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Drought resistance of tree species in the Congo Basin
interspecific variation of seedling responses and traits

Sabrina COSTE *(1,2,3)*, **Michael D. SWAINE** *(1)*, **Mélanie TOTO** *(2)* **and Bettina M. J. ENGELBRECHT** *(4)*

(1) School of Biological Sciences, University of Aberdeen UK; (2) CRDPI, Pointe Noire, Republic of the Congo; (3) Department 'Natural Forest Dynamics', CIRAD, Montpellier, France; (4) Department of Biology, Chemistry and Geological Sciences, University of Bayreuth, Germany.

***Correspondence**: sabcost@hotmail.com*

Congo Basin forests are facing increasing anthropogenic pressure and are predicted to experience droughts of greater intensity in the coming decades. Understanding how these changes will affect tree species distribution and abundance requires an understanding of species' drought resistance and the underlying traits.

The main objectives of this study were:

(1) QUANTIFY the variations of drought resistance (e.g. ability to survive periods of low water availability) among a large number of tree species from the Congo basin,

(2) Identify morphological and/or functional TRAITS underlying these variations

VARIATION of DROUGHT RESISTANCE

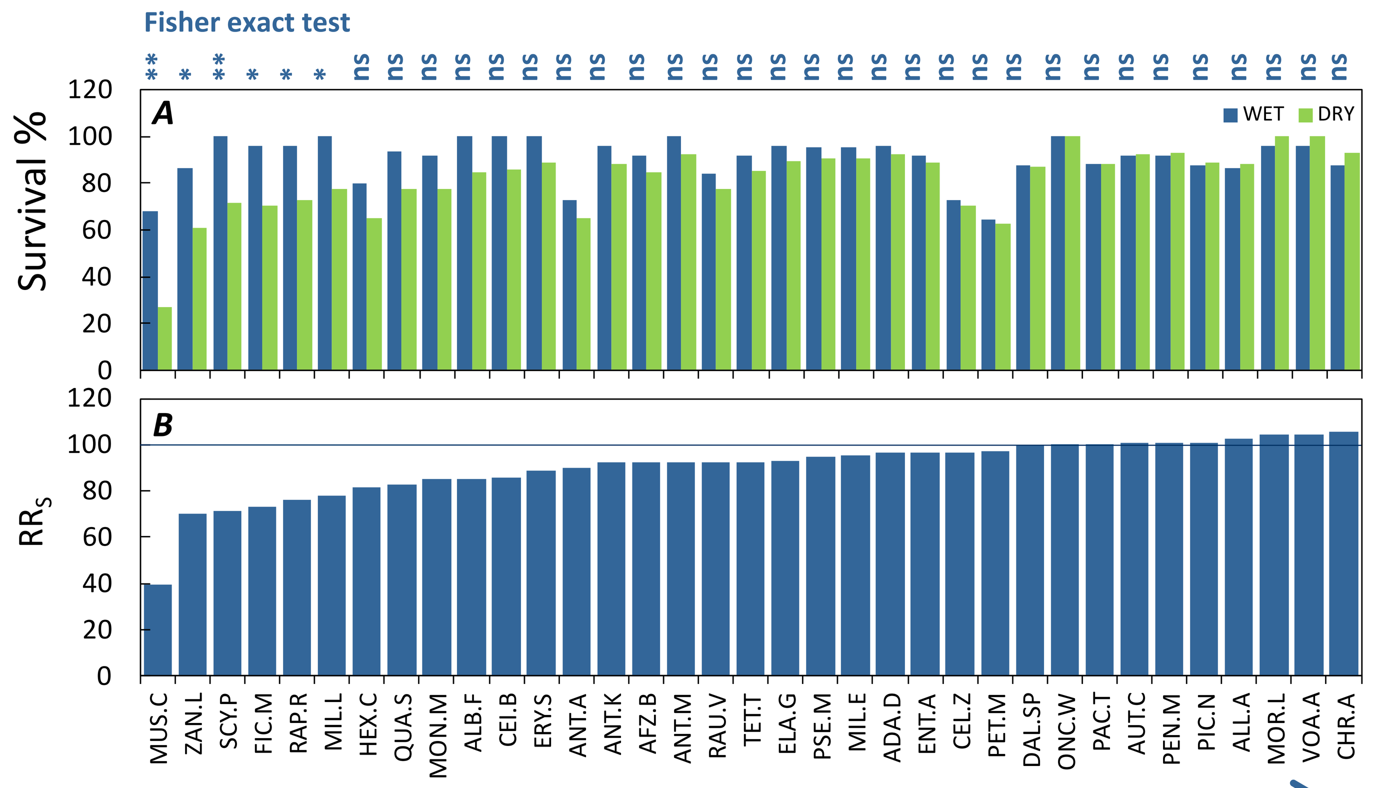
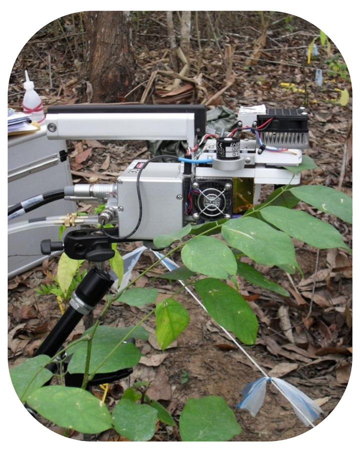


Figure 1. ***A*** Relative seedling survival in a dry an irrigated treatment. ***B*** Drought resistance index (survival dry / survival irrigated for 35 tree species from the Congo basin.



- Seedlings of species from the Congo Basin had **high survival** even under severe drought conditions (-4 to -6 MPa) and were thus very drought resistant.
- Most species were considerably **more drought resistant than species in a similar study in Panama** (Engelbrecht et al. 2007), which showed lower survival despite of less severe drought conditions.

UNDERLYING TRAITS



Structural traits	Functional traits
LMA: leaf mass per area (g m^{-2})	***A_{sat}*m**: light saturated net CO_2 assimilation rate (nmol g^{-1} s^{-1})
LDMC: leaf dry matter content (mg g^{-1})	***g_s***: stomatal conductance for water vapour (mol m^{-2} s^{-1})
T_k: leaf thickness (µm)	***E_m***: transpiration rate (nmol g^{-1} s^{-1})
N_m: total leaf N content (mg g^{-1})	**δ^{13}C**: leaf carbon isotope composition (‰)
C_m: total leaf C content (mg g^{-1})	**WUE**: Intrinsic water use efficiency (A/g_s; µmol mol^{-1})
RD: rooting depth (cm)	***g_{min}***: minimum epidermal conductance (mmol m^{-2} s^{-1})
SD: stem density (g cm^{-3})	**Ψ**: midday leaf water potential (Mpa)

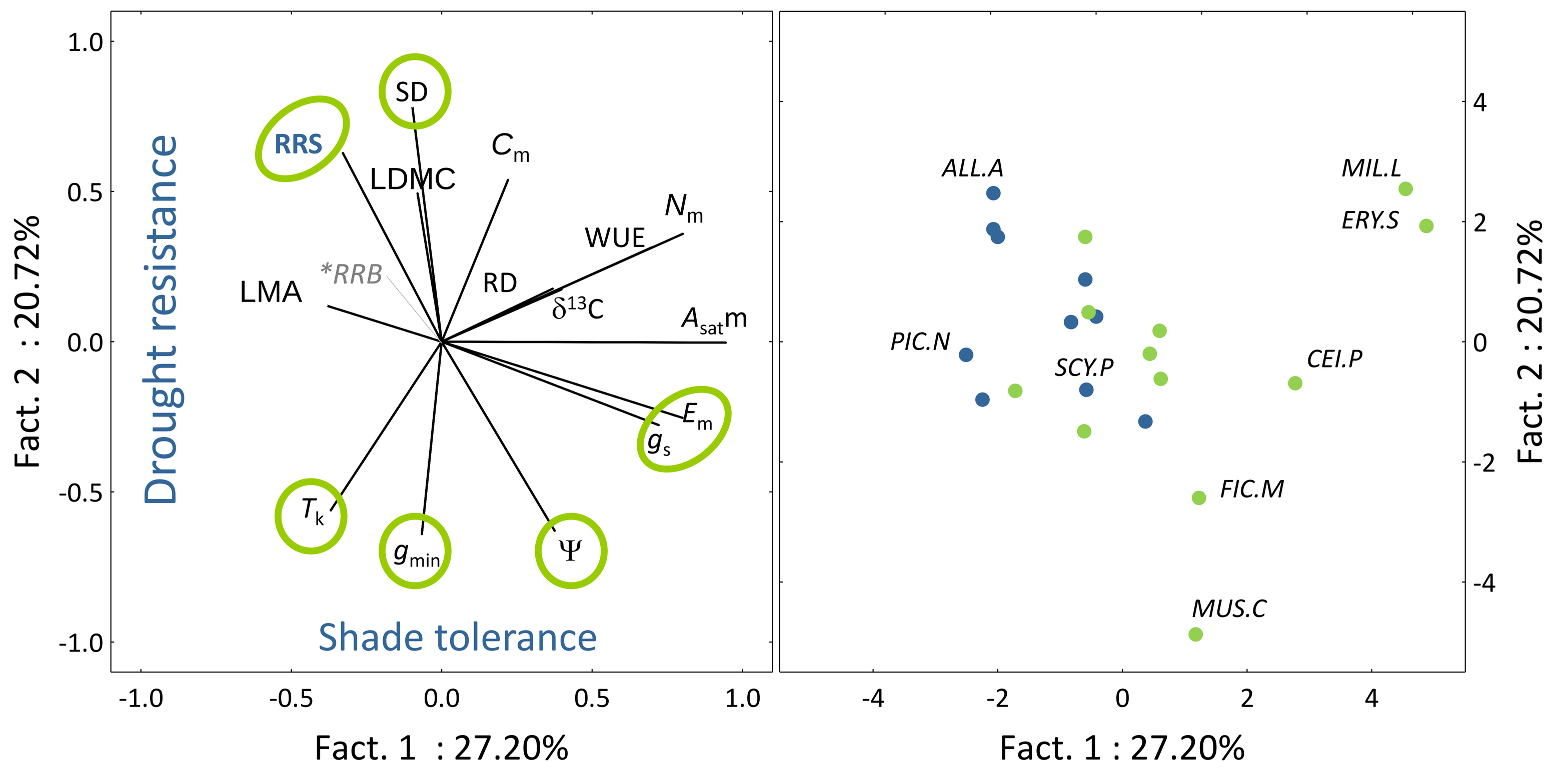


Figure 2. Principal component analysis of 15 traits for 22 studied species. RRB was projected as additional variable. Pioneer species are indicated by green dots.

- The results suggest that **high desiccation tolerance**, associated with **high stem density** (which should be related to low vulnerability to xylem embolism), as well as **low water loss** from transpiration (E_m , g_s and g_{min}) are especially important for variation of drought resistance in these species. Rooting depth and water use efficiency, in contrast, were not important.
- Drought resistance in terms of growth (biomass or leaf area) was unrelated to any of the traits examined.
- The results suggest the **independence between shade and drought tolerance**: axis 1 from the PCA, where species with high assimilation rate are opposed to one with high LMA, should correspond to a shade tolerance axis. This is support by the projection of species on the factor plane.

- **This study provides the first step for linking drought resistance (and shade tolerance), as well as the underlying traits, to species distribution in the Congo basin.**

Material & Methods

○ **Overview:** Seedling performance was compared under dry and irrigated conditions to assess drought resistance, and traits were assessed.

○ **Study Site:** The experiment was conducted at Pointe Noire (Republic of Congo) in a Eucalypt plantation on deep sandy soil in the 5-month dry season (annual rainfall 1400mm).

○ **Species:** 35 Central African species (33 trees and 2 palms) from 19 families. The seedlings were grown from seeds collected in semi-deciduous forest in the south Central African Republic and South Cameroon, and transplanted to field plots.

○ **Experimental design:** 1-year seedlings were transplanted in 60 plots. For the duration of the dry season, half of the plots were irrigated while the other half were allowed to dry, and seedling performance was monitored.

○ **Quantifying plant drought resistance:** Effect on DRY and WET treatment on species SURVIVAL and GROWTH:

$$RR_S=(Survival_{DRY} / Survival_{WET}) \times 100$$
$$RR_B=(Biomass_{DRY} / Biomass_{WET}) \times 100$$

○ **Traits measurements (WET plots):** traits potentially involved in the capacity to survive drought were assessed in plants in the irrigated treatment, and the variation across species and covariation among traits was assessed.

SCIENTIFIC PARTNERS

CIRAD : French Agricultural Research Centre for International Development, France
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