Hungary-Serbia
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Abstracts of oral presentations

Organic agriculture in Serbia – present status and future trends

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Organic farming presents a reasonable opportunity for Serbian farmers to meet demands of the EU market and the world market by producing larger quantities of certified food of high quality which would also meet high health and biological standards. Domestic demands should also be taken into consideration.

For several years now, Serbia has been undertaking enormous efforts to modernize its economy and join the WTO and EU. In this context, one of the areas which require considerable adjustements is Serbia‘s agricultural sector. Serbia has excellent eco-climatic and technical conditions to cultivate, in addition to the traditional berries and fruits, organic cereals and oil crops that are in high demand. On more than 8.000 ha of agricultural land, a product portfolio mostly consisting of: fruits, berries, vegetables, some cereals and some oil crops, generates a farm-gate value of some EUR 25 million.

The total area covered by organic production methodology by 2012. in Serbia amounts to 8.700 ha. In the period from 2004. to 2009., there could be noticed an increased number of land areas where organic production methods were being applied.

Non govermental organisations have played a key role in the initial steps in the development of organic agriculture in Serbia. A pioneer was the Terras from Subotica. In recent time it has formed an umbrella association, Serbia Organica.

The Serbian National Action Plan for Organic Agriculture shows that Serbian political decision-makers have realised the country‘s potential for organic farming and started preparing the necessary framework to turn opportunities into real business. The overall objective of the action plan is to increase the total area of cultivated land as certified organic or in conversion to 50.000 ha until 2015.

Despite the financial crisis, the world markets for organic products are stable and in many countries the turnover with organic products is steadily rising. Europe is one of the

major markets for organic products from Serbia. The demand for a number of Serbian products exceeds the offer. Not only is organic farming significant in meeting and protecting consumer demand, it also serves to the public interest in the protection and improvement of biodiversity, environment and natural resources as well as in sustainable development, protection and improvement of good health of people and animals.

Drought response of cereal plants monitored by the complex stress diagnostic system in greenhouse and field studies

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Since water limitation is one of the major problems for global crop production and it can cause significant yield loss also in Hungary, breeding for drought tolerance of cereals is a high priority that requires concerted support from the integration of genomics with phenotyping of abiotic stress responses. As a reverse genetic approach first allele mining was conducted on a panel of drought related candidate genes in a set of 92 barley genotypes using EcoTILLING, which is a variant of the targeting induced local lesions in genomes (TILLING) technology. Parallel with haplotype discovery in barley candidate genes we have initiated the development of a semi-automated phenotyping platform called "*complex stress diagnostic system*". In this greenhouse facility barley or wheat plants from selected genotypes were grown in pots and morphological, physiological and agronomic parameters were monitored by digital photography, chlorophyll-fluorescence and thermal imaging under normal (60%) and low (20%) soil water content. During the non-destructive screening of above ground parts of plants different images of each plant were recorded and analyzed by applying image analysis algorithms. Based on the generated data we could establish a rank of genotypes according to the resistance under greenhouse conditions. The same set of barley genotypes were also tested under field conditions by using automatic rain shelter and control plots. Despite of the more severe stress exposure in the greenhouse, the two phenotyping systems categorized the analyzed genotypes essentially similarly. This observation may support the use of this complex stress diagnostic system as a pre-selection tool in breeding schemes. The computer program controlled watering allowed the determination of water use efficiency

(WUE) for the tested genotypes and correlate this parameter with seed yield. Comparative studies indicated an increased water use and higher ΔT(ºC) values for the tolerant than the sensitive genotype. Thermal images reflected a cooler canopy temperature as the result of respiratory function.

Root system architecture (RSA) and development plays a pivotal role in adaptation to water shortage. Therefore we aim to extend the presented complex stress diagnostic system with root phenotyping platform that includes monitoring of cellular functions and using also microscopic techniques. Comparing various technologies we concluded the need for monitoring root growth in soil during characterization of drought responses. Therefore presently we grow barley seedlings in plexiglass rhizoboxes filled with soil calibrated for the defined water content. By using digital camera for image acquisition root type-specific traits were measured including number of roots, length, growth rate. Normally barley plants stop root growth in soil with low water content. Genotypes with a potential for accelerated root growth under suboptimal water supply have special significance in improving drought adaptation. The enlarged roots can originate from cell elongation or from continuation of cell division. After identification of genotype with drought stimulated root growth we could identify higher frequency of S-phase cells by fluorescent labeling technology based on incorporation of 5-ethynyl-2'-deoxyuridine (EdU) than in roots of sensitive plants. We expect that the phenotyping technologies can be improved to monitor cellular traits in an automated ways that allow high-throughput.

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FIELD EXPERIMENT WITH CEREALS AND PSEUDOCEREALS AT CERTIFIED ORGANIC FIELD FOR AGRONOMIC RESEARCH AND EDUCATION

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Organic production as a response to the numerous problems in conventional agricultural production is becoming more and more interesting on global as well as local scale. Hungary and Serbia both accept organic production and there is an increasing choice of different products based on organically produced ingredients, including cereals as well as seudocereals.

Organic farming in Serbia is intensively developing. The Action Plan (2012-2015) envisages an increase of organic agriculture up to 55,000 ha by 2015. The situation is similar in Hungary. The most important contributions of organic agriculture are the protection of biodiversity, pesticide free production, production of food and feed safe for human and animal health, sustainable development of rural areas, etc. Having in mind the relatively short history and the present limited areas under organic production in Hungary and Serbia, there is urgent need for scientifically based results applicable in local conditions for improvement in organic agriculture.

The aim of the research is to carry out field experiments with different Hungarian and Serbian cultivars of cereals (Table 1) as well as pseudocereals (*Panicum miliaceum and Fagopyrum esculentum*). The Institute of Field and Vegetable Crops in Novi Sad possess organic experimental field in third year of certification. Detailed observations will be taken in order to precisely describe the performances of cereal and pseudocereal cultivars under organic production managements.

Some economically important aphid specii in small grains in Serbia will be monitored: *Metopolophium dirhodum* (Walk.), *Rhopalosiphum padi* (L.), *Schizaphis graminum* (Rond.) and *Sitobion avenae* (Fabr.). In addition to aphids, an important pest species in wheat entomofauna is cereal leaf beetle (*Oulema melanopus*). The application of botanical insecticides in organic production is limited by many factors and technically often not very feasible, which is why the testing of wheat genotypes for resistance and tolerance is very significant. This field trial would encompass the following cultivars: ‘Nirvana’ (*Triticum spelta*), and two *Triticum aestivum* cultivars: ‘Europe 90’ (resistant to cereal leeches) and

'Stamena' (cultivar adapted to extensive growing conditions). Testing for resistance would be performed under field conditions of spontaneous pests attack on cultivars grown without the use of insecticides.

Considering the crop's needs for nutrients, fertilizers containing microbial specii showing specific relationships with wheat cultivars would be utilised. Liquid microbial fertilizers would be applied by foliar application during phenological stages of tillering and boot stage in the quantity of 7 l ha^{-1}.

The results obtained will be used to educate our direct target group (family-size farmers, small- and medium size companies, some bigger ones) about the technology of sustainable and profitable organic production of cereals and pseudocereals on a field day as well as by publications (printed and electronic) explaining the principles and methods of organic production are planned.

Table. 1. Cereals demonstration trial on the organic experimental field of the Institute of Field and Vegetable Crops in Novi Sad (Serbia) established in October 2012.

Plot number	Species	Cultivar
1	*Triticum aestivum*	Milijana
2		GK Fény
3		GK 04.10
4	*Triticum monococcum*	MV-Alkor
5	*Triticum dicoccum*	MV-Hegyes
6	*Triticum durum*	NS Dur
7		GK Bétadur
8	*Triticum spelta*	Nirvana
9		GK Tönköly
10	*Triticum compactum*	Bambi
11	*Triticale*	Odisej
12		GK Rege
13	*Secale cereale*	GK Wibro
14		Nonius
15	*Hordeum vulgare*	GK Rézi
16	*Avena sativa*	NS Jadar

17		NSOR 1001

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Use of molecular and conventional resistance breeding methods in increasing the tolerance of wheats to biotic stresses

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Foliar diseases of wheat such as rusts and leaf spots are one of the most important fungal diseases of wheat in Hungary. Under favorable conditions pathogens can cause yield loss more than 50% in susceptible cultivars. Although fungal diseases can be controlled with fungicides, however, growing resistant cultivars considered to be an efficient, environmentally safe and economical approach in reducing damage by these diseases. To use genetic control, it is important for breeders to know the resistance levels and the genetic background of the resistances in their cultivars. Up to this time we determined the presence/absence and frequency of the most important stem rust resistance genes (*Sr31* and *Sr36*) and some leaf rust resistance genes in wheat cultivars registered in Hungary over a period of 35 years (1970-2005). We started an extensive marker assisted selection program to transfer effective leaf rust resistance genes to adapted wheat cultivars in Hungary. One of this line as a variety candidate GK 04.10 having an excellent resistance and good yielding ability was entered into state trial in 2010. (Within the present cooperation program this genotype would be tried in the Hu-Srb transborder region.) Decrease of genetic diversity in breeding materials posing a great threat for wheat breeding both in Hungary and Serbia (e.g. new virulent races of pathogens can appear which would break resistance of present cultivars). The transborder cooperation in exchange of resistant cultivars, mutual field trials and pathological observations and also the use of molecular markers would result new possibilities in fighting against biotic stresses in the transborder region.

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Small grain cereals suitable for environmentally sound, sustainable agriculture

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In Hungary and Serbia, as in many parts of the world, an increasing part of the land area is used by farmers for low-input agriculture practices. In most cases, these areas are not typically organic farms, however farmers use low chemical fertilization rates and no or rare chemical treatments in their crops. In many cases, the concerned areas are infertile, dry or wet, acidic or alkali soils, marginal agricultural lands. The performance of certain intensive types of cereal cultivars in such environments may be very poor. For farmers, the cultivars that can produce sufficient yield at low fertilizer rates mean really high values due to economical reason. Beside, the emerging concern about the environment and land-use and the farmers' demand for such cultivars has lead us to develop cereal varieties for low input areas. Such genotypes may be used for environmentally sound crop production practices in the Hungarian-Serbian Cross Border Region, too. The aim of this work is to portray the characteristics of some alternative type cereal cultivars suitable to the above, low input production areas. In this work, we concentrate mostly for triticale (*Xtriticosecale Witt.*) rye (*Secale cereale L.*), barley (*Hordeum vulgare L.*), and oat (*Avena sativa L.*) produced in a relatively smaller portion of the arable land. Wheat (*Triticum aestivum L.*) varieties suitable for low input, eco-production are also subjects on this introduction.

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SELECTION METHODS FOR DROUGHT TOLERANCE IN A WHEAT BREEDING PROGRAM

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Drought is a worldwide phenomenon and is a major production constraint limiting crop yields. One of the possible defenses against water deficiency is breeding for drought tolerance. Under our conditions the goal is to produce genotypes which are able to adapt to drought in every developmental period of their life.

Advantageous, if developmental cycles fit the most prevalent weather conditions (pe.: earliness if late drought is frequent). Whereas desirable that the morphological characters would assist the most efficient water use and minimize the losses while maximize the uptake of water from the surrounding environment.

Tolerance to drought is a quantitative trait, with a complex phenotype, often confounded by plant phenology. A research program for increasing drought tolerance of wheat should cope with the problem in a multi-disciplinary approach, considering interaction between multiple stresses and plant phenology, and integrating the physiological dissection of drought tolerance traits and the genetic and genomic tools, such as quantitative trait loci (QTL), microarrays, and transgenic crops.

Since the weather and natural water supply is changing year after year in Hungary, grain yield data are not suitable to judge the tolerance level of the cultivated genotypes. The problem is even more complicated, because the most of drought tolerance mechanisms are in negative correlation with grain yield capacity. We have to evaluate the tolerance level of genotypes by inexpensive, fast but reliable testing methods which can be done in the field or even in laboratory and can be performed independently from weather conditions.

In this presentation we discuss the possibilities to apply various testing methods in phenotyping and the breeding procedure of winter wheat for drought tolerance.

At the Cereal Research Non-Profit Co. we developed a selection program for drought tolerance of wheat by the chemical dessiccation method and the flag leaves' water retention ability. Our testing methods were developing, after we could make irrigation tests, we started to select for drought tolerance by the remote thermometry of canopy surface (photosynthetic activity during drought stress). Since the year 2006 a mobile automatic rain shelter helps the

selection for the tolerance to water shortages *per se* in the field. In this test we evaluate the advanced lines of our breeding program.


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