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# Microorganisms in the rhizosphere of useful tropical plants

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*Abstract*

The cupuacu tree (*Theobroma grandiflorum* (*WILLD. EX SPRENG.*) *SCHUM.*)) and the pupunha tree (*Bactris gasipaes H.B.K.*) are grown throughout the Amazon region as part of orchards or small scale production systems. In a preliminary study the number of oligotrophic not nitrogen-fixing, oligotrophic nitrogen-fixing bacteria and fungi associated with the root surface, soil in 2–10mm and soil in >10–20mm from the root surface were assessed. The highest number of the culturable bacteria were associated with the rhizoplane. With greater distance from the root surface the total number of bacteria decreased.

## INTRODUCTION

Soil microorganisms can increase nutrient availability through mineralization of soil organic matter and have special physiological properties like nitrogen-fixation and P-solubilization (Illmer and Schinner 1994, Lee and Pankhurst 1992, Sparling 1994, Grayston 1995, DeLuca 1996). The colonization of the rhizosphere by microorganisms with diverse physiological properties will have important consequences for plant growth in mixed culture systems.

The cupuacu tree (*Theobroma grandiflorum*) and the pupunha tree (*Bactris gasipaes H.B.K.*) are grown in mixed culture systems in the Amazon basin for fruit, seed production (cupuaçu, pupunha) and heart of palm (pupunha). Present demand exceeds supply and is reflected in the relatively high market value (Laker and Trevisan 1992, Venturieri 1993).

The objective of this preliminary study was to determine the composition of oligotrophic bacteria with and without the capacity to fix nitrogen as well as fungi in different distances from the root surface growing in two different culture systems of an 5 year old plantation system near Manaus, Brazil.

## MATERIAL AND METHODS

### *Sample collection*

Rhizoplane and rhizosphere soil samples were collected from pupunha- and cupuaçu-plants in two mixed cultivation systems (1 and 2) as part of a recultivation experiment of a 19 ha fallow rubber plantation on a former terra firme rainforest area near Manaus (Feldmann 1995). The climate data measured near the experimental site (2°51'south 59°52'west) are typical for humid tropics (Cabral 1993). Rainfall: 2500mm per year, 300mm monthly maximum, 110mm monthly minimum with explicit dry season. Air temperature: 24–26°C mon...

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averages, 30–33°C maxima, 21–23°C minima. Relative humidity: 87% monthly average maximum, 82% monthly average minimum.

The soil was determined as a xanthic ferralsol (FAO-classification) of low fertility and of a considerably high content of plant available aluminium (Schmidt 1993).

Rhizosphere microorganisms from 2–10mm and >20–20mm distance were extracted by shaking 1g of rhizosphere soil in 99ml of 0.9% NaCl solution. The microorganisms of the rhizoplane were extracted by shaking 1g of the roots in 99ml of 0.9% NaCl solution containing glass beads (5g).

The rhizosphere and rhizoplane samples were serially diluted ($10^{-5}$, $10^{-6}$, $10^{-7}$) and 0.1ml suspensions spread, in five replicates, on the following media: 2g glucose, 0.5g $K_2HPO_4$, 0.5g $MgSO_4$ x 2 $H_2O$, $Na_2MoO_4$ x 2 $H_2O$, 1 ml trace element solution, dest. water ad 1000ml plus cycloheximid (100µg x $l^{-1}$) for enumeration of oligotrophic not nitrogen-fixing bacteria; the same media without nitrogen-source was used for enumeration of oligotrophic nitrogen-fixing bacteria; and Sabouraud agar plus streptomycin (100µg x $l^{-1}$) for enumeration of fungi.

The tubes were incubated at 28°C and counted after 7 days for bacteria and fungi (Alef 1991).

## RESULTS

The majority of oligotrophic bacteria was able to fix nitrogen. The highest percentage of nitrogen fixing bacteria was found on the rhizoplane. Both, the number of oligotrophic bacteria and nitrogen-fixing bacteria decreases with increasing distance from the rhizoplane (See Figure 1 and 2).

In the rhizosphere of pupunha in culture system 1, where pupunha-plants were directly neighboured to mamão (passion fruit, *Carica papaya*), the percentage of not-nitrogen-fixing bacteria was higher than in system 2 (See Figure 2).

In cultivation system 1, the number of fungi was higher in the rhizosphere of pupunha than in the rhizosphere of cupuaçu. In cultivation system 2 the number of fungi was similar in the rhizosphere of both plant species (See Figure 3 and 4).

## CONCLUSION

The plant species have a significant effect on the number of the not-nitrogen-fixing and nitrogen fixing bacteria.

The higher amount of not-nitrogen-fixing bacteria and the lower number of nitrogen-fixing bacteria in the rhizosphere of pupunha (>2–20mm) in culture system 1, may be due to the effect of neighbouring mamão-plants. In cultivation system 1 mamão was directly neighboured to the row of pupunha plants until spring 1997. Mamão-plants are known as nutrient suppliers for other plants in sustainable cropping systems.

## ACKNOWLEDGEMENTS

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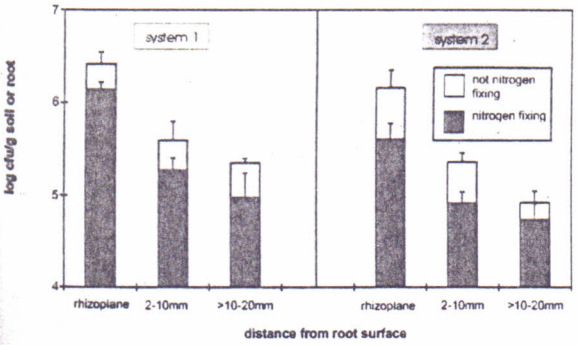


Figure 1. Number of not-nitrogen and nitrogen fixing oligotrophic bacteria in the rhizosphere of cupuaçu with and without the capacity to fix nitrogen.*

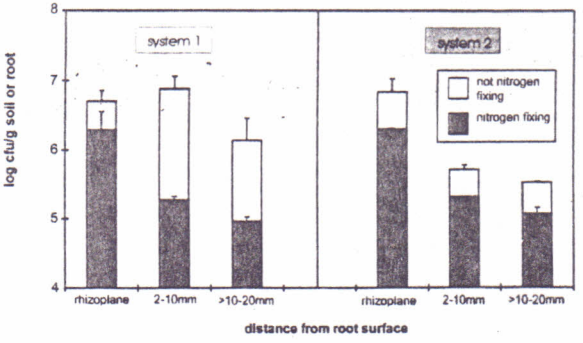


Figure 2. Number of not-nitrogen and nitrogen fixing oligotrophic bacteria in the rhizosphere of pupunha with and without the capacity to fix nitrogen.*

* The number of bacteria has been recorded in terms of colony forming units per gram soil or root. All samples have been collected in 0–5cm soil depth. Every column represents 5 plants with three repeats. The plants have been monitored from April to May 1997. At this time all plants were 4.5 years old.

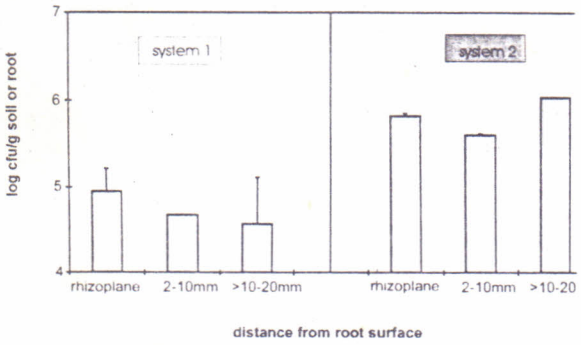


Figure 3. Number of fungi in the rhizosphere of cupuaçu.*

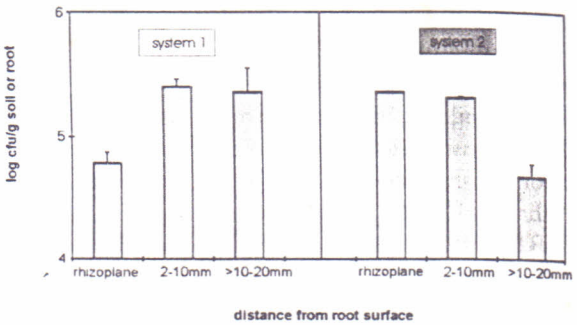


Figure 4. Number of fungi in the rhizosphere of pupunha.*

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