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Seedball-Induced Changes of Root Growth and Physico-Chemical Properties in the Rhizosphere of Pearl Millet Seedlings

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Abstract

Seedball technology is a cheap "seed-pelleting-technique" that combines 80 g sand, 50 g loam, 25ml water, 2.5 g seeds and 1 g NPK-mineral-fertiliser to produce about ten seed-containing-balls of 1.5–2.0 cm diameter size to enhance pearl millet seedlings establishment. Despite its significance for seedling improvement, little is known about early root-development and nutrient-dynamics in the root-zone, influenced by root activity. Therefore, our major objective was a non-destructive monitoring of nutrient-distribution and early root-development in seedball-derived pearl millet seedlings (one seedling/tube) using a computer-tomography (CT) assisted-scanner (XT H 225; NikonR Alzenau, Germany) with a micro-focus X-ray tube and suction-cup methods. Measurements were conducted at three time intervals at 7, 14 and 21 days after planting (DAP). Three treatments comprising non-coated seeds (control), nutrient-free seedballs (SB) and NPK–seedball (SB+NPK) were used to germinate and grow seedlings in cylinder tubes (height: 25 cm, diameter: 7 cm) for 24 days under controlled growth-chamber conditions (temperature: 30°C, humidity: 65 %, light: 12 h light, 300μmol m^2/s) in a completely randomised design of six treatment repetitions on a sandy soil (pH $CaCl_2$: 4.5, >90 % sand, P-Bray: 33.2 mg kg^{-1}). A soil moisture content of 16 % (w/w) was adjusted gravimetrically every 24^{th} h. Suction cups (www.rhizosphere.com) were used for sampling of soil solutions from the upper 3.5 cm soil layer (seedball location) and lower (7.0 cm) parts of the growth-tubes. Root dry-matter increments by 30 %, and shoot biomass and shoot dry-matter by 164 % and 225 % in SB+NPK compared to non-coated-seed control and by 60 % and 57 % compared with the nutrient-free SB variant were observed. The X-ray CT-scanning images revealed more intense development at the upper layer in the SB+NPK treatments detectable within the first 14 DAP which may reflect the well-documented root-attracting properties of localised N and P supply. The P concentration in the soil solution collected from SB+NPK root-zone was significantly 954,999 % and 4,049 % higher than in the non-coated-seed control and the SB variant, respectively. This was associated with 10 % and 48 % increase of electrical conductivity (EC), respectively. EC and P determined in the sampling-solutions declined with time, reflecting root uptake and/or translocation of nutrients into deeper soil layers.

Keywords: Arid/semi-arid seedlings, local materials, pearl millet roots, rhizosphere dynamics, seedball technology, seedlings establishment

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