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FINE ROOTS DISTRIBUTION, LIGHT CONDITIONS AND YIELD IN A TREE-BASED INTERCROP SYSTEM IN SOUTHERN QUEBEC, CANADA

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INTRODUCTION

In tree-based intercrop systems (TBI), trees are planted in widely spaced rows to allow agricultural activities to continue. These agroforestry systems are new in Québec but well known in Europe, USA and China (Baldy *et al.*, 1993; Rivest and Olivier, 2007). The integration of trees into an agroforestry system has the potential to enhance soil fertility, reduce erosion, improve water quality, increase biodiversity and aesthetics, and sequester carbon (Jose, 2009; Montagnini and Nair, 2004). However, the presence of trees also results in aboveground and belowground interspecific interactions with crop, which can include competition, facilitation or complementarity (Jose *et al.*, 2004; Rivest and Olivier, 2007; Van Noordwijk *et al.*, 1996). In theory, TBI systems can be more productive than the respective monocultures if trees have the capacity to take resources like water and nutrients in deeper soil layers than those used by crops (Cannell *et al.*, 1996).

OBJECTIVES AND METHOD

Spatial distribution of fine roots were studied in a replicated TBI system with *Quercus rubra* L., *Populus deltoides* x *nigra* (DN3570) and hay species in southern Québec (Canada), including monoculture controls. The study site is located in a marginal area for agriculture, where the soil is acidic and relatively poor. Fine root length density (FRLD) of trees and crop were determined at different distances from the tree line to a depth of 100cm using the trench profile and core break methods (Böhm, 1976; Mulia and Dupraz, 2006; Van Noordwijk *et al.*, 2000). The impact of trees on light availability and crop yield were also analysed.

RESULTS AND DISCUSSION

Results didn't show deeper root profiles for trees in TBI. Profiles were superficial as commonly found for tree species grown in conventional plantations or in natural ecosystems in a humid temperate climate (Achat *et al.*, 2008; Bakker *et al.*, 2008; Schmid and Kazda, 2002). More than 95% of fine roots were found in the first 25cm and 45cm for red oaks and hybrid poplars, and in 35cm for hay, respectively. The soil acidity, low fertility and a possible aluminium toxicity could also explain the observed shallow root systems (Ryan *et al.*, 1993). However, greater spatial separation exists between red oaks and hay fine roots as red oaks allocated fewer fine roots in the top 10cm of soil, and more between 10cm and 30cm. Hybrid poplar fine roots didn't show any adaption when intercropped with hay and a high value of FRLD in top soil layer near the tree line (~ 40km.m^{-3}) reduces pasture FRLD by 45%, suggesting strong competition for resources. Differences in ecological succession status between hybrid poplar and red oak may explain differences in fine root architecture, as pioneer species (hybrid poplar) tend to produce thinner and more branched roots (Bauhus and Messier, 1999; Finér *et al.*, 1997). Fodder yield analysis in the TBI system revealed biomass reduction near trees, particularly near PEH. However fodder yield in mid-alley was similar with yield obtained in the no-tree controls. The results of a principal component analysis indicated a stronger negative effect of light reduction on pasture yield than the presence of tree fine roots.

CONCLUSION

Hybrid poplars, a fast growing species, have stronger impacts than red oaks on pasture yield but will be harvested sooner and larger alleys should benefit the intercrop. However, their larger and denser root system could be beneficial for environmental issues, such as limitation of soil erosion, improving water quality or enhancing carbon sequestration. The dynamic aspect of TBI systems is close to natural ecosystems and should be further investigated for future success.

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