Soil Nutrient Leaching in Mixed Tree Cropping Systems in the Central Amazon

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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.

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%15N 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.

The increase of the ^{15}N signatures even at 2 m depth indicated rapid leaching of fertilizer N already after a few days after application. 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. 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 2 m depth. Consequently, the highest ^{15}N contents in the soil at 2 to 5 m depth were found under *Theobroma*, followed by *Bertholletia*. 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-labeled 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.