3 Uptake of mineral elements in the fine roots

The influx of calcium from an external source into primary roots of 3-year-old *Carapa guianensis* plants was monitored with the stable isotope ^{44}Ca of this macro-nutrient calcium.
The uptake of calcium into the fine roots of *Carapa guianensis* for example is strongly determined by the fine structure of exodermis and endodermis. The time series for labeling with ^{44}Ca started with two minutes, followed by 16 min and 64 min respectively.
The structural characteristics of the exodermis apparently influence the uptake of calcium, which is particularly obvious in the outer cortex. In *Carapa* the uptake of the ^{44}Ca-labelling into the outer cortex amounts to about 3% after 2 min. Only at longer time of application, the transport into the central part of the fine root is evident. After 64 min the ^{44}Ca-label amounts about 58% of the total Ca content in the primary xylem.
Obviously the relationship of structure and barrier behavior is in the exodermis and endodermis different, indicating a specific strategy in adapting to site conditions.

4 Conclusions

- The fine roots of *C. guianensis* are remarkably well adapted to dry periods to maintain tree growth.
- *C. guianensis Aubl.* exhibits a specialized fine root structure, expressed in particular in the development of the cell wall layers of the exodermis and endodermis. These structural characteristics of fine roots coincide with the special kinetics for the uptake of mineral elements such as calcium.
- The results on structure and function of the fine roots support the findings on water and mineral element balance, which indicate a good adaptation of *C. guianensis* to the site conditions at the "terra firme" in Central Amazonia.

New Approaches towards Sustainability of Land-use Systems in Tropical Brazil

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Traditionally, tropical soils have been frequently used in a sustainable way by slash and burn. But currently, this method accelerates land degradation due to increasing population pressure. Fallow periods are therefore shortened, thus reducing the potential for soil regeneration. There is, without doubt, an urgent need to develop new approaches for sustainable land-use in tropical regions. In the following some interesting activities on this subject are referred on, partly developed within the SHIFT-program.
The SHIFT-program ENV 44 tries to maintain soil fertility in the Bragantina area (Pará) by production of mulch material from fallow vegetation. A main focus with respect to sustainability deserves to be agroforestry. It could be shown by the SHIFT project ENV 45 that individual trees have fundamentally different effects on sustainability, e.g. by different root activity patterns allowing different access to subsoil nutrients (especially nitrogen) and different nitrate leaching rates. In collaboration with the University of Uberlândia and CIAT it was shown that intensive tree fallow using pines strongly enhances soil acidification. If the soil nutrient status allows, the introduction of high quality timber into agroforestry systems, as studied by SHIFT project ENV 42, would enhance the commercial productiveness of the system. An interesting approach towards sustainability of acid soils in South America was developed by CIAT, rotating acid tolerant crops with improved pasture using nitrogen fixing plant species like pueraria. Analyzing the soil solution it could be shown that the nutrient status of these systems is comparable to the one of the natural Cerrado Vegetation. The introduction of the improved pasture rotation also strongly contributes to land-use sustainability by increasing soil organic carbon contents. Recently, we could identify charcoal as an important soil organic carbon constituent contributing to the sustainability of the Terrae Pretae in Amazonia. This finding offers new approaches to soil organic carbon and nutrient management concepts for sustainable agriculture in the tropics.
Up to now the mulch and agroforestry systems are not fully accepted by land-users. Especially large scale farmers and

partly also small-holders prefer mechanized farming with consequent application of mineral fertilizers and biocides. Some of these chemicals are persistent and may accumulate in soil, water, and crops. Since the application of biocides is part of most land-use practices in humid and sub-humid Brazil, the investigation of their environmental behavior and their effects on biodiversity are important issues in the evaluation of sustainability. First results of the SHIFT project ENV 54 show that the dissipation time of frequently used biocides in the Cuiabá (Mato Grosso) region is astonishing short; but nevertheless biocide leaching within the soil does still take place.

All these research lines do contribute to a better understanding and management of tropical land-use systems. Only with a sustainable land management a continuous economic development can take place and at the same time ecological risks on the local and global scale are minimized.

Biocide Pools in Tropical Soils of the São Lourenço River Basin Implications from Dissipation Studies in Soil Density Fractions

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Various studies show that biocide degradability decreases with residence time in soil. Thus, a slow enrichment of pesticides could take place, though half-lives of biocides are very short in the tropics.

Some studies indicate a biphasic dissipation kinetic: In a first phase higher rate constants (of an first order kinetic) are observed than in a second phase. The biphasic dissipation kinetic implies that pesticides distribute between pools of different degradability in soil. Since pesticides interact preferably with the soil organic matter, we aimed to elucidate if pesticide pools are related to different soil organic constituent such as represented by soil density fractions.

In our field experiment we applied endosulfan, chlorpyrifos, l-cyhalothrin and trifluralin on a Humic Acrustox of the São Lourenço river basin and studied the dissipation in different density fractions. Soil samples were collected repeatedly during the whole Experiment (28 d) and fractionated by physical means into five density Fractions (< 1.6, 1.6-2.0, 2.0-2.4, 2.4-2.6 and > 2.6 g cm^3), in which we measured the biocide concentrations. The biocide concentrations were significantly correlated to the carbon contents of the fractions, underlining the importance of soil organic matter for biocide sorption. The dissipation of endosulfan, chlorpyrifos and trifluralin in the bulk soil as well as in the fractions was described best using a bi-exponential model, which is the sum of two first-order kinetics. Since the rate constants of dissipation were the same in all fractions, it is concluded that the processes causing the decrease of rate constants were present in all fractions and cannot be related to the organic C-pools of density fractions. However l-cyhalothrin disappeared more slowly in the light fractions < 2.0 g cm^3 than in other fractions, but only incidentally. A few days later, the rate constants were comparable in all fractions. It is concluded that density fractions in an oxisol represent pools of different biocide accumulation but not of different biocide dynamics.