Tertiary waste water treatment using short rotation willow coppice in Belgium

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This paper firstly develop the reasons why short rotation willow coppice for tertiary water treatment system might develop in Belgium. A demonstration project is presented with first results showing the effectiveness of the system.

Introduction

Combining short rotation coppice (SRC) cultivation for biomass production with water purification is studied for a long time [for example 1 - 3], mostly in Sweden where dissemination takes place. A demonstration project has been started in Belgium.

The aim is to grow willows at high density (10-20 000 plants.hectare^{-1}), with a harvesting cycle of 2 to 5 years. Wood can then be converted into renewable energy, heat and/or electricity. When irrigated with wastewater, the SRC plantation acts as a biological filter media to remove nutrients and some heavy metals contained in the wastewater. Three effects are combined in such soil-plant system : the filtration of effluents by soil particles, the transformation of nutrients by macro- and micro-organisms, the uptake of nutrients and heavy metals by the plants. This biofiltration system can replace conventional tertiary treatment while increasing the SRC biomass yield due irrigation and fertilisation.

The system has many advantages like recycling of nutrients, reducing health hazards as SRC is a non food crop, good energy balance, cheaper purification system for water companies, higher profitability for the growers due to a lower cost for fertilisers and a higher yield. The principle drawbacks are a lower purification potential during winter and the extensive character of the system which needs relatively large areas.

This kind of system has some potential to develop in Belgium, particularly in Wallonia (the South region), for several reasons. Renewable energies are actively promoted with clear objectives (from 1,8% renewable electricity in 1998 to 8% in 2010, backed up by green certificates).
The quality of surface water in Belgium is extremely bad according to a recent survey [4]. Less than half the population is connected to drain systems and purification stations (this should change soon thanks to huge investments – 880 millions EUR during 2000-04 period). The whole Wallonia is classified as sensitive area (with regard to tertiary treatment, required for stations higher than 10 000 equivalent inhabitants (EI)).

The demonstration project

(1) Material and methods : In spring 1998, 1 ha of SRC was planted close to a small water purification station (1500 EI) in Sart-Bernard (50°24' N, altitude 190 m). The split-plot design of the trial allows to compare two willow clones (Tora – Salix viminalis x schwerinii and Jorunn – S. viminalis) and three treatments (no irrigation, irrigation with distribution water, irrigation with secondary water – coming out of the secondary treatment), with three repetitions.

Irrigation is carried out using a droplet system with automatic control units and water meters for each parcel (400 m^2). Ceramic cups (with the limitations linked to such sampling method) have been installed at 60 cm deep in the soil in order to sample water in all parcels.

Both types of irrigation waters and ground water were analysed once a month for the following elements : $N_{Kjeldhal}$, NH_4^+, NO_3^-, PO_4^{2-}, P, K, CDO, BDO_5, pH, SO_4^{2-}, HCO_3^-, Cl^-, Mg^{2+}, Ca^{2+}, Na^+, and twice a year for heavy metals : Cd, Cr, Cu, Ni, Pd, Zn. The soil is analysed each year as well as biomass for its productivity and elements concentration.

(2) Results : The system has been running the whole growing season from 15 March to 28 September 2000 on willows at stage R3S2 (roots of 3 years old and stems of 2 years old). The inputs on the crops are presented in table 1.

Table 1. Inputs by irrigation

Treatment	Water quantity (mm)	Nitrogen* (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
No irrigation	0	0	0	0
Distribution water	708	36	0	12
Secondary water	701	57	7	80

* without natural inputs (mineralisation, atmospheric fall down)

Comparisons of the irrigation water to the soil water show that the system is efficient for all three major elements N, P and K (figure 1 presents results for total nitrogen). For SO_4^{2-}, HCO_3^-, Cl^-, Mg^{2+}, Ca^{2+}, Na^+ concentrations in ground water is increasing with time and attention should be paid is future irrigation years. There are no statistical difference among clones or irrigation treatments.

Biomass measurements have shown no statistical differences.

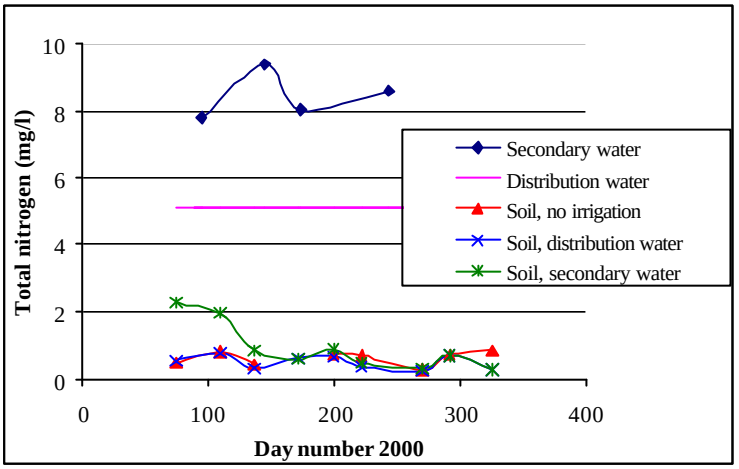

Figure 1. Nitrogen in irrigation water and in ground water under willows

Conclusion

The tertiary treatment of waste water might be developed in the future in Belgium. Preliminary results of a demonstration project are positive and show that irrigation level might even be increased. However experimentation should go on and results confirmed to ensure that the system is sustainable long term.

References

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Acknowledgement : this project is supported by the Walloon region, Belgium.