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and

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Water and nutrient fluxes as indicators for the stability of different land use systems on the Terra firme near Manaus

Annual Report 1999

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Abstract

This is the annual report of the SHIFT project "Water and nutrient fluxes as indicators for the stability of different land use systems on the Terra firme near Manaus". The experiments started during the first year of the second phase of this project were continued, such as studies about the effect of trees on soil phosphorus and sulfur availability, dissolved organic nutrients in rainfall, throughfall, stemflow and soil solution. Additionally, we focussed on the effects of cover crops on tree nutrition, soil nutrient and water dynamics. Soil nitrogen and phosphorus uptake was investigated using different N-15 and P-32 tracer experiments. The fate of fertilizer nitrogen was studied with N-15 labelled ammoniumsulfate in plant, soil, soil extracts and soil solution. In laboratory incubations, the effect of leaf quality on decomposition and incorporation of nutrients into soil organic matter was studied as affected by soil microbes and soil fauna.

11) Nutrient leaching in mixed tree cropping systems

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Introduction

Ferralsols of the central Amazon are low in available nutrients. Additionally, leaching rates are very high and may lead to large losses of applied fertilizers. Very little is known about the ability of tree crops to reduce nutrient leaching and retrieve nutrients from the subsoil. Therefore we studied the leaching losses of applied ^{15}N tagged fertilizer during one rainy season.

Methods

TDR, tensiometers and suction cups were installed under *Theobroma grandiflorum* (Willd. ex Spreng.) K. Schum. (cupuaçu); *Bactris gasipaes* Kunth. (peachpalm); *Bertholletia excelsa* Humb.& Bonpl. (Brazil nut); *Bixa orellana* L. (annatto) in a multi-strata agroforestry system. TDR were installed at 0.1, 0.3, 0.9 and 1.5 m, and suction cups at 0.1, 0.6 and 2 m depth in three replicates. Additionally, a soil pit was dug up to 3 m depth. TDR and tensiometers were inserted at 0.1, 0.3, 0.9, 1.5, 2.5, 3.5 and 4.5 m and suction cups at 0.1, 0.6, 1.2, 2, 3 and 5 m depths from the side. The instruments reached below the canopy of *Theobroma* and *Bactris* and *Pueraria phaseoloides* (Roxb.) Benth. (pueraria). Additionally, a data-logger system was installed with TDR at 0.1 and 0.9 m, and tensiometers at 0.1, 0.3, 0.9, 1.5, 2.5 and 3.5 m depths. A mobile meteorological station was built next to the soil pit. ^{15}N was applied as ammonium sulfate (10 atom%^{15}N excess) at 1g ^{15}N per tree. Soil water measurements and soil solution sampling were done in weekly intervals. Soil solution was directly analyzed after freeze-drying.

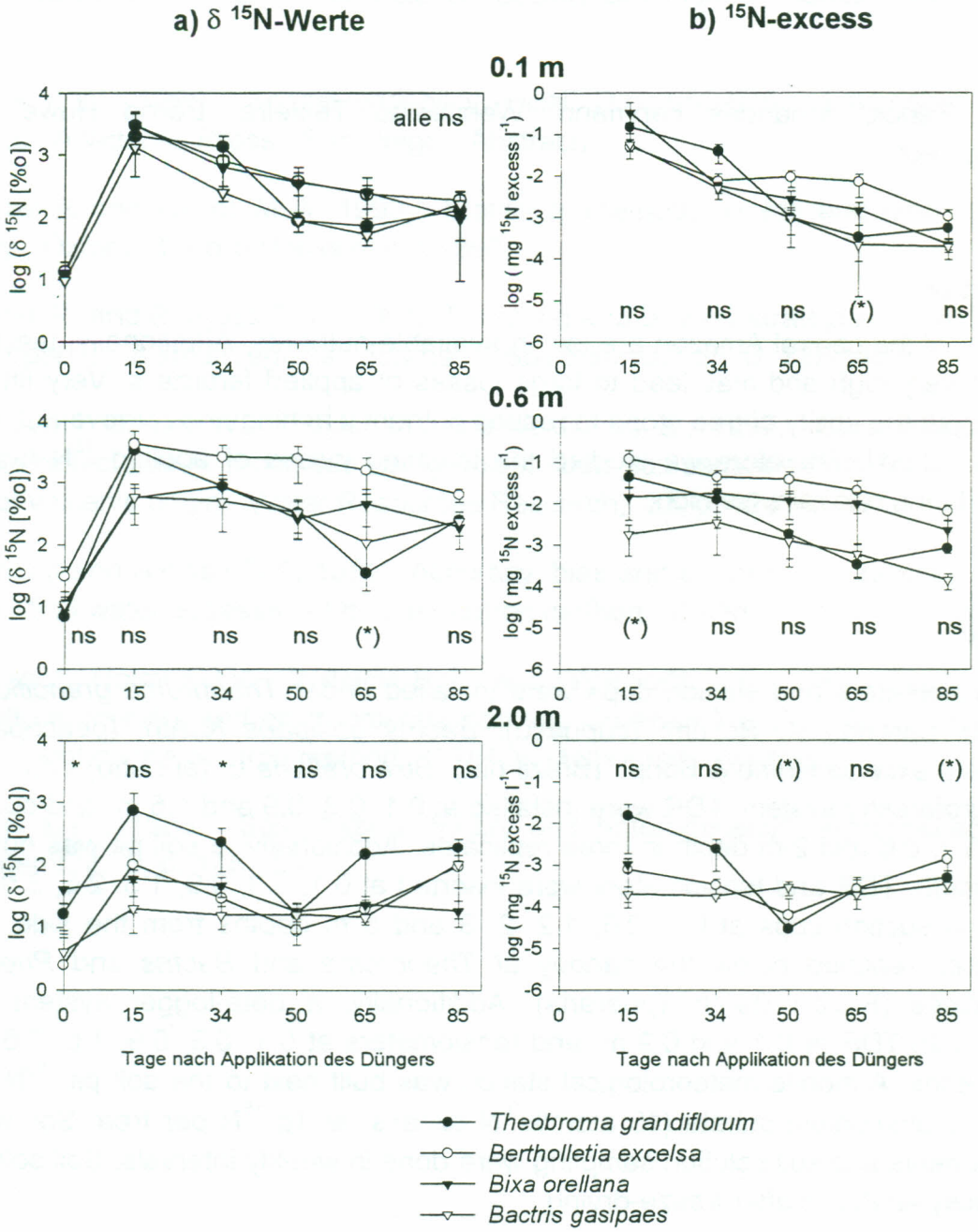

Figure 1 ^{15}N values of soil solution under *Theobroma*, *Bactris*, *Bertholletia* and *Bixa* at 0.1, 0.6 and 2.0 m depth before (day 0) and after the application of ^{15}N-enriched fertilizer; means and standard errors (n=3).

Results and Discussion

The increase of the ^{15}N signatures even at 2m depth indicated rapid leaching of fertilizer N already after a few days after application (Figure 1). A large portion of the applied ^{15}N was found in the dissolved organic matter, stressing the importance to include organic nutrient species in nutrient budgets. Additionally, it could be shown

that this organic N species were mobile in soil. The tree species had only a limited effect on the amount of N and ^{15}N in the topsoil solution after fertilization (Figure 1). The water movement was probably too fast to be affected by the trees during the rainy season, and topsoil mineral N contents were generally high. In greater depths, nitrate in the soil solution was significantly enriched with ^{15}N under *Theobroma* compared to the other tree species. High organic N contents were found in the soil solution of *Bertholletia* at 2m depth. Consequently, the highest ^{15}N contents in the soil at 2 to 5m depth were found under *Theobroma*, followed by *Bertholletia* (Figure 1). Generally high mineral N contents in the subsoil indicate that N leaching was high under all trees. Cutting *Bactris* for heart of palm harvest may have caused an additional input of N into the soil through root turnover, as non-labelled N was found in large quantities thereafter. Cutting may be more suitable at other times of the year when leaching losses are less likely to happen than at the onset of the rains.

The trees affected leaching losses of applied N to a different extend, and *Bactris* and *Bixa* were better able to do so than the other investigated species. However, losses of applied fertilizer N can not entirely be prevented considering the extremely rapid soil water percolation under the studied humid tropical conditions and the highly permeable soils.