Norway spruce fine roots and seasonal drought – results of a three-year field experiment in southern Finland

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The effects of seasonal drought periods on Norway spruce (Picea abies [L.] Karst.) especially, were widely discussed in Finland during the early 1990´s, and again, after last years´ severe drought periods.

In 1998, we started a study to determine the effects of seasonal drought and an elevated soil nitrogen status on Norway spruce in a field experiment. One sub project concentrated on fine root (< 2 mm diameter) dynamics. We hypothesised that, if the effects of drought on trees are not only caused by a decreased availability of water and nutrients but also due to damage to fine roots, then the recovery from drought may take longer. A higher N status may be beneficial during drought but it may also change the pattern of carbon allocation in the trees, favouring aboveground growth.

The treatments included control, N fertilization 630-1000 kg/ha (80-180 kg N/ha given every five years during a 35-year period), drought for three months (May-July during three summers 1998-2000), and N fertilization combined with drought. The experimental stand was 67 years old and growing on a fertile site type. The drought treatment was carried out by covering the 900 m2 plots with a plastic roof 1-4 m above ground level. The moisture content of the top soil (down to a depth of 15 cm) after seven weeks drought was 9-13 % of the water holding capacity on the drought-treated plots, and 23-35 % on the plots without drought.

Fine roots were sampled with soil coring and using ingrowth cores before, immediately after, and two months after the end of each annual drought period. The diameter growth of the trees was monitored using automatic girth bands. In addition, soil, soil water and tree nutrient status were determined.

Norway spruce fine roots, foliage and diameter growth reacted rather rapidly to water deficiency in soil. The biomass production of fine roots was lower on drought treatments - 170 g/m2 during the growing season in 2000 while it was 190 g/m2 on the control plot. The ingrowth core results showed that fine root mortality was high on drought plots, resulting into clearly lower fine root biomasses compared with the control at all samplings during the study period.

The results on fine root dynamics are discussed in relation to results on diameter growth and soil and tree nutrient status.