



## FPS COST Action FP1202

Strengthening conservation: a key issue for adaptation of marginal/peripheral populations of forest trees to climate change in Europe (MaP-FGR)



### Short-Term Scientific Mission - Report

# Leaf physiological differences between central and southern beech provenances growing at a dry site

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## Purpose of the STSM

Beech (*Fagus sylvatica* L.) is one of the most important native tree species in Europe. Beech forests have been mainly grown by natural regeneration, and their provenances developed through adaptation to local climatic conditions (Müller-Stark 1997). The expected prolonged and frequent summer drought periods may affect water regime, nutrient uptake, growth, fitness, and interactions of beech with other organisms, especially in soils with low capacity for water retention (Geßler *et al.* 2007). In the context of climate change, information regarding beech provenance tolerance becomes notably important, particularly for forest management and future reforestation. In seedling studies and experiments, eastern and southern provenances were found to be more drought-adapted (Czajkowski *et al.* 2005, Czajkowski and Bolte 2006, Rose *et al.* 2009, Thiel *et al.* 2014). This finding can be explained by the evolutionary adaptation of beech at the xeric 'rear edge' of its distribution under high selection pressure from frequent and intensive drought events (Hampe and Petit 2005, Bolte *et al.* 2007).

Provenance trials might provide an excellent basis to assess the potential of various provenances to adjust to given climate conditions. The pan-European networks of European beech provenance trials were established in five series in 1986, '87, '89, '95 and '98 (von Wuehlisch 2004). Unfortunately, within these series, the provenances from the central Balkan region (Bosnia and Herzegovina, and Serbia) were omitted, while the provenances from Croatia were poorly represented. Due to the expected genetic variation in this region, the most recent series of international beech provenance trials were established in 2007. For this purpose, seven provenance trials were established across a range of environments in five countries. Contrary to previously established series, this was the first time that the majority of the provenances originated from the Balkan region (20 provenances). Such an approach provided the opportunity to compare performance in the field trials among the Balkan provenances and provenances originating from the core of Europe.

## Description of the work carried out during the STSM

The research was conducted in the beech provenance trial established at the Fruška Gora Mountain, which is located in the Northern part of Serbia. This mountain appears as an "island" and it is surrounded by lowland agricultural land and floodplain forests of pedunculate oak and poplar plantations. For this reason, beech appears here as the marginal population. The trial is situated at the 370 m a.s.l. on a north-west exposed slope and it is arranged in a randomized complete block design. Fifty saplings were planted per plot with 1x2 m spacing.

The climate of the Fruska Gora is temperate continental with a mean annual temperature of 11.1°C and annual precipitation sum of 624 mm. Mean air temperature during the vegetation period (April–September) is 17.8°C, while the sum of precipitations for the same period amounts to 369 mm.

Study involved four provenances originating from Hungary, Germany, Bosnia and Herzegovina and Serbia (Table 1).

**Table 1.** General data about provenances involved in the study.

Code	Provenance	Country	Latitude	Longitude	Altitude (m)	Annual mean air temperature (°C)	Annual sum of precipitation (mm)
HU42	Valkonya	Hungary	46°30'	16°45'	300	9.5	800
DE48	Höllerbach	Germany	49°01'	13°14'	755	5.0	1200
RS36	Fruska Gora	Serbia	45°10'	19°55'	370	11.1	624
BA33	Grmeč	Bosnia	44°46'	16°16'	650	10.3	1304

Photosynthesis (A), stomatal conductance (gs) and transpiration rate (E) were measured using the ADC BioScientific Ltd. LCpro+ Portable Photosynthesis System. Measurements were made under constant light conditions (PAR 1000  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ) and CO<sub>2</sub> concentration (350  $\mu\text{mol mol}^{-1}$ ). Temperature and humidity inside of chamber were at the ambient levels. Measurement was conducted in 5 replications on 10 plants per single species. Fully expanded leaves of the same developmental age, with the same orientation, placed in the upper part of the crown were used as samples. Measurements were done in sunny and clear weather, in the period between 09:00 and 11:00 hours. Instantaneous WUE ( $\text{WUE}_i = A/E$ ) was calculated by dividing photosynthetic rate by transpiration and was expressed in unit  $\mu\text{mol CO}_2/\text{mmol H}_2\text{O}$ .

We used Handy Pea fluorometer (Hansatech Ltd., Kings Lynn, UK) for measurements fast kinetics of chlorophyll *a* fluorescence. We assess maximal fluorescence yield ( $F_v/F_m$ ), photosynthetic performance index (PI).

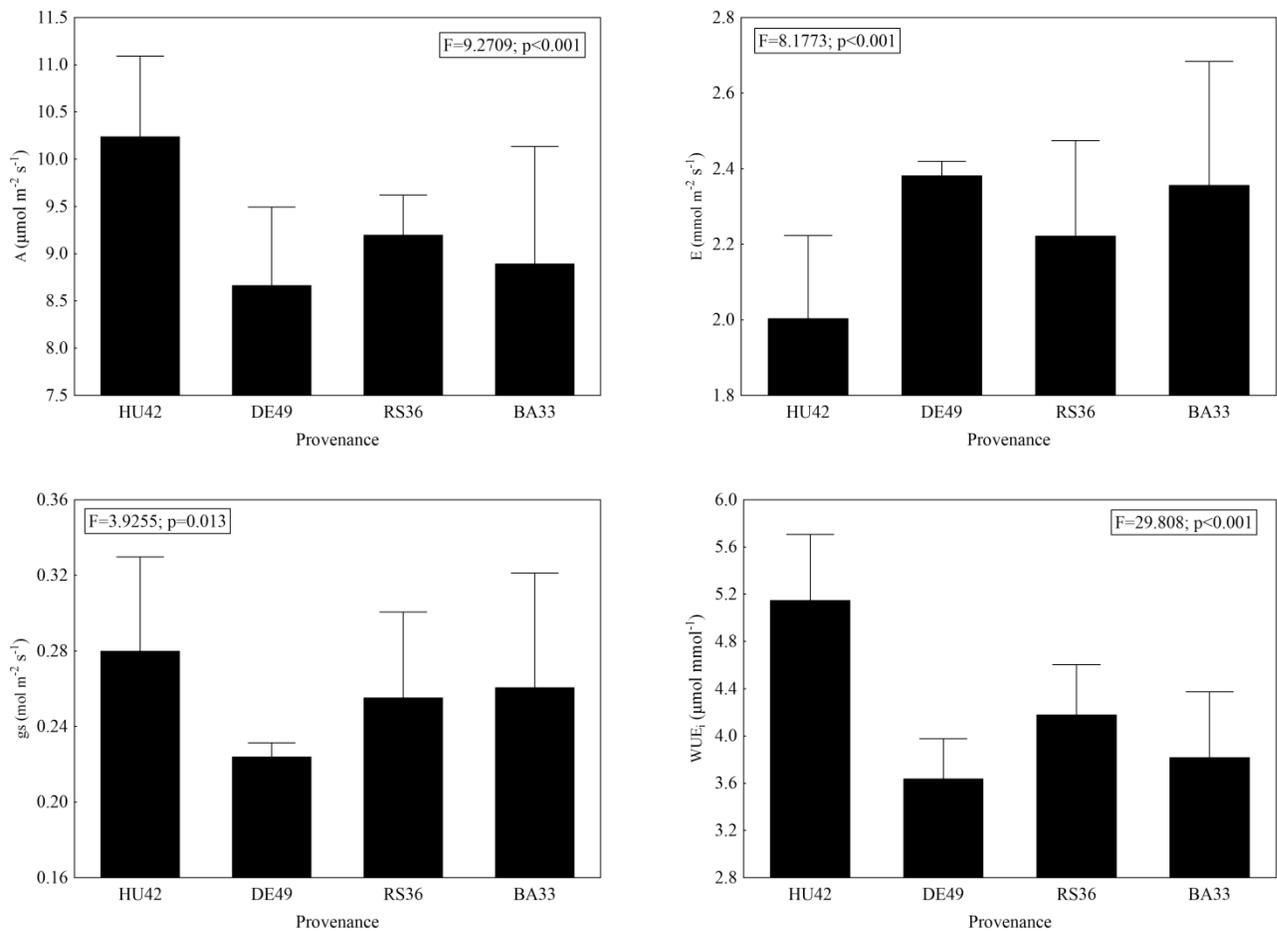
A MINI-PAM photosynthesis yield analyzer (Heinz Walz GmbH, Effeltrich, Germany) records Rapid Light Curves (RLCs) for assesses slow kinetics of chlorophyll *a* fluorescence. The MINI-PAM records all relevant fluorescence parameters: effective quantum yield ( $\Phi_{\text{PSII}} = \Delta F/F_m'$ ); electron transport rate (ETR) values at a given actinic irradiance PAR ( $\text{ETR} = \Phi_{\text{PSII}} \times \text{PAR} \times 0.5 \times 0.84$ ), where 0.5 is a multiplication factor for two quanta of light required for the transport of one electron, and 0.84 is the species-specific fraction of incident quanta absorbed by the leaf; photochemical quenching (qP), non-photochemical quenching (qN) and a parameter describing non-photochemical quenching (NPQ) assuming a matrix model of the antenna system based on Stern-Volmer quenching.

We measured Relative chlorophyll content (Fig. 3) using the CL-01 Chlorophyll Content Meter (Hansatech Ltd., Kings Lynn, UK), which determine the relative content using dual wavelength optical absorbance (620 nm and 940 nm) expresses as a 'Chl index'.

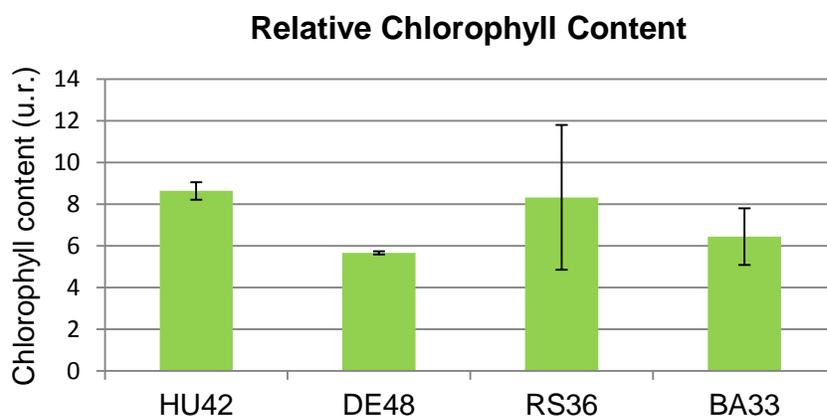
## Description of the main results obtained – preliminary results

Most of the collected data (chlorophyll fluorescence data) are currently being analysed. For this time are available results of photosynthetic parameters ( $A$ ,  $E$ ,  $g_s$  and  $WUE_i$ ) and relative chlorophyll content.

**Figure 1.** Mean + standard deviation of investigated physiological parameters: net photosynthesis ( $A$ ), rate of transpiration ( $E$ ), stomatal conductance ( $g_s$ ) and instantaneous water use efficiency ( $WUE_i$ ) in four European beech provenances.



**Figure 2.** Mean + standard deviation of Relative chlorophyll content in leaf samples of studied provenances



The results indicate that all four provenances responded to plot conditions. We found different level in all photosynthesis parameters (Fig. 1) - net photosynthesis (A), rate of transpiration (E), stomatal conductance (gs) and instantaneous water use efficiency (WUE<sub>i</sub>).

From the figures of results is clear that the samples originating from Hungarian provenance manifested by the best vitality compare to German, Serbian and Bosnian provenance samples. We can also say that the best ability of adaptation to the plot condition were recorded in Hungarian provenance.

In Relative Chlorophyll Content we recorded the similar trend in studied provenances (Fig. 2) but the significant differences were not observed. Related to origin from differ altitude we observe gradient of elevation (results are not represented in Fig.).

### Foreseen publications/articles resulting from the STSM

The work developed during the STSM will be published as soon as the processing of results will finish

### Acknowledgments

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This report can be posted at the COST Action website.

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