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Research Article

Effects of Hydrogel Amendment to Different Soils on Plant Available Water and Survival of Trees under Drought Conditions

Dedicated to Aloys Hüttermann, to his honor and memory

The effect of super absorbent polyacrylate (SAP) hydrogel amendment to different soil types on plant available water (PAW), evapotranspiration and survival of *Eucalyptus grandis*, *Eucalyptus citriodora*, *Pinus caribaea*, *Araucaria cunninghamii*, *Melia volkensii*, *Grevillea robusta*, *Azadirachta indica*, *Maesopsis eminii* and *Terminalia superba* was investigated. The seedlings were potted in 3 kg size polythene bags filled with sand, loam, silt loam, sandy loam and clay soils, amended at 0 (control), 0.2 and 0.4% w/w hydrogel. The tree seedlings were allowed to grow normally with routine uniform watering in a glass house set up for a period of eight weeks, after which they were subjected to drought conditions by not watering any further. The 0.4% hydrogel amendment significantly ($p < 0.05$) increased the PAW by a factor of about three in sand, two fold in silt loam and one fold in sandy loam, loam and clay soils compared to the control. Similarly, the addition of either 0.2 or 0.4% hydrogel to the five soil types resulted in prolonged tree survival compared to the controls. *Araucaria cunninghammi* survived longest at 153 days, while *Maesopsis eminii* survived least (95 days) in sand amended at 0.4% after subjection to desiccation. Evapotranspiration was reduced in eight of the nine tree species grown in sandy loam, loam, silt loam and clay soils amended at 0.4% hydrogel. It is probable that soil amendment with SAP decreased the hydraulic soil conductivity that might reduce plant transpiration and soil evaporation.

Keywords: Drought; Hydrogel; Plant available water; Transpiration; Tree survival

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1 Introduction

Hydrogels, which were developed to increase the water holding capacity of amended media, have been used to aid plant establishment and growth in dry soils [1]. They have the potential to absorb water many times their weight, retain it and supply it to plant roots during water stress, thereby enhancing plant survival and growth [2–6]. The water absorbency of super absorbent polyacrylates (SAPs) depends on the degree of neutralization of monomer acid, the amount of initiator and the volume of polymerization mixture [7]. The addition of hydrogel to soils can improve not only its water holding capacity [1], but also the supply of plant available water [8, 9]. The addition of 4–6 g/kg of hydrogel to soil increased the available water content in sandyloam by a factor of 2.2–2.3, whereas in clay that factor was 1.1–1.2 [10, 11]. The plant available water (PAW) storage capacity of a soil provides a buffer which determines a plant's ability to withstand dry spells, hence its survival and growth [4–6, 12, 13]. An increase in plant available water of about 100% in sandy loam and loam soils when amended with hydrogels has been reported [6].

Most successful hydrogel studies have been conducted on sandy soils with a narrow range of tree species [4] and a few on sandy loam and loam soils using agricultural crops [6]. In a field trial by [14] to test tree survival and growth of *Eucalyptus grandis* clones grown on a hydrogel amended sandy clay loam soil, a highly significant ($p < 0.01$) interaction between hydrogel and water that had a positive impact on both transplant survival and growth was observed compared to water only treatments.

In spite of many success stories with hydrogel application, some responses of moisture requiring plants to hydrogels have been inconclusive and sometimes negative when used in field and container productions [11]. In a container production of *Betula pendula* (European birch), hydrogel addition into the medium showed reductions in the overall plant mass and the amount of available water in the plants [15]. The relative effectiveness of the hydrogels depends on its chemical properties, such as molecular weight, and it tends to have differing effects on various soil properties [11]. No studies have been done so far to compare hydrogel effects on a range

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Abbreviations: **PAW**, Plant available water; **SAP**, Super absorbent polyacrylate

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