Scientific Papers Series Management , Economic Engineering in Agriculture and Rural Development
Vol. 13 , Issue 1, 2013
PRINT ISSN 2284-7995 , E-ISSN 2285-3952

ENVIRONMENTAL AND SOCIO-ECONOMIC ASPECT OF GROWING MISCANTHUS GENOTYPES

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Abstract

Deliberate cultivation of plants for energy biomass is becoming increasingly important. Biomass should significantly contribute to increase the share of renewable energy in the European Union. On the research locality of Slovak University of Agriculture in Nitra localized in the village Kolíňany (Slovak Republic) is implemented basic research focused on the growth and production of the two genotypes energy grass Miscanthus. Research is carried out since 2010. In the third year after planting (the year 2012) were confirmed biomass production depending on the genotype of 35.45 and 36.67 t ha^{-1}. Based on the analysis of growth and production performance of Miscanthus genotypes can be evaluated the high environmental and socio-economic aspects of growing energy crops, depending on the specific agro-ecological conditions.

Key words: *energy crops, environmental, genotype, Miscanthus, renewable resources*

INTRODUCTION

Economic growth has the task of ensuring job growth and sustainable development. Rising and unstable oil prices focus attention of EU leaders on Europe's increasing dependency on energy imports. This suggests the need to orientate energy policy towards energy independence to countries outside the EU. The use of renewable energy sources is one possible solution.

In many developed countries of the world are experimenting with the cultivation of biomass for energy purposes. The current state of agriculture in Slovakia offers question of the possibility of growing energy plants. The production of environmentally clean energy is a further possibility. Biomass energy in Slovakia significantly lags behind the potential options, both in terms of quantity, energy and economic efficiency, as well as potential environmental benefits [5].

Deliberate cultivation of plants for biomass energy is becoming increasingly important. Plantations of fast-growing trees, which are founded in Slovakia, but are extensively abroad are quite known. The energy plants of herbal character are less known. As energy plant is most often recommended energy grass *Miscanthus* spp.

The use of biomass as a renewable energy source is a significant source in developed countries [3]. Sweden uses biomass as a fuel source for 27% of total energy consumption, 23% of Denmark and Austria, it is about 19%. The share of Slovakia on the use of biomass is less than 1%

Biomass should significantly contribute to increase the share of renewable energy in the European Union (EU).

Energy crops are plants that are grown primarily for energy use. They are not used for the production of food or for technical use. In principle, each plant can be used for energy, but only crops with are suitable for energy use [6]. Specific conditions are mainly:

- good conversion efficiency of carbon dioxide to biomass using sunlight and therefore high primary production, specifically C4 plants,

- high solids content (low water content) at the time of harvest,
- high calorific value and low ash content,
- undemanding water and nutrients,
- resistance to pests and diseases.

MATERIALS AND METHODS

In addressing the research projects at the Department of Ecology and Department of Sustainable Development Faculty of European studies and regional development (FESRD) in Nitra (Slovakia) is carried out research of production and energy indicators of energy plants since year 2006.

Basic research of growing two *Miscanthus* genotypes is based on research locality to the Slovak University of Agriculture in Nitra, in Kolíňany village. The research location is situated in the cadastral municipality of Kolíňany.

Climatic indicators (temperature and precipitation) were expressed as an average value for the years 2007 - 2012.

In year 2010, the two crops *Miscanthus* genotypes were established. Each genotype was planted to an area of 100 m^2 in a planting distance 1x1 m. Planting density is 12100 plants to 1 ha.

The exact definition of the research area was carried out using global positioning system – GPS60CS GARMIN. Selected characteristics of research stand are documented in Table 1.

As plant material was used: *Miscantus* × *giganteus* [2], often used in the field experiments [7]. Rhizome planting material was made by Hannes Stelzhammer Austria. *Miscanthus sinensis* (Tatai) was cultivated foreign pollination genotypes of *Miscanthus sinensis*. Planting material were seedlings, they were grown in vitro in Power-H Kft, Hungary.

The selected indicators of growth and production organs plant *Miscanthus* were followed in the dynamic abstraction (two-week intervals during the growing period) in the years 2010 to 2012. Specifically, there were observed [4]: the numbers of stems in a clump, stem length, stem thickness, number of green leaves and dry leaves on the stem and total dry weight of the clump.

The gross production of biomass suitable for energy use was fixed on the basis of the fundamental research.

Monitoring and analysis of dynamics growth of experimental plants allowed to define the environmental and socio-economic aspect of growing *Miscanthus* on agricultural land (in rural areas).

Table 1: Selected characteristics of the research stand

Stand characteristic	Stand/locality
	Kolíňany
location	13 km north from Nitra town
altitude	199 m above sea level
GPS localization	48° 21' 21.6752115" N 18° 12' 23.8327789" E
average year air temperature / temperature in growing season	11.0 °C / 15.4 °C
average annual sum of precipitation / in growing season	594.22 mm / 429.88 mm
soils	fluvial gluey, medium weight soil
relief	plane without expression of surface erosion

RESULTS AND DISCUSSIONS

Relatively new sources of biomass are crops called energy crops - plants. Term energy crops are referred taxons of trees, perennials and herbs, that botanical species, cultivars, clones, natural and intentional hybrids. These plants are used or tested for the deliberate production of biomass suitable for energy sector - production of bio fuels, or incineration or co-incineration. Growth and especially production in $t.ha^{-1}$ energy crops by vigorous growing significantly above average in other crop in particular growing conditions.

Production potential of *Miscanthus* genotypes depends on the life cycle of individuals. The environmental conditions, particularly climate (temperature and precipitation), are the basic prerequisite for the high production potential. Scheme on figure 1 shows growth cycle of *Miscanthus*. Sprouting shoots is affected by air temperature at the beginning of the vegetation period. The beginning of the growth of new shoots represents temperatures above 10 ° C (in the years 2010 to 2012 it was the end of March to early April). Phase of growth and nutrient recycling is characterized by the rise of phytomass plants.

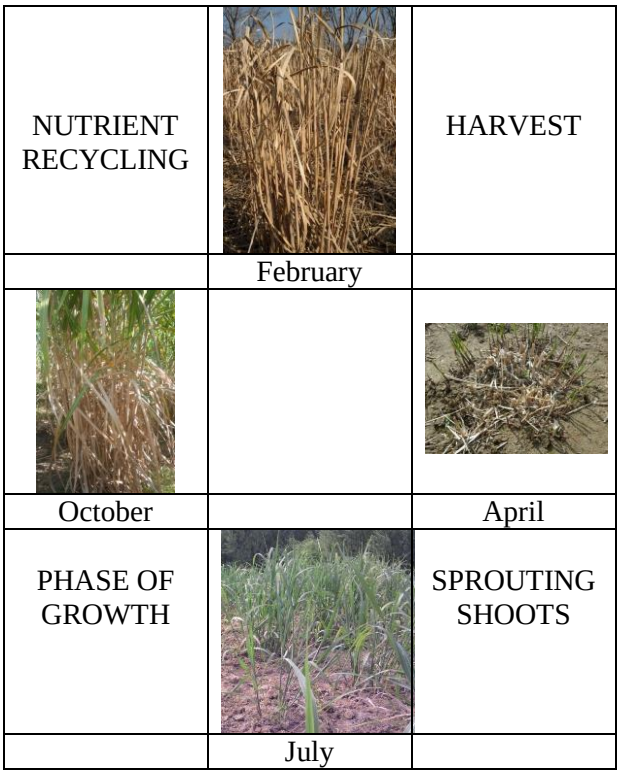

Fig.1. Growth cycle of *Miscanthus sinensis* x *giganteus* on the research locality Kolíňany
Source and photo: own adaptation (2013)

Table 2: The average values of aboveground organs growth in vegetation period from 2010 to 2012

genothype	***Miscantus* × *giganteus* (Greef et Deuter, 1993)**			***Miscanthus sinensis* (Tatai)**		
Year	2010	2011	2012	2010	2011	2012
Number of stalks in the clump	**26.07**	**40.60**	**76.94**	**37.60**	**43.73**	**80.19**
Clump height in meters	**1.63**	**2.60**	**2.70**	**1.24**	**2.52**	**2.79**
Dry weight of the clump in $kg.m^{-2}$	**1.11**	**1.81**	**3.03**	**1.08**	**1.69**	**2.93**
Total undergroun d biomass in $t.ha^{-1}$	**13.43**	**21.90**	**36.67**	**13.07**	**20.45**	**35.45**

The *Miscanthus* genotypes are compared according to the height and number of stalks in the years 2010 to 2012 in table 2. Energy crops were established in year 2010. The year 2012 is the third year after planting and the growth potential is characterized by insufficient production of biomass suitable for the harvest and subsequent energy use.
Aboveground biomass harvesting period is February to March. This is the period when the dry weight of biomass is the highest (Table 2 - dry weight of the clump).

Aspects of growing *Miscanthus* species in Slovakia

/A/ Environmental aspects

Growing energy crops of *Miscanthus* is a renewable resource (unlike fossil fuels). At the end of the growing season, nutrients in the aboveground part of the individual are moved to rhizomes - underground section. It's environmentally friendly type of renewable energy, in terms of production of greenhouse gases. Non-agricultural land can be use for establishment of *Miscanthus* crops. According to land registry, the area of agricultural land in Slovakia is 2,417,933 hectares, which is almost half the size of Slovakia. It is now 19% of non-agricultural land. 11.7% soils in Slovakia are very suitable for growing of *Miscanthus*, especially the western part of Slovakia. In Europe is currently about 15 million hectares of land that could be put out of cereal production and use for energy plants, which would eliminate the overproduction of food and government subsidies to agriculture. It contributes to the maintenance of a favourable microclimate in the country. Aboveground biomass protects soils from drying out and it prevents soil erosion by massive root system. The growth of *Miscanthus* crop is characterized by increasing power of tillering circle, increase the number of stalks and height of crop (table 2). The increase in the number of stalks on both *Miscanthus* genotypes is nearly 300% (in the third year after planting) compared to crop establishment. These plants can be grown on contaminated soils and in areas with reduced possibility of application of agrochemicals. Phytoremediation effect of *Miscanthus* will by the subject of the further research. As stated in [1] the basic ecological benefits of growing energy crops is an increase in species diversity of agricultural land and its cultivation is of great importance in terms of landscape. As fewer obstacles is growing reliance on climatic and soil conditions of non-agricultural soils, especially uniform distribution of precipitation during the growing period.

/B/ Socio-economic aspects

Growing biomass improves social conditions in rural areas, particularly in the transformation of agriculture (conversion from industrial to food production). With the increase of biomass will increase employment in the growing, harvesting and processing. It can significantly contribute to an alternative program for agricultural business, rural development and the protection of the country. It represents an attractive area for international investment too. The increase in the importance of renewable energy in the energy economy is an opportunity to develop the new industries, focused on growing, harvesting and processing of biomass. The risks by in establishment and growing of *Miscanthus* crops are a lack of their own financial resources, higher demands for investment and equipment, lack of long-term and reliable domestic supply of biomass and lack of experience with the storage and processing of biomass, the absence of a functioning biomass market, the lack of information about the cultivation, marketing problems of the production and a lack of business infrastructure.

CONCLUSIONS

EU energy policy orientation heads towards energy independence on countries outside the EU. The energy grass *Miscanthus* spp. is one possibility for the production of biomass energy use. The potential use of this energy plant is particularly as energy raw material for the production of heat. Yield potential of this plant exceeds the possibilities of domestic species grown in Slovakia, including fast-growing trees. Biomass of *Miscanthus* has a higher calorific value than fossil fuels - brown coal. The production of biomass on our research locality in the third year after planting is 35.45 (*Miscanthus sinensis* (Tata)) to 36.67 (*Miscantus* × *giganteus* (Greef et Deuter, 1993)) $t.ha^{-1}$. Natural and ecological conditions, particularly climate and soil, are very important determinant of the cultivation energy plants, in addition to spatial localization. Their knowledge is important in determining the choice of genotype for cultivation in specific agro-ecological conditions. Cultivation of energy plants of *Miscanthus* has in addition to production of the above-ground biomass significant ecological, environmental and socio-economic aspects too.

The non-agricultural land can be use on the cultivation of energy plants. It can be grown on contaminated soils and in areas with reduced possibility of application of agrochemicals. Growing biomass improves social conditions in rural areas, particularly in the transformation of agriculture (conversion from industrial to food production). With the increase of biomass will increase employment in the growing, harvesting and processing. Planting of energy plants create an attractive place for international investment.

ACKNOWLEDGMENTS

This work was supported by VEGA (Agency of The Ministry of Education, Science, Research and Sport of the Slovak Republic) under the contract 1/1220/12 Modelling growth of energy plants grown in climatic conditions of southern Slovakia.

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