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ASPECTS OF "ENERGY WILLOW" (*SALIX VIMINALIS* L.) CULTIVATION

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Abstract: *Salix viminalis* L. is native to this land. It has been cultivated at a smaller scale for making baskets and other household items.

„Energy willow" has catkin flowers, dicotyledonous, dioecious, arborescent, insect pollinated plant. It is deciduous and has cylindrical shoots. Its leaves are alternate and lance shaped. It is one of the fastest growing trees. Its shoot grow 3-5 cm a day. In first year it reaches 3-3.5 m in height and yields 8-10 tonnes/ha cuttings. It yields 20-40 t/ha following the third year. It has a high salicylic alcohol content, consequently a fairly high energy – 29,2 MJ/kg, as shown by Endre Kiss [1].

Growing this plant may bring the beneficial aspects of a decentralised energy system into consideration for a settlement rethinking the links between the settlement and its environment, in spite of biomass energy production has the largest potential though it will contribute only at a small scale to the renewable energy sources used in Hungary.

Keywords: *Salix viminalis* L., waste water treatment, energy crops, rural development

Willows in their natural environment

Willows are one of the major plant species of the pioneer soft-wood dominated woodlands of the often inundated flood plains, riverbanks and sandbars. These associations have fairly few species. In gallery forests these associations often form complexes with other plant species. Flooding provides the ideal circumstances for willows but they often facet he extremes – inundated in spring and dried out circumstances in the summer – yet the still mange to grow well [2]. Soó [3] ranked the poplar (*Populus*) and willow (*Salix*) genus into the Willow (*Salicaceae*) family and within that he described the species, variants and hybrids. Borhidi [4] in his classification work ranked the willow genus into the order of *Salicales*, and willow (*Salicaceae*) family. Simon [5] treated the family of willows (*Salicaceae*) and *Salix* genus in a similar way listing 13 species.

The utilisation of temporarily flooded areas with energy willows

Croplands covered in spring melt waters reached 200 000 ha in the first decade of May 2006. At the same time there was an all time high snow amassed in the catchments of river

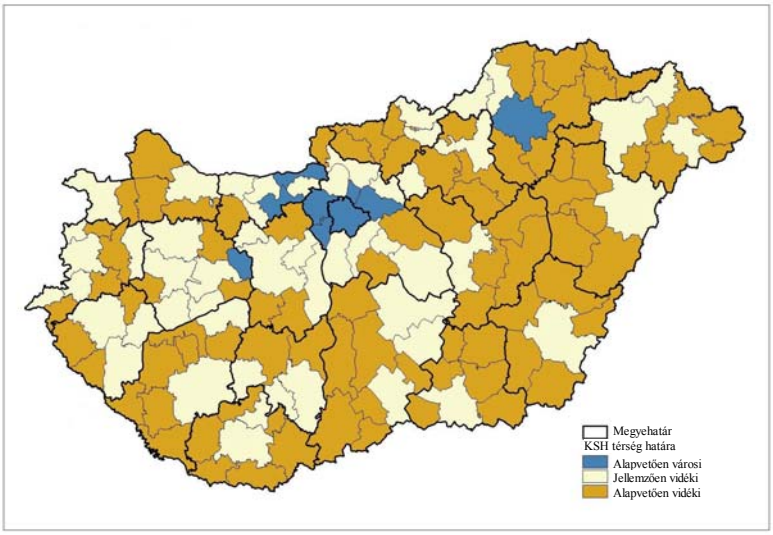
Tisza. Due to the rapid melting of this snow there was a severe risk of record flooding. Floods come very fast in the upper reaches of the Tisza, for example the water level rose 7-8 metres in 36 hours in 2001 resulting in the washing away of the dyke system.

This regular problem results in great losses for agriculture in every year. It is a major problem to find the right crop and land use system for these lands.

„Energy willow" prefers wet, moist conditions and can tolerate flooding waterlogged conditions. Due to its preferences it can be an alternative crop besides the commonly cultivated plants in areas such as riversides, floodplains, waterlogged areas where traditional agriculture is less productive but agriculture is still needed either for environmental purposes or to provide rural population with an alternative income source besides the traditional crops.

The advantages of using energy willow for waste water treatment

According to EU criteria 96% of hungary is classified as rural are[1] (figure 1.) where lives 74.5% of the population. Primarily rural areas are 58.3% holding 31.3% of the population, this figure is 3.2 times higher than the Eu average (9.7%). 35.9 5 of the population lives in villages.



Source: KSH TSTAR

Figure 1: Rural areas in Hungary (NUTS IV.) as per OECD criteria

[1] To identify rural areas we used the OECD criteria:
- **dominantly rural area:** area where more than 50% of the population lives in settlements with population density less than 120 person/km^2 (marked as orange);
- **typically rural area:** area where 15-50% of the population lives in settlements with population density less than 120 person/km^2 (marked as yellow);
- **urban area:** area where less than 15% of the population lives in settlements with population density less than 120 person/km^2 (marked as blue).

54.3 % of the settlements have less than 1000 inhabitants, one fifth of the population lives in these villages. There is also a need in these small settlements for the treatment of the waste water. In places where the water base is not classified as sensitive or vulnerable from the available cost effective methods poplar or willow plantations may provide a practical soultion.

The energy willow (*Salix viminalis* L.) has the biggest water need and tolerance of all the possible species. In the treatment of pre-treated waste water it shows better results than poplars. It utilises the nitrogen and phosphorus present in high concentration in waste waters well and grows exceptionally fast – consequently able to treat large amounts of water.

It can be used widely and be produces cost effectively that may provide a new alternative for environmentally friendly waste water treatment.

The willow used for recultivation

The energy willow is able to grow under extremely unfavourable circumstances and can be used to recultivate open pit mines. Obviously it shows a slower rate of growth than in ideal conditions but its extensive root system makes it able to grow on really bad soils. It can provide a significant amount of humus in a short time. The ideal pH for the plant s is 5.5-6.5 but tolerates the wide extremes of 3.5-10 pH. It is also an advantage if the water providing ability of the soil is fair though if regular irrigation is possible this aspect is not important. [6].

Willows as energy crops

As fossil fuel stocks are falling and certain problems and consumer fears around nuclear energy are unsolved the use of renewable energies gain popularity. Though renewable energies are the oldest used by humankind its share is little on a global scale.

Researches show that in Hungary renewables were only 3.6% of all energy sources in Hungary in 2003 [7]. With signing the Kyoto protocol and the EU accession Hungary has the undertaking to double this figure by 2010.

It is important to point out that these international obligations actually fall in line with our best domestic interest as with the use of renewables we should be able to reduce pollution and dependence on energy import.

Of all renewables biomass has one of the biggest potential in Hungary [8], as the country has favourable conditions to produce biomass. From all sources considered biomass energy production energy willow (*Salix viminalis* L.) has an outstanding potential.

A hybrid from Japan with the qualities of a good energy source: grows very fast, studies show 3-5 cm of growth a day, has a high yield, 20-40 t/ha/year. It has high salicylic alcohol content and able to provide 29.2 MJ/kg energy.

Aspects of pest control in energy willow plantations

Willows are planted in the following way: 75 x 45-50 cm between rows and plants in twin (double) rows followed by a 110 cm row then 75 x 45-50 cm again followed by a 260 cm wide path left for the machinery. This way about 18-20,000 plants are planted on one ha.

During the growing season there are certain pest control measures that need to be considered.

Our aims:

- To set up the pre-emergent weed control for large scale willow plantations with the allowed herbicides;
- To identify insect pests, to estimate the level of their damage and set up effective preventive measures;
- To study the diseases affecting willows and work out effective protection against them.

For the initial trials of pre-emergent weed control we designated 500 $m^{2\ large}$ lots that had been planted with willows. The soil included both heavier sediment type soils and looser sand type soils. We did 4 repetitions. The doses we applied were calculated according to the technical recommendations, on sandy soils we used the lowest dose, on heavy soils the highest recommended dose. We applied the herbicides in the following combination:

1. terbutilazin	+ S-metolaclorine,	Click FL	+ Dual Gold 960 EC
2. mezotrion	+ S-metolachlorine,	Calisto 4 SC	+ Dual Gold 960 EC
3. pendimetalin	+ S-metolachlorine,	Stomp 330	+ Dual Gold 960 EC.

We concluded that pre-emergent weed control did not affect the willows in any of the above combinations and doses. The results were however varied. The results of the various combinations are shown in table 1. The character weed species on sandy soils though became less numerous did not die. Higher doses on heavier soils brought satisfactory results.

Based on these results the registered tests appear to be strongly supported to work out the complex weed control of the energy willow.

Table 1. Effectiveness of various herbicide combinations on weed control in energy willow plantations

chemical combinations	observation 1.	observation 2.
Click FL + Dual Gold 960 EC	**Appeared**: goosefoot family, ragweed. **Did not appear**: monocotyledonous weeds.	**Appeared:** monocotyledonous weeds in traces, ragweed sparsely, goosefoot family on an average coverage.
Calisto 4 SC + Dual Gold 960 EC	**Appeared**: Of monocotyledonous weeds: Setaria glauca. **Did not appear:** dicotyledonous weeds.	**Appeared**: hungry rice in a great amount. Of monocotyledonous weeds: goosefoot family. **Did not appear:** ragweed.
Stomp 330 + Dual Gold 960 EC	**Appeared:** ragweed. **Did not appear:** monocotyledonous weeds.	**Appeared:** ragweed on a considerable scale. **Did not appear:** monocotyledonous weeds were still not trackable.

During the works carried out on the plantation in 2005 and 2006 we observed that various insects damaged the plants. In year one the damage was insignificant, only *Aphis farinosa* was recorded. The viral transmission of the species was however obvious causing leaf deformations and forking. Plants overcame this damage in a few weeks time.

In 2006 – we designated sampling spots that were continuously netted in every two weeks. Pests were identified and recorded, damages were also described and the scale of damage estimated and based on theses findings we applied pest control twice.

We described that in 2006 pittle bug (*Lepyronia coleoptrata*), lueberry flagleaf webworm (*Chemiophila salicella*), red-tipped Clearwing (*Synanthedon formicaeformis*), the small willow aphid (*Aphis farinosa*), and the grubs of common cockchafer (*Melolontha melolontha*), damaged the plantation to various degree.

As the plantation covers a significant area it is expected that more insect species are to be detected and some of them may became a major pest causing significant damage.

Our aim is to monitor the movement, presence, caused damage of insect pests. We estimate the scale of damage, the time it occurs and try to find effective measures to tackle it.

There are no licensed pesticides for energy willow plantations, including insecticides we were granted a research license to test various pesticides. As soon the relevant authority based on our results - grants a license to use these in energy willow plantations we will be able to work out the complete technology for this plant.

Willows in rural development

In the EU agriculture not only the end product is the aim but also focuses on the landscape values, the viability of rural communities, the improvement of environmental aspects. This multifunctional agriculture is the centre piece of the European agricultural model. From the point of economics these additional services of agriculture come under public goods, to produce these on mere market terms is not possible the support of the state and EU is needed. Cultivation of the land, the conservation of landscape values, building on local advantages, all come under rural development that has a priority in the EU. Rural development is not only for the rural communities it is the interest of the society as a whole.

The aim of rural development measures to maintain the socio-economic cohesion and abilities of the rural communities and even out the differences between urban and rural differences in income, social services, opportunities to work and creating the freedom of choice for people to choose where they want to live. Rural development measures complete the measures of Common Agriculture Policy (CAP). The CAP market measures are different from the rural development measures that the latter is no tan automatic payment but a programme financing mechanism. One of the measures financed by the European Agriculture and Rural Development Funds in the 2007-2013 period is the support of energy plantations, that includes willow plantations as well.

Other advantages of cultivating willows

The harvest of willow falls between November-February providing work in an otherwise inactive period and increasing the better utilisation of machinery. With the use of appropriate burning equipment the heating needs of a village or individual units can be met in an environmentally safe way. Literature shows that the energy willow (*Salix viminalis* L.) is a good source of honey thus can complement this activity successfully.

Literature

1. A. BORHIDI: Magyarország növénytársulásai. Akadémiai Kiadó, Budapest. 383-392.p (2003)
2. A. BORHIDI: A zárvatermők fejlődéstörténeti rendszertana. Nemzeti Tankönyvkiadó, Budapest. 250-251.p. (1995)
3. E. KISS: Mérési jegyzőkönyv. Dunaújvárosi Főiskola, Természettudományi és Környezetvédelmi Tanszék, Dunaújváros. 3 pp. (2005)
4. A. KONCZLIK, Zs. KAZAI és G. KŐRÖS: Új utak a mezőgazdaságban. Energia Klub Környezetvédelmi Egyesület, Budapest. 6 pp. (2005)
5. T. SIMON: A magyarországi edényes flóra határozója. Nemzeti Tankönyvkiadó, Budapest. 657-660.p. (2000)
6. J. Stehlik: Milyen szennyvízelvezetést és tisztítást válasszak az adott településen, különös tekintettel a szennyvíz Hasznosításra. http://www.aquadocinter.hu (2007)
7. R. SOÓ: A magyar növényvilág kézikönyve II. Akadémiai Kiadó, Budapest. 826-833.p. (1951)
8. F. TAR, Z. KÁRPÁTI és J. MARTICSEK: Megújuló energiaforrások termelésének és felhasználásának lehetőségei a mezőgazdaságban. FVM, Budapest. 45 pp (2005)