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Growth and photosynthetic responses in *Jatropha curcas* L. seedlings of different provenances to watering regimes

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Abstract

Seedlings from four provenances of *Jatropha curcas* were subjected to 80, 50, and 30% of soil field capacity in potted experiments in order to study their responses to water availability. Our results showed that with the decline of soil water availability, plant growth, biomass accumulation, net photosynthetic rate, stomatal conductance (g_s), and transpiration rate (E) decreased, whereas leaf carbon isotope composition ($\delta^{13}C$), leaf pigment contents, and stomatal limitation value increased, while maximal quantum yield of PSII photochemistry was not affected. Our findings proved that stomatal limitation to photosynthesis dominated in *J. curcas* under low water availability. The increase of $\delta^{13}C$ should be attributed to the decrease in g_s and E under the lowest water supply. *J. curcas* could adapt to low water availability by adjusting its plant size, stomata closure, reduction of E, increasing $\delta^{13}C$, and leaf pigment contents. Moreover, effects of provenance and the interaction with the watering regime were detected in growth and many physiological parameters. The provenance from xeric habitats showed stronger plasticity in the plant size than that from other provenances under drought. The variations may be used as criteria for variety/provenance selection and improvement of *J. curcas* performance.

Additional key words: carotenoids; chlorophyll fluorescence; gas exchange; water-use efficiency.

Introduction

It is well known that either excessive or insufficient soil water content leads to stress (waterlogging or drought) for plants. Accordingly, plants possess genetically controlled mechanisms that allow them to live and grow under stress (Boyer 1982) including changes in structure, photosynthesis, osmotic adjustment, antioxidative protection, organ, whole-plant hydraulics (Dichio *et al*. 2013), and water-use efficiency (WUE) (Kheira and Atta 2009). Plant establishment and productivity are tightly related to leaf carbon gain and its response to drought. Under water stress, a reduction in photosynthesis was attributed to both stomatal and/or nonstomatal limitations (Varone *et al*. 2012). Generally, stomatal limitations are invoked by stomatal closure and nonstomatal limitations include both diffusive (reduced mesophyll conductance) and metabolic (photochemical and enzymatic limitations) processes (Galmés *et al*. 2007, Varone *et al*. 2012). As a photochemical parameter, maximal quantum yield of PSII photochemistry (F_v/F_m) of dark-adapted leaves by chlorophyll (Chl) fluorescence measurements is often used to indicate plant photosynthetic

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Abbreviations: C_a – ambient chamber CO_2 concentration; Car – carotenoids; Chl – chlorophyll; C_i – intercellular CO_2 concentration; E – transpiration rate; FC – soil field capacity; FM – fresh mass; F_v/F_m – maximal quantum yield of PSII photochemistry; g_s – stomatal conductance; L_s – stomatal limitation value; P_N – net photosynthetic rate; R_s – root/shoot ratio; WUE – water-use efficiency; $\delta^{13}C$ – carbon isotope composition.
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