International Poplar Commission
Environmental Applications of Poplar and Willow Working Party

Growth and productivity of willow and poplar in SRIC for treatment of aquaculture effluents in southern Quebec: preliminary results

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INTRODUCTION

•During the last years, SRIC has been often associated with additional purposes other than biomass production like the treatment of certain effluents.

•One of the new environmental application of willow and poplar in SRIC is represented by the treatment of aquaculture effluents.

•However, due to high water flow rates involved, these effluents often present a relatively low level of nitrogen and phosphorus. In addition, plants may grow under partially flooded conditions and high water supply can lead to a leaching of nutrients from soil and consequent loss of fertility.

•The aim of this study was to evaluate growth and productivity of willow and poplar in SRIC grown under such conditions.

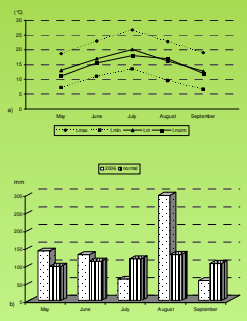

Fig. 1. Seasonal temperature (a) and rainfall (b) at Chartierville

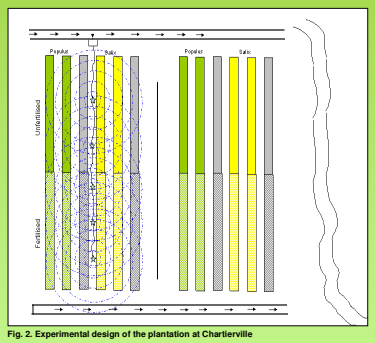

Fig. 2. Experimental design of the plantation at Chartierville

MATERIALS AND METHODS

•The trial was set up in a fish farm located at Chartirerville in southern Quebec.

•Temperature and rainfall patterns for 2006 are shown in fig.1.

•In 2004, *Salix viminalis* and *Populus maximowiczii x P. nigra* (NM5) cuttings were planted at a density of 20.000 plants per hectare in a single row on a surface of about 0.25 ha. At the end of the second growing season all the plants were cut down.

•In spring 2006, the experimental field was split into four main treatments per species as follows: fertilised-irrigated (F-I), fertilised-non irrigated (F-NI); non fertilised–irrigated (NF-I), non fertilised-non irrigated (NF-NI). Sprinkler irrigation started on July 1st and ended on September 30th using water form the basin of sedimentation (Fig.2).

•About 42 mm of effluent was provided daily for a total of about 3700 mm throughout the growing season. Fertilisation was performed by applying 200 kg ha^{-1} of nitrogen (urea) once in spring.

•The height of the main stem, its basal diameter, the number of stems per plant as well as the oven-dry biomass were evaluated on 144 plants (6 per block for each treatment chosen randomly) for each species. Leaf specific weight (SLW) was also determined.

•Chemical analysis were conducted on leaves and stem samples collected respectively in August and at the end of the growing season.

•Analyses of variance followed by multiple comparisons of means according to Tukey's method were performed using SAS software to determine significant differences among various treatments.

RESULTS

•Irrigation treatment (I) negatively affected most growth parameters with the only exception of SLW (Tab.1).

•Fertilisation (F) did not seem to affect most growth parameters (i.e. height and diameter) in either species. Fertilised willow (F), as compared to unfertilised (NF), reached a higher level only in terms of biomass yield (respectively 4.3 and 1.9 t ha^{-1}). Poplar biomass yield, which ranged from 2.5 to 3.4 t ha^{-1}, showed no change due to fertilisation.

•Compared with poplar (P), willow (S) showed maximum heights and number of stems per plant in both irrigated and non irrigated conditions while poplar reached higher diameters. Willow showed higher SLW than poplar. In terms of biomass production the differences between two species were not significant.

•N-content in both leaves and stems was fairly constant in all treatments and did not differ from other previously reported data for the same species (Fig. 3). Therefore, under different treatments, plants were likely not affected by nutrient shortage.

•N-removal efficiency seems to be high for both species in fertilised-non irrigated conditions while was rather low within fertilised-irrigated treatments. However, the attitude in N-remove seemed to be similar for both species under the same treatment (Tab.2).

Parameter	*Populus*				*Salix*				Statistical		
	Irrigated		Non-irrigated		Irrigated		Non-irrigated				
	(F)	(NF)	(F)	(NF)	(F)	(NF)	(F)	(NF)	Irr.	Fert.	Species
Height (m)	1.28	1.18	1.7	1.51	0.99	0.81	1.56	1.28	I<NI	F=NF	S>P (I,NI)
Diameter (mm)	10.86	10.37	1.58	1.44	0.75	0.66	1.11	0.89	I<NI	F=NF	S<P (I,NI)
Number of stems per plant	2.92	2.92	3.5	2.67	7.42	6.17	8.39	8.19	I<NI	F=NF	S>P (I,NI)
Average leaf surface (cm^2)	43.9	43.3	119.5	108.1	9.2	6	12	8.70	I<NI	F=NF	S<P
Average leaf dry weight (g)	0.32	0.27	0.79	0.73	0.07	0.05	0.09	0.07	I<NI	F=NF	S<P
Specific leaf weight ($g\ cm^{-2}$)	7.4×10^{-4}	6.2×10^{-4}	6.7×10^{-4}	6.7×10^{-4}	7.9×10^{-4}	8.6×10^{-4}	7.8×10^{-4}	8.4×10^{-4}	I=NI	F=NF	S>P
Yield ($tDM\ ha^{-1}$)	1.56	1.34	5.24	3.64	1.8	1.08	6.84	2.88	I<NI	F=NF (P) F>NF (S)	S=P

Tab. 1. Effect of irrigation and fertilisation on growth and productivity of poplar and willow at the end of the first year after coppice. Differences (p< 0.05) between species (P,S) and irrigation (I,NI) and fertilisation (F,NF) are expressed by using comparison symbols (>=<).

PRELIMINARY CONCLUSIONS

•Effluent volumes involved in this trial likely exceeded water requirements of both species.

•N-content in both leaves and stem was fairly constant in all treatments.

•Therefore, reduced biomass yield is likely due to excess water which probably created a flood environment in which plants could not to develop normally.

•Fertilisation might, in some cases, positively affect growth and productivity. In particular, compared with poplar, willow seemed to take more advantage of N application.

•Both species seemed to show a good response in terms of N-uptake, although poplar in some cases presented the greatest ability to remove N.

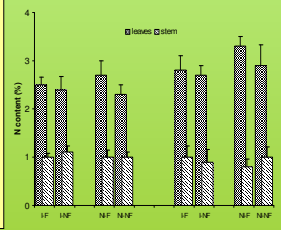

Fig. 3. Total N content in biomass

Species	Treatment	N input ($kg\ ha^{-1}$)	Yield ($kg\ DM\ ha^{-1}$)	Average biomass N content %	N removed	
					($kg\ ha^{-1}$)	%
Willow	F - I	268.2	1560	1.8	27.3	10
	F - NI	200	5240	1.8	91.7	46
	NF - I	68.2	1340	1.9	24.8	36
	NF - NI	-	3640	1.7	60.1	-
Poplar	F - I	268.2	1800	1.9	34.2	13
	F - NI	200	6840	1.8	123.1	62
	NF - I	68.2	1080	2.1	22.1	32
	NF - NI	-	2880	2.0	56.2	-

Tab. 2. Nitrogen removed by plants at the end of the growing season.

Acknowledgements
This study was financially supported by the Technology and Innovation (T&I) program of the Canadian Biomass Innovation Network and "*FQRNT-Actions concertées consolidation de la recherche sur l'environnement rural*".