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Gravel Content of Soil Impact on Water Use, Growth and Yield of Pearl Millet

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Abstract

The effect of gravel content (GC) of soil on water use efficiency (WUE), growth and yield of pearl millet (*Pennisetum glaucum*) was investigated under greenhouse conditions at the University of Ghana. Pearl millet was grown either in repacked soil columns with varying gravel contents (0, 10 %, 20 %, 30 %, 40 %, 50 % 60 % and 70 %), and in undisturbed monoliths which had 10 %, 34 %, 64 % and 72 % GC (w/w). The plants were irrigated following rainfall pattern in the Upper East Region of Ghana from where the soils were sampled and noted for pearl millet production. All the trials received fertiliser application of 100 kg N ha^{-1}, 20 kg P ha^{-1} and 20 kg K ha^{-1}. Data collected during the plant growth included runoff, drainage, plant evapotranspiration (ETa), and nutrient leaching. Plant data included plant height, number of leaves, chlorophyll, biomass, and grain yield at maturity. The WUE was determined as the ratio of grain yield to ETa. The results indicated that there was no significant difference between the ETa of the repacked soil columns and undisturbed monoliths. In soil columns with more than 40 % GC, appreciable (64 %) of irrigation was lost via runoff and drainage. On the contrary, soils with less than 40 % gravel lost on average 43 % of irrigation via runoff and drainage. Nutrient leaching, estimated as the Total Dissolved Salts in the drained water (TDS) showed that soils columns with more than 40 % GC lost at least 40 % of the applied nutrients and this was significantly ($p = 0.001$) higher than nutrient lost in columns with 0 % GC. Chlorophyll and leaf number were significantly higher ($p = 0.001$) when the GC was between 0 % and 40 %. Shoot, root, grain yield, and WUE were significantly higher ($p = 0.001$) at GC = 40 % compared to GC = 0 % and declined as the GC increased. As the GC increased (>50 %), soil moisture content decreased, and nutrient leaching increased. The study showed that increasing GC reduces soil and plant productivity, and such soils would require specialised amendments to offset the adverse impact of gravels on plant growth.

Keywords: Gravel content, nutrient leaching, plant growth, water use efficiency, yield

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