Comparing contrasted biomass crops cultivated under different cropping managements

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Comparing contrasted biomass crops cultivated under different cropping managements

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Biomass from dedicated crops is expected to significantly contribute to the replacement of fossil resources. However, the development of these crops must not occur to the expense of neither food production nor environment. The biomass crops and the cropping management will have to answer to these constraints. This paper aimed at comparing contrasted biomass crops cultivated under different cropping management in the same long term experiment.

Methodology

The long term experiment is located in Estrées-Mons in Northern France (50°N, 3°E, 85 m elevation). The soil is a deep silt loam (Ortic Luvisol). Seven crops with two levels of nitrogen were compared (N- and N+): poplar (0 and 60 kg ha^{-1}), *Miscanthus x giganteus* (0 and 120 kg ha^{-1}), switchgrass (0 and 120 kg ha^{-1}), fescue (n*40 and n*80 kg ha^{-1}, n depending on the number of cut per year), alfalfa (no fertilization), triticale (60 and 120 kg ha^{-1}) and fiber sorghum (0 and 120 $kgha^{-1}$).The poplars were cultivated in very short rotation coppice, harvested every two years. For miscanthus and switchgrass two harvest dates were also compared: early harvest in October (E) or late harvest in February (L). Biomass production and nutrient content (N, P, K) were measured at harvest

Results and discussion

The hierarchy between crops in terms of biomass production was relatively constant over the years with a superiority of the C4 perennial crops, particularly when harvested early, then all annual and pluriannual crops and finally poplar (Fig. 1). There was a slight effect of N fertilization on the yield of miscanthus from 2008 in E treatments, and a significant effect on the yield of switchgrass from 2007 for both harvest treatments, but stronger in E treatments. The interaction between early harvest and fertilization is likely due to depletion in rhizome N reserves (Strullu et al., 2011).The trend for the yield of alfalfa and fescue was quite similar, with a high variability between years. For both crops, the biomass yield obtained never exceeded 20 t ha^{-1}, which is likely to be due to lower RUE of C3 compared to C4 crops. The yield of triticale was low, especially in N- treatments. The biomass production of fiber sorghum was low, which is mainly due to its susceptibility to the low temperatures of Northern France. The biomass production of poplar coppice was low compared to the other crops.

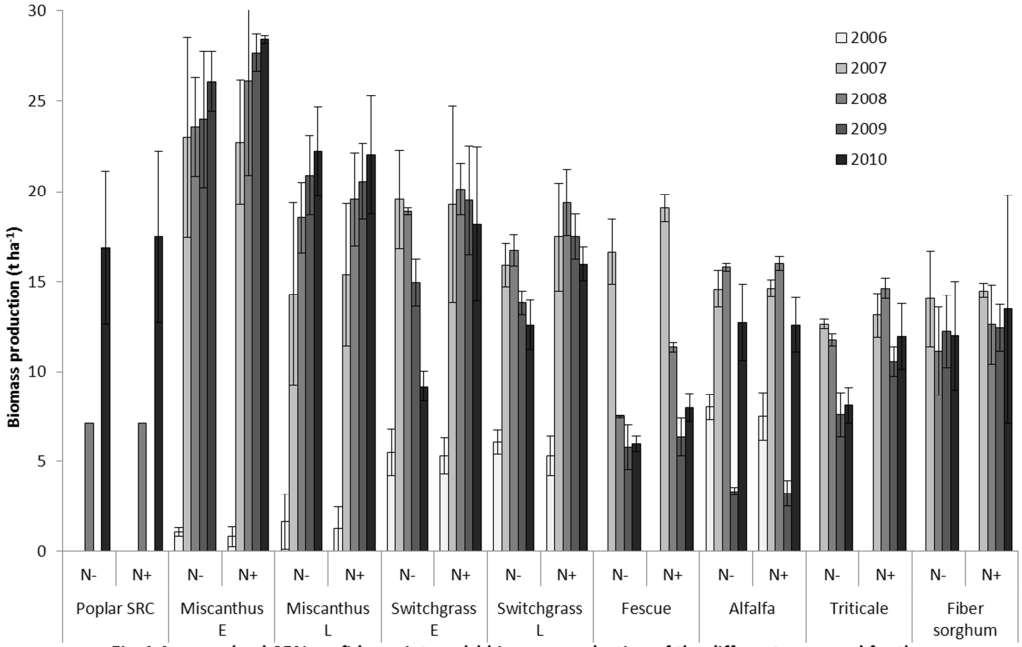

Fig. 1 Average (and 95% confidence intervals) biomass production of the different crops and for the different experimental treatments over the period 2006-2010

The nutrient content at harvest was expressed by unit of C produced to give efficiencies of nutrient removal. The nutrient/C ratio was low on average for miscanthus and switchgrass (Fig. 2) especially for L treatments, due to nutrient translocation during winter. The trend for poplar was very similar to the perennial C4 crops. The nutrient/C was high for both pluriannual crops: it has been previously identified as a major disadvantage of using these crops for bioenergy (Ceotto, 2009). The nutrient/C ratio of both annual crops was intermediate, which was yet described by Scholz and Ellerbrock (2002).

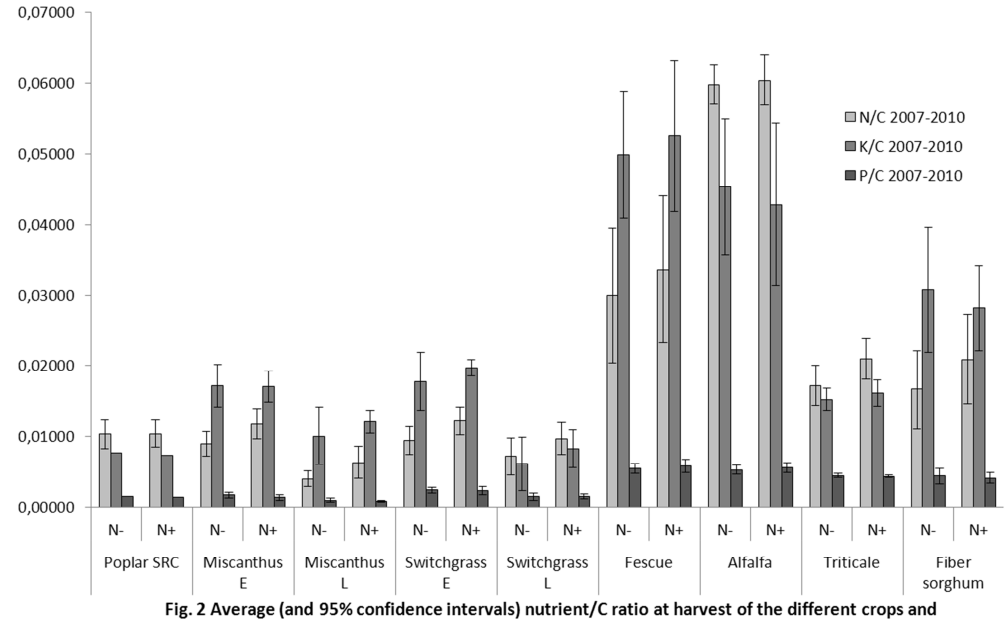

Fig. 2 Average (and 95% confidence intervals) nutrient/C ratio at harvest of the different crops and for the different experimental treatments over the period 2007-2010

Conclusion

Miscanthus and switchgrass, harvested late, were able to conciliate high biomass production and low nutrient removal at harvest. The biomass production was lower and the amount of nutrient removed at harvest was higher for the other crops. For pluriannual crops, concerns appeared especially on the large K removal. Further researches are needed to study the environmental consequences of these behaviors.

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