WP11: **Enhancement and/or development of medium/high throughput phenotyping of traits**

Tree - Water relationships : Assessing the most vital functions of forest trees

INRA Nancy, INRA Orléans, BOKU Austria, SBS Germany, Ugent Belgium

Oliver Brendel

Context and Objectives

- In many research fields (modelling, genetics, breeding, etc): need to get access to thousands **phenotype** data from many species/genotypes, environments, and years for increasing sets of traits

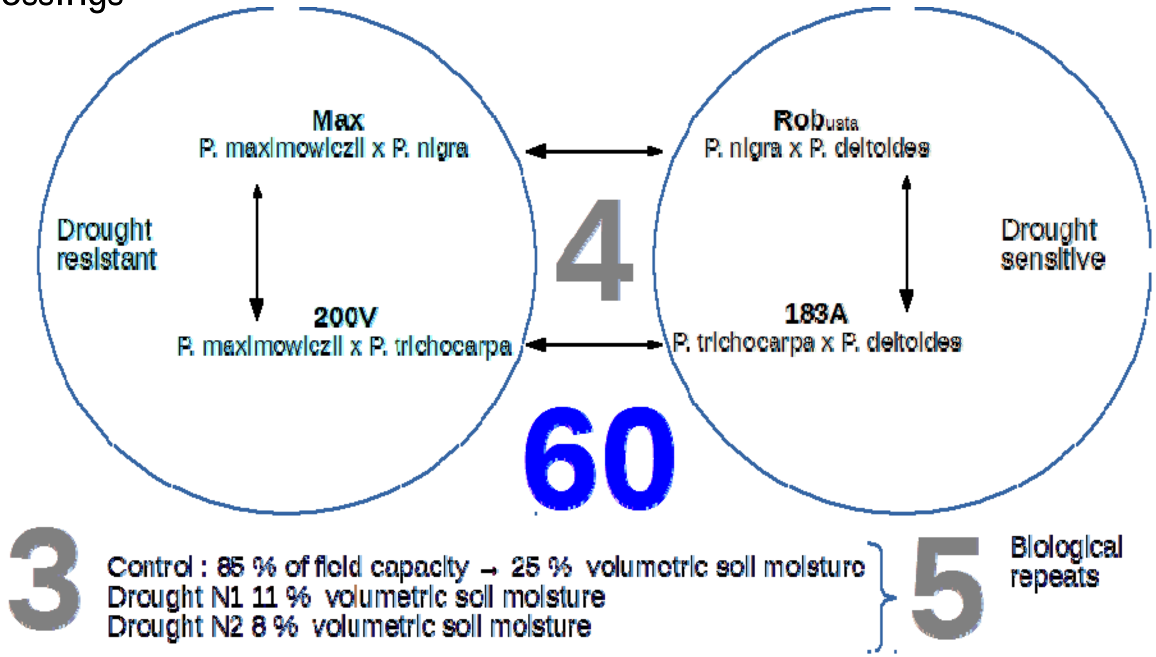
- Compared to massive progress in genotyping, **phenotyping has become a major new bottleneck**, especially when dealing with complex traits.

General objective: to develop/improve medium → high-throughput phenotyping methodologies

Detailed objective : comparing different drought stress response traits with NIRS analyses for high throughput phenotyping

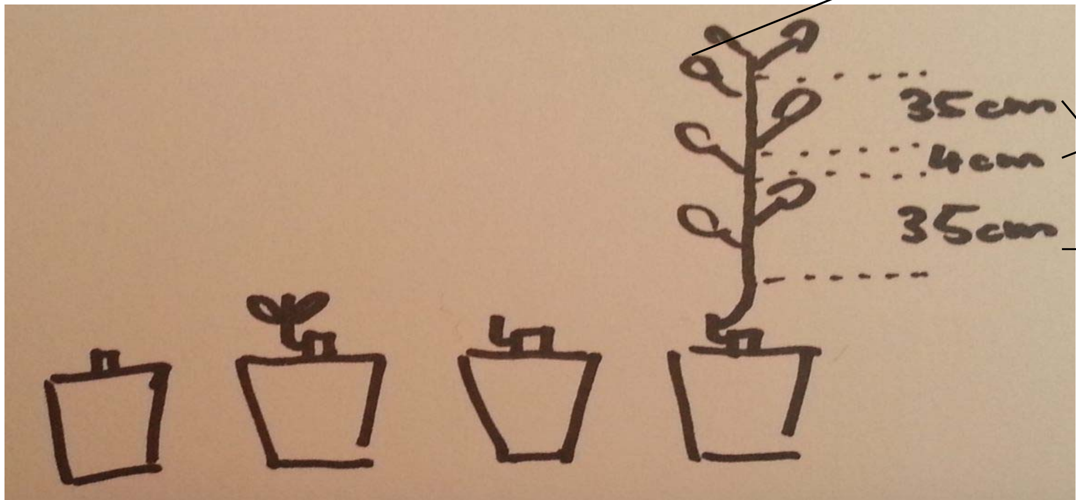
Poplar Core experiment 2013 in Nancy

- Objective : Grow different poplar genotypes under different soil water availability to evaluate impact on wood properties
- Genotypes chosen from SBS from different nigra, maximowiczii, trichocarpa and deltoides crossings



Max	*nigra*	Rob
maximo	*delto*	
200V	*tricho*	183A

Plant material

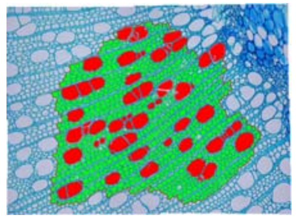


Carbon isotope analysis
INRA Nancy

Analysis of
Wood constituents
INRA Nancy

Vulnerability
to cavitation
INRA Bordeaux
& SBS

Structure-function
relationships
BOKU / UGent ...



Rooted cuttings planted
25th April

Re-cut shoots
19 July

Drought established
12th August

Above ground biomass harvest
7 October

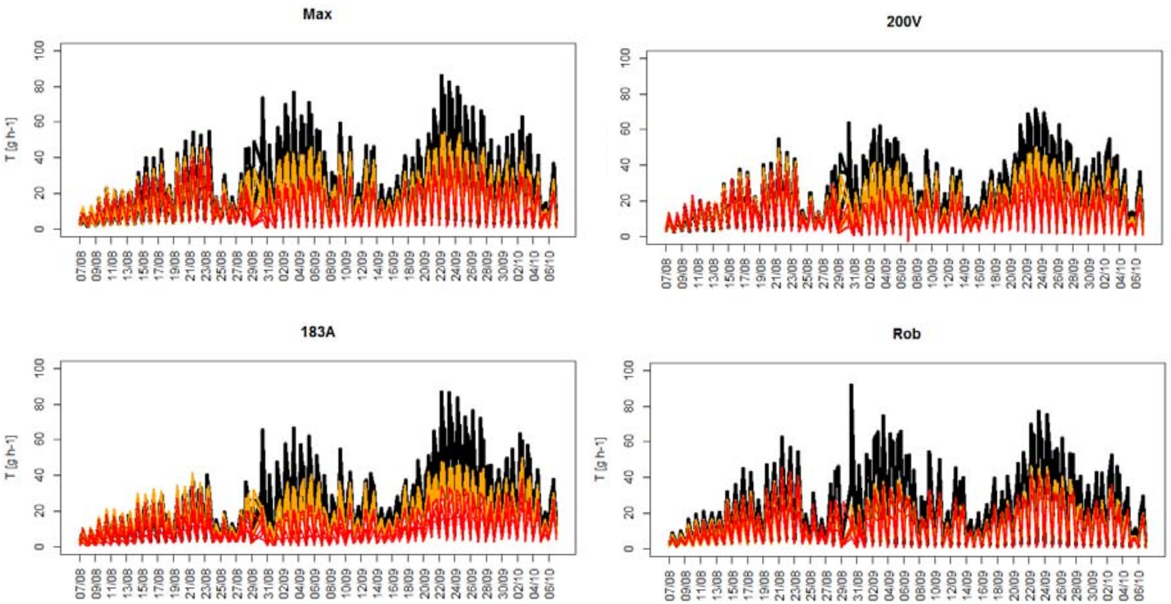
Total aboveground dry mass
Leaf mass area ratio
Leaf surface (estimated)
Leaf mass / shoot mass ratio

Daily whole plant transpiration
Cumulative water loss

Whole plant Transpiration Data in g/hour

Drought resistant clones

Drought sensitive clones



CONTRO L

11 % DROUGHT

8 % DROUGHT

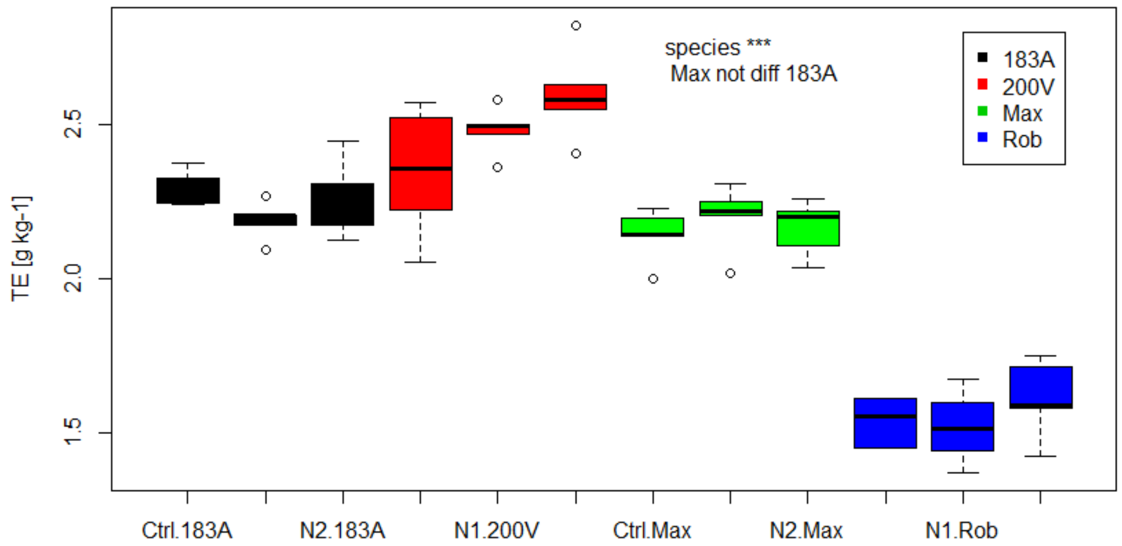
> 10.000 data points of differential water loss measurements

The 8 % SWC drougth level has clearly a stronger effect than the 11 % one, except for Rob

→ from these data a cumulative water loss can be calculated over the whole experimental period

Transpiration Efficiency TE

As above ground dry mass / cumulative water consumption (measurements from the robotic system)

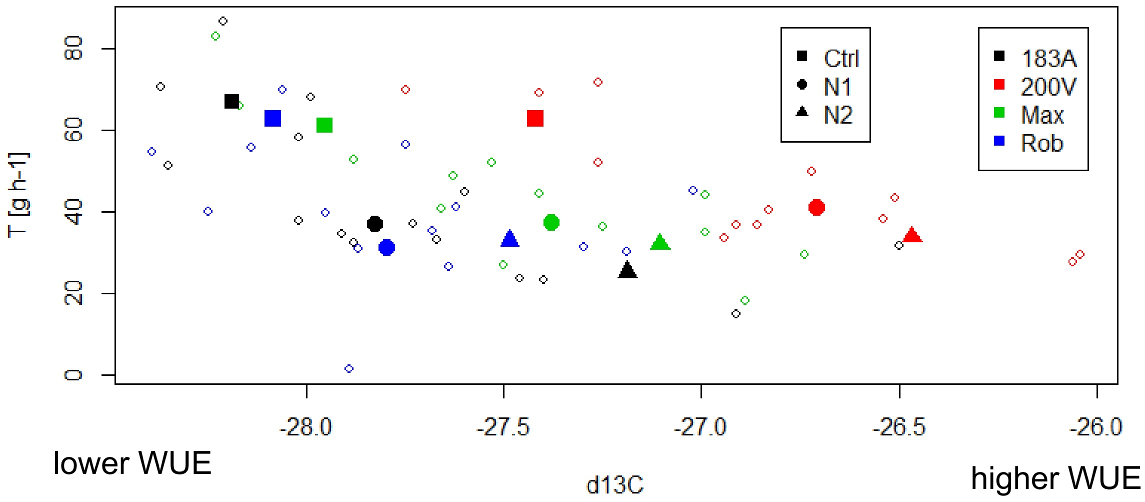


Johannes Baptista
Van Helmont
Oriatrike or Physick Refined
Willow Experiment

Even though effect of drought cleary visible on whole plant transpiration data
→ no clear tendency for whole plant TE, only 200V and Rob show a typical reaction
→ aboveground biomass not affected by drought ??
→ there might be big differences in root biomass (not measured)

TREES 4 FUTURE

Relationship of whole plant transpiration with carbon isotope composition of wood

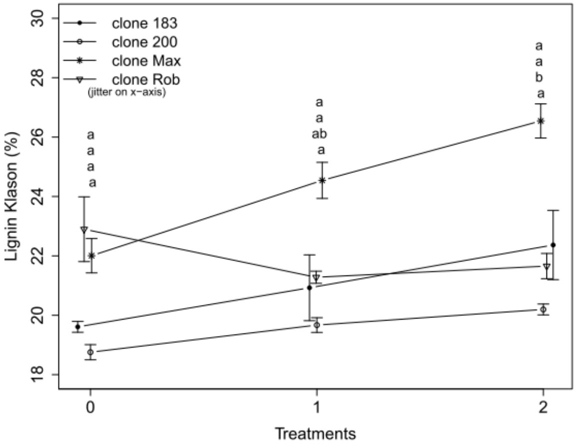


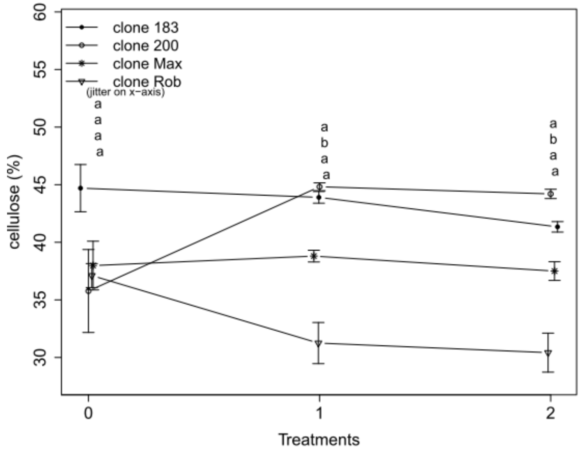
Transpiration from one high transpiration day (23/08)

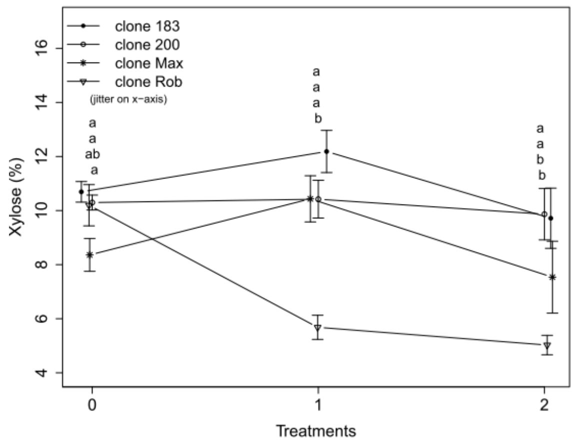
- Higher transpiration plants have lower WUE
- Both treatments have significant effects on WUE
- 200V shows significant higher WUE (non GxT interaction)
- No genotype effect on transpiration
- No significant difference between drought stress levels on transpiration of this day

Wood constituents vary with drought stress

B. Richard (extraction and quantity), C. Hossann, N. Angeli (isotopic analyses)





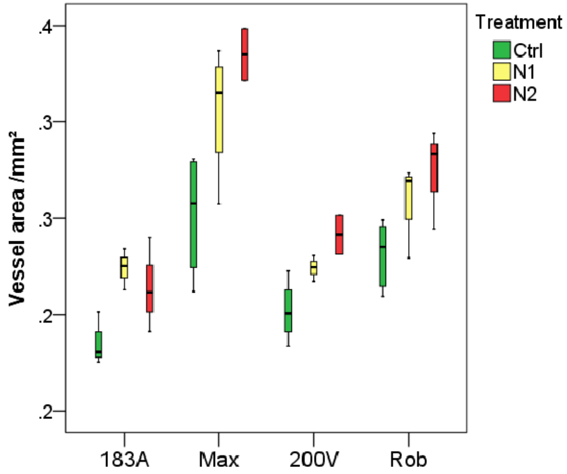


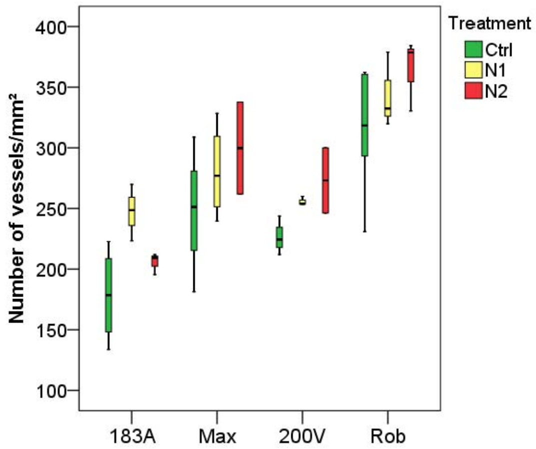
Klason Lignin increases significantly with drought for clone Max

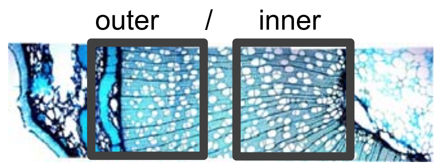
Only clone 200V significantly increases **Cellulose** content with drought stress

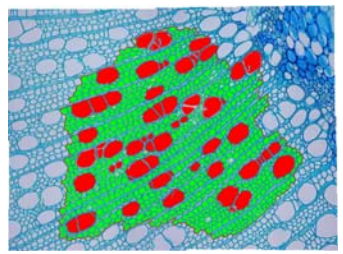
Only clone Rob decreases **Xylose** content with drought stress

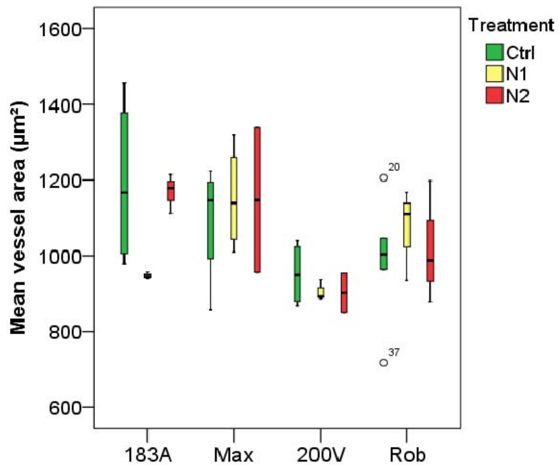
Anatomical analyses



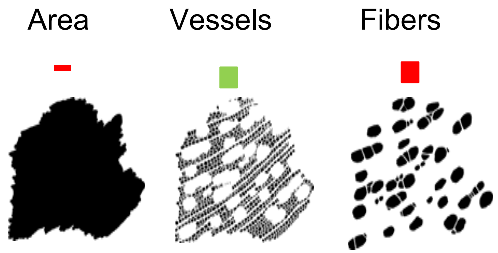




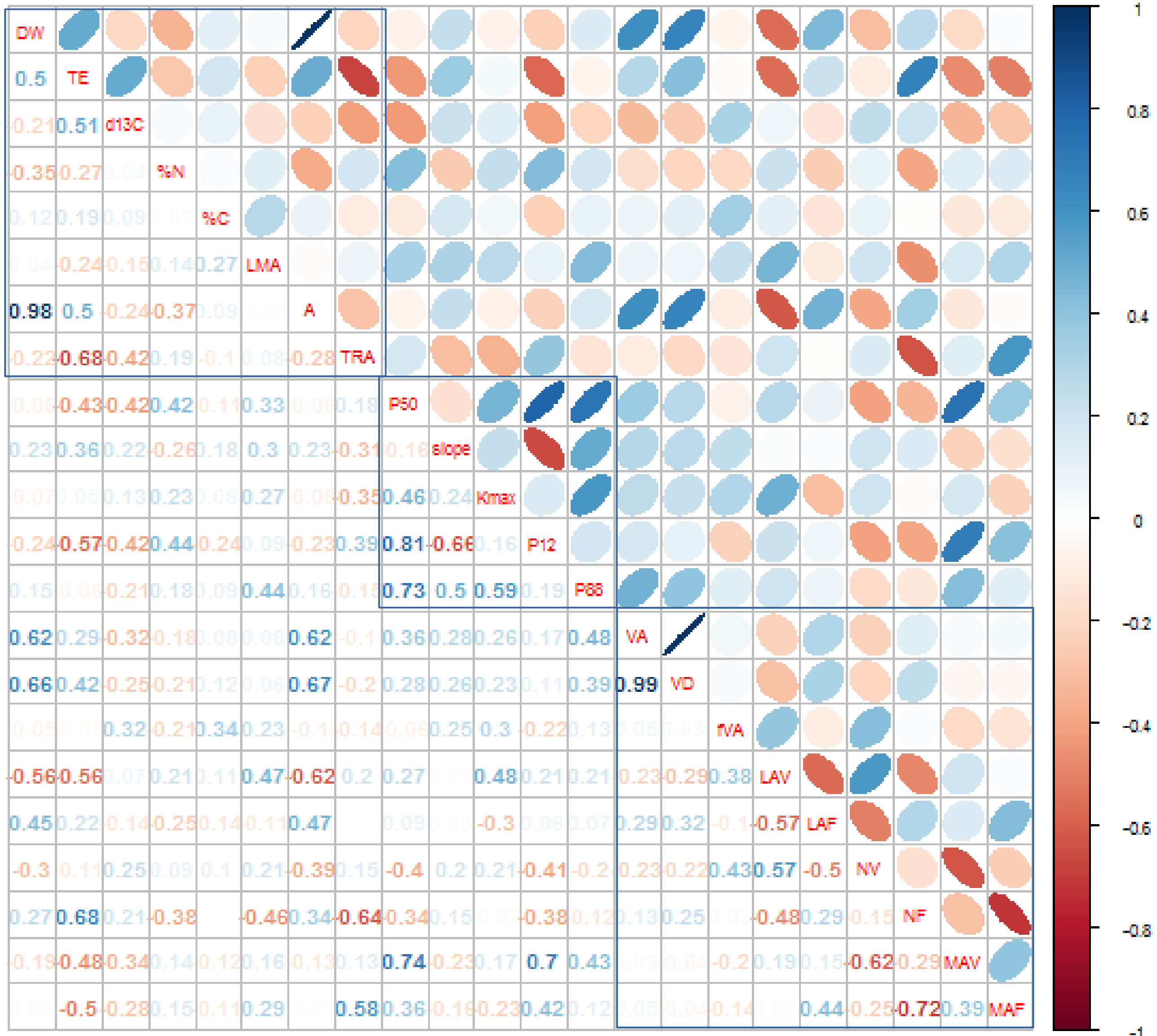




Also anatomical analyses by BOKU Vienna, but also by University of Gent but on a lower number of samples



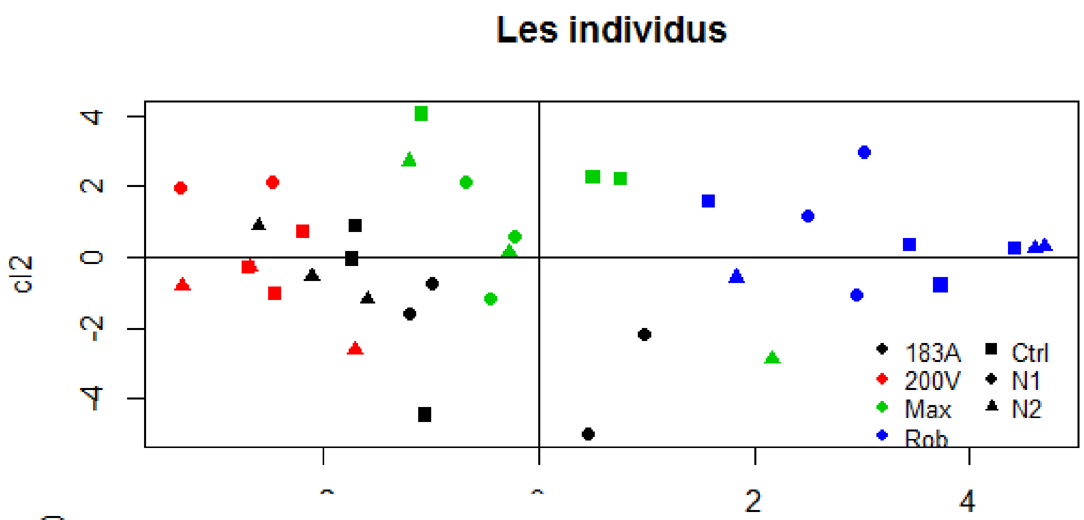
DW aerial dry biomass
TE Transpiraiton Efficiency
δ13C carbon isotope compositio
%N leaf nitrogen
%C carbon in leaf material
LMA leaf mass per area
A totalleaf furface
TRA plant transpiration / leaf are
P50 water potential at 50 % loss
Slope of cavitation response
Kmax hydraulic conductivity
P12 water potential at 12 % loss
P88 water potential at 88 % loss
VA vessel area
VD vessel diameter
fVA fraction of vessel area / tota
LAV lumen area vessel
LAF fiber lumen area
NV number of vessels / mm²
NF number vessels / mm²
MAV mean vessel area
MAF mean fiber area

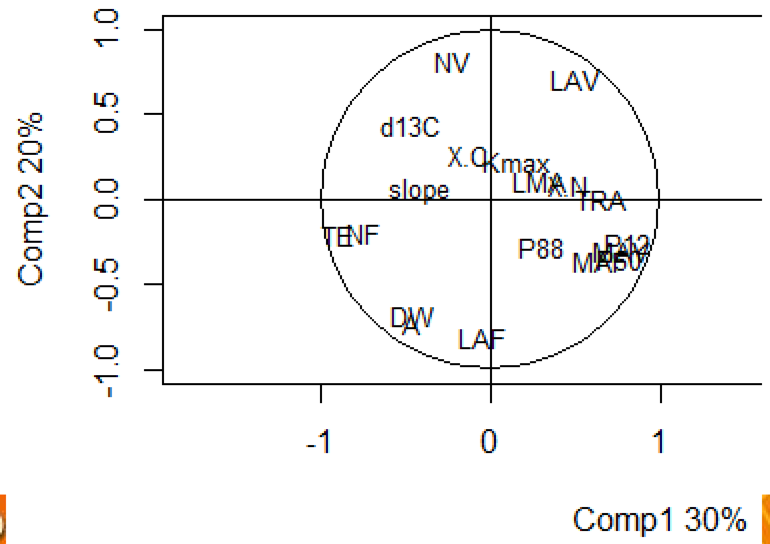


Across species and across drought levels

Principal Components Analysis

DW aerial dry biomass
TE Transpiraiton Efficiency
δ13C carbon isotope composition
%N leaf nitrogen
%C carbon in leaf material
LMA leaf mass per area
A totalleaf furface
TRA plant transpiration / leaf area
P50 water potential at 50 % loss cond
Slope of cavitation response
Kmax hydraulic conductivity
P12 water potential at 12 % loss cond
P88 water potential at 88 % loss cond
VA vessel area
VD vessel diameter
fVA fraction of vessel area / total area
LAV lumen area vessel
LAF fiber lumen area
NV number of vessels / mm²
NF number vessels / mm²
MAV mean vessel area
MAF mean fiber area





Trait space of drought response traits
→ NIRS analyses will indicate possibilities for high throughput phenotyping

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