

Soil strength and maize yield after topsoil removal and application of nutrient amendments on a gravelly Alfisol toposequence

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Abstract

Vast areas of degraded soils exist in southwestern Nigeria due to topsoil removal by soil erosion and gravel/stone mining operators. The restoration of such soils has become imperative to sustain food production in most rural communities. Therefore, a factorial field experiment in three replicates of a randomized complete block design was carried out in 2003 and 2004 with the factors being slope positions (upper and lower slopes), topsoil removal (0, 15 and 25 cm depths) and nutrient amendments (0, 10 t ha⁻¹ poultry manure and 60:30:30 N:P₂O₅:K₂O as NPK + urea). This was complemented with a laboratory study to determine the effects of soil water, gravel concentration and gravel size on soil strength. Maize (*Zea mays* L.) was planted as a test crop to determine the effects of treatments on yield and the effect of root growth on soil strength. Soil strength was measured with a self-recording penetrometer at soil depth interval of 2.5–50 cm depth. Soil bulk density, water content, maize root and shoot biomass and grain yield were measured. In the laboratory, soil strength decreased from 483 to 314 kPa as water content increased from 0.05 to 0.62 cm³ cm⁻³ while it increased from 294 to 469 kPa as gravel concentration increased from 100 to 500 g kg⁻¹. Soil strength was affected more by water content and gravel concentration than gravel size. Under various moist conditions in the field, soil strength increased with soil depth from 1177 to 5000 kPa at the upper slope and from 526 to 5000 kPa at the lower slope. Thus, the lower slope had significantly lower soil strength than the upper slope. Soil strength increased with increasing soil depth removal and was significantly reduced by poultry manure. For the 2 years of study, high grain yields were sustained with poultry manure/no topsoil removal (1784–3571 kg ha⁻¹) and NPK + urea/no topsoil removal (2371–2600 kPa) at the lower slope. However, soil at the upper slope was more resistant to degradation as 16–67% loss in yield was observed compared to 65–75% for lower slope when no nutrients were applied. Nonetheless, both the upper and lower slope positions were productive with the application of poultry manure irrespective of topsoil removal, compared to NPK + urea, which was only effective without topsoil removal. Therefore, poultry manure was a better soil ameliorant than NPK + urea after topsoil removal.

Keywords: Soil strength; Gravelly Alfisol; Artificial desurfacing; Maize; Poultry manure; Soil rehabilitation.