International Scholars Journals

African Journal of Estate and Property Management ISSN 2756-3308Vol. 8 (1), pp. 001-005, May, 2021.
Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

The long-term land management effects on soil properties and microbial populations in a maize-bean rotation at Kabete, Kenya

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Accepted 17 May, 2021

The effect of continued application of mineral and organic fertilizers on soil agro-properties and soil microbial populations and activity, was studied in a long-term field experiment at Kabete, in the highlands of Kenya. The area is sub-humid with an average bimodal rainfall of 980 mm and two cropping seasons per year. The main treatments were 3 rates of inorganic N and P fertilizers, farmyard manure (FYM) with or without stover retention. Maize and beans were planted during the long and short rain seasons, respectively. Total % N declined by 25% from 0.16% while soil organic carbon decreased from 2 to 1.2%. The soil pH value dropped by 1.3.units from 5.5 but the decrease in bulk density from 1.04 to 1.08 g cm^{-3} soil in the no-input control treatment was not significant. Use of FYM alone or in combination with chemical fertilizers led to higher numbers of microbes and enhanced microbial respiration than use of chemical fertilizers alone. The topsoil layer had significantly (p = 0.05) higher microbial activity than the sub-soil regardless of management strategy. Bacteria were more numerous {1 × 10^5 cfu (colonies forming units) g dry wt. soil $^{-1}$} than fungi (1 × 10^3 cfu g dry wt. soil $^{-1}$), which may lead to more soil organic matter (SOM) mineralization and less SOM retention in this cropping system. Integrated use of organic inputs such as farmyard manure and chemical fertilizers is recommended to maintain soil productivity under continuous cultivation.

Key words: Land management, fertilizers, farmyard manure, crop residues, soil properties, mineralization, microbial population.

INTRODUCTION

Increased food production in the sub-Saharan African region is dependent on intensive agricultural production to meet acute food deficits and overcome effect of declining agricultural land productivity. Follett and Schimel (1989) reported a more rapid mineralization of SOM when continuous cultivation was combined with residue removal and tillage. Thus continuous cropping may enhance loss of SOM stocks due to accelerated mineralization unless appropriate land management practices are put in place. However, current economic policy reforms have led to high fertilizer prices compared to crop harvests leading to low inputs : output returns and stagnation in agricultural productivity (Heerink, 2005).

Soil biota plays a major role in the decomposition and mineralization of plant residues (Pankhurst and Lynch, 1994). Microflora, including bacteria, fungi and actinomycetes, are the main agents of nutrient cycling. During the decomposition and transformation of organic substances, part of the substrate carbon is released as carbon dioxide (CO_2); another part is used for the production of new microbial tissue and population maintenance, while the remainder becomes a constituent of humus (Tesarova, 1988). Nitrogen, which is a key element for growth is also released through mineralization by the nitrifying bacteria.

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Other microorganisms especially fungi are important in stabilizing the soil structure. The basic unit of a fertile soil