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The effect of biochar on the transpiration rate response of upland rice to water deficit

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Introduction

Upland rice in the Brazilian cerrado (savanna) experiences multiple abiotic stresses. One of the main risk factors contributing to the heterogeneity of plantations is variable water availability. In this region upland rice growers are mostly small and family based holdings, associated with low inputs and effectively shallow fertile soil layers that enhance drought effects. Biochar might be a promising alternative to diminish this uncertainty in upland rice production. The pore size distribution in biochar added to the soil may have a direct impact on soil pore structure at the macroscale, suggesting that in the longer term the effect of biochar on available moisture would be positive in sandy soils ordinarily dominated by much larger pores than present in biochar. The objective of this study was to evaluate the effect of eucalypt (*Eucaliptus sp.*) charcoal fines, a byproduct of charcoal production, on the transpiration rate of upland rice (*Oryza sativa* cv. Curinga) as a function of water deficit, a measure that expresses the response of plants to drought stress. Two greenhouse experiments, at different dates, were installed. The experimental design was completely randomized with subdivided "plots", the main factor being the presence or not of water deficit and the sub-factor charcoal amendments (doses) added to the basic substrate (sand) (T1: 0%, T2: 6%, T3: 12% e T4: 24% charcoal). The charcoal was ground to pass a 2 mm sieve. To describe water deficit the water transpiration from soil (FTSW) and transpiration rate (TR) were calculated. The daily TR was normalised using control (no water deficit) data to receive the normalised transpiration rate (NTR). The NTR and FTSW values were combined using a non linear model (equation 1) to get the response curve.

$$NTR = \frac{1}{\left(1 + a * \exp(-b * FTSW\right)} \quad \text{eq. 1}$$

Being *a* and *b* model empirical parameters.

Results and Discussions

The empirical *a* and *b* parameters determined in equation (1) for the 4 treatments are showed In Table 1.

Table 1. Empirical a and b model parameters for treatments T1, T2, T3 and T4, for cultivar BRSMG Curinga.

Treatments	a	b
T1	1.54*	6.35*
T2	1.85*	7.87*
T3	3.31*	12.38*
T4	3.87*	12.77*

* = significant to 5% of probability level.

The adjusted model (equation 1) for treatments T1, T2, T3 and T4 are presented in Figure 1 a, b, c and d. Basically, increasing the biochar levels has an effect on the BRSMG Curinga transpiration response curve. This effect is related with the available soil water. Many studies have been related that at the highest potential the volumetric water content was double that of soil without biochar added [1,2]. In this study it was observed that the increase of biochar levels was responsible for an increase of available soil water as illustrated by Figure 2.

Conclusions

The biochar had a positive effect on plant transpiration.

The increase in the proportion of biochar occurred greater availability of water in different treatments.

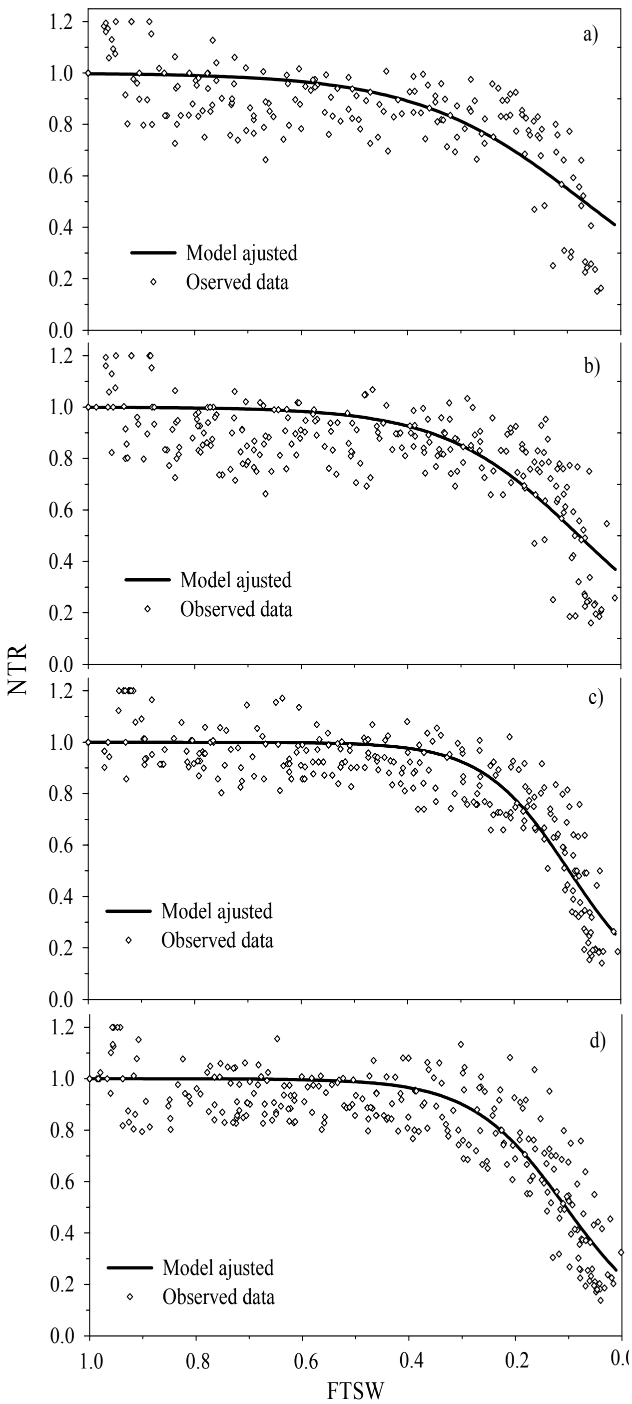

Figure 1. Relationship between the normalized transpiration rate (NTR) and the fraction of transpirable soil water (FTSW) for treatments a) T1 (0% of biochar), b) T2 (6% of biochar), c) T3 (12% of biochar) and d) T4 (24% of biochar) for BRSMGCuringa cultivar.

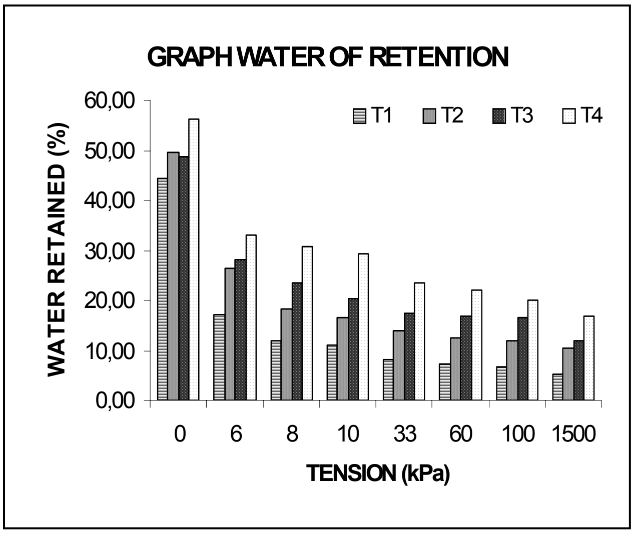

Figure 2. Graph water retention in treatments a) T1 (0% of biochar), b) T2 (6% of biochar), c) T3 (12% of biochar) and d) T4 (24% of biochar).

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