Root distributions and traits in a semi-arid agroforestry parkland dominated by Faidherbia albida: potential impacts on soil C and nutrients stocks?

Lorène Siegwart, Isabelle Bertrand, Christophe Jourdan

Root distributions and traits in a semi-arid agroforestry parkland dominated by *Faidherbia albida*: potential impacts on soil C and nutrient stocks?

Siegwart Lorène[1], Bertrand Isabelle[1], Jourdan Christophe[1,2]

[1]UMR Eco&Sols, Univ Montpellier, CIRAD, INRAE, IRD, Montpellier SupAgro, Montpellier, France
[2]CIRAD, UMR Eco&Sols, F-34398 Montpellier, France

lorene.siegwart@supagro.fr

The **objectives** of this study were:

- to assess the tree and crop root distribution and traits down to 150 cm deep in a Sub-Sahelian agroforestry parkland dominated by *Faidherbia albida* in Senegal
- to quantify the contribution of tree and crop root-derived C inputs to soil C stocks along the soil profile

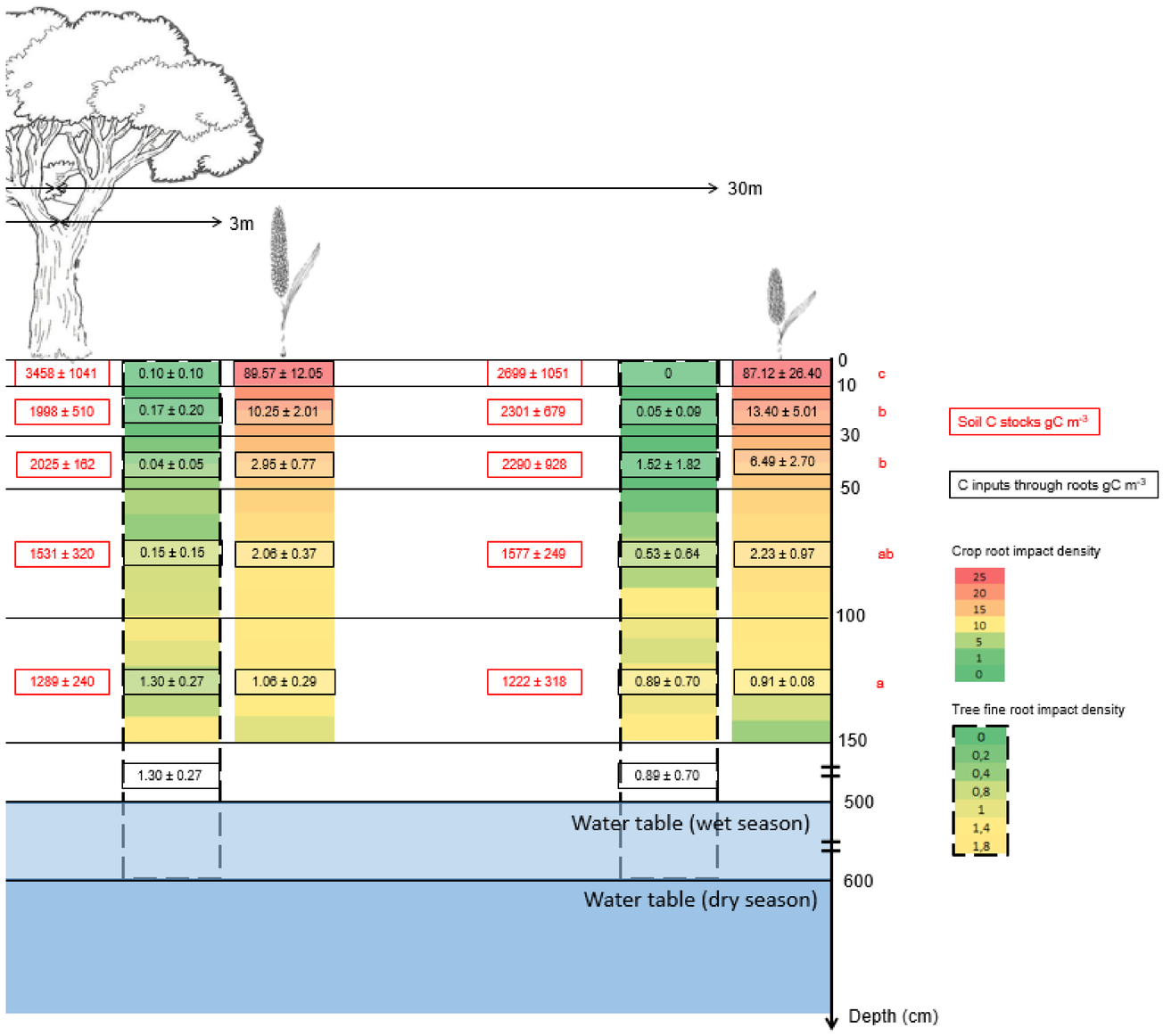

Fig. 3 Annual root C inputs from tree and crop down to 6m deep, under and far from the tree. Gradients in colour are indicating tree and crop root impact density. Red and black framed figures are indicating soil C stocks and root-derived C inputs to soil respectively

Tree roots were found at 5m deep → the annual root-derived C input was extrapolated from 100-150 to 100-500 cm of depth

Highlights

- **Tree fine roots found at +30m of the trunk at 30 cm of depth: attesting the compromise between water and nutrient acquisition**
- **96% and 83% of the tree root C inputs are located below 100cm of depth under and far from the tree, respectively**
- **From the topsoil to the water table, the tree fine roots contribute to 27% (under) and 18% (far from tree) of the total annual root-derived C inputs to soil**

Acknowledgments
The authors thank Ibou Diouf (Sob, Senegal) for technical support in root observations and Patricia Moulin (LAMA/IESOL, Senegal) for conducting all soil analyses, and Aline Personne, Nancy Rakotondrazafy and Didier Arnal from Eco&Sols for helping with the root processing and analyses.

5th World Congress on Agroforestry 2022. 17-20th of July, 2022. Québec City, Canada.

Methods

Experimental set-up of the pits (1m * 1m * 2m deep):

2 locations (under the tree and far (+30m) from the trunk)
x **5 soil layers** (0-10, 10-30, 30-50, 50-100, 100-150 cm)
x **2 plant species** (tree and annual crop)
x **2 rotations** (2020: pearl millet and 2021: groundnut)
x **3 replicated trees**

Root biomass density was measured by manual sorting from a large volume of soil (1m² x soil layer). Root mapping was assessed by counting the root impacts. Roots were sampled for functional traits and chemical composition analysis.

Wet season (july – october)
Crops growing
Tree defoliated

Dry season (november – june)
No crop
Tree foliated

Fig. 1 Faidherbia reversed phenology across the seasons

Results

Deep tree roots with low biomass density vs. shallow crop roots with high biomass density p-value = 6.31×10^{-3}

→ *complementarity theory for associated plants* *(Van Noordwijk et al. 1996)*

At 30cm deep, tree roots were found at +30m from the trunk, in higher quantity than under the tree p-value = 3.88×10^{-3}

→ *compromise of the tree between water acquisition in deeper soil layers during the dry season (Fig. 3) and nutrient acquisition in topsoil during the wet season → plasticity of the perennial root system* *(Zanetti et al., 2015)*

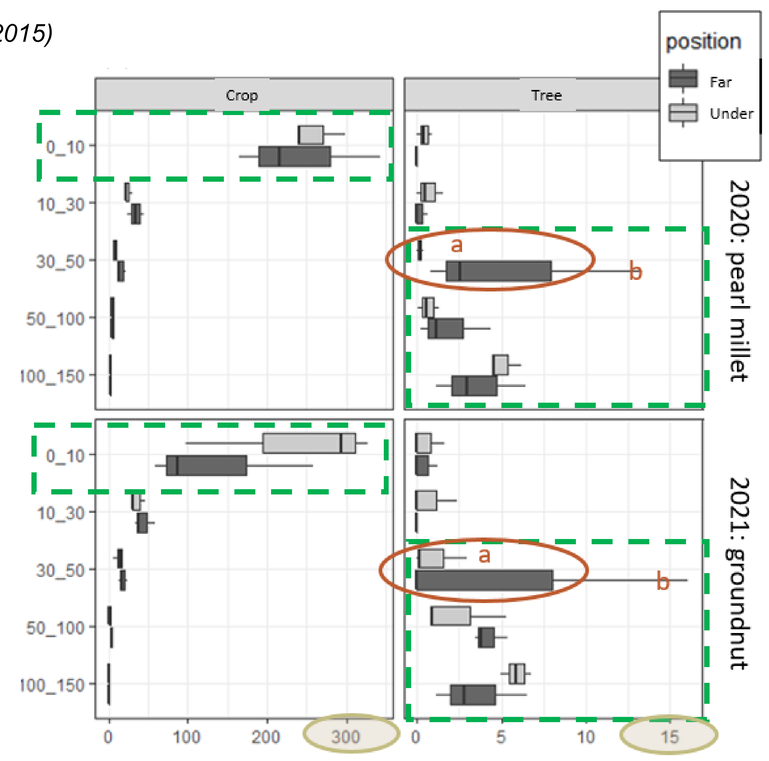

Fig. 2 Crop (left) and tree (right) fine root distribution within 0-150 cm soil profile for pearl millet (2020, top) and for groundnut (2021, bottom)