

Dynamics of fine-root, rhizosphere and soil parameters in a silver birch stand chronosequence on reclaimed oil shale mining area

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The alkaline and stony abandoned opencast oil shale mining area (OSMA) needs reclamation. Planting of trees, especially fast-growing deciduous species as silver birch (*Betula pendula*) on OSMA is the best means to help a new forest ecosystem to develop rapidly. A chronosequence of silver birch stands of different ages (1, 2, 3, 4, 7, 31, 43) on reclaimed OSMA was investigated to reveal changes in short root morphology and activity of microbial communities in the soil root interface (Rhiz) and in the bulk soil (Bulk) during stand development to sustain and improve plant nutrition in harsh conditions. Short root morphological parameters were measured using WinRHIZOTM. Biolog Ecoplates were used to determine community-level physiological profiles (CLPP) of culturable bacteria in Rhiz and Bulk. Soil pH decreased and organic matter % increased logarithmically with increasing stand age (from 8.1 to 7.0 and from 1.8% to 15%, respectively); $\text{pH} = 8.0 - 0.29 \cdot \ln(\text{stand age})$, $r^2 = 0.97$, $p < 0.01$. Mean short root tip frequency per root length (RTFL), mass (W), diameter (D), and tissue density (RTD) increased, and short root length (L), short root tip frequency per root mass (RTFM), specific length (SRL) and specific area (SRA) decreased according to a power function with stand age ($0.85 < r < 0.98$, $p < 0.05$). Soil N% was negatively correlated with SRL, L and RTFM ($-0.88 < r < -0.82$, $p < 0.05$) and positively with D, W and RTFL ($r < 0.9$, $p < 0.01$ for both). Microbial biomass in soil was positively correlated both with soil N% ($r = 0.96$, $p < 0.01$) and stand age ($r = 0.91$, $p < 0.05$). Rhiz/Bulk AWCD ratio indicating the plant support of rhizosphere microbial communities was low after planting, reached the maximum after two years and decreased thereafter hyperbolically with age. In conclusion, 1) silver birch on reclaimed OSMA supported rhizosphere microbial communities to improve mineral nutrition; 2) among short root morphological parameters RTFL, characterizing root ramification, responded most strongly to stand development.

Keywords: chronosequence of Silver birch stands, fine root morphology, rhizosphere processes, mining area reclamation