Greenhouse gas emissions from energy willow, nature conservation field and grass on a peat soil with raised ground water level

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Background

In Finland organic soils cover about 12% of the cultivated area (ca. 263 000 ha). These fields produce a significant amount of greenhouse gas emissions nationally in the agriculture and land use sectors. Due to their high emission load, peatlands appear to be the most potential target for greenhouse gas mitigation measures. Raising the ground water level (GWL) and selecting crops suitable for wet conditions could be a partial solution to mitigate these emissions. We started an experiment with the aims of 1) monitoring the success of three potential species in wet cultivation and 2) estimating the impact of a moderate water level rise on greenhouse gas emissions.

Material & method

Research field was established in 2018 to study the success of energy willow (*Salix*), bog whortleberry (*Vaccinium uliginosum*) and grass mix for silage on a peat soil that has been cultivated for more that 100 years. To raise the ground water higher than the conventional level, submerged drainage was established. We measured the growth and annual yield of different plant species, as well as GWL, CO_2 balance, nitrous oxide (N_2O) and methane (CH_4) gas fluxes on average every second week.

Results

Yields and plant success. Bog whortleberry did not succeed and the plots were converted to nature conservation treatment in 2020. Silage grass was harvested three times in 2019, but yield remained low due winter damages (Fig.1). In 2020 grass was harvested twice. Willow was harvested in late Feb 2021 (results not shown).

Groundwater level. GWL did not raised sufficiently with controlled drainage during the first two growing seasons (Fig. 4). To raise GWL we had to start pumping water in middle of June 2020. After that the GWL raised for the rest of the growing season by about 20 cm compared to the year earlier.

Soil respiration. It seems that estimated CO_2 flux corrected to zero-temperature (R0; Lohila et al. 2003) did not vary a lot during the measured period showed in Figure 2. However, the average R0-flux was lower (49 kg ha^{-1} day^{-1}) and GWL higher (-54 cm) during Jul – Oct 2020 compared to same period in 2019 (R0 = 68 kg ha^{-1} day^{-1}, GWL = -74 cm) (Fig. 4).

Methane. Raised GWL did not markedly increase methane emissions (Fig 2).

Nitrous Oxide. Variations in N_2O fluxes were most likely connected to cultivation managements (such fertilization, soil disturbance), crop density, seasonal variation (freeze – thaw cycles) (Fig 3).

Conclusions

Bog whortleberry did not thrive in longtime cultivated, limed and nutrient rich peat. Permanent biomass production did not suffer from raised GWL and is a good option for such fields. Preliminary results show that N_2O fluxes were lowest for forage production and raising GWL by 20 cm reduced peat decomposition.

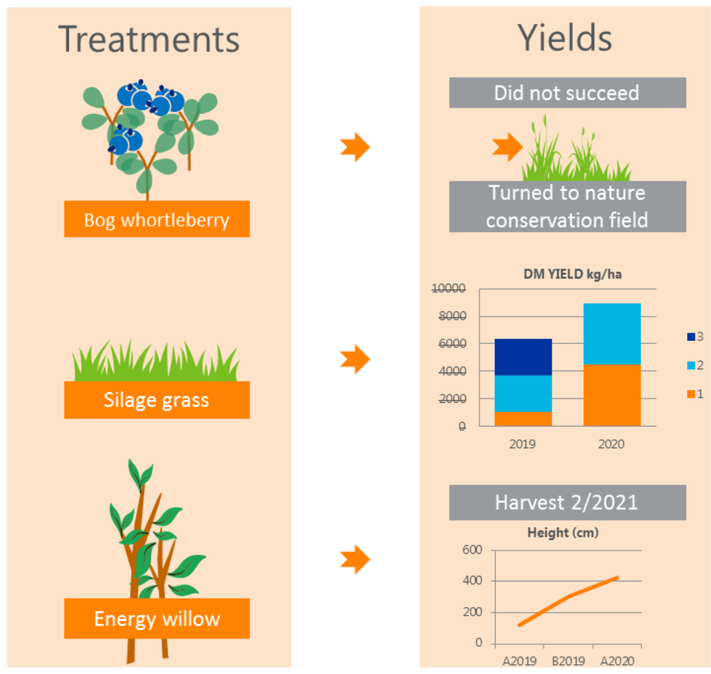

Figure 1. Success of bog whortleberry, willow and silage grass were monitored.

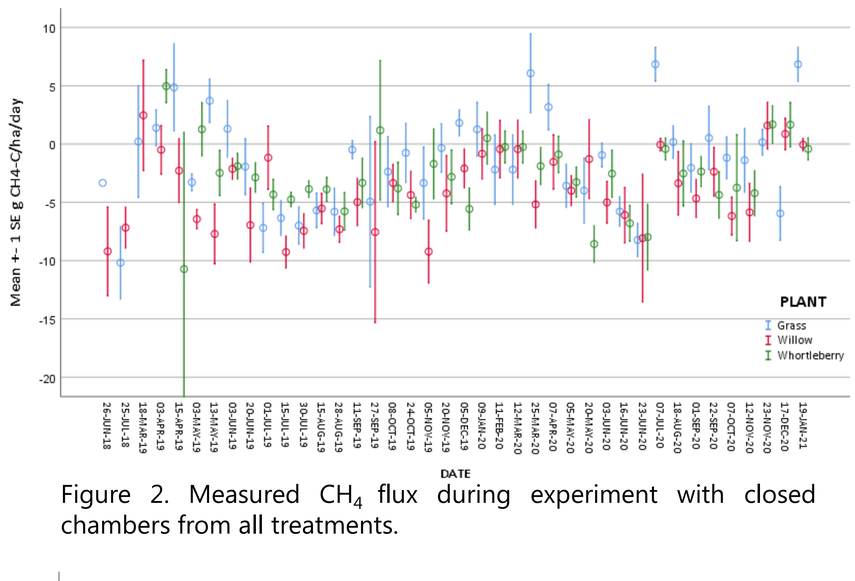

Figure 2. Measured CH_4 flux during experiment with closed chambers from all treatments.

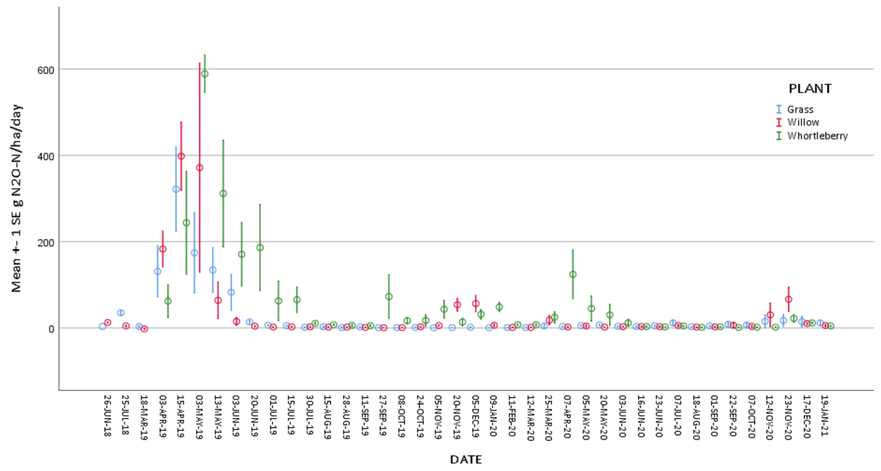

Figure 3. Measured N_2O flux during experiment.

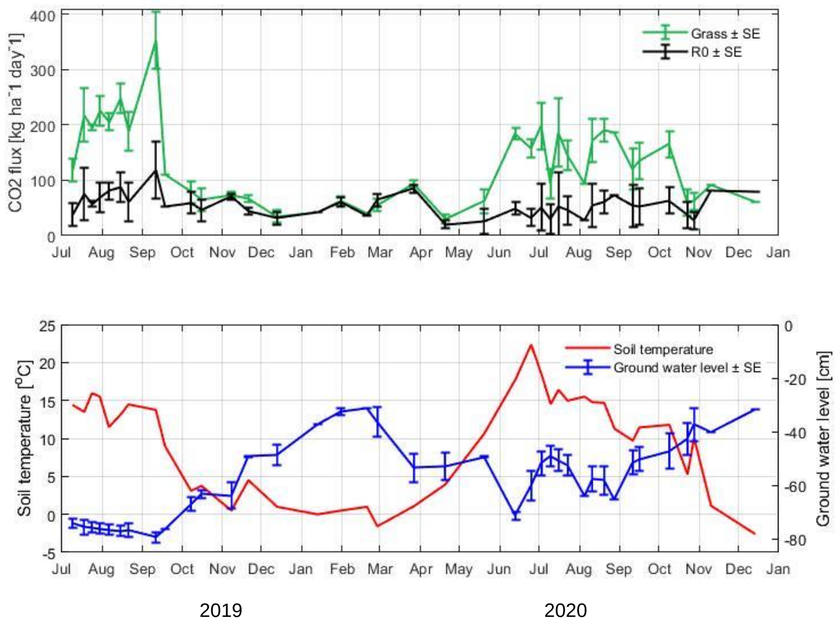

Figure 4. Soil respiration was measured from silage grass plots with chamber technique during Jul 2019 – Dec 2020. Soil respiration at zero-temperature (R0) was estimated for data points with equation 1. Ground water level and soil temperature were monitored at the same time.

References

Lohila, A., Aurela, M., Regina, K. et al. Plant and Soil (2003) 251: 303. https://doi.org/10.1023/A:1023004205844

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