Cover Crop and Fertilization Effects on Nutrient Dynamics in Fruit Tree Cropping in the Central Amazon

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The soils in the central Amazon are highly weathered and have low nutrient contents. Therefore, fertilization is essential for fruit tree production. Nitrogen may additionally be supplied by biological N fixation of a legume cover crop, which is often planted in tropical fruit tree plantations. However, the effectiveness of the atmospheric N from the legume for tree N nutrition, and the combined effects of fertilization and cover cropping on the soil N dynamics and nutrient uptake by the fruit tree has rarely been assessed in tropical cropping systems with perennial plants. Therefore, we studied the soil and plant N dynamics as affected by fertilization and intercropping with a legume.

Soil samples up to 4 m depth were taken under guarana (*Paullinia cupana*) and in the middle between the trees at the end of the rainy and the end of the dry season. Treatments were full fertilization and control with and without intercropping with *Pueraria phaseoloides* in a completely randomized design with four replicates. Samples were extracted with KCl and analyzed for ammonium and nitrate. Subsamples were incubated for 36 days to measure potential N mineralization. At 0-0.1 m depth, we also analyzed the N in microbial biomass by fumigation extraction.

Topsoil nitrate contents were lower at the end of the wet season, whereas subsoil nitrate contents showed the opposite effect. This can be explained by high leaching of the mobile nitrate. Subsoil nitrate contents slightly increased due to fertilization indicating losses of applied N. The nitrate contents to a depth of 2 m were higher between the trees where the legume cover crop was growing showing an excess of N input partly caused by the legume which could not be used by the tree. However, even without a legume intercrop large amounts of nitrate were found in the subsoil between the trees, but only when the trees were not fertilized. With fertilization there were no differences in subsoil nitrate contents between and underneath the trees. This can be explained by the more vigorous tree growth of fertilized trees which have a larger nutrient demand and exploit a larger soil volume. Without a legume cover crop, the guarana can utilize the excess N in the subsoil between the trees. With a legume cover crop, more mineral N is available at the topsoil which is subsequently leached into the subsoil.

The results indicate large risks of nitrate leaching and a lack of available N at the end of the rainy season. The tree was able to use N from the subsoil and between the trees. However, without adequate fertilization with other nutrients than N and also with a cover crop, the N availability was higher than the demand by the tree. This lead to N leaching. Therefore, N fertilization could be reduced to more efficiently utilize the soil inherent N sources and the N supplied by the legume cover crop.