

## THE BEHAVIOR OF WILLOW COMMERCIAL CLONES IN THE FIRST GROWING SEASON. A CASE STUDY FOR THREE DIFFERENT SITES FROM BANAT AREA

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### ABSTRACT

*Willow short rotation coppice is an option for raising demand for bioenergy. But willows are also important for phytoremediation or salicylic acid content. In order to develop willow SRC in Romania, three experimental plots with fourteen clones (seven Swedish clone and seven Romanian ones) have been established in Banat area: ash pond Timisoara, saline soil and control (Ghilad, Timis county). Results were very different in terms of biometrical observation. The Swedish clones (Inger, Jörr, Olof, Tora, Tordis, Torhild, Sven) performed very well in control plot, the Romanian clone RO892, RO1077, RO1082 performed very well in Ghilad area (saline soil and control) and also showed good survival rate in ash pond. The other Romanian clone, Cozia, Fragisal, Pesred and Robisal did not show good results in any experimental plots.*

### INTRODUCTION

The production of biomass for energy crops it will become more and more important in Europe (Weih and Nordh, 2005) and world in the next years. In the search of perennial energy crops, *Salix* sp. are front-runners because their high yielding and capacity to grow in different site conditions (Weih, 2009). Willows have many other important characteristics: coppice ability after multiple harvests, low investments after its establishment, a broad genetic base (Ledin and Willebrand, 1996), and capacity to efficiently use the land with positive effects on rural economy (Dimitriou and Arosson, 2005) and ability to recycle wastewater (Dimitriou et al, 2009). The largest area with willow short rotation coppice is in Sweden where, more than 14.000 ha were established starting from 1970 (Mola-Yudego and González-Olabarria, 2010). In Romania, willow SRC for biomass production started after 2005 (Nicolescu and Hernea, 2015). About 800 ha of willow SRC was established in our country but only few research have been made in order to test the capacity of willow clones to adapt in different sites condition. The aim of this study is to assess the ability of seven Swedish and seven Romanian willow clones to perform on marginal land: salty soil and ash pond.

### MATERIAL AND METHOD

**Material.** Seven Swedish clones (Inger, Jörr, Olof, Tora, Tordis, Torhild and Sven) and seven Romanian clones, three of them provided by National Institute for Research and Development in Forestry "Marin Drăcea" – NIRDF (RO892, RO1077, RO1082) and four of them provided by Fruit Growing Research and Development Unit of Vâlcea (SCDP Vâlcea) and CHPs Govora (Cozia\_1, Fragisal, Pesred and Robisal) were used for establishment.

**Filed trial.** In order to assess the comportment of willow clones in different site condition (Fig. 1), field trials were established in spring 2015 in Timis county: Ghilad Control (45°28'719" Lat. 21°02'199" Long., 86 m elevation, alluvial soil, pH 7.5), Ghilad saline soil (45°27'116" Lat. 21°10'261" Longt., 92 m elevation, pH 8.5) and ash pond

Timisoara (45°41'26" Lat. 21°07'50" Long., 83 m elevation, pH 8.3). Field preparation included plowing and harrowing for both Ghilad sites and only harrowing for ash pond. The field was planted manually using 20 cm long cuttings, in double rows at a spacing 150 x 75 cm and 70 cm between cuttings. Weeding control was performed using herbicides and mechanical tilling.



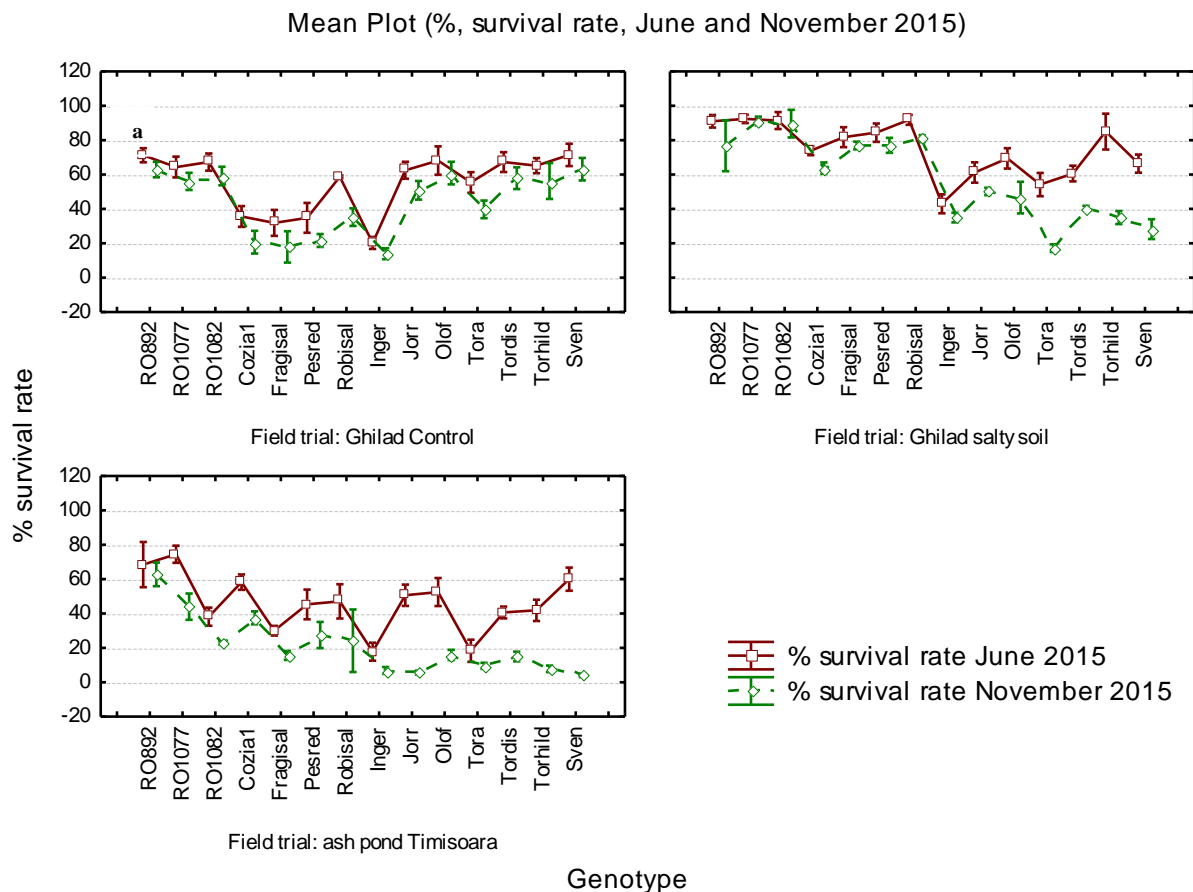
Figure 1 Location of the experiment: Control Ghilad, Salty soil Ghilad, ash pond Timisoara.

**Plant survival and biometrical observation.** Observations were made in order to establish the survival rate and also biometrical parameters. The number of shoots per stool and the maximum height of the shoots (cm) were registered in June for all plants. In November 2015, for 50 willow plants were registered the number of shoots per stool, the maximum height of the shoots (cm) and the diameter (cm) of the highest shoot per stool.

**Data analysis.** Analyses of variance (ANOVA) were used to assess the effect of site conditions and clones and of the interaction between them. Statistics were computed by STATISTICA 10 software.

## RESULTS AND DISCUSSIONS

After establishment, the survival rate of the willows has depended on the quality of the cuttings and pedoclimatic conditions (Fig. 2). The best results in terms of survival rate, in the Western of Romania, were registered for Romanian clones. In field trial "Ghilad salty soil", a rate of survival more than 80% were registered for Romanian clones provided by NIRDF, 60-80% for clones provided by SCDP, and less than 50% for Swedish clones. In field trial "Ghilad Control", a rate of survival between 50-60% were registered for Romanian clones provided by NIRDF, 20-40% for clones provided by SCDP, 40-60% for Swedish clones, except clone Inger with a survival rate less than 20%. In field trial "ash pond Timisoara", a rate of survival between 40-60% were registered for Romanian clones provided by NIRDF (except clone RO1082 with a survival rate less than 20%), 20-30% for clones provided by SCDP, less than 20% for Swedish clones. All Romanian clones were registered a higher rate of survival on trial with "salty soil" compare with trial "Control" probably because the higher water availability on salty soil compares with alluvial soil and their ability to tolerate the alkaline pH. Not the same results were obtained by Swedish clones probably because that, for these clones soil pH requirement should be in the range 5.5 – 7.5 (Castlin at al. 2010). In field trial "ash pond", only Romanian clones RO892 (62,75%) and RO1077 (44,0%) registered reasonable results.



**Figure 2 Survival rate of willow commercial clones in different sites from Banat area**

Analysis of variance revealed that all analyzed characteristics were greatly affected by location (pedoclimatic conditions), genotype and their interaction (Table 1).

*Table 1*

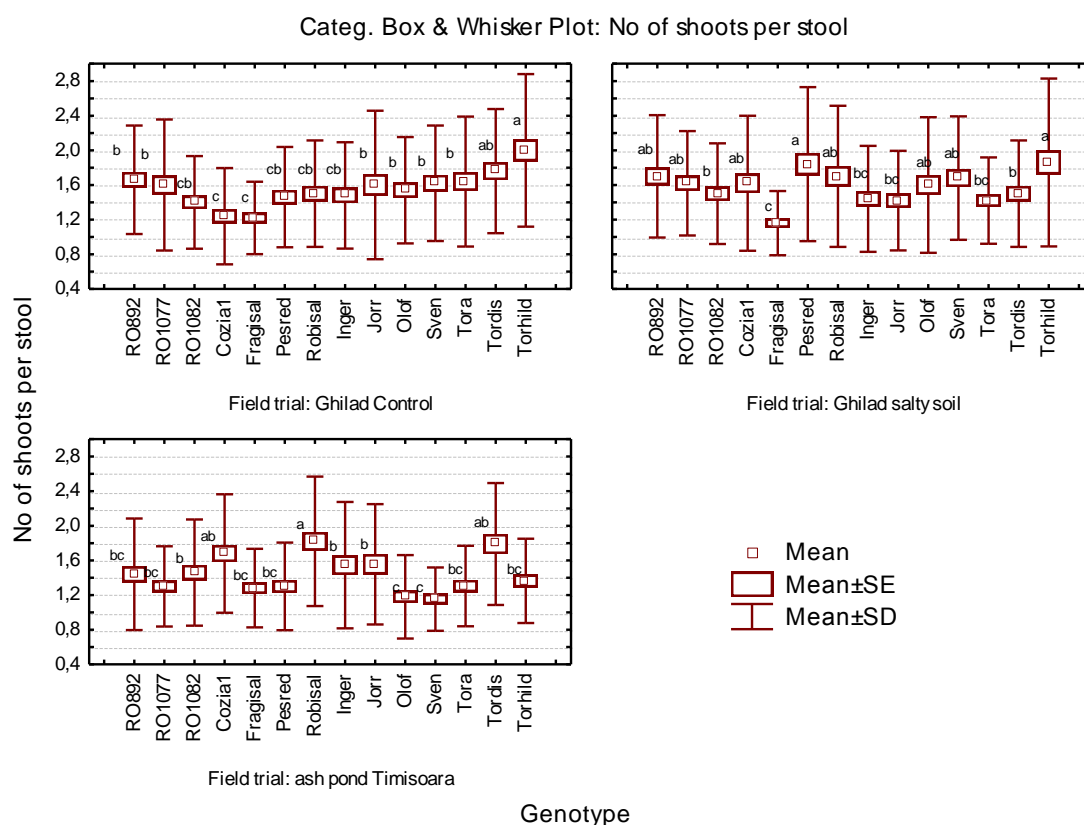
**The effect of location (pedoclimatic conditions) and genotype on yield parameters of willow field trial (Fisher Test)**

Analysis of Variance <i>Salix</i> sp. (Marked effects are significant at $p < ,05000$ ).			
1 = location 2 = genotype			
Parameters	Factors (F, p)		
	1	2	1 x 2
Survival rate (%) June 2015	<b>40,090200</b> <b>0,000000</b>	<b>7,007800</b> <b>0,000000</b>	<b>97,894500</b> <b>0,000000</b>
Survival rate (%) November 2015	<b>43,668700</b> <b>0,000000</b>	<b>4,709300</b> <b>0,0000010</b>	<b>181,412600</b> <b>0,000000</b>
No of shoots per stool	<b>7,973100</b> <b>0,000355</b>	<b>5,482200</b> <b>0,000000</b>	<b>4,710300</b> <b>0,000000</b>
diameter at the base of the shoot	<b>262,434800</b> <b>0,000000</b>	<b>16,767200</b> <b>0,000000</b>	<b>39,935700</b> <b>0,000000</b>
Maximum height of shoot per stool	<b>311,143900</b> <b>0,000000</b>	<b>42,970500</b> <b>0,000000</b>	<b>88,111600</b> <b>0,000000</b>

The yield parameters evaluated after the first growing season were: no of shoots per stool, diameter at the base of the shoot (mm) and the maximum height of the shoots (cm). All of these are positively correlated with shoot biomass.

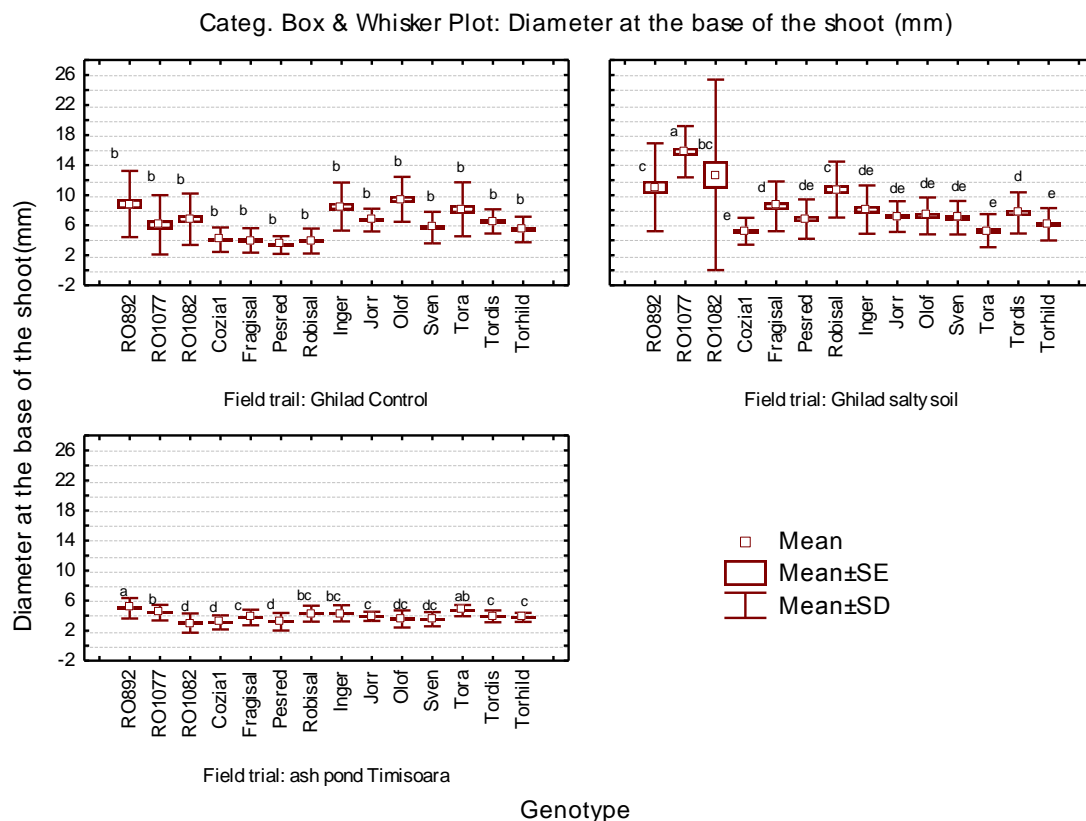
Sprouting capacity is a parameter with genetic determinism but it is also expressed by pedoclimatic conditions (Fig. 3).

The number of shoots per stool was between 1,22 (Fragisal) and 2,0 (Torhild) în filed trial Ghilad Control. A good sprouting capacity has been noticed for Swedish clones and Romanian ones provided by NIRDF. No significant differences were registered for field trial „Ghilad salty soil”. Clones Torhild, Tordis, RO892, RO1077, Sven, Tora showed a significant positive spouting capacity compare with the mean of the experiences, both in Control and salty soil field trial. In ash pond Timisoara field trial, the parameter values were lower for all clones, except Robisal (1,82 no of shoots per stool – significant positive differences compared to Control) and Tordis (1,79 no of shoots per stool - insignificant positive differences compared to Control).

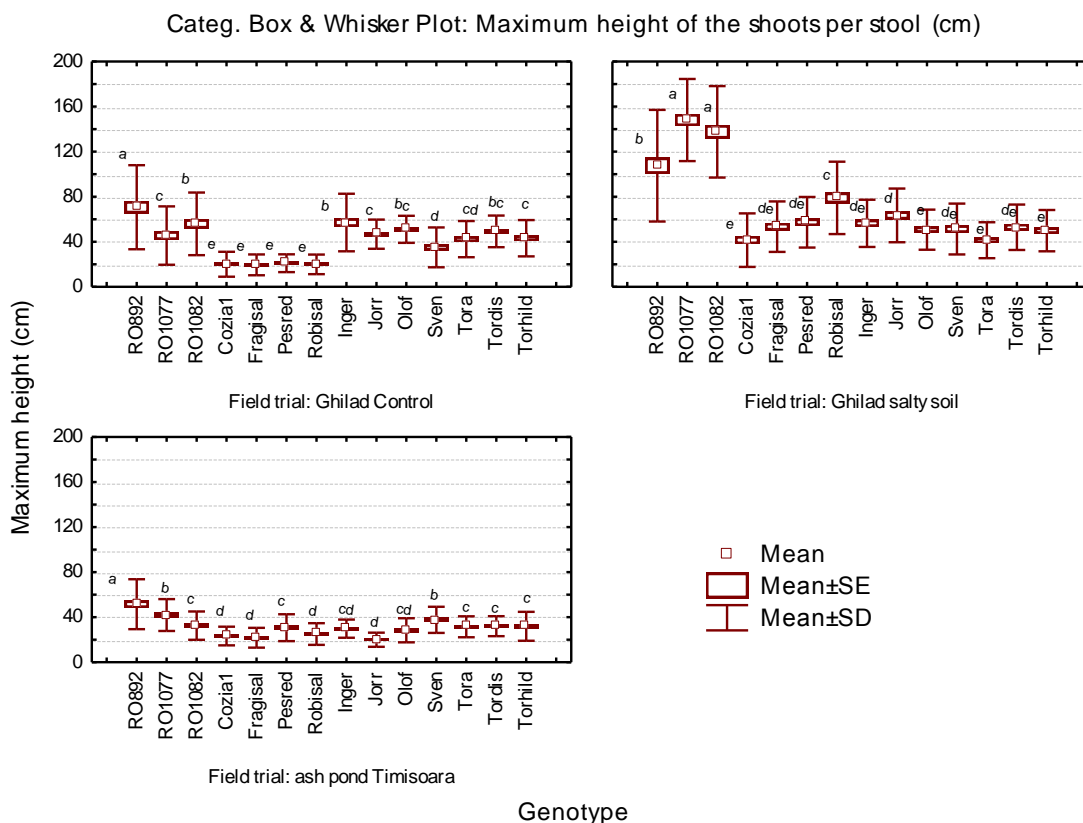


**Figure 3 Sprouting capacity of willow commercial clones in different sites from Banat area**

Diameter at the base of the shoot and shoot height are positively correlated ( $r = 0,7263$ ;  $p = 0,0000$ ), depend on pedoclimatic conditions but have a genetic determinism. For most clones, the values registered on field trial „salty soil Ghilad” were higher than „Control” field trial. Best results were noticed for Romanian clones RO892, RO1077, RO1082: 11,0-15,8 mm diameter at the base of the shoot and 107,6 -148,12 cm shoot height. These values revealed significant positive differences compared to Control. The willow culture established on ash pond have been stressed by soil toxicity, summer extreme temperature and water deficit. In these circumstances the best results were obtained by Romania clone RO892: 62.75% survival rate, 1.44 no of shoots per stool, 4.98 mm diameter at the base of the shoot and de 51.56 cm shoot height (Fig. 4 and 5).



**Figure 4** Diameter at the base of the shoot of willow commercial clones in different sites from Banat area



**Figure 5** Maximum height of the shoots per stool for willow commercial clones in different sites from Banat area

Botu et al. reported similar results for Romanian clones provided by SCDP and CHPs (Cozia, Fragisal, Pesred and Robisal) and Swedish clones Tordis and Inger but not the same results were registered in the trial from Ghilad area.

## CONCLUSIONS

The behavior of willow clones in the marginal area, salty soil and ash pond have been evaluated after the first growing season. Under saline stress, the best result was registered for Romanian clones RO892, RO1077, RO1082: 77-92% survival rate; 1,5-1,7 no of shoots per stool; 11,0-15,8 mm diameter at the base of the shoot and 107,6 -148,12 cm shoot height. These value revealed significant differences for the mean of the experiences. Under ash toxicity and hydric stress, the best results were obtained by RO892: 62,75% survival rate, 1,44 no of shoots per stool, 4,98 mm diameter at the base of the shoot and 51,56 cm height (significant positive differences, for the mean of the experiences). The Swedish clone Inger, the most cultivated clone in Romania, did not show expected results for analyzed characteristics.

## Acknowledgements

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