses in the plants (Banon et al., 2006; Sack, Holbrook, 2006), because of the sensitivity to the environmental conditions (Larcher, 2003; Banon et al., 2006, Pallardy, 2008). This provides an opportunity to be useful for the development of technology of plant growing.

In our experiment it was measured more than 30 parameters (morphological, biomass, physiological) and more were calculated from them. This article reports the leaf area ratio, chlorophyll content and stomatal conductance of leaves.

### Material and method

The experiment was established at a multi-purpose scientific experimental workplace on plots of the Faculty of Horticulture in Lednice in 2004–2006. The same method was used in these three years of the experiment. One year old seedlings were planted out into special 2-litre nursery containers. For the individual treatments of the experiment a substrate was pre-mixed with an addition of the hydroabsorbent TerraCottem (5 $g.l^{-1}$). The composition of the substrates was as follows:

**A1**: substrate RKS II (peat-bark substrate); **A2:** substrate RKS II + TC (hydro-absorbent TerraCottem); **A3**: sand + TC; **A4**: bark substrate + TC; **Control:** plants were grown on open land and planted in the conventional nursery manner on an open site.

The experiment was assessed in three repetitions. Each treatment was represented by 75 plants.

For examination of leaf area ratio all the leaves of 3 plants per repeat were collected, before the falling, in October (25.10.2004, 24.10.2005, 23.10.2006). The leaf area was measured by AM 200. After the measuring all the sample plants were dried in 105 °C, and the dry weights were recorded . The *Leaf Area Ratios (LAR):* total leaf area per plant [$m^2$] / total dry mass of plant [kg] were then calculated.

The relative chlorophyll content of leaves was measured by Chlorophyll Content Meter CCM 200, whereas Porometer AP4 was used to measure the stomatal conductance. The three youngest full-developed leaves of 5 plants per repeat (15 plants/treatment) were measured, and the plants were described by the average of the three leaves. The dates of measuring of chlorophyll content were as follows: in 2005: 13.06., 26,06., 13.07., 25.07., 08.08., 25.08.; in 2006: 13.06., 28.06., 14.07., 27.07., 09.08., 23.08. The dates of measuring of stomatal conductance were as follows: in 2004: 15.06., 29.06., 11.07., 26.07., 10.08., 24.08.; in 2005: 14.06., 27.06., 14.07., 26.07., 09.08., 26.08.; in 2006: 14.06., 29.06., 15.07., 28.07., 10.08., 24.08.

The same leaves were examined for the purpose of measuring both the chlorophyll content and the stomatal conductance. For discussing, the averages of 6 measuring dates per year and the variances of individual data of measuring dates, as yearly fluctuation, were calculated.

For statistical processing ANOVA was used for the purpose of comparing the treatments. For statistical analysis of the treatments in pairs, Tukey-Kramer method was used in the case of equal variances Games-Howell method was used in the case of unequal variances.

## Results and discussion

### *Leaf area ratio*

This ratio is determined by ratio of total leaf area and dry weight of plants (Fig 1.). The highest values mean the relative big leaf area and/or relative small dry weight of plant, while the low value was caused by the small leaf area and/or relative high weight of plant. The ratio is useful in relating the total photosynthetic to total respiratory material within the plant (Dictionary of botany).

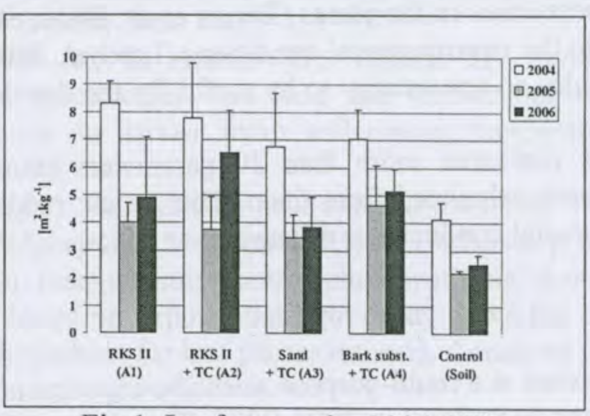


Fig 1. Leaf area ratio, 2004-2006

In 2004, the highest value was observed as effect of A1 treatment (8,31 $cm^2.g^{-1}$), however, each container treatments showed statistically similar results. The plants grown in the soil were characterized by statistically lower values (4,15 $cm^2.g^{-1}$) than each container treatments. In 2005, the highest value (4,66 $cm^2.g^{-1}$) was measured in the A4 treatment. The lowest value was observed in case of plants grown in the control treatment (2,18 $cm^2.g^{-1}$). TerraCottem decreased the values to a little extent, which was measured in the RKS II treatment. In the third experimental year, the highest average value was observed in the A2 treatment (6,54 $cm^2.g^{-1}$), while the lowest mean value (2,52 $cm^2.g^{-1}$) was observed in case of plants grown in the original soil (this was high significantly lower than the mean values of A2 and A4 treatments. The TerraCottem increased the value of RKS II (from 4,91 to 6,54 $cm^2.g^{-1}$), but the differences were not significant because of the relative high variance.

***Relative chlorophyll content of leaves***

In 2005, the effect of treatments as the mean value of 6 measuring times compared (Fig. 2.), the plants grown in soil had the highest chlorophyll content (29,20 CCI, according to the statistical analysis on a level that is higher than each other treatment), while A4 and A3 were characterized by the significantly lowest mean values (12,95-13,93 CCI). As the effect of TerraCottem, the chlorophyll contents of leaves as the mean values decreased; however, the difference was not significant. The highest fluctuations in the year were observed in the case of the bark and sand based substrates, whereas the lowest fluctuations were observed in the peat-based and the control treatments.

In 2006, the average values of the 6 measuring times examined, the plants grown in the soil had the highest value (23,36 CCI). In the container substrate treatments, the plants grown in the bark based substrate were characterized by the highest chlorophyll content (19,46 CCI). Very high fluctuations were observed in the A1 and A4 treatments, while in the control treatments, the variance was very low. Comparing the different years, higher chlorophyll content was observed in 2005, except for the bark substrate.

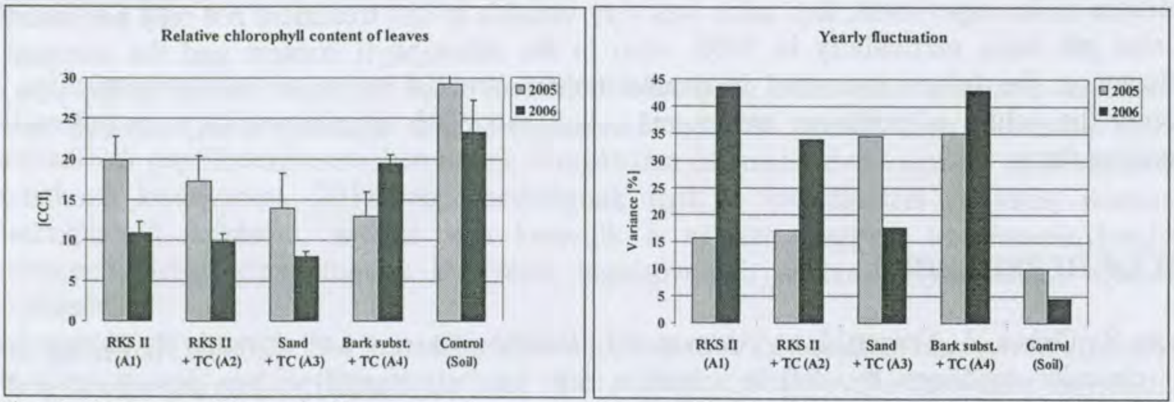


Fig. 2. Average chlorophyll content (average of 6 measuring times per year, 2005-2006) and yearly fluctuations (variance in the percentages of average values of groups)

***Stomatal conductance***

Based on the mean value of 6 measuring times (Fig. 3), in the first experimental year (2004) the plants grown in A2 treatment were characterized by the highest stomatal conductance (377 $mmol.m^{-2}.s^{-1}$) and the lowest values were observed in the case of plants grown in the soil (243 $mmol.m^{-2}.s^{-1}$). Adding hydroabsorbent to the RKS II did not demonstrate any statistically meaningful effect. The fluctuation in the year was the lowest in case of control treatment (23,5%). Based on yearly average values, no significant differents between the treatments were observed in the year 2005. However, the yearly fluctuation was very high in case of the A4 treatment. In the third experimental year, the highest average conductance was found in the A3 and A2 treatments (418 and 398 $mmol.m^{-2}.s^{-1}$), and the lowest values in the controls (231 $mmol.m^{-2}.s^{-1}$). The fluctuations in the year were relative low in the A1, A2 and Kontrola treatments (43,1-45,9%).

Comparing the different years, the average conductance was the lowest in the year in 2005 in almost each treatment, except for the control and the A4 treatments. The highest values were observed in 2006. The yearly fluctuation was the lowest in 2004, except for A2 (where the 2005 year resulted the lowest average value). In the other two years the values of variance percentages varied by treatments.

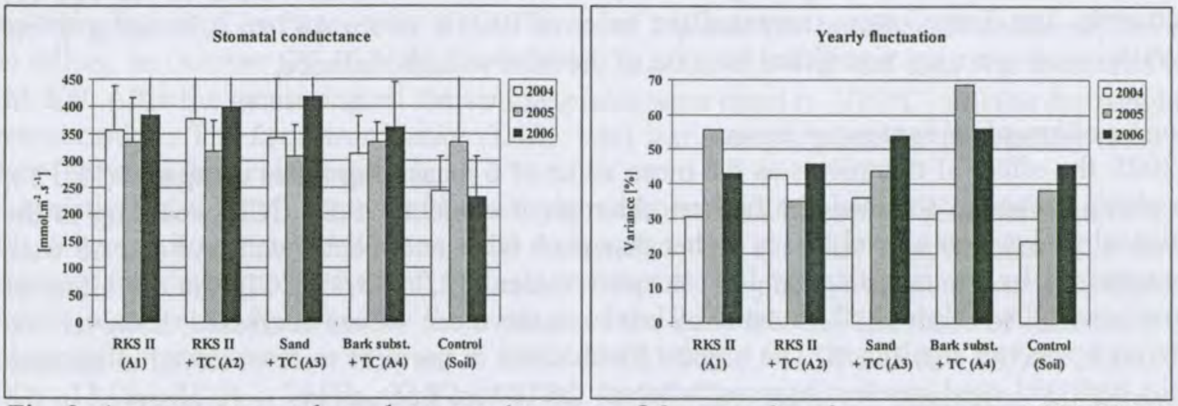


Fig. 3. Average stomatal conductance (average of 6 measuring times per year, 2004-2006) and yearly fluctuations (variance in the percentages of average values of groups)

Summarizing our experiences with regards to measuring the presented physiological parameters, time can be the limit of number of measured plants and compared treatments, especially if we consider all continuously changing conditions which have effects on the leaf conductance (light, air humidity, water in root zone, temperature and part of the day). Probably because of the sensitivity of the stomatal conductance to the environmental conditions in the experiment, this value was very variable in one treatment not only per years, but also per days, particularly in 2005. Also in the chlorophyll content and the stomatal conductance, the values measured in control treatment were the most stabile in the year, however the values of container treatments usually changed relatively a lot, between two measuring dates.

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