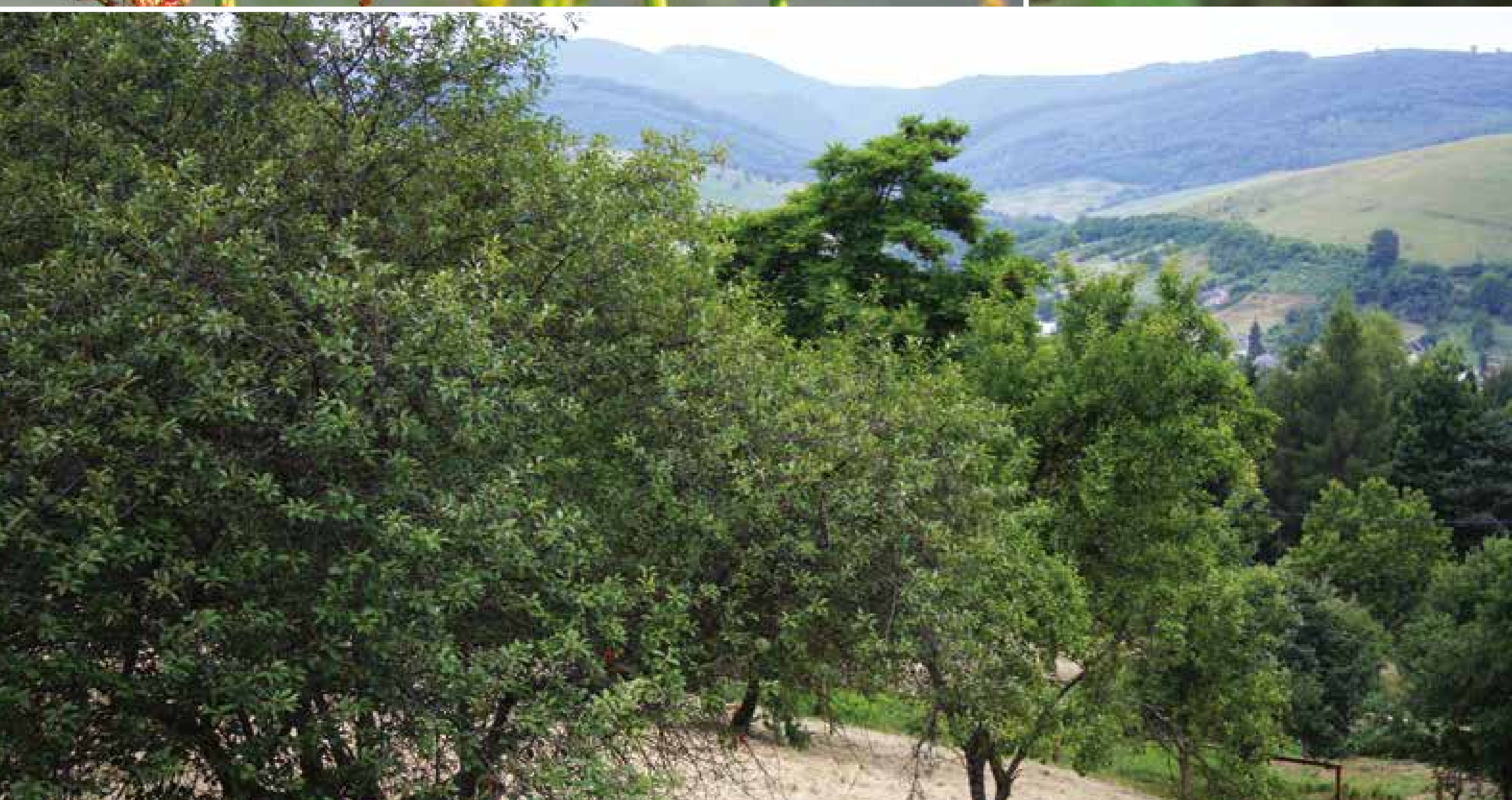
HUF 950/$ 4

HUNGARIAN AGRICULTURAL RESEARCH

September 2015

Journal of the Ministry of Rural Development Hungary



FROM CONTENTS

HERMAN OTTÓ INTÉZET

SAGITER
'Agroecological Knowledge and Ingenuity of territories'

SAGITER project intends to participate in a dynamic of promoting/upgrading the agroecological knowledge, and of these ingenious systems implemented with the passing of time on the territories. In this context, the training is aimed at developing the evolution of representations, acquisition, or reintroduction of technics, consolidation of network and of social links.

SAGITER it is a study- action which leans essentially on the ways of transmission of the knowledge and aims for:

• Producing and spreading educational resources
• Facilitating sharing of experiences and practices
• Participating in the consolidation of a real European network built around the agroecological knowledge which - as of the agroecology in general - has been one of the priorities of the member states of the European Union

Project Partners:
The project is coordinated by Montpellier SupAgro, Institute for Higher Education in Environment – Florac (France)

Fumeterre (France)
Savoir-Faire & découverte (France)
The Merle training center SupAgro (France)
Geyser (France)
Department of Geography, University of Marburg (Germany)
Federation of family agrarian schools in Galicia (Spain)
Vlaamse Landmaatschappij (Belgium)
Chamber of Agriculture and Forestry (Slovenia)
Szent István Univerity (Hungary)
USAMV de Cluj Napoka (Romania)

Homepage: http://www.sagiter.eu

www.sagiter.eu

SAGITER is supported by the European Union
through the Leonardo Da Vinci Lifelong Learning program

Lifelong Learning Programme

HUNGARIAN
AGRICULTURAL
RESEARCH
September 2015
Vol.24, No. 3.

Published by
HERMAN OTTÓ INTÉZET
H-1223 Budapest, Park u. 2. Hungary
www.agrarlapok.hu/hungarian-agricultural-research I info@agrarlapok.hu

Owner
FÖLDMŰVELÉSÜGYI MINISZTÉRIUM

Editorial Office
Faculty of Agricultural and Environmental Sciences
Szent István University, Gödöllő I H-2103 Gödöllő
Hungary

Subscription request should be placed with the Publisher (see above)
Subscription are HUF 3900 (only in Hungary) or $16 early plus $5 (p & p) outside Hungary

HU ISSN 1216-4526

Cover photo:
Selection of nature pictures (Mónika Rákhely)

INVESTIGATION OF GROUND AND ARTESIAN WATERS AS IRRIGATION WATER ON THE GREAT HUNGARIAN PLAIN

JUDIT **PETŐ**[1] – EDIT **HOYK**[2] – ATTILA **HÜVELY**[1]

[1]Kecskemét College, Faculty of Horticulture, Department of Horticulture, 6000 Kecskemét, Hungary

[2]HAS Research Centre for Economic and Regional Studies, Great Plain Research Department, Institute for Regional Studies, 6000 Kecskemét, Hungary

Corresponding author: Edit Hoyk, email: hoyk.edit@krtk.mta.hu; tel.: +36 76502840

ABSTRACT

One of the most significant attribute of soils is that they function as water reservoirs. Subsurface waters – used as irrigation water – can contribute to nutrient supply, but their pollution has a negative impact on the conditions of cultivation. In our study we present the results of our investigation of ground and artesian water samples from the Great Hungarian Plain, mostly from Kecskemét and its surroundings.

Based on the depth of the sampling points, we divided the samples into three categories: between 10-30, 31-70 and 71-275 meters. The results showed that the salt content is decreasing with the deepness, primarily because of the decrease in sodium, hydro-carbonate and chloride contents in the samples. The level of nitrogen and phosphorous-ions were low in almost all water samples. Iron, manganese and arsenic content were the highest in the middle deep waters (31-70 m depth).

These results – especially in the case of iron and arsenic – can cause problems in the use of these waters in agriculture for cultivation and irrigation. Nowadays decreasing groundwater stocks decrease the water sources of irrigation. Nevertheless usage of subsurface waters for irrigation is important in the future, for example about their function as a potential nutrient sources. Their sensitivity against pollutions draw attention to the essential task of continuous quality parameters monitoring of subsurface waters.

keywords: ground water, artesian water, irrigation, nutrient reservoir, water pollution

INTODUCTION

One of the most significant attribute of soils is that they function as water reservoirs. Subsurface waters – used as irrigation water – can contribute to nutrient supply, but their pollution has a negative impact on the conditions of cultivation.

Almost every year we have problem with water in Hungary, sometimes floods, sometimes droughts are the reason of it. These problems have special significance on the sand ridges between the Danube and Tisza rivers, where cultivation – especially horticulture – is important. But we have to accept, that inordinate precipitation is a typical characteristic of our climate (Rakonczai 2000). That is why irrigation is so important for agriculture in Hungary.

From the point of view of irrigation water sources, we have to point out the zone near the surface – it means groundwater (0-30 m) – which is an infiltration zone with changeable solute, and it is not a complete underground system. That is way investigation of this system is justified. Under this shallow zone, a 31-300 m deep zone can be found, with migrate waters towards centre of Carpathian basin and tempered chemical compounds. In centre and south part of the Great Plain, in the upper 500 m layers usually we can found water bases with less than 1 g l^{-1} solutes which is typical for Pleistocene and Pliocene residual water supply layers. These waters usually have drinking water quality. Waters have Calcium – Hydro-carbonate aspect in infiltration areas, which more and more Alcalic – Hydro-carbonate towards horizontal flow. Because of this phenomenon waters can be too soft in the middle of the Great Plain, which restricts the consumption (Kuti et al. 1999).

Anaerob processes can rise iron, manganese and ammonia content of artesian waters. Grown arsenic content could come forward as a problem in one part of irrigation waters. In some cases salt content can be high of artesian waters near the surface, solutes can be higher than 1 g l^{-1} (Kuti et al. 1999).

We investigated irrigation waters of South Great Plain in our work, in order to submit of utilization in agriculture on the base of our results mainly in case of horticultural irrigation.

MATERIAL AND METHODS

Irrigation water samples from 2007-2014 were examined in Soil and Plants Analysis Laboratory of Kecskemét College. We investigated 110 water samples from different wells. Based on the depth of the sampling points, we divided the samples into three categories: between 10-30, 31-70 and 71-275 meters. We show the position of the wells on Fig. 1. Place of origin is mainly Kecskemét and its surroundings, but we had samples from Bács-Kiskun county and agricultural areas in south part of Tiszántúl region.

Rules of sampling are the following: collection of water sample from drilled wells after streaming a few minutes, washed out with well-water of sample collection containers, and it is necessary to close tight immediately after the sampling. After a longer storage the results of the investigation are not trusty.

Examination of pH was made by potentiometer, electric conductivity (EC) by conductometer. Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, PO_4^{3-}, SO_4^{2-} ions, and Fe-, Mn- As-content were measured by ICP-OES spectroscopy. Investigation of ammonia- and nitrate-content were made by photometer (Fig. 2.), chloride by argentometer, carbonate and hydro-carbonate ions by neutralized titration. Methods were based on standards.

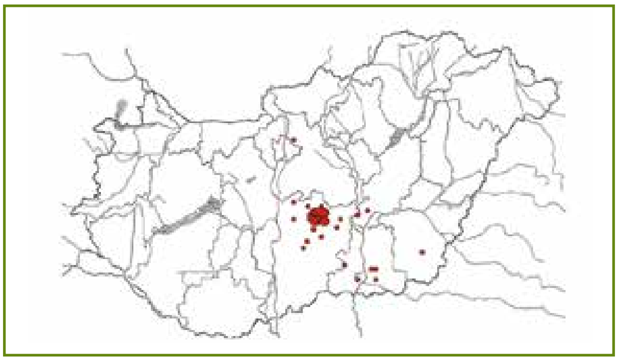


Figure 1: Situation of the sample points

RESULTS

PH values of investigated underground water samples were between 6,5-7,8, the average was 7,3, stand by a medium deviation with decreasing water depth. Conductivity, which refers to the salt content, shows high variability. Average conductivity value exceeded 1000 μS cm^{-1} in higher layers

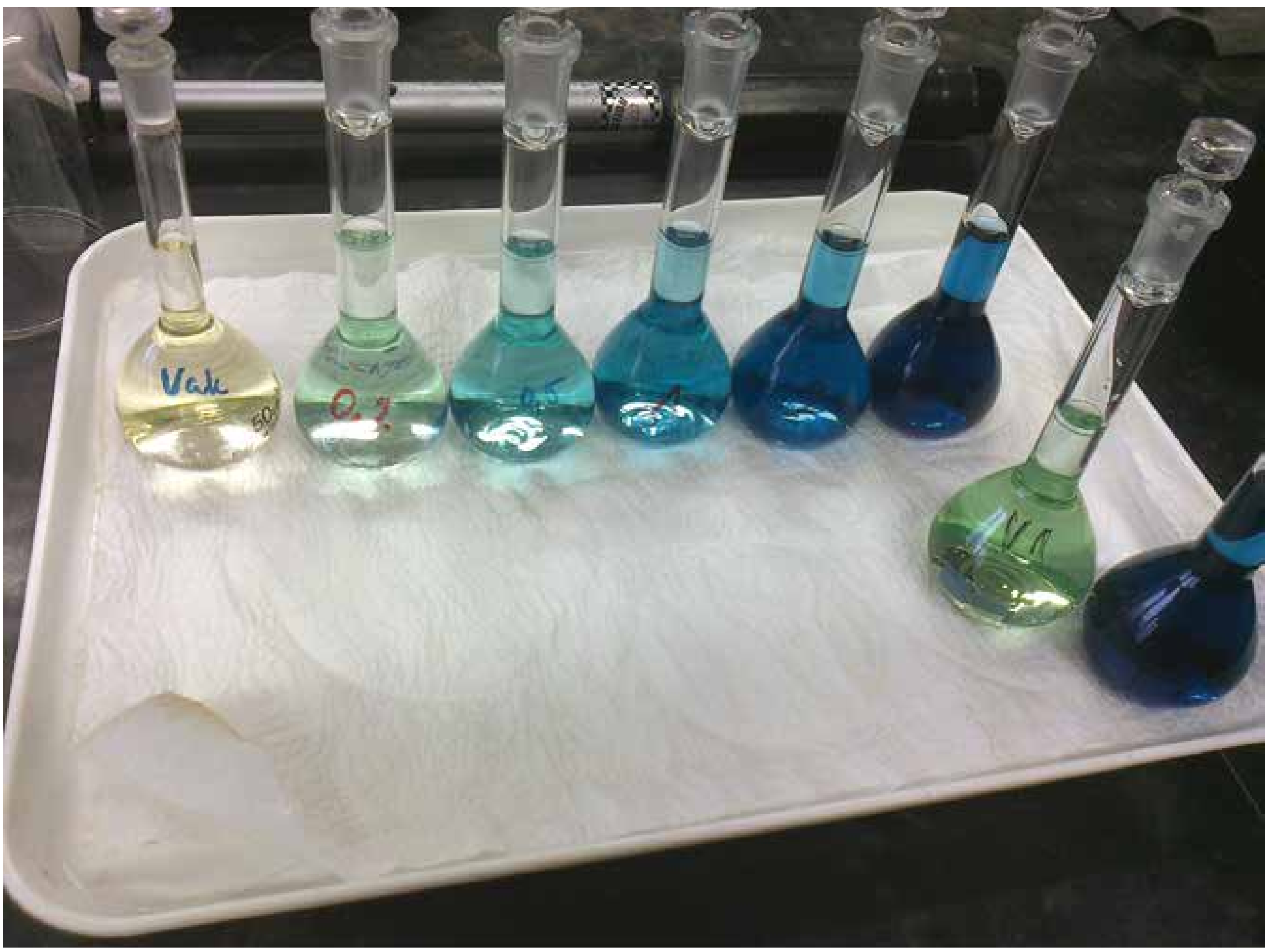


Figure 2: Some water samples for NH_4^+ analysis via photometric method

Table 1: Changes of pH and EC values by depth

	10-30 m		31-70 m		71-275 m		limit value
	average	deviation	average	deviation	average	deviation	
pH	7,26	0,37	7,32	0,38	7,29	0,25	6,5-7,8
EC, μS cm^{-1}	1020	763	975	833	682	267	1000

which is recommended in irrigation waters, while values in medium depth were close to this. Salt content of waters reduced and balanced in lower layers (Table 1.)

Most typical metal ions in the nature are Na, K, Ca and Mg. Chloride and hydro-carbonate ions are the most important among accompanying anions. On the basis of our results, potassium ion was in minimum quantity with low value, which hardly changed with depth (from 1,86 to 2,45 mg l^{-1}). Carbonate ion was not detected in either samples. We show changes of other samples with the depth on Fig. 3. Practically decreasing tendency of concentration was detected of all ions with the depth.

Average values of ions did not exceed the limit values for irrigation waters, in any cases of ions or depth. It is important, that in case of water samples from shallow depth, and especially of sodium and chloride ion concentration, deviation was large. 4 % of samples had very high (>400 mg l^{-1} Na^+; >500 mg l^{-1} Cl^-) concentrations in wells shallower than 42 m.

Different forms of nitrogen and phosphorus show antropogenic pollution principally. Most important ions of N and P can be seen on Fig. 4. Investigated water samples were not near the limit values for nitrate and phosphate (50 and 30 mg l^{-1}). It was not the case with ammonium ion, where values exceeded the limit value (0,5 mg l^{-1}) in many cases, in higher layers. But under 45 m it was not case occurred. Probable farmyard manure was the reason of the higher NH_4^+ pollution.

Iron, manganese and arsenic are the most important micro-pollutants. Concentration changes of these ions can be seen on Fig. 5.

Iron exceeds the limit value, which can be seen clearly. We can see very large deviation in case of every investigated pollutants. We detected the highest concentrations in middle depth.

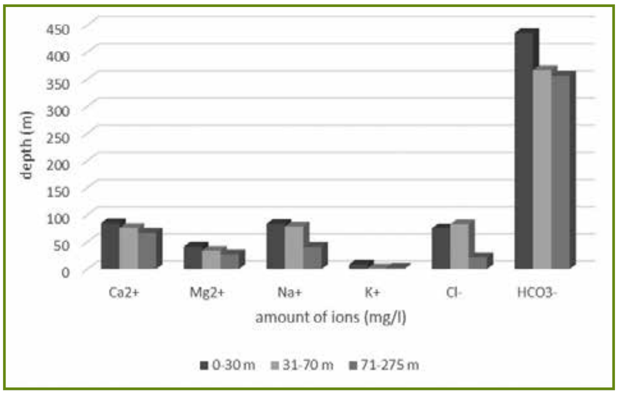


Figure 3: Changes of different ions with the depth

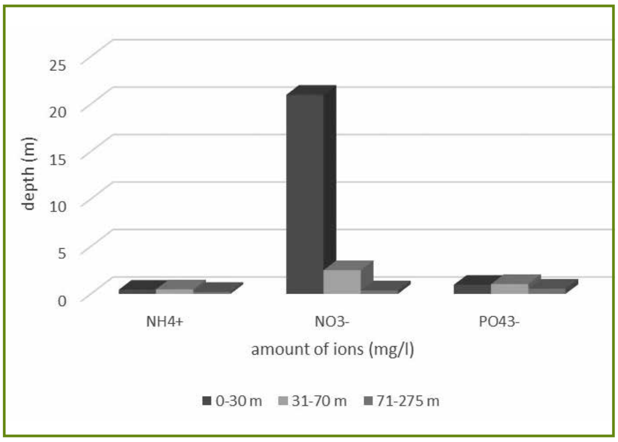


Figure 4: Changes of different ions with the depth

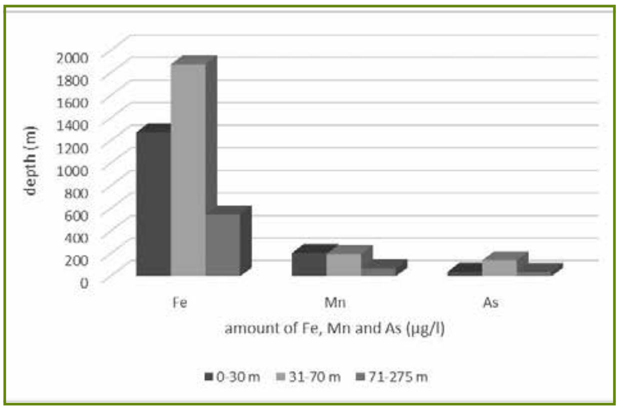


Figure 5: Concentration changes of iron, manganese and arsenic ions with the depth

DISCUSSION

Lower part of investigated irrigation water samples is groundwater from 10-30 m depth, majority is artesian water from deeper depth (31-70 and 71-275 m). On the base of our investigation we can concluded, that pH values of water samples were near neutral, average value was 7,3. Hydro-carbonate with its slightly alkaline effects affects the acid-base balance.

Water samples from deepest layers had the most stable composition both pH and ion content in respect. Salt content decreased going down, which is favourable influenced irrigation use of these waters (Terbe 1995; Cserni 1991). Reduction of salt content thanks to decrease of potassium- and chloride-ions in one hand, on the other hand primarily it thanks to decrease of hydro-carbonate ions.

It is a curiosity of groundwaters in Great Plain that different salts dissolved in the most diverse concentration. Salt content of these waters usually exceed 1000 mg l^{-1}. Sodium – hydro-carbonate is the most frequent salt in our region, in other places sodium-sulphate and magnesium-sulphate waters also occur. Depth around 30 m means a transition between groundwater and artesian water, while depth between 250-300 m is a border of a geological formation. Elderly waters occur in artesian wells under 300 m with high content of dissolved materials and high chloride concentration which were not investigated (Liebe 2000; Borsné Pető et al. 2011). Waters in shallower depth are probably younger. These waters dissolved from the surface directly, or not too far from the place where we can find it nowadays. Composition of water samples is varied because of the water flows beneath the surface, moving up and down. Investigated waters are medium hardness, potassium content is expressly low, because of the minor clay content.

Water sources under the surface are compromised in many ways. High concentration of nitrate and chloride ions refers to pollution from the surface, but iron, manganese and ammonium concentration can rise in natural circumstances because of the dissolution from base rocks around the water sources. Presence of ammonium can refer to fresh pollution. Iron can be an original component of the water, or can appear as a secondary pollution in obtaining water, as a consequence of large free carbonated water's aggression (Nemes 2007). Iron and manganese content should be avoided under drip irrigation because of the risk of clogging. Higher content of iron and manganese in waters (1,5 mg l^{-1}) is not a problem from plant nutrition perspective. We can expect increase of arsenic content in case of middle layer irrigation waters on the South Great Plain, based on our results.

CONCLUSIONS

Drought and inland water have similar frequency on the Great Plain, but drought affects much bigger area than inner water. Sand ridges between the Danube and Tisza rivers is the most sensitive to drought, moreover the middle and lower parts of Tisza region. This is the reason, why irrigation and quality control of waters are so important. Because of inland water sensitivity, application of facilities which are suitable both of irrigation and drainage is particularly justified in our region (Pálfai 1995).

Half part of obtaining waters originates from artesian waters in Hungary, quantity is 1,0-1,1 million m^3 per day (daily amount has halved from 1985 in the country – parallel with water price increase –, nowadays the quantity is stagnant).

Artesian water levels permanently decreased due to obtaining artesian water. From 5-10 m decreasing in water level and decompression occurred from the 1970s, especially around larger waterworks (for example Kecskemét). Due to decrease of obtaining waters, some places have seen a rise in the artesian water level nowadays.

The situation is different in the groundwater, because groundwater level decreases on the sand ridges between the Danube and Tisza rivers since decades. Decreasing groundwater stocks decrease the water sources of irrigation. Particularly worrisome that we can find thousands of illegal groundwater wells on the sand ridges, through this usage of water sources is unchecked.

Nevertheless usage of subsurface waters for irrigation is important in the future, for example about their function as a potential nutrient sources. Their sensitivity against pollutions draw attention to the essential task of continuous quality parameters monitoring of subsurface waters both as drinking and irrigation water. Our investigation drew attention primarily possibilities of iron and arsenic pollution which can be harmful and disturbing in cultivation and irrigation.

REFERENCES

1. Borsné Pető J. – A. Hüvely – I. Cserni – J. Nagy 2001. A termálvíz összetételének jellemzése Kecskeméten, (12.) AGTEDU 2011. Magyar Tudomány Ünnepe, 169-174.
2. Cserni, I. 1991. A sókimosódás és szerepe öntözéses zöldség- és növénytermesztésben sós sivatagi homoktalajon, ZKI bulletinje, 17-32.
3. Kuti L. - T. Tóth –L. Pásztor – U. Fügedi 1999: Az agrogeológiai térképek adatainak és a szikesedés elterjedésének kapcsolata az Alföldön. Agrokémia és Talajtan, 3-4 (48): 501-516.
4. Liebe, P. 2000. Az Alföld felszín alatti vízkészlete. In: A víz szerepe és jelentősége az Alföldön. A Nagyalföld Alapítvány kötetei 6. 105-117.
5. Nemes, Zs. J. 2007. Öntözővizek minősége a hazai vízkultúrás zöldségtermesztésben, PhD értekezés, BCE, 1-179.
6. Pálfai, I. 2000. Az alföld belvízi veszélyeztetettsége és aszályérzékenysége. In: A víz szerepe és jelentősége az Alföldön. A Nagyalföld Alapítvány kötetei 6. 85-95.
7. Rakonczai, J. 2000. A környezet-átalakítás hidrogeográfiai összefüggései az Alföldön. In: A víz szerepe és jelentősége az Alföldön. A Nagyalföld Alapítvány kötetei 6. 26-36.
8. Terbe, I. 1995. A fajlagos elektromos vezetőképesség (EC) mérése a gyakorlatban. Hajtatás, korai termesztés. 26:4. 14-18.

THE IMPACT OF CROP YEAR AND AGROTECHNICAL FACTORS (FERTILISATION, IRRIGATION) ON THE PROTEIN CONTENT OF HYBRIDS

ADRIENN **SZÉLES**[1] – ATTILA **VAD**[2] –PÉTER **RAGÁN**[1]

[1]University of Debrecen, Faculty of Agricultural and Food Sciences and Environmental Management, Institute for Land Utilisation, Regional Development and Technology, 4032 Debrecen, Hungary

[2] Institute for Farm and Regional Research, Centre for Agricultural Sciences

Corresponding author: Adrienn Széles, email: szelesa@agr.unideb.hu; tel.:+36 52508444 (88045)

ABSTRACT

The aim of this study was to analyse the problems caused by weather and its consequences and the alternatives of improving quality with fertilisation and irrigation.

Examinations were performed in a moderately warm and dry production area in Eastern Hungary (47° 33' N, 21° 26' E, 111 m asl) on mid-heavy calcareous chernozem soil in 2011, 2012 and 2013. Six N doses were used in the field experiment (0,30,60,90,120,150 kg ha^{-1}) in non-irrigated and irrigated treatments. The examined hybrids were FAO 390, FAO 410 and FAO 450.

Averaged over the examined years, three-way ANOVA showed that fertilisation, hybrids and crop years had a significant effect ($P<0.001$) on grain protein content and irrigation had no such effect. Based on MQ values, fertilisation had the most significant effect (21.865), followed by crop year (19.275) and hybrids (6.107).

Protein content linearly increased with increasing fertiliser doses. Averaged over treatments, the fertiliser dose of 150 kg N ha^{-1} (8.3 g per 100g dry matter, $P<0.001$) provided better conditions for the development of extra proteins.

Irrigation slightly reduced protein content, although this difference is not significant.

The FAO 410 hybrid had the highest protein content (7.6 g per 100g dry matter) both in non-irrigated and irrigated treatments.

Of the examined years, the driest year of 2013 resulted in the highest protein content (7.6 g per 100g dry matter) and the closest correlation ($r=0.789^{***}$) between fertilisation and protein content.

keywords: maize, fertilization, irrigation, protein content

INTRODUCTION

Of the different macroelements, nitrogen is the most responsible for yield quantity and grain quality (Bocz 1976; Jellum et al. 1973; Sarkadi 1975; Getmanets and Klyavzo 1981; Nagy 2007). Protein content linearly increases with increasing nitrogen fertiliser doses (Szirtes 1970; Ványiné et al. 2012), but it does not increase protein quality, as the proportion of less important amino acids (e.g. zein) increases (Németh et al. 1976), possibly reaching even up to 40–50% (Menyhért 1977).

The common use of NPK fertilisers results in higher content values (Bocz 1976). The upper value of the interval increases to 12.9% (protein), 4.5% (oil) and 75.6% (starch) (Robert et al. 2001). Huang et al. (2004) obtained the highest protein content by applying 195 kg N, 60 kg P and 105 kg K ha^{-1}, while Győri (1999) reached the highest respective value by applying 100 kg N, 100 kg P and 100 kg K ha^{-1}.

The nutrient conversion ratio; therefore, the raw protein content of maize grain is strongly affected by weather. As a result of fertilisation, raw material content increases more significantly in dry years than in rainy years (Győri and Győriné 2002; Ványiné et al. 2010). Also, even reduction can be observed in years with good precipitation supply (Győri and Sipos 2005). In wet and cold growing seasons, the raw material content decreases to 8.4-10.2% in comparison with the respective range of 11.17–12.87% in warm growing seasons (Izsáki 2006).

MATERIAL AND METHODS

The examinations were carried out at the Látókép Experiment Site of the Centre for Agricultural Sciences of the University of Debrecen on mid-heavy calcareous chernozem soil (in a moderately warm and dry production zone) in a multifactorial small plot field experiment with four replications and a strip plot design between 2011-2013. The plot size was 15 m^2.

The yearly applied fertiliser treatments were 1, 2, 3, 4 and 5 times the basic nitrogen dose of 30 kg N ha^{-1}, plus a non-fertilised control treatment. The whole fertiliser quantity was applied in the autumn. The long-term field experiment had non-irrigated and irrigated treatments. The quantity of irrigation water applied in the 2011 growing season was 25 mm on 29th June, that in 2012 was 35 mm on 14th July, while the 80 mm irrigation water in 2013 was applied on two occasions (40 mm on 17th July and 40 mm on 30th July). Irrigation was performed with a Valmont linear irrigation equipment. Crop density was set to 70 thousand plants per hectare both in non-irrigated and irrigated treatments. Hybrids involved in the examination were FAO 390, FAO 410 and FAO 450. The harvested grain yield was provided at 14% moisture content.

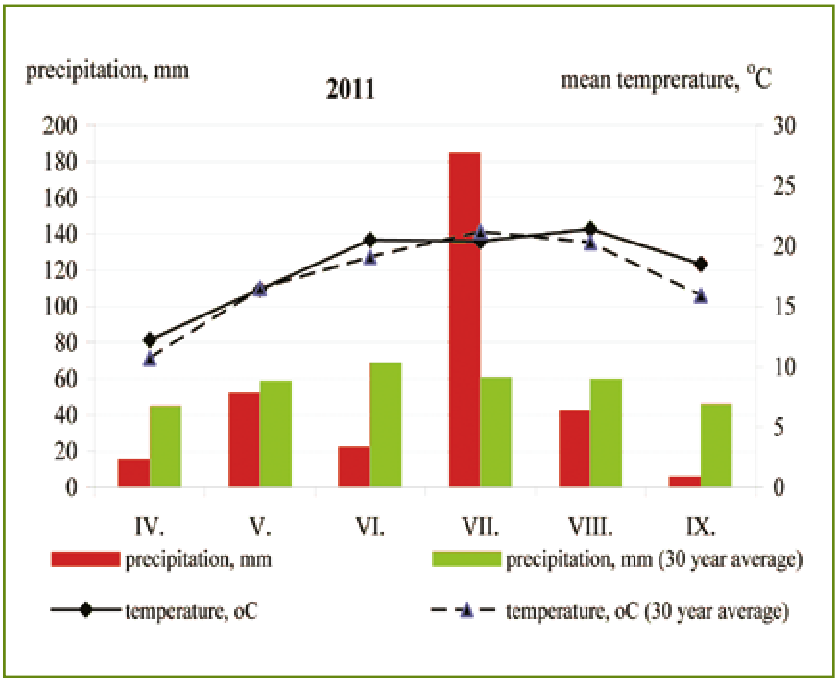


Figure 1: Precipitation and temperature during the growing season (Debrecen, 2011).

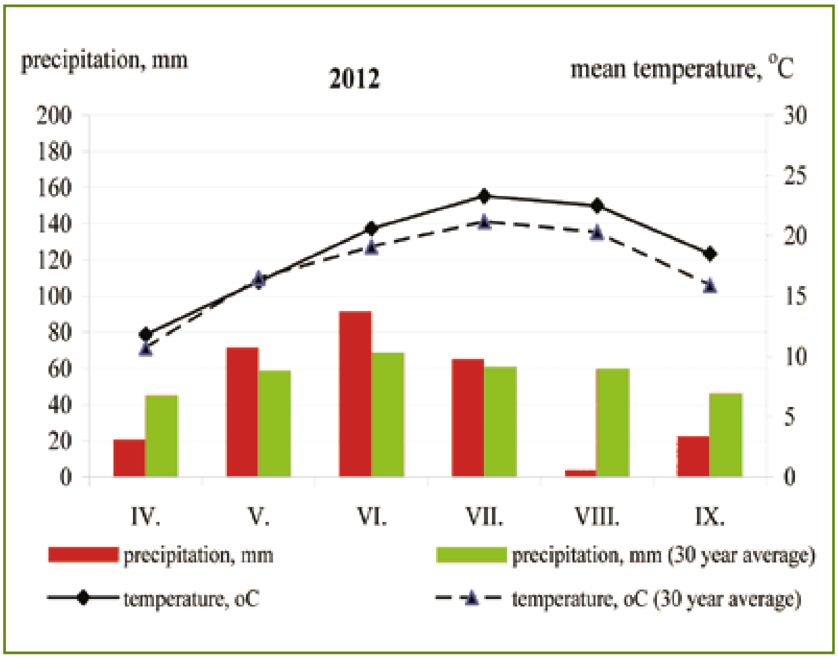


Figure 2: Precipitation and temperature during the growing season (Debrecen, 2012).

Weather was evaluated on the basis of data measured and logged by the automatic weather station set up at the experiment site.

In ***2011***, the precipitation deficit during the growing season was only 16 mm compared to the multiple-year average, but the distribution of precipitation was uneven and the mean temperature was also 0.9 °C warmer than the multiple-year average (Figure 1.).

There was severe drought in ***2012***. Also, 65 mm precipitation deficit was measured at the end of the growing season and the mean temperature was above the multiple-year average (Figure 2).

In ***2013***, the weather was dry and the temperature was high. The growing season ended with 88 mm precipitation deficit in comparison with the multiple-year average and the mean temperature was also 5.5 °C higher (Figure 3).

The protein content was determined with near-spectroscopic technique, using a Foss Infratec™ 1241 instrument which is based on a transmission measurement principle.

Statistical evaluation: A general linear model (GLM) was used to determine the effect of treatments on protein content. The significant difference of 5% ($LSD_{5\%}$) was determined in order to compare the treatment mean values and homogeneous groups were developed with multiple mean value comparison tests using Duncan's test. Yields within the homogeneous groups did not differ from each other at the significance level of 5%. Linear regression analysis was performed in order to determine the correlations between independent and dependent variables. Evaluation was performed with SPSS for Windows 14.0.

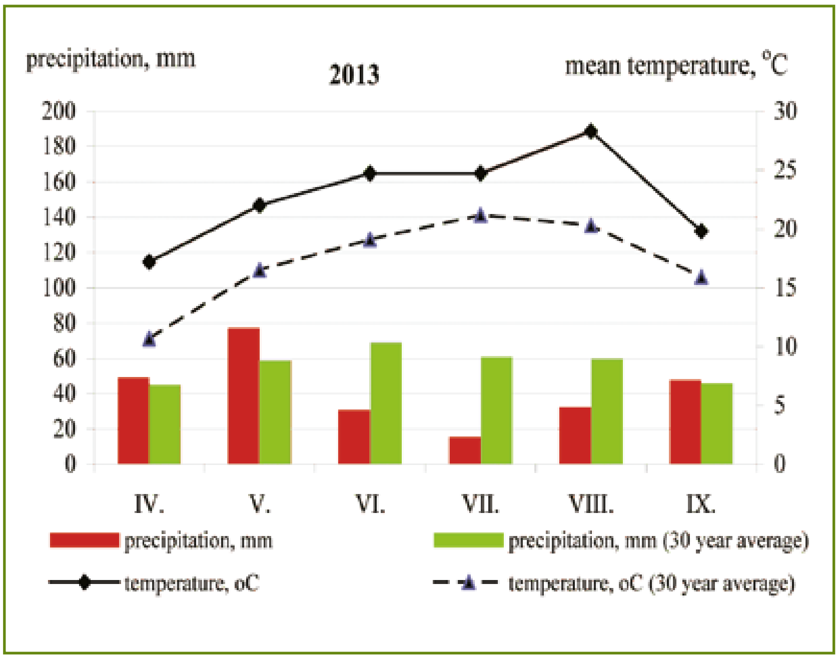


Figure 3: Precipitation and temperature during the growing season (Debrecen, 2013).

RESULTS

As a result of the applied fertiliser treatments in non-irrigated conditions, the lowest protein content was shown by the FAO 390 maize hybrid in 2011 (7.2 g per 100g dry matter). No significant difference was observed in comparison with the FAO 450 hybrid, while there was 0.8 g per 100g dry matter (P<0.001) less protein than the FAO 410 hybrid. In 2012, no statistically quantifiable difference was observed between the examined hybrids. In 2013, the FAO 450 hybrid was shown to be successful (7.9 g per 100g dry matter) as its protein surplus was 0.5 g per 100g dry matter (P<0.05) in comparison with the FAO 410 hybrid and 0.4 g per 100g dry matter (P<0.05) compared to the FAO 390 hybrid. There was no significant difference between the FAO 390 and FAO 450 hybrids (Figure 4).

In irrigated conditions in 2011, the highest protein content was observed in the FAO 410 hybrid with an average protein content of 7.9 g per 100g dry matter, which was not significantly different from that of the FAO 450 hybrid. However, there was a significant difference between the protein content of the FAO 390 and the FAO 450 hybrids (0.8 g per 100g dry matter, P<0.001), and between the FAO 390 and FAO 410 hybrids (0.7 g per 100g dry matter, P<0.001). In 2012, there was a decreasing tendency in the protein content of both hybrids in comparison with the FAO 390 (7.1 g per 100g dry matter) hybrids, but the only statistically significant reduction was observed in the case of the FAO 450 hybrid (6.7 g per 100g dry matter, P<0.05). In 2013, there was a significant difference between the examined hybrids. The highest protein content was observed in the case of the FAO 410 hybrid (8.0 g per 100g dry matter), exceeding the protein content of the FAO 390 hybrid by 0.8 g per 100g dry matter (P<0.001) and that of the FAO 450 hybrid by 0.4 g per 100g dry matter (P<0.001). The protein content of the FAO 390 hybrid was significantly lower (7.3 g per 100g dry matter) than that of the FAO 450 hybrid (7.7 g per 100g dry matter, P<0.05). Irrigation had a posive impact on the FAO 450 hybrid, as the protein content increased in two years (2011, 2013), of which the increase in 2011 was significant (P<0.05). In the case of the other two hybrids, reduction was observed, the extent of which is not mathematically significant. The application of 120 kg N ha^{-1} resulted in the highest protein content (P<0.05) – in non-irrigated conditions – in the case of all three examined hybrids in 2013, while the same was observed in the case of the FAO 390 and FAO 410 hybrids

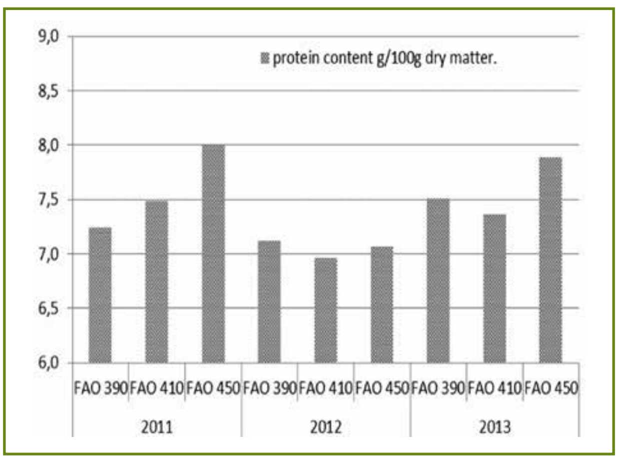


Figure 4: Protein content of hybrids in non-irrigated conditions (Debrecen, 2014).

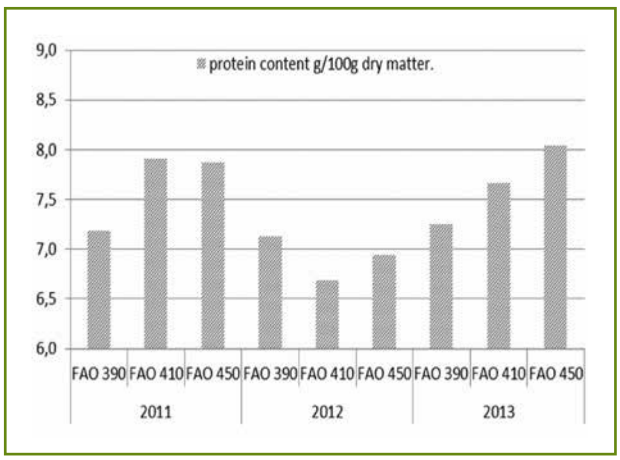


Figure 5: Protein content of hybrids in non-irrigated conditions (Debrecen, 2014).

in 2011. The FAO 450 hybrid responded to increasing fertiliser doses with increasing protein content, but this was not statistically significant. The application of 150 kg N ha^{-1} ($P<0.05$) resulted in the highest protein content for all three hybrids in 2012 (Figure 5).

Irrigation resulted in a similar tendency to that of fertilisation in terms of the protein content of maize hybrids, except for 2011. In 2013, the highest protein content of all three hybrids was observed in the case of applying 120 kg N ha^{-1} ($P<0.05$) and the same refers to the application of 150 kg N ha^{-1} ($P<0.05$) in 2012. In 2011, the protein content of the FAO 390 hybrid linearly increased with increasing fertiliser doses, but this growth is not significant. Higher protein contents were obtained with the application of 150 kg N ha^{-1} ($P<0.05$) in the case of the FAO 410 hybrid, 90 kg N ha^{-1} ($P<0.05$) in the case of the FAO 450 hybrid.

DISCUSSION

C assimilation, photosynthesis and transpiration decrease in the case of unfavourable water supply. However, protein breakdown increases (Andrade et al. 2002; Bänzinger et al. 2002); therefore, if precipitation and the easily available water stock of the soil do not satisfy crops' water need, the deficit has to be made up for with irrigation (Petrasovits 1970). Irrigation affects the protein content of maize grain in different ways. In years with favourable water supply, irrigation resulted in slight decrease of grain protein content. In more favourable crop years, the impact of irrigation is more significant, but the examined variable was affected in the opposite direction. The outcomes of the research also revealed that the most favourable interaction of each factor and the harmony of nutrient and water supply have to be provided simultaneously; therefore, the effect of irrigation can only be utilised with applying the proper amount of nutrients.

ACKNOWLEDGEMENTS

This publication was supported by the internal research project of the University of Debrecen.

REFERENCES

1. Andrade, FH. – L. Echarte – R. Rizzalli - A. Della Maggiora – M. Casanovas 2002. Kernel number prediction in maize under nitrogen or water stress. Crop Science 42: 1173–1179.
2. Bänzinger, M. – GO. Edmedaes – HR. Laifitte 2002. Physiological mechanisms contributing to the increased N stress tolerance of tropocal maize selected for drought tolerance. Field Crops Research 75: 223–233.
3. Bocz, E. 1976. Trágyázási útmutató. Mezőgazdasági Kiadó, Budapest, 257.
4. Getmanets, A. Ya. – S.P. Klyavzo 1981. Effect of fertilizers on quality of maize grain. Agrokhimiya. Ukrainian, 2: 146–153.
5. Győri, Z. – M.I. Győriné 2002. A kukorica minősége és feldolgozása. Szaktudás Kiadó Ház, Budapest, 69.
6. Győri, Z. – P. Sipos 2005. Kukoricahibridek minőségének változása agrotechnikai kísérletben. [In: Nagy J. (szerk.) Kukoricahibridek adaptációs képessége és termésbiztonsága]. DE ATC, 101–114.
7. Győri, Z. 1999. A tápanyagellátás hatása a növényi termékek minőségére. [In: Füleky Gy. (szerk.) Tápanyag–gazdálkodás.] Mezőgazda Kiadó, Budapest, 600–605.
8. Huang, S.W. – G.F. Sun – J.Y.Jin – Y.B. Zuo – P. He 2004. Effect of nitrogen, phosphorus and potassium application on grain yield and qulity of high–oil and high starch maize. Plant nutrition and Fertilizer Science. 10. 3: 225–230.
9. Izsáki, Z. 2006. A N- és P-ellátottság hatása a kukoricaszem (Zea mays L.) fehérjetartalmára és aminosav összetételére. Növénytermelés. 55. 3–4: 213–230.
10. Jellum, M. D. – F.C. Boswell – C.T. Young 1973. Nitrogen and boron effects on protein and oil of corn grain. Agronomy Journal. 65: 330–331.
11. Menyhért, Z. 1977. A kukorica minőségi nemesítése. [In: Bálin A. (szerk.) A kukorica jelene és jövője.] Mezőgazdasági Kiadó, Budapest, 66–70.
12. Nagy, J. 2007. Kukoricatermesztés. Akadémiai Kiadó, Budapest, 393.
13. Németh, J. – S. Szél – F.né Notheisz – R. Nehéz 1976. A kukorica szemtermés beltartalmának javítása szelekciós úton. Növénytermelés. 25. 4: 325–333.
14. Petrasovits, I. 1970. Vízgazdálkodás a növénytermesztésben. Növénytermelés, 19, 2: 182–192.
15. Robert, P. C. – R.H. Rust – W.E. Larson 2001. Corn oil, protein and starch variability as affected by yield, fertility and field position. Proceedings of the 5th International Conference on precision agriculture. Bloomington, Minnesota, USA. 1–16.
16. Sarkadi, J. 1975. A műtrágyaigény becslésének módszerei. Mezőgazdasági Kiadó, Budapest.
17. Szirtes, V. 1970. A nitrogén műtrágyázás hatása a kukorica tápanyagfelvételére. Növénytermelés. 19. 4: 373–384.
18. Ványiné Széles, A. – A. Megyes – J. Nagy 2010. Vetésidő és az évjárat hatása a kukorica hibridek terméshozamára és a minőségére. Növénytermelés. 59. 4: 63–88.
19. Ványiné Széles, A. – B. Tóth – J. Nagy 2012. Effect of nitrogen doses on the chlorophyll concentration, yield and protein content of different genotype maize hybrids in Hungary. African Journal of Agricultural Research. 7. 16: 2546–2552.

EFFECTS OF HOT WATER EXTRACTS OF A COMPOSTED GREEN WASTE AND SEWAGE SLUDGE ON PLANT GERMINATION IN MODEL EXPERIMENT

[1]Miklós **Gulyás** – [2]András **Béres** – [1]László **Tolner** – [2]László **Aleksza** – [1]Imre **Czinkota**

[1]Szent István University, Institute of Environmental Sciences, Department of Soil Science and Agricultural Chemistry, 2103 Gödöllő, Hungary
[2]Szent István University, Institute of Environmental Sciences, Department of Water- and Waste Management, 2103 Gödöllő, Hungary
Corresponding author: Miklós Gulyás, email: gulyas.miklos@mkk.szie.hu; tel.: +36 28522000

ABSTRACT

Application of aqueous extract of different compost materials (called as "compost tea") in horticulture is a well known topic but the agricultural use of these products is a much less investigated subject. Compost tea application improves plant health, crop yield and quality. The primary mechanism of this response is not clearly understood. It is believed that soluble mineral nutrients, organic acids and water-soluble plant-growth regulators extracted in the tea have positive effects on initial root development and plant growth. Living microorganisms present in compost tea may also induce disease resistance as well as stimulate nutrient uptake and plant growth.

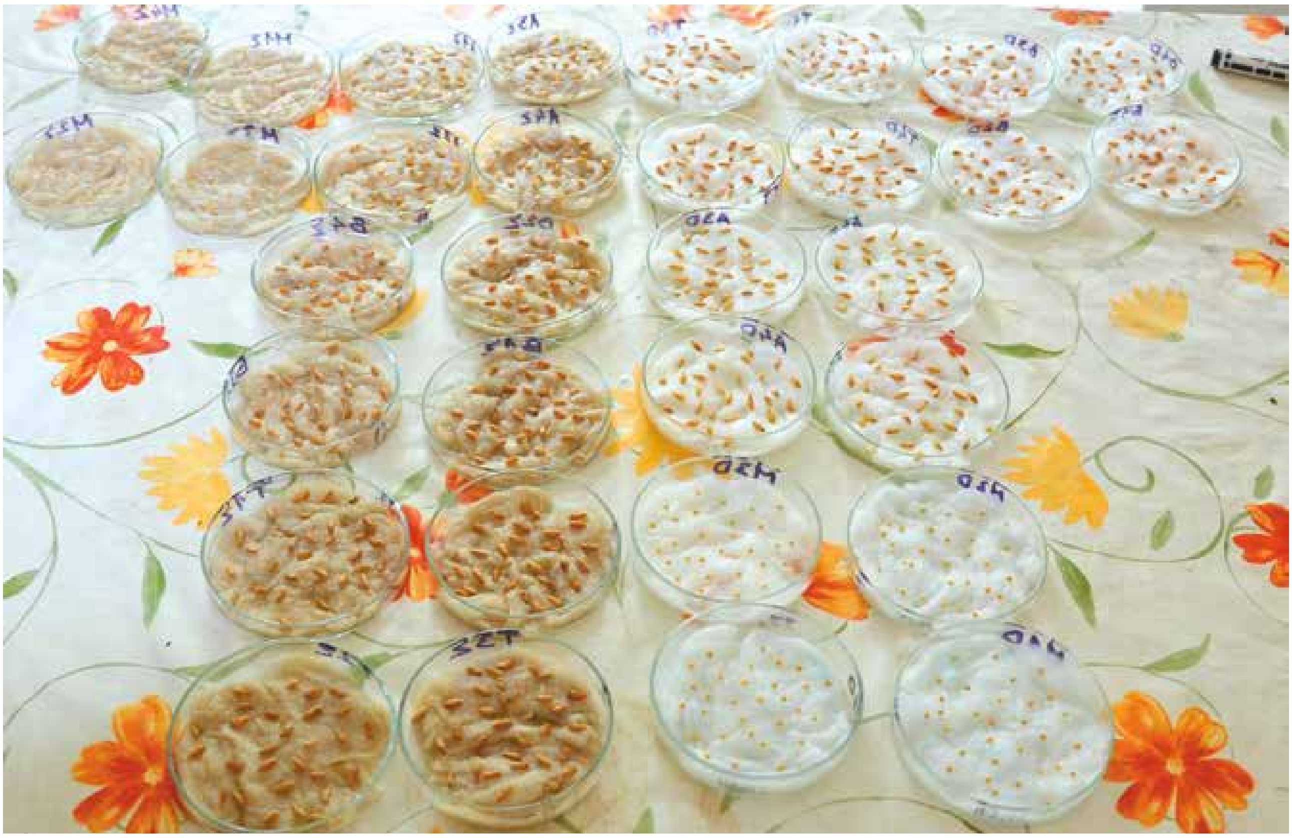


Figure 1: Prepared seeds on the day zero

This prestudy investigated the effect of hot water extracts on germination and growing rate in laboratory model experiment. White mustard (*Sinapis alba*), spring barley (*Hordeum vulgare L.)*, winter wheat (*Triticum aestivum L.*) and triticale (*Triticosecale*) was used as test plant in 4 replications. Optical method was used to investigate the germination and growing rate of the test plants during the test period (Figure 1). This method is based on pixel analysis. Pictures were taken from 8 different angles from the rotated plants (Figure 2). Pixel analysis showed that the plants had different answers to the hot water extracts. Our results show that the extracts have positive effect on seed germination and growing rate.

Figure 2: Theoretically operation of optical observer

keywords: compost extract, compost tea, optical analysis, laboratory model experiment

INTRODUCTION

Compost is the product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth. Compost is an organic matter resource that has the unique ability to improve the chemical, physical, and biological characteristics of soil or growing media (Debosz et al. 2002). It contains plant nutrients but is typically not a fertilizer. Several publications noticed that composting practice was already known in the Roman times too. Modern composting and the scientific researches started in the early XX's (Reeve et al. 2010). The first compost extract users were the organic farmers who aimed to reduce the chemicals on farms some decades later.

The primary reason for producing "compost tea" from different compost materials is to transfer microbial biomass, fine particulate organic matter, and soluble chemical components of compost into an aqueous phase that can be applied to plant surfaces and soils in ways not possible or economically feasible with solid compost. In our present days we know many things about these extracts but the mode of action is not clearly understood. Compost extracts or "teas" are not fertilizers but can increase the soil fertility. It is not a fungicide, insecticide or herbicide but can prevent, reduce or solve the plant protection problems (On et al. 2015).

MATERIAL AND METHODS

The laboratory model experiment was conducted on July 16 to July 17 in 2014. White mustard (*Sinapis alba*) (M), spring barley (*Hordeum vulgare L.)* (A), winter wheat (*Triticum aestivum L.*) (B) and triticale (*Triticosecale*) (T) was used as test plant. 30 seeds were transferred to petri dishes containing 2 g cotton-wool and wetted with the compost extracts or distilled water. Completely randomized design was used with three treatments, distilled water control (D), green waste compost extract (Z), and sewage sludge compost extract (S). All treatments with all plants were replicated four times. The moisture content of petri dishes during the test was monitored with daily weighing and was watered (distilled water or compost extracts) to weight accordingly.

Table 1: Metal content of non diluted compost extracts

Parameters	Green waste compost extract (mg l^{-1})	Sewage sludge compost extract (mg l^{-1})
Al (394,401 nm)	32,63 ± 0,01	7,91 ± 0,06
Ca (315,887 nm)	101,5 ± 0,9	291,7 ± 0,4
Cd (214,441 nm)	Below limit of detection	Below limit of detection
Cr (205,571 nm)	0,07 ± 0,00	0,035 ± 0,004
Cu (324,754 nm)	0,28 ± 0,00	0,270 ± 0,000
Fe (259,940 nm)	21,53 ± 0,01	9,26 ± 0,03
Mg (285,213 nm)	29,82 ± 0,22	99,77 ± 1,25
Mn (257,610 nm)	0,95 ± 0,01	0,438 ± 0,004
Ni (222,296 nm)	0,08 ± 0,00	0,101 ± 0,004
Pb (220,353 nm)	0,03 ± 0,00	Below limit of detection
Zn (213,857 nm)	0,48 ± 0,01	0,65 ± 0,01

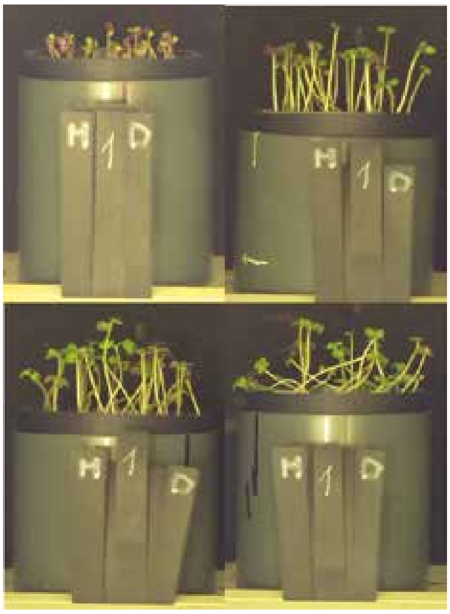


Figure 3: White mustard growing intensity during the test period

Compost extracts were made from the compost samples using 200 g dry weight equivalent compost in 1000 cm^3 distilled water. Samples were boiled for 30 min, rested for 2 h., and strained through a 0.45 μm sieve. Initial extracts were diluted with distilled water to 1:10. The non diluted extracts metal content were measured by HORIBA JOBIN YVON ACTIVA-M ICP-OES.

Optical method was used to investigate the germination and growing rate of the test plants during the test period. This method is based on pixel analysis. Pictures were taken from 8 different angles from the rotated plants. On the plant images the image processing program counts the green pixels representing the color of leaves. In this way we could convert the plant growing status to numerical data (Tolner et al. 2010). Differences by treatments and plants were analyzed statistically using by Microcal Origin 6.0.The following equation was used which is a composition of a classic Mitscherlich growing function, and a continuous linear decreasing caused by ageing and drying and other effects.

$$y=A*(1-exp(-(t)*b))+c*t$$

Where: y is the actual size (in pixels), t is the time (in days) a A is a maximal growing (in pixels), b is a growing constant (in 1 $days^{-1}$), c is a decreasing constant (in pixels $days^{-1}$)

RESULTS AND DISCUSSION

Metal content of aqueous extracts are very low. These values far below the compost limit, that mean the metal content of composts are not water soluble. Relatively high calcium and magnesium content of sewage sludge compost extract come from the added additives.

Distilled water (D) application did not cause any effect on test plants (*Figure 4*-a.). Growing intensity of test plants originated from the store of seeds (*Figure 3*.).

The decreasing tendency of pixels might indicate nutrient deficiency or the opportunity to finish the test. Green waste extract significantly increased the number of pixels in each plant. In case of triticale and white mustard the positive effect of compost extract is clearly visible. The treatment has an effect on growth of spring barley also (*Figure 4*-b.). Sewage sludge compost extract has an effect on test plant also but this increasing was not so outstanding compared to green waste compost extract (*Figure 4*-c.).

CONCLUSIONS

It has been found that this method is suitable to carry out and evaluate short plant tests. Extracts have very low metal content and it could not cause any depression, harmful or toxic accumulation in plants. Compost extracts have effect on test plants despite boiling (Table 1). Green waste compost extract has outstanding effect on plant grow. Although sewage sludge compost extract increased the number of pixels, this effect was less than in case

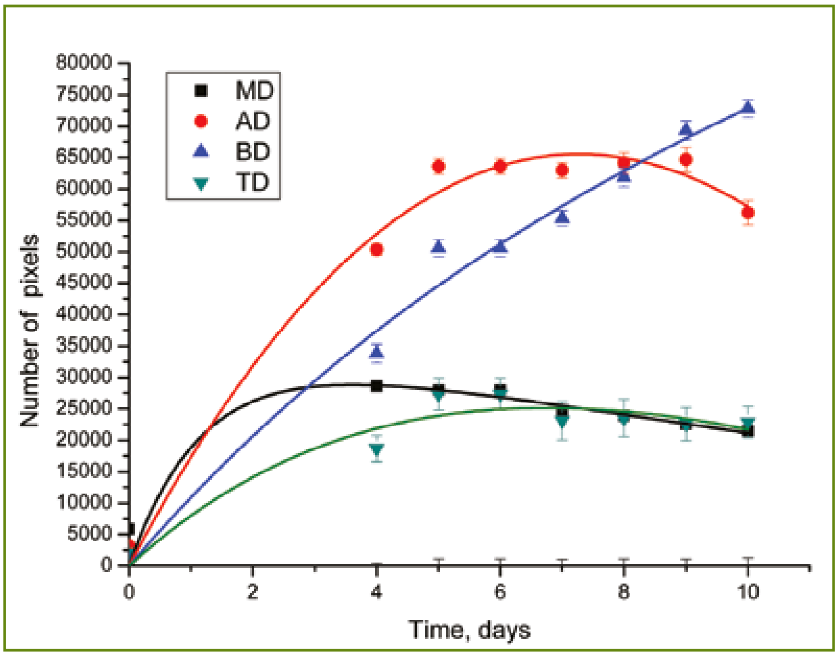


Figure 4-a: Effect of different compost extracts on plants biomass (white mustard (M), spring barley (A), winter wheat (B), triticale (T), distilled water control (D), green waste compost extract (Z), sewage sludge compost extract (S))

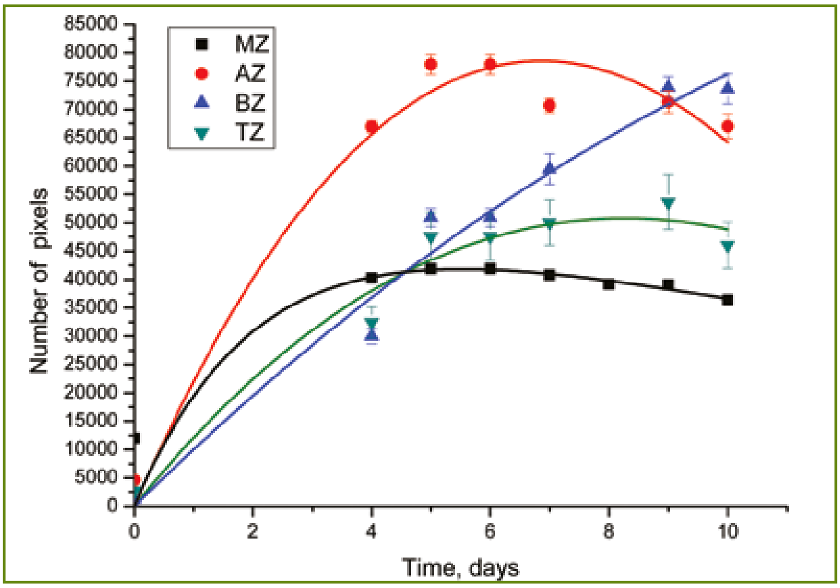


Figure 4-b: Effect of different compost extracts on plants biomass (white mustard (M), spring barley (A), winter wheat (B), triticale (T), distilled water control (D), green waste compost extract (Z), sewage sludge compost extract (S))

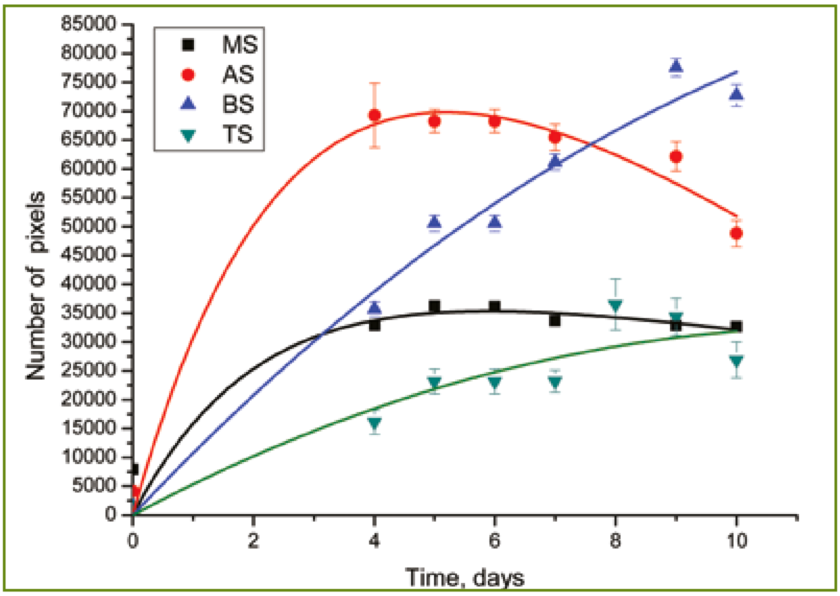


Figure 4-c: Effect of different compost extracts on plants biomass (white mustard (M), spring barley (A), winter wheat (B), triticale (T), distilled water control (D), green waste compost extract (Z), sewage sludge compost extract (S))

of the green waste extract application. Winter wheat did not show any responses. Extracts work as a plant conditioner but nutrient supplement needed. These results create good basis to the further experiments in the near future.

ACKNOWLEDGEMENTS

This work was supported by the KTIA_AIK_12-1-2013-0015 program of the Hungarian National Development Agency. Special thank to the many people who have made this experiment possible.

REFERENCES

1. Tolner, L. – I. Czinkota – G. Sándor – K. Tolner 2010. Testing the effect of redirected glycerol by-products on the nutrition providing ability of the soil. In: Gilkes RJ, Prakongkep N, editors. Proceedings of the 19th World Congress of Soil Science; Soil Solutions for a Changing World; ISBN 978-0-646-53783-2; Published on DVD; http://www.iuss.org; Symposium 3.3.1; Integrated nutrient management; 2010 Aug 1-6. Brisbane, Australia: IUSS; 2010, pp.298-301.
2. Kasia, D. - S. O. Petersen - L. K. Kure - P. Ambus 2002. Evaluating effects of sewage sludge and household compost on soil physical, chemical and microbiological properties, Applied Soil Ecology, Volume 19, Issue 3, March 2002, Pages 237-248
3. Reeve, J. R. – L. Carpenter-Boggs - J. P. Reganold – A. L. York - W. F. Brinton 2010. Influence of biodynamic preparations on compost development and resultant compost extracts on wheat seedling growth, Bioresource Technology, Volume 101, Issue 14, July 2010, 5658-5666
4. On, A. – F. Wong – Q. Ko - R. J. Tweddell - H. Antoun - T. J. Avis 2015. Antifungal effects of compost tea microorganisms on tomato pathogens, Biological Control, Volume 80, January 2015, 63-69

THE QUALITY AND QUANTITY OF WINTER WHEAT IN SMALL PLOT EXPERIMENTS

ÁKOS **TARNAWA**[1] – ZSOLT **SZENTPÉTERY**[2] – ANDRÁS **MÁTÉ**[1] – ADRIENNE **CSÚRNÉ VARGA**[1] – FERENC **NYÁRAI-HORVÁTH**[1] – MÁRTON **JOLÁNKAI**[1]

[1]Szent István University , Faculty of Agricultural and Environmental Sciences, Institute of Crop Production, 2103 Gödöllő, Hungary

[2]Szent István University, Faculty of Mechanical Engineering, 2103 Gödöllő, Hungary

Corresponding author: Ákos Tarnawa, email: tarnawa.akos@mkk.szie.hu; tel.: +36 28522000 (1676)

ABSTRACT

In our changing world, crop production gained a notable importance, and winter wheat is still one of the most relevant cereals in the world, just as in Hungary. The reason of it could be some important features, like high level of ecological adaptability, and the high value of flour that could be made of it containing carbohydrate and protein in proper ratio for human consumption.

The quality is primarily determined by protein content. The amount and quality (gluten ratio) of wheat proteins are driven by nitrogen metabolism. The source of nitrogen in case of wheat is the soil, where the form and level can be controlled by agrotechnics. The main method of that control is manuring. The uptake of plants for protein synthesis is driven by physiological and environmental factors, as well.

Our experiment was set up in Hatvan-Nagygombos, with the use of several winter wheat variety. Different nitrogen doses were used in varied methods of broadcasting during topdressing. The quality was evaluated by Instalab 600 NIR analyser, at the laboratory of the Szent István University.

According to the amount of nitrogen given, and the method of broadcasting at topdressing, significant differences were found both in quantity and quality.

keywords: winter wheat, cropyear, protein content

INTRODUCTION

Crop production is one of the oldest human activities with a continuous history for about 10.000 years, nowadays it has an emphasized importance due to the rising level of human population that cased problems in food supply in certain regions. Agricultural production has long been a major issue in Hungary because almost 50% of the country's land is arable. Just as in the entire world, also in Hungary, cereals represent a most plausible source of human alimentation, hence, for centuries, winter wheat was the most commonly cultivated crop. It still keeps the first or second place as crop with largest area, depending on cropyear. There exist numerous factors that having effect on yield (Tarnawa and Klupács 2006) and among them there are some that could be influenced by the farmer and also some that could not be. The first group is the set of elements of agronomic management and the second group is the set of factors of environment (Várallyay et al. 1985). In the set of environmental factors there are some with more or less effect on yield (Klupács et al. 2010). Even because cropping practice is not an indoor activity but mostly outdoor, the weather and climate has high impact on it as environment (Láng et al. 2007), and according to former observations, weather plays a significant role (Szöllősi et al. 2004.).

Our world is heterogeneous from most point of view and different problems occur in different regions. Wheat gives example for most of them, therefore the aim of wheat production is twofold: to provide quantity and quality. Known that, in wheat production the yield quantity and quality are determined by ecological and agro-technical factors. Precipitation is the most important environmental factor during the life of this crop. Among agro-technical parameters nutrient management is one of the most important factor for all grain crops, including wheat, and the management of nitrogen has the highest importance. Milling and baking quality of wheat is mainly determined by the genetic background, however it can be influenced by management techniques (Jolánkai et al. 2010). Accordingly adaptability to the variable ecological, mainly weather conditions is a measure of value characteristics of the individual species (Balogh and Pepó 2008).

Regarding the technology it can be stated, that even the uptake and usage of nitrogen by crops are biochemical processes, they are affected by temperature and the water balance, so these factors have an interaction with N management. Both of them are characterized by the climate, so it plays a significant role in nitrogen process, mostly the efficiency of N fertilizer given. As the yields still showing lower or higher fluctuation from the long term averages or trends, it should be more than useful to explore how it depends on each element of climate (Pepó 2010).

This study focuses on the nutrient management in association with the cropyear in the winter wheat production. If we use less fertilizers it might cause less problems but as the use of them is necessary we should use adequately. In this paper we studied the connection between main climatic factors (precipitation) and the most important agronomical factor (N supply) and the level of wheat yield.

MATERIAL AND METHODS

In favour of solving that set of problems, in long term field trials a wide range of high quality winter wheat varieties were examined under identical agronomic and monitored climatic conditions. The small plot trials were run at the Nagygombos experimental field of the SZIU Crop Production Institute. Soil type of the experimental field is chernozem (calciustoll). Experiments were conducted in split-plot design with four replications. The size of each plot was 10 m^2. Various agronomic treatments were applied to plots. Precipitation records have been evaluated in relations with yield quantity and quality. Yield, hl-weight, protein content, farinographic value, wet gluten content and Hagberg falling number were correlated with precipitation and temperature.

From the year 2012 a new factor was integrated to that long term experiment. From the varieties we have chosen the Magdaléna variety, because this type was examinated for a longer time. Regarding for topdressing some new combinations were used with smaller distance between each step. Total amount of N runs from 0 to 160 kg ha^{-1} by 20 kg of steps, with two time of topdressing. In second time 0, 20 or 40 kg ha^{-1} were used.

Data were collected in 2012 and 2013. The cropyear 2012 was interesting, because the extremely wet 2010 was followed by two years of extreme drought. 2013 was a typical year with no extremities for winter wheat. Quality parameters were measured in the laboratory of SZIU Crop Production Institute with an Instalab 600 NIR analyser. Statistical analysis was performed by using the MS Excel program packages.

In this paper the data of the year 2013 presented, and compared with the same data of the year 2012 already published (Tarnawa 2013). Even this experimental design was originally used for an experiment dealing with photosynthetic activity, but the results of yield and quality data can be analysed simultaneously as well. From this point of view side-data are evaluated.

RESULTS AND DISCUSSION

For the better view results were illustrated on figures. On figure 1 and 2 yield result are sorted by the amount of second N topdressing, respectively 0, 20 and 40 kg ha^{-1}. Polynomial trendlines were taken and the strength of fitting can be seen (R^2) for each.

On figure 3 and 4 parallel data can be seen, the result of protein content measurements sorted by the amount of second N topdressing as well. Polynomial trendlines were taken again and the strength of fitting can be seen (R^2) for each.

CONCLUSIONS

Among conclusions the most important is that with agrotechnics even the quality and the quantity of yield can be increased in spite of weather extremities.

It can be seen on all figures, that R^2 values are rather low in 2012 and in some cases (yield, the set of +20) cannot be even explained. These correlations are much stronger in 2013. The reason of it is clear, that there was such a strong drought in 2012 that oppressed the impact of N fertilization. As 2013 was a normal cropyear, the goal of

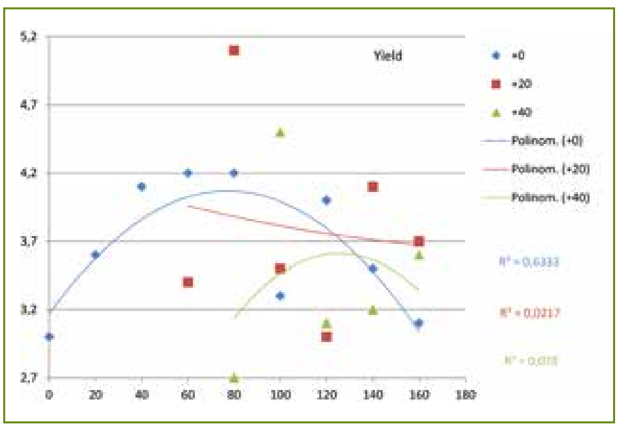


Figure 1: Yield formation by the set of treatments (Nagygombos, 2012).

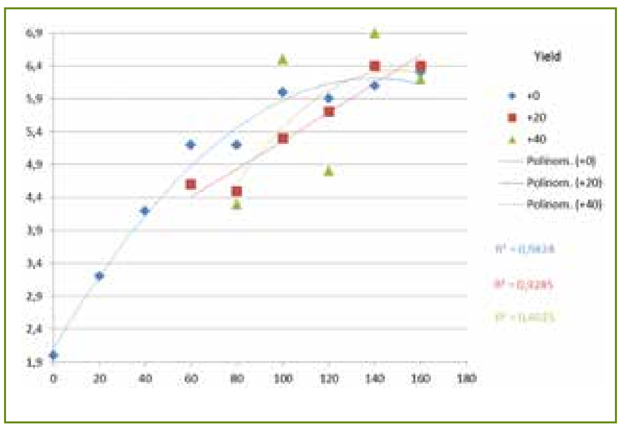


Figure 2: Yield formation by the set of treatments (Nagygombos, 2013).

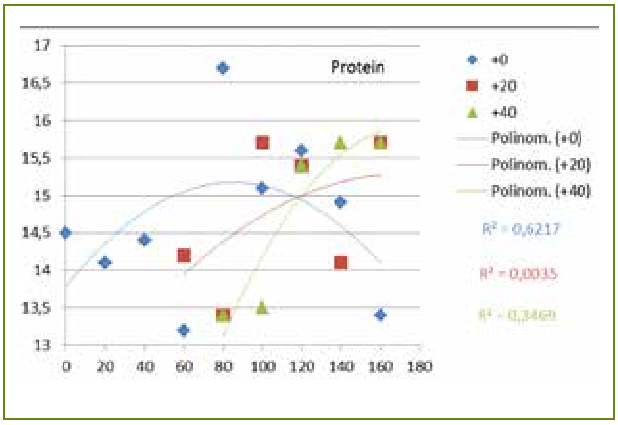


Figure 3: Protein content by the set of treatments (Nagygombos, 2012).

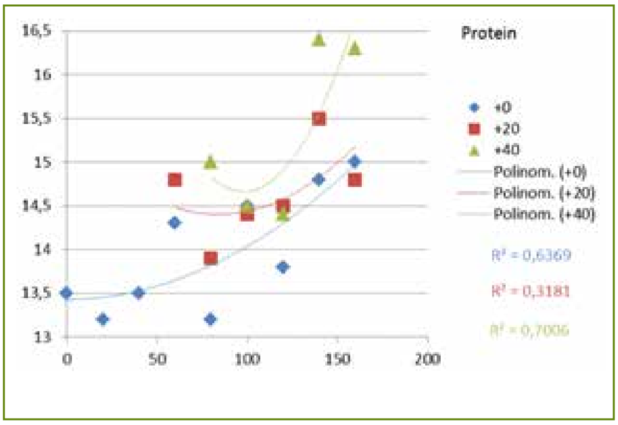


Figure 4: Protein content by the set of treatments (Nagygombos, 2013).

N topdressing was completed. N is taken up in a water soluble form, but if there is a too high concentration of that in groundwater, crops are unable to use it, just as in 2012.

Also, it can be seen that splitting the amount of N into two applications, higher impact on protein content could be observed than that of yield figures. That should be the effect of timing, as yield components correlated with quantity formed earlier than those of quality. Connections are more visible on figure 2 and 4 than on figure 1 and 3; that is the result of the pattern in precipitation. In the case of the 2013 cropyear the fitting of trendlines are very strong for some of the treatments. That points significantly that the main role played by weather and agrotechnics can just buffer extremities.

As polynomial trendlines were used, a maximum value can be estimated, and if it exists, with splitting the amount it is always at higher values even for the same total amount.

In the case of yield production, the maximal level were reached in 2012 for all combinations from 80 to 140 kg ha^{-1} N doses but much higher in 2013, even the maximum level was also higher as well.

For the protein content, the N topdressing has a very impressive effect. In 2013 it seems to exceed the theoretical biological potential of the wheat varieties.

In general, it can be concluded, that the splitting of the total N amount has beneficial effect on both the quantity and the quality of the winter wheat, and as the pattern of precipitation cannot be predicted, 140-160 kg ha^{-1} of total amount is good to be used.

ACKNOWLEDGEMENTS

This project was carried out in the Institute of Crop Production at Szent István University, supported by TÁMOP-4.1.1.C-12/1/KONV-2012-0018; KTIA_AIK_12-1-2012-0015 and VKSZ_12-1-2013-0034 - Agrárklíma.2 projects.

REFERENCES

1. Balogh, Á. – P. Pepó 2008. Crop year effects on the fertilizer responses of winter wheat genotypes. Cereal Res. Comm. 36: 731-734.

2. Jolánkai, M. – F.H. Nyárai – K. Kassai 2010. Impact of long term trials on crop production research and education. Acta Agronomica Hungarica. 58. Suppl. 1-5 pp.

3. Klupács, H. – Á. Tarnawa – I. Balla – M. Jolánkai 2010. Impact of water availability on winter wheat (*Triticum aestivum* L.) yield characteristics. Agrokémia és Talajtan. 59. 1. 151-156.

4. Láng, I. – L. Csete – M. Jolánkai 2007. A globális klímaváltozás: hazai hatások és válaszok. A VAHAVA Jelentés. Szaktudás Kiadó Ház, Budapest.

5. Pepó, P. 2010. Adaptive capacity of wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.) crop models to ecological conditions. Növénytermelés. 59. Suppl. 325-328.

6. Szöllősi, G. – A. Ujj – Zs. Szentpétery – M. Jolánkai 2004. A szántóföldi növénytermesztés néhány agroökológiai aspektusa. AGRO-21 Füzetek. 37. 77-88 pp.

7. Tarnawa, Á. – H. Klupács 2006. Element and energy transport model for an agricultural site. Cereal Research Communications. 34. 1. 85-89 pp.

8. Tarnawa, Á. –Zs. Szentpétery – Á. Fekete – H. Ördögh – A. Máté 2013. Effect of rate and method of nitrogen topdressing on the quality and quantity of winter wheat (*Triticum aestivum* L.) in an extremely dry cropyear. Növénytermelés, vol 62 Suppl. 183-186 pp.

9. Várallyay, Gy. – L. Szűcs – P. Zilahy – K. Rajkai – A. Murányi 1985. Soil factors determining the agroecological potential of Hungary. Agrokémia és Talajtan. 34. Suppl. 90-94 pp.

ENVIRONMENTAL EFFECTS OF ORGANIC AND MINERAL FERTILISER USE – A COMPARATIVE STUDY

ANNA **NÉMETH**[1] – NORBERT **KOHLHEB**[2]

[1] Szent István University, Faculty of Agricultural and Environmental Sciences, Institute of Environmental Science, 2100 Gödöllő, Hungary

[2] Szent István University, Faculty of Agricultural and Environmental Sciences, Institute of Nature Conservation and Landscape Management, 2100 Gödöllő, Hungary

Corresponding author: Norbert Kohlheb, email: kohlheb.norbert@mkk.szie.hu; tel.: +36 28522 000(2266)

ABSTRACT

Agriculture has a significant contribution to climate change, where fertilisers play a decisive role. The aim of our comparative study was to assess the environmental effects of organic and mineral fertilisers using the LCA methodology. The life cycle inventory was set up using equivalent amounts of organic and mineral fertilisers providing the same nutrition effect. Our results show that the values for manure are much more favourable in all impact categories than the values of mineral fertilisers. Although farmyard manure provides several environmental advantages like less environmental emission and resource depletion, enrichment of soil organic content and of ecosystem, during storage and application a great amount of serious emission can occur like nitrous oxide and methane. These can be mitigated by smart techniques and appropriate timing, meanwhile the beneficial environmental effects of the organic fertilisers can be enhanced.

keywords: agriculture, environmental impact assessment, mineral fertilizer, organic fertilizer, manure, greenhouse gas emissions, eutrophication, acidification

INTRODUCTION

Agriculture has a significant contribution to climate change: about one-third of the emitted greenhouse gases (GHG) originate from agricultural systems (FAO 2011), including carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) (Tilman et al. 2002). Agriculture is responsible for approx. 60% of global anthropogenic N_2O emissions too (Aguilera et al. 2013), which emanates in a huge share from mineral fertiliser production. Additionally, industrialized agriculture substitutes natural resources for artificial inputs, like mineral fertilizers while burdening the surrounding ecosystems (Tilman et al. 2002).

Fertilizers supply the necessary nutrients for plants, especially nitrogen (N), phosphorus (P) and potassium (K) are needed together with macro and microelements (Ca, Mg, S, Fe, B, Mn, Zn, Mo, Cu) (Füleky-Sárdi 2014). The lack of nutrient use can cause vegetative and regenerative problems or even serious damages for the plants. Also, overdosing results in nutrient imbalance or toxicity. However, mineral fertilizers are mainly produced by fossil resources to provide the macro nutrients and other micronutrients. Meanwhile, organic fertilisers are by-products of plant production and animal husbandry or originate from treated organic wastes.

Industrialized agriculture is highly dependent on non-renewable resources to produce food for the increasing population. The fertilizer industry extracts phosphorus from phosphate rocks which are expected to deplete within the next 50-100 years. Today around 148 million tonnes of phosphate rock are mined each year only in a few countries. The nutrient demand will grow in the future as the global food production is estimated to increase by around 70% by 2050 (Bateman et al. 2011; Cordell et al. 2009). Nitrogen fertilizer production requires 40-45 GJ energy to produce a ton of ammonia (Ahlgren et al. 2008), which is manufactured mainly from fossil resources also.

The negative impacts have different local and global effects not only on the environment but also on the human-made habitats and human health. These negative impacts are due not just to their resource intensive character but also to the very poor efficiency of utilization of mineral fertilizers: only 30-50% of applied nitrogen fertilizers and approximately 45% of phosphorus fertilizers is taken up by plants (Tilman et al 2002).

Compared to mineral fertilisers organic fertilizer use has several environmental friendly benefits like mitigation of GHG emissions (Liu et al. 2015), soil quality improvement, soil workability, moisture content, weed, pest and decease suppression, and soil erosion prevention (Martínez-Blanco et al. 2013). Nonetheless, not adequately managed organic fertilisers also have numerous drawbacks like weeding effect, ammonia, methane and nitrous oxide emissions (Yamulki 2006).

And what is more, not appropriate agricultural production and mineral fertilizer use decreases soil carbon content, meanwhile intensive cultivation and heavy machinery contributes to soil erosion and compaction on the contrary organic fertilizers can increase the soil organic content and reduce soil erosion. Approximately 45% of the soils in Europe have lower soil organic matter (SOM) content then required. Thus, an alternative nutrient management can contribute to the mitigation of these environmental burdens to avoid nutrients losses and emissions. (Schröder 2005; Tilman et al. 2002).

The aim of our comparative study is to assess the environmental effects of organic and mineral fertilisers. In the first part of our paper we introduce the methodology and the input data. Afterwards the results are presented and compared to the literature and possible further environmental mitigation measures are shown.

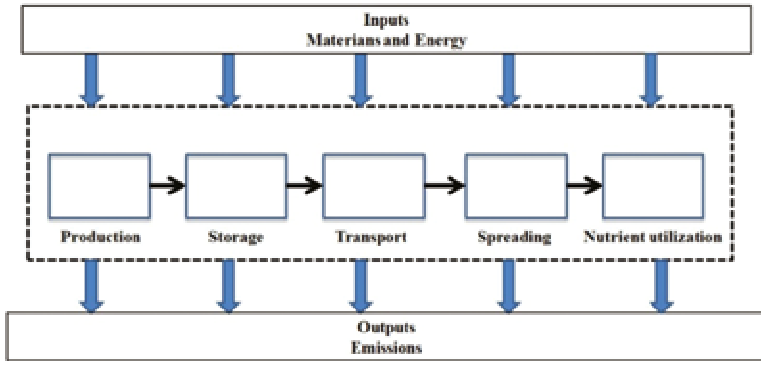


Figure 1: System boundaries of mineral fertiliser LCA

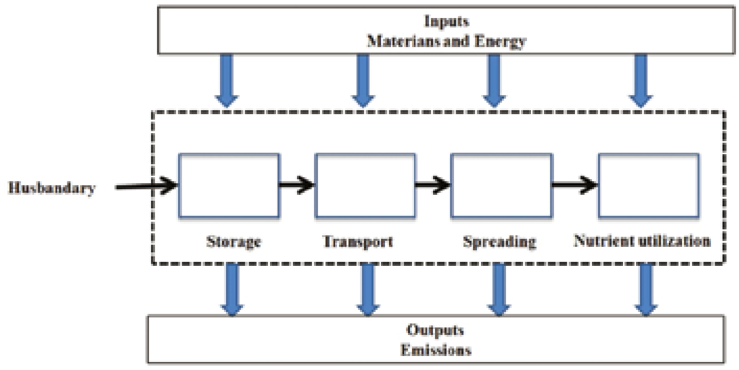


Figure 2: System boundaries of manure LCA

MATERIAL AND METHODS

Since life cycle assessment (LCA) has been widely used for assessing environmental effects of agricultural processes (Gaillard-Nemecek 2009; Sleeswijk et al. 1996), in our study this method was chosen. The environmental effect of different fertilizers producing the same amount of agricultural good, i.e. 5 t wheat on 1 ha arable land, was calculated. This is the functional unit to which all the relevant environmental effects are referred. The method is thoroughly described in the EN ISO 14044:2006 standard (ISO 2006).

The system boundaries of the mineral and organic fertilising processes are different due to their diverse character in producing environmental effects. In case of mineral fertilisers the whole up-stream input and output flows are considered, which means a cradle-to-gate type of life cycle (see Figure 1). In case of organic fertilisers (cattle manure) a gate-to-gate life cycle is applied that considers environmental effects emerging only in the storage and application part of manure life cycle (see Figure 2). This is because manure is a by-product of animal husbandry and its environmental burdens are usually accounted for the functional units of animal products like milk or meat.

First, the life cycle inventory (LCI) was established with all relevant inputs and outputs crossing the system boundary. This determines the life cycle impact assessment (LCIA) that transforms in the previously defined elementary flows into environmental impact categories summarising environmental impacts. The necessary amounts of basic nutrients under the given soil conditions for producing 5 t wheat are summarised in Table 1.

Table 1: Necessary amount of nutrients to produce 5 t wheat per hectare

1. Nutrition	2. Necessary amount [kg/ha]
3. N	*4.* 125
5. P	*6.* 50
7. K	*8.* 65

Source: based on Füleky-Sárdi 2014

The life cycle inventory was set up using equivalent amounts of organic and mineral fertilisers providing the same nutrition effect (Füleky-Sárdi 2014). In Table 2 the necessary amount of fertiliser with the relevant emission values are summarized.

LCA was compiled by using GaBi 6 (PE International AG), with Ecoinvent 3.0 database (Swiss Centre for Life Cycle Inventories, 2014) where the following processes were used for mineral fertilizers:

Table 2: Material flows of the fertilising process

Material flows	CAN*	Single superphosphate P_2O_5	K_2O	Manure – cattle
Amount needed for providing the same fertilising effect for winter wheat on Cambisol or Luvisol	754.72	369.05	169	27,083.29
CH_4, g/m³	Emissions defined by Ecoinvent 3.1. database			4046,9
NH_3, g/m³				226,7
N_2O, g/m³				23,9
CH_4, kg/t				4,37
NH_3, kg/t				0,25
N_2O, kg/t				0,03
CH_4, kg/ha				118.36
NH_3, kg/ha				6.63
N_2O, kg/ha				0,70

CAN - calcium ammonium nitrate

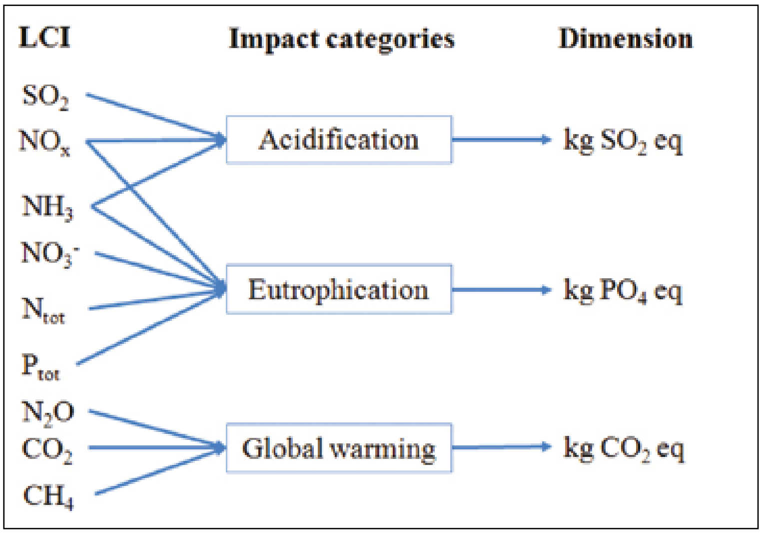


Figure 3: The most important LCI flows and their aggregation impact categories
Source: Skowrońska-Filipek 2014

- single superphosphate, as P_2O_5, at regional storehouse
- potassium sulphate, as K_2O, at regional storehouse
- CAN, as N, at regional storehouse
- transport, van <3.5t
- three application periods: autumn for P and K), early spring for N, and early summer for N
- fertilising by broadcaster.

To access the solid organic cattle manure in LCA the following input data were used:

- Cattle manure input data
- Transport, tractor and trailer
- Solid manure loading and spreading, by hydraulic loader and spreader
- Tillage, hoeing and earthing-up

RESULTS

We assumed that the organic fertilizer will have better environmental performance as it is the by-product of livestock production and uses up less natural resources compared to the manufactured industrial fertilizers. The hypothesis has been proven: the calculations show favourable values for manure in all impact categories (Table 3).

In case of GHG potential mineral fertilizers and solid cattle manure resulted 8,048.39 kg CO_2 eq./ha and 3,279.30 kg CO_2 eq./ha emissions, respectively. Calcium ammonium nitrate production (6,531.33 CO_2 eq./ha) was

Table 3: Environmental impacts of mineral fertilizers and solid cattle manure

Impact categories	Mineral fertilizers 42. (single superphosphate, potassium sulphate, calcium ammonium nitrate)	Solid cattle manure	Unit
GHG potential	8,048.39	3,279.30	kg CO_2 eq./ha
Acidification potential	43.89	11.30	kg SO_2 eq./ha
Eutrophication potential	15.79	2.74	kg PO_4 eq./ha
Abiotic depletion potential	0.03	0.0004	kg Sb eq./ha

responsible for more than two-third of the emissions, this was followed by single superphosphate production (964.88 CO_2 eq./ha) in case of mineral fertilizers. Methane is the main contributor to the GHG emissions from cattle manure.

The acidification potential for mineral fertilizers and solid cattle manure is 43.89 kg SO_2 eq./ha and 11.30 kg SO_2 eq./ha, respectively. Organic fertilization contributes approximately four times less to acidification than mineral fertilizers, where calcium ammonium nitrate and single superphosphate production are the main contributors to these impacts.

The eutrophication potential for mineral fertilizers and solid cattle manure is 15.79 kg PO_4 eq./ha and 2.74 kg PO_4 eq./ha, respectively. Calcium ammonium nitrate and single superphosphate production are the most important sources. Ammonia, nitrogen oxides and nitrous oxides are the main emissions to air but some components are also emitted to fresh water.

Within the abiotic depletion potential impact category, the difference between the impact of mineral fertilizers and solid cattle manure is very significant, 0.03 kg Sb eq./ha and 0.0004 kg Sb eq./ha, respectively. It is mainly because the production of mineral fertilizers requires a remarkable amount of fossil resources like phosphate rock and potash but also gold, copper, chromium, molybdenum, nickel, silver, and tin.

DISCUSSION

The results of mineral fertilizer assessment the GHG potential (8,048.39 kg CO_2 eq./ha) was larger compared to the literature (1,010-1,695 kg CO_2 eq./ha, Berthoud et al (2012)). The author reported 6.5-35.65 kg SO_2 eq./ha while we got 43.89 kg SO_2 eq./ha for acidification potential. These differences are due to the fact that Berthoud et al (2012) only considered nitrogen fertilization without taking the phosphorus and potassium supply into account.

Nemecek et al. (2011) presented slightly higher emission potentials for farmyard manure in GHG potential and acidification potential, 2,150-4470 kg CO_2 eq./ha and 41-88 kg SO_2 eq./ha, respectively in the total plant production system, including storage and application. The higher values are due to additional emissions of SO_2, NO_x and NH_3 from diesel use. Altogether, our results are well in the range of the data published in the literature.

Nevertheless, with the drastic reduction of artificial fertilizers, nutrient surpluses and smart decisions on application rates, timing and placement the relative nitrogen fertilizer value can be increased to 40-80% while environmental protection and the preservation of resources can be realized (Schröder 2005).

Although farmyard manure provides several environmental advantages as mentioned above, during storage and application the amount of emitted nitrous oxide and methane can be remarkable (Yamulki 2006). These emissions can be effectively mitigated with different techniques. For instance, if manure heaps are covered and compacted methane losses can be alleviated (Yamulki 2006). With the addition of straw to manure in a ratio of 50% of total weight at the start of storage period CH_4 emission can be reduced by 45% (Chadwick et al. 2011). If straw or other high C-additives are added to the manure heaps, the C:N ratio, the dry matter content and the aeration are increased, which results in nitrous oxide and methane reduction (Yamulki 2006).

Potential reduction measures can be carried out also when the feeding strategy of the cattle's is modified. The reduction of crude protein content of diets causes saving in N_2O, NH_3 and CH_4 emissions (Chadwick et al. 2011).

As the NH_3 emissions are higher in composting systems but more significant quantities of N_2O and CH_4 are lost during anaerobically stacked storage quantities of N_2O and CH_4 are lost during anaerobically stacked storage (Amon at al. 2001), it might be an environmentally sound solution to treat the farmyard manure in controlled anaerobic digesters.

To maximize the nitrogen fertilizer value of manure, an appropriate time for fertilization needs to be chosen. Farmyard manures are more efficiently utilized during autumn applications. After fertilization direct incorporation is needed in order to reduce e.g. ammonia emissions (Schröder 2005).

CONCLUSIONS

Organic fertilizers are much more environmental friendly solutions compared to inorganic fertilizers, especially when manure management is improved. Not only the dependence on unsustainable, fossil fuel based mineral fertilizers can be reduced but significant amounts of emissions can be avoided during fertilization. Simultaneously with GHG reductions, the carbon content of the soil is increasing which helps to reach GHG reduction targets (Chadwick et al. 2011).

REFERENCES

1. Aguilera, E. - L. Lassalettac - A. Sanz-Cobena - J. Garnier - A. Vallejo 2013. The potential of organic fertilizers and water management to reduce N_2O emissions in Mediterranean climate cropping systems. A review. Agriculture, Ecosystems and Environment 164: 32–52.
2. Ahlgren, S. - A. Baky - S. Bernesson - Å. Nordberg - O. Norén - P.-A. Hansson 2008. Ammonium nitrate fertiliser production based on biomass – Environmental effects from a life cycle perspective. Bioresource Technology 99: 8034–8041.

3. Amon, B. - Th. Amon - J. Boxberger - Ch. Alt 2001. Emissions of NH3, N2O and CH4 from dairy cows housed in a farmyard manure tying stall (housing, manure storage, manure spreading). Nutrient Cycling in Agroecosystems 60: 103–113.
4. Bateman, A.- D. Horst - D. Boardman - A. Kansal - C. Carliell-Marquet 2011. Closing the phosphorus loop in England: The spatio-temporal balance of phosphorus capture from manure versus crop demand for fertiliser. Resources, Conservation and Recycling 55: 1146–1153.
5. Berthoud, A., Buet, A., Genter, T., Marquis, S. 2012. Comparison of the environmental impact of three forms of nitrogen fertiliser. InVivo AgroSolutions, Paris, France 24 p.
6. Chadwick, D. - S. Sommer - R. Thormanb - D. Fangueiroe - L. Cardenas - B. Amonc, T.Misselbrooka 2011. Manure management: Implications for greenhouse gas emissions. Animal Feed Science and Technology 166–167: 514–531.
7. Cordell, D. - J-O. Drangert - S. White 2009. The story of phosphorus: Global food security and food for thought. Global Environmental Change 19: 292–305.
8. FAO 2011. Organic farming and climate change mitigation. A report of the Round Table on Organic Agriculture and Climate Change. Rome, Italy
9. Füleky, Gy. - K. Sárdi 2014. Tápanyag-gazdálkodás mezőgazdasági mérnököknek. Mezőgazda Kiadó
10. Gaillard, G. - T. Nemecek 2009. Swiss agricultural life cycle assessment (SALCA): an integrated environmental assessment concept for agriculture. In: Int. Conf. ''Integrated Assessment of Agriculture and Sustainable Development, Setting the Agenda for Science and Policy'', Egmond aan Zee, The Netherlands. AgSAP Office, Wageningen University, pp. 134–135.
11. Heijungs, R. - J.B. Guinée - G. Huppes - R.M. Langreijer - U. de Haes - A.W Sleeswijk 1992. Environmental Life Cycle Assessment of Products – Backgrounds 9267. CML, Leiden. 130 p.
12. ISO 2006b. ISO 14044 - Environmental Management - Life Cycle Assessment - Requirements and Guidelines.
13. Liu, H. - J. Li - X. Li - Y. Zheng - S. Feng - G. Jiang 2015. Mitigating greenhouse gas emissions through replacement of chemical fertilizer with organic manure in a temperate farmland. Science Bulletin 60: 598–606.
14. Martínez-Blanco, J. - C. Lazcano - T. H. Christensen - P. Muñoz - J. Rieradevall - J. Møller - A. Antón - A. Boldrin 2013. Compost benefits for agriculture evaluated by life cycle assessment. A review. Agronomy for Sustainable Development 33: 721-732.
15. Nemecek, T. - D. Dubois - O. Huguenin-Elie, G. Gaillard 2011. Agricultural Systems 104: 217–232.
16. Schröder, J. 2005. Revisiting the agronomic benefits of manure: a correct assessment and exploitation of its fertilizer value spares the environment. Bioresource Technology 96/2: 253–261.
17. Skowrońska, M. - T. Filipek 2014. Life cycle assessment of fertilizers: a review. International Agrophysics 28: 101-110.
18. Sleeswijk, A.W. - M.J.G. Meussen - H.van Zeijts - R.Kleijn - H. Leneman – J. Reus - H. Sengers 1996. Application of LCA to agricultural products. CML, Leiden. 106 p
19. Tilman, D. - K. G. Cassman - P. A. Matson - R. Naylor - S. Polasky 2002. Agricultural sustainability and intensive production practices. Nature 418: 671–677.
20. Yamulki, S. 2006. Effect of straw addition on nitrous oxide and methane emissions from stored farmyard manures. Agriculture, Ecosystems & Environment 112: 140–145.

ORGANIC SECTOR IN BULGARIA AND HUNGARY: A REVIEW

PAULINA **JANCSOVSZKA** - DÓRA **MÉSZÁROS** - BALÁZS **SIPOS** - TAMÁS **SZALAI**

Szent István University, Faculty of Agricultural and Environmental Sciences, Institute of Nature Conservation and Landscape Management, 2100 Gödöllő, Hungary
Corresponding author: Dóra Mészáros, email:meszaros.dora@mkk.szie.hu; tel.: +36 28522000 (2262)

ABSRACT

The organic agriculture in Bulgaria and Hungary is a relatively "young" sector. In Hungary the organic movement has begun in the early eighties whereas in Bulgaria only in the late nineties. Both countries have excellent natural conditions and the EU and national policies in this field are favourable for the development of the sector. The weight of this sector and the share of organic market in both countries is not significant (more than 1.2% in Bulgaria and less than 1% in Hungary), accordingly it has a high development potential. In Bulgaria the organic agriculture is in steady growth for the last few years which became faster after EU accession and continued even during the economic crisis. After quick growth between 1996 and 2004, the organic sector in Hungary has been stagnating. This article makes an overview of some characteristics of the Hungarian and Bulgarian organic sectors – organic land, organic operators, average size of organic farms in the NUTS 2 regions. Regardless of their differences and despite the various challenges as e.g. particularly underrepresented organic husbandry, their opportunities and prospects for future development are similar which this paper is aimed to summarize.

keywords: organic agriculture, Bulgaria, Hungary, development opportunities

INTRODUCTION

The organic agriculture has become more and more popular worldwide, but while in some countries it is only a niche of roughly 1% of global agricultural production, in others, as the leading European countries, it is getting more and more widespread, having potential to become mainstreamed (Niggli 2014). Although within the European Union, the "old" Member States (joined EU before 2004 EU-15) have the determinant role in the development of this sector, in the new Member States (joined EU after 2004 EU-N12) relatively the same trend of rapid growth is observed (EB 2013). Undoubtedly the EU regulation is decisive for the organic farming in Hungary and Bulgaria as well by providing the common legal framework of standards, however concerning its development differences appear not only between the EU-15 and EU-12 groups but between the Member States as well. Although in Bulgaria (EU Member since 2007) in the period after 2005 high growth rate is noted (due to initial low level), in the case of Hungary (EU Member since 2004) the value of this indicator is stagnant since 2004 and it is one of the few European countries where the organic sector has not been expanding. Despite of this fact both Hungary and Bulgaria were within the 10 countries with the highest growth of organic agricultural land in 2013 (OrganicDataNetwork- FiBL-AMI survey 2015).

The article aims to review the evolvement of the organic agriculture in Bulgaria and Hungary and to summarize the threats and opportunities of the future development of their organic agricultural sectors.

MATERIAL AND METHODS

Definition and analysis of the trends of development, based on the appropriate interpretation of statistical data from various sources concerning the following specific indicators: legal and institutional background, organic land area, distribution by regions of organic holdings, number of operators, organic market share, certification and control bodies.

RESULTS

The Hungarian organic movement started in 1984 when Bioklub[1] was founded by Hungarian agricultural experts. It was a bottom-up organized movement leading to a rapid increase of organic land. By 1996 Biokontroll Hungária

[1] „Organic Club"

Ellenőrző és Tanúsító Nonprofit Kft.[2] was established as the first inspection and certification organisation in Hungary (www.biokontroll.hu), followed by Hungária Öko Garancia Kft.[3] in 2001. (www.okogarancia.hu).

So far there were two national level frameworks for organic farming: the so called Nemzeti Agrár-környezetvédelmi Program (NAKP 2000-2006)[4] with only one scheme designed for supporting the organic farming and the Új Magyarország Vidékfejlesztési Program (UMVP 2007-2013)[5] including three schemes for organic agriculture. (www.umvp.eu).

However, since 2014 there is no agri-environmental schemes available for organic farmers, instead there is only one valid action plan called Nemzeti Akcióterv az Ökológiai Gazdálkodás Fejlesztéséért (2014-2020)[6] which aims to double the organic land (increase the current area to 350000 hectare) in Hungary by 2020 (www.videkstrategia.kormany.hu). The European Commission has recently approved Hungary's Rural Development Program (2014-2020) which provide 64 billion HUF financial support for the organic agriculture.

In Hungary organic farming related researches are done mainly by Biokontroll, ÖMKi[7] and agricultural universities. All these organisations have a wide spectrum of R&D activities. Biokontroll runs – among others - several projects since 2004 to improve the data quality and availability in the area of organic farming. ÖMKi started its operation in 2011 and has built up an on farm research program to find practical answers to the most important questions of Hungarian organic farming and to provide hands-on trainings for farmers. Universities, like Szent Istvan University contributes to the development of training programs (e.g Ecovoc[8]) on different level.

The Bulgarian organic agriculture can be dated from the nineties. The external driving forces - foreign programs and organizations - contributed to institutionalization of the organic agriculture in Bulgaria by providing financing resources (Swiss government), human resources and capacity building (Research Institute of Organic Agriculture, FiBL) for policy and institutions development (Stoeva et al. 2014). Between 1996 and 2000 the first activities on this field, such as trainings for farmers, literature release, preparation of the legal framework, were made. In this period started the "Development of organic farming in the Central Balkan Region", financed by the Swiss Agency for Development and Cooperation (SDC) and implemented by FiBL. The Foundation for Organic Agriculture Bioselena was established in 1997 by FiBL. The organic farming sector was not initiated by the state (as e.g. in Poland) and it was not established by farmers' organisations either, as in Hungary. The academic sphere played an important role in setting up the national legislation which was published between 2000 and 2004. The first organic certification was given in 2001. The small scale support for organic farming[9] in the period before the accession to the EU was provided by international donors, mainly by the Swiss Agency for development and cooperation.

After the so-called "organic boom" period (2005-2008), between 2007 and 2013 the support for organic farming was carried out under the EU Rural Development Program, most directly under Measure 214 "Agro-ecological payments". However these payments are lower

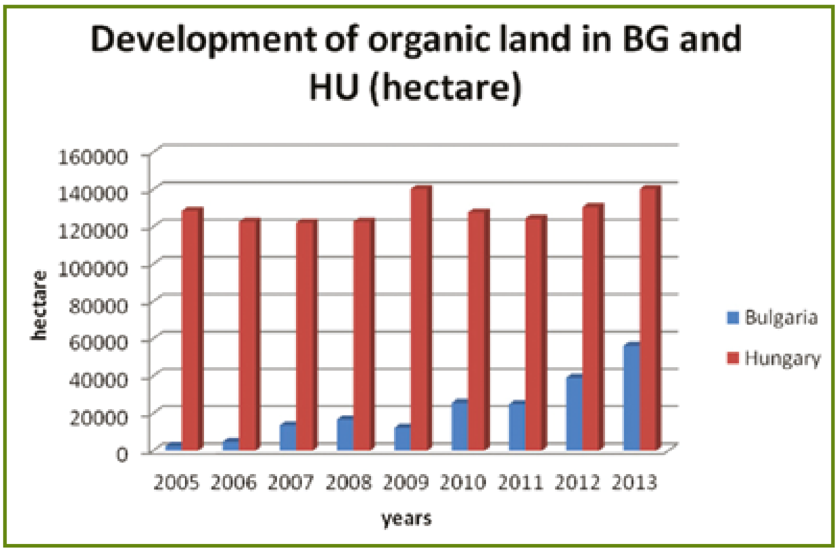


Figure 1: Total organic land area in Bulgaria and Hungary, 2005-2013
Source: Figure made by authors based on data from Eurostat, FiBL&IFOAM and http://www.sarkozybio.hu/sarkozy/emlekulesek/images/2012/az_okologiai_gazdalkodas_helyzete_magyarorszagon.pdf)

[2] Biokontroll Hungária Inspection and Certification Nonprofit Ltd. (This company was established by the Biokultura Federation (association) which is the domestic umbrella organisation of the organic agricultural civil movements in Hungary. Untill 1996 the Biokultura association was responsible for the inspection and certification of the organic farming in Hungary (in the early eighties the dutch Skal certified the organic farms). The Biokontroll took this funcion after its recognition by the EU as an accredited control body according to the 2092/1991/EU regulation.)
[3] Hungaria Eco Guarantie Ltd. (an Austrian owned company in Hungary)
[4] National Agri-Environmental Programme
[5] New Hungary Rural Development Programme
[6] National Action Plan for the Development of Organic Farming
[7] Research Institute of Organic Agriculture (Partner of FiBL Switzerland)
[8] http://ecovoc.com/
[9] Practically until 2005 there was no real domestic financial support

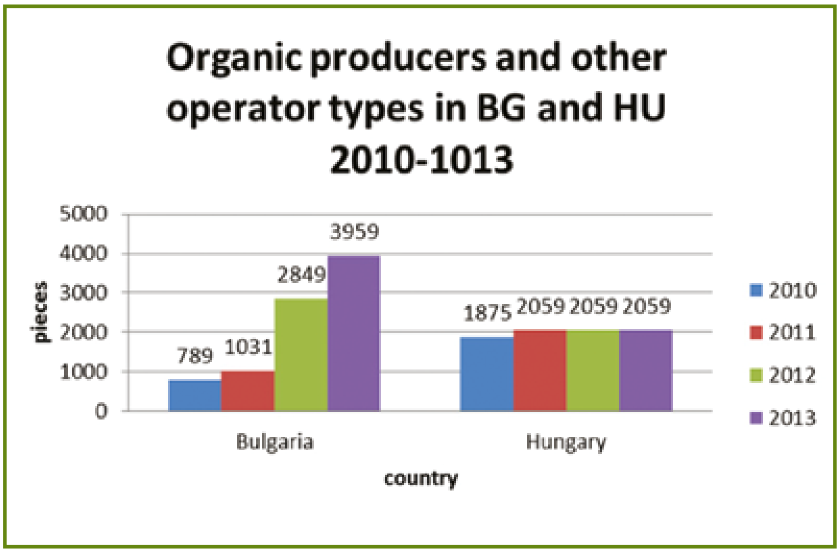


Figure 2: Number of organic producers and other operator types (processors, exporters and importers) in Bulgaria and Hungary, 2010-2013
Source: Figure made by authors based on data from FiBL&IFOAM

Under the new CAP (2014-2020) the organic farms will benefit from the "greening" component and the Rural Development measures will more widely address organic farming[10].

The organic farming research in Bulgaria is carried out by few NGOs, research institutes and universities (first of all Agrarian University of Plovdiv and University of Agribusiness and Rural Development) as part of number of projects related to training and capacity development. Some organisations (as e.g. Bioselena) offer consulting services and organise professional training in organic agriculture for farmers.

CHARACTERISTICS OF THE ORGANIC SECTOR IN BULGARIA AND IN HUNGARY

compared to other EU Member States. That problem can be explained by the minimum size-area requirement (0.5 ha) on the base of which the small-scale organic farmers (near three quarters of all) are not eligible for these subsidies (Kayryakov 2010).

The National Plan for Organic Sector (2007-2013) aimed to achieve 8% of agricultural land under organic farming by 2013 and 3% share of organic food on the market (Ministry of Agriculture and Food, 2006). By the end of the period the organic area has increased, the share of it out of total UAA remained below 1% and the share of organic food on the market was far below the target.

In the period 2005-2012 steady growth of the arable area used for organic farming was observable in Bulgaria. Its increase from 2005 to 2006 almost doubled and in 2007 tripled, probably due to the accession to the EU among other factors (Figure 1.). Between 2006 and 2010 the growth of organic agricultural land in Bulgaria was the highest (5.46 times) in the EU (FiBL&IFOAM, 2012). The land with permanent meadows and pastures had almost doubled within two years – from 7 957 ha in 2012 to 15 476 ha in 2013 (MAF, 2014).

In Hungary there are more than 140'000 hectares of certified organic land, which is about 3,3 % of the total

Table 1: Areas (under conversion and converted) under organic crops in Bulgaria (2012)

Crop category	Main crops	Total organic area, HA
Grains, including rise	wheat, barley, corn, rye, oats, triticale	7,532
Techn. crops including oil bearing rose	sunflower, rapeseeds, soybeans, roses, medicine plants, herbs	7,909
(Rosa damascene)		1,144
Fresh vegetables, melons, strawberries, mushrooms	cucumber, artichoke, tomatoes, peas, melons, strawberries and mushrooms	1,421
Orchards	apples, plums, cherry, apricots, walnuts, almonds, hazelnuts, chestnuts	10,959
Permanent meadow and pasture		7,957
Feed crops		2,044
Fallow land		2,315

Source: Ministry of Agriculture and Foods 2013 Annual Report, pp. 54-55, http://www.mzh.government.bg/MZH/Documents/reports.aspx

[10] Subsidies will vary from 160 to 514 €/ha depending on the crops

Table 2: Areas (under conversion and converted) under organic crops in Hungary (2014)

Crop category	Main crops	Total organic area, HA
Grains	wheat, corn, triticale	17570,46
Dry leguminous crops	potatoes	1816,07
Root crops		80,45
Industrial corps	oil seeds, medicine plants, herbs	8536,32
Crops harvested green	temporary grassland	12852,74
Fresh vegetables, melon	leaf vegetables	1883,76
Strawberries		8,13
Cultivated mushrooms		0,83
Fruits	apple, cherry, sour cherry, plum	1640,53
Berries		818,54
Nuts and walnuts		1197,81
Vineyard		956,05
Other perennial crops		23,44
Permanent grassland		62259,1
Fallow land		2641,67

Source:http://www.biokontroll.hu/cms/images/downloads/eves_beszamolok/eves_jelentes_2014.pdf

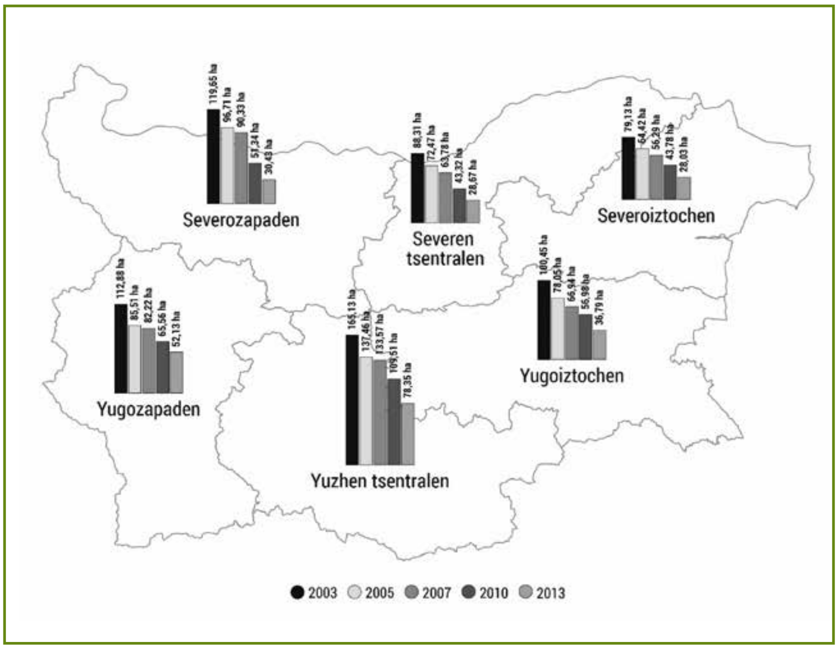


Figure 3: Average size of organic farms in NUTS 2 regions of Bulgaria
Source: Figure made by authors based on data from Eurostat http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do; Eurostat FSS data (online data code: ef_mporganic)

agricultural area. Between 2005 and 2012, the organic land increased only by 1.03 times in the country (Figure 1.).

Tables 1. and 2. list the main organic crops and their areas in Bulgaria and in Hungary.

In the period 2005-2012 the number of organic operators significantly increased in Bulgaria. This country was in the first place in EU concerning the growth of number of organic operators (2,2 times). Especially spectacular was the increase by more than six times in the period from 2009 to 2012.

In Hungary the number of organic operators is lower compared to Bulgaria. After moderate increase in 2011, in the next two years it remained unchanged (Figure 2.).

In Bulgaria the region of Plovdiv (in Yuzhen tsentralen) is the most dense regarding organic farms - which is not surprising, taking into account the great natural conditions (e.g. fertile soil) and that the Agrarian University of Plovdiv is the scientific heart of the organic agriculture in Bulgaria – followed by Sofia, Sofia province (in Yugozapaden), and Silistra (in Severoiztochen). Figure 3. presents the average size of Bulgarian organic farms which decreased between 2003 and 2013. The map also shows that the largest organic farms can be found in the above-mentioned region, Yuzhen tsentralen.

In Hungary, organic farms seems to be presented in greater extent not in regions around the capital but in the Eastern and Southern part of the country which are considered to be the least developed parts. Similar to Bulgaria the size of the organic farms decreased in Hungary as well between 2003 and 2013 (Figure 4.).

In Bulgaria the share of the organic product market is still modest, but in progress (except the decline in 2009 due to the economic crisis). Since 2007 rapid growth can be observed and in 2012 it attained almost 1,28%. In absence of official data on sales in Bulgaria, the market for organic products is estimated between 6 to 8 million

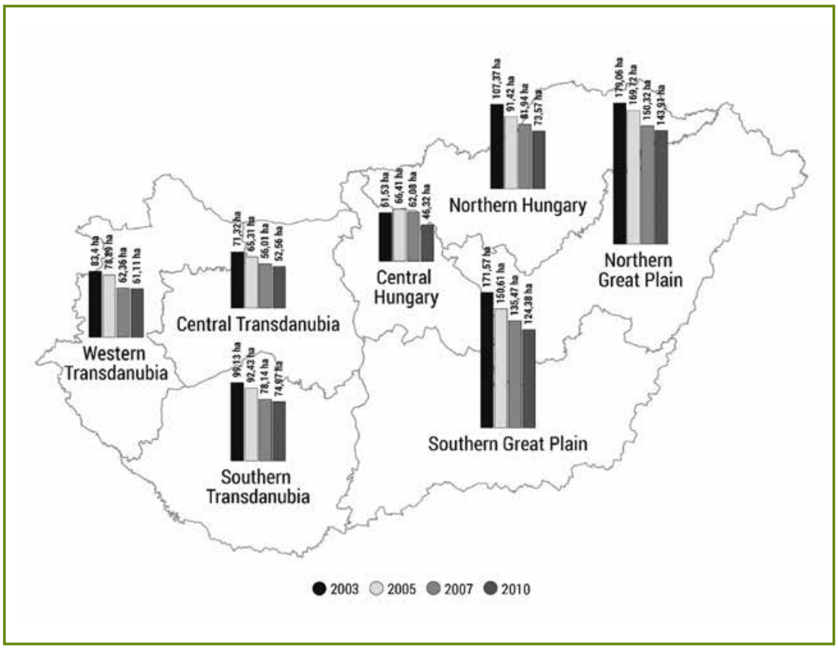


Figure 4: Average size of organic farms in NUTS 2 regions of Hungary
Source: Figure made by authors based on data from Eurostat http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do; Eurostat FSS data (online data code: ef_mporganic)

euros (800 000 euros in 2005, 5 million euros in 2008 and 7 million euros in 2010) (Bioselena 2009; FiBL&IFOAM 2013, 2014). According to Bioselena and Dicon Group[11], 90-95% of the organic production is sold on the international market (Central and Western European countries, USA, Canada and Japan) principally as raw materials and not as processed products.

In Hungary the domestic market is estimated to amount to 25 million euros (FiBL & IFOAM 2015, www.biokutatas.hu, www.biokontroll.hu). Today, organic products in Hungary have just a small market share and about 85 % of the organic production is exported. Most of the products leave the country as raw materials or as low added-value produce and most of go to the EU (Germany, Austria and the Netherlands) and to Switzerland.

DISCUSSION

The Bulgarian organic agriculture is in permanent development in the last few years, but the number of producers, operating mostly on small farms, still remains limited. Subsidies are the principal motivation for organic farming instead of the commitment to the organic concept or the answer to the market signals (demand). On one hand the three-year support for conversion which is attractive for the farms, does not guarantee its achievement. On the other hand there is no control of the organic products actually produced. On this basis and with regard to the subsidies per area, the increasing organic land does not necessarily mean a growing volume of organic production. It has to be noted that beside the push measures pull measures – e.g. marketing support, information campaigns - are needed as well for the future market development.

One of the principal challenges for the Bulgarian organic sector is the organic animal husbandry (only five farms in 2012), which can be explained with the lack of financial support (no subsidies for breeding and certification).

In Hungary although more than half of the organic area is grassland, organic animal husbandry is relatively insignificant compared to crop production. In 2010, less than 100 farms kept certified organic livestock, which is less than one tenth of the organic producers. The reason is that most of the animals grazing on organic fields are not certified because farmers consider the certification costs to be too high, and the existing regulations do not stipulate that only certified animals can be kept on organic grassland. As a result, organic grasslands receive substantial subsidies without creating any significant organic production. That is due to the weakness of that support: it aims to encourage the farmers to use the abandoned grasslands and not to boost the organic animal husbandry.

The small domestic market of organic products is undoubtedly an obstacle for the development of organic sector of both countries. The organic as a kind of "luxury" product is inaccessible for most Bulgarians because of their low income. The limited demand of the organic products is due to the low public awareness and the lack of reliable information concerning the organic farming.

The new CAP intends to stimulate the organic farmers better, with regard to the target for CAP greening (the organic farmers are entitled to the green payment in the direct payment scheme as "green by definition") and the new RDP introducing a specific measure for organic farming.

CONCLUSIONS

The organic sector in Hungary and Bulgaria has not yet reached its full potential and there are numerous unexploited opportunities. Apparently, there are differences between these countries (e.g. growth rate, driving forces in the beginning), however the development possibilities

[11] There is lack of official export data

are similar. The EU provides a common legal background for Bulgarian and Hungarian organic agriculture and the success of the sector depends on the new CAP (2014-2020) implementation.

The Bulgarian organic agriculture has a great potential, principally because of the favourable agro-ecological conditions. Moreover in the last fifteen years the organic sector was recognised by the EU and national policies were launched which provide legal (among others extremely restrictive law on GMO) and economic framework for its development.

Hungary offers promising conditions for organic agriculture as well. Its constitution bans the use of GMOs and many of its low-intensity agricultural areas (mostly pastures, meadows, fallows) are free from the effects of agro-chemicals.

The direction of development of the sector could be the transformation of weaknesses into strengths: e.g. creation and promotion of competitive Bulgarian brands (missing at the moment both on the domestic and the international market) and export of processed organic products. In Hungary there is a significant lack of organic processing capacity as well, and this could provide interesting potential market opportunities for organic food processing companies. This market opportunity is further enhanced by Hungary's proximity to countries with large organic markets. Efforts are needed to increase local consumer awareness to enable the local organic market to grow.

For the future development of the Bulgarian organic agriculture more incentives (e.g. more targeted measures) are needed to improve the motivation of the operators. It is needed to reinforce the link between the production and the market, and in this way to reshape the organic farming from an only subsidy-oriented economic activity to a market-oriented one.

Cooperation and a better communication between organic stakeholders, including producers, traders, umbrella organisations, certifiers, and research institutions, is important for the development of the organic agriculture in Bulgaria and Hungary as well.

ACKNOWLEDGEMENT

The research was carried out within Szent István University, Faculty of Agriculture and Environmental Sciences (Research Centre of Excellence-9878/2015/FEKUT).

REFERENCES

1. IFOAM (International Movement of Organic Agriculture Movements) 2010. Definition of Organic Agriculture.
2. http://www.ifoam.org/growing organic/definitions/doa/index.html (accessed on 13.01.2015)
3. FiBL&IFOAM 2012. Survey
4. Niggli, U. 2014. Sustainability of organic food production: challenges and innovations. Proceedings of the Nutrition Society, pp. 1-6; http://europepmc.org/abstract/med/25221987 (accessed on 12.12.2014)
5. ÖMKi 2012. Ökológiai gazdálkodás helyzete. Trendek és kitörési pontok. http://www.biokutatas.hu/images/stories/cikkek/konf%20kiadvany%20honlapra.pdf (accessed on 31.07.2015)
6. Biokontroll 2014. Az ökológiai gazdálkodás feltételrendszere, ellenőrzési rendszere. Az ökológiai gazdálkodás minősítési rendszere: (http://www.biokontroll.hu/cms/images/stories/eloadasok/karcag_gazdakor.pdf (accessed on 01.08.2015), Hungária Öko Garancia: http://www.okogarancia.hu/cegunkrol/index.htm# (accessed on 01.08.2015)
7. Új Magyarország Vidékfejlesztési Program 2007. http://www.umvp.eu/sites/default/files/umvp_program_teljes.pdf (accessed on 01.08.2015)
8. Vidékfejlesztési Minisztérium: Nemzeti Akcióterv az Ökológiai Gazdálkodás Fejlesztéséért 2014. http://videkstrategia.kormany.hu/download/3/c8/90000/Nemzeti%20Akci%C3%B3terv%20az%20%C3%96kol%C3%B3giai%20Gazd%C3%A1lkod%C3%A1s%20Fejleszt%C3%A9s%C3%A9%C3%A9rt_vegleges.pdf (accessed on 02.08.2015)
9. Stoeva, S. - Slavova, P. - Georgieva, Z. 2014. Development of the Organic Sector in Post-Socialist Bulgaria 1990-2013. In: Rahmann, G. & Aksoy, U. (Eds.) (2014): Proceedings of the 4th ISOFAR Scientific Conference "Building the Bridges". Organic World Congress 2014, 13-15 Oct., Istanbul, Turkey, pp. 93-95.
10. Kayryakov, 2010. Development of Organic Farming in Bulgaria. Trakia Journal of Sciences, 8(3), 147-152.
11. Ministry of Agriculture and Food 2014: Annual Report 2013. Ministry of Agriculture and Food (2013): Annual Report on the situation and development of agriculture. http://www.mzh.government.bg/MZH/Libraries/AgryReports/2012.sflb.ashx, (accessed on 10.01.2015)
12. Ministry of Agriculture and Food 2006. National Plan for Development of Organic Farming in Bulgaria. http://www.mzh.government.bg/MZH/Libraries/Organic_Farming/NOFAP_FINAL_en.sflb.ashx (accessed on 10.01.2015)
13. FiBL and IFOAM 2012. The word of organic agriculture. https://www.fibl.org/fileadmin/documents/shop/1581-organic-world-2012.pdf (accessed on 03.08.2015)
14. FiBL and IFOAM 2013. The word of organic agriculture. https://www.fibl.org/fileadmin/documents/shop/1606-organic-world-2013.pdf (accessed on 03.08.2015)
15. FiBL and IFOAM 2014. The word of organic agriculture. https://www.fibl.org/fileadmin/documents/shop/1636-organic-world-2014.pdf (accessed on 03.08.2015)
16. FiBL and IFOAM 2015. The word of organic agriculture. https://www.fibl.org/fileadmin/documents/shop/1663-organic-world-2015.pdf (accessed on 03.08.2015)

Eurostat: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do (accessed on 08.08.2015)

A New Organic Agricultural Engineer MSc program is launched at the Faculty of Agricultural and Environmental Sciences, Szent István University

The Faculty of Agricultural and Environmental Sciences of Szent István University has more than 20 years' experience in organic farming education. In February 2016 a full-time Organic Agriculture Engineer Master Course MSc (4 semesters) will be launched in Hungarian language, with the following aims:

- graduated students will be equipped with specific professional knowledge related to organic agriculture that enable them to design and manage organic farms
- graduated students will be able to plan, design and manage organic farming related activities
- graduated students will be qualified to convert existing farming operations into organic farming
- graduated students will be qualified to organic farming certification systems and/or the administrative/policy segment of the sector

In order to achieve these targets:

- the MSc course will have a broad spectrum with diverse subjects - the university's 10 institutions will take part in the course
- the MSc course will be practice-oriented concerning the theory-practice proportion, the different farming enterprise visits, and the individual tasks of the students

The practical part of the MSc course will be guaranteed and supported by:

- GAK Nonprofit Public Utility Ltd-Ecological Market Garden of Babat-valley that operates under the professional supervision of the Institute for Nature Conservation and Landscape Management of SZIE
- The outsourced Institute of Gene Conservation and Breeding Department
- The responsible department of the course -The Organic Farming and Agri-environment Planning Department –has a well-established professional relationship with the control organizations, with the Research Institute of Organic Agriculture (ÖMKI) and with numerous organic farmers and practionners from many regions of the country

Another important element of the MSc course is that each student will develop a complex organic farm plan within the framework of his/her own project plan for the end of the course. Those students who graduate successfully will obtain a Masters Degree as an Organic Agricultural Engineer and for those who are preparing for careers in science, the Faculty of Agricultural and Environmental Sciences offers the opportunity to continue his/her studies at 4 postgraduate schools.

We welcome applicants from those who are interested in the topic, who want to focus on the practice, and are dedicated towards the profession and last but not least want to gain a deeper knowledge, and qualification in the field of organic agriculture!

ADMISSION INFORMATION:

Address:
H-2100 Gödöllő, P.O.Box 3. Hungary

email:
tircza.imre@mkk.szie.hu

homepage:
www.mkk.szie.hu; www.felvi.hu
date of the information day will be published at
www.mkk.szie.hu

SZENT ISTVÁN UNIVERSITY
FACULTY OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES, GÖDÖLLŐ