

Regulation of soil organic carbon dynamics by microbial communities during reforestation of Chinese fir plantations after clearcutting

Wenhua Xiang¹, Ying Wang¹, Liang Chen¹, Xiulan Zhang¹, Yan Ren¹, ZHIMING GUO², and Anna Gunina³

¹Central South University of Forestry and Technology

²South China Botanical Garden

³University of Kassel

September 22, 2023

Abstract

Reforestation after forest clearcutting is an effective measure to increase soil organic carbon (SOC) sequestration. However, the soil C balance and functions of microbial communities under reforestation remain to be determined. Samples of organic (0-2 cm) and mineral (2-10 cm) horizons were collected from the 7-, 15-, 20-, 29-, and 36-year-old forest stands of Chinese fir developed after plantation clearcutting in subtropical climate zone under the condition of phosphorus limitation. Particulate organic carbon (POC), mineral-associated organic carbon (MAOC), microbial phospholipid fatty acids (PLFAs), and enzymatic activities for C, nitrogen (N), and phosphorus (P) acquisition were analyzed. The lowest contents of POC (10 %) and MAOC (13 %) in the organic horizon were found in 7-year-old stands due to the slow tree regrowth and extensive decomposition of SOC in the first years of forest regrowth. POC (2.0x) and MAOC (0.8x) increases in the organic horizon with forest age were attributed to the stand development and accumulation of above and belowground litter. The organic horizon had a higher POC: MAOC ratio than the mineral (0.7-1.1 vs. 0.2-0.5), indicating lower SOC stability in the first one. A positive correlation of the Gram-positive to Gram-negative bacteria (G+:G-) ratio with the POC: MAOC ratio may point to developing specific substrate utilization strategies for microbial communities. Microorganisms were limited by C and P; however, the C limitation was alleviated in the 36-year-old plots in the organic horizon due to increased litter input. Microbial C and P limitations increased with total PLFAs and the G+:G- ratio, indicating the strong influence of community structure on nutrient acquisition from SOC. Thus, soil C sequestration under reforestation of Chinese fir can be controlled by microbial community structure and metabolic limitation, which both shifted with the stand age.

Hosted file

Manuscript File.docx available at <https://authorea.com/users/291445/articles/667769-regulation-of-soil-organic-carbon-dynamics-by-microbial-communities-during-reforestation-of-chinese-fir-plantations-after-clearcutting>