

Phytodepuration processes in two short rotation forestry systems within venice lagoon watershed

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Introduction

Bioenergy crops are promising option for integrating fossil fuels and achieving European environmental targets. Wooded systems like Short Rotation Forestry (SRF) in the plain areas, counting agroforestry as well, start to be considered an opportunity for sustainable agricultural development, because of the environmental benefits related to their use on agricultural lands. One of this is to enhance water resources quality. Moreover the EU has encouraged the use of biogas to produce energy, and consequently there is a need of recycling digestate as fertilizer with high content of inorganic N. However the geographical concentration of livestock in areas with little or no agricultural lands has led to manure management worries for fresh water and groundwater. This research has highlighted the virtuous pairing of the bioenergy promotion (biogas and wood energy sectors) and a correct management of digestate. The experimentation was carrying out in two SRF plantations.

The aims of this study are:

- 1) to measure nitrogen leaching in two quite diverse SRF plantations fertilized by two different amount of digestate;
- 2) to assess the benefit of digested slurry spread on SRF in terms of biomass growth.



Experimental

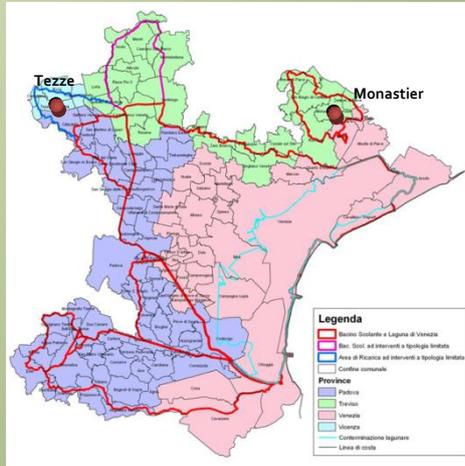
The two experimental sites are located in the North East of Italy within the Venice Lagoon drainage basin:

TEZZE lays in the upper plain, it is characterized by a loamy-skeletal, mixed, mesic soil. In the upper 90 cm the soil is a mixed of coarse and fine sediment. The groundwater level fluctuates approximately between 15 and 19 m below ground level. The experimental site consist of monoculture plot (60x50 m) of *Platanus hispanica* (Mill) ex Muench, a hybrid of *Platanus orientalis* x *Platanus occidentalis*, with a density of 1125 trees/ha.

MONASTIER is located in the low plain, it has a clay soil until 120 cm depth so the water flows are very slow except during dry season when soil fissures caused preferential flows. The planting system (*Populus X canadensis* Mönch "Baldo clone") has a density of 1125 trees/ha.

In each of the two experimental sites 2 theses with different amount of digested slurry from biogas plant were tested.

cod thesis	N spread Kg ha ⁻¹	sand %	silt %	clay %	skeleton %
TEZZE SUL BRENTA - <i>Platanus hispanica</i>					
TA0	0				
TA1	170	50	34	16	abundant
TA2	250				
MONASTIER- <i>Populus X canadensis</i> Mönch (clone Baldo)					
MA0	0				
MA1	170	0	8	92	absent
MA2	340				

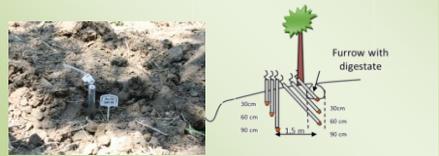


Methods

The soil water content, expressed as % of volumetric water, was registered every 30 minutes through FDR Probes (Frequency Domain Reflectometry) connected to a data logger and placed at different soil depths (15, 30, 60 and 90 cm below the soil surface).

Measurements on N losses have been done over the four thesis and two control plots for three years from November 2012 to October 2015. Water samples were collected at 30 cm, 60 and 90 cm using tension lysimeters. Only in Monastier the soil water samples were collected inside the furrow (MA1in and MA2 in) and just outside of it (MA1ex and MA2ex).

Only in Tezze site the daily balance of N leached have been calculated by multiplying the daily volume of water deep seepage (at 90 cm) by the concentration measured during the sampling date considered representative for that period.



DIGESTATE SPREADING

In the **TEZZE** site due to the consistent presence of cobble and the high soil permeability instead to bury the digestate in the soil it was sprinkled on the top where was slightly move the tiny superficial soil skin. In this way the permanence on the surface is short but at the same time the first layer rich in fine sediment is fully exploited.

In **MONASTIER** the digestate was buried within furrows, at about 20-25 cm depth.

Results

Hydrology

As a consequence of the two site locations (high and low plain) and quite different soil textures the hydrology result strongly different in the two experimental sites. In all area of Tezze there is quite fast vertical infiltration rate (Ks) toward the groundwater, but the presence of significant content of fine sediment in the first 45 cm layer leads to a delay in percolation time. On the other hand the clay-loamy soil in Monastier acts like a sponge, during the wet season absorb water by increasing its volume while in the dry season due to evapotranspiration and evaporation processes, the soil water content is reduced by up to form several cracks.

Nitrogen leaching

The hydrology has a strong influence on phyto-depuration processes. Such differences in hydrology dynamics affect strongly the nitrogen processes and as result the nitrogen leaching. In Tezze site, although a suitable method of digestate distribution was applied, significant N leaching was calculated to be about 36-37% in TA1 and TA2 respectively. Differently in Monastier where we have not N leaching. The digestate remained confined within the furrow where it is used and transformed by plant uptake and microbial processes (Denitrification). This aspect was confirmed by the very low N concentration measure at short distance (about 1m) from the furrow where the digestate was buried.

Woody biomass

In the Tezze site the total fresh woody biomass estimated after 7 years was about 104 t/ha. Although the mean values showed some difference between the theses, control plot included, was not possible to argue that digestate had a significant effect on the woody biomass production, because the comparison between the theses, performed via T Student test, was not significant. Monastier at the end of the research was still at his early stage, 3rd year, as a consequence was not possible to compare the thesis to see the digestate effect, anyway the fresh woody biomass estimated at the end of the study period ranged between 35 t/ha to 40 t/ha.

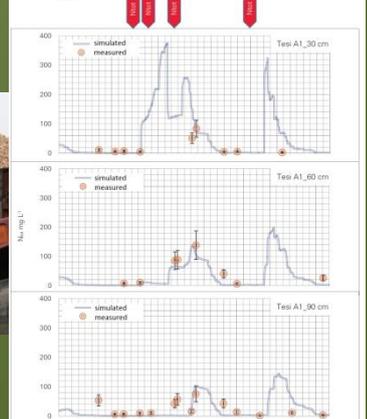
Conclusion

The results achieved have identified significant differences within the Venice Lagoon watershed both in the functioning and effectiveness of these productive forested systems. Policy has to interface with diversity and complexity of the territory in order to increase the effectiveness of environmental measures. These differences hire a strategic importance in landscape planning and the identification of suitable areas. It is important to focus efforts and financial incentives on areas most at risk instead of spreading them all over the territory (see RDPs, Greening etc.).



Tezze					
year	Thesi	N _{tot} applied Kg/ha	N _{tot} leaching Kg/ha	%	%
2012 - 2013	A1	177,7	17,6	9,9	
	A2	260,4	17,6	6,8	
2013 - 2014	A1	161,0	104,1	64,7	
	A2	237,0	169,0	71,3	
TOTAL	A1	338,7	121,8	35,9	
	A2	497,4	186,7	37,5	

Tezze



References

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