STReESS - Studying Tree Responses to extreme Events: a SynthesiS

STSM Report

Intra-specific variability of cavitation resistance in European beech

COST Action: FP1106

COST STSM Reference Number: COST-STSM-FP1106-16073

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Period: 24th of March to the 18th of April 2014

❖ Purpose of the STSM

The expected climatic changes with increasing in the frequency and duration of intense summer droughts (IPCC, 2007), will negatively affect forest tree species. That important stress factor will have an economical influence on beech production and management in Europe. Thus, the future survival and sustainability of European beech ecosystems in Europe has become of great concern may be cite some modelling studies that reported this. Therefore, knowledge on the capability of trees to cope with and adapt to stress is of crucial importance to predict future performance of beech trees and forests and assess sensitivity of drought in different provenances.

The main objective of the STSM “Intra-specific variability of cavitation resistance in European beech” was an answer to the question if European beech populations growing at

xeric marginal sites are more tolerant than populations from the northern margin. The aim was also to transfer knowledge between the INRA-UB and the Faculty of Horticulture, Biotechnology and Landscape Architecture on the mechanisms of tree mortality induced by drought stress.

We still know little about the intra-specific variability of cavitation resistance in trees, which is one of the most relevant traits for tracking tree survival during extreme droughts (Brodribb et al 2010 and Urli et al 2013). Only four recent studies have assessed genetic variation in resistance to cavitation (Corcuera et al., 2011; Lamy et al., 2011; Lamy et al. 2013; Wortemann et al., 2011) but they never studied populations at the margins of the species' distribution. Here we studied 15 beech populations covering the entire range of the species distribution, with a special emphasis on populations from the southern margin. Variability of drought-induced cavitation has been assessed to improve fundamental understanding of the adaptive capacities of tree populations and their responses to severe drought. This adaptive trait has been described as highly variable in a wide range of tree species, but little is known about the extent of genetic and phenotypic variability within species. This information is essential to our understanding of the evolutionary forces that have shaped this trait, and for evaluation of its inclusion in breeding programs. We hypothesize that populations from the southern margin are more cavitation resistant and therefore more prone to cope with warmer and drier conditions in the future.

❖ Description of the work carried out during the STSM

Activities carried out during the STSM could be separated into several phases:

- collecting of samples on the field,
- preparation of samples and cavitation resistance measurements,
- preparation of additional samples in case of not successful measurement,
- measurements,
- processing of obtained data.

Branches were collected in natural populations in different countries through Europe (via Cost partners). In the experiment is planned to study 15 beech populations through Europe. Collecting of samples was carried out in the spring of 2014. In time of STMS not less than 10 individuals per population (two branches per individual) from 8 countries were tested.

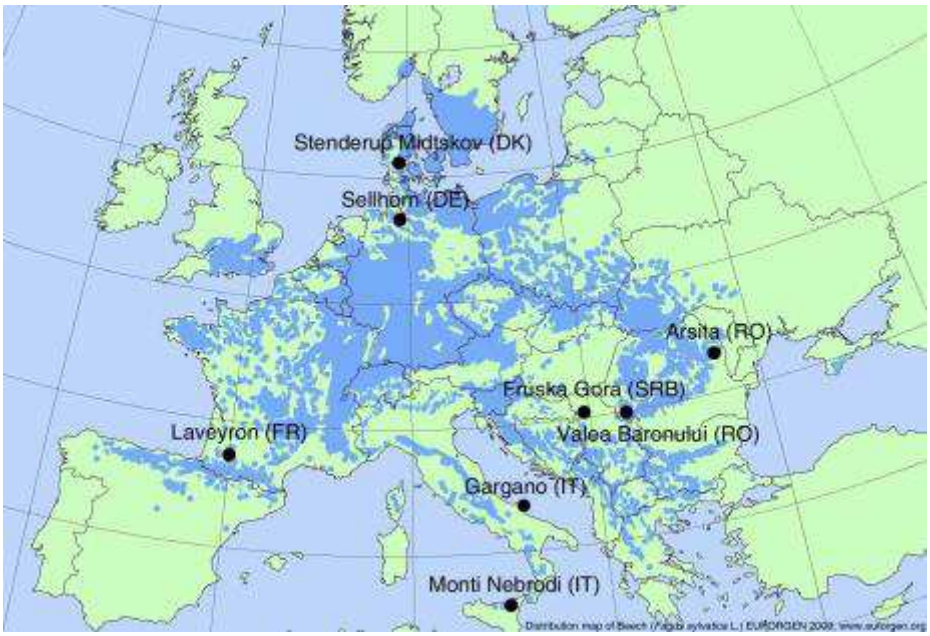


Figure 1. Locality of European beech provenances and places involved in study.

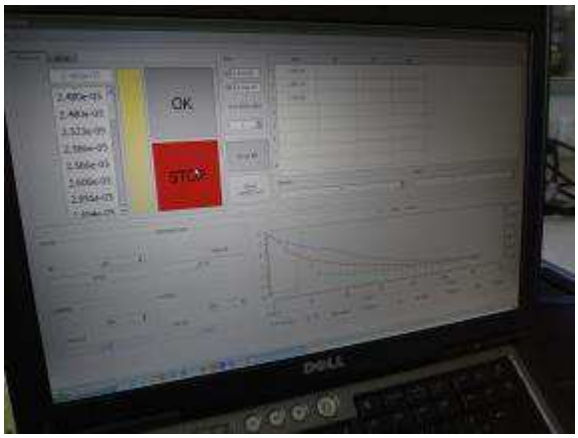
Samples were collected from the forest and immediately after collecting branches were wrapped with moist paper and conditioned within plastic bags to avoid any water loss. Then samples were brought back or send to the high-throughput phenotyping platform (http://sylvain-delzon.com/caviplace, UMR BIOGECO,University of Bordeaux, France) and prepared for cavitation measurements. Sample for cavitron had 35 - 40 cm (no less than 30cm) of straight branch. The maximum branch diameter was 1 cm (not including bark) and each branch had label with code (Fig. 1). Samples that waited for a measurement were store in the fridge (3 to 5°C).

Figure 2. Samples collection and preparation for measurements.

The vulnerability curve were obtained using the CAVITRON technique (Cochard et al. 2005; Delzon et al. 2010) in order to estimate P50 for each species (proxy of cavitation resistance corresponding to the xylem pressure inducing 50% loss of hydraulic conductance) (Fig 3).

Figure 3. The software for cavitation measurement.

Additionally in time of STMS hydraulic conductance data were obtained with the Xylem before and after flushing to estimate the native embolism (Fig. 4).



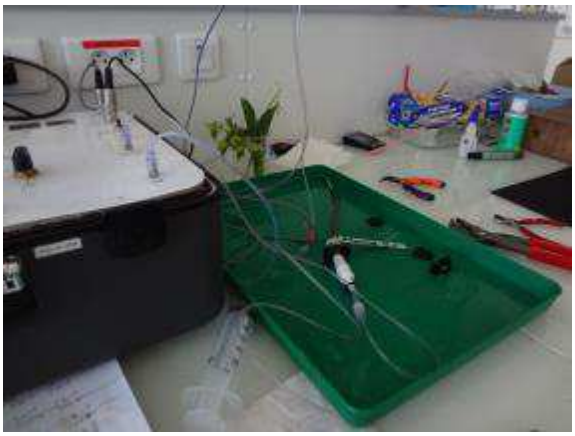


Figure 4. Measurement of Xylem.

❖ Description of the main results obtained

We compared 15 beech populations for cavitation resistance and hypothesized that the Southernmost populations, experiencing severer drought events, are more resistant than populations from the core and Northern Europe. First results show that there are weak but significant differences between populations, beech from France and Bosnia seem to be more resistant while the ones from Denmark and Germany are more vulnerable. The next step will be worked on the hydraulic conductance data obtained with the Xylem before and after flushing to estimate the native embolism and also compare the xylem hydraulic conductance measured with the xylem and cavitron (k_s).

❖ Future collaboration with the host institution

During the STSM it was expressed mutual interest in continuing of cooperation. Because the researches in the field of hydraulic and anatomy in relation to stress is insufficient developed on the Faculty of Horticulture, Biotechnology and Landscape Architecture, we recognized the INRA-UB as the partner which could help us to improve these fields of research on the mechanisms of tree mortality induced by drought stress also on urban areas. We are interested in conduct mutual researches in which we could investigate plant response to climate conditions different of those on the place of origin. Visiting of UMR BIOGECO INRA-UB at University of Bordeaux provided me opportunity to learn different several techniques (i.e. CAVITRON technique to get vulnerability curves, methods to assess conduit size and pit membrane anatomy, etc.). These methods will be applied to urban trees to study stress relationships and assess sensitivity of drought.

❖ Contribution to the action aims

The STSM was based on the aim of the Action FP1106 to link scientific expertise and facilitate data exchange and organization. The STSM fostered collaboration between the beneficiary and Dr Sylvain Delzon, sharing techniques and infrastructure available in the host institution. During the STSM the collaboration between members of the two institutions was strengthened on the adaptation and response to environmental changes in one of forest tree species with important ecological value. This project will actively contribute to the STReESS action by studying the susceptibility of beech to climate-related stress conditions in Europe of European trees, in urban and periurban areas.

❖ Projected publications to result from the STSM

At the moment with the help of colleagues from INRA Institute we are finishing the experiment and are going to prepare a manuscript based partly on the results of this STSM which will be submitted to the IAWA Journal.

❖ Confirmation by the host institution of the successful execution of the STSM

The confirmation letter by the host institution of successful execution of the STSM is enclosed in the separate file.

❖ References

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