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Communication

Amending Soils with Hydrogels Increases the Biomass of Nine Tree Species under Non-water Stress Conditions

The classical aim of the application of super absorbent polyacrylate (SAPs) hydrogels is the prolonging of plant survival under water stress. Their effect on plant growth during non-water stress conditions is not known. This study examined the root and shoot biomass of seedlings of nine tree species; *Eucalyptus grandis*, *Eucalyptus citriodora*, *Pinus caribaea*, *Araucaria cunninghamii*, *Melia volkensii*, *Grevillea robusta*, *Azadirachta indica*, *Maesopsis eminii* and *Terminalia superba*. The seedlings were potted in five soil types; sand, sandy loam, loam, silt loam and clay. These were amended at two hydrogel levels: 0.2 and 0.4% w/w and grown under controlled conditions in a green house. Root and shoot growth responses of the seedlings were determined by measuring the dry weight of the roots, stems, leaves and twigs. The addition of either 0.2 or 0.4% hydrogel to the five soil types resulted in a significant increase of the root dry weight ($p < 0.001$) in eight tree species compared to the controls after 8 wk of routine watering. Also, the dry weight of stems and leaves and twigs were significantly ($p < 0.001$) higher in the nine tree species potted in hydrogel amended soil types than in the hydrogel free controls. These results suggested that hydrogel amendment enhances the efficiency of water uptake and utilization of photosynthates of plants grown in soils which have water contents close to field capacity.

Keywords: Biomass; Hydrogels; Nine tree species; Non-water stress; Soil types; Super Absorbent Polyacrylate (SAPs)

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1 Introduction

Water is the most important soil physical factor that affects plant growth and quantification of such growth (e.g., height, biomass) is relevant for the understanding of the plant-water relationship [1]. Roots conduct water, nutrients, provide mechanical support to plants and are the primary sensors of water stress [2]. Roots are dependent on shoots for carbohydrates as shoots depend on roots for water and nutrients [2]. Optimum growth of plants depends on an efficient balance in the functions of roots and shoots [2]. A developed root system determines plant growth and survival in any soil type because rapid root development enhances lateral and vertical access of water in the layers of soil. The use of hydrophilic polymer (hydrogel) amendments is one known method of supplying additional water to plants (e.g., [3–11]) by increasing the stored water in the root zone for use by the plant.

Hydrogels maintain a conductive soil environment that facilitates water and nutrient absorption for plant root and shoot growth in periods of water stress. The highly cross-linked polyacrylamide hydrogels (Super Absorbent Polymers (SAPs)) that can absorb and hold up to 400 times their weight of water [6, 11, 12] aid tree establishment in various media including degraded and polluted soils where water retention and root development are reduced [11].

Highly cross-linked hydrogels have been shown to favor good tree root development [6] and improve root growth during water stress conditions [6, 13–16]. It has been shown that hydrogels also increase root growth under saline conditions [17]. Experiments on the effects of hydrogels on plant growth indicate increased shoot biomass in terms of root collar diameter, height and number of leaves [14, 16, 18] under water stress conditions. It was found for the Hot-Dry Valleys in Yunnan, China, that several tree species had higher growth in hydrogel amended soils [19]. Increased root growth of *Photinia fraseri* plants in hydrogel amended media was shown during irrigation [20]. Increases in growth were also reported in citrus seedlings grown in well watered hydrogel amended sand soil [21]. Hydrogel induced plant growth under water stress conditions in sand, sandy loam and loam soils has been demonstrated for several tree species (e.g., [6, 7, 9, 22]).

However, the effects of SAPs on the biomass of a wide range of trees species in soils of different particle sizes has not yet been comprehensively studied under non-water stress conditions. In this study, the effects of different levels of hydrogels on the root and

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Abbreviations: **ANOVA**, Analysis of variance; **CEC**, Cation exchange capacity; **SAP**, Super absorbent polymers