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Root architecture in relation to tree-soil-crop interactions and shoot pruning in agroforestry

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Abstract. Desirable root architecture for trees differs between sequential and simultaneous agroforestry systems. In sequential systems extensive tree root development may enhance nutrient capture and transfer to subsequent crops via organic pools. In simultaneous systems tree root development in the crop root zone leads to competition for resources.

Fractal branching models provide relationships between proximal root diameter, close to the tree stem, and total root length or surface area. The main assumption is that a root branching proportionality factor is independent of root diameter. This was tested in a survey of 18 multipurpose trees growing on an acid soil in Lampung (Indonesia). The assumption appeared valid for all trees tested, for stems as well as roots. The proportionality factor showed a larger variability in roots than in stems and the effects of this variability should be further investigated. A simple index of tree root shallowness is proposed as indicator of tree root competitiveness, based on superficial roots and stem diameter.

Pruning trees is a major way to benefit from tree products and at the same time reduce above-ground competition between trees and crops. It may have negative effects, however, on root distribution and enhance below-ground competition. In an experiment with five tree species, a lower height of stem pruning led to a larger number of superficial roots of smaller diameter, but had no effect on shoot:root ratios or the relative importance of the tap root.

Introduction

Competition for below-ground resources between trees and food crops may mask or surpass many of the advantages trees may provide for the long term sustainability of agroforestry systems. Competition depends on above-ground demand for water and nutrients, as well as possibilities for uptake. Here initial tests of a new method to characterize the competitive strength of trees, as far as it is based on root distribution, are described.

Agroforestry systems can be biologically more productive than either pure crop or pure tree systems provided that trees and crops are at least partly complementary in the use of resources (above- and/or below-ground). If the tree and crop component represent approximately equal direct value to the farmer relative to the area occupied, a weak complementarity is sufficient to justify agroforestry; if trees have less or no direct value, the complementarity has to be pronounced [Van Noordwijk, in press].

Tree-(food) crop interactions in agroforestry can be spatial, temporal or both (Fig. 1). The lower left corner of Fig. 1 does not classify as agroforestry as the interactions are too weak, the upper right corner is only viable for shade-