Shear strength enhancement by Digitaria setivalva associated with NPK and bio green application on Bungor soil slope

ABSTRACT

Understanding the chemical constraints to plant growth and their amelioration is critical for erosion control and slope stability on artificial landforms. Limited studies have investigated the effects of chemical amendments on grass growth, and effects on soil physical and chemical characteristics on the slope surface. Digitaria setivalva (Mardi Digit grass) was used as a grass coverage to control erosion on the steep man made slope. The current slope studies (45o-50o) on Bungor soil series to address two objectives; (1) to investigate the effects nitrogen (N)-phosphate (P)-potassium fertilizer (NPK) and Bio Green fertilizer (BG) on above-ground and root growth, and (2) to determine physico-chemical properties and root shear strength after application of treatments. The Bungor series was acidic pH (4.63), moderate soil organic carbon (1.42%), total N (0.12%),available P (12.2 mg kg-1) and potassium (0.44 mg kg-1), indicating low inherent infertility and chemical constraints to plant growth. Therefore, above-ground biomass (kg m-3) for nutrient and organic amendments; NPK+BG (7.2), BG (6.1) > NPK (2.2)was more than double that of the unamended control (1.3). A similar trend was observed for root biomass density (kg m-3);NPK+BG (272.94), BG (262.70)>NPK (133.76) > control (98.60) and root length density (cm m-3); NPK+BG (8332.0), BG(8092.0) > NPK (5200.0) > control (4000.0). Rapid vegetation growth observed within a 6-month period demonstrates that NPK and Bio Green application effectively ameliorated chemical constraints to plant growth. Enhanced vegetation growth subsequently reduced soil leachates (N, P and K) from the slope significantly as compared to NPK and Control treatments. The application of NPK+BG and BG fertilizer showed significant effect in reducing nutrients loss, increased soil aggregate stability, water retention, hydraulic conductivity and improved macro- and micro nutrients content. Enhanced vegetation growth subsequently increased shear strength (s) as evidenced by positive power relationships (r2 = 0.53-0.69, p<0.05) between root density, and angle of internal friction (ɸ) and shear strength. The significant root-ɸ relationship indicates that root enhanced shear strength by increasing the frictional component but not cohesion. The increase in shear strength was attributed to increase in virtual density and reduced pore water pressure attributed to root water uptake associated with rapid vegetation growth. Root biomass and root length density may increase the shear strength and reduced pore water pressure attributed to root water uptake associated with rapid vegetation growth. Under field conditions, a dense canopy and root network also reduces soil detachment and transport by raindrop impact and runoff. These multiple vegetation-soil interactions are critical for erosion control and slope stability on artificial land forms such as cut slopes.

Keyword: Artificial landforms; Chemical constraints; Cut slopes; Surface coverage; Rapid growth; Root relationships; Vegetation-soil interactions