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Impact of water regime on reed canary grass (Phalaris arundinacea) cultivation in an abandoned peat extraction area with very low soil

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Reed canary grass (RCG) cultivation in 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. Climate change scenarios indicate increasing precipitation in northern Europe. We investigated the impact of water regime on the RCG cultivation in an abandoned peat extraction area with very low soil pH located in Estonia.
RCG was sown in July 2015. Eight experimental plots (6x8 m), four replicates with high (H) and four with low (L) ground water level (GWL) were established. At the beginning of the experiment, all plots received 22 kg N, 25 kg phosphorus (P), and 53 kg potassium (K) of mineral fertilizer per hectare. Fertilization rate in the second and third year was N45P11K45 and N100P25K100, respectively. Liming (8 t ha-1) was carried out in all plots each year. That 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 (net ecosystem exchange, ecosystem and heterotrophic respiration), methane (CH4) and nitrous oxide (N2O) using opaque static and transparent dynamic chambers.
The 30-year (1984-2014) mean precipitation during the vegetation period (April - September) was 327 mm. In 2016 and 2017 the vegetation-period rainfall was 470 and 277 mm, respectively. The H-GWL plots were irrigated with 767 mm groundwater in 2017. Average GWL during the growing season 2016 was -33 cm in the H-GWL plots and -34 cm in the L-GWL plots, whereas in 2017 the respective values were -22 cm and -38 cm.
Mean aboveground biomass on H-GWL plots was 181.5 g m-2 in 2016 and 388 g m-2 in 2017. Respective values for L-GWL plots were 158.8 g m-2 and 136.5 g m-2. 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 C source.
Despite of additional water in 2017, the total organic carbon (TOC) values did not increase in the piezometer water of H-GWL plots. In 2016, average TOC content in the H-GWL plots was 83 mg L-1 and 73 mg L-1 in the L-GWL plots while same parameters for 2017 were 76 mg L-1 and 56 mg L-1, respectively.
Both CH4 and N2O fluxes were relatively low in the growing season. N2O fluxes peaked after fertilization being also higher in the 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) than those in the L-GWL plots (-13 to 117 and -6 to 511 μg N m-2 h-1).
Reed canary grass cultivation on abandoned peat extraction areas with very low pH value does not have any environmental nor economic benefits due to positive global warming potential and low biomass production.