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Effects of harvest time and nutrient supply on fuel quality of Paludiculture plant species

Claudia Oehmke, Franziska Eller, Wenyong Guo, Linjing Ren,
Nora Köhn, Tobias Dahms, Franziska Tanneberger, Brian K. Sorrell, and Hans Brix

Background

Paludiculture as a sustainable use of rewetted peatlands:

- reduces GHG emissions enhance water and nutrient retention,
- preserves peat soils as agricultural land, restores and maintains habitats for rare and threatened species and
- **allows the production of "clean" biomass** that hardly competes with food production, replaces fossil resources by renewable biomass alternatives f.e. **solid biofuel for heat generation**

Biomass requirements on soild biofuels: low concentrations of combustion related chemical elements, low ash content

Research question

Is the combustibility of Paludiculture plants influenced by harvest time and nutrient supply?

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Biomass characteristics are effected by harvest date and nutrient supply

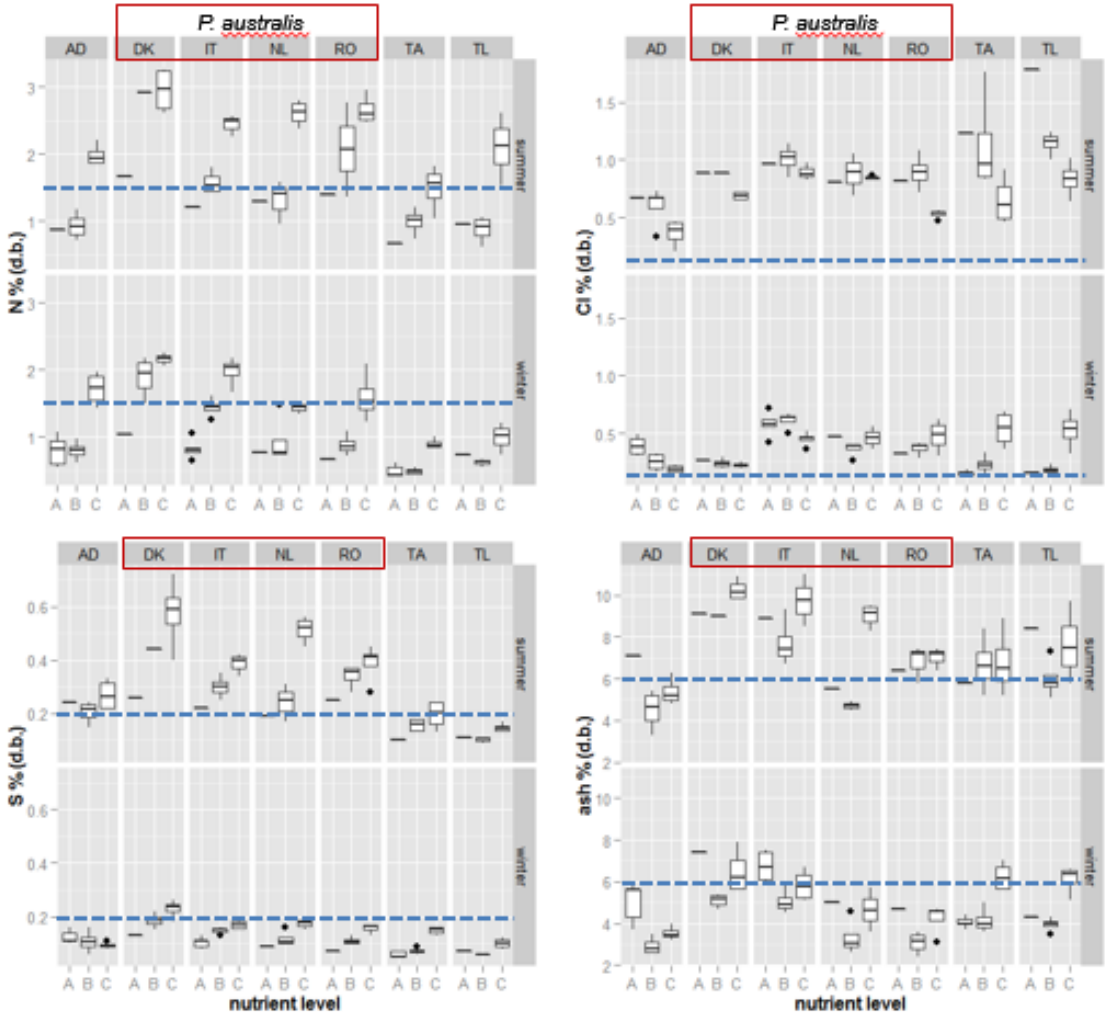

Fig. 2

Elemental concentration of N, Cl, S and ash content of A. donax (AD), T. latifolia (TL), T. angustifolia (TA), P. australis genotypes from Denmark (DK), Italy (IT), Netherlands (NL) and Romania (RO). The blue lines indicate treasure values after DIN EN ISO 17225-6 for trading solid biofuels of non-woody biomass. Concerning N concentrations winter harvested P. australis (IT), Typha angustifolia as well as T. latifolia could meet the treasure values at all nutrient levels. S concentrations were only for Typha angustifolia and T. latifolia below the treasure values at summer harvest, but for all plants at winter harvest. Ash contents were very high for all plant species in summer (>6 %) – except for A. donax and P. australis (NL). Summer harvest showed for all parameters stronger effects of nutrient levels on the biofuel quality than winter harvest.

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Conclusions

- Late harvest improves combustion quality
- This experiment indicates: Biofuel characteristics are influenced by harvest date > nutrient level > plant species (stronger > lesser)
- nutrient supply had an effect on biofuel characteristics, but it decreased from summer to winter
- Paludiculture can contribute to the energy transition with the production of sustainable biomass or biomass pellets for heat generation

Effects of harvest time and nutrient supply on fuel quality of Paludiculture plant species

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Introduction

In comparison to the drainage based agriculture on fens the shift to Paludiculture[1] (wet peatland management) will drastically reduce CO_2 emissions (Fig.1). The production of solid biofuels is one promising use option. Biofuels have to meet quality standards to minimize pollution and technical damage to boilers. The quality parameters of DIN EN 17225-6 give standards for non-woody biomass pellets that are recommended for the trade and use in Europe[3]. Although there are some studies that already showed that late harvest improves biomass quality for combustion[4,5], the influence of nutrient supply on the biofuel quality for different paludiculture plant species is still not known.

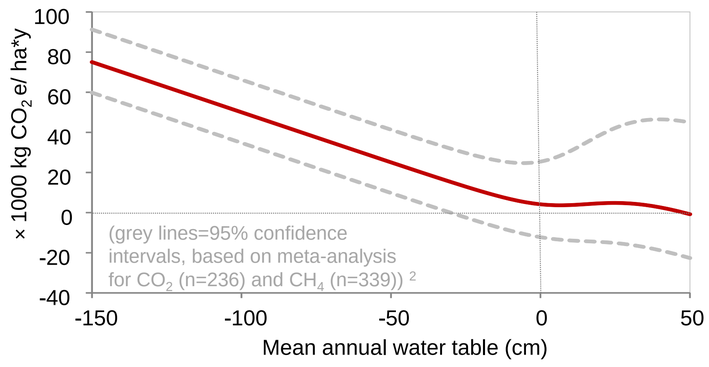


Fig. 1 *Net GHG balance (red line) decreases after rewetting peatlands – raising mean annual water levels by 10 cm reduces 5 t CO_2 e/ ha*y*

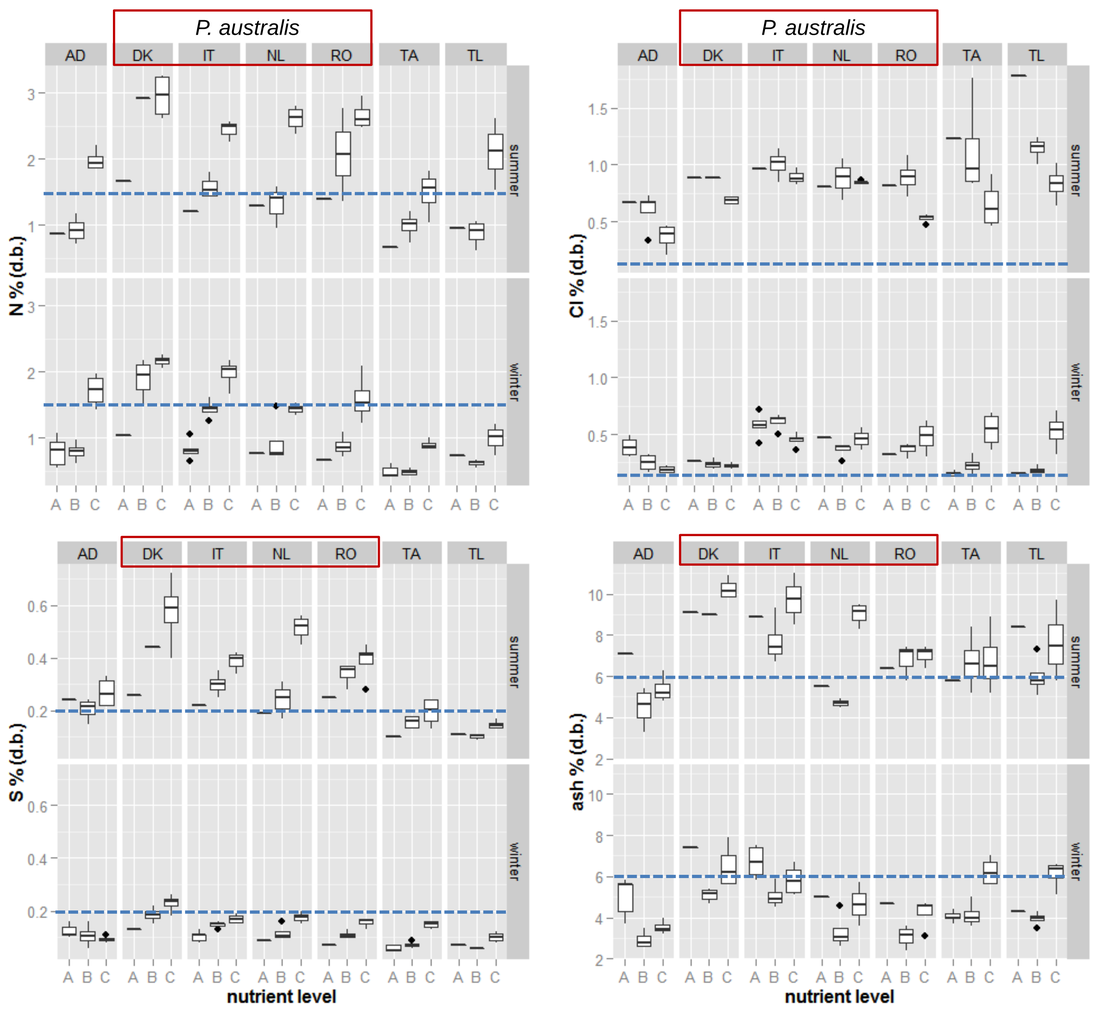


Fig. 2

Elemental concentration of N, Cl, S and ash content of A. donax (AD), T. latifolia (TL), T. angustifolia (TA), P. australis genotypes from Denmark (DK), Italy (IT), Netherlands (NL) and Romania (RO). The blue lines indicate treasure values after DIN EN ISO 17225-6 for trading solid biofuels of non-woody biomass. Concerning N concentrations winter harvested P. australis (IT), Typha angustifolia as well as T. latifolia could meet the treasure values at all nutrient levels. S concentrations were only for Typha angustifolia and T. latifolia below the treasure values at summer harvest, but for all plants at winter harvest. Ash contents were very high for all plant species in summer (>6 %) – except for A. donax and P. australis (NL). Summer harvest showed for all parameters stronger effects of nutrient levels on the biofuel quality than winter harvest.

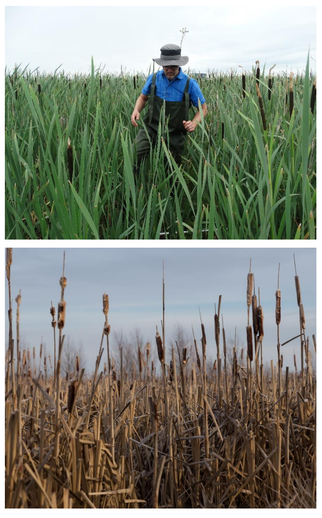
Methods

We selected seven wetland plants suitable for paludiculture (*Typha latifolia*, *Arundo donax* and four distinct genotypes of *Phragmites australis* from Denmark, The Netherlands, Romania and Italy) and set up a growth experiment with three different nutrient availability treatments in waterlogged peat soil. Aboveground biomass was harvested in summer and winter. We analysed concentrations of combustion relevant chemical elements C, H, O, N, Cl, S as well as ash content. Higher Heating value (HHV) was calculated.[6]

Conclusions

Due to their high biomass productivity, *T. latifolia*, *A. donax*, *P. australis* (NL) and (RO) had the greatest potential to produce bioenergy feedstock[7]. In this study the nutrient supply had an effect on biofuel characteristics, but it decreased from summer to winter (Fig.2). For S and N concentrations higher nutrient supply resulted in higher elemental concentrations in the biomass, but for summer harvest concerning Cl and ash content this trend was mostly not clear. Biofuel characteristics are influenced by harvest date > nutrient level > plant species (stronger > lesser).

As there is a demand for solid biofuels from biomass, paludiculture can contribute to the energy transition with the production of loose biomass or biomass pellets. The implementation of Paludiculture on rewetted peatlands will additionally support several ecosystem services[8]: the production of biomass that hardly competes with food production, replaces fossil resources by renewable biomass alternatives, enhance water and nutrient retention, preserves peat soils as agricultural land and can also restore and maintain habitats for rare and threatened species in special cases.



Figures *Typha latifolia in July (above) and in January (below). Summer biomass contains higher concentrations of elements that indicates lower quality for combustion, in contrast to brown winter biomass that has been leached by precipitation events.*

1 Wichtmann et al. (Ed.) (2016) Paludiculture-productive use of wet peatlands. Schweizerbart Science Publishers, Stuttgart 2 Couwenberg, J., Reichelt, F. & Jurasinski, G. (unpubl.) 3 DIN EN 17225-6: Solid biofuels - Fuel specifications and classes. - Part 6: Graded non-woody pellets 4 Dahms, T. (2017) Paludi-Pellets-Broschüre, Panzig Greifswald. 5 Giannini, V., Oehmke, C., Silvestri, N., Wichtmann, W., Dragoni, F., Bonari, E., (2016) Combustibility of biomass from perennial crops cultivated on a rewetted Mediterranean peatland. Ecol. Eng. 97 6 Sheng, C., Azevedo, J.L.T., (2005) Estimating the higher heating value of biomassfuels from basic analysis data. Biomass Bioenerg. 28 (5), 499–507. 7 Assessing nutrient responses and biomass quality for selection of appropriate paludiculture crops 8 Wichtmann et al. (2010) Paludiculture is paludifuture. Climate, biodiversity and economic benefits from agriculture and forestry on rewetted peatland

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