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## MODERN DEVELOPMENT OF BREEDING AND REGISTRATION OF MISCANTHUS SPECIMENS IN UKRAINE AND IN THE WORLD

*In article the brought results over of analysis of the state of businesses in a selection and registration of new varieties of miscanthus and some other biopower cultures to that belong: wheat soft and hard, corn ordinary, sunflower one-year, to sugar and feed beets, potato, rape, soy, topinambour, as sources of high-quality raw material for bioenergetic in Ukraine and other countries.*

**Keywords:** *bioenergy; breeding; miscanthus; registration of varieties*

**Introduction.** Among bioenergy raw material resources of the world a special place take grass plants, which include: sugar cane, sunflower, corn, rape, soya, wheat, topinambour, sugar beet, fodder beet, sugar sorghum etc. Fast exhaustion of extractive energy urge society to re-evaluate the energy potential of agriculture, to change attitudes to biomass phytoenergetics in general because new technologies allow to convert biomass energy accumulated by plants during the growing season to the energy source that may be subsequently used by man [1, 2].

Among the wide range of issues related to the increase in the cultivation of bioenergy crops problem of selection is crucial. The solution is to create a varietal bank for phytoenergetics. Criteria for evaluation of newly created varieties of exotic plants and as raw materials for phytoenergetics is a combination of high biological, environmental, economic, economic characteristics, which include fast growth, high biomass productivity, disease resistance, adaptability to different soil and climatic conditions, non-pretentiousness to soil quality and low production costs.

Miscanthus or "elephant grass" is a priority crops here. Miscanthus belongs to the division of angiosperms (*Angiospermales*), class monocots (*Monocotyledoneae*), family cereals (*Gramineae*), genus (*Andropogon*). It is known that more than 20 species of miscanthus, which extended to the tropical, subtropical Asia, Africa, Australia, and East areas. Most spread among them is 11 species: *M. floridulus* (Labill.) Warb., *M. intermedius* (Honda) Honda, *M. longiberbis* Nakai, *M. lutariparius*, *M. oligostachyus* Stapf, *M. papiculatus* (B.S.Sun) Renvoize & SLChen, *M. sacchariflorus* (Maxim.) Hack, *M. sinensis* Anderss, *M. tinctorius* (Steud), *M. transmorrisonensis* Hayata, *M. × giganteus* Greef & Deuter et al. and Renvoize.

However, in terms of breeding the most important are 3 types:

**M. sacchariflorus** with stem 2.5 to 3 m tall, with long rhizome. It quickly occupies ground space, forming a dense plantation. In most cases, this tetraploid has chromosome number 76.

**M. sinensis** (Chinese miscanthus). Its height is 2 to 3.5 m, rhizomes 5-10 cm long, slowly occupies ground, forming a bush on a lot shoots. The number of chromosomes varies from 35 to 57. Populations are anisoploid. More common are diploid plants with chromosome number 38.

**M. × giganteus** (Giant Miscanthus, *giganteus*). Plants of this specie are very tall (up to 5 meters), winter hardiness, drought resistance. It is a natural triploid hybrid between Chinese and *M. sacchariflorus*. Chromosome number is 57. Propagates vegetatively only.

The positive aspect of giant miscanthus that significantly distinguish it from other bioenergy crops is its being unpretentious, fertilizing itself, providing quick harvest. Its performance is 20-25 t/ha of dry matter, which is obtained at the 2-3 year. Solid biofuels could be produced of this crop, namely pellets, briquettes, fuel chips [3].

In terms of ecology miscanthus is an ideal plant for another reason, that is belonging to C4 plants in which photosynthesis is full utilization of carbon dioxide, i.e, with respiration no CO<sub>2</sub> is released outside, and turned back on in the process. The combustion of biomass does not cause the

greenhouse effect, the amount of CO<sub>2</sub> does not exceed an amount previously absorbed by plants during photosynthesis (closed cycle). Miscanthus contains large amounts of cellulose (from 40 to 64-71%), and marked by high resistance to mechanic damage. Due to the high content of cellulose and lignin Miscanthus is also a valuable raw material for the production of building materials, it is used in the pulp and paper industry and in agriculture. In addition, miscanthus has a positive energy balance and on humus, because after four years of growing it accumulates 15-20 tons of underground biomass, which is equivalent to 7.2-9.2 t/ha of carbon. One plantation can be used about 25 years, and commercial cultivation 20 years [4].

In view of the above, the aim of our work was to conduct a systematic analysis of the selection and registration of new varieties, as well as outlining the prospects for its use as a source of high quality raw materials for phytokinetics in countries IUPNV members and Ukraine in particular.

**Results and discussion.** According to the literature sources, breeding process on new hybrid miscanthus is carried out in Sweden, Denmark, Germany, the USA and Japan. Breeding programs being developed all around the world are aimed both at creating new and improving existing forms of miscanthus (Table 1).

*Table 1*

**Miscanthus breeding programs in the world**

Country	Breeding program
Japan	Searches for triploid seeds in natural populations of sugar and Chinese varieties to obtain new germplasm [5]
Ireland	Investigation of the possibility of developing new improved varieties Sinensis M. and M. Giganteus and creating improved methods for seed producing, determination of its potential for Northern Ireland.
U.S.	Program selection and propagation of the genus Miscanthus with German company Tiplant Biotechnik, which invested for 15 years in the breeding process and improvement of seeds production [5]. Created were two new hybrid varieties of miscanthus «Amuri» and «Nagara» under the breeding program “Tiplant” in 2006. These new varieties are the result of interbreeding sacchariflorus M. and M. sinensis and exhibit a greater degree of hardiness than M. giganteus; creation of transgenic miscanthus, creating varieties with boost degree of cell membrane degradation, creating varieties with a high content of lignin, resynthesis of new triploid hybrids [7].
University of Illinois + British Petroleum (BP)	Research methods on increasing biomass, creating varieties of miscanthus through chromosome doubling, obtaining polyploid plants (hexaploid). Other research objectives include obtaining transgenic plants with increased resistance to herbicides, altered lignin content and delayed flowering [8].
Denmark	Denmark is the only country in Europe which introduced miscanthus. Breeding work in Denmark was targeted at acclimatization and breeding varieties resistant to low temperatures. Danish company Nordicbiomass currently provides intensive commercialization of miscanthus. However, the improvement of methods of creation, miscanthus plant propagation from seed and cost reduction are important goals in the development of breeding of Denmark. [9]

As a result of breeding researches in the world, it was accumulated a large gene pool of miscanthus plants, including several species, hundreds of genotypes within a species, as well as the corresponding progeny from crosses.

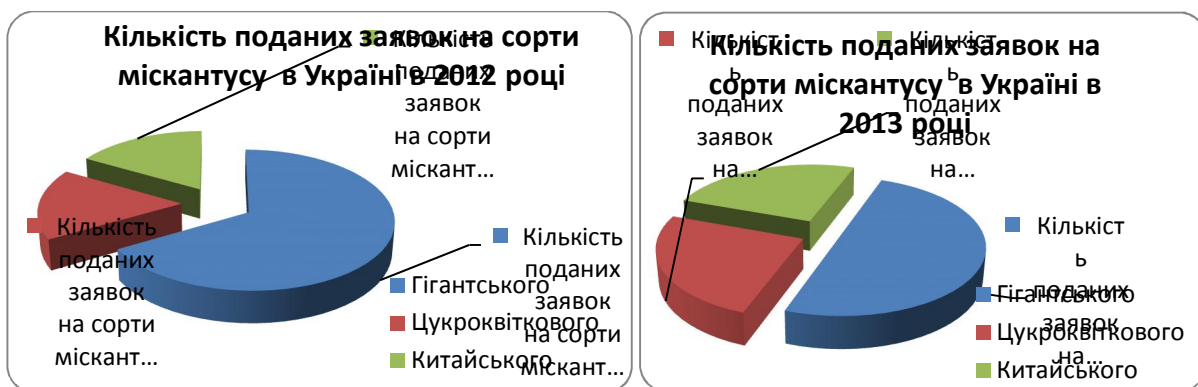
In Ukraine, the breeding of miscanthus is, above all, the increase in biomass growth, improving its mineral composition, obtaining viable seeds and preserve it for a long time.

It is known that any new plant variety must be registered and, if desired, to obtain a patent. Therefore, you can confirm authorship and copyright to protect the variety. Variety rights can be acquired in Ukraine by filing application form, examination and registration by authorities [10].

Substantive examination of miscanthus varieties is taken according to the applicant's data. Since March 2012 the State Veterinary and Phytosanitary Service of Ukraine in general has been submitted six applications for giant miscanthus varieties, 2 applications of Chinese miscanthus varieties and 2 applications of sugar miscanthus varieties (Fig. 1, 2).

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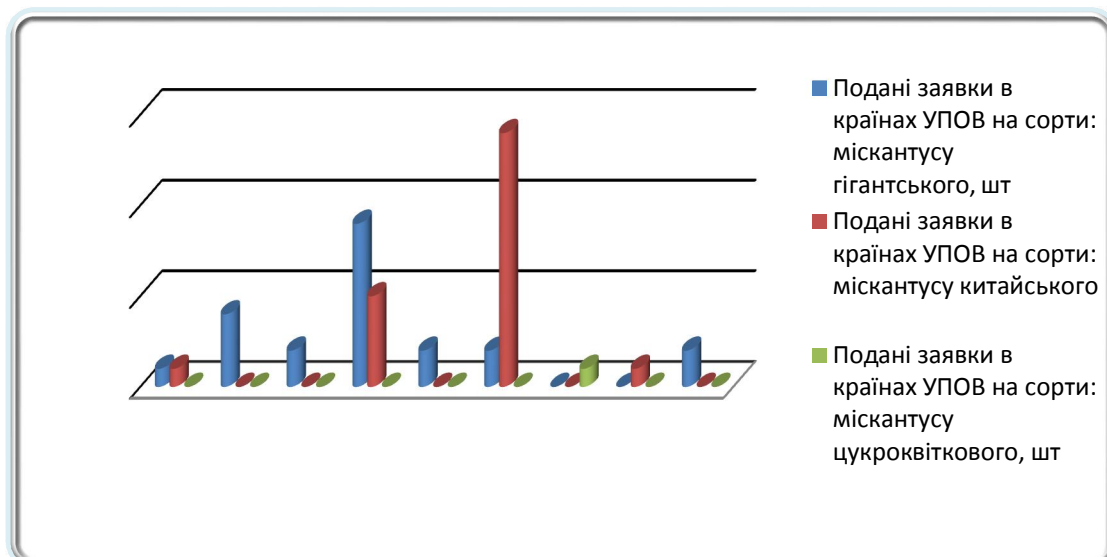
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**Fig. 1, 2. Patent applications for miscanthus varieties in Ukraine in 2012 and 2013**

The most intensive applications process on miscanthus varieties took place in 2012. Over the last year trend for submitting applications is somewhat reduced. The leading institutions on miscanthus breeding in Ukraine are the Institute of Bioenergy Crops and Sugar Beet NAAS, Grishko National Botanical Garden, "AMACO Ukraine" company

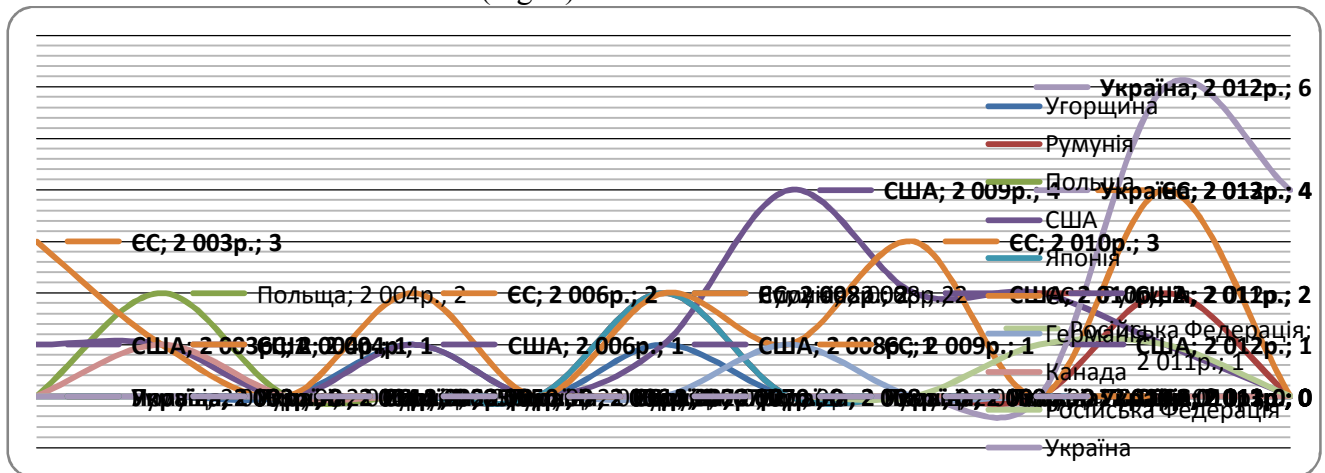
The registration procedure on plant variety rights abroad is similar to that in Ukraine. However, miscanthus became a popular crop abroad earlier and, therefore, the breeding process there is much more intense, as evidenced by the tendency of applying for registration in IUPNV member states over the last 10 years (Fig. 3).



**Fig. 3. Trend of applying for registration of miscanthus varieties in countries IUPNV members for the last 10 years**

The most intensive applications process on Chinese varieties of miscanthus takes place in the European Union, on the giant miscanthus varieties in the U.S., but related the sugar miscanthus variety there was only one application in Germany, which may indicate some difficulties in the breeding process of this type [11].

While breeding work on miscanthus in Ukraine started much later than in other IUPNV member states, the number of submitted to the test varieties in the past year is greater than in any other countries members of IUPNV (Fig. 4).

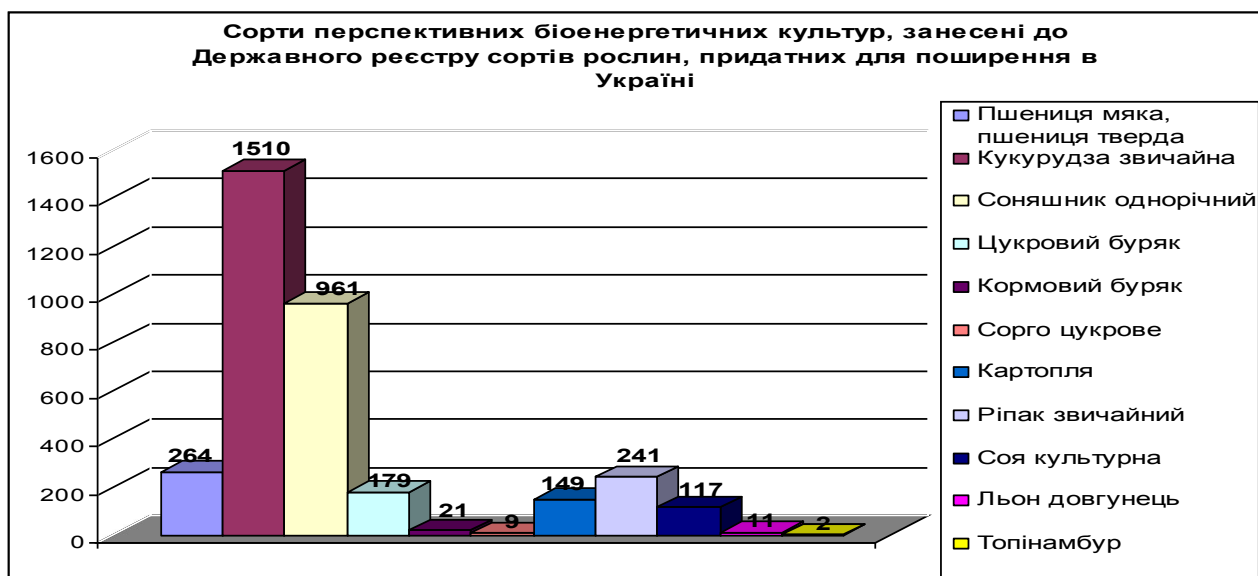


**Fig. 4. Trend of applying for miscanthus varieties registration in countries IUPNV members (2003 - 2013)**

As of December 1, 2013, Ukraine is a leader among the states for the submission of applications for Miscanthus varieties to trial for the past two years.

Over the last year the State Veterinary and Phytosanitary Service of Ukraine entered into the State Register of Plant Varieties suitable for distribution in Ukraine and the State Register of intellectual property rights for plant varieties, three new domestic varieties of giant miscanthus, namely Universalnyi, Poliskyi and Energetychnyi, applied by Limited liability company «AMACO Ukraine» [12].

Estimating the number of bioenergy crops varieties (Fig. 5) and the number of varieties of miscanthus listed in the State Register of Plant Varieties suitable for distribution in Ukraine, it should be noted that Ukraine has a large varietal potential for growing crops for biomass.



**Fig. 5. Registered varieties of promising bioenergy crops in Ukraine**

Thus, the number of the registered varieties of only 11 promising bioenergy crops is over 3.5 million (3564). The amount of varieties of miscanthus compared with world leaders in this field - corn and sunflower (1510 and 961 respectively) incomparably low. However, given that the number of applications for new varieties of miscanthus is rising, and, correspondingly, the number of registered varieties each year is growing rapidly, indicating the intensity of the breeding process, the prospects of miscanthus as energy crops are quite large. In the future, it will significantly reduce the country's dependence on non-renewable energy sources.

#### **Conclusions.**

1. Ukraine has great potential of bioenergy crops, which include soft and hard wheat, corn, sunflower, sugar and fodder beets, potatoes, canola, soya and topinambour. The number of the registered varieties is above 3500.

2. Miscanthus is a perfect bioenergy crop both in Ukraine and abroad. Intensive breeding process and growth number of applications for registration of new miscanthus varieties indicates growing bioenergy potential of these newly created varieties and prospects for their widespread introduction in Ukraine as well as abroad.

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#### **Анотація**

**Роїк М.В., Гонтаренко С.М., Лашук С.О.**

***Сучасний стан розвитку селекції та реєстрації представників роду *miscanthus* в Україні та світі***

*У статті наведені результати аналізу стану справ в селекції та реєстрації нових сортів міскантусу та деяких інших біоенергетичних культур, до яких відносяться: пшениця м'яка і тверда, кукурудза, соняшник однорічний, цукрові та кормові буряки, картопля, ріпак, соя, топинамбур, як джерел високоякісної сировини для фітоенергетики в Україні та інших країнах світу.*

**Ключові слова:** біоенергетика, селекція, міскантус, реєстрація сортів

#### **Аннотация**

**Роик Н.В., Гонтаренко С.Н. Лашук С.О.**

***Современное состояние развития селекции и регистрации представителей рода *Miscanthus* в Украине и мире***

*В статье приведены результаты анализа состояния дел в селекции и регистрации новых сортов мискантуса и некоторых других биоэнергетических культур, к которым относятся: пшеница мягкая и твердая, кукуруза обычная, подсолнух однолетний, сахарная и кормовая свекла, картофель, рапс, соя, топинамбур, как источников высококачественного сырья для фитоэнергетики в Украине и других странах мира*

**Ключевые слова:** биоэнергетика, селекция, мискантус, регистрация сортов