International Poplar Commission
Environmental Applications of Poplar and Willow Working Party

Effects of aeration and water table depth on rooting habit of willow

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INTRODUCTION

• Willows are currently one of the most common plants proposed for phytoremediation. However, in many cases, the environment in which they must live is not the best suited for plant growth (e.g. polluted sites, flooded areas, etc.). In addition, most willow clones are planted as unrooted stock (i.e. cuttings, rods, etc.), which means that during the establishment year they have to produce a totally new root system under these adverse conditions. When pollutants lie in deeper soil layers, most phytoremediation techniques require plants that may withstand polluted, low-oxygenated and frequently flooded conditions.

• In 2009, we conducted a project whose aim was to decontaminate deep soil layers from organic pollutants (mostly chlorinated hydrocarbons). The proposed approach was to grow long, unrooted willow rods in holes dug on the site to stimulate/enhance microbial degradation of these toxic compounds. Unfortunately, after some weeks, most of the plants died unexpectedly (Fig.1).

Fig.1. Set-up of the phytoremediation project in 2009. Early in summer most plants were already dead and not root formation was observed on the stems

• We hypothesized that the failure in plant establishment was due to either low-oxygen availability or to high levels of pollutants or a combination of the two.

AIMS

• The current trial was carried out to test whether and to what extent aeration and water table depth would affect root formation on willow long cuttings.

MATERIALS

• In spring 2010, one-year-old unrooted *Salix miyabeana* (clone SX64) rods (3.5 m tall) were grown for 3 months in a greenhouse under 3 different heights of water table (0.50 - 0.75 - 1 m) into plastic pipes.

• The water table level was kept constant by adding water daily, following the plant's water consumption. In addition, from the beginning of the trial, half of the plants were aerated with two aquarium pumps which blew air into the bottom of each tube.

• At the end of the trial, all 36 plants were taken out from the pipes and the dry matter of leaves, twigs and roots at different depths (in 0.25 m long stem sections) was determined.

• The data collected were statistically analyzed using SAS software supplemented with a multiple-comparison test of the means using the Tukey method with a significance level of $p < 0.05$.

RESULTS

• After three months of growth, all plants (aerated and not) had developed a functional root system.

• However, at any water table depth, aeration significantly increased root biomass, enhancing root biomass by about 87 - 134 and 96% for the different treatments (Table 1). The air treatment significantly enhanced leaf production mainly in plants grown with 100 and 75 cm of water table depth.

• The aeration also affected root production along the profile of the stem at different depths (Fig.2). Although the majority of roots were found in the first 25 cm layer below the water surface, an additional amount of air underwater enhanced root production in the lower layers of the stems.

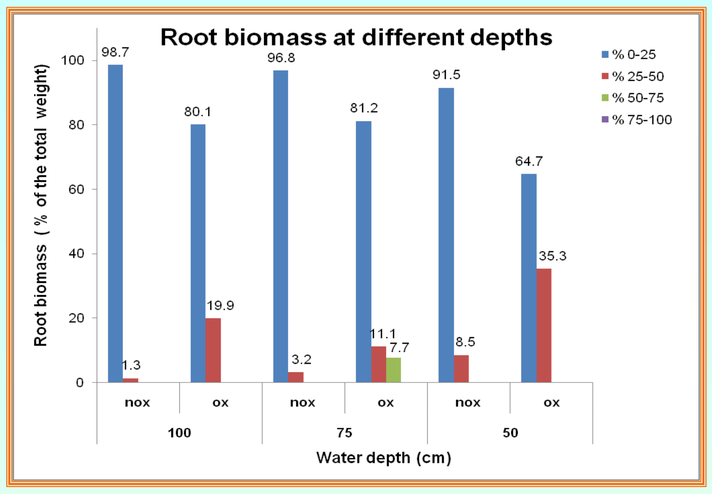
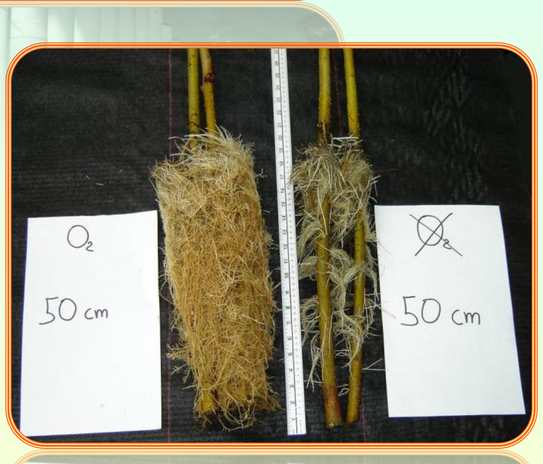


Fig. 2. Root development along the stem profile. In all treatments aeration positively affected root emission in the deeper stem sections.

Treatments		Dry Biomass (g)								
Water Depth (cm)	Aeration	Leaves		SD		Twigs		SD	Roots		SD	
100	nox	11.5	±	6.5	a	2.7	±	1.8	2.7	±	1.0	a
	ox	19.9	±	7.5	b	6.6	±	5.6	5.4	±	1.5	b
	Δ(%)	72.5				145.9			96.2			
75	nox	18.2	±	3.4	a	4.1	±	3.8	3.5	±	1.0	a
	ox	30.0	±	10.0	b	7.8	±	2.8	8.2	±	2.7	b
	Δ(%)	64.5				92.7			133.7			
50	nox	30.0	±	4.2		9.5	±	4.0	5.0	±	1.1	a
	ox	31.6	±	3.5		11.7	±	5.1	9.5	±	2.9	b
	Δ(%)	5.3				23.6			87.4			

Table 1. Leaves, twigs and roots biomass at the end of the trial. Values are the averages (mean ± standard deviation; *n* = 6) for each treatment. Different letters within the same column indicate a significant effect of aeration on biomass production according to Tukey-test ($p < 0.05$).



PRELIMINARY CONCLUSIONS

• Growing unrooted willow rods under permanently flooded conditions for three months does not prevent root emission.

• However, under these conditions, supplying air to the root zone also enhances root formation in the distal portion of the stem.

• Thus, high mortality observed in the field could be due to other factors (e.g. pollution) than flooding, and further research on this subject is required.