International Symposium “Root Research and Applications”
RootRAP, 2–4 September 2009, Boku – Vienna, Austria

Root dynamics and nitrogen uptake in a future climate

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ABSTRACT

Climate change has great impact on natural ecosystems, and plant root responses are a major part of whole-plant responses to climate change. Little information is available on below-ground plant responses as to how root growth and turn-over, root morphology and nutrient use efficiency change in response to climate change. In the CLIMAITE experiment root biomass and nutrient uptake have been studied in different treatments with higher CO_2, temperature and a drought period. Preliminary results show a decrease in root biomass with increasing temperature, while the root biomass was increased under elevated CO_2 concentrations. Nutrient uptake in *Deschampsia flexuosa* is higher in the CO_2 treatments and lower in the combined Temperature*Drought treatment.

KEYWORDS: CLIMAITE, root growth, NH_4, bioassay, *Calluna vulgaris*, *Deschampsia flexuosa*

1. INTRODUCTION

Climate change has great impact on natural ecosystems, but little information is available on below-ground plant responses. In the Danish multifactor manipulation experiment ‘CLIMAITE’, effects of future climate change are studied *in situ*. The manipulations involve three main factors in 6 blocks:

1. A Free Air Carbon Enrichment (FACE) increases CO_2-concentrations to 510 ppm. (**CO_2**).

2. Night time warming (reflective curtains) increase temperature 1-2 °C (**T**).

3. Prolonged drought – precipitation is removed for 4-8 weeks in the summer by automatic rain covers (**D**).

Besides the single factor treatments the combined effects are also studied. The experiment is located in a Danish heathland/grassland ecosystem dominated by the evergreen dwarf-shrub *Calluna vulgaris* and the grass *Deschampsia flexousa*. The objective of the study is to investigate root dynamics in a changing climate and how this affects overall ecosystem carbon balance.

2. METHODS

To investigate root biomass, dynamics and turn-over rate we use minirhizotrons, root in-growth bags, and sequential soil sampling. Sequential soil coring to 15 cm depth is used to estimate root biomass. Soil samples are sorted and fine roots washed before drying and weighing to get the total biomass.

In-growth cores are used to estimate relative growth and to observe the effects of experimental manipulations on root growth. The in-growth cores were placed in the field and were taken up after 1 year (in November 2008), and the roots were then used for bioassay of N uptake (^{15}N labeled NH_4). The bioassays of N-uptake in fine roots of the two dominant species were separated into the depths: O-horizon, 0-5 cm and 5-10 cm. The roots were sorted and fine roots washed in demineralized water. The roots were put in a plastic bag with a damp/moist hand towel cloth and put in refrigerator until analysis (maximum time before analysis was 4 days). Roots were labeled with a name tag and the roots were first put in the pre-soak treatment (solution of CaCl2) and after put in the ^{15}N labeled NH_4-solution (20% enrichment). The roots were in the N-solution for 2 hours, and then washed in running demineralized water for 15 minutes, put in paper bags and dried in the oven for 2 days at 70 degrees. The root material was then analyzed for ^{15}N on a spectrophotometer. Excess ^{15}N (at %) was converted to absorption rate of N (Michelsen *et al*., 1999).

3. RESULTS AND DISCUSSION

Preliminary results show a decrease in root biomass with increased temperature, while the root biomass was increased under elevated CO_2 concentrations. Further results will show if this pattern continues throughout the growing season. The

In the grass *Deschamsia flexuosa* the absorption of NH_4 (mean of 3 depths) was lower in the treatment 'Temp*Drought', while the absorption of NH_4 in the upper 15 cm was higher in the CO_2 treatment. The higher uptake of NH_4 in the CO_2 treatment is probably due to the increased growth seen in the root biomass and therefore a higher demand for nutrients.

4. CONCLUSION

The results show a decrease in root biomass with increasing temperature, while the root biomass was increased under elevated CO_2 concentrations. The nutrient absorption study shows a higher NH_4 uptake in the CO_2 treatments, while the interaction 'Temp*Drought' was lower than the other treatments.

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