Evolution of soil chemical properties in the rotational agroforestry system with *Acacia auriculiformis* during 22 years, DRC

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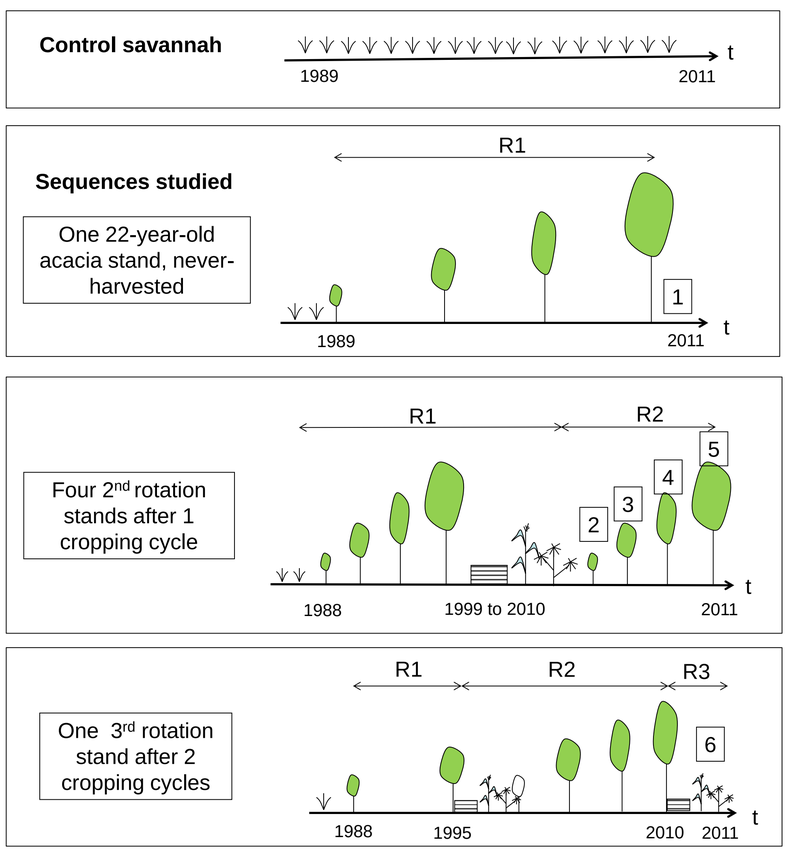
Background

To produce charcoal and prevent deforestation around Kinshasa, 7,700 ha of *Acacia auriculiformis* were planted on savannah ecosystems in 1987 (Bateke Plateau). Since 1995, the plantation was managed using the rotational woodlot system alternating agricultural and charcoal production on the same area (Kimaro *et al.*, 2007). Since 2005, the burning of residues was used to activate the germination of acacia seeds after carbonization. The objective of the study was to analyze the long term effect of rotational woodlots with N_2-fixing trees on soil chemical fertility.

Methods



Sequences	Logging dates
1	Never logged
2	2010
3	2007
4	2003
5	1999
6	1995 and 2010

Savannah

Acacia auriculiformis

Kiln

Maize, cassava

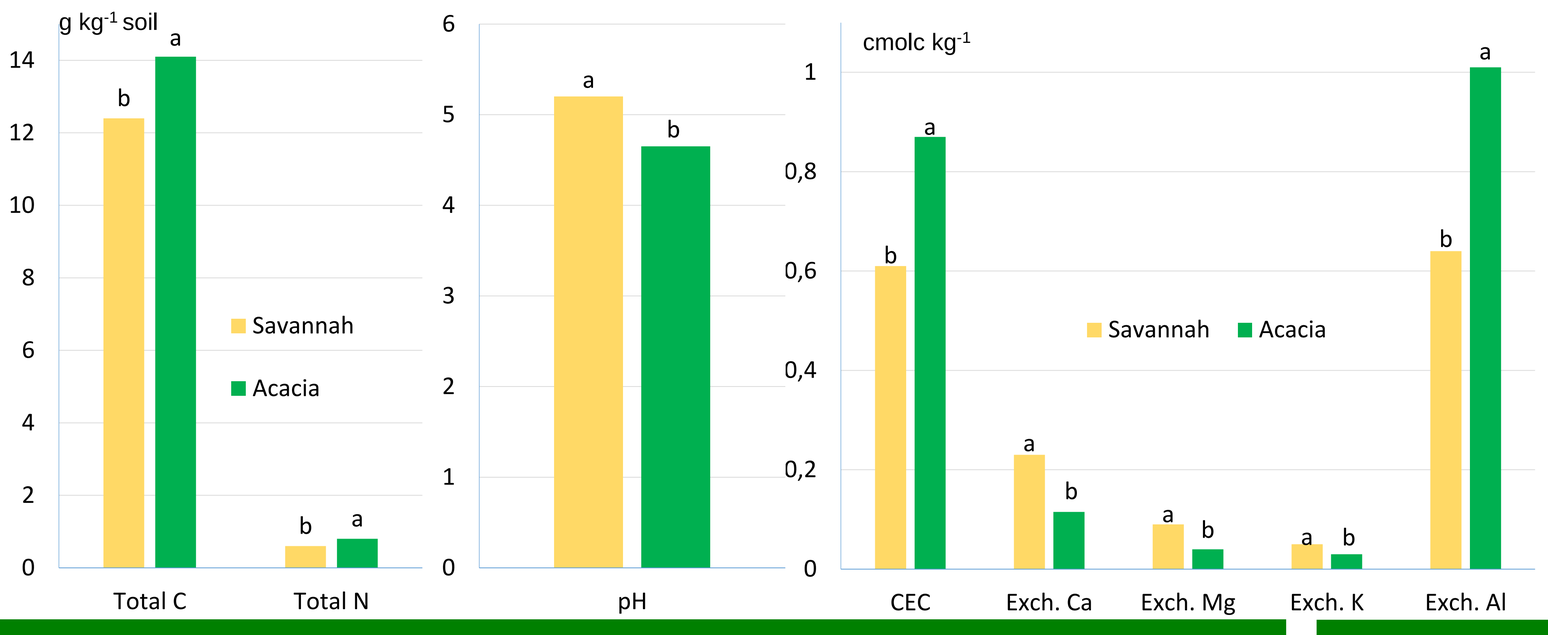
1 ... 6 Sequences

Figure 1: *Succession of tree fallow rotation, slash-and-burn and food crops in different sequences studied (1 to 6) : R1 is the first rotation of acacia planted on the savannah, followed by the second rotation: R2 : stemming from natural regeneration growing for 18 months in association with crops, followed by the third rotation: R3 : with the same regeneration process.*

Savannah soils are sandy, acidic, chemically very poor, with a very low water retention capacity (Kasongo *et al.*, 2009).

The chemical properties of top soil (0–20 cm) from savannah were compared with those from acacia plots that had undergone one, two or three rotations of acacia during the 22 year period (Fig 1).

Results



Compared to the original savannah, all acacia stands showed an increase in soil C, N and NO_3^- contents, but a decline in soil pH and exchangeable cations, and an increase in exchangeable Al and CEC (Fig. 2).

The number (R1, R2 and R3) and the duration of acacia rotations generally did not modified soil parameters.

***Figure 2**: Total C, total N, pH in water, Cation Exchange Capacity (CEC), Exchangeable Ca, Mg, K and Al in the top soil (0-20 cm) in the savannah (yellow) and the six acacia stands (green). Letters indicate significant differences ($p < 0.05$) between the savannah and the acacia stands.*

Discussion

We found that afforestation with acacia trees increased soil organic carbon (SOC) and total soil N and decreased soil pH. Compared to savannah, the lower exchangeable Ca, Mg and K and higher exchangeable Al contents suggest a high transfer of basic cations from soil to trees. No difference between all sequences also suggests an efficient fixation and recycling of N, but a loss of soil cations through the successive tree rotations, slash-and-burn, charcoal and food crops harvests (Dubiez et al., 2018). The decline in the production of charcoal, maize and cassava from the 1st to the 3rd rotation has been noticed by several farmers.

Recommendations

To maintain the sustainability of the system, we recommend different practices in order to improve the nutrient balances and decrease the soil acidity. Such practices are the debarking of tree stems before carbonization, the restitution of small branches and charcoal residues to the soil, and the supply of natural rock phosphate (Dubiez *et al.*, 2018).

However, it will be important to study the economic and technical feasibility of these recommendations and to examine their impacts on nutrient balances and soil fertility.

References

- DUBIEZ E, FREYCON V, MARIEN JN, PELTIER R, HARMAND JM (2018) Long term impact of *Acacia auriculiformis* woodlots growing in rotation with cassava and maize on the carbon and nutrient contents of savannah soils in the humid tropics (Democratic Republic of Congo. Agrofor Syst. https://doi.org/10.1007/s10457-018-0222-x
- KASONGO RK, VAN RANST E, VERDOODT A, KANYANKOGOTE P, BAERT G (2009) Impac of *Acacia auriculiformis* on the chemical fertility of sandy soils on the Bateke plateau, DR Congo. Soil Use Manag 25 (1) : 21-27.
- KIMARO AA, TIMMER VR, MUGASHA AG, CHAMSHAMA SA, KIMARO DA (2007) Nutrient use efficiency and biomass production of tree species for rotational woodlot systems in semi-arid Mogoro, Tanzania. Agrofor Syst 71 (3) :175-184.

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