

## THE IMPACT OF WILLOW GROWINGS IN ENERGY FORESTRY SYSTEMS UPON THE ENVIRONMENT

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**Abstract:** *Energy willow growing is a culture which involves a reduced number of procedures and treatments. The life span of a willow plantation is about 20 – 25 years. Apart from representing an important source of electrical and thermal energy, the willows, thanks to their characteristics, willows are able to clean the water in waste water purifying plants, thus reducing the risk of polluting the ground water.*

**Key words:** *biomass, energy willow, environment, culture, varieties.*

### INTRODUCTION

Biomass is considered to be an important source of energy, both thermal as well as electrical. The biomass obtained from energy willows is one of the most important types of biomass on European level and worldwide. It is expected this type of biomass will widely contribute to achieve the targets regarding the amounts of electric and thermal energy derived from renewable resources.

The surveys on energy willow growing were initiated in 1970, the moment the oil crises set in. The Swedish were the first to take interest in willow growing. The first studies were initiated more than 40 years ago at the Lantmännen Agroenergi Institute. Here, using sources of germplasm, coming from European collections and from Russia, hybridisations were performed in order to obtain productive varieties with a rapid growth rhythm and a high caloric efficiency.

The varieties used to obtain the hybrids are: *Salix viminalis*, *Salix dasyclados*, *Salix schwerinii*, *Salix triandra*, *Salix pentandra*. The species obtained from these varieties have a caloric efficiency up to 4,900 kcal/ kg, score a daily growth of 3-3.5 cm during the vegetation period, they are resistant to diseases, vermin and frost.

Currently in countries like Sweden, the USA and the UK the research studies continue with the goal to improve the particularities of the species in the way of productivity, caloric efficiency, resistance to pedoclimatic factors, diseases and vermin.

Apart from these goals, willow plantations are studied regarding their impact upon the environment, upon the particularities of the soil, the air and the biodiversity.

### MATERIALS AND METHODS

The authors of the paper were used as methods of work: data collection, processing, analysis, observation and their interpretation.

## RESULTS AND DISCUSSIONS

**Botanical and biological particularities of the varieties and hybrids.** The energy willow belongs to the botanical family of Salicaceae, genus *Salix*. The *Salix* genus comprises 350 woody varieties, perennial, with falling leaves. These varieties prefer watery soils and in nature they are met especially in the Northern Hemisphere, near water.

The energy willow varieties are able to adapt to warmer regions with less rainfall. The recommended minimal rainfall is about 500 mm/ year, but it may set also in conditions of 350-400 mm/ year, but the output will be reduced. Regarding resistance to frost, all commercialized energy willow varieties resist frost, even at temperature of minus 35°C.

Four species have been tested and approved by the State Institute for Testing and Recording Culture Species in Romania. The four energy willow species are mentioned and described in the Official Catalogue of Species on the pages 88 and 187.

“The species belonging to all varieties have been tested for their distinctiveness, uniformity and stability.” (Official Catalogue of Species 2012). In the catalogue are specified the holder, the denomination of the species, the year of registration, the use category of the species. Genetically modified organisms are accompanied by the symbol 39.

The four species obtained at the Lantmännen Agroenergi Institute and registered in Romania are: *Salix viminalis*, *Salix dasyclados*, *Salix schwerinii* and *Salix triandra*.

For the plantations in the Danube Delta were chosen the species *Tordis* and *Inger*. These two species were chosen, because they are highly resistant to low rainfall and high temperatures and because they are hybrids obtained from genotypes belonging to the species *Salix viminalis* and *Salix triandra*.

*Salix viminalis* is an arbustive native species. The stalks are long, straight, very flexible, green or brown-yellowish, grey-pubescent at the beginning. The buds are unequal in size, compressed on the stalks, sometimes pairwise over the stigma, yellow-brownish, tomentous.

Linear spear-leafed, 8-15 cm, extreme breadth in the lower half, acuminate, irregular-sinuuous margin or complete, revolute to the lower face, underneath grey-silky-hairy, with adherent hairs and the median nervure protruding and yellow. The aments appear before foliation. The osier is found in the Eurasian habitat.

In Romania it often appears in the meadows of the rivers from the plains up to the lower mountainous regions, often together with *Salix purpurea*. This is a native variety in the Danube Delta, which was entered the red list of the endangered species.

*Salix triandra* is a native arbustive variety. The stalks are glabrous, flexible, brown-reddish, when the bark is rubbed it emanates a scent of almonds. The sprouts are blunt, edged, tan.

Oblong-spear-leafed, 5-10 cm, acute or shortly acuminate, cuneate or slightly rounded, on the front side dark green, underneath green, glaucous, glabrous, on the margins small serrated. The male flowers have three stamens and two nectariferous glands at the bottom, those female ones having one gland; it blossoms in April-May, sometimes it may blossom again for 2-3 times within one vegetation season (summer, autumn).

This variety is specific for the Eurasian habitat. In Romania it frequently appears on the river banks, in groves, in the meadows of the rivers in the plains and hills; sporadically in the mountains, too. *Salix triandra* is entered the list of specific varieties of the Danube Delta Biosphere Reserve. Ecologically this variety may be classified as belonging to the mezzo-hygrophilous plants.

When scheduling the energy willow plantations in the Danube Delta the pedoclimatic factors, as well as the restrictive conditions of the area are to be taken into account. Considering the climatic conditions, defined by low rainfall two drought-resistant species: Inger and Tordis were chosen.

**Inger.** It is an hybrid obtained by crossing the genotypes of *Salix Viminalis* and *Salix triandra*. Morphological particularities: the sex of the plant is deoïque female. Foliation in spring is early. The main side shoot support is upright. The number of branches which exceed five centimeters on the main side shoot is large up to very large. The angle between the branch and the main side shoot is medium. The branch support is curved upright. The leaf stem is short to middle long. The stem breadth is middle to broad. The colour of the upper side of the stem is medium green. The length of the leafstalk is medium to long. The colour of the branch is green with a yellow tint.

The root is ramose and it develops up to a depth of 50-60 cm. It has no adventive roots and is not sending out suckers, there being no possibility to extend uncontrolled.

End-use. The willow is industrially processed.

**Tordis.** It is an hybrid obtained by crossing the genotypes of *Salix viminalis*. Morphological particularities: the sex of the plant is deoïque female. Foliation in early to mid spring. The main side shoot support is upright. The number of branches which exceed five centimeters on the main side shoot is small. The angle between the branch and the main side shoot is medium to large. The branch support is curved upright.

The leaf stem is long and it is broad to very broad. The length of the leafstalk is long to very long. The colour of branch is brown with a red tint. .

The root is ramose and it develops up to a depth of 50-60 cm. It has no adventive roots and is not sending out suckers, there being no possibility to extend uncontrolled.

End-use. The willow is industrially processed.

**Growing technology and the impact upon the soil and the environment.** Growing energy willow is an agricultural culture. But in contrast with the classical agricultural cultures, energy willow growing involves a reduced number of proceedings and treatments.

First and foremost the negative impact upon the soil and the biological activity is reduced. It is well known the intensive tillage of the soil affects the soil quality, diminishes the concentration of organic substances and affects the micrological activity of the soil.

*Salix* growing needs proceeding the soil only in the year the trees are planted and according to the researches performed it became clear that *salix* growing has a profitable impact upon the physical and microbiological properties of the soil (Makeshin 1994, Paine et al., 1995, Perttu 1998, 1999, Borjesson 1999, Kahle et al. 2007, Rowe et al. 2007).

The soil preparatory works are identical to those for the classic agricultural cultures: scarification, ploughing and milling. The difference is, that these works are performed only when planting the willows and not every year as with other cultures.

The advantage of this culture is, that it can be established on qualitative poor soils. The growings can be established on soils with high erosion potential, thus contributing to stop this phenomenon. Willows improve very humid soils, which even are recommended, as they can not be used for other cultures.

*Salix* growings can be established on soils polluted with heavy metals or nitrites and nitrates.

A very important characteristic is the reduced number of chemical treatments necessary for this culture. Herbicides are used in the year previous to the establishing of the willow growing, in the first year and only occasionally during the second year. Altogether the number of treatments is essentially diminished compared to other cultures.

The herbicides used in energy willow growing are broad-spectrum preparations in disease control and are advised for use in the Danube Delta. The herbicides used in willow growing are: Roundup (Glyphosate 360 g/l), Goal 2E (Oxyfluorfen 240g/l), Stomp 330 EC (Pendimethalin 330 g/l), AGIL 100 EC (Propaquizafop 100g/l) și LONTHREL 300 (Clopyralid 300g/l).

The life span of a plantation is about 20-25 years. During this time the works necessary in the plantation are minimal, being reduced to cropping and fertilization every two years. It is also recommended to loose the soil every 4 year.

The dissolution of the culture is relatively easy. After the last harvesting has been performed, the plants will enter in vegetation and when they attain the height of 10-15 cm the herbicide Roundup will be applied followed by discing. After this the field can be reintroduced in the circuit. The researches performed in Sweden proved that willow growing does not fatigue the soils and the cultures established after willow growing score normal or even higher crop yields.

**The impact of salix growing upon biodiversity.** Apart from the studies performed to improve the output of the salix varieties, the researchers focussed their attention also upon the impact the salix growings have upon other species of plants, animals, birds and insects.

Following these surveys a greater density and diversity of birds was observed in Sweden (Goransson 1990, 1994, Berg 2002), in the U.S.A. (Christian et al., 1994, Dhont et al., 2004) and in the United Kingdom of Great Britain (Kavanagh 1990, Sage and Robertson, 1996, Sage and Tucker, 1998, Coates and Say, 1999). In energy willow cultures with short time crop rotation was observed an increasing number of bird species in comparison with the established agricultural habitat. Goransson (1990) and Berg (2002) have inferred the salix plantations generally increase the diversity in birds and especially in pheasants. Berg (2002) also concluded that energy willow plantations could be the preferred habitat for rare or endangered species. In spring the birds are attracted by the great number of insects to be found in these plantations. The age and the developmental stage of the plantation have an effect upon the presence of the birds (Goransson, 1994, Sage and Robinson, 2006, Dhont et al., 2007). Some species prefer the recently harvested areas while others prefer the scrubs, which will be harvested in the near future (Goransson, 1994).

These cultures offer an excellent habitat for deer, hares and other species of small mammals. The energy willow growings are an impact factor upon the flora. The willow plantations call for weed control only during the first year and only occasionally during the second year. As of the second year the developing of the plants within the plantation area do not represent any impediment in the development of the willows.

## CONCLUSIONS

The main goal of introducing energy willows as a source of biomass for producing energy is to replace conventional fuels insofar as possible, thus reducing the pollution level of the atmosphere and the greenhouse effects. Apart from representing an important source of electrical and thermal energy, the willows, thanks to their characteristics are able to clean the water in waste water purifying plants, thus reducing the risk of polluting the ground water. Salix growings can solve the problem of the sewage sludges from the water purifying plants (European Directive 86/ 278/ EEC, 75/ 440/ EEC, 80/ 68/ EEC and the Order 334/ 2004). Sewing sludges are successfully used in fertilizing these plantations thus solving the problem of the disposal of sludges.

Salix growings can be established on soil polluted with heavy metals or high contents of nitrites and nitrates.

An important advantage of this agricultural culture is that it turns to profit soils improper for other agricultural cultures, as it is no threat for food plants. The energy willow growings can be established on soils with high erosion potential, thus contributing to stop this phenomenon, as well as on soils with high levels of ground water.

The cultivated varieties are not invasive plants, as they are not able to proliferate naturally and they cannot extend uncontrolled. Willow growings are easily dissolved and do not degrade the soil.

The energy willow growings improve the landscape and the biodiversity of the area.

The surveys performed by universities from Wales, Ireland and England concluded the energy willow growings offer shelter for a wide range of mammals, birds, insects and plants (The biodiversity of short rotation willow coppice in the Welsh landscape).

Considering that the demand for biomass is continuously increasing the energy willow growings are an alternative to the intensive clearance of forests.

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