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The water relations of Inga multinervis for efficient water use in forest systems

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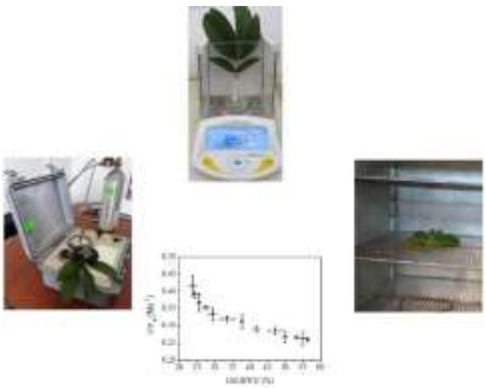
Graphical Abstract



Abstract

Inga multinervis, a little-known species, is being used in agroforestry systems for nitrogen fixation and soil improvement. The aim of this research was to characterize the water relations of the species I. multinervisfrom pressure–volume measurements. The results indicated that the species has the capacity for osmotic and elastic adjustment, given to the low solute potentials and elasticity of the cell walls, thus its use is recommended in degraded forest systems with low water levels in the soil.

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Introduction

Inga multinervis is a species of legume in the Fabaceae family, which grows only in Ecuador. Its natural habitats are subtropical or tropical moist lowland forests and subtropical or tropical moist montane forests (Neill and Pitman, 2004). This little-known species is being used in agroforestry systems for nitrogen fixation and soil improvement. Consequently, from the physiological point of view it's important to increase the knowledge of this speciesfor future forest management, which will allow its use in mitigating environmental impacts.

Pressure–volume (P–V) curves are frequently used to analyze water relation properties of woody plants in response to transpiration-induced tissue water loss. Generally, P–V-derived parameters reflect the environmental conditions of growth.

Reforestation of degraded land requires the use of selected species which shouldprovide sustainable long-term ecological services. Eco-physiological properties of trees are commonly considered when their capacity for growth and stress tolerance are evaluated (Kozlowski and Pallardy, 1997; Larcher, 2003).

The aim of this research was to characterize the water relations of the species I. multinervis forefficient use of water in forest systems.

Materials and Methods

Study site and plant materials

The study was carried out at Universidad EstatalAmazónica, located in the Province of Pastaza, Ecuador. Sampling was carried out in the proximity to the university. Plant material included the tree specieI. multinervis.

P–V curve analysis

Measurements for P–V analyses were performed using a pressure chamber (Model 1000, PMS instruments Corvallis, OR) following the method described in previous studies (Tyree and Hammel 1972; Kubiske and Abrams 1990).

Statistical analysis

Statistical analyses were performed using analysis of variance.

Results and discussion

P–V parameters

Figure 1 shows typical Höfler diagrams obtained from P–V curves for I. multinervis. These diagrams represent dynamic changes of water potential (Ψ_w), osmotic potential (Ψ_p), pressure potential (Ψ_p) andbulk elastic modulus (ε) in relation to relative symplastic water content (SWC).

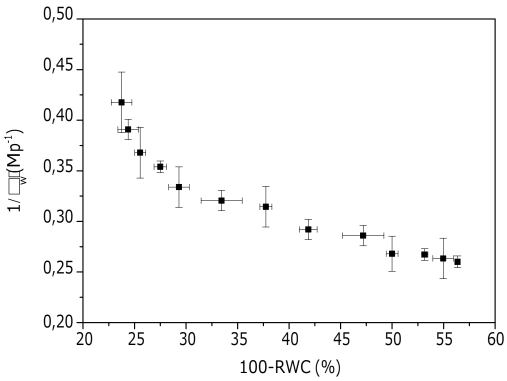

Figure 1. Plots of relative water content (RWC) against water potential (Ψw).

Table 1 shows the water relation parameters derived from P–V curves for I. multinervis.

Table 1. Water parameters from I. multinervis

Osmotic potential (MPa)	-2.41
Osmotic potential at water saturation with full Turgor (MPa)	-3.62
Bulk elastic modulus (MPa)	7.81
Relative water content at turgor loss point (%)	73.31

I. multinervis showed higher osmotic potential and osmotic potential at water saturation with full turgor than other species, such as Robiniapseudoacacia, Quercusliaotungensis, Syringaoblata, Acer stenolobum, Armeniacasibirica, Pyrusbetulaefolia, Caraganamicrophylla, Rosa hugonisaccording to reported by Yan et al.,(2013). These authors reported for these species bulk elastic modulus and relative water content at turgor loss point above those shown by I. multinervis.Bulk elastic modulusis one of the key leaf physiological traits of plantdrought tolerance estimated from the relationship betweenthe leaf–water potential and leaf–water volume, alsoknown as the pressure–volume curve.□ is mechanistically related to other P–V parameters that includeosmotic potential at turgor loss point, osmoticpotential at full turgor, and relative water content at turgor loss point. These parameters have alsobeen correlated with various aspects of drought tolerance(Lenz et al.2006; Bartlett et al.2012; Touchetteet al., 2014). For instance, a more negativeosmotic potential at turgor loss pointextends therange of leaf–water potential at which the leaf remainsturgid and maintains stomatal and hydraulic conductance,photosynthetic gas exchange, and plant growth, which isespecially important when drought occurs during thegrowing season (Lenz et al., 2006; Bartlett et al., 2012).

These results indicate that the species presents high water absorption capacity of the soil, so it is recommended to use it for low water consumption and consequently less impact on the soil and the environment.

Conclusions

The determination of the water parameters from the P-V curves allows the characterization of the water relations of forest species. I. multinervis presented low values in the osmotic potential at water saturation with full turgor and in the water potential at turgor loss point, as well as low bulk elastic modulus, indicating that it is a suitable species for forest systems in low water content soils. The species is recommended to mitigate the environmental impacts associated with drought degraded soils.

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