WHOLE-TREE NITROGEN DYNAMICS ACROSS SEASONS IN RESPONSE TO DEFOLIATION AND DROUGHT IN 10 YEAR-OLD BEECH TREES

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CONTEXT

- According to current scenarios for climate change in **France**, **extreme drought** events are expected to occur more **frequently**. Such events will not only **limit** supply of water but also the **availability of soil N for trees.**
- **Nitrogen (N)** is one of the **main nutrient** driving **growth** and **productivity** in many forest.
- **Drought** and **defoliation** are environmental factors expected to affect drastically the N balance of trees by decreasing access to water and nutrient of the soil (drought) or through a major loss of leaf N (defoliation).

HYPOTHESIS

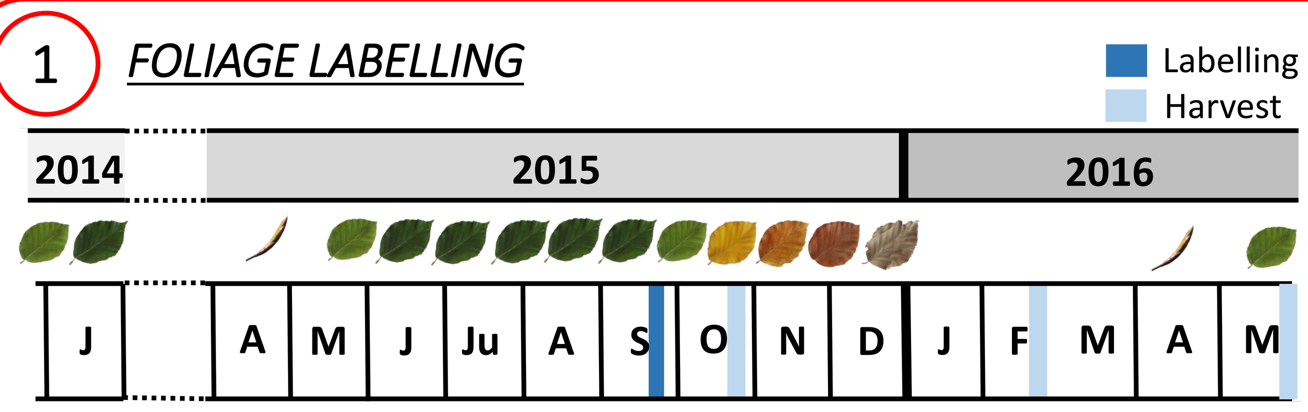
- Defoliation and drought will cause a shortage of N.
- This shortage will modify the N dynamics within the tree.
- Trees will adapt their strategy of N storage to cope with theses extremes constraints.

EXPERIMENTAL DESIGN

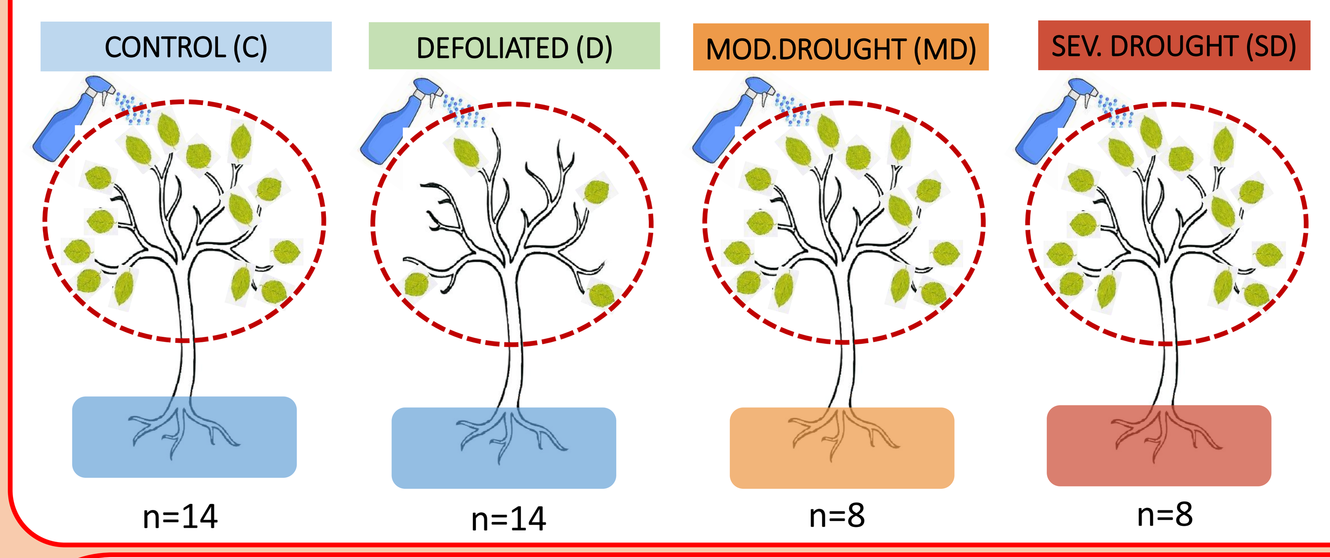
- 10 year-old beech trees (*Fagus Sylvatica)* grown in a nursery under a rain exclusion roof (INRA Grand Est, Nancy, France)
- Four growth conditions : **control (C), defoliation (D), moderate drought (MD), severe drought (SD).**
- Automatic watering (control, defoliation). Manual defoliation of 75% of the foliage (defoliation), drought monitoring with neutron probes (moderate and severe drought)

MATERIALS AND METHODS

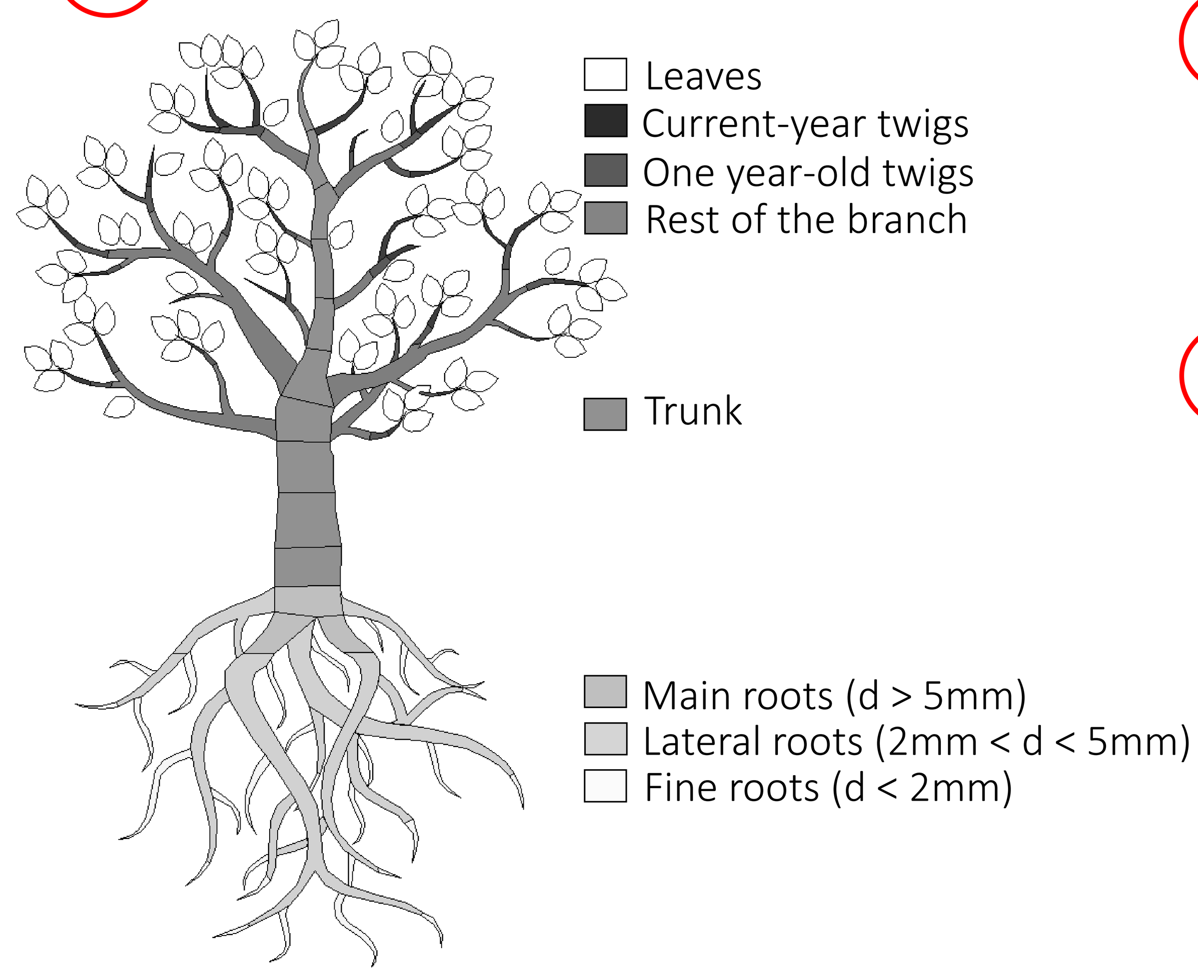
1 FOLIAGE LABELLING



27 ±2 mg per tree of UREA-$^{15}N_2$ 10,4 atom% ^{15}N has been applied using a method derived from Zeller *et al.* (1998).



2 TREE SAMPLING



3 ISOTOPIC ANALYSES

Isotopic analyses carried out at the isotopic platform of B&PMP (INRA, Montpellier, France) on a Elemental Analyser EURO-EA3024 (Eurovector, Redavalle, Italy) coupled to an Isoprime (Elementar UK).

4 ISOTOPIC CALCULATIONS

- The isotopic abundance for N in atom% :

$$A_N\% = \frac{^{15}N}{^{14}N+^{15}N} * 100$$

- ^{15}N atom% excess in each tissue in atom% :

$$^{15}N\ atom\%_{excess} = atom\ \%\ ^{15}N_{(labelled\ tissue)} - atom\ \%\ ^{15}N_{(unlabelled\ tissue)}$$

- ^{15}N proportion in percentage :

$$^{15}N\ of\ compartment\ (\%) = 100 * \frac{^{15}N\ quantity\ of\ compartment\ (g)}{^{15}N\ quantity\ the\ whole\ tree\ (g)}$$

RESULTS

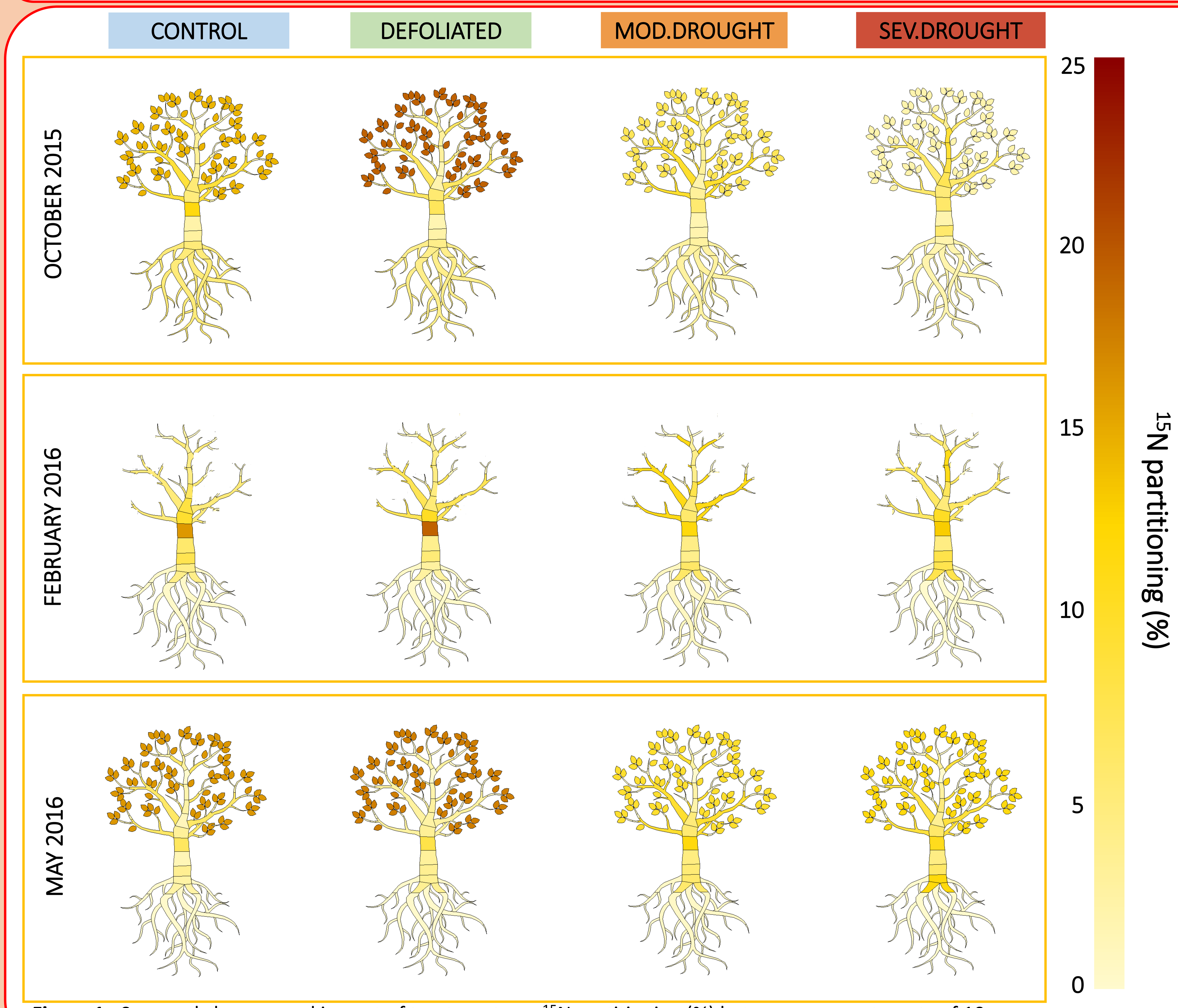


Figure 1 : Seasonal changes and impact of treatments on ^{15}N partitioning (%) between compartments of 10 year-old beech trees

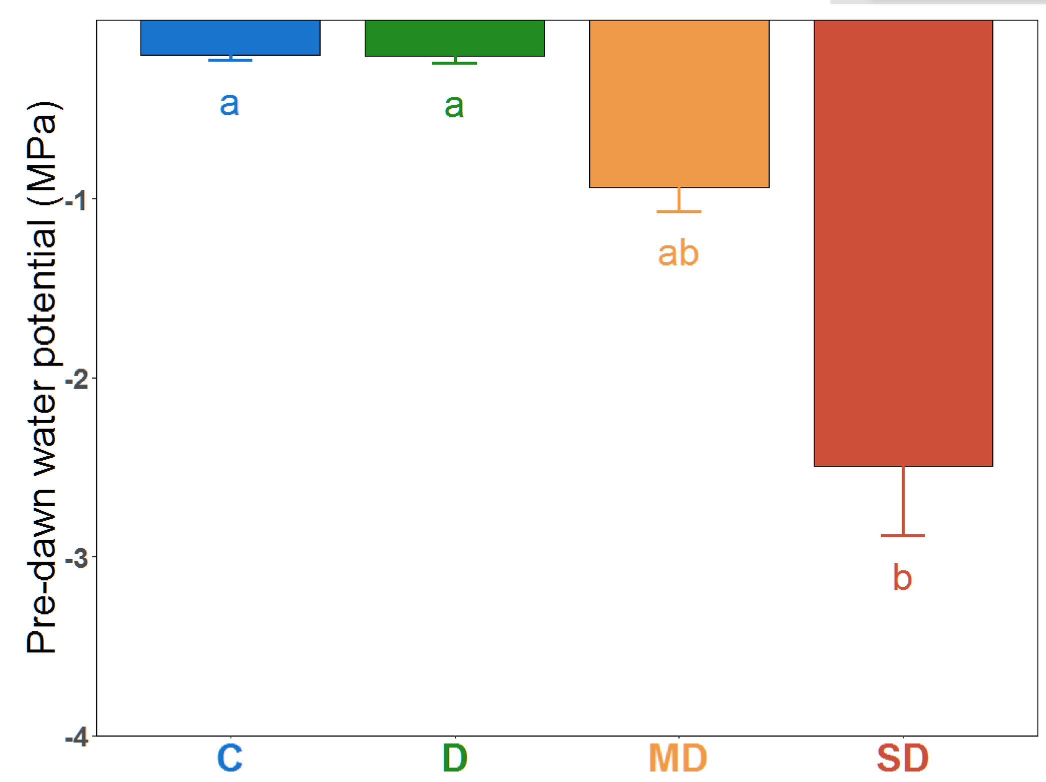


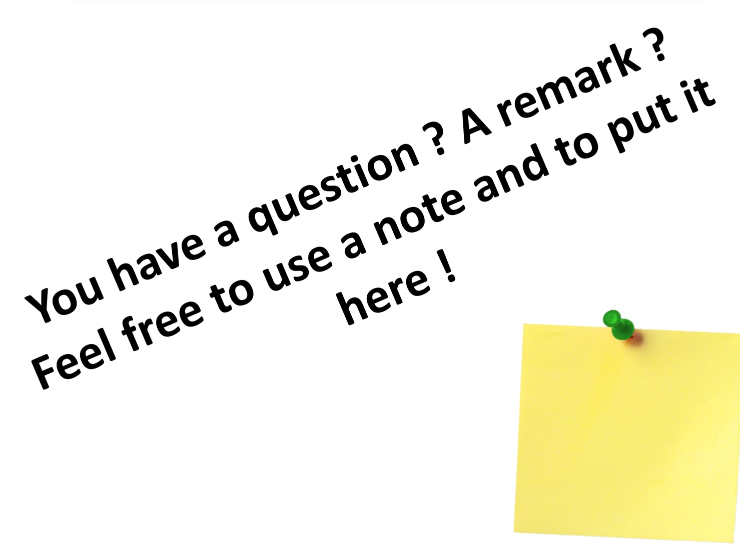
Figure 2 : Average pre-dawn water potentials of 10 year-old beech trees the September 28th 2015 (prior to the labelling). Different letters indicates difference between treatments ($p < 0{,}05$, Anova)

- ✓ In October 2015, in autumn before leaf fall, more ^{15}N was retained in leaves in control than in other treatments (*p<0,05*). More ^{15}N was found in proximal woody compartments (*e.g* twigs) in both drought treatments (*ns*).
- ✓ In February 2016, in winter, at the theoretical maximum storage of nitrogen, we found no difference between treatments. In all treatments, the trunk is the main compartment for nitrogen storage, due to its large biomass. ^{15}N was found mainly in aboveground part of the tree in all treatments.
- ✓ In May 2016, in spring, after leaf expansion, ^{15}N was mainly concentrated in leaves and proximal woody compartments in control treatment whereas in other treatments, ^{15}N is still high in other perennial compartments.
- ✓ Whatever the date x treatment, more was preferentially located in older tree part in the trunk.

DISCUSSION

In autumn, it seems that N exportation from leaves to perennial compartments already occur in moderate drought with more ^{15}N found in twigs than in leaves. An earlier remobilization could be a response of trees to water constraint. Trees could accelerate their senescence to cope with constraints (Vitasse *et al.* 2014) *e.g* cold acclimation occurring from autumn to early spring. Cold acclimation needs C and N compounds, which may be greatly reduced when a drought occurs and remains. N remobilization in spring rely mainly on nitrogen reserve (El Zein *et al.* 2011). Then, we found no significant difference between treatments on ^{15}N repartitioning in spring indicating that previous constraints seem to have no effect for nitrogen remobilization in spring. **In conclusion, it seems that nitrogen storage strategy is maintained even under extreme constraints. In a changing world with a decrease of nitrogen availability may occur, nitrogen should be included in tree mortality processes because the nitrogen storage strategy of trees offers few plasticity.**

REMARKS ? QUESTIONS ?



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Zeller, B., Colin-Belgrand, M., Dambrine, É., & Martin, F. (1998). 15N partitioning and production of 15N-labelled litter in beech trees following [15N]urea spray. *Annales Des Sciences Forestieres*, *55*(3), 375–383. http://doi.org/S

El Zein, R., Bréda, N., Gérant, D., Zeller, B., & Maillard, P. (2011). Nitrogen sources for current-year shoot growth in 50-year-old sessile oak trees: An in situ 15N labeling approach. *Tree Physiology*, *31*(12), 1390–1400. http://doi.org/10.1093/treephys/tpr118