

**Measurements of Photosynthetic  
Activity and Stomatal Conductance  
in *Reynoutria japonica* under  
Laboratory Conditions**

Introduction	2
Materials and Methods	2
Results	3
Discussion	5
References	6

## Introduction

Photosynthetic activity indicates how much carbon dioxide a plant absorbs and converts into chemical energy, namely glucose. The measurements combine gas exchange analysis and the determination of chlorophyll content in a plant. This allows quantification of how much carbon dioxide is absorbed and how much oxygen is released (Tsuyama et al., 2003).

The higher the potential photosynthetic rate of a plant, the higher its chlorophyll content. In general, the photosynthetic rate measures the amount of CO<sub>2</sub> converted per leaf area per unit of time (Pan et al., 2020).

## Materials and Methods

The measuring device used was a LI-600 from LI-COR Biosciences. It measures gas exchange and chlorophyll fluorescence through a chamber in which a leaf can be clamped (LI-COR Biosciences, 2024).

The device calculates the photosynthetic rate ( $\Phi_{PSII}$ ) using the following formula, expressed in  $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ :

$$\Phi_{PSII} = \frac{F_m - F_s}{F_m}$$

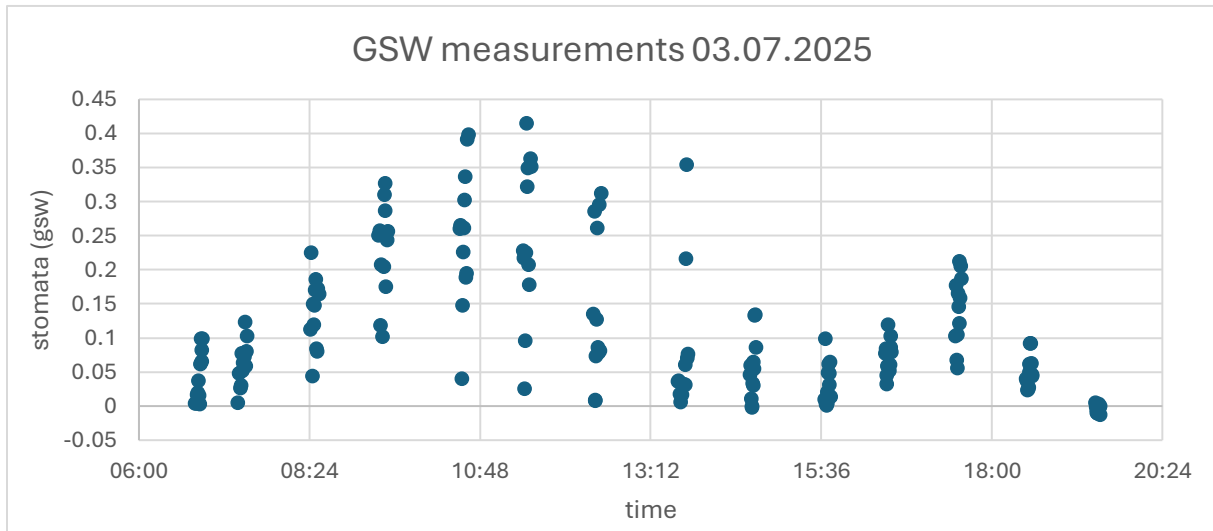
- $F_m$  = steady-state fluorescence under light
- $F_s$  = maximum fluorescence after a short, intense light pulse (LI-COR Biosciences, 2024)

For our experiment, we used three small and three large individuals of *Reynoutria japonica*. Two leaves per individual were measured. Three fully developed leaves were first marked on each plant. The middle leaf was treated with herbicide, while the leaves above and below it were used for photosynthesis measurements.

All values were recorded manually and later entered into an Excel file for evaluation at the end of the experiment.

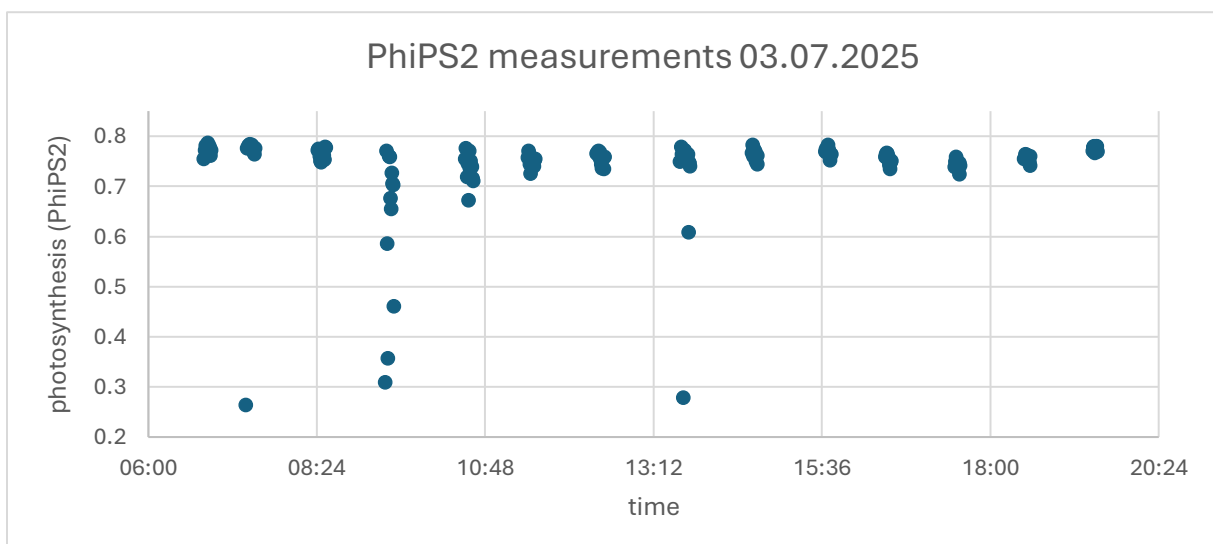
## Results

In Figure 1, a scatter plot of the first measurements can be seen, showing the daily course of the water vapor released by the stomata.



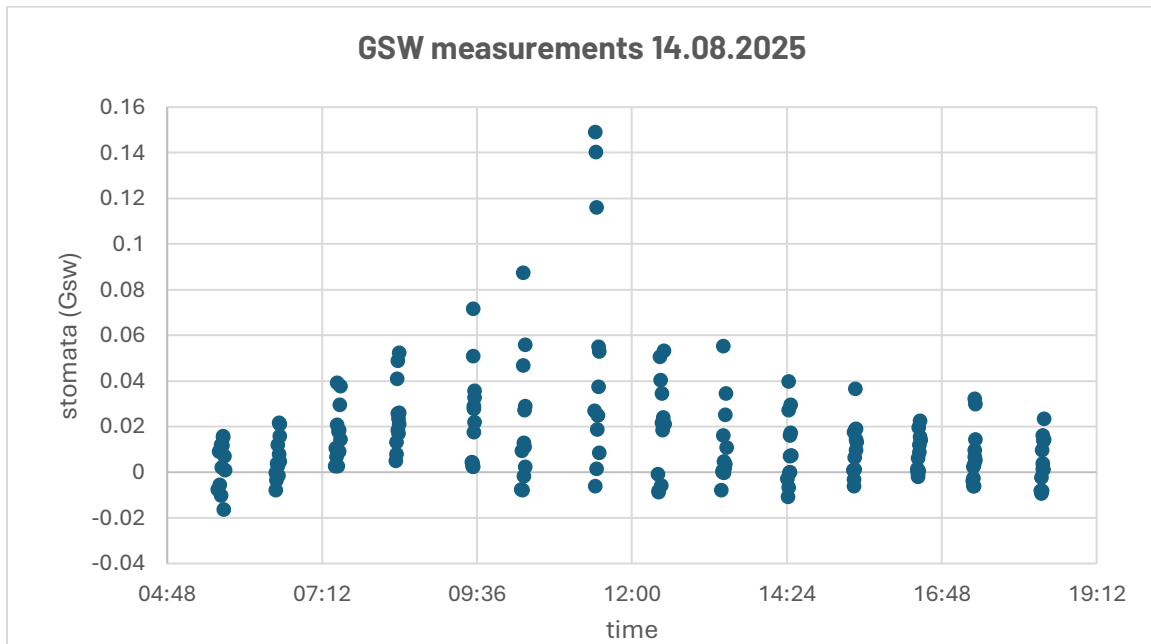
**Figure 1:** The graph shows a strongly increasing stomatal activity of the leaves of *Reynoutria japonica* up to midday. The plant reaches a second peak in the early evening hours.

In Figure 2, another scatter plot is shown, illustrating the daily course of the photosynthetic activity of the leaves of *R. japonica*.



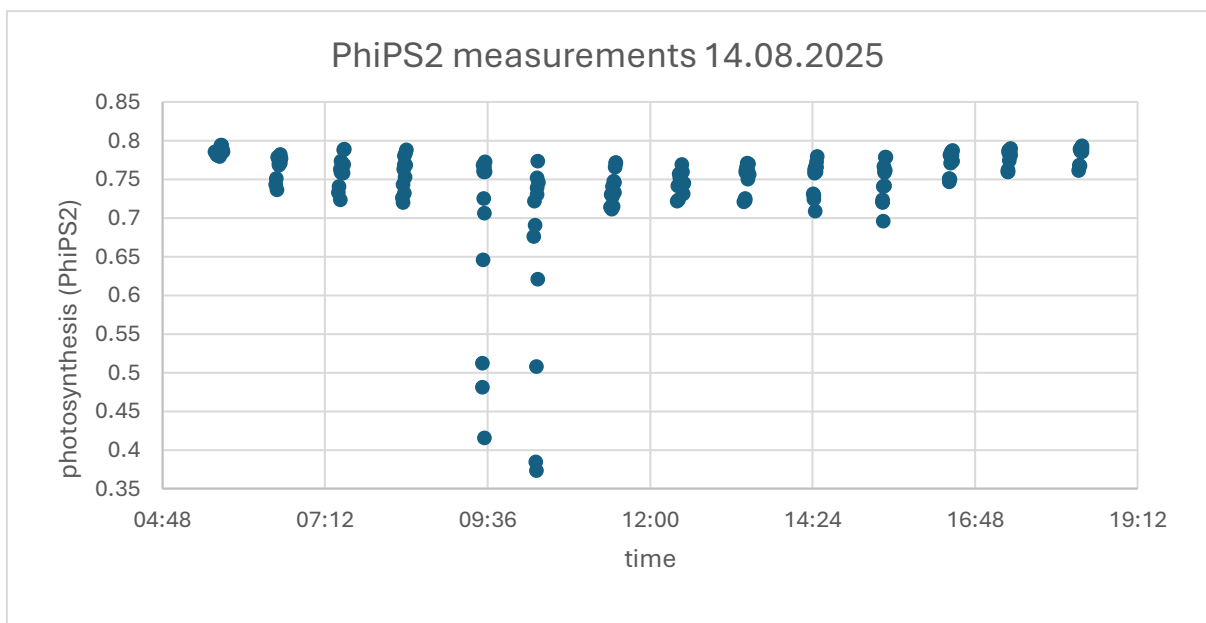
**Figure 2:** The daily course of the photosynthetic rate is very constant. The few fluctuations or outliers can be attributed to individual leaves. In the morning hours, a decrease in the photosynthetic activity of some leaves can be observed.

In Figure 3, the scatter plot of the measurements of stomatal activity is shown.



**Figure 3:** From the beginning of the measurements in the early morning hours, a steady increase in stomatal activity can be seen. The peak occurs around midday, after which the activity declines again.

In Figure 4, a scatter plot can be seen that shows the daily course of photosynthetic activity of *R. japonica*.



**Figure 4:** The photosynthetic activity is again relatively constant and reaches its highest values in the early morning and evening hours. In the morning, a decrease in the photosynthetic activity of some leaves can be observed.

## Discussion

The graphs of stomatal activity reveal a clear daily pattern. In both July and August, values are low in the early morning, rise until midday, and then decline again. In July, a second evening peak is observed before stomatal conductance drops.

It is important to note that the measurements were taken during midsummer. By late morning, high temperatures increase the vapor pressure deficit (VPD). When VPD becomes too high, stomata close temporarily. As temperatures and VPD decrease later in the day, the stomata reopen, explaining the second peak in the evening (Joshi et al., 2022).

In July, two peaks occurred, while in August only one was seen. This difference can be explained by environmental conditions: July was mild and humid with mostly cloudy skies and relatively low temperatures, reducing light stress in the greenhouse. As a result, stomata could recover more quickly and reopen twice daily. August, on the other hand, was much hotter and sunnier, with maximum sunlight intensity. Thus, stomata opened fully only once per day. Overall, stomatal activity was higher in July, and *R. japonica*'s growth peaked during that month (Franco et al., 2002).

The photosynthetic activity displayed a more consistent pattern. In July, the photosynthetic rate remained mostly steady, whereas in August, slightly higher activity occurred in the morning and evening hours. On both measurement days, a drop in photosynthetic activity was observed in some leaves around 9:00–10:00 AM. These were poorly supplied leaves affected by strong sunlight, leading to photoinhibition—where more light energy reaches the plant than it can utilize. Despite this, the plants were largely able to sustain photosynthesis in most leaves, temporarily reducing activity in a few (Gu et al., 2017).

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