Abstract

Effects of forest restoration tree species on soil properties in Southern Rwanda

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Understanding the effects of tree species on soil properties is primordial for the development of forest restoration policies regarding the choice of species that will meet both environmental and local livelihood needs. We investigated the effects of exotic and native tree species, planted in 27 plots (31-82 years old), on selected soil properties (pH, SOM, water-extractable C and N) and soil exchangeable base cations (EBC) at two soil layers (0-5 cm and 5-10 cm) in the arboretum of Ruhande, Southern Rwanda. Given that trees were planted on one site with similar land-use history, climatic conditions, parent material, and soil type, we expect current differences in soil characteristics to reflect the influence of the tree species.

The effects of tree species were most apparent in the upper thin layer (0-5 cm) and the values of parameters were higher in this layer compared to the lower soil layer. The influence of tree species at 5-10 cm depth, was less marked and the values were lower for all measured parameters except for Al^{3+} and Fe^{2+} concentration. *Eucalyptus species* stands had the lowest soil pH (3.7) and mixed native species had the highest soil pH (5.8) as well as the highest exchangeable base cations (EBC) at both 0-5 cm depth (63±1.4 cmol $_{(+)}$/kg) and 5-10 cm depth (9.3±0.2 cmol $_{(+)}$/kg). Water extractable C and N fractions were higher at the upper soil layer compared to the lower layer. At 0-5cm, hot and cold water-extractable C and N fractions were positively correlated to soil organic matter (SOM) and negatively correlated to pH, but no significant correlation was observed at 5-10 cm. Our results showed that: (i) the two soil layers (0-5 cm and 5-10 cm depths) which were visibly undistinguishable under most of the species significantly differed in soil properties. This highlights the importance of the upper thin layer (0-5 cm depth) in tropical soils, which are generally poor and rely heavily on internal nutrient cycling through rapid decomposition of above-and belowground litter from vegetation (ii) *Eucalyptus* had negative consequences on soil pH and EBC, whereas soil under mixed natives had higher pH and EBC (iii) The sensitivity of water-extractable C and N fractions to detect tree species effects and their correlation with SOM indicates that these fractions could be used as substitutes to SOM analysis.

Keywords: *Eucalyptus; organic matter; water-extractable C and N; exotic tree species; soil nutrients; soil quality; Ruhande Arboretum*