The response of *Musa* cultivar root systems to a tree shade gradient

Charlotte Dreiseidler, Jürgen Burkhardt, Oscar Bustamante[1], Pablo Siles, Charles Staver, Erwid Perez Valdivia

Introduction:

Commonly, bananas and plantains are grown throughout Latin America in mixed agroforestry systems by small farmers for home consumptions and national markets. A wide range of *Musa* cultivars is planted. A research project funded by GIZ through Bioversity International in collaboration with national research organisations and German universities aims to identify approaches to improve farmers returns both in terms of production and income. The purpose was to study the banana root distribution compared to its aerial biomass to understand the partitioning of light, water and nutrients in this multi-strata agroforestry system. Is the formation of banana roots mainly influenced by a strong light deficiency or inter-specific root competition?

Materials and methods

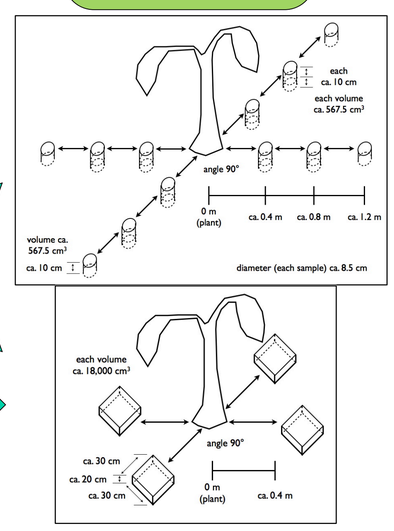
Poró shade levels:
minimal, 25%, 50%, 75%

Bananas: 6 months age
3 replications

Musa cultivar
- AAA 'Gros Michel'

Musa cultivars:
- AAA'Red' ('Morado')
- AAB 'Curraré'
- ABB 'Pelipita

Two soil core methods:



Roots: >1mm diameter

- washed
- separated

- scanned
  WinRHIZO 3.9 2004 ©
- weighed

- Conducted in an organic coffee farm near Turrialba, Costa Rica
- *Coffea arabica* dwarf variety 'Caturra' intercropped by *Musa* and Poró (*Eryhtrina poeppigiana*)

Results

Monolith (large samples):
- Significant decrease of *Musa* root density in 75% shade (Fig. 1)
- The root density of the other plants, i.e. trees and coffee shrubs, increases very little with the increase in shade.

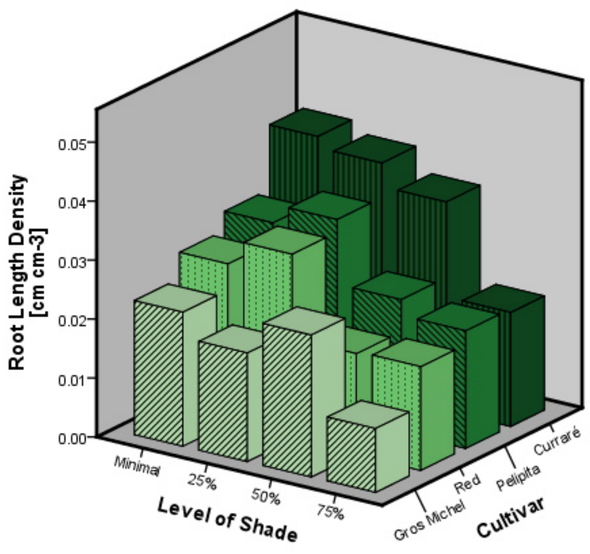


Fig. 1 *Musa* root content in monoliths (large samples) under four natural shade levels by Poró.

Auger (small) samples:
- *Musa* root density decreases significantly in depth (0-10 cm to 10-20 cm), and decreases insignificantly in distance.
- Those 'normal' declines are stronger in 75% shade
- The roots of the trees and coffee shrubs are found spatially 'complementary' to the *Musa* roots, i.e. they are found particularly distant from the bananas. But they increase again only poorly in 75% shade.

At the end, we estimated the total root system of AAA 'Gros Michel' out of the auger method. We then calculated the share of one monolith of the total root system, and transferred this percentage to the other three *Musa* cultivars.

Correlations:
- *Musa* and 'other' root contents in samples uncorrelated (correlation coefficients < 0.2).

On the contrary (Tab. 1):
- *Musa* root contents moderately correlated to *Musa* shoot

Tab. 1 Correlation coefficients of *Musa* root contents in large samples (dry biomass per unit of soil, in [g dm^{-3}]) to the total shoot dry biomass (in [g]).

	Monoliths (large samples)			
	'Gros Michel'	'Red'	'Curraré'	'Pelipita'
Correlation Coefficients	0,30	0,51	0,40	0,61

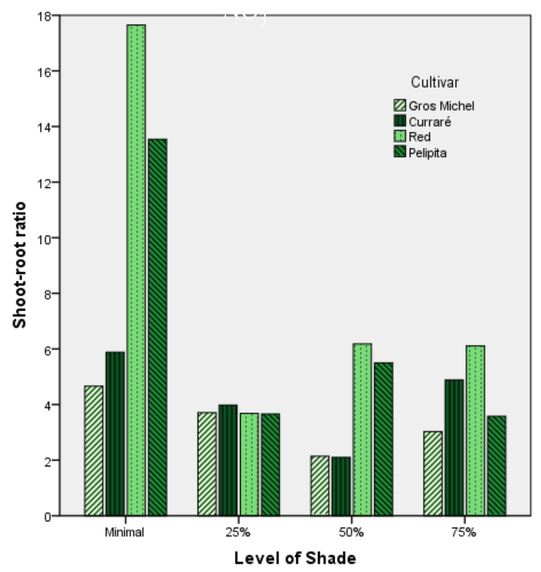


Fig. 2 Shoot-root ratios of *Musa* plants: total shoot dry biomass [g] divided by estimated total root dry biomass [g]

Shoot-root ratios (Fig. 2):
- The sharp decline from minimal to 25% in the cultivars 'Red' and 'Pelipita' is particularly caused by increased root systems.
- The increase in the ratios from then onwards, either in 50% or 75% shade, is caused by a reduction of both root system and shoot, with little change in the shoot-root ratio.

Conclusions:

Therefor, light deficiency seems to be the major influence on *Musa* root formation under high natural shade, instead of inter-specific root competition. Bananas in 75% shade are generally smaller, and naturally have smaller root systems. The relations of roots to the shoot development then are the essential ones, which determine the root decline in 75% shade, stimulated by the low light availability. The root system is probably discriminated in favour of forming more leaf area in the bananas, to capture the reduced available light still penetrating the Poró canopy.

[1] Bioversity International, CATIE, Turrialba, Costa Rica
o.bustamante@cgiar,.org, www.ibioversityinternational.com

Centro Agronómico Tropical de Investigación y Enseñanza