Responses of fine root production to warming under different water-table level scenarios in sedge fens

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Introduction

In boreal sedge fen peatlands, carbon sequestration is largely mediated by sedge roots. Most of sedge biomass, in some cases more than 90%, is allocated belowground to the root systems (Sjörs 1991, Saarinen 1996). Thus, roots provide a direct input of organic matter to the peat, and their turnover is a major component of the C cycle. A small fraction of change in root production can thus affect the ecosystem C sink. Climate warming may affect the production patterns both per se and by shifting peatlands towards drier conditions. In order to predict the scale and nature of the likely effects of the warming climate, the responses of root production in sedge fens need to be assessed.

Methods and aims

Here we examine the effect of warming under wet (ambient) and drier conditions on fine root production (FRP) and its depth distribution at two sedge fens in Finland: northern (Lompolojänkkä) and southern (Lakkasuo), using ingrowth cores. FRP was estimated using ingrowth-dividing method (Bhuiyan et al. 2017). Warming was induced with open-top chambers (OTC) and drying with shallow ditches. Contributions to FRP by different plant functional types were estimated utilizing infra-red spectroscopy.

Experimental setup with OTCs and shallow ditches in Lompolojänkkä site

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Results

In the southern fen, FRP under warming in wet conditions, W, showed an increasing trend, which was not significantly different from FRP under ambient conditions, however. In contrast, W resulted in lowering FRP trend compared to ambient in the northern fen (Fig.1)

Neither drying, WTD, nor warming under drier conditions, WWTD, affected FRP significantly in the southern fen. However, in the northern fen, both WTD and WWTD showed an increasing trend in FRP as compared to ambient. In addition, FRP was significantly different between W and WWTD in the northern fen (Fig 1).

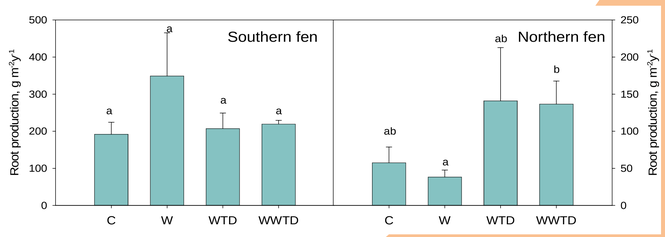

Figure 1. Fine root production for C- control, W- warming, WTD- water-table drawdown, WWTD- warming + water-table drawdown) in the southern and northern fens. Bars are standard error of mean. Different superscript letters indicate significant difference ($p<0.05$) between the treatments. Note the difference in y-axis scales between the two fens.

In the southern fen, warming showed greater FRP for each depth class compared to ambient , the difference being significant in the 30-40 cm depth class (Fig 2). In the northern fen, the depth classes below 10 cm showed several significant differences between treatments : C vs WWTD in 10-20 cm, 20-30 cm, 30-40 cm and WTD vs WWTD in 40-50 cm depth class. Only WTD and WWTD showed any FRP at 50-60 cm.

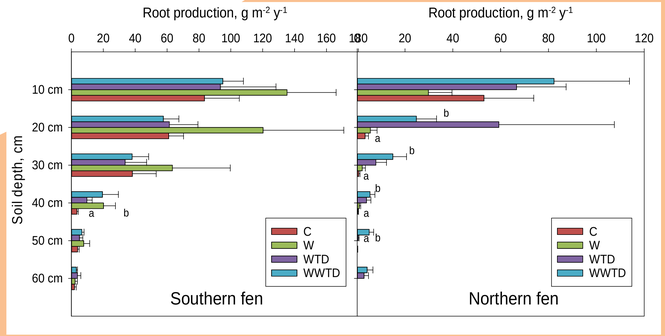

Figure 2. Distribution of FRP by depth classes for each treatment in the southern and northern fens. Bars are standard error of mean. The superscript letters indicate significant difference ($p<0.05$) between treatments for each depth class.

In both sites, sedge contribution to FRP was more than 70% under wet (ambient water-level) conditions. However, after drying (WTD) sedge contribution decreased in the 0-10 cm of the southern fen and in 10-60 cm layer of the northern fen, while those of shrubs and forbs increased (Fig 3).

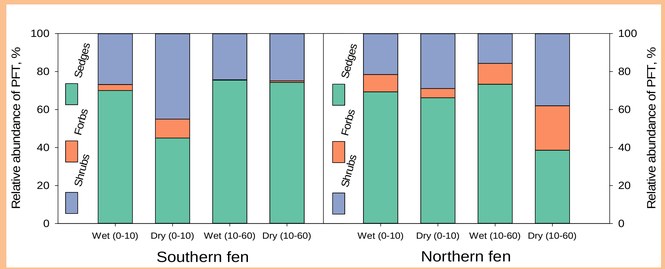

Figure 3. Relative abundance (%) of each plant functional type (PFT): sedges, forbs, shrubs estimated by infrared spectroscopy using regression models . Wet represents C+W treatments and Dry represents WTD+WWTD treatments.

Conclusions

Our results show that FRP can vary widely both between and within sites representing the same habitat type. They further suggest that the responses of FRP to climate change are in general minor. However, there may be changes in depth distribution and plant group composition that depend on the moisture regime. Such subtle changes in both the depth profile and decomposability of the organic matter inputs may yet affect the C cycle of sedge fens in the future.

References:
Bhuiyan R, Minkkinen K, Helmisaari H-S, Ojanen P, Penttilä T, Laiho R (2017) Estimating fine-root production by tree species and understorey functional groups in two contrasting peatland forests. Plant and Soil: 412 (1): 299-316
Saarinen T (1996) Biomass and production of two vascular plants in a boreal mesotrophic fen. Canadian Journal of Botany 74: 934-938
Sjörs H (1991) Phytomass and necromass above and below ground in a fen. Holarctic Ecology 14: 208-218