European Journal of Soil Biology 69 (2015) 33–40

Contents lists available at ScienceDirect

European Journal of Soil Biology

journal homepage: http://www.elsevier.com/locate/ejsobi

Original article

Microbial and enzymes response to nutrient additions in soils of Mt. Kilimanjaro region depending on land use

Kevin Z. Mganga [a, b, *], Bahar S. Razavi [a], Yakov Kuzyakov [a, c, d]

[a] Department of Soil Science of Temperate Ecosystems, University of Göttingen, Büsgen-Institute, Büsgenweg 2, 37077 Göttingen, Germany
[b] Department of Range and Wildlife Sciences, South Eastern Kenya University, P.O. Box 170-90200, Kitui, Kenya
[c] Department of Agricultural Soil Science, University of Göttingen, Institute of Soil Science, Büsgenweg 2, 37077 Göttingen, Germany
[d] Institute of Environmental Sciences, Kazan Federal University, Kremlevskaya, 18, 420049 Kazan, Russia

ARTICLE INFO

Article history:
Received 10 April 2015
Received in revised form
1 May 2015
Accepted 12 May 2015
Available online 16 May 2015
Handling editor: B.S. Griffiths

Keywords:
β-glucosidase
Cellobiohydrolase
Chitinase
Phosphatase
Land use
Mt. Kilimanjaro
Carbon cycle
Soil fertility

ABSTRACT

Microbial and enzyme activities can be used to identify and assess the impacts of changes in land use management on soil quality. However, only few studies have investigated the effects of land use and nutrient additions on enzyme activities and microbial processes in tropical African soils. Glucose and nutrients (N and P) were added to soils (0–20 cm) from natural and agricultural ecosystems: (1) savannah, (2) maize fields, (3) lower montane forest, (4) coffee plantation, (5) grasslands (6) *Chagga* homegardens common at Mt. Kilimanjaro region and East Africa. Microbial biomass and activities of β-glucosidase, cellobiohydrolase, chitinase and phosphatase were monitored over 60 days incubation period. Microbial biomass content and enzyme activities were generally higher in soils under natural vegetation compared to corresponding agricultural soils. Decline in microbial biomass C content over time was higher in natural ecosystems compared to agricultural soils. However, the microbial biomass C content in *Chagga* homegarden soils was relatively stable. Land use was negatively correlated to β-glucosidase, cellobiohydrolase and chitinase activity, but positively correlated to phosphatase activity. β-glucosidase and cellobiohydrolase, involved in the C-cycle, were the most sensitive to landuse change. Chitinase activity was 2–6 times higher in soils under natural vegetation compared to corresponding arable soils. Phosphatase displayed very high activities in all land use types. This is attributed to the high P retention capacity common for andic soils similar to those occurring at Mt. Kilimanjaro region. Increased P availability stimulated enzyme activities in lower montane forest and *Chagga* homegarden soils. Overall, microbial biomass and enzyme activities showed a strong decrease with increased land use intensity and should therefore be taken into consideration in monitoring and assessing the impact of land use change at Mt. Kilimanjaro region.

1. Introduction

Land-cover change stemming from anthropogenic land uses represents a major source and component of global environmental change. During the 1980–2000 period, half of the new arable land in the tropics came at the expense of intact forests and another 28% came from disturbed forests [28]. In Africa, conversion of forests to permanent agriculture accounted for 16% of the change in forest area during the same period [24]. Savannah ecosystems in Africa are also under immense pressure and are being brought to intensive agricultural use [21]. Conversion of these natural ecosystems to agroecosystems is primarily driven by the need to feed the increasing human population and livestock. Currently, land use in East Africa is characterised by more agricultural land than natural ecosystems [32]. The population density in Africa in the next 30 years is projected to rise from 26 to 60 people km^{-2} and therefore further anthropogenic pressure will affect the natural environment [15].

Global effects of such land-use changes include the decreasing capacity of land for sustainable crop production due to loss of soil fertility. Microbial and biochemical characteristics of soil have been proposed as indicators of soil quality both in natural and agricultural systems. This is mainly attributed to their central role in cycling of C, N and other nutrients as well as sensitivity to change

* Corresponding author. Department of Soil Science of Temperate Ecosystems, University of Göttingen, Büsgen-Institute, Büsgenweg 2, 37077 Göttingen, Germany.
E-mail addresses: kzowe@yahoo.com, kmganga@gwdg.de (K.Z. Mganga).

http://dx.doi.org/10.1016/j.ejsobi.2015.05.001
1164-5563/