CocoaSoils

Nutrient distribution in cocoa trees

M.A.Slingerland, F. Calvo Romero, L. Woittiez, K.E. Giller

Plant Production Systems group, Wageningen University

Abstract

Information on biomass and nutrient partitioning in cacao tree organs is needed for modelling and tree nutrient management for production increase. This study has developed a measuring protocol and applied it in destructive measurements of 4 repetitions of cocoa trees of 1.5, 5.0, 10 and 15 years old. The proportion stem and branch increased with tree age. Specific Leaf Area of previous flush increased from upper to middle to lower canopy layer. Beans had relatively high P content whereas pods had high K content. For all ages, the leaf component stored the greatest part of nutrients.

Keywords: Biomass and nutrient distribution, measuring protocol, cacao

Introduction

Information on biomass production and nutrient partitioning within the biomass is important for the selection and management of trees for improved productivity and efficient nutrient and carbon cycling in cacao production systems (Dossa et al., 2008a). This study will provide a basis for the description of cacao tree structure, and give insight in the nutrient resource allocation among different plant organs and within the same organ (stem, branches, leaves, pods, and roots). This information will be of use in experimental and modelling studies dealing with nutrient cycling in cacao trees and in larger agro-ecosystems and serve as a basis for appropriate nutrient management recommendations for such systems.

The aim of this research is to:

- Generate a protocol to determine the biomass and nutrient distribution in cacao trees, including destructive and nondestructive methods.
- Quantify and compare the biomass, the nutrient allocation and concentration in cacao trees between tree of four different physiological ages (1.5, 5, 10 and 19 years old trees).

Materials and Methods

Literature review was conducted to find biomass and nutrient distribution among plant organs in cacao for trees of different age classes aiming to inform modeling work. Literature was also used to develop a standardized protocol to measure such parameter. Actual destructive measurements took place on 3 trees of each age class 1.5, 5, 10 and 19 years. All parts were measured, weighed fresh and dry, sampled for nutrient analysis. The research was conducted in Divo cocoa research station, Ivory Coast.

Results and Discussion

Protocol

Tree architecture was defined according to the branching order, the tree height, the stem diameter and the canopy size. Tree branches were then labelled and “harvested” accordingly. Leaves were collected from three layers of the canopy and three classes: current, previous flush, senescent.

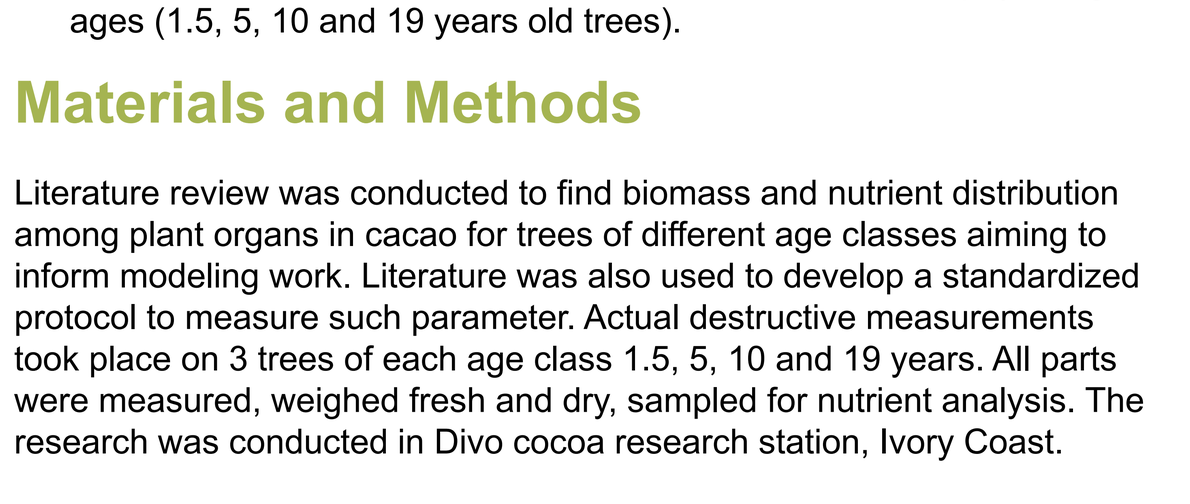
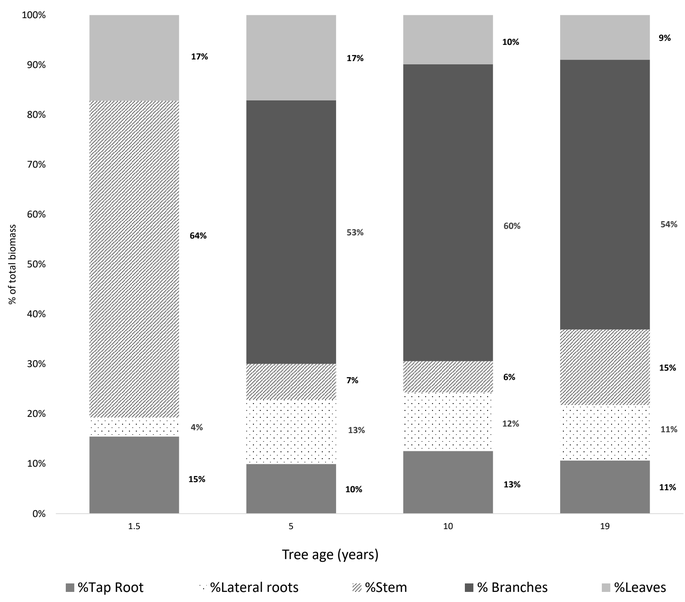


Figure 1 Example of tree architecture labelled for measurements according to stem and branch order and leaf position in the canopy.

Biomass an nutrients

Per canopy layer leaves were separated in three categories: current flush, prior flush and senescent. Specific Leaf Area was measured. Roots were classified into lateral roots and tap root. Both roos were exposed and followed as far as possible, cut, measured and weighted and dried before sending for nutrient analysis. Biomass distribution over the respective plant organs was calculated (Figure 2)



Proportion woody increases from 5 years onwards with increase in age and proportion leaves then declines. Stem increases with age but branches do not due to pruning. Young trees hardly have any branches and the tree clearly start its investments in its stem.

Figure 2 Distribution (%) of plant organs: leaves, stem and branches and roots, in relation to total biomass of cacao trees at four different ages. Fruits are not considered. **(1.5, 5, 10 and 19 years after planting)**

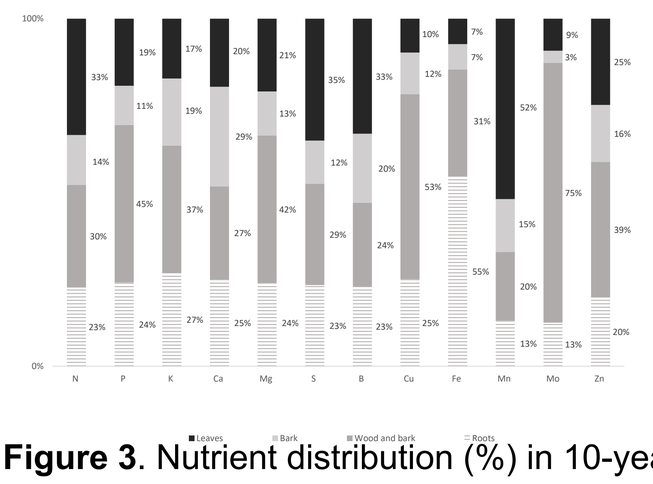


Figure 3. Nutrient distribution (%) in 10-year-old cacao tree organs

Nutrient distributions differ per age class but for all ages the leaf component has the highest proportion of nutrients. Specific Leaf Area of previous flush increased from upper to middle to lower canopy layer. Beans had relatively high P content whereas pods had high K content.

Conclusion

It is possible to assess biomass and nutrient distribution with proposed protocol. It could be partly replaced by using a stemborer to take a sample fo the woody part as long as bark is correctly separated. Tree age matters both for biomass and nutrient distribution. Management such as pruning will heavily affect biomass (plus nutrient) distribution by reducing branch biomass.

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Contact: maja.Slingerland@wur.nl