Tropentag, September 16-18, 2026, hybrid conference

"Towards multi-functional agro-ecosystems
promoting climate resilient futures"

Comparative analysis of organic and inorganic soil amendments on microbial biomass and nutrient dynamics in maize-based systems of Wondo Genet, Ethiopia

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Abstract

Soil degradation threatens agricultural sustainability in Ethiopia, necessitating effective fertilisation strategies to maintain productivity. This study systematically evaluated the effects of organic and inorganic fertilisers on microbial biomass and soil nutrients in Wondo Genet, Ethiopia. Using a randomised complete block design, three treatment rates of forest soil (organic fertiliser) and chemical fertiliser were applied alongside control treatments. Soil samples were collected from two depths (0–10 cm and 10–20 cm) and analysed for microbial biomass and key soil nutrients. Results demonstrated that both soil amendments significantly improved microbial biomass and soil nutrients compared to the control ($p < 0.05$). Organic treatments achieved the highest microbial biomass carbon (MBC: 1979.72 μg/g) and nitrogen (MBN: 141.92 μg/g), followed by inorganic and control treatments. Organic amendments increased soil organic carbon (SOC) and total nitrogen (TN) by 34.11 % and 34.04 %, respectively, while inorganic fertiliser increased these parameters by 21.44 % and 12.77 %. Additionally, organic fertiliser enhanced available potassium and phosphorus by 12.19 % and 25.7 % compared to inorganic treatments. Fertiliser application rates significantly influenced microbial biomass, with optimal rates of 0.75 $^{kg}/_{m^2}$ for organic and 4.9 $^{g}/_{m^2}$ for inorganic amendments. Soil depth critically affected microbial biomass distribution, with consistently higher values in topsoil, though soil nutrients remained unaffected by depth. Correlation analysis revealed strong positive relationships between MBC and MBN, and between SOC and TN. These findings demonstrate the superiority of organic fertilisers in enhancing soil microbial biomass and key nutrients, indicating greater potential for improving soil fertility and sustainability. The results advocate for organic-based soil management strategies to restore soil health and support sustainable crop production in the Ethiopian Rift Valley and similar vulnerable agroecosystems.

Keywords: Fertilisers, microbial biomass, soil degradation, soil nutrients, sustainable agriculture

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