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RETRANSLOCATION OF NUTRIENTS IN THREE INDIGENOUS TREE SPECIES IN GOZAMN WOREDA, NORTH CENTRAL ETHIOPIA

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ABSTRACT: *The retranslocation rates of major nutrients (N, P, and K) in the leaves of three dominantly available indigenous tree species (Hagenia abyssinica, Croton macrostachyus, and Cordia africana) was studied in Gozamn Woreda, North Central Ethiopia. Both green and abscised leaves of these tree species were collected to quantify the retranslocation rates of the major nutrients. Results of the analysis indicated that the retranslocation rates of nutrients in the leaves of C. africana, C. macrostachyus and H. abyssinica were 32 to 56%, 31 to 59%, and 42 to 61% respectively. Specifically, 56 to 61% for N, 54 to 59% for P, and 31 to 42% for K were recorded. Generally, the retranslocation rates of nutrients was in the order of N > P > K and thus leads to the conclusion that there is a difference in the retranslocation rate of nutrients in these species. Application of green manure from these species can therefore improve the availability of N and P in the soil.*

KEYWORDS: *Retranslocation, indigenous tree species, Hagenia abyssinica, Croton macrostachyus, Cordia africana*

INTRODUCTION

Indigenous tree species such as *C. africana, C. macrostaychus,* and *H. abyssinica* are the most abundant trees and are under different agroforestry practices at farmers' level in Eastern Gojjam Zone, Amhara Region. Farmers are letting these tree species to grow in their farms because they consider these tree species can improve the fertility status of their soils (Kiros et al., 2015). Understanding the internal nutrient recycling from these tree species by retranslocation (resorption) is an important factor in the supply of nitrogen, phosphorus and potassium for new growth in tree species at different phases of foliage development (Aerts 1996, Saur et al. 2000, van Heerwaarden et al. 2003). Nutrient retranslocation studies also provide information for soil nutrient management (Akselsson et al., 2004).

This shows the need for greater attention particularly from the point view of integrated soil fertility management. However, very few attempts have been made to study the issue and

therefore, the present study investigates the rate of retranslocation of major nutrients from the three dominantly available indigenous tree species.

MATERIALS AND METHODS

Site description

The study was conducted in Gozamin Woreda, East Gojjam Zone, Ethiopia which lies between 10^0 20' N lat, 37^0 43' E long; elevation 2200 m above sea level with an average annual temperature of 18 °C. Geographically, the area exhibits valleys and plateaus (Kiros et al., 2015). The mean annual rainfall of the area is 1628 mm. The soils are grouped under Vertisoil, Nitisol, Regosol, Litosol, Acrisol, and Luvisol (Abraham and Azalu, 2013). The most common tree/shrub species are *Hagenia abyssinica, Croton macrostachyus, Cordia africana, Milletia ferrugina, Accacia decurrens, Accacia saligna, Gravellia robusta, Sesbania sesban,* and *Leucina leucocephala* (Kiros et al., 2015).

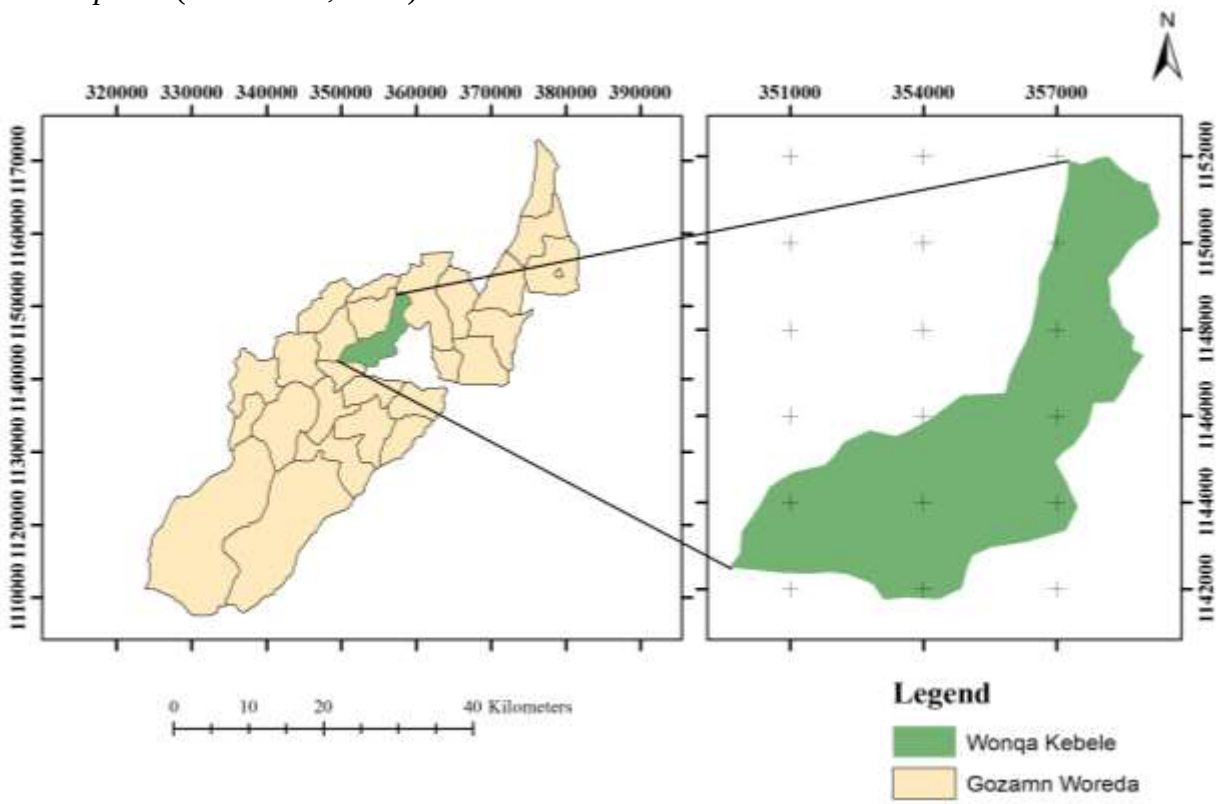

Figure 1: Map of Gozamn Woreda with location of the study area (Wonqa Kebele).

Leaf sampling

According to Kiros et al. (2015), *C. africana, C. macrostachyus,* and *H. abyssinica,* are the three most dominantly available indigenous tree species in the study area. And therefore, these tree species were used for this particular study. Random complete block design was employed to collect both the green and the abscised leaves from nine sampling tree species (3 tree species × 3

replications) grown in similar soil and topography with similar age. A minimum of 15 leaves per individual sampling tree were collected from all canopy positions and were treated separately. The samples were air dried, oven dried at 65 ºC for 24 hours, and grounded into powdered form to pass through the mesh screen for chemical analysis.

Nutrient analysis

The nutrient analysis for N was determined by the micro-Kjeldahl method by digesting 0.5 g samples in 10 ml concentrated H_2SO_4, using a catalyst mixture ($CuSO_4$, K_2SO_4 and selenium powder) and distillation. P was determined in digested samples colorimetrically using the ammonium molybdate stannous chloride method (Olsen and Sommers, 1982). K was analyzed by a flame photometric method (Jackson, 1967).

Statistical analysis

The percent nutrient retranslocation efficiency (NRE) was calculated according to Finzi *et al*. (2001): $NRE\ \% = \{(A - B) / A\} \times 100$

Where: A is the nutrient in green leaves and B is the nutrient in abscised leaf litter.

The data were subjected to Analysis of Variance (ANOVA). Means were compared using Tukey's Honestly Significant Difference tests and were tested at alpha 0.05 for significant differences.

RESULTS AND DISCUSSION

The retranslocation rates of nutrients in the leaves of *C. africana*, *C. macrostachyus* and *H. abyssinica* were 32 to 56%, 31 to 59%, and 42 to 61% respectively. It was 56 to 61% for N, 54 to 59% for P, and 31 to 42% for K and were statistically ($p < 0.05$) significant. Similarly, Kumar and Singh (2005), examined variation among eight tropical species grown over mine spoils and reported retranslocation efficiency during leaf senescence from 38 to 69% for nitrogen and 50 to 71% for phosphorus. Saur et al. (2000) also studied retranslocation in E. globules and found the following percentage retranslocation: N 51%; P 54%; and K 31%.

Table 1: Nutrient concentrations and the retranslocation rates of major nutrients in the leaves of *C. africana, C. macrostachyus* and *H. abyssinica* tree species in the study area.

	C. africana			*C. macrostachyus*			*H. abyssinica*		
Nutrients	A	B	%	A	B	%	A	B	%
N (%)	12.21	5.32	56	15.31	6.21	59	15.62	6.14	61
P (mg/g)	2.57	1.17	54	2.43	1.08	56	2.64	1.21	59
K (mg/g)	9.12	6.23	32	12.23	8.45	31	10.08	4.06	42

A: The nutrient in green leaves, B: The nutrient in abscised leaves, %: Retrasnlocation rate

Most perennials resorb 40-65 % of N and P from leaves before abscission (Aerts, 1996), permitting these nutrients to be recycled internally and used in the construction of new tissues (Regina and Tarazona, 2001; Lusk et al., 2003).

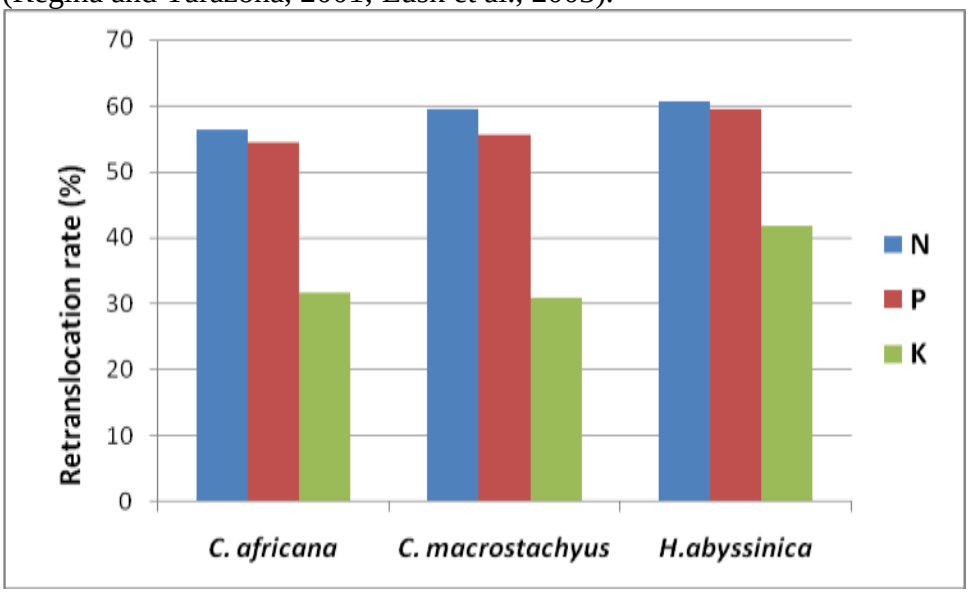

Figure 2: The retranslocation rates of major nutrients in the leaves of *C. africana*, *C. macrostachyus* and *H. abyssinica* tree species.

Tree species of *C. africana,* and *C. macrostachyus* play a great role in maintaining soil fertility and provide various products and services to the local farmers (Abraham, 2014). Similarly, farmers in the study area often consider these tree species can improve the fertility status of their soils because they observed that their abscised leaves are easily decomposable compared to the other available tree species. The result of this study also depicted that nutrients in the green leaves of these tree species were higher than in the abscised leaves (Table 1). This result is in agreement with the observations of Read and Lawrence (2003); Ca´rdenas and Campo (2007), who described that N and P are the most tightly cycled major plant nutrients and usually more than half of N and P in deciduous leaves are re-translocated back to the trees before leaf abscission.

The values found for nutrient resorption in this study are incongruent with the data of Scott et al. (1992) who reported resorption efficiencies of 17 to 73% for N and 41 to 82% for P in six Brazilian rain forest species. A similar finding was observed by DeLucia and Schlesinger (1995). In contrast, in our study, percentage N retranslocation was slightly greater than that of P. This is in accordance with Chapin and Kedrowski (1983) which reported 52% N and 43% P retranslocation among certain boreal forest species. Thus, the retranslocated nutrients (N, P and K) become an important source to support the initial demand of newly emerging leaves during the dry period when nutrient uptake from the soil is hindered due to very low soil moisture.

CONCLUSION

Results of the current study indicated that there are differences in the retranslocation rates of major nutrients in the leaves of *C. africana*, *C. macrostachyus* and *H. abyssinica* tree species. The rates were in the order of N > P > K in all the three species. This indicates that the concentration of N and P is higher in the green leaves of these tree species than the abscised leaves and therefore it is advisable to apply the green leaves from these tree species in order to improve the soil quality.

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