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Reed canary grass (Phalaris arundinacea) cultivation as bioenergy crop on an abandoned peat extraction area with low soil pH

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Reed canary grass (RCG) cultivation on former peat extraction areas is a potential after-use option that provides a source of renewable energy while mitigating climate change through enhanced carbon (C) sequestration. We investigated the impact of water management on the RCG cultivation on an abandoned peat extraction area with very low soil pH in eastern Estonia. RCG was seeded in July 2015. Eight experimental plots (6x8 m), four replicates with high (H) and four with low (L) ground water level (GWL) were established. The difference in GWL values between H- and L-GWL plots during vegetation period (from May to September) was 1 cm in 2016 and 16 cm in 2017. All plots received 22 kg N, 25 kg phosphorus (P) and 53 kg potassium (K) of mineral fertilizer per hectare at the beginning of experiment. The fertilization rate in the second and third year was N45P11K45 and N100P25K100, respectively. Each year liming (8 t ha-1) was carried out on all plots. It increased pH from the initial 2.7 up to 5.0 after the third liming event.

We analyzed above- and belowground biomass and its nutrient content, soil and water samples for physico-chemical parameters, and measured fluxes of carbon dioxide (CO_2; net ecosystem exchange (NEE), ecosystem and heterotrophic respiration), methane (CH4) and nitrous oxide (N2O) using dynamic and static chambers.

The mean aboveground biomass on H-GWL plots was 181 g m-2 in 2016 and 388 g m-2 in 2017. Respective values for L-GWL plots were 159 g m-2 and 136 g m-2. The root:shoot ratio was 2.1 for H-GWL plots in 2016 and 1.9 in 2017 and the ratio for L-GWL plots was 2.4 and 4.2, respectively. Due to low plant productivity in all sites NEE was positive, i.e. ecosystem respiration was higher than fluxes of C assimilated by vegetation and the area functioned as a net C source. Total organic carbon (TOC) losses from H-GWL plots were up to 2-fold higher compared to L-GWL plots, whereas TOC loss from cultivated plots was lower than from bare soil. During the vegetation period CH4 fluxes from H-GWL plots (-56 to 60 μg C m-2 h-1 in 2016 and -9 to 585 μg C m-2 h-1 in 2017) were lower than fluxes from L-GWL plots (-13 to 1780 μg C m-2 h-1 in 2016 and -14 to 2005 μg C m-2 h-1 in 2017). Also, N2O fluxes from H-GWL plots (-6 to 79 μg N m-2 h-1 in 2016 and -3 to 335 μg N m-2 h-1 in 2017) were lower than fluxes from L-GWL plots (-13 to 117 μg N m-2 h-1 and -6 to 511 μg N m-2 h-1).

According to low biomass production, positive NEE and high TOC leaching we can conclude that cultivation of RCG on abandoned peat extraction areas with very low pH value does not have any environmental nor economic benefits.