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KUNTSYO I.O., jun. researcher¹

HUMENTYK .J.M., Candidate of Agricultural Sciences²

¹National University of Life and Environmental Sciences

²Institute of bioenergy crops and sugar beet NAAS of Ukraine

E-mail: Kuntsyo.Igor @ gmail.com

GROWING OF ENERGY WILLOW AS A FEEDSTOCK FOR THE PRODUCTION OF SOLID BIOFUELS UNDER FOREST- STEPPES OF UKRAINE

*The paper considers and analyzes the use of raw materials based on energy willow *Salix viminalis* L. for the production of solid biofuels in the forest- steppes of Ukraine. Found that the introduction of energy willow plantations will increase the share of biomass in the energy balance of Ukraine.*

Keywords: *energy willow, bioenergy, biomass, productivity, energy value.*

Introduction. Global climate changes and its impact on the environment give rise to review energy strategies and finding new technological solutions in the field of renewable energy sources (RES). Less than three centuries, since the industrial revolution, mankind has used more than half of the fossil fuels that accumulated over millions of years. Current approaches to the use of energy from fossil fuels are changing rapidly towards renewable sources of energy. In particular, there is an active search and use of high valuable bio- cultures to grow biomass for the production of solid biofuels in the form of fuel pellets.

In the structure of the renewable energy sources are more than 50% has energy derived from origin plant biomass and 15 % of the total energy which is used [1,2]. The current state of renewable energy and biofuels in Ukraine is in its infancy and is about 1% of the total energy consumption. Among the wide range of problems in the new fields of legislation and regulations, lack of harmonized European standards for

raw materials, biofuels producers are facing a shortage of raw materials for normal work of enterprises throughout the year. For stable capacity of the work of biofuels plants enterprises it is required planned amount of organic material, perfect logistics and to store it. This problem can be solved by creating their own energy crop plantations with highly rapid rotation and the high yields of biomass with a high content of cellulose and lignin. Among a number of highly promising feedstock crops for biofuels production in the form of wood pellets is willow «*Salix viminalis*», referring to the high-productive and fast-growing wood. In the world practice, the plants of this group have a common name - "energy willow" [2]. Among all power plants in the world today willow is worldwide used as a major energy crops for the production of solid fuel. The most rapid growth in Fitoenergetik this culture has in the Nordic countries, it is recommended to grow on waterlogged and unproductive lands. Biomass energy willow chips as a fuel is the main raw material for the production of green energy power stations in Denmark, Belgium, Finland, England, Germany, Austria and Poland. Significant progress in growing energy willow reached Sweden, which increases plantations during the long time, their currently account is approximately 18 000 - 20 000 ha. In Ukraine, despite the large number of unused agricultural lands, industrial plantations of energy crops is still not enough.

The purpose of the study. Set the productivity, to justify elements of technology growing energy willow biomass and analyze the use of raw materials for the production of solid biofuels under forest-steppes of Ukraine.

Materials and research methods. The study was conducted under conditions of micro field experiments in research areas of the Institute of bioenergy crops and sugar beet in 2010-2013 years on gray forest soils. Agrochemical characteristics of topsoil is 0-30 cm, humus content by Turin is 2,0-2,3 %, hydrolytic acidity by Kappen is 3,5 -4,0 mEq . per 100 g soil , the contents of movable and exchangeable potassium (by Chirykov) are 11,2-14,0 and 12,5-14,5 mg and 100 g of soil.

Lot size is 4 m² , quadruple repetition . Energy willow is twiglike (*Salix Viminalis*).

Studies. Currently, the Institute of Bioenergy and sugar weed NAAS of Ukraine is working on studying the gene pool of the genus *Salix* L. different ecological and geographical origin on the grounds of performance, suitability for mechanical harvesting, high energy value. The studies released the material source for breeding for stable performance and energy properties. In the area of research institute planted different species and hybrids of willow (*Salix* L.) provided by Panfilsky DS NAAS of Ukraine. One of the most productive species distinguished by the dimensional parameters of height and diameter of the barrel is twiglike energy willow (*Salix Viminalis*).

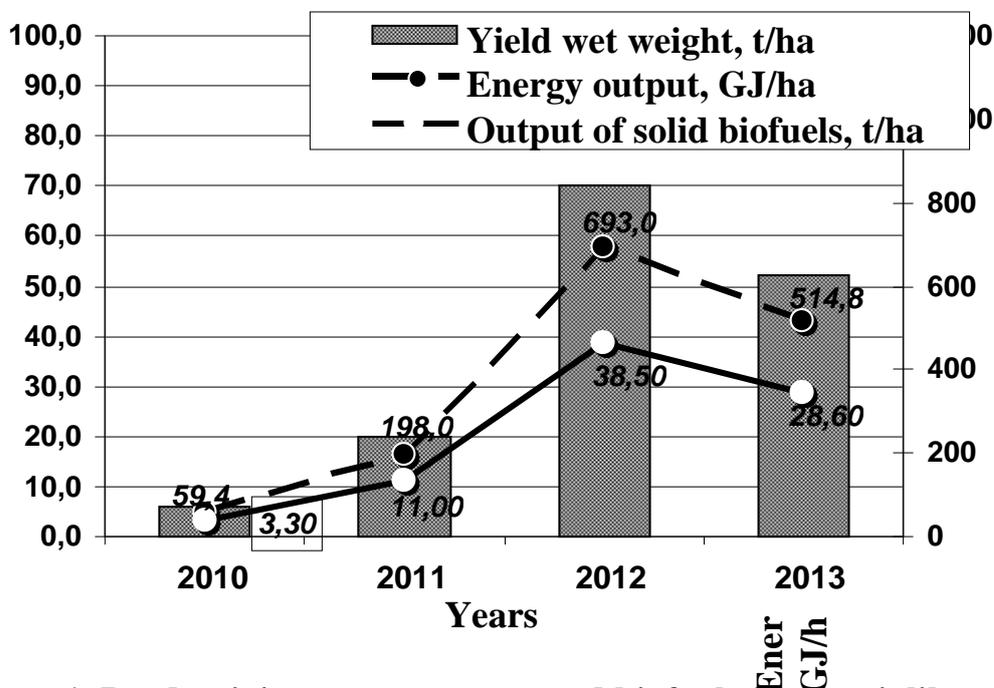


Figure 1. Productivity, output power and biofuels from twiglike energy willow biomass (average for 2010-2013).

According to Fig. 1. yield of energy willow biomass at first year of growth compared to the third year and increased 10 times. The growth of biomass in the fourth year of growth increases significantly due to shoots branching.

Energy willow «*Salix Viminalis*» differ from conventional trees by high gain weight and small requirements for the soil. Industrial use is practicing the third year of growing season. The best development it has on wetland soils by soil acidity pH 5, 5 -7, 5. Favorable soil and climate zone for growing when there is 500-700 mm. of

precipitation. Willow refers to a light wood with a density of 450-470 kg/m³ at 12-14% humidity. The minimum calorific value of dry willow wood is 18.0 MJ / kg, which is almost equal to the corresponding index of coniferous trees.

The industrial growing energy willow plantations requires knowledge of technology and a set of special machinery for its implementation [1, 8]. Willow propagates vegetative by cuttings of willow shoots productive forms. Properly prepared engraftment should be 25-30 cm long and 0, 8-1, 8 cm thick. Shoots for cuttings (handles) harvested from the second week of November to the first half of March. Handles must have at least 5 dormant buds, clean, healthy and have adequate moisture. The top of the cuttings have to be treated with paint, with the addition of antifungal drugs. Immediately before planting handles it should be a harrowing or raking and spraying the fields by soil herbicides. Seedlings of approximately 25-30 cm must be planted on the prepared area plantations. Planting depth is about 25 cm - so that they were above the soil surface 3-5 cm, the angle of planting is 45. The distance between saplings is 60-70 cm, the average distance between rows - 75-100cm. On 1 ha of area 20-25 thousand of cuttings are planted.



Figure 2. Energy willow plantation

Care is to combat weeds, which is very important in the first year of cultivation. Significant threat to energy willow plantations especially in the first year of cultivation are perennial weeds and pests larvae that are in the soil. Most attention to weed control should be given in spring, tilling of plantations can be chemical or

mechanical - by treatment with herbicides or row continuous cultivation. Mechanical cultivation has advantages in helping to reduce the population of pests in arable soil layer and create a layer of loose soil. The first collection of willow plantations biomass does in the first year of its laying. At this time, get the best planting material. The procedure for cutting in the first year is very important because it promotes better tillering and proliferation of willow bush, increase the number of shoots. First year shoots cut at a height of 5-10 cm by hand or by mechanical means [9].

Whereas, the cultivation of willow offered on unoccupied lands, manufacturers are faced with the availability of highly productive varieties of willow. Breeding work has been started in the 70 's and 80 's of last century in Switzerland and the UK. Using a variety or hybrid, zoned for a particular region is a prerequisite for success. Plantation productivity depends primarily on the type of wood and clone, site conditions, age of planting, crop rotation or period of use, as well as the density of planting plants [7, 9]. To collect willow can special combine type "Klaas", which makes fuel chips size 2-3 cm [4, 7]. The heat of combustion of one ton of dry raw material is 18.0 GJ / t, respectively one hectare of willow plantations gives 180 GJ of energy. With one hectare of willow plantation per year you can receive an average of 10 tons of dry material equivalent to 5 tons of fuel, or more than 5 thousand cubic meters of natural gas. With the increase in the industrial area of growing energy crops in Ukraine, there is a need to study and on introduction of new elements in technologies of culture care, establishing evidence-based parameters and methods of cultivation, such as the timing and depth of planting cuttings (Handles) and their impact on the structure of the harvest , biological features and performance of agrophytocenoses. In this regard, scientists focused on improving the basic techniques of growing energy willow. Knowledge of basic morphological and biological properties allow to identify species, determine their viability, and to predict the biological productivity, predict behavior by introduction [1].

According to the results of previous studies found that the productivity of energy willow biomass, reducing the cost of raw materials received , reducing pollution and carbon dioxide in the atmosphere is important to the proper selection of

high-quality material of energy willow, optimization and improvement of the technological elements of soil preparation, planting of cuttings, assembly technology of biomass (wood chips) to the specific soil and climatic and weather conditions of different zones of Ukraine. Energy willow among woody plants are most suitable feedstocks for bioenergy in many countries for the production of solid biofuels. Willow shoots can accumulate a large amount of biomass by photosynthesis that occurs over a long period - from early spring to late autumn.

Conclusions. Ukraine has significant potential for energy plantations, specially grown on land that is currently unused. According to the statistics there are about 3 million hectares derived from agricultural use. By using this reserve lands Ukraine is able to increase the share of biomass in the energy balance to 20-25 %. Among the wide range of different species and hybrids of energy willow is twiglike willow (*Salix Viminalis*), which is advisable to grow under forest-steppes of Ukraine. Fitoenergetik based on vegetable raw materials is a new and promising area of agricultural production. Therefore, energy willow as a high-performance culture has the right to compete with other types of raw materials.

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Анотація

Кунець І.О., Гументик М.Я.

Вирощування енергетичної верби як сировини для виробництва твердих видів біопалива

В статті розглянуто та проаналізовано використання сировини на основі енергетичної верби для виробництва твердих видів біопалива. Встановлено, що запровадження плантацій енергетичної верби буде сприяти підвищенню частки біомаси в енергетичному балансі України.

Ключові слова: енергетична верба, біоенергетика, біомаса, енергетична цінність.

Аннотация

Кунець И.О., Гументик Я. М.

Выращивание энергетической ивы как сырья для производства твердых видов биотоплива

В статье рассмотрено и проанализировано использование сырья на основе энергетической ивы для производства твердых видов биотоплива. Установлено, что ввод плантаций энергетической ивы будет способствовать повышению доли биомассы в энергетическом балансе Украины.

Ключевые слова: *энергетическая ива, биоэнергетика, биомасса, энергетическая ценность.*