3rd Scientific Conference

Theme:
New findings in organic farming research and their possible use for Central and Eastern Europe

Bořivoj Šarapatka (ed.)

CTPOA

IFOAM EU GROUP

Proceedings

3rd Scientific Conference

Theme:

New findings in organic farming research and their possible use for Central and Eastern Europe

Date:

14th – 15th November 2011

Venue:

Prague, Czech University of Life Sciences, University Hall

CTPOA

IFOAM EU GROUP

3rd Scientific Conference 2011 – Proceedings

New findings in organic farming research and their possible use for Central and Eastern Europe

Bořivoj Šarapatka (ed.)

Scientific Committee

Chairman
Bořivoj Šarapatka (Czech Republic)

Members
Karin Stein-Bachinger (Germany)
Jana Hajšlová (Czech Republic)
Bernhard Kromp (Austria)
Miloš Michlovský (Czech Republic)
Otto Schmid (Switzerland)
Atle Wibe (Norway)

Translation Ina Leckie, Jim Leckie
Technical editor Milan Matoušek
Published by Bioinstitut, Křížkovského 8, 771 47 Olomouc, www.bioinstitut.cz

Text in its original form without correction

1st Edition

Olomouc, 2011

ISBN 978-80-87371-12-1

CONTENT

Dear colleagues and friends of organic farming,

The last Scientific Conference on Organic Farming in the Czech Republic was held within Bioacademy 2009 in Lednice. At that time, it was decided that Bioacademy would have a more practical orientation and that there would not be a scientific element to it in the future. In the following year, the Czech Technology Platform for Organic Agriculture (CTPOA) was established, bringing together those interested in organic farming, both scientists and practitioners. Several CTPOA meetings brought forth requests for a scientific conference which would follow on from the traditional Bioacademy. These requests have been granted and you can now take part in the 3rd Scientific Conference, to be held in Prague this time, and look forward to contributions from Central and Eastern European researchers in the form of lectures and poster presentations. You can also study individual contributions in the published Proceedings which you now hold. The lecture section now also includes requested contributions by other European experts.

Before you begin reading I would like to thank everyone who was involved in the organisation of this, the 3rd Scientific Conference. The logos of supporting organisations are shown on the back cover of the publication. The level of the Scientific Conference is guaranteed by the Scientific Committee. In cooperation with a team of colleagues from scientific institutes in many European countries the committee has undertaken a considerable task in putting together the programme and opposing contributions.

Once more, on behalf of the Organisational and Scientific Committee, I welcome you to Prague and hope that the time you spend in this pleasant atmosphere will enrich you with new knowledge and that you will enjoy the hospitality of the Czech Republic and the beauty of historical Prague.

I sincerely believe that the event will fulfil your expectations and that you will continue to support research into organic farming and conservation of individual components of the environment in the future.

Prof. Dr. Bořivoj Šarapatka
Chairman of the Scientific Committee

3rd Scientific Conference

ORAL SECTION

WHY DO CZECH CONSUMERS PURCHASE ORGANIC FOOD?

ZVĚŘINOVÁ, I.[1], URBAN, J.[2] & ŠČASNÝ, M.[3]

Key words: organic food consumption, purchase behaviour, Czech Republic

Abstract

The objective of this paper is to analyze empirically factors that explain organic food purchase behaviour, using data on a representative sample of inhabitants of Czech Republic. First, socio-demographic characteristics of organic food consumers are examined. Second, the motivational factors and barriers that affect purchase decision-making related to organic food are identified.The results of the study show that organic food is purchased more likely by younger households, households from larger cities and households with the highest income. Health-related beliefs, environmental beliefs, and normative beliefs have positive effect on organic food purchase. On the other hand, low trust in certification system, lack of information and perceived shorter shelf life of organics are the important barriers to organic food consumption.

Introduction

Production, processing, transport and consumption of food form a significant part of the environmental burden. Tukke and Jansen (2006) reviewed studies that analyzed the life-cycle impacts of total societal consumption and the relative importance of different final consumption categories and they found that food contributed 20–30 % to the total environmental impacts. Organic farming represents for many experts, policymakers and for a part of lay public a way to reduce the environmental burden. Furthermore, organic farming can encourage social and economic development of rural regions. The volume of organic food production hinges on, among others, the consumer preferences and purchase behaviour.

Although organic market has been growing fast in the Czech Republic recently (Václavík, 2009), consumption of organic food has been still quite low in comparison to Old EU states and organic food turnover per capita amounted only to € 6,5 (BÖLW 2011).

The knowledge of determinants of organic food purchase behaviour is useful for decision-making of politicians and enterprises involved in the field of organic food production, distribution and sales. This paper is for these reasons aimed at analysis of factors that explain consumer's purchase behaviour related to organic food.

Up to now, we have still relatively little information about factors that influence organic purchase decisions of Czech consumers. In fact, there are available recent descriptive statistics of data representative of general adult population (for example CVVM 2008; Václavík, 2009) and descriptive statistics of some subsamples of the Czech population (for example Ogilvy, 2008). However, there are already few studies that examined determinants of organic food purchasing

1 Charles University Environment Center, José Martího 2/407, 162 00 Praha 6, Czech Republic, E-Mail: iva.zverinova@czp.cuni.cz, Internet http://www.czp.cuni.cz

2 As Above

3 As Above

behaviour (Urban et al., 2008i) and willingness to pay for organic food (Urban et al., 2008ii), but these studies analyzed data from representative surveys of Prague and Znojmo region.

However, there are available recent review studies of foreign empirical studies on determinants of environmentally-responsible products consumption (e.g. Boccaletti, 2008; Hughner et al., 2007). Based on the literature review of Czech and foreign studies, we formulated hypotheses that are tested in this paper.

Materials and methods

The data come from two representative surveys of general adult population of the Czech Republic that have been conducted in the turn of November and December 2010. The both surveys took form of structured face-to-face interviews.

The first data come from the omnibus survey conducted on a representative sample of population older than 15 years. Stratified random sampling with quota restrictions for gender, age and region was used to draw sample with size of 1793 observations. This data include information on household food expenditures. In this paper, the data are analyzed using binary logistic model to explain whether respondent's household bought organic food in the last month by the socio-economic and socio-demographic variables.

The second data consist of two subsamples, each with size of 525 observations, totaling to 1050 observations. The subsamples were drawn from the population older than 18 years using quota sampling with quotas for age, gender, education level, and size of the place of residence. The research has been based on the theory of planned behaviour (Ajzen, 1991), which postulates, among others, that "human action is guided by three kinds of considerations: beliefs about the likely outcomes of the behavior and the evaluations of these outcomes (behavioral beliefs), beliefs about the normative expectations of others and motivation to comply with these expectations (normative beliefs), and beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs) " (Ajzen, 2002: 1). The theory of planned behaviour has been successfully applied on explanation of consumption behaviour. Therefore we gathered data on beliefs about organic food consumption that are analysed in this paper. First, buyers´ and non-buyers´ perception of organic food (belief strengths) are compared using nonparametric tests for the equality of means. Second, belief strength is multiplied by outcome evaluation to get a measure of beliefs. Third, beliefs that have significant effect on organic food purchase are identified using binary logistic model.

Results and discussion

The socio-economic and demographic variables, particularly the household income category, size of the place of residence and the respondent's age, influence whether household purchased organic food last month. Organic food has been purchased more likely by households younger 29 years. There is higher probability that households from cities with more than 100 thousands inhabitants will purchase organic food in comparison with inhabitants of smaller municipalities. The highest odds of purchasing organic food have households in the highest income category, that is households with net monthly income greater than 40 thousands CZK. In the highest income category, 55 % of households purchased organic food. Interestingly, the relationship between household income and organic food purchase is not linear. The results suggest that households with net monthly income between 11 001 and 15 000 CZK purchased organic food significantly less often.

In order to get better understanding of motivation and barriers of organic food purchase behaviour, we examined beliefs related to organic food consumption. Our findings confirm that beliefs of respondents who bought organic food last month (further we call them buyers) significantly differ from beliefs of respondents who did not buy organic food last month (non-buyers).

Organic food buyers more likely state that organic food contains no preservatives and additives, or residuals of animal antibiotics and steroids, and that organic food is more environmentally friendly, healthier, higher quality and tastier than conventional food. However, both buyers and non-buyers perceive health benefits of organic food stronger than environmental benefits. Buyers as well as non-buyers agree that organic food has in general shorter shelf life than conventional food. Buyers perceive shorter shelf life of organic food even stronger.

Important finding is that both buyers and non-buyers do not trust in the organic certification system. Not surprisingly, mistrust of non-buyers is much deeper. Further, organic food is generally perceived as more expensive than conventional food. Non-buyers judge organic food as expensive significantly more often than buyers. According to both groups there is lack of information about organics and insufficient assortment of organics in the stores. Non-buyers are more concerned also about these barriers than buyers.

Buyers´ and non-buyers´ beliefs about the normative expectations of others are very different. Non-buyers perceive that their significant others disapprove, or only slightly approve organic food purchasing, or they have no idea. In contrast buyers think that their significant others, at most their partners, children and friends, approve organic food purchasing.

Finally, we identified beliefs that influenced whether respondent purchased organic food in last month or not. Respondents, who think and highly value that organic food contains no preservatives and additives, organic food is more environmentally friendly and it has in general longer shelf life than conventional food, more likely purchased it. Organic food purchase is also positively influenced by partner´s pressure on organic food purchasing. The higher probabilities of organic food purchase have respondents who trust in organic food certification system. We added into our model also the knowledge of official organic food logos and found that it has positive significant effect on organic food buying.

This analysis of organic food purchase behaviour focused separately on socio-demographic characteristics and on the beliefs about organic food. In the following research, organic food purchase behaviour will be explained by beliefs about organic food controlling for socio-demographic characteristics. Further, we are going to apply the complete theory of planned behaviour on organic food purchasing behaviour.

Conclusions

Based on our results, we suggest that campaigns aimed at motivation of consumers to buy organic food might be more successful if they try to enhance trust in organic food certification system and increase knowledge of official organic food labels. The attention might be also paid to promotion of contribution of organic agriculture to the protection of the environment. The issue of promotion of health benefits is quite complicated. On the one hand, health-related benefits are perceived more intensively than environmental friendliness of organic food production and promotion of health benefits could have the impact on enhancing organic food consumption. On the other hand, results of nutritional, toxicological, and epidemiological studies (see e.g. Hoefkens et al., 2009) concerning the health benefits of some organic food are not conclusive. Thus, we suggest being rather cautious about claims indicating health benefits, especially about general claims.

Acknowledgments

We gratefully acknowledge support from Ministry of Education, Youth and Sports of the Czech Republic, Grant No. 2D06029 "Distributional and social effects of structural policies" funded within National Research Program II.

References

- Ajzen I. (1991): The theory of planned behavior. Organizational Behavior and Human Decision Processes 50: 179–211.
- Ajzen I. (2002): Constructing a TpB Questionnaire: Conceptual and Methodological Considerations, http://www.people.umass.edu/aizen/tpb.html (accessed 2010–03–23).
- Boccaletti, S. (2008): Environmentally Responsible Food Choice. In Ferrara I., Serret Y. (Eds.): Household Behaviour and the Environment: Reviewing the Evidence. OECD, Paris.
- BÖLW (2011): Zahlen, Daten, Fakten: Die Bio-Branche 2011. Bund Ökologische Lebensmittelwirtschaft e. V., Berlin, www.boelw.de (accessed 2011–03–02).
- CVVM. (2008): Jak chráníme životní prostředí? Sociologický ústav AV ČR, Praha.
- Hoefkens, C., Vandekinderen, I., De Meulenaer, B.; Devlieghere, F., Baert, K., Sioen, I., De
- Henauw, S., Verbeke, W., Van Camp J. (2009). A literature–based comparison of nutrient and contaminant contents between organic and conventional vegetables and potatoes. British Food Journal 111 (10), 1078–1097.
- Hughner R. S., McDonagh P., Prothero A., Shultz C. J., Stanton J. (2007): Who are organic food consumers? A compilation and review of why people purchase organic food. Journal of Consumer Behaviour 6: 1–17.
- Tukke A., Jansen B. (2006): Environmental Impacts of Products: A Detailed Review of Studies Journal of Industrial Ecology 10 (3): 159–182.
- Urban, J., Ščasný, M., Zvěřinová, I. (2008i): Buy or Not to Buy Organic Food? A Case study on Prague's population. Proceedings from Sustainable Consumption 2008 Conference, Oct. 8, Corvinus University of Budapest, Budapest, http://eman2008.uni-corvinus.hu/index.php? id=20243 (accessed 2011–03–02).
- Urban, J., Ščasný, M., Zvěřinová, I. (2008ii): How much are Prague consumers willing to pay for organic food? In Šauer, P.: Environmental Economics and Policy – Young Researchers Perspective. Nakladatelství a vydavatelství litomyšlského semináře, Praha.
- Václavík T. (2009): Český trh s biopotravinami 2009. Navíc: Slovenský trh s biopotravinami. Green Marketing.

COST COMPETITIVENESS OF SELECTED AGRICULTURAL PRODUCTS IN CONVENTIONAL AND ORGANIC FARMS IN POLAND

ŻEKAŁO, M. [1]

Key words: economic results, direct costs, cost competitiveness, agricultural products

Abstract

This paper presents the possibility of using economic accounts for assessment of agricultural production and management decisions at operational (or tactical) level at the farm. On the market for agricultural products the cost competitiveness plays an important role for organic production, especially when customers are not able to pay much more for organic products compared to conventional. The calculation of gross margin gives the possibility to have a full insight on actual direct costs and to compare the competitiveness of different agricultural production activities carried out on organic farms. The farm management on the production level can be facilitated with gross margin calculations which give the possibility for the right decisions for future production.

Introduction

Farmers always have to make various decisions at the farm. They are no longer only plant specialists or breeders, but also farm managers. To make right decisions farmers need a lot of information from surroundings of the farm and primarily a very good knowledge of their own farm. The use of economic accounts, including gross margin account, facilitates production management at the operational (or even tactical) level. The gross margin is the first category of income and can be used for short-term management decisions on the farm. According to EU methodology at the level of agricultural production activities a very detailed data on direct costs are collected. The accounting of gross margins allows to assess economic results and to plan agricultural production on the farm. The gross margin is an appropriate objective criterion because it is based on actual direct costs incurred by the agricultural production activity. This income category allows comparing the economic results on the production level between the farms and different types of farming.

Materials and methods

Accounting data on agricultural activities were collected and processed according to the rules of the Agricultural Products Data Collection System (AGROKOSZTY). The survey covered farms located across Poland and engaged in the activities selected for the survey. Accounting data were collected for the most important agricultural activities, which had the biggest economic importance. Surveys in the system were conducted since 2004 in conventional farms and since 2005 in certified organic farms as well. Surveyed farms were selected from a representative

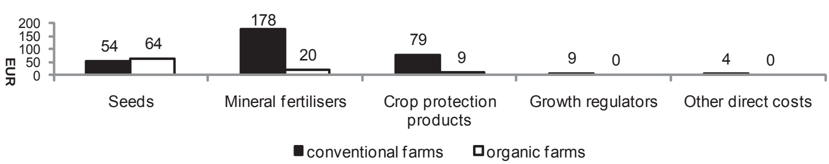
[1] Institute of Agricultural and Food Economics – National Research Institute, Warsaw, Poland, E-Mail Marcin.Zekalo@ierigz.waw.pl, Internet www.ierigz.waw.pl, www.agrokoszty.pl

sample of Polish FADN[1]. They rank among the economically strongest agricultural individual holdings with output for family farms above the national average. For this reason, the results obtained should not be directly translated into national average results. However, multiannual surveys indicated that the calculations provided a reliable picture of the economic situation in groups of farms and correctly reflected cost trends of production.

Under the AGROKOSZTY system, the methodology used for calculating the gross margin was consistent with the EU rules (Augustynska, Goraj, Tarka, Pokrzywa, Skarzynska, 2000). The gross margin was calculated by deducting the corresponding direct costs from the value of production (from one hectare of cultivation or from one animal). In crop and animal production, the production value depends on the yield and the selling price for products. For the accounting, annual average transaction prices or 'at the farm gate' prices (i.e. for on-farm sale) were used for determining the production value. To be classified as direct costs it is necessary to simultaneously meet three conditions: 1.) only those costs can be undoubtedly attributed to a specific activity, 2.) if their level was proportional to the scale of production and 3.) they had a direct effect on output (in terms of quantity and value). Among direct costs of crop production we can distinguish: costs of seeds, mineral fertilizers, organic fertilizers, crop protection products, growth regulators and other direct costs (insurance, special expenditure, special services, seasonal labour hired for special work). For livestock production, direct costs are as the following: livestock replacement, feeding stuffs (purchased, marketable and unmarketable produced on the farm), other direct costs (livestock insurance, rent for the use of forage area, medicines and veterinary services, special expenditure and services, seasonal labour hired for special work). Additionally, corresponding subsidies were taken into account. The item of subsidies only comprised those which directly concerned particular activities, mostly supplementary payments. In case of organic production also agri-environmental payments were taken into account.

Results

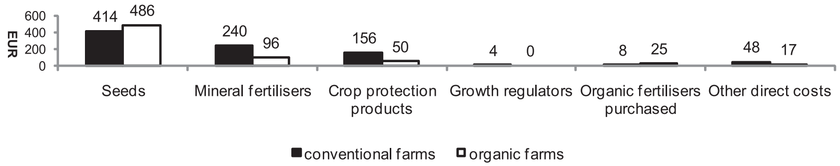
For this study in order to compare agricultural activities for conventional and organic production system 'winter wheat' and 'edible potatoes' and 'dairy cows' were selected. The



Source: calculations based on AGROKOSZTY database

Fig. 1: Direct costs of winter wheat production in selected conventional and organic farms in 2008 in Poland [per ha of cultivation]

[1] Polish Farm Accountancy Data Network



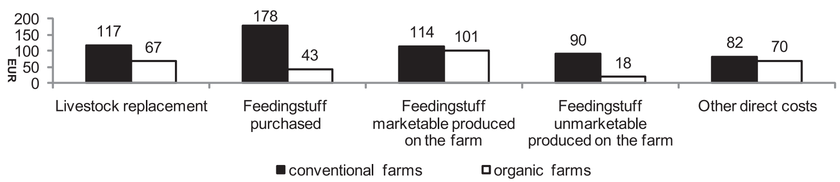
Source: calculations based on AGROKOSZTY database

Fig. 2: Direct costs of edible potatoes production in selected conventional and organic farms in 2008 in Poland [per ha of cultivation]

direct costs of production in surveyed farms are shown on graphs (Fig.1, Fig.2, Fig.3). In summary comparison table (Tab. 1) basic data of selected activities and gross margin accounts are presented.

Main direct costs in crop production are costs of seeds, mineral fertilisers and crop protection products. The cost of seeds are higher in organic farms mainly due to enhanced amount of seeds for sowing (which is an agronomical practice often used in organic crop production). Seeds for sowing mostly are taken from own production (from 65 % to 93 % of seeds for sowing) in both cases of conventional and organic farms. A different situation shows in costs of used fertilizers and crop protection products. They were higher in conventional crop production than in organic. Of course it came from the specification of 'low input' organic production system (Rigby, Caceres, 2001). By the way, organic fertilizers and crop protection products are rather very expensive. Instead of this, organic farmers use manure and slurry or green wastes for compost to improve soil fertilization (Lohr, Park, 2007) and also use natural crop protection products made on the farm (but their costs are not taken into gross margin account). Surprisingly, amongst the other direct costs there are no costs incurred for organic crop insurance.

Direct costs of milk production are generally focused on feeding stuff costs and they are lower in surveyed organic farms where farmers mostly used feeding stuff produced on the farm. Also the costs of livestock replacement are lower due to longer productive life of organic dairy cows.



Source: calculations based on AGROKOSZTY database

Fig. 3: Direct costs of milk production in selected conventional and organic farms in 2009 in Poland [per dairy cow]

From the other direct costs lower level of medicine and veterinary service costs were observed in organic farms. Organic dairy cows mostly were selected from the local breeds of cow which were more suitable for organic production (more healthy) but less productive.

Considering components of production value the prices for organic products are often higher than for conventional (Offerman, Nieberg, 2000). The same situation was in groups of surveyed farms except of the organic milk price (organic milk is sold mainly to conventional milk factories). The scale of organic production (in terms of area under cultivation or number of animals per farm) was lower than in conventional farms and lower yields of organic products were observed as well.

Tab. 1: Gross margin from crop production in 2008 and milk production in 2009 in selected conventional and organic farms in Poland

Specification	Average results by group of surveyed farms					
	Winter wheat		Edible potatoes		Dairy cows	
	conventi-onal	organic	conventi-onal	organic	conventi-onal	organic
Number of surveyed farms	152	19	92	21	167	20
Area under cultivation	20,7	2,9	5,1	1,1	-	-
Annual average number of dairy cows	-	-	-	-	23	9
Yield [dt/ha] [liter/cow]	61,2	28,4	261,0	189,0	5506	3346
Selling price [EUR/dt] [EUR/liter]	15	22	10	19	0,22	0,19
	Per ha of area under cultivation [EUR]				Per dairy cow [EUR]	
Total production value	907	635	2681	3604	1384	848
Total direct costs	324	93	869	674	581	291
Gross margin without subsidies	583	542	1812	2930	803	557
Subsidies	77	253	-	170	63a	210a
Gross margin	660	795	1812	3100	866	767
Share of subsidies in gross margin [%]	12	32	-	5	7	27

a) contain the supplementary, livestock and agri-environmental payments related to forage area per dairy cow
[-] means 'not occurred'

Conclusions

Results from the survey should be treated carefully due to small sample of surveyed organic farms. In general total direct costs of analyzed agricultural activities are lower in organic farms. Further reduction of direct costs is not necessary for better economic results. The problem is the low scale of production on organic farms. For this reason the enhanced support for organic production from public funds is justified. In the gross margin account subsidies play a big role in supporting particular organic agricultural activities (see Tab. 1). Real possibilities of increasing the scale of organic production are often limited (i.e. by the poor condition of soil or the lack of forage area for cows). But farmers need to know what level of direct costs could be incurred on particular agricultural activities to ensure sufficient levels of gross margin. Moreover farmers can estimate what level of direct costs allows increasing production. Of course an economic accounting at farm level could give a complete picture of the farm condition but the operational decisions can be easily supported with gross margin calculation on particular agricultural activities.

References

- Augustyńska-Grzymek I., Goraj L., Tarka S., Pokrzywa T., Skarżynska A. (2000): Metodyka liczenia nadwyżki bezpośredniej i zasady typologii gospodarstw rolniczych, FAPA, Warszawa.
- Lohr L., Park T. A. (2007): Efficiency analysis for organic agricultural producers: The role of soil-improving inputs. Journal of Environmental Management 83, p. 25–33.
- Offermann F., Nieberg H. (2000): Economic performance of organic farms in Europe. Organic Farming in Europe: Economics and Policy.
- Rigby D., D. Caceres D. (2001): Organic farming and the sustainability of agricultural systems. Agricultural Systems 68, p. 21–40.

RASPBERRY PROCESSING BY USING NEW SEPARATION PROCESSES

MOLNÁR, ZS.[1], ČUČEK, D.[2], PERKO, T.[2], ILIC, L.[2], ŠKERGET, M.[2], KNEZ, Ž.[2], BÉKÁSSY-MOLNÁR, E.[1], VATAI, GY.[1]

Key words: raspberry, membrane filtration, micronization, extraction

Abstract

Because of the valuable components have good effects on human organism, it is important to save them during the processing of raspberry (juice and marc).

Mild concentration of raspberry by membrane-filtration was the aim of our experiments. For prefiltration, to remove suspended solids, ceramic tube microfiltration-membrane (MF) was applied. The prefiltrated raspberry juice was concentrated by nanofiltration (NF) and reverse osmosis (RO). In case of RO the further concentration of the retentate was carried out by osmotic distillation (OD).

For the second step retentate of OD were further formulated using supercritical fluid technology, namely Particles from Gas Saturated Solution (PGSS™). The PGSS™ formulation was carried out using supercritical carbon dioxide, which results in an organic solvent-free product. The investigated carrier material was glycerol tristearate.

The marc, which remained after the fruit juice production, is also rich in valuable components. In our research from the raspberry marc active materials were extracted by supercritical carbon dioxide and conventional extraction. Some experiments were made for solvent recovery (concentration and separation the solvent) and concentrate the polyphenols and anthocyanins after conventional extraction by MF and RO combination.

The applied processing led us to mild technology and high valuable products.

Introduction

With membrane filtration techniques new ways for food processing have been found to fulfil the consumer demand for healthy food rich in valuable components and allowing preservation without any chemical additives. These up-to-date membrane methods give a possibility to increase food safety and to reduce energy consumption and environmental impacts. In addition, membrane processes are interesting alternative methods instead of thermal processes which cause loss of yeasts, vitamins, proteins and other valuable components (Tasselli, Cassano & Drioli, 2007.).

[1] Faculty of Food Science, Department of Food Engineering, Corvinus University of Budapest, Ménesi str. 44., H-1118 – Budapest, Hungary. E-mail: zsuzsanna.molnar@uni-corvinus.hu

[2] Laboratory for Separation Processes and Product Design, Faculty of Chemistry and Chemical Engineering, University of Maribor, Smetanova 17, SI-2000 –Maribor, Slovenia

The aim of the study is to work out the basis of a complex membrane filtration method which can be applied for raspberry juice process and preservation of anthocyanins and phenolics by different methods. (Castañeda-Ovando, Pacheco-Hernández, et all, 2009)

Materials and methods

The raspberry juice was provided from the grower. The juice was produced by pressing. Before the pressing pectolytic enzyme was added to destroy the pectin molecules.

The *microfiltration* process was applied like prefiltration to clarify to the raspberry juice, to remove of suspended solid contents. The membrane was ceramic tube microfiltration-membrane (0.125 m^2 filtration-surface, 0.45 μm pore size). The recirculated flow rate was 500 L/h and transmembrane pressure difference was 3.9 bar on 30 °C.

The prefiltrated raspberry juice was concentrated by *nanofiltration* (NF) flatsheet-membrane (0.046 m^2 filtration-surfaces, 75 % salt rejection) and *reverse osmosis* (RO) flatsheet-membrane (0.216 m^2 filtration-surfaces, 97 % salt rejection) on 30 °C.

After RO the retentate was more concentrated by *osmotic distillation* (OD).

On the strength of results with the resistance model the membrane- and the fouling resistance were determined in case micro- and nanofiltration and reverse osmosis.

In the course of filtration and concentration total soluble solid (TSS) content was measured with manual refractometer and total acid, phenolic, capacity of antioxidants and anthocyanin content of samples were determined by analytical methods.

The concentrated raspberry juice was formulated into powderous form by PGSS™ (Particles from Gas Saturated Solution) process. In PGSS™ process the compressible medium is solubilized in the substance which has to *be micronized*. Then the gas-containing solution is rapidly expanded in an expansion unit and the gas is evaporated (Vemavarapu, Mollan, Lodaya, & Needham, 2005).

After the press valuable components which stayed in the fruit marc were extracted and then concentrated. In this study filtration and reverse osmosis (RO) were used for concentration and separation solvent from solutions prepared by extraction of raspberry marc with ethanol. Extraction was performed by a conventional method for 2 h at permanent temperature. Extract solutions were collected. For clarifying a laboratory scale filtration equipment was used to remove suspended solids from the extraction solution. After the filtration the clarified permeate was concentrated by RO, with a polyamide flat sheet membrane.

Results and conclusions of measurements

During the measurements the permeate flux was continuously calculated, which decreased until the end of the filtrations. By the microfiltration raspberry juice was prepared to the concentration. During this step value of the valuable components did not change significantly. According to analytical analysis microfiltration was suitable for prefiltration technology, because retention of valuable component (anthocyanin, antioxidant) was not remarkable.

After the prefiltration raspberry juice was concentration by nanofiltration, reverse osmosis and osmotic distillation. *Figure 1* shows how the concentration of raspberry retentate changed

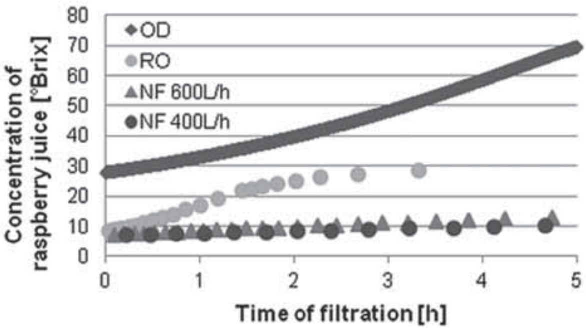


Fig. 1: Concentration changing of raspberry juice during concentrations

during the concentrations in the first 5 hours. In case of NF effect of flow rate was studied for the permeate flux.

At the nanofiltration recirculated flow rate did not influence largely outcome of measurement. Neither flux nor analytical analysis showed remarkable changing. With the NF 14–15°Brix was reached. Other pre-concentration method was the reserve osmosis. With this process we could reach 28,3°Brix total solid content (TTS). After the pre-concentration the RO retentate was more concentrated by osmotic distillation. In this case the highest TSS was reached (76°Brix) next to 30L/h flow rate and 24°C.

Before and after the filtrations pure water flux was measured in all case. From these the resistances of membrane and fouling membrane were determined *[Fig.2.]*. The membrane

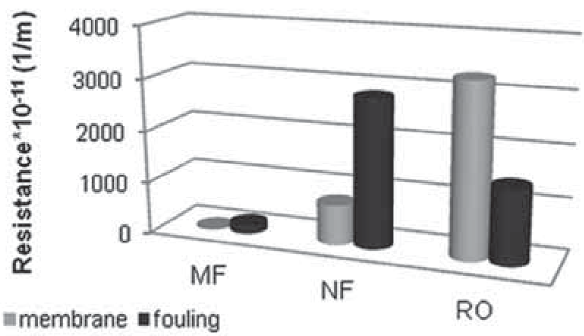


Fig. 2: Resistances of membrane and fouling membrane during the measurements

resistance was the lowest in case of MF because almost all components can go through the microfiltration membrane and the highest was in case of RO. It was because on the pore size too. The value of fouling membrane resistance was the highest in case of NF and here the filtration time was the longest also because of this.

In case of micronization the melted glycerol tristearate fat was mixed with the emulsifier, carboxymethil-cellulose sodium or pure starch and the raspberry concentrate (OD) using an electrical homogenizer in different concentrations. The emulsion was put into the autoclave and supercritical CO_2 was introduced using a high pressure pump until the desired pressure was achieved (~ 200 bars). The autoclave was then heated up to the operating temperature which was slightly higher than the melting point of the fat (~70 °C). Simultaneously the pressure reached the operating value. The autoclave with its content was mixed constantly until reaching the equilibrium (approximately 2 h). The gas saturated solution was then expanded through the nozzle and the compressible gas evaporated in the expanding chamber causing the micronization of the particles. (Su, Tang, Chen, 2009) *Table 1* shows the used parameters. Four different samples are presented; the obtained products were homogeneous free flowing powders with pink colours.

Tab. 1: Parameters of micronization

Samples	Concen-trate (%)	Emulsifier (%)	Glyceryl tristearate (%)	Cellulose (%)	Starch (%)	p (bar)	T (°C)	Yield (%)
OD1	69	1	20	10	-	190–210	70–71	84
OD2	50	1	44	5	-	190–209	70–72	91,4
OD3	70	1	19	-	10	150–157	54–57	79,4
OD4	50	1	44	-	5	185–210	70–71	87

After the press valuable components which stayed in the fruit marc were extracted and then concentrated. In this study microfiltration and reverse osmosis membrane were used for concentration and separation solvent after the conventional extraction. For clarifying a laboratory scale filtration equipment was used to remove suspended solids from the extraction solution. After the filtration the clarified permeate was concentrated by RO, with a polyamide flat sheet membrane. The volumes of valuable components were determined by analytical methods. The results of analytical methods were shown that separated solvent did not contain valuable components and solid content therefore can be reused in extraction process. Combination of (membrane) filtration processes was appropriate for concentration of the valuable compounds from extract solutions without losses of compounds. The removal of the solvent by membrane filtration is energetically more efficient than by evaporation.

Acknowledgments

The authors would like to acknowledge the support of the Hungarian-Slovenian R&D Cooperation (SI-11/07), the Hungarian National Science Foundation (OTKA CK-81011) and Hungarian Research Institute of Organic Agriculture (ÖMKi).

References

- Araceli Castañeda-Ovando, Ma. de Lourdes Pacheco-Hernández, Ma. Elena Páez-Hernández, José A. Rodríguez, Carlos Andrés Galán-Vidal (2009): Chemical studies of anthocyanins: A review, Food Chemistry, Volume 113, Issue 4, 15 April 2009, Pages 859–871
- Su, C.-S., Tang, M., Chen, Y.-P., (2009): Micronization of Nabumetone Using the Rapid Expansion of Supercritical Solution (RESS) Process Jurnal of Supercritical Fluids, doi: 10.1016/j.supflu.2009.04.013
- Tasselli, F., Cassano, A. & Drioli, E. (2007): Ultrafiltration of kiwifruit juice using modified poly (ether ether ketone) hollow fibre membranes, Separation and Purification Technology, Volume 57, Issue 1, Pages 94–102
- Vemavarapu, C., Mollan, M. J., Lodaya, M. & Needham, T. E. (2005): Design and process aspects of laboratory scale SCF particle formation systems, International Journal of Pharmaceutics, Volume 292, Issues 1–2, Pages 1–16

EFFECT OF DIFFERENT GRASSLAND COMMUNITIES IN ORGANIC FARMING ON CHOSEN SOIL PROPERTIES WITH FOCUS TO CARBON

ŠARAPATKA B.[1], ČÍŽKOVÁ S.[2]

Key words: Soil, grassland, biodiversity, quality, organic matter, sequestration

Abstract

In our research we focused on studying the diversity of grassland in upland areas of the Czech Republic and on selected soil characteristics of these biotopes. In the first phase of the project we studied 44 soil characteristics and found mutual correlations between many of them. In the following phase we chose characteristics which correlated most with other soil characteristics and, at the same time, were easy to evaluate in practise. A great number of correlations were also evidenced between many soil characteristics closely linked to organic matter in soil. In studying these characteristics on selected areas with different types of grass vegetation and consequential cluster analysis and further evaluation, we divided the plots – grassland – into three groups, from newly established vegetation to species-rich communities. We carried out non-parametric analysis on the results and thus proved a statistically significant difference between the species rich and poor vegetation and content of carbon and nitrogen in the soil. These results show differences in carbon content in soil of different grassland communities which could be important for carbon sequestration.

Introduction

Soil plays an important role in the carbon cycle on Earth and also ensures key functions related to productivity of the world's agroecosystems. Carbon is also a suitable agro-environmental indicator of the quality of soil. The global estimate of C content in arable soils is about 10 % of total soil reserves (Paustian et al., 2000) while grassland contains about 30 % of this amount.

Content of organic matter in soil often increases when a crop-based system is changed to permanent vegetation. Such vegetation can be considered, in terms of landscape heterogeneity and biodiversity, to be another indicator of the quality of the environment. Few publications have so far dealt with the influence of biodiversity on carbon fluxes. Among the few studies published, Adair et al. (2009) state that the total subsurface C allocation increased in response to increasing biodiversity. In a study published by Steinbeiss et al. (2008) carbon storage significantly increased with sown species richness in all depth segments and carbon losses were even significantly lower with higher species richness. The majority of published studies involve time-restricted experiments which do not make use of the semi-natural communities that are

1 Department of Ecology and Environmental Sciences, Palacký University Olomouc, tř. Svobody 26, 771 46 Olomouc, Czech Republic, e-mail: borivoj.sarapatka@upol.cz

2 Bioinstitut, o. p. s., Křížkovského 8, 771 47 Olomouc, Czech Republic

also used for production purposes. This comparison was carried out for the Central-European conditions of Austria by Gerzabek et al. in 2002.

Materials and methods

In the first phase of the study, while monitoring soil on Czech organic farms, from a wide spectrum of soil characteristics we selected those between which there was the greatest correlation. These were then further studied on farms in the Jeseniky Microregion (Fig. 1) with various types of grassland. In this area 10 farms were chosen which are managed organically according to EU Council Regulation No. 834/2007. The chosen areas of farmland varied in management, and therefore also in diversity of grassland. Since the year 2000 this has been evaluated 3x and soil samples were repeatedly taken for analysis on the chosen areas of land. In our soil research we used methods utilized in accredited Czech laboratories.

The floristic survey within the area studied was processed comprehensively, using basic floristic methods. Only taxons of higher vascular plants were recorded and the nomenclature corresponds to the "Key to Czech Flora" (Kubát, 2002).

The results of soil analysis were worked out at the beginning of the project with the use of correlation. With the use of Kruskal-Wallis analysis we identified statistically significant differences in individual groups of grass vegetation on the basis of soil characteristics. Cluster analysis was used to express the similarities between individual farms according to soil characteristics. A "Statistical" programme (StatSoft) was used.

Results

The study of soils in the Jeseníky microregion showed a range of correlation between soil characteristics of areas of grassland, which are described in Table 1. A simultaneous survey of the quality of grass communities, in terms of their diversity, was carried out.

We then processed the results with a cluster analysis and after evaluation we divided the locations – grassland into three groups, from newly established grass vegetation (16 plant species on an evaluated area of 16–25 m^2 on average), to species-richer communities (33 plant species on the evaluated area). During the research we registered important correlations between a number of soil characteristics and the content of organic carbon and organic nitrogen (Table No. 1). Non parametric analysis of these results confirmed a statistically significant difference between species-poor and species-rich plant communities in terms of the content of carbon and nitrogen in the soil. During our evaluation we found that the difference between intensive and extensive species-rich communities varies between 40–50 t C per ha. This is evident from the data obtained, which shows that 58.9 t $C.ha^{-1}$ was found in the 0–20 cm layer in re-cultivated, species-poorer pasture while in species-rich communities this amount was significantly higher – 106.1 t $C.ha^{-1}$. Other differences were also registered in other soil parameters in individual types of communities. Statistically significant differences found in parameters relating to soil organic matter via the Kruskal Wallis test are stated in Table No. 2.

Tab. 1: Correlations between soil characteristics of grassland ($p < 0.05$, 0.01, resp.)

Por.	Cond.	pH/$CaCl_2$	P	K	Ca	Mg	$C_{org.}$	$N_{org.}$	HA: FA	Resp.	
x	-	X	-	-	-	-	x	x	-	x	Bulk dens.
	x	-	-	-	-	-	-	x	-	x	Por.
		X	x	x	x	x	x	x	x	-	Cond.
			x	x	x	x	x	x	x	-	pH/$CaCl_2$
				x	x	x	-	-	x	-	P
					x	x	x	x	x	-	K
						x	x	x	x	-	Ca
							-	x	-	-	Mg
								x	x	x	$C_{org.}$
									x	x	$N_{org.}$
										-	HA: FA

Key: x significant correlation (Czech organic farms and/or farms in the Jeseníky)
– no significant correl. (Czech organic farms and/or farms in the Jeseníky)
Por. = porosity, Cond = conductivity, Resp. = respiration

Tab. 2: Comparison of $C_{org.}$ and $N_{org.}$ content in relation to diversity of grassland

	$C_{org.}$ (%)	**$N_{org.}$** (mg kg^{-1})
Newly established grassland	+ 2.02	+ 2069.90
Older grassland re-cultivation	- 2.76	- 3167.13
Species-rich communities of grassland	+ 3.93	+ 5704.15

Key: + there is a difference between groups
– no statistical difference was found between groups
number – average value for $C_{org.}$ and $N_{org.}$

Discussion

Correlation was found between a number of soil characteristics and the content of humus and total nitrogen within the research. Significant difference between species-poor and species-rich plant communities was described in terms of these characteristics. This is in accordance with e.g. results by Conant et al. (2001), who conclude that grassland can act as a significant carbon sink with the implementation of soil-protecting management. Steinbeiss et al. (2008) studied relationships between plant diversity and carbon storage. Carbon storage significantly increased with species richness achieved by additional sowing and carbon losses were significantly smaller with higher species richness. The increasing species diversity increased root biomass production and this diversity was very important for changes in soil carbon.

Similarly, results of Austrian research refer to the difference in carbon content in the soil of intensively utilized grassland and extensive communities (alpine meadows) (Gerzabek et al., 2002). This data also corresponds to our findings.

Some studies emphasize a higher biomass of subsurface plant parts in species-richer grassland in comparison to intensively fertilized re-cultivated grassland.

Conclusion

Enrichment of species diversity is one of the indicators of quality of the environment but its effects can also be found in the soil environment. In our research we confirmed a number of correlations between soil characteristics, as well as differences in these characteristics due to the type of grassland management and history of grassland. Soil organic matter is of great significance in these characteristics, where we found considerable differences between renewed and near-natural ecosystems. These results are comparable with data stated in specialist publications relating to Central European conditions (e.g. Gerzabek et al., 2002). Besides enriching species diversity, the described qualitative change can also affect carbon sequestration. Besides the benefits to carbon sequestration, the qualitative change in grassland has a range of non-productive effects in the landscape. Within the changes to agroenvironmental measures that we have described, these effects can even be of economic benefit to individual farms.

Acknowledgements

The authors of this article would like to express their thanks to the Czech Ministry of Education, Youth and Sports (grant NPV II No. 2B06101) and to the Czech Ministry of the Environment (grant VaV SP/2d3/155/08) for their support in this research.

References

- Adair CE, Reich PB, Hobbie SE, Knops JMH (2009). Interactive effects of time, CO_2, N, and diversity on total belowground carbon allocation and ecosystem carbon storage in a grassland community, Ecosystems 12, 1037–1052.
- Conant RT, Paustian K, Elliot ET (2001). Grassland management and conversion into grassland. Effects on soil carbon. Ecological Applications 11, 343–355.
- Gerzabek MH, Strebl F, Tulipan M, Schwarz S (2002). Quantification of carbon pools in agriculturally used soils of Austria by use of a soil information system as basis for the Austrian carbon balance model. In: Scott Smith, C.A. (ed.) Soil organic carbon and agriculture: developing indicators for policy analyses. Proceedings of the OECD Expert Meeting. Agriculture and Agri-Food Canada, 73–78.
- Kubát K (ed.) (2002). Klíč ke květeně České republiky. (Flowers of the Czech Republic) Academia, Praha (in Czech).
- Paustian K, Six J, Elliot ET, Hunt HW (2000). Management options for reducing CO_2 emissions from agricultural soils. Biogeochemistry, 48,147–163. 130–154.
- Steinbeiss S, Bessler H, Engels C, Temperton VM, Buchmann N, Fischer C, Kreutziger Y, Baade J, Habekost M, Gleixner G (2008). Plant diversity positively affects short – term soil carbon storage in experimental grasslands. Global Change Biology 14, 2937–2949.

INFLUENCE OF FLESH COLOUR ON THE CONTENT OF MAJOR ANTIOXIDANTS IN POTATOES FROM ECOLOGICAL GROWING

HAMOUZ, K.[1], LACHMAN, J.[1], DVOŘÁK, P.[1], HEJTMÁNKOVÁ, K.[1], CIMR, J.[1] & ČÍŽEK, M.[2]

Key words: potato varieties; antioxidants; chlorogenic acid; ascorbic acid; anthocyanins

Abstract

In 2010 a field trial at the Experimental station of the Czech University of Life Sciences in Prague Uhříněves in terms of organic (ecological) conditions with 6 blue- or red-fleshed potato varieties and with the yellow-fleshed control Agria variety was performed. After harvest, tubers were analyzed for the content of chlorogenic acid (ChA), ascorbic acid (AA) and total anthocyanins (TA). Flesh colour significantly influenced the ChA content, which was in the varieties with coloured flesh from 1.29 to 1.88 times higher in comparison with the yellow-fleshed Agria variety. Significant differences in the content of ChA were found among the different varieties with coloured flesh, a decrease of the variety with the lowest content to the highest content was 31.6 %. In contrary, AA content did not depend on the colour of the flesh, but the genotype of each variety, as the difference of AA contents between the Blaue Elise (176.7 mg/kg FM – blue-fleshed), Agria (170.6 mg/kg FM – yellow-fleshed) and Highland Burgundy Red (160.3 mg/kg FM – red-fleshed) varieties was inconclusive. TA content was demonstrably influenced by the genotype of the variety, the highest value reached the Blaue Elise variety (84.6 mg cyanidin/kg FM).

Introduction

Potato tubers, due to the amount consumed, are one of the main sources of antioxidants in the human diet. Most antioxidant compounds represented by the yellow-fleshed potatoes are polyphenols (chlorogenic acid, caffeic acid, etc.), ascorbic acid, carotenoids, tocopherols, and selenium (Lachman et al., 2009). For purple- or red-fleshed varieties antioxidant effect of about two to three times higher is reported, which is attributed to the content of other phenolic compounds of the flavonoids – anthocyanin pigments (Reyes et al. 2005). About these varieties in some countries have recently been interested lovers in healthy food and in connection with this also plant breeders. For example, several new varieties of this type have been bred in recent years in the U.S. (Brown et al., 2008), in the Czech Republic was bred the Valfi variety, which was registered in 2005. Previous published data do not explain fully what is the content of major characteristic antioxidants present in varieties of potatoes and there is a lack of knowledge of the conditions of organic cultivation. Therefore, the purpose of this study was just examine the effect of potato genotype and the colour of flesh of the organically grown varieties on the content of chlorogenic acid, ascorbic acid and also in flesh colour varieties the effect of genotype on anthocyanin content.

[1] Czech University of Life Sciences in Prague, Faculty of Agrobiology, Food and Natural Resources, Kanýcká 129, Praha 6 – Suchdol, 165 21, Czech Republic, E-mail hamouz@af.czu.cz, Internet www.czu.cz

[2] Potato Research Institute, Havlíčkův Brod, Czech Republic, Internet www.vubhb.cz

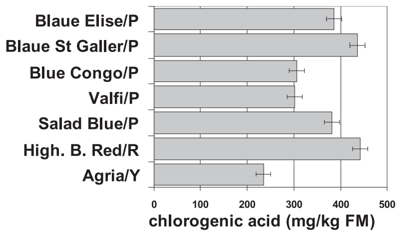
Materials and methods

In 2010 the exact field trial with potato varieties with coloured flesh in Prague Uhříněves was founded on organically certified land in the local research station, which is a field office of the Department of Crop Production of the University of Life Sciences in Prague. Uhříněves Research Station is located in sugar beet agricultural production area at an altitude of 295 m, long-term average annual temperature is 8.4 °C and sum of long-term annual precipitation 575 mm; black earth soils predominate with neutral pH and organic matter content of 1.74 % to 2.12 %. Previous crop was a mixture of peas and beans, which was broken in the process mulcher in the growth phase of green beans, and this biomass has been after wilting plowed into the soil. The experiment was based on four replications without fertilization with mineral fertilizers, protection against late blight of potato consisted of three preventive sprayings with Kuprikol 50, to control beetles two sprays with plant extract Neem Azal T/S (both products allowed in organic farming) were made. Five purple-fleshed varieties (Blaue Elise, Blaue St. Galler, Congo Blue, Salad Blue, Valfi), one red-fleshed (Highland Burgundy Red) and the control yellow-fleshed Agria variety were cultivated. After harvesting of the crop at physiological maturity, experimental samples of tubers of all varieties were analyzed in the laboratory of Department of Chemistry of Life Sciences in Prague. The content of chlorogenic acid (CHA) was determined by RP-HPLC-DAD, the content of ascorbic acid (AA) by HPLC and total anthocyanin content (TA) spectrophotometrically and expressed as cyanidin equivalent. The results were evaluated statistically by analysis of variance and for a more detailed assessment by Tukey's test with SAS program (version 8.02) at significance level P = 0.05.

Results and Discussion

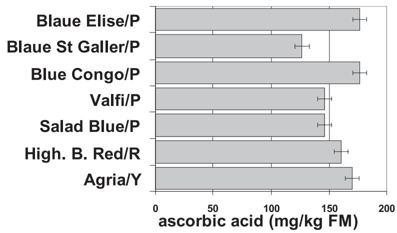
Content of chlorogenic acid: ChA contents ranged from 234.4 mg/kg FW to 441.8 mg/kg FW; the lowest content of ChA was observed in the control yellow-fleshed variety Agria (Figure 1). For varieties with coloured flesh we found levels of ChA by 28.9 % and 88.5 % higher. Significant differences were also observed in the varieties with coloured flesh, which we can in view of significance of differences in content between ChA divide into three groups. To the first one with the highest content of ChA belongs the Highland Burgundy Red variety and Blaue St. Galler, to the second group the Blaue Elise and Salad Blue varieties and to a third group the Congo and Valfi varieties. The fundamental difference in ChA content between the control yellow-fleshed variety and purple- and red-fleshed varieties is associated with the content of anthocyanin colourants in the varieties with coloured flesh. Our finding is consistent with results of other authors (Friedman, Levin 2009, Brown et al. 2007). For varieties with coloured flesh at less intense staining or more of light marbling lower levels of ChA are evident. Likewise André et al. (2007; 2009) found that the content of total antioxidant phenolic compounds and some individuals such as major contained chlorogenic acid could be significantly influenced by different intrinsic factors, as variety, yellow-, red- and purple-fleshed potatoes.

Content of ascorbic acid: Of the six varieties with purple and red flesh produced in 2010 in Uhříněves in the AA content the three varieties were almost identical with the yellow-flesh control Agria variety (statistically insignificant difference), while in the other three varieties was identified against the Agria variety a decrease by 13.2 % to 25.8 % (Figure 2) in its content. From the results significant differences between the AA content in some varieties with coloured flesh are obvious.



vertical lines represent HSD $_{(P\leq0.05)}$ = 32.492; P – purple-, R – red-, Y – yellow-fleshed variety

Fig. 1: Effect of varieties with different colour of flesh on the content of chlorogenic acid (mg/kg FM)

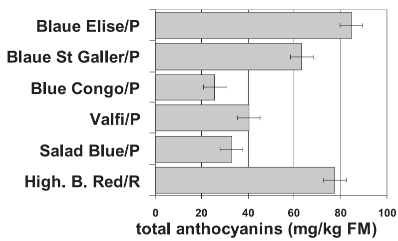


vertical lines represent HSD $_{(P\leq0.05)}$ = 12.113; P – purple-, R – red-, Y – yellow-fleshed variety

Fig. 2: Effect of varieties with different colour of flesh on the content of ascorbic acid (mg/kg FM)

The highest content of AA was observed in the varieties Blaue Elise and Blue Congo (176.7 and 174.2 mg/kg FW), mean content in the only red-fleshed Highland Burgundy Red variety (160.3 mg/kg FM) and significantly low levels of AA were found in the Salad Blue, Valfi and Blaue St. Galler varieties (148.1, 145.9 and 126.5 mg/kg FM). The results show that the AA content depends not on the colour of flesh, but the genotype of each variety – this shows balanced levels of AA with inconclusive differences between the Blaue Elise Blue Congo, Agria and Highland Burgundy Red varieties. AA concentrations in potatoes from our experiments and significant effect of the variety on the AA content correspond to the recently published results (Brown, 2005).

Content of total anthocyanins: TA content ranged in a fairly wide range from 25.8 mg/kg FM cyanidin to 84.6 mg/kg FM cyanidin, and to some extent, it again corresponded (as in the case of ChA) with the intensity of colour range and pale flesh marbling of individual varieties. High contents of TA reached the Blaue Elise variety (84.6 mg cyanidin/kg FM – purple flesh) and the Highland Burgundy Red (77.3 mg cyanidin/kg FM – red flesh), mean content was found in the Blaue St. Galler variety (63.3 mg cyanidin/kg FM) and the Valfi variety (40.3 mg cyanidin/kg FM) and demonstrably the lowest levels in Salad Blue (32.8 mg cyanidin/kg FM) and Blue Congo (25.8 mg cyanidin/kg FM) varieties. The relatively large range of the TA between each variety corresponds with our previous findings (Lachman et al. 2009) and corresponds to the published data of Brown (2005).



vertical lines represent HSD $_{(P\leq0.05)}$ = 9.861; P – purple-, R – red-fleshed variety

Fig. 3: Effect of variety on the content of total anthocyanins

Conclusions

ChA, AA and TA content was confirmatively influenced by cultivar genotype. Cultivars with purple and red pulp reached by 28.9 % to 88.5 % higher ChA content in comparison with yellow pulp cultivar Agria. In AA content we did not find in three from six cultivars with colour pulp significant difference in comparison with yellow pulp cultivar and in other three cultivars we found lower content by 25.8 %. Regarding cultivars with colour pulp the highest AA content was reached in cultivar Blaue Elise. TA content ranged from 25.8 to 84.6 mg of cyanidine/kg of n.w. and corresponded with intensity of colour and with extent of light marbling of pulp in tubers of individual cultivars. Potatoes with colored flesh are shown to be suitable for cultivation in organic farming. For their health benefits they have the potential to gain popularity among fans of a healthy diet, so in the future they may become an alternative to yellow-fleshed varieties on the market for organic products with higher selling price.

Acknowledgments

This work was supported by the Ministry of Agriculture of the Czech Republic, Project No. QI101A184 and by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. MSM 6046070901.

References

- ANDRÉ, Ch. M. – OUFIR, M. – GUIGNARD, C. – HOFFMANN, L. – HUSMAN, J. F. – EVERS, D. – LARONDELLE, Y. (2007): Antioxidant profilig of native Andean potato tubers (Solanum tuberosum L.) reveals cultivars with high levels of β-carotene, α-tocopherol, chlorogenic acid, and petanin. Journal of Agricultural and Food Chemistry, 55: 10839–10849.
- ANDRÉ, Ch. M. – SCHAFLEITNER, R. – LEGAY, S. – LEFÈVRE, I. – ALIAGA, C.A.A. – NOMBERTO, G. – HOFFMANN, L. – HAUSMAN, J.F. – LARONDELLE, Y. – EVERS, D. (2009): Gene expression changes related to the production of phenolic compounds in potato tubers grown under drought stress. Phytochemistry, 70: 1107–1116.
- BROWN C. R. (2005): Antioxidants in potato. Am. J. Pot. Res., 82: 163–172.
- BROWN, C. R. – CULLEY, D. – BONIERBALE, M. – AMOROS W. (2007): Anthocyanin, carotenoid content, and antioxidant values in native South American potato cultivars. Horticultural Science, 42: 1733–1736.
- BROWN, C. R., DURST, R.W., WROLSTAD, R., DE JONG, W. (2008): Variability of phytonutrient content of potato in relation to growing location and cooking method. Potato Research, 51: 259–270.
- FRIEDMAN M., LEVIN C. E. (2009): Analysis and biological activities of potato glycoalkaloids, calystegine alkaloids, phenolic compounds, and anthocyanins. In: Singh J., Kaur L. (eds.): Advances in Potato Chemistry and Technology, Academic Press, Burlington, 127–162.
- LACHMAN, J. – HAMOUZ, K. – ŠULC, M. – ORSÁK, M. – PIVEC, V. – HEJTMÁNKOVÁ, A. – DVOŘÁK, P. – ČEPL J. (2009): Cultivar differences of total anthocyanins and anthocyanidins in red and purple-fleshed potatoes and their relations to antioxidant activity. Food Chemistry, 114: 836 – 843.
- REYES, L.F. – MILLER, J.C. – CISNEROS-ZEVALLOS, L. (2005): Antioxidant capacity, anthocyanins and total phenolics in purple- and red-fleshed potato (Solanum tuberosum L.) genotypes. Am. J. Pot. Res., 82: 271–277.

CURRENT SITUATIONS IN ORGANIC CEREAL SEED OFFER IN THE CZECH REPUBLIC

KONVALINA, P.[1], STEHNO, Z.[2], CAPOUCHOVÁ, I.[3], HŮDA, P.[1], MOUDRÝ J.[1] & MOUDRÝ J. JR.[1]

Key words: Organic seed availability, Cereals, Czech Republic

Abstract

Organic farmers are obliged, in compliance with the valid legislation, to use seed originating from the organic production when establishing the crop stands. In a survey we found certified organic cereal seed is used on 6 %, conventional untreated seed on 37 %, and farm seed on 57 % (of the organically farmed area in the Czech Republic). The main reasons for that are as follows: the insufficient surface of land intended for the reproduction of organic seed, the low proportion of accepted seed coming from the accepted reproduction surface. Therefore, low-quality farm seed is used on a large proportion of organically farmed land, which has a negative effect on the yield level of the cereals. These observations were also confirmed by results obtained in a farmer survey. Farmers indicated that they are interested in certified organic seed if it is available. However, the sufficient supply and favourable prices are important for them.

Introduction

The surface of arable land represented 12.26 % (54,937 ha) in the organic farming system (OF) in the Czech Republic (CZ) by 31 December 2010. The cereals are the most important market crops grown on arable land (Václavík, 2008). There were 22,762 ha of the organic cereals in CZ in 2009 (figures were published in the yearbook of the Organic Farming of the Ministry of Agriculture in 2009). The Council Regulation (EC) No. 834/2007 of 28 June 2007, and the Commission Regulation (EC) No. 889/2008 of 5 September 2008, are the most important European legislative instructions on OF, and are binding for all member states of the European Union." They lay down a permit to solely use organic seed in order to establish organic crop stands. The seed must originate from plants being grown in compliance with OF rules for at least one generation. The seed reproduction is an extremely difficult process (Thommen, A., Schmid, O., 2006). The reproduction crop stand and seed must meet the requirements of the seed certification and authorization procedure as the conventional plants and seed do, but the OF does not allow any pesticides or mineral nitrogenous fertilizers, etc. (Houba and Hosnedl, 2002). Organic farmers may use certified organic seed or farm seed in order to establish the crop stand. They may also apply for an exception (derogation) and use the conventional untreated seed.

There is a long-lasting deficiency of organic seed in CZ. However, exact data are currently not available. Study aimed to analyse the availability of certified organic seeds in CZ and summarize

[1] University of South Bohemia, Studentská 13, 370 05 České Budějovice, CZ, konvalina@zf.jcu.cz
[2] Crop Research Institute, Drnovská 507, 161 06 Prague 6, CZ, stehno@vurv.cz
[3] Czech University of Life Sciences, Kamýcká 120, 165 21 Prague 6, CZ, capouchova@af.czu.cz

the use of each category of seed in practice. To find out the experience of OF with the certified organic seed is also a objective of the study.

Materials and methods

Data concerning the structure of multiplication crop stands, permitted seed and the range of seed at the market, were obtained from the Department of seed and planting materials of the Central Institute for Supervising and Testing in Agriculture and the Ministry of Agriculture. A questionnaire survey was carried out between 2009 and 2010; 329 questionnaires were sent to organic farmers working on arable land, of which 42 % were sent back. The farmers were asked to answer nine questions. The questionnaires were converted into the electronic versions and assessed by the contingency tables in Excel program.

Results

Between 2008/09 and 2010/11 there was a gradual increase in the land area dedicated to organic cereal seed production. They represented, nevertheless, 1.5 % (349 ha) of the total organic land surface in 2009 in CZ. Regarding the average model seeding rate of 220 kg.ha^{-1}, we would need 5,008 t of seed to plant the entire area of cereals in a particular year. In 2009, the average grain yield of organic cereals in CZ represented 2.94 t.ha^{-1} (Ministry of Agriculture, 2009). It means we would need the reproduction areas of 1,703 ha of 100 % of the seed were allowed to be used. In 2009, seed were reproduced on 20.5 % of the required land surface. It is unrealistic to expect that certified organic seed 100 % seeds. Comparison between the allowed multiplication land surface and amounts of allowed winter wheat seed shows that the major part of harvested seed have not been certified as organic seed in 2009 (Table 1). In the same year, 90.95 t of the winter wheat seed were certified as organic. However, this winter wheat was grown on 125 ha of land. It means that the major part of the harvested material did not meet the requirements of the seed certification procedure (same as the major part of the other cereal species). The range of the reproduced organic cereal species is very narrow. The growing of the suitable varieties on the local farm land and climatic conditions are strongly limited, becouse of limited organic seed availability.

Since 2009, organic farmers used a lot of conventional untreated seed they had asked for. In 2009, 398 exceptions for 1,664 t of seed were granted. Table 2 shows the evident difference between the amount of allowed conventional spelt wheat and triticale seed. The sufficient amount of the organic spelt wheat seed were multiplicated in 2009, organic farmers could, therefore, use only organic seed. On the other hand, triticale was in a high demand, *but there was almost no organic seed*.

Except for the certified organic seed (Table 1) and conventional untreated seed (Table 2), the organic farmers also use their own (so called farm saved) seed in order to establish the crop stands. There is not enough information on the applied amount of farm seed. Therefore, the following model amount of seeds was used for 2009: amount of certified organic seed = 281 t/seeding rate of 0.22 t.ha^{-1} = 1,277 ha of the seeded surface; amount of conventional untreated seed = 1,664 t/seeding rate of 0.22 t.ha^{-1} = 7,564 ha of the sown surface. The surface of grown cereals represented 22,762 ha – 1,227 ha – 7,564 ha = 13,971 ha where the farm seed were applied. The proportion of each seed type is presented in Chart 1. The certified seed should not be ideally resown more than once, which is not, nevertheless, respected.

Tab. 1: Seed production and certified seed offer in the Czech Republic

Species	2008–2009				2009–2010				2010–2011[2]	
	Seed production		Certified seed		Seed production		Certified seed		Seed production	
	NV[1]	ha	NV	t	NV	ha	NV	t	NV	ha
Winter wheat	5	72	4	73	7	125	5	91	4	102
Spring wheat	1	13	1	23	-	-	-	-	1	15
Spelt	2	66	2	159	2	89	2	79	3	143
Spring barley	2	21	1	21	2	26	-		3	20
Triticale	-	-	-	-	1	18	1	8	2	45
Winter rye	-	-	-	-	1	8	1	8	2	37
Naked oat	2	28	2	23	2	34	2	28	1	15
Oat	2	27	-	-	2	50	2	40	2	44
Total	14	227	10	299	17	349	13	254	18	422

[1]NV = number of varieties; [2]no seed certified

Tab. 2: Exceptions for conventional untreated seed use in the Czech Republic

Species	2009		2010	
	Number of exceptions	Seed (t)	Number of exceptions	Seed (t)
Bread wheat	66	271	112	515
Spelt	5	78	9	8
Barley	47	129	77	319
Triticale	86	651	76	455
Rye	23	12	20	42
Oat	161	523	174	444
Total	398	1664	468	1783

Tab. 3: Organic farmers' attitudes to seed issues

Reason for farm seed use (%)		Use of organic seed database (%)		Would you prefer organic seed (%)	
Suitability of varieties	16	Yes, I use the database	51	Yes, I would	75
Seed price	37	Yes, I sometimes use	16	No, I would not	14
Transport distance	18	I know but I do not use	20	I do not know	11
Supply	24	I have no access	7		
Others	5	Others	6		

A further part of the questionnaire aimed to find out how organic farmers find and gather information on seed. The main information resources are as follow: internet, consultancy, from the Association of Organic Farmers and seed companies. The official database of the certified organic seed (http://www.ukzuz.cz/Folders/2295–1-Ekologicke+osivo.aspx) is also frequently used by the organic farmers (Table 3). The obligation to document the absence of the certified

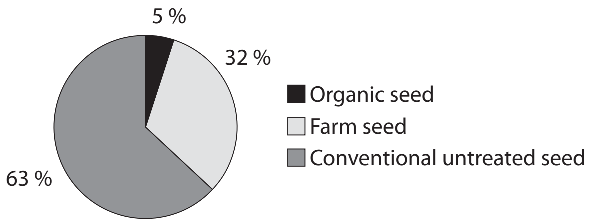


Fig. 1: Cereal seed use in organic farming in the Czech Republic (2009) (%)

organic seed when applying for an derogation in the conventional untreated seed use, is one of important reasons. Most of the organic farmers (75 % of the farms) would prefer the certified organic seed if the supply was sufficient and prices favourable (Table 3). Only 14 % of the farms explicitly prefer conventional untreated seed. The suitability of varieties and transport distance are another reasons for the farm seed preference (Table 3).

Discussion

The application of organic seed becomes more important in many European countries thanks to the legislative measures and increasing demand for the organic products (Václavík, 2008). It is, nevertheless, one of the most developing parts of the organic farming system (Shamash, 2008). However, the total supply of organic seed is still quite low. The high proportion of common farm seed coming from repeated seeding contributes to a reduction of the yield rate of the crop stands (Lammerts van Bueren, E. T. et al., 2003). The seed certification process is very demanding, as the organic seed undergo the control of the Central Institute for Supervising and Testing in Agriculture and of the organic farming (Houba, Hosnedl *et al.*, 2002), but organic farming regulations do not allow to use any supportive, etc. (Lampkin, 1990).

Conclusions

There is a deficiency of the organic seed in the Czech Republic. The authorized multiplication land surface is insufficient. Most of the seed have not been certified as organic, especially because of their health. Therefore, the seed certification process should be revised (nowadays, the same requirements are imposed on the organic and conventional seed, however the organic farming system is not allowed to use any pesticides). Seed producers should also be motivated, by special benefits and grants for example. It is also possible to import the seed from the countries providing a sufficient supply of them, but just for a limited period of time.

Acknowledgments

This work was supported by the Ministry of Agriculture of the Czech Republic – NAZV, Grant No. QI91C123.

References

- Houba, M., Hosnedl, V. (2002): Osivo a sadba. Profi Press, Praha, 186 p.
- Lammerts van Bueren, E. T., Struik, P. C., Jacobsen, E. (2003): Organic propagation of seed and planting material: an overview of problems and challenges for research. NJAS Wageningen Journal of Life Sciences 51: 263–277.
- Lampkin, N. (1990): Organic farming. Farming press, Ipswich, 701 p.
- MZe (2009): Ročenka ekologické zemědělství 2009. MZe ČR, Praha, 44 p.
- Shamash, J. (2008): Developments in seed production. Horticulture Week 41: 2.
- Thommen, A., Schmid, O. (2006): The use of organic cereal seed in selected European countries. In: Joint Organic Congress, Odense, Denmark, May 30–31, 2006.
- ÚKZÚZ (2011): Ekologické osivo, http://www.ukzuz.cz, (accessed 2011–06–26).
- Václavík, T. (2008): Ročenka český trh s biopotravinami. Green marketing, Praha, 65 p.

3rd Scientific Conference

POSTER SECTION

PHENOTYPIC YIELD STABILITY OF FIVE SWEET CORN HYBRIDS GROWN IN ORGANIC, LOW INPUT AND CONVENTIONAL AGRICULTURAL SYSTEMS

CORDEA, M.I.[1], ARDELEAN, M.[2] BORS, A.[3] & HAŞ, V.[4]

Key words: sweet corn, ear yield, P_i index of stability, G and G x E effects

Abstract

Five Romanian sweet corn hybrids (Prima, Estival, Deliciul verii, Dulcin and T-145) released by the Agricultural Research Station, Turda, Romania, were tested in three years (2008–2010) in three locations of Central Transylvania. A split plot design was used in which, on a general level of organic fertilization (40 t/ha manure), four levels of mineral N fertilization were applied (kg/ha, active matter): N_0, typical for organic technologies; N_{50}, corresponding to the low-input (sustainable) system; N_{100} and N_{150} customary with conventional system of agriculture. Based on ear yield data registered for hybrids in locations x years x cropping system, a superiority index (P_i) was computed (LIN and BINNS, 1988) for each sweet corn hybrid illustrating the stability of their ear yields, with and without husks. The share of genotypic and G x E effects in the total value of P_i has been also evaluated. It is concluded that, at least for the time being, the initiation of an organic breeding program for sweet corn, in Romania, is not economically justified. Moreover, among the recently released sweet corn hybrids one can find certain genotypes highly adapted to organic (i.e. Deliciul verii, Estival) or low input (Dulcin, Estival) agricultural practices.

Introduction

As it is well known, sweet corn needs high quantities of nitrogen for its vegetative and generative development. Most of farmers agree upon the fact that high and profitable yields in sweet corn are possible only by supplying the crop with important quantities of nitrogen, either as organic and/or mineral compounds. Thus a rather natural answer arises: how far should one go with mineral N fertilization of the existing sweet corn hybrids? To this question the present paper tries to give an answer based on results obtained in rigorous field experiments carried out in Central Transylvania, Romania.

Materials and methods

Five Romanian sweet corn hybrids (Prima, Estival, Deliciul verii, Dulcin and T-145) released by the Agricultural Research Station, Turda, Romania, were tested in three years (2008–2010) in three

1 University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3–5 Manastur Street, 400372 Cluj-Napoca, Romania, E-Mail mirelacordea@yahoo.co.uk, Internet www.usamvcluj.ro

2 As above

3 As above

4 Agricultural Research Station, 27 Agricultorilor Street, Turda, Romania, E-mail hasvoichita@gmail.com, Internet www.scdaturda.ro

locations of Central Transylvania (Turda, Jucu and Morău, all three in Cluj County), with obviously different soil and climatic condition. The experiments were organised in a split plot design in which, on a general level of organic fertilization (40 t/ha manure), four levels of mineral N fertilization were applied (kg/ha, active matter): N_0, typical for organic technologies; N_{50}, corresponding to the low-input (sustainable) system; N_{100} and N_{150} customary with conventional system of agriculture. The specific technologies of weed and pest control were applied in each agricultural system.

Based on ear yield data registered for hybrids in locations × years × cropping system, a superiority index (Pi) was computed for each sweet corn hybrid, illustrating the stability of their ear yields, with and without husks. LIN and BINNS' (1988) procedure and formula were used to compute Pi which is the measure of deviation of performances of a certain genotype from the maximum value of the studied character (i.e. ear yield) across all environments. Thus, the cultivar with the lowest Pi value will be considered the most stable one, the most adapted to the various environments in which the experiment has been carried out. The authors consider that the first part of the proposed formula is quantifying the contribution of genotype (G) while the second part is indicating the share of G × E to the total value of Pi. On this basis the shares of genotypic (G) and G × E effects in the total value of Pi have been evaluated.

Results

It is well known the fact that sweet corn yields poorer than the normal one (HEMPHILL and HART, 1992; SALARDINI et al., 1992.) but nevertheless it can yield as high as 35–40 t/ha unhusked cobs (HAS VOICHITA, 2002) on condition that its needs of nitrogen are properly supplied (ARDELEAN et al., 2010). Since, in Romania, sweet corn is consumed mainly as fresh vegetable (boiled ears), farmers are less interested in husked ear yield and more attentive to produce great number of marketable ears/ha. Table 1 shows the yield performances (t/ha unhusked ears) of the tested sweet corn hybrids grown on different levels of mineral N fertilization as well as their index of superiority and the shares of G and G × E in the total value of these indices.

As it has been expected, Prima cv. registered the poorest yields, most probably due to its earliness which did not allow the plants to use the additional mineral N fertilization. Even on N_{100} and N_{150} this genotype has an unhusked ear yield which differs from that registered on N_0 only slightly above the limits of $P_{5\%}$.

Tab. 1: Unhusked ear yields (t/ha) and their index of superiority (P_i)

Hybrid	Organic (N_0)				Low input (N_{50})				Conventional (mean N_{100} – N_{150})			
	Yield t/ha	P_i	G effect	GxE effect	Yield t/ha	P_i	G effect	GxE effect	Yield t/ha	P_i	G effect	GxE effect
Prima	17.0 f	35.3	25.4	9.8	18.1 ef	30.9	14.6	16.3	20.3 de	37.1	17.7	19.5
Dulcin	20.0 de	16.2	8.4	7.8	22.2 cd	21.6	5.2	16.4	26.2 ab	3.1	0.4	2.7
Estival	21.1 cd	8.6	4.7	3.9	22.9 cd	18.3	4.8	13.5	26.7 a	1.4	0.2	1.2
Deliciul v.	23.4 bc	10.7	0.2	10.5	26.0 ab	18.6	1.4	17.2	29.0 a	11.3	4.9	6.5
T – 145	19.2 ef	16.1	12.1	4.0	23.5 bc	18.7	3.9	14.8	26.6 a	14.6	5.8	8.8

SD5 % for two hybrid x fertilization means: 2.9 – 3.7 t/ha
Note: The difference between any two values, followed by at least a common letter, is not significant

The highest unhusked ear yields were noticed in semiearly and semilate hybrids (26.2–29.0 t/ha) with high and very high rates of additional mineral N fertilization (N_{100} and N_{150}). It is worth mentioning the fact that in Deliciul verii cv. (semilate) the increase of additional mineral N, from N_0 to N_{50} and from N_{50} to N_{150}, was not accompanied by significant increases of unhusked ear yields. Theses results might suggest that for certain sweet corn genotypes, the fertilization with high and very high rates of additional mineral N might not be economically efficient since the yield increase is far from being significant as compared with yield obtained with low rates of mineral N. Such genotypes are highly suitable both for organic and low input agricultural technologies.

In different agricultural systems the tested hybrids were classified differently on the basis of their P_i values. Thus, in the organic system, Estival and Deliciul verii showed the lowest P_i values (the highest stability) for unhusked ear yield, but in Deliciul verii, with the highest ear yield, the share of genotypic effects was very small while in Estival the genotypic and G x E effects were approximately equal. In the sustainable subsystem three hybrids (Dulcin, Estival and Deliciul verii) showed the highest stability of their approximately equal levels of unhusked ear yields while under conventional practices of mineral N fertilization Estival and Dulcin ranked as the most stable genotypes for unhusked ear yield.

Tab. 2: Husked ear yields (t/ha) and their index of superiority (P_i)

Hybrid	Organic (N_0)				Low input (N_{50})				Conventional (mean $N_{100} – N_{150}$)			
	Yield t/ha	P_i	G effect	GxE effect	Yield t/ha	P_i	G effect	GxE effect	Yield t/ha	P_i	G effect	GxE effect
Prima	12.4 g	34.4	26.6	7.8	13.2 g	30.9	21.3	9.7	14.7 fg	32.5	15.7	16.8
Dulcin	15.9 ef	15.9	12.9	5.7	18.3 cde	18.6	10.9	7.7	20.7 ab	2.8	0.2	2.5
Estival	17.2 cde	17.4	9.4	8.0	19.2 bc	14.3	6.5	7.8	21.4 ab	1.5	0.6	0.9
Deliciul verii	18.4 cde	13.0	6.3	6.7	18.2 cde	13.1	4.8	8.3	22.6 a	8.1	3.1	4.9
T – 145	16.3 ef	18.5	11.7	6.8	18.8 bcd	10.7	4.8	5.9	21.4 ab	9.8	4.1	5.7

$SD_{5\%}$ for two hybrid x fertilization means = 2.4 – 3.3 t/ha
Note: The difference between any two values, followed by at least a common letter, is not significant

The ear yield without husks followed rather closely the pattern described for unhusked ear yield. Again significant yield increases are noted only with high rates of N (N_{150}) where the semiearly and semilate genotypes registered husked ear yields very significantly higher than those registered with N_0.

Discussion

There should be emphasized the fact that in all of the three tested agricultural practices the best yielding cultivar (Estival) did not ranked as the most stable one. This result might suggest that, in sweet corn genotypes with high yielding potential, the stability of such yields are more drastically affected by the G x E interaction, no matter what type of agricultural practices are applied.

It is interesting to note that, for husked ear yield, the ranking of the tested cultivars was entirely different in the three agricultural systems. Thus, in the organic and low input systems, the highest yield stability was found in T-145 while under conventional agricultural practices Estival showed the most stable husked ear yield. There can be concluded that for sweet corn, the conventional practices of mineral N fertilization should consider as really efficient only high rates of additional mineral N (N_{150}). The low input practices of N fertilization are far from rewarding the farmer with significant yield increases in comparison with no mineral N application.

Conclusions

1. For sweet corn, the conventional practices of mineral N fertilization should consider as really efficient only high rates of additional mineral N (N_{150}). The low input practices of N fertilization are far from rewarding the farmer with significant yield increases in comparison with no mineral N application.
2. Early genotypes register poor ear yields (with and without husks), most probably due to their short vegetative period which does not allow the plants to use the additional mineral N fertilization.
3. For certain semiearly sweet corn genotypes, the fertilization with high and very high rates of additional mineral N might not be economically efficient since the yield increase is far from being significant as compared with yield obtained with low rates or no mineral N fertilization.
4. Such genotypes (i.e. Deliciul verii) are highly suitable both for organic and low input agricultural technologies.
5. There could be stated that, at least for the time being, the initiation of an organic breeding program for sweet corn, in Romania, is not economically justified, since among the recently released sweet corn hybrids one can find certain genotypes rather highly adapted to organic or low input agricultural practices.

Acknowledgments

This paper is based on results obtained in the CNCSIS project ID no. 1489/2009 financed by the Ministry of Education, Research, Youth and Sports, Romania.

References

- Ardelean M., Mirela Cordea, Voichiţa Haş, Agnes Bors, (2010): Yield and kernel quality performances of five sweet corn hybrids grown in conventional and organic systems of agriculture, Proceedings of ISHS Congress, Lisabona.
- Haş Voichiţa, (2002): Fresh market sweet corn production, “Biotehnologie şi biodiversitate” Ed. Agroprint Timişoara, 213 – 218 p.
- Hemphill, D., J. Hart, (1992): Nitrogen rate, form and placement on sweet corn yield and nitrogen uptake, Oregon State University.
- Lin, C.S., M.R. Binns, (1988): A superiority measure of cultivar performance for cultivar x location data. Can. J. Plant Sci. 68: 193–198.
- Salardini, A.A., L.A. Sparrow, R.J. Holloway, (1992): Sweet corn responses to basal and top-dressed rate and sources of nitrogenous fertilizers. Australian Journal of Agricultural Research 43:171–180.

EFFECTS OF ORGANIC WHEAT CULTIVATION IN WIDER ROWS ON THE GRAIN YIELD AND QUALITY

CAPOUCHOVÁ, I.[1], BICANOVÁ, E.[1], PETR, J.[1]

Key words: winter wheat, organic cultivation, wider rows, yield, quality

Abstract

Exact field small-plot trials with winter wheat varieties Ludwig and Sulamit (both the quality group E – elite) were conducted in organic farming system in the sugar beet growing region of Central Bohemia to test the possibility of increasing in the crude protein content in grain and thereby improving of baking quality under the change of the wheat stand structure (row spacing 125, 250 and 375 mm, sowing rates 200, 300 and 400 germinating kernels per m^2). Statistically significant increase of crude protein content in the wheat grain dry matter by approximately 0.7 % was found at widening of row spacing from 125 to 250 mm and by about 1.5 % by widening of row spacing from 125 to 375 mm. So, the variants cultivated in wider row spacing fulfilled the requirements for crude protein content in grain dry matter of bread-making wheat for minimum 11.5 %. Increase of values of sedimentation test Zeleny was found at widening of row spacing from 125 to 375 mm, too. Wheat cultivation in wider rows had no negative impact on the grain yield.

Introduction

It is now clearly established that wheat grain quality is a function of grain composition, principally in proteins (Triboi et al., 2000). Also according to Pan et al. (2006) grain nitrogen concentration is one of the main quality parameters of the wheat grain.

Organic techniques of cultivation can have an adverse effect on the technological quality, especially when protein content is an important factor. Lower protein content in the wheat grain limits the possibilities of food, especially baking processing (Moudrý, Prugar, 2002). For wheat under the system of organic farming not using mineral nitrogen fertilizers, it is necessary to find another way that should have allowed increase of protein and hence improvement of baking quality.

One of the possibilities is selection of variety. The use of varieties of the quality group E (elite) is above all a prerequisite of success of cultivation of bread-making wheat in organic farming, because as reported by Petr et al. (1998), the varieties with genetically established good milling and baking quality preserve these traits at different cultivation systems, i.e. also at lower inputs.

Protein production in grains, particularly of gliadins and glutenins fractions is also affected by duration and intensity of plants irradiation in the stand (Petr et al., 1987). Therefore, different type of wheat stand structure (wider row spacing, lower sowing rate) that should allow as best

[1] Czech University of Life Sciences (CULS) Prague, 165 21 Prague 6 – Suchdol, Czech Republic, E-mail Capouchova@af.czu.cz, Bicanova@af.czu.cz, Petr@af.czu.cz, Internet www.czu.cz

as possible irradiation benefit could be one of the options, how to improve baking quality of organic wheat.

Materials and methods

Exact small-plot field trials with two varieties of winter wheat Ludwig and Sulamit (both quality group E – elite) were conducted in the years 2006–2008 on the experimental station of Department of Crop Production, CULS Prague in Uhříněves (295 m above sea level, average annual temperature 8.3°C, sum of precipitation 575 mm). Experimental station Prague-Uhříněves is certified for conductance of experiments in organic farming system.

Experiments were carried out by the method of randomised blocks in three replications; average size of experimental plot was 10 m^2. Row spacing 125, 250 and 375 mm and sowing rate 200, 300 and 400 germinating kernels per m^2 were used in the trial. Pea was the preceding crop. Hoeing at the widest row spacing was used, other variants were harrowed.

After the trials harvest the yield was assessed, crude protein content in grain dry matter (Czech Standard ČSN ISO 1871), Zeleny sedimentation test (ČSN ISO 5529) and grain storage protein composition – quantitative evaluation of SDS-PAGE electrophoretic analysis according to Wrigley (1992) were determined.

Yield results and results of quality evaluation were statistically assessed by analysis of variance, 4 factors ANOVA (variety, year, sowing rate and row spacing) in the SAS system, significance of differences between means was verified by multiple range test (LSD test, $\alpha = 0.05$). Results of this test are presented below.

Results

Increase of crude protein content in grain dry matter was found with wider row spacing (tab. 1). At the row spacing 250 mm higher content of crude protein by 0.7 % was recorded, whereas at the row spacing of 375 mm this value was higher by 1.54 % compared to variant with traditional narrow row spacing 125 mm. The variants with the widest row spacing fulfilled the requirements for crude protein content in grain dry matter of bread-making wheat – bottom limit 11.5 % according to the Czech standard ČSN 461100–2. It is also evident from the results, that the crude protein content in grain dry matter was affected the most by row spacing, followed by the year and variety. On the contrary, crude protein content was not affected significantly by the sowing rate.

The quality of protein complex in view of baking utilization is well characterized by Zeleny sedimentation test. The Czech Standard 461100–2 gives 30 ml as a bottom limit of Zeleny test of baking wheat. It is evident from our results, that with widening of row spacing also increased values of Zeleny test, but the limit for baking wheat was fulfilled even in variants cultivated in traditional narrow rows.

Another characterization of baking quality of wheat protein complex can be quantitative evaluation of SDS-PAGE electrophoretic analysis of storage proteins. It follows from our results (tab. 2), that with row spacing widening increased percentage of HMW glutenin subunits, that are responsible for the dough elasticity and decreased percentage of residual albumins and globulins, that affected quality of dough rather negatively.

Except the quality of production it is necessary to pay attention to the grain yield. Our results showed, that the grain yield was the most affected by the variety, followed by the year and sowing rate. Effect of row spacing on yield was significantly lower.

Tab. 1: LSD test for the wheat grain yield, crude protein content in grain dry matter and Zeleny test (LSD, α = 0.05)

Variant/parameter		Grain yield ($t.ha^{-1}$)	Sign.	Crude protein content in grain DM (%)	Sign.	Zeleny test (ml)	Sign.
Variety	Ludwig	5.80	b	11.14	a	38.39	a
	Sulamit	5.01	a	11.86	b	45.15	b
LSD		0.16		0.28		1.87	
Row spacing (mm)	125	5.35	ab	10.76	a	38.63	a
	250	5.28	a	11.45	b	41.35	a
	375	5.59	b	12.30	c	45.33	b
LSD		0.24		0.39		2.76	
Sowing rate ($grains.m^{-2}$)	200	4.85	a	11.50	a	42.08	a
	300	5.57	b	11.52	a	41.24	a
	400	5.80	b	11.49	a	42.04	a
LSD		0.30		0.37		2.48	
Year	2006	5.70	b	10.96	a	43.86	b
	2007	5.70	b	11.61	b	44.50	b
	2008	4.81	a	11.94	b	36.94	a
LSD		0.24		0.36		2.72	

LSD = least significant difference. Values with the same letters are not significantly different.

Tab. 2: Effect of row spacing on percentage of storage protein subunits in the wheat grain (quantitative evaluation of SDS-PAGE electrophoresis of storage proteins, average of 2006–2008)

Variety	Row spacing (mm)	HMW glutenins (%)	LMW glutenins + gliadins (%)	Residual albumins + globulins (%)
Ludwig	125	16	71	13
	250	18	70	12
	375	22	73	5
Sulamit	125	18	69	13
	250	21	72	7
	375	25	70	5

HMW = High-molecular-weight; LMW = Low-molecular-weight

Discussion

The system of wheat cultivation in wider rows was tested in Germany, where it had beed proved that at wide row spacing not only the protein content is increasing but also the values of sedimentation test (Förster et al., 2004). Hiltbrunner et al. (2005) performed the similar research. They reported a statistically significant increase in crude protein content in grain dry matter (by about 1 %) at widening of row spacing from 187.5 to 375 mm. At the same time they add that no decrease in grain yield was found with row spacing increasing.

A significant role for baking use is played not only by amount but also by quality of the wheat protein. Our results showed increasing of Zeleny test values with the row spacing widening, but the limit for bread-making wheat was fulfilled even in variants cultivated in narrow rows. These results giving evidence of relatively high genotype dependence of Zeleny test are in accordance with conclusions made by Kadar & Moldovan (2003).

Conclusions

Our results confirmed the possibility to increase the crude protein content in grain dry matter and improvement of baking quality of winter wheat in organic farming system under the change of the stand structure – cultivation of wheat in wider row spacing. Wheat cultivation in wider rows had no negatice impact on the grain yield.

Acknowledgments

Supported by the research projects MSM 6046070901 and NAZV QG50034.

References

- Förster, Ch., Wilmersdorf, G., Lutz, C., Müller, E. (2004): Praxiseinführung des Anbaukonzeptes Weite Reihe für eine umweltgerechte Getreideproduktion unter besonderer Berücksichtigung des Qualitätsaspektes bei Backweizen. Final report of research project of Institut für Pflanzenbau und Pflanzenzüchtung, Univ. Giessen, http://www.agranet.de/6222.php.
- Hilbrunner, J., Liedgens, M., Stamp, P., Streit, B. (2005): Effects of row spacing and liquid manure on directly drilled winter wheat in organic farming. Europ. J. Agron., 22:441–447
- Kadar, R., Moldovan, V. (2003): Achievement by breeding of winter wheat varieties improved bread-making quality. Cereal Res. Commun., 31:89–95
- Moudrý, J., Progar, J. (2002): Bioprodukty – jakostní hodnocení, zpracování a marketing. (Bioproducts – quality evaluation, processing and marketing). Handbook of organic farmer, No. 1, MZE (ÚZPI) Prague, 34 pp.
- Pan, J., Zhu, Y., Jiang, D., Li, Y., Cao, W. (2006): Modelling plant nitrogen uptake and grain nitrogen accumulation in wheat. Field Crops Res., 9:322–336
- Petr, J. et al. (1987): Počasí a výnosy (Weather and yields), SZN Prague, 368 pp.
- Petr, J. sen., Petr, J. jun., Škeřík, J., Horčička, P. (1998): Quality of winter wheat from different growing systems. Scientia Agriculturae Bohemica, 29:161–182
- Triboi, E., Abad, A., Michelena, A., lloveras, J., Ollier, J.L., Daniel, C. (2000): Environmental effects on the quality of two wheat genotypes: I. quantitative and qualitative variation of storage proteins. Eur. J. of Agronomy, 13:47–64
- Wrigley, C.W. (1992): Identification of cereal varieties by gel electrophoresis of grain proteins. Seed Analysis – Berlin, Heilderberg, Springer Verlag, 17–41 pp.

INFLUENCE OF SURFACE MULCHING ON THE QUALITY OF POTATO TUBERS

DVOŘÁK, P.[1], TOMÁŠEK J.[1], HAJŠLOVÁ J.[2] & SCHULZOVÁ, V.[2]

Key words: Potato; Mulching; Vitamin C; Dry matter; Chlorogenic acid

Abstract

This paper explores the effectiveness of organic and plastic mulching for potato production in two regions of the Czech Republic. The mulching with chopped grass (GM) and black textile mulch (BTM) were compared to non-mulching control variant (C) with mechanical cultivation. The results of the experiment did not prove any decreasing of dry matter of tubers in treatments with mulch (BTM or GM) in comparison with C variant without mulch. Next results showed that lower content of Vitamin C in GM (by 0.08 %) and BTM (by 6.21 %) in comparison with C variant was recorded. There was recorded a trend of lower content of chlorogenic acid in GM (by 6.61 %) and BTM (by 1.67 %) in comparison with C variant.

Introduction

Mulching which has become more popular lately is an important way of soil protection in the plant production. Surface mulching is one of the most cost effective means (Shelton et al., 1995), because of a range of positive effects on the soil fertility and other factors important for plant production.

The growing technology as a mulching can have an effect on the external quality of tubers (scab of tubers, mechanical damages, greening of potato-tubers) and inner quality (chemical composition) as well. From inner quality point of view, potatoes are valued mainly for the content of niacin, vitamin B6 and especially for the high content of vitamin C (Asghari-Zakaria et al., 2009). Just vitamin C is the main vitamin in potatoes. Global dietary contribution of vitamin C from potatoes is important with an estimate of 40 % of daily-recommended intake. Just the concentration of vitamin C is in most cases consequence of the reaction of potato varieties to climatic conditions and ways of agricultural engineering (Hamouz et al., 2009).

The aim of this paper was to evaluate the effect of different mulch materials (organic and plastic mulch) on the quality of potato tubers in two regions of the Czech Republic. The research was mainly focused on the effect of mulching on dry matter content, vitamin C and chlorogenic acid.

[1] Department of Crop Production, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Kamýcká 129, Prague 6 – Suchdol, Czech Republic, E-Mail dvorakp@af.czu.cz, Internet www.czu.cz

[2] The Institute of Chemical Technology, Prague, Technická 5, 166 28 Prague 6 – Dejvice, Czech Republic, Internet www.vscht.cz

Materials and methods

Field experiment. Potato tubers for analysis were got from field experiments on two sites -Leškovice in the Czech-Moravian Highlands (potato growing region) and Uhříněves (sugar beet region). In the experimental sites Leškovice (LE) and Uhříněves (UH), mulching with chopped grass (GM) and black textile mulch (BTM) were compared to non-mulching control variant with mechanical cultivation (C).

The samples. Tubers were harvested by hand. Post harvest analyses were focused on the determination by quality of tubers from each variant. All treatments were divided into four parallel determinations (plot trials 7.2 m^2). Summary statistics of the effect of mulching on tubers quality were obtained by using Statgrafic Plus 5.1. Statistical analyses were performed by using the ANOVA. Means were compared by using Tukey test at the level of significance $\alpha = 0.05$.

Vitamin C. A sample of 25–30 g fresh potato was homogenized in 100 ml 3 % metaphosphoric acid. The vitamin C content in this extract was determined by HPLC (HP 1200, Hewlett-Packard, equipped with DAD detector, USA) at UV 258 nm. A reversed phase octadecylsilica column (Merck, Germany) LiChroCART (125–4 mm), LiChrospher 100 RP-18 (5 µm) with precolumn (Merck, Germany) LiChroCART (4–4 mm), LiChrospher 100 RP-18 (5 µm) was used for HPLC separation. The mobile phase was 5 % MeOH; pH=3 (H_3PO_4), the flow rate was 0.8 ml/min, the column temperature was 35 °C. Method performance characteristics: RSD of the method was 5 %, recovery 95 % and LOD 0.5 mg/kg.

Chlorogenic acid. 30 g of fresh potato sample were homogenized in 200 ml of methanol and after filtration of the crude extract chlorogenic acid was after dilution by water ten times determined by HPLC (HP 1200, Hewlett-Packard, equipped with DAD detector, USA) using UV detection at 324 nm. The reversed phase column (Merck, Germany) LiChroCART (125-4 mm), LiChrospher 100 RP-18 (5 µm) with precolumn (Merck, Germany) LiChroCART (4–4 mm), LiChrospher 100 RP-18 (5 µm) was used for HPLC separation. The mobile phase was: A – methanol, B – 2 % acetic acid (linear gradient A: 0 %, 3 min; 10 – 50 %, 11 min; 50–100 %, 3 min, 4 min post time), the flow rate was 0.6 ml/min, the column temperature was 40 °C. Method performance characteristics: RSD of method was 5 %, recovery 95 % and LOD 5 mg/kg.

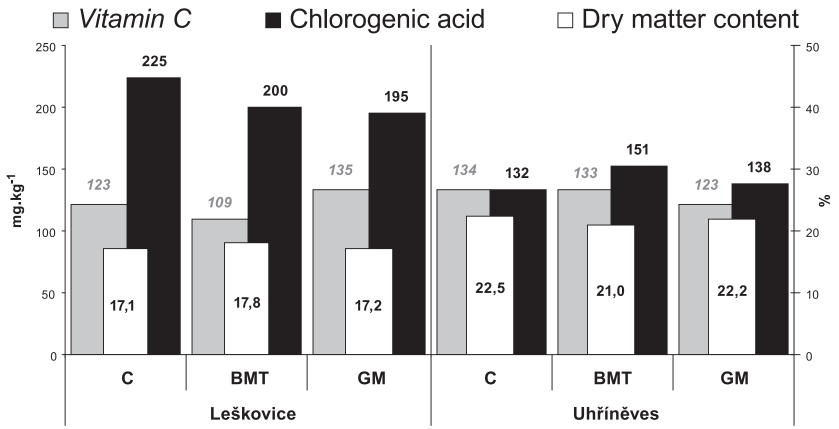
Dry matter. 5 g of homogenised potatoes were dried at 105 °C 5 hours.

Results

Dry matter. The results of the experiment did not prove any decreasing of dry matter of tubers in treatments with mulch (BTM or GM) in comparison with C variant without mulch, nor between sites (Fig. 1). On average of years and sites the tendency of lower dry matter content of tubers in variant with GM and BTM in comparison with C variant (by 0.1, respectively 0.4 %) was found, whereas the difference between GM and BTM treatments was not significant.

Vitamin C. In the experiment the differences of vitamin C content among variants with different types of mulching were not significant on average of both sites and years (Fig. 1). Only trend of lower content of Vitamin C in GM (by 0.08 %) and BTM (by 6.21 %) in comparison with C variant was recorded.

Chlorogenic acid. Also in case of chlorogenic acids have not been found out a negative influence of mulch on chlorogenic acids content in potato tubers (Fig. 1). There was recorded



Note: for dry matter content $HSD_{0.05}$ (LE) = 2.807, $HSD_{0.05}$ (UH) = 5.689; for vitamin C content $HSD_{0.05}$ (LE) = 97.00, $HSD_{0.05}$ (UH) = 91.83; for chlorogenic acid content $HSD_{0.05}$ (LE) = 122.4, $HSD_{0.05}$ (UH) = 94.55

Fig. 1: Effect of mulching on Dry matter content (%), Vitamin C ($mg.kg^{-1}$) and Chlorogenic acid content ($mg.kg^{-1}$) of potatoes (var. Katka) on average 2008–2009

a trend of lower content of chlorogenic acid in GM (by 6.61 %) and BTM (by 1.67 %) in comparison with C variant. The content of chlorogenic acid was significantly affected only by site conditions (chlorogenic acid content was higher by 32 % in LE than in UH).

Discussion

A probable reason of dry matter content reduction in variant with BTM in UH is the shorter period of existence of assimilation apparatus as a consequence of damaging leaves by beetles and larvae of CPB. It corresponds to Hamouz et al. (2005), who mentioned significant damaging of assimilation apparatus of organic growing potatoes by CPB and also by Late blight. Comparing experimental sites, lower dry matter content (by 4.5 %) was determined in LE, which is locality with lower temperature and higher sum of rainfalls than UH. This result corresponds to experiments of Hamouz et al. (2007a); Zgórska, Frydecka-Mazurczyk (2000) where correlations between meteorological conditions and dry matter content had been found (higher sum rainfalls and lower air temperature determined lower dry matter content of tubers).

Analogous to by other authors (Hamouz et al., 2009; Hamouz et al., 2007b; Zgórska and Frydecka-Mazurczyk, 2000; Pawelzik et al., 1999) were found expressive differences of vitamin C content among varieties and sites (in LE was found about 5.92 % lower content of vitamin C than in UH).

Conclusions

In the experiment no significant effect of mulching on tubers quality (dry matter content, Vitamin C content, chlorogenic acid content) was observed.

Acknowledgments

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QH 82149, by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. MSM 6046070901 and by project CIGA reg. No. 20112004.

References

- Asghari-Zakaria, R., Maleki-Zanjani, B., Sedghi, E. (2009): Effect of in vitro chitosan application on growth and minituber yield of Solanum tuberosum L. Plant Soil Environ., 55: 252–256
- Hamouz, K., Lachman, J., Dvořák, P., Orsák, M., Hejtmánková, K., Čížek, M. (2009): Effect of selected factors on the content of ascorbic acid in potatoes with different tuber flesh colour. Plant Soil Environ., 55: 281–287.
- Hamouz, K., Dvořák, P., Pardera, J. (2007): Influence of different soil-climatic conditions on the quality of table potatoes. Sci. Agric. Bohemica, 38: 6–12.
- Hamouz, K., Lachman, J., Dvořák, P., Dušková, O., Čížek, M. (2007): Effect of conditions of locality, variety and fertilization on the content of ascorbic acid in potato tuber. Plant Soil Environ., 53: 252–257.
- Hamouz, K., Lachman, J., Dvořák, P., Pivec, V. (2005): The effect of ecological growing on the potatoes yield and quality. Plant Soil Environ., 51: 397–402
- Pawelzik, E., Delgado, E., Poberezny, J., Rogozińska, I. (1999): Effect of different climatic conditions on quality of certain German and Polish potato varieties. In: Abstracts of 14th Triennial Conference, EAPR, Sorrento: 635–636.
- Shelton, D.P., Dickey, S.D., Hachman, S.D., Steven, S., Fairbanks, K.D. (1995): Corn residue cover on soil surface after planting for various tillage and planting system. J. Soil and Water Conser., 50: 399–404.
- Zgórska, K., Frydecka-Mazurczyk, A. (2000): The influence of weather conditions during growing season and storage temperature on processing quality of potatoes. Biuletyn Instytutu Hodowli i Aklmatyzacji Roślin, Jadwisin, 213: 239–251.

EFFECT OF MULCHING MATERIALS ON THE SOIL TEMPERATURE, SOIL WATER POTENTIAL, NUMBER AND WEIGHT TUBERS OF ORGANIC POTATOES

DVOŘÁK, P.[1], TOMÁŠEK J.[1], HAMOUZ, K.[1] & KUCHOVÁ, P.[1]

Key words: grass mulch, textile mulch, yield, organic agriculture

Abstract

The mulching with chopped grass (GM) and black textile mulch (BTM) were compared to non-mulching control variant (C) with mechanical cultivation in two regions of the Czech Republic. Especially in plots with BTM were first formed ridges and covered by the black polypropylene non-woven textile and then they were planting. The surface mulching of potatoes affected the soil temperature (higher about 0.2 – 1.6 °C than in C) and water potential of the soil (higher only by 8 kPa than in C). GM had a significant effect on the yield of ware potatoes. The final tuber yield was higher by 22.9 % on plots with GM in comparison with C. GM resulted in a significant increase of the number and weight of tuber fraction 56–60 mm and over 60 mm.

Introduction

Mulching which has become more popular lately is an important way of soil protection in the plant production. Surface mulching is one of the most cost effective means (Shelton et al., 1995), because of a range of positive effects on the soil fertility and other factors important for plant production. Moreover mulch improves soil conditions, especially reduces water evaporation from soil and helps to maintain stable soil temperature (Ji and Unger, 2001; Kar and Kumar, 2007). The cover of mulch influences soil moisture as well (Ramakrishna et al., 2006). Mulch maintains stable soil moisture, especially in surface soil layer. In warmer areas the Colorado potato beetle (CPB) is considered as the most important pest species. The CPB is a great problem especially in organic growing potatoes, because the CPB has relatively few natural enemies (Rifai et al., 2004). The aim of this paper was to evaluate the effect of different mulch materials (of vegetable origin and plastic mulch) on the yield of tubers and on some factors influencing potatoes production in two regions of the Czech Republic. The research was mainly focused on the effect of mulching on soil temperature, soil water potential (SWP).

Materials and methods

Field experiments were conducted over two years on two sites – Leškovice (LE) in the Czech-Moravian Highlands (potato growing region) and Uhříněves (UH) – sugar beet region. Leškovice is 498 m a.s.l., the average of annual temperature is 6.9 °C and annual precipitation is 630 mm.

[1] Department of Crop Production, Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Sciences Prague, Kamýcká 129, Prague 6 – Suchdol, Czech Republic, E-Mail dvorakp@af.czu.cz, Internet www.czu.cz

On the site the type of soil is pseudogleyic acid cambisol (brown gleysol), mostly prevail lighter, loam-sandy soils. Uhříněves is 295 m a.s.l., the average of annual temperature is 8.4 °C and annual precipitation is 575 mm. The soil used in the experiment was Luvisol.

Soil temperature was measured in all treatments (BTM, GM and C) in the depth of 100 mm in 15-min intervals during period from planting to harvest by MicroLog SP (EMS, Brno). Soil water potential (SWP) was measured in all treatments (BTM, GM and C) in the depth of 240 mm in 30-min intervals during period from planting to harvest with sensor Watermark 200SS-X cooperates with MicroLog SP (EMS, Brno). **Mulching.** GM (material from natural meadows *Dactylis glomerata* – 40 %, *Festuca pratensis* – 20 %, *Lolium perenne* – 20 %, *Poa pratensis* – 10 %, *Alopecurus pratensis* – 10 %) was spread manually in a 25-mm thick layer 14th day after planting (immediately after second hoeing). In plots with BTM ridges were formed firstly and then covered by the black polypropylene non-woven textile. During hand-planting potato tubers in demanded spacing (450 mm x 800 mm) were set to prepared holes in the textile. The fertilizers, fungicides, and other formulation against CPB or slugs were not applied in this experiment. The area of the trial plot was 7.9 m^2. There were 4 replicates of each variant. Tubers were harvested by hand. Harvested tubers were sorted out with commercial potato sorters (tubers with potato blight, necrosis or grow green were previously removed) into four fractions (under 40 mm, 40–55 mm, 56–60 mm and over 60 mm). Statistical calculations were done with SAS ver. 9.1.3. (SAS Institute Inc., 2003).

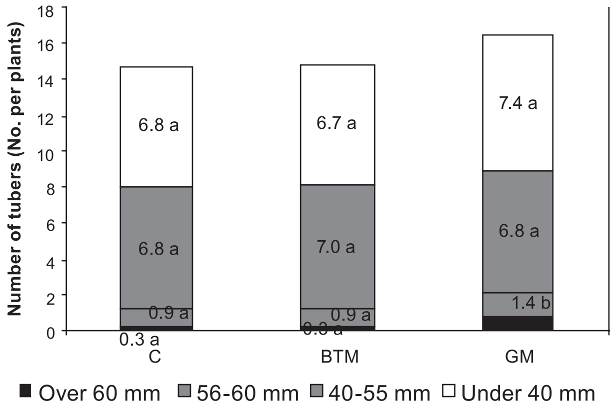
Results

Soil temperature was generally about 0.2–1.6 °C higher in treatments with BTM (at both sites) than in control variant (without mulch). Comparing treatments with BTM at both sites in 2009, soil temperature was about 2.1°C higher in UH than in LE.

The course of soil moisture during the year is strongly influenced by annual precipitation and its distribution during the year. Nevertheless **SWP** was generally higher in the GM and BTM treatments (only by 8 kPa and 1kPa) than in the C variants in UH. Those trends were measured as well in LE.

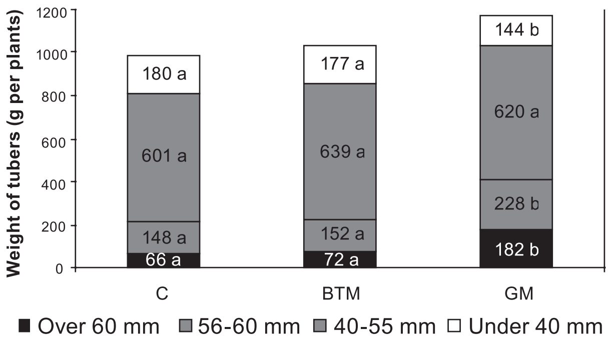
Tuber fractions and yields. An application of GM (Fig. 1, 2) resulted in a significant increase of the number and weight of tubers (tuber fraction 56–60 mm and over 60 mm), on the other hand GM decreased weight of tubers under 40 mm.

For that reason a very significant differences of yield of ware potatoes (Table 1) were found between GM (34.04 $t.ha^{-1}$) and C variant without mulch (26.23 $t.ha^{-1}$). No significant difference of yield of ware potatoes between BTM (28.33 $t.ha^{-1}$) and C was observed. Tuber yield also strongly differed between years, with generally lower yields in 2008 (by 5.5 $t.ha^{-1}$) than in 2009. Yield was not significantly influenced by site (for all that trend higher yields by 1.3 $t.ha^{-1}$ were at LE than at UH).



Note: $HSD_{0.05}$ (under 40 mm) = 3.985, $HSD_{0.05}$ (40–55 mm) = 0.819, $HSD_{0.05}$ (56–60 mm) = 0.316, $HSD_{0.05}$ (over 60 mm) = 0.207

Fig. 1: The effect of different types of mulching on the number of tubers (on average of the sites and years)



Note: $HSD_{0.05}$ (under 40 mm) = 26.74, $HSD_{0.05}$ (40–55 mm) = 79.99, $HSD_{0.05}$ (56–60 mm) = 51.65, $HSD_{0.05}$ (over 60 mm) = 50.90

Fig. 2: The effect of different types of mulching on weight of tubers (on average of the sites and years)

Tab. 1: The effect of different types of mulching on larvae of CPB (number per 10 plants) and tuber yields ($t.ha^{-1}$) of ware potatoes (on average 2008–2009)

Site/Variant of mulching	Leškovice		Uhříněves		Average of sites
	larvae of CPB	yield	larvae of CPB	yield	yield
C	0.1 a	24.9 a	26.9 a	27.6 a	26.2 a
BTM	0.7 a	31.7 b	42.2 b	24.9 a	28.3 a
GM	0.7 a	33.9 b	13.3 a	34.2 b	34.0 b
$HSD_{0.05}$	1.451	4.564	16.82	3.340	3.327

Discussion

According to Brust (1994) potato is sensitive to higher soil temperature and low soil moisture and will not grow properly under these conditions. Brust (1994) mentioned that increase of tuber yields in mulching plots may have been result of lower soil temperature and higher soil water content. The higher soil temperatures was reported also in the plastic mulch by Ramakrishna et al. (2006) by 4 °C at 100 mm depth and by Wang et al. (2009) by 2 – 9 °C. The lowest yield of tubers in treatment with BTM in UH (Table 1) was related to higher occurrence of larvae of CPB and thereby with higher defoliation. In this experiment higher number of CPB egg clusters was found at on plots with BTM compared to C treatments. Potatoes can usually tolerate substantial defoliation without decrease of tuber yield, up to 30 % (when they are in vegetative stages). But they are more sensitive to the effects of defoliation (and bring decrease of tuber yield) when tuber are beginning to bulk and can only tolerate about 10 % defoliation (Hare, 1990). Zehnder and Hough-Golstein (1990) found out significantly lower number of overwintered adult beetles and first generation larvae on plots with straw mulch compared to those without mulch.

Conclusions

The mulching treatment systems affected the soil temperature and water potential of the soil on dependence of the physical and chemical properties of soil as well as organisms that live there.

This study indicated higher incidence of larvae and higher defoliation in BTM than in non-mulched potato plots.

In the experiment the mulching of chopped grass significantly decreased the small size tuber fraction (under 40 mm), while the large size fractions (56–60 mm and over 60 mm) were significantly increased.

The mulching had a positive effect on tuber yield (on average of sites and years). Tuber yields were significantly higher by 22.9 % on plots with GM and higher by 7.4 % in BTM (in comparison with C treatment without mulch).

Acknowledgments

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QH 82149, by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. MSM 6046070901 and by project CIGA reg. No. 20112004.

References

- Brust G.E. (1994): Natural enemies in straw-mulch reduce Colorado potato beetle populations and damage in potato. Biological Control, 4: 163–169
- Ji S., Unger P.W. (2001): Soil water accumulation under different precipitation, potential evaporation and straw mulch conditions. Soil Science Society of America journal, 65: 442–448.
- Kar G., Kumar A. (2007): Effects of irrigation and straw mulch on water use and tuber yield of potato in eastern India. Agriculture Water Management, 94: 109–116
- Ramakrishna, A., Tam, H.M., Wani, S.P., Long, T.D. (2006). Effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. Field Crops Res., 95, 115–125.
- Rifai N.M, Astatkie T., Lacko-Bartosova M., Otepka P. (2004): Evaluation of thermal, pneumatic and biological methods for controlling Colorado potato beetles (Leptinotarsa decemlineata Say). Potato Research, 47: 1–9.
- Shelton, D.P., Dickey, S.D., Hachman, S.D., Steven, S., Fairbanks, K.D. (1995): Corn residue cover on soil surface after planting for various tillage and planting system. J. Soil and Water Conser., 50: 399–404.
- Zehnder, G.W., Hough-Goldstein, J. (1990). Colorado potato beetle (Coleoptera: Chrysomelidae) population development and effects on yield of potatoes with and without straw mulch. J. Econ. Entomol., 83, 1982–1987.

INFLUENCE OF YEAR AND VARIETY TO PRODUCTION OF ECOLOGICALLY GROWN SPRING BARLEY

HONSOVÁ, H.[1]

Keywords: spring barley, organic agriculture, cultivars, yield

Abstract

At an experimental station in Prague – Uhříněves (2005–2010) we tested influence of ecological growing system and of cultivar on spring barley yield. In our experiments we found significant influence of growing year and of cultivar. Yields varied from two to six tonnes per hectare. In six years average the most yielding cultivars became the cultivars Malz and Tolar. In all years, except year 2009, we reached high thousand seeds weight – above forty grammes.

Introduction

In malting barley growing obtained yields together with quality vary significantly according to weather conditions in individual years and harmful agent impact. This fact is confirmed by the results of many authors. Influence of weather on yield components in ecological and conventional growing of spring barley was found e.g. by Macák et al. (2008). We can reach also high yields and good malting quality, but only under favourable conditions of the specific year. Amount of yield together with quality of harvested grain is more significantly influenced by weather in comparison with common agrotechnics with use of fertilizers and chemical protection. This fact was confirmed by the results of presented six years experiments, where hectare yields ranged approximately from two to six tonnes.

Materials and methods

In six years experiments, established at the experimental station of Department of Crop Production of Czech University of Life Sciences in Prague – Uhříněves during the years 2005 – 2010 by classical agrotechnics with autumnal tillage and arrangement of furrow in spring, we compared influence of ecological growing system and of cultivar on production ability of spring barley stands.

At the parcels of harvest area of 10 square meters we sowed 400 of germinative grains per square meter. The experiments were established in four repetitions. Each year we sowed seed produced by ecological method in Uhříněves from cultivars Jersey, Malz, Prestige, Sebastian and Tolar.

In all years we evaluated field emergency, number of spikes per square meter, yield and thousand seeds weight of harvested grain. At ecological area weeds were removed by harrowing

[1] Czech University of Life Sciences in Prague, Department of Plant Production, Czech Republic, E-mail honsova@af.czu.cz

(three times per year), and no fertilizers were used. Harvest was performed in full maturity by small plot harvest machine.

The results were evaluated by statistical program SAS using analysis of variance at significance level $\alpha = 0,05$. Confirmatively different values are marked with different letters (a, b, c, d).

Results and Discussion

Results of experiments were influenced especially by weather course in specific year of growing and importance had also cultivar. Each year barley stands emerged properly, number of plants per square meter reached relatively high values (Table 1). The best emergence had barley in 2010 and 2006, when stand density reached 294 and 292 plants per square meter. In average of six years the differences were non-confirmative among compared variants of varieties. In comparison of years significant differences were not found.

Tab. 1: Number of Plants per Ecological Area During 2005–2010

cultivar	plants (1 m^2)						
	2005	2006	2007	2008	2009	2010	average
Jersey	293	299	253	263	271	309	281 a
Malz	258	304	279	282	261	284	278 a
Prestige	243	305	272	286	268	318	282 a
Sebastian	294	264	268	289	307	278	283 a
Tolar	288	290	274	275	273	279	280 a
Average	279 a	292 a	269 a	279 a	276 a	294 a	281

Number of spikes per square meter before harvest in ecological method of growing did not reach high values (Table 2). The highest number of spikes was created by barley in 2006, in average it was 483 of spikes, the lowest number in 2010. Modern cultivars of spring barley create the yield i.e. by number of spikes, but in organic farming it is difficult to reach necessary amount of spikes in spring barley, because the plants do not have nitrogen in crucial phases of yield formation. Nitrogen is releasing from soil, but in higher amount it is during period, when it cannot support amount of fertile sprouts, but it only influences size of grains.

In experiments during years 2005 – 2008 it was proved, that in spring barley a limiting element of yield formation is obtained number of spikes. With low density of stand it is not usually possible to obtain high yield not even by creation of higher number spikes and with high value of thousand seeds weight.

In the year 2009, which was unfavourable for barley, with above-average temperatures at the beginning of vegetation and with low temperatures in June, even high number of spikes was not sufficient for obtaining of adequate yield. On the contrary the year 2010 became exception, when with very low number of spikes we reached the second best yield during the six years period of experiments. In 2010 the stands were significantly infested with weed (white mustard), which was removed manually from experimental plots. This also damaged some plants of barley, which caused lower density of stands. Spudding of soil during weeding probably caused loosening of nitrogen and its higher intake by plants with sufficient amount of nitrogen.

Shoots formation ability of individual cultivars is genetically determined and depends on specific conditions of the year of growing. From compared cultivars the highest number of spikes in average of six years was created by Sebastian. In average of six years the differences were confirmative among compared variants of varieties. In comparison of years significant differences were found.

Tab. 2: Number of Spikes per Ecological Area During 2005–2010

cultivar	spikes (1 m^2)						
	2005	2006	2007	2008	2009	2010	average
Jersey	313	535	304	387	437	298	379 ab
Malz	317	473	311	336	440	266	357 b
Prestige	357	471	284	423	421	313	378 ab
Sebastian	375	447	404	423	451	297	400 a
Tolar	319	488	326	356	420	297	368 ab
Average	329 b	483 a	326 b	385 ab	434 ab	294 c	375

As it was already presented, obtained hectare yields of grain in individual years varied significantly according to current weather course. The highest yield converted to 14 % moisture of grain was obtained in 2006, in average of all cultivars it was 5,58 t/ha. In other years the yields were much lower, they range in average of individual years from 2,32 to 4,39 t/ha (Table 3). The most yielding in six years average of ecological experiments was cultivar Malz with 4 tonnes per hectare and the second most yielding cultivar was Tolar with 3,91 t/ha. In average of six years the differences were confirmative among compared variants of varieties. In comparison of years significant differences were found.

Tab. 3: Yields at Ecological Area During 2005–2010

cultivar	yield (t/ha)						
	2005	2006	2007	2008	2009	2010	average
Jersey	3,71	5,04	1,98	3,56	1,67	4,82	3,46 b
Malz	3,78	6,13	2,48	3,73	3,39	4,50	4,00 a
Prestige	3,71	5,51	2,28	4,09	2,96	4,56	3,85 ab
Sebastian	3,70	5,06	2,47	4,33	2,43	3,66	3,61 ab
Tolar	3,66	6,16	2,38	3,52	3,30	4,43	3,91 a
Average	3,70 cd	5,58 a	2,32 d	3,85 c	2,75 cd	4,39 b	3,77

Thousand seeds weight of harvested grain reached in ecological growing system in all years except 2009 high values, above 40 grammes (Table 4). In comparison of growing years very high TSW value had grain from the year 2005, more than 50 grammes. The highest TSW value in six years average reached cultivars Prestige and Tolar, which exceeded 45 grammes. In average of six years the differences were confirmative among compared variants of varieties. In comparison of years significant differences were found.

Tab. 4: Thousand Seeds Weight at Ecological Area During 2005–2010

cultivar	TSW (g)						
	2005	2006	2007	2008	2009	2010	average
Jersey	51,6	39,2	40,4	40,1	30,5	44,3	41,0 c
Malz	49,4	40,1	40,0	44,3	35,7	44,6	42,3 b
Prestige	55,5	43,6	43,4	45,9	37,3	46,7	45,4 a
Sebastian	53,3	41,5	38,6	41,4	31,0	42,2	41,3 c
Tolar	53,2	45,1	40,6	48,4	37,7	45,1	45,0 a
Average	52,5 a	41,9 bc	40,6 bc	44,0 b	34,4 c	44,6 b	43,0

Conclusion

In the six years experiments at the ecological area of the Experimental station of the Department of Crop Production of CULS – Uhříněves it was confirmed, that obtained results in ecological method of growing are influenced especially by weather course in individual growing years. In 2007 with lack of spring moisture and high temperatures we obtained very low yields.

Of all years the best production ability had spring barley seed in 2006, when stands emerged very well and formed the highest number of spikes. In average of compared cultivars we obtained the yield of 5,58 t/ha with 14 % of grain moisture in 2006. But in other years hectare yields were much lower. The second highest yield was obtained in 2010 despite the low number of spikes. The highest yields were obtained in cultivars Malz and Tolar in the six years average of ecological experiments.

Acknowledgments

This research was supported by Research Purpose of MSM 6046070901 – Sustainable Agriculture, Quality of Agricultural Production, Landscape and Natural Resources.

References

- Macák, M., Pospíšil, R., Žák, Š, Hanáčková, E. (2008): Systém variability úrody zrna a úrodotvorných prvkov jačmeňa jarného pestovaného v ekologickom a low input systéme. Sborník z konference 1. vedecké agronomické dni, Slovenská poľnohospodárska univerzita Nitra, 308 s.

POSSIBILITIES OF LEGUME-CEREAL INTERCROPPING TO INCREASE SELF-SUFFICIENCY WITH ANIMAL FODDER IN ORGANIC FARMING

HUŇADY, I.[1], LØES, A-K.[2], LAČŇÁK, V.[3], PONÍŽIL, A.[1]

Key words: organic farming, green fodder, pea, wheat, barley

Abstract

Intercropping of grain legumes and cereals is of special interest in organic farming to increase and stabilise yield levels, reduce weed pressure and sustain plant health. On animal husbandry farms, pea-cereal mixtures may be an interesting crop for green fodder as well as for concentrates. Increasing the self-sufficiency of fodder is in line with the principles of organic agriculture, and reduces the risks related to import of soyprotein, that it may be polluted with GM soya. In 2009 on five certified organic farms, controlled field trials (FT) were conducted with field pea, spring barley and spring wheat in monocultures and mixtures (pea: cereal ratio 60:40). Hay yields were recorded at pea growth phases BBCH 79 and 83. In 2008 and 2009, plot trials (PT) with intercropped peas and spring cereals (wheat, barley) were conducted. Varieties and pea-cereal combinations were screened to evaluate the suitability of the varieties for intercropping, and the best pea to cereal ratio in the seed mixture. Results show that intercropping peas and spring cereals may produce high yields of green fodder.

Introduction

Intercropping can be defined as the agricultural practice of growing two or more crops in the same space at the same time (Andrews & Kassam 1976). This technology may enable an intensification of the farm system, leading to increased productivity and biodiversity in the intercropped fields as compared to monocultures of the intercropped species (Vandermeer, 1989). Intercropping may reduce weed infestation (Jensen 2008). Further, intercropping can be advantageous to control plant diseases such as common bacterial blight and fungal rust diseases (Boudreau and Mundt, 1992; Fininsa, 1996). The plant diversity in an intercrop generates fundamentals for a more diverse development of beneficial predators inhibiting pest propagation (Hauggaard-Nielsen and Andersen 2000). As pesticides are not allowed in organic farming, the weed, disease and pest reducing effects make intercropping of cereals especially interesting in such farming systems. Currently, however, LCI is not used to a great degree in the CR. This is generally due to agricultural intensification, where the benefits of LCI are outcompeted by

[1] Agritec, research, breeding and services Ltd., Zemědělská 16, Šumperk 787 01, Czech Republic

[2] Bioforsk – Norwegian Institute for Agricultural and Environmental Research, Organic Food and Farming Division, Gunnars veg 6, NO-6630 Tingvoll, Norway

[3] Bioinstitut, o. p. s., Institute for Organic Agriculture and Sustainable Landscape Management, Křižkovskeho 8, 771 47 Olomouc, Czech Republic

cheap chemical inputs of fertilizers, pesticides and imported concentrates commonly based on cheap soyproteins.

The main objective of the paper is to present results of growing monocultures and mixtures of peas and spring cereals under Czech conditions. This may support an expansion of legume cereal intercropping, to help Czech organic farmers to become more self-sufficient with fodder for their bred animals.

Materials and methods

Farm level field trials on organic farms (FT). FT with mixtures and monocultures of field pea and spring cereals were carried out on five certified organic farms in 2009. Selected varieties were field pea Bohatyr (B) – leaf type, spring barley Pribina (P) and spring wheat Sirael (S). A pea: cereal ratio of 60:40 was chosen because this ratio was expected to give the highest yields (Huňady et al., 2008). On each farm, 2.5 ha of land were divided into five sub-plots of 0.5 ha where the varieties were grown as monocultures and pea-cereal mixtures (60:40). Green matter yields were recorded twice, at pea green ripening (BBCH 79, Meier, 2001) and at early pea ripening (BBCH 83). The samples were dried at 60°C for 24 hours. This drying produced stabilised hay samples.

Field experiments in plot trials (PT). In 2008 and 2009, a field experiment with PT (PT-RA, PT-PO) was carried out on the experimental fields of the company AGRITEC, Ltd. in Rapotin (RA) in district Sumperk in Central Moravia. In 2009, the same experiment was carried out under certified organic conditions on EKOFARMA CECHOVI in Postrelmov (PO), close to Rapotin. The selected varieties were pea varieties Bohatyr (B), and Terno (T) – semi-leafless – and cereals spring wheat variety Sirael (S), spring barley variety Pribina (P). The seed mixtures were pea: cereal ratios of 40:60 and 60:40. To determine land use efficiency, net yields of fractionated peas and cereals were used to calculate land equivalent ratio (LER).

Results

Farm level field trials on organic farms (FT). At the first sampling (BBCH 79), the hay yields varied from 6.0 to 7.3 t ha^{-1}. The largest yields were produced by pea-barley mixture, 7.3 t ha^{-1}. This was 105 % of the yield of pea monoculture (7.0 t ha^{-1}). Pea-wheat yielded 96 % of the yield of pea monoculture. The overall highest yield, 9.4 t ha^{-1} was produced by pea monoculture on FT-CI. The cereal monocultures produced somewhat lower hay yields than pea monoculture and mixtures at the BBCH 79, between 6.0 and 6.4 t ha^{-1}. Compared to monocultures of pea, the other treatments were not statistically significantly different (Tab. 1). At the second sampling (BBCH 83), the hay yields were generally lower due to the development of the crop towards ripening. Especially the pea-barley mixture yielded well – 6,9 t ha^{-1}, which was 33 % higher than the yield of pea monoculture (5.2 t ha^{-1}). The differences between treatments at the second sampling were not statistically significant.

Field experiments in plot trials (PT). In Rapotin, pea monocultures in most cases gave much lower yields than cereal monocultures and mixtures. At the farm (PT-PO), all treatments gave high yields, and Terno monoculture even produced the second highest average yield recorded in this trial in 2009, 4.48 t ha^{-1}. For pea variety Bohatyr, there were some differences in performance between the mixtures of pea-wheat and pea-barley. In PT-RA the average net yield of pea-wheat (B60S40) for both years was 3.31 t ha^{-1}. This is notably higher than for the pea-barley mixture B60P40, which yielded 2.75 t ha^{-1} on average. In PT, both positive and negative LER values were found for the pea-cereal mixtures, indicating both positive and negative effects of intercropping. In PT-RA, the LER for B60S40 was as high as 1.68 in 2008, but only 1.10 in 2009. The highest value was found in a season with lower pea yields due to virus disease. This shows that remarkably high LER values may indicate not only a positive effect of intercropping, but also that the crop yield was for some reason not satisfactory.

Tab. 1: Plot trials (PT) – Net yields of grain (t ha^{-1}) and LER (Land Equivalent Ratio) of pea-cereal mixtures in 2008 and 2009.

Treatment	In total		LER		Treatment	In total		LER	
	2008	2009	2008	2009		2008	2009	2008	2009
PT-RA									
B100	1.35 b	2.70 b			T100	0.50 c	2.16 c		
B60S40	2.59 a	4.02 a	1.68	1.10	T60S40	1.93 b	3.55 b	1.08	1.11
B40S60	2.75 a	4.48 a	1.23	1.13	T40S60	2.78 a	3.97 ab	1.23	1.14
S100	3.05 a	4.58 a			S100	3.39 a	4.65 a		
B100	1.69 a	2.96 b			T100	0.75 b	2.81 c		
B60P40	1.71 a	3.79 a	1.02	1.12	T60P40	1.55 a	3.31 b	1.61	0.99
B40P60	1.73 a	3.98 a	1.02	1.08	T40P60	1.58 a	3.54 ab	1.12	1.03
P100	1.61 a	3.77 a			P100	1.65 a	3.90 a		
PT-PO									
B100		3.78 a			T100		4.48 a		
B60S40		3.11 b		0.83	T60S40		3.42 a		0.83
B40S60		3.41 ab		0.91	T40S60		4.22 b		1.11
S100		3.68 a			S100		3.26 c		
B100		4.48 a			T100		2.56 c		
B60P40		3.42 b		0.83	T60P40		3.12 bc		1.14
B40P60		4.22 a		1.11	T40P60		3.69 a		1.30
P100		3.26 b			P100		3.11 bc		

Lower case letters a, b, c indicate statistically significant differences at the 5 % level by Fisher LSD test within each site and year.

Hence, we concentrate mostly on the data from 2009, where we also have results from the PT-PO. At Rapotin, a positive effect of intercropping was found for pea variety Bohatyr both for mixtures with wheat and barley. This effect was statistically significant. For wheat mixtures, the average LER for B60S40 and B40S60 in 2009 was 1.12, and for barley mixtures B60P40, B40P60 it was 1.10 (Tab. 1). For mixtures with pea variety Terno a comparable positive effect was found in wheat, but in barley the effect was close to zero.

Discussion

The results presented here clearly demonstrate that under organic growing conditions, with reduced possibilities to control weeds, pests and diseases, crop yield levels are highly variable in space and time. Longer time periods than one or two seasons are required to produce reliable data. However, the project funding the farm level experiments only lasted for 1.5 years. A leafy pea variety will climb too heavily, even on short-stemmed cereal varieties, and cannot be recommended to produce mixed pea-cereal concentrates. However, if the purpose is green fodder for hay or silage, pea-cereal mixtures with a leafy pea variety may be quite successful. If weeds and diseases are better controlled, such as demonstrated in the PT, pea-cereal mixtures may also give high yields of grains for concentrates, with a significant positive intercropping effect as shown by relatively large LER values. However, artificially high LER values were obtained both on farm level and in the plot trial under conditions with bad crop performance. This shows that LER values must be interpreted with care and should not be used unless yield levels are reasonable.

Conclusions

In spite of the short experimental period, the study has produced some valuable knowledge. Dependent on what is the aim of the production, legume-cereal intercropping may be utilised to maximize green matter yields (leafy pea variety), to increase the yields of protein/peas if peas are the main goal of production, and to increase the yields of grains (peas-cereals) if concentrates are the main goal of production. Such concentrates may be harvested as dry grain or with a higher water content and used as a concentrate silage.

Acknowledgments

The FT experiments were conducted as a part of the project A/CZ0046/1/0024 "Utilizing Legume Cereal Intercropping to Increase Self-sufficiency in Animal Feed and Maintain Soil Quality on Organic Farms in the Czech Republic", supported by the EHP and Norway Financial Mechanisms and the Czech State budget via the Research Support Fund. The PT experiments was supported by the Ministry of Agriculture of the Czech Republic via the National Agency for Agriculture Research, as part of the project QH82027 „Innovation of cereals and grain legumes intercropping in organic farming systems and their impact on selected soil parameters in relation to nitrogen dynamics ".

References

- Andrews, D. J., A. H. Kassam (1976): The importance of multiple cropping in increasing world food supplies. pp. 1–10 in R. I. Papendick, A. Sanchez, G. B. Triplett (Eds.), *Multiple Cropping*. ASA Special Publication 27. American Society of Agronomy, Madison, WI.
- Boudreau M. A., Mundt C. C. (1992): Mechanisms of alterations in bean rust epidemiology due to intercropping with maize. Phytopathology, 82, 1051–1060.
- Fininsa C. (1996): Effect of intercropping bean with maize on bean common bacterial blight and rust diseases. Int. J. Pest Man., 42, 51–54.

- Hauggaard-Nielsen, H., Andersen M. K. (2000): Intercropping grain legumes and cereals in organic cropping systems. Grain Legumes 30, 18–19
- Huňady, I. et al. (2008): Partial report on the results of project QH 82027 in 2008 (Partial report for the first year of the project QH 82027). Agritec Ltd. Šumperk 2008
- Jensen E. S., Hauggaard-Nielsen H., Jørnsgaard B., Kinane J. (2008): Grain legume–cereal intercropping: The practical application of diversity, competition and facilitation in arable and organic cropping systems. Renewable Agriculture and Food Systems, Volume 23, Special Issue 01, March 2008, pp 3–12
- Meier, U. et al. (2001): Growth stages of mono-and dicotyledonous plants. BBCH monograph, 2. edition. Federal Biological Research Centre for Agriculture and Forestry. ISBN 10 3826331524
- Vandermeer, J. (1989): The Ecology of Intercropping. Cambridge University Press, Cambridge.

EVALUATION OF SELECTED TRAITS OF PROSO MILLET GROWN UNDER ORGANIC AND CONVENTIONAL FARMING SYSTEMS

D. JANOVSKÁ[1], M. KÁŠ[1], A. PROHASKOVÁ[1] & J. HERMUTH[1]

Key words: proso millet; fatty acids; organic farming; conventional farming

Abstract

In 2009 and 2010, field trials with proso millet under conditions of organic and conventional growing systems were performed. In both systems, the same design with catch crops was used. During vegetative period, selected morphological and phenological traits were evaluated in the field conditions. After harvest, the analyses of fat quality and quantity were done. From the results is clear that neither growing condition system nor catch crops influenced quantity of fat in grains. The used catch crop influenced the content of stearic and eicosenoic acid. Content of certain acids was influenced by conditions during year.

Introduction

Proso millet (*Panicum miliaceum* L.) belongs among the world's most important and ancient domesticated crops. It was domesticated about 8 000 years before present (Lu et al., 2009). It is widely grown in temperate climates across the world. The biggest producers in the world are China, India, Nepal, Pakistan, Russia, Ukraine, USA, and many European countries (FAOStat, 2011; Arendt & Dal Bello, 2008).

Proso is well adapted to short-season production with both quick maturity and a low water requirement (Baltensperger & Cai, 2004).

In Europe, the renewed interest in the proso exploitation for human food was caused by health reasons. In the Czech Republic, its popularity increased with a development of organic farming in 90's of 20th century. FAO data on area, yield and production of all millets are given together under the general heading of millet. Exact statistical data about proso millet are unavailable (Kalinová & Moudrý, 2006). From the nutritional point of view, proso millet has good nutritive values with higher protein content (>14 %) than wheat (*Triticum aestivum*) (11.8 %) and rice (*Oryza sativa*) (6.8 %). Proso millet is also rich in minerals and trace elements like iron, zinc, copper and manganese (Gopal Reddy *et al.*, 2007). Cereal grains are very rich in unsaturated fatty acids (Fujino *et al.*, 1996). The fatty acid profile of proso millet showed that saturated fatty acids occupy about 20 % while unsaturated fatty acids totalled 78 to 82 % (FAO, 1995).

During the last century, green manure and catch crops lost importance as the use of chemical pesticides and fertilizers became widespread, but are now regaining importance to cope with environmental constraints on agricultural production. The renewed interest is mainly due to environmental concerns such as problems with nitrate leaching losses and soil degradation due to erosion and loss of organic matter. The possibility for stopping the leaching of nitrogen

[1] Crop Research Institute, Drnovska 507, 16106 Praha 6-Ruzyně, Czech Republic,
E-mail: janovska@vurv.cz; kas@vurv.cz, prohaskova@vurv.cz, hermuth@vurv.cz

and degradation of soil by erosion is utilization of catch crops in the crop rotations (Thorup-Kristensen et al., 2003).

The aim of this work was to evaluate the influence of growing system, year and catch crop to content and quality of fat and fatty acids in proso millet.

Materials and methods

During 2009 and 2010 two field trials were established at the Crop Research Institute, Prague – Ruzyně (350 m above sea level, 50°4'54." N, 14°18'12." E). Soil type is according to FAO classification Orthic Luvisol, clay-loam, developed on diluvial sediments mixed with loess.

Two varieties of proso millet (Unikum and Gorlinka) were growing under two farming systems – organic and conventional. Field trials were conducted in the near field to avoid the influence of micro-ecological differences between trials. Both systems had the same design. Before proso millet there were grown in every system catch crops such as mixture of vetch cv. Detenicka and winter wheat cv. Alka (LOS), mustard cv. Severka and *Phacelia tanacetifolia* cv. Vetrovska. Fallow ground was a control plot. All catch crops were sowed in both years in the second half of September. Proso millet genotypes were sown in three replications randomized in the block of every catch crop. Following traits were evaluated during the vegetative period: Number of days from sowing to emergence (NE), number of days from emergence to maturity (NM), panicle length, stem height, weight of thousand seeds (WTS) and yield.The harvest area was 7 m^2. Analysis of variance (ANOVA) and the Tukey HSD test were used for statistical evaluation.

Results and Discussion

Table 1 shows the results of selected traits from field trials. From results follows that only in case of NM were not obtained the statistical significant differences between growing systems. Differences of all other traits were statistical significant in both – organic and conventional systems. In case of cereals and influence of farming systems, Mader et al (2007) for example published, that WTS of wheat showed no significant variations between farming systems. Many authors published that yield of many crops under organic farming systems is lower in comparison to conventional systems (Posner et al., 2008). The better results of WTS and yield possessed the organic growing proso millet. It can be caused by birds, which damaged part of conventional field trials in 2009 in milk maturity. As published McKenzie & Whittingham (2010), birds select conventional over organic grains when given free choice. Under organic cultivation, proso millet grew up higher, but it caused lodging. Used catch crops influenced only NE and stem height. The results of fat analyses are shown in Tab. 2 and 3. The fat content was in the range from 4.05 to 4.76 %. Fat content was influenced only by variety. The quality of proso millet is very similar to oil from seeds of sunflower and safflower (Dubois et al., 2007). Content of saturated fatty acids (SFA) was influenced by year. The statistical significant differences were found out in the case of stearic acid, where the highest content was in proso millet cultivated after mustard; the lowest content was in case of cultivation after fallow ground. In the case of unsaturated fatty acids, growing systems and used catch crops had no effect on the quality and content of fatty acids. Only in case of eicosenic acid, there were found out statistical significant differences among used catch crops. The highest content was obtained in grains from plants growing after mustard.

Tab. 1: Means and standard deviations of phenological and morphological traits of proso millet for both growing systems and influenced by previous catch crops

	Days from sowing to emergence	Days from emergence to maturity	Panicle length (cm)	Stem height (cm)	WTS (g)	Yield (t.ha-1)
Organic	44,48±5,70a	113,67±3,00a	24,75±3,41b	113,63±7,36b	7,36±1,10b	4,09±0,93b
Conventional	50,83±9,87b	113,71±3,00a	23,98±4,43a	89,48±19,79a	7,02±1,25a	2,51±1,23a
2009	55,15±5,55b	110,77±0,63a	23,77±3,74a	95,21±22,54a	7,40±0,99b	3,14±1,29a
2010	40,17±2,27a	116,60±0,49b	24,96±4,09b	107,90±12,38b	6,97±1,33a	3,46±1,39a
mustard	46,67±8,69a	113,71±3,07a	23,71±3,71a	98,38±19,36a	7,20±1,08a	3,12±1,33a
Phacelia	48,00±8,93b	113,63±2,99a	24,33±3,81a	102,17±18,60ab	7,21±1,10a	3,62±1,41a
LOS	47,88±8,69ab	113,75±3,04a	24,63±4,40a	101,25±20,80ab	7,21±1,26a	3,40±1,39a
fallow	48,08±8,69b	113,67±3,03a	24,79±4,00a	104,42±18,62b	7,12±1,35a	3,05±1,25a
Unikum	48,15±7,91b	113,69±3,02a	27,60±2,63b	110,40±14,15b	6,09±0,52a	3,64±1,34b
Gorlinka	47,17±9,36a	113,69±2,98a	21,13±1,77a	92,71±19,59a	8,29±0,29b	2,96±1,28a

P=0.05

Tab. 2: Fat content and saturated fatty acids in the oil of proso millet grains (% of total fatty acids)

	fat (g/100 g of sample)	Palmitic acid	Stearic acid	Arachidic acid	Behenic acid	SFA
		16:00	18:00	20:00	22:00	
Organic	4,43±0,18a	6,92±0,64a	1,89±0,81a	0,63±0,19a	0,38±0,04a	9,82±1,63a
Conventional	4,39±0,23a	6,93±0,59a	1,94±0,85a	0,63±0,20a	0,38±0,05a	9,89±1,65a
2009	4,46±0,18a	7,19±0,63b	2,10±0,86b	0,69±0,19b	0,41±0,04b	10,39±1,68b
2010	4,36±0,22a	6,66±0,46a	1,73±0,76a	0,57±0,18a	0,36±0,04a	9,32±1,40a
mustard	4,46±0,21a	6,97±0,61a	2,00±0,88b	0,67±0,20a	0,41±0,04a	10,06±1,70b
Phacelia	4,44±0,19a	6,97±0,73a	1,87±0,83ab	0,60±0,19a	0,36±0,04a	9,81±1,74ab
LOS	4,36±0,19a	6,91±0,57a	1,95±0,85ab	0,65±0,19a	0,39±0,02a	9,90±1,60ab
fallow	4,38±0,24a	6,85±0,63a	1,84±0,88a	0,60±0,21a	0,37±0,04a	9,67±1,73a
Unikum	4,27±0,15a	7,44±0,39b	2,70±0,27b	0,80±0,08b	0,40±0,04a	11,33±0,75b
Gorlinka	4,55±0,14b	6,42±0,23a	1,14±0,16a	0,46±0,07a	0,37±0,04a	8,38±0,46a

Tab. 3: Unsaturated fatty acids in oil of proso millet grains (% of total fatty acids)

	Palmitoleic acid	Oleic acid	Vaccenic acid	Linoleic acid	Eicosenoic acid	α-Linolenic acid	PUFA
	16:01	18:01	18:1 n=7	18:02	20:01	18:3 a	
Organic	0,17±0,03a	21,67±0,37a	0,61±0,12a	66,25±1,49a	0,33±0,09a	1,18±0,11a	90,21±1,64a
Conventional	0,16±0,03a	21,29±0,49a	0,61±0,10a	66,52±1,55a	0,34±0,10a	1,22±0,15a	90,13±1,66a
2009	0,16±0,04a	21,47±0,36a	0,63±0,09b	65,94±1,40a	0,33±0,10a	1,10±0,07a	89,64±1,68a
2010	0,16±0,02a	21,48±0,57a	0,60±0,13a	66,83±1,51b	0,34±0,09a	1,30±0,08b	90,70±1,41b
mustard	0,16±0,04a	21,77±0,23a	0,62±0,13a	65,89±1,42a	0,36±0,10b	1,17±0,10a	89,97±1,71a
Phacelia	0,17±0,04a	21,28±0,51a	0,62±0,11a	66,65±1,55a	0,32±0,10a	1,18±0,16a	90,22±1,73ab
LOS	0,15±0,02a	21,70±0,31a	0,62±0,11a	66,14±1,33a	0,35±0,10ab	1,18±0,10a	90,13±1,60ab
fallow	0,16±0,02a	21,16±0,50a	0,59±0,10a	66,87±1,76a	0,32±0,10a	1,26±0,15a	90,36±1,73b
Unikum	0,17±0,03a	21,47±0,39a	0,51±0,04a	65,09±0,69a	0,25±0,03a	1,20±0,12a	88,69±0,75a
Gorlinka	0,15±0,02a	21,48±0,55a	0,71±0,04a	67,68±0,79b	0,42±0,03b	1,20±0,14a	91,65±0,46b

P=0.05, PUFA – total polyunsaturated fatty acids

Conclusion

We can conclude that neither growing system nor catch crops influenced the quantity of oil in proso millet grains. The used catch crop influenced the content of stearic and eicosenoic acid. The results confirmed that proso millet is very modest crop which is suitable for growing systems with low-inputs.

Acknowledgments

This work was supported by the Ministry of Agriculture of the Czech Republic MZE0002700604

References

- Arendt E., Dal Bello F. 2008. Gluten-Free Cereal Products and Beverages. Academic press. 464 pp. ISBN 978–0-12–373739–7
- Baltensperger D., Cai Y. Z. 2004. Minor. In: Wrigley et al. Encyclopaedia of Grain Science. Three-volume set. 1360 p ISBN: 978–0-12–765490–4
- Dubois V., Breton S., Linder M., Fanni F., Parmentier M. 2007. Fatty acid profiles of 80 vegetable oils with regard to their nutritional potential. European journal of lipid science and technology. 109:710–732
- FAOStat. 2011. Published on URL http://faostat.fao.org/[15–3-2011]
- FAO (1995). Sorghum and Millets in Human Nutrition. Rome: FAO Food and Nutrition Series, No. 27.
- Fujino, Y., Kuwata, J., Mano, Y. Ohnishi, M. (1996). Other grain components, 289–320. In: R. J. Henry and P. S. Kettlewell (Eds.), Cereal Grain Quality. London: Chapman & Hall.
- Gopal Reddy V, Upadhyaya HD, Gowda CLL. 2007. Morphological characterization of world's proso millet germplasm collection. Journal of SAT Agricultural Research. 3 (1): 1–4
- Kalinova J., Moudry J. 2006. Content and Quality of Protein in Proso Millet (Panicum miliaceum L.) Varieties. Plant Foods for Human Nutrition (Formerly Qualitas Plantarum). 61 (1): 43–47
- Lu H., Zhang J., Liu K., Wu N., Li Y., Zhou K., Ye M., Zhang T., Zhang H., Yang X., Shen L., Xu D., Li Q. 2009. Earliest domestication of common millet (Panicum miliaceum) in East Asia extended to 10,000 years ago. PNAS. 106: 7367–7372. doi: 10.1073/pnas.0900158106
- Mader P., Hahn D., Dubois D., Gunst L., Alfoldi T., Bergmann H., Oehme M., Amado R., Schneider H., Graf U., Velimirov A., Fliebbach A., Niggli U. 2007. Wheat quality in organic and conventional farming: results of a 21 year field experiment. Journal of the Science of Food and Agriculture. 87 (10): 1826–1835 DOI: 10.1002/jsfa.2866
- McKenzie A.J., Whittingham M.J. 2010. Birds select conventional over organic wheat when given free choice. *Journal of Food Science and Agriculture*. 90: 1861–1869
- Posner J.L., Baldock J.O., Hedtcke J.L. 2008. Organic and Conventional Production Systems in the Wisconsin Integrated Cropping Systems Trials: I. Productivity 1990–2002. Agronomy Journal. 100:253–260
- Thorup-Kristensen K., Magid J., Stoumann Jensen L. 2003. Catch crops and green manures as biological tools in nitrogen management in temperate zone. Advances in Agronomy. 79: 227–302

INNOVATIVE EXPERIENCE OF ECOLOGICAL TECHNOLOGIES IMPROVEMENT IS ON A WAY TO AN ORGANIC PRODUCTION

KAPSHTYK, M.[1]

Key words: organic agriculture, ecological technologies, soil protective tillage

Abstract

The practical experience of "Agro-ecology" private farm in the Poltava region is analyzed & summarized in relation to the gradual transition to organic agriculture through the stages of implementation of the non-plough system of agriculture; minimum tillage of Chornozemic soils; and gradual development of a more ecological systems of crop growing by means of the gradual reduction of application of herbicides, pesticides and synthetic mineral fertilizers. Transition to organic agriculture in Ukraine is not accompanied by a significant reduction in the crop productivity. Agri-economical efficiency even grows.

Introduction

Principles of organic agriculture are well known for many years in Ukraine due to development of concept of "biological agriculture". This concept provides scientifically professional resources, capable of quickly mastering the international special standards, in ways to adapt them to Ukrainian conditions; and to realize them in practice. A front-rank agrarian company, for example, the "Agro-ecology" private agricultural company (APAC farm) in Poltava region et al, actually carries out agricultural production by such methods. This allows the certification of their products as organic.

Beginning from the end of 1970's in Ukraine the large-scale Poltava experiment was carried out with introduction of a soil protective non-plough agricultural system. There is very impressive practical experience of Semen Antonets, – a most successful supporter of soil protective non-plough tillage system and present leader of APAC. Choosing soil protective cropping technologies with non-plough soil tillage system on a background of application of high quantities of organic fertilizers, – (over 20 tonne per ha.), – APAC managers came to the conclusion about the necessity to subsequently lower the soil tillage depth and application of synthetic herbicides, pesticides and mineral fertilizers. Thus the APAC progressed to the gradual development of a more ecological (environmentally-friendly) systems of agriculture. The soil protective technologies already mentioned in combination with the noted measures were instrumental in gradual renewal of natural self-regulation of agro-ecosystems in production terms.

These technologies gradually created favourable conditions for transition to the organic agricultural production system. And it did so, because certification is indicative of the potential success in this business. An organic production systems can not be developed or have any prospects of success without creation of the whole system and state support. The government

[1] Institute of Agroecology & Environmental Management, Metrologichna 12, 03143 Kiev, Ukraine, E-Mail kapshtyk@gmail.com, Internet www.agroeco.org.ua

of Ukraine uses certain steps for creation of favourable terms for development of organic production. However a bil draftl «About an organic production» is Verkhovna Rada of Ukraine on April, 20, 2011, was unfortunately rejected by President of Ukraine.

At the beginning of 21st. century, APAC moved completely to an organic production systems in the crop sector with the expectation of the subsequent export of organic products abroad. However, the prospective exporter did not purchase sufficient quantities and the APAC lost the official organic status gradually, mainly because of the lack of state support of organic production and marketing problems.

Materials and methods

Research tests of the different stages of soil protective non-plough tillage systems, as a way of converting to organic agriculture, and then organic food production have been carried out by the analysis of it's efficiency and comparing statistical annual data on crop yields and calculation of economical indicators for their growing (expenses, income, profitability).The data afterwards was grouped and middle indices for five years have been calculated. Therefore, these indices have been calculated for each 5 year periods in the following order: 1) when conventional system of farming was jointly used with plough soil tillage system; 2) when system of agriculture with non-plough till and gradual diminishing in application rate of mineral fertilizers and pesticides; 3) during next 5 years the non-plough system of agriculture was used simultaneously with minimum soil till and gradual stopping of applying mineral fertilizers and pesticides. There were also analysis of the efficiency of the various systems of crop fertilizing under conditions of non-plough tillage in a stationary field trial, laid out on typical medium loamy chernozemic soil in the same farm. The variants of fertilizer are as follows: A) control (without fertilizers); B) farm manure 16 t•ha^{-1}+$N_{77}P_{90}K_{50}$ (standard); C) farm manure 16 t•ha^{-1}+straw 2 t•ha^{-1}+N_{20}; D) farm manure 16 t•ha^{-1}+straw 2 t•ha^{-1}+N_{20} +green manure 2,5 t•ha^{-1}.

Results

Since1990 the reduction in the use of synthetic pesticides and mineral fertilizers has resulted in the growth of average crop yields (Tab.1).

Tab. 1: Average crop yields depending on organic farming stage, t·ha^{-1}

Year	Cereals	Winter wheat	Sunflower	Sugar beet
1971–1975	2,61	2,92	1,61	25,5
1986–1990	4,89	6,32	2,86	29,2
1991–1995	4,61	5,73	2,31	41,2
1996–2000	4,17	4,33	2,44	40,0
2001–2005	3,88	4,83	1,68	29,5
2006–2009	4,89	5,68	2,30	48,8

In that time, economic efficiency of production did not diminish, but even grew due to reduction of costs on the use of mineral fertilizers, herbicides and pesticides; and also on reduced soil cultivation. Sainfoin helps to solve the problem of providing soil cover quickly and therefore suppresses the growth of weeds. That's why in APAC farm there also sows a lot of green manure crops.

For this purpose they utilize such crops as mustard, crucifer crops, oil-seed rape, etc. These crops are also instrumental in enriching the soil by the addition of nitrogen of biological/organic origin. Application of systematic non-plough soil tillage ('Mi-Til').

Tab. 2: Efficiency of soil protective technologies and fertilizing systems

Variant of fertilizer	Winter wheat Yield, $t \cdot ha^{-1}$	Additional expenses, $uah \cdot ha^{-1}$	Total income $uah \cdot ha^{-1}$	Profit-ability, %
A	2,69/3,12	0,00	0,00	0,00
B	4,31*/5,13*	48,6/57,5	70,4/83,5	144/145
C	3,40 */4,06*	20,3/26,9	29,7/39,1	140/145
D	3,80 */4,49*	31,7/39,1	46,3/56,9	141/146

* significant for P<0.05; **a numerator is ploughing; a denominator is minimum till.
promotes efficiency of organic agriculture considerably.

Gradually reducing the depth of soil till, the system attained a level 5–7 c.m. in 1995. Thus, the systems does not utilize chemical substances for almost the last 30 years; and for last 5 years, this enterprise is certificated according to organic standards. The APAC did not have the special problems in transition to organic agriculture, which are related to the pests and crop diseases control. It is very important to utilize all the possibilities for the stimulation of natural enemies in the control of harmful insects. For example, rooks and starlings eat up the fat caterpillar (larvae) of may-bugs.

In 1997, grain crops were damaged by grain-eating beetles which ate whole plants and full grains during the period of ripening. In this case also, no insecticides were applied, as the farm managers firmly decided to take a course on a organic production based on modern standards.

Exactly due to the ecologization of agriculture which finally resulted in the complete transition to organic agriculture in recent years, the level of the productivity of agricultural crops and husbandry increased and grew. Unfortunately, basic crop products, still realized only average prices through the lack of markets development for the sale of organic agricultural/food products. At the same time, even organically produced milk, is for sale at prices which by far exceed the average, although the husbandry enterprize is not certificated as organic!

The development of organic agricultural systems depends on acceptance by the government of the proper normatively legal acts which would stimulate change/transition of agricultural producers to organic methods of farm management.

Discussion

On this basis the APAC farm in obedience to information of M.K. Shikula (2000), the scientists of the National Agrarian University were apply the soil protective technologies of organic agriculture.

Experience of APAC farm testifies that an organic production gives not only a certain economic value but also allows settling a lot of ecological problems by conserving and sustaining nature. Due to improvements in the natural properties of agrarian ecosystems in organic agriculture, the capacity of the soil increases to resist washing off and washing away, to wind erosion, and it's fertility is renewed and reproduced. Experience of countries of Western Europe testifies that the productivity of cultures in transition on organic agriculture is 60–110 % greater than traditional systems.

Because in Ukraine, the average productivity of agricultural crops is 2–3 times lower than in the countries of Western Europe, it follows that we can expect that level of the productivity of agricultural enterprises in transition on organic agriculture will not differ widely from the level of the productivity of crops produced according to the traditional method of agriculture.In organic agriculture, soil erosion resistance and efficiency of non-plough technologies increase considerably. The satiation of crop rotation is instrumental in it by perennial plants, vertical orientation of soil aeration pores, formation of water resistant soil structure, due to the prolonged re-generation of organic matter in the soil. Organic agriculture in essence is *the multifunctional agro-ecological model of production* and is based on the careful management (planning and management) of agrarian ecosystems. For the purpose of increasing the productivity of production and quality of products, the biological factors which increase of natural fertility of soils are maximally utilized. Agro-ecological methods of pest and crop diseases control, and also advantages of bio-diverstity, – in particular local and unique kinds, sorts, breeds and other flora and fauna, are re-created.

Economical advantages of organic production in APAC depend on the condition of the proper introduction of modern technologies of growing of agricultural crops and breeding of cattle in accordance with the principles and requirements of organic production; on the subsequent internal market development in Ukraine; and on the medium-term prospect that profitability of production of organic goods will grow and on it's capacity compete on internal and export markets.

In this enterprise, on an area over | more than | 8 thousand hectares based organic | organo | production it succeeded substantially to economize on farm input costs by not savings | expendon mineral fertilizers and chemicals, although the costs fuel | carburant | not diminish. The productivity sometimes is less than | less | , than in traditional economies.

According to the Mr.S.S. Antonets, leader of APAC farm, organic | organo | agriculture is | appear | expensive, and | but | the productivity diminishes | reduce | sometimes. No economy of fuel | is observed | exist | but about | order | four millions of UAH a year are saved on mineral fertilizers, pesticides | and herbicides. The basic | main | advantage is that organic | organo | agriculture allows to | recreasoil fertility to reproduce in natural way. And | but | in addition, this succeeds in get | receive | organic | organo | products | production | which | what | residues | oddmentof chemicals are not in.

Experience | tentative | of APAC farm confirms that an organic | organo | production gives | giveth | not only a certain | definite | economic | economical | value but also allows deciding a lot | many | of ecological | ecofriendly | problems, by conserving and sustaining | savnature. Due to respecting the | renenatural | real-life | properties | virtue | of agrarian ecosystems | in organic | organo | agriculture, the ability | power | of soil | earth | increases to resist washing off and washing away, to wind erosion | anabrosis | . In these ways soil | ifertility and productivity is reproduced | recreates | , improved and enhanced

Conclusions

On condition of the proper introduction of modern agro-ecological technologies and subsequent internal market development in Ukraine, the *growth of competitiveness of organic products* will promote in a medium-term prospect, the following: gradual growth of the natural productivity of organic agrarian production; substantial reductions of production costs, e.g. Reduced applications of expensive chemicals and reduced power-requirements of field cultivations & crop spraying; in particular, minimization of fuel consumption for tractors, etc.

References

- Kapshtyk M. V., Demydenko O. V. (2011): Soil-protective technologies as a precondition for organic farming. Agroecol. News 129:325–336.
- Shykula M., Antonets S., Kapshtyk M. et all. (2001): Soil protective biological system of farming in Ukraine. Oranta, Kyiv, 333 p.
- Shykula M., Antonets S., Kapshtyk M. et all. (1998): Soil fertility reproduction soil protective system of farming. Oranta, Kyiv, 333 p.

INFLUENCE OF YEAR AND CULTIVATION PRACTICE ON COMMON BUCKWHEAT

KÁŠ[1], M. & JANOVSKÁ[1], D.

Key words: common buckwheat, organic farming, conventional farming, achene yield

Abstract

Common buckwheat is crop with the lower sensitivity to the environment. It can be grown also in the marginal land or in systems with low-inputs. It predestinates common buckwheat for cultivation in the organic farming systems. In 2007–2009, there were conducted the field trials with two varieties of common buckwheat (Pyra, Špačinská 1) in Lukavec under organic and conventional growing practice with two inter-row distances. From the result is clear that year, cultivation practice (organic vs. conventional, two different inter-row distance) and also variety had statistically significant influence on achene yield and weight of thousand achenes. No statistically significant differences were found out only in the case of yield influenced by inter-row distances. The biggest yield was obtained from plots cultivated under organic conditions in 2007.

Introduction

Common buckwheat (*Fagopyrum esculentum* Moench.) is a pseudocereal that is widely cultivated for its achenes over the northern and to some extent the southern hemisphere. Buckwheat has been a crop of secondary importance in many countries and yet it has persisted through centuries of civilization and enters into the agriculture of nearly every country where cereals are cultivated (Campbell 1997; Kalinová&Vrchotová, 2011). Buckwheat was grown in the Czech and Slovak territories from the 12th and 13th centuries (Michalova 2003). In many regions, buckwheat was very popular and it was included in many daily meals. But its importance was subsequently decreased. The buckwheat renaissance has come since 90´s of 20th century with suitability in low-input systems and also unpretending cultivation. The next reason is the good nutritional and dietetic value (Janovská et al. 2008).

Materials and methods

The field trials with common buckwheat were conducted in Lukavec in 2007–2009. The experimental field is situated in a potato-growing region (49°37´ N, 15°03´ E), 620 m above sea level with a sandy-loam cambisol soil. The average temperature and precipitation were 6.9°C and 686 mm, respectively. Two common buckwheat varieties were evaluated – Pyra and Špačinská 1. Both varieties were grown under conditions of organic and conventional farming with two different inter-row distances (12.5 and 37.5 cm). The trials were sown in the middle of

[1] Crop Research Institute, Drnovska 507, 16106 Praha 6-Ruzyně, Czech Republic,
E-mail: kas@vurv.cz, janovska@vurv.cz

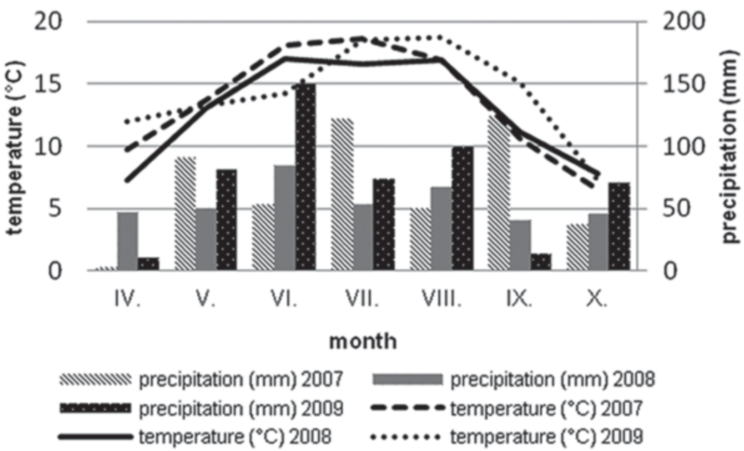


Fig. 1: Sum of precipitation and average air temperature in 2007–2009 years

May and the sowing density was 200 achenes per m^2 for all plots. The area of a particular plot was 17 m^2. Before sowing the conventional trial was fertilised by mineral fertilizers (50 kg N/ha, 60 kg P/ha and 80 kg K/ha). All plots were carried out in three replications. The colonies of bees were placed in the field at the beginning of flowering. In the variant with the wider inter-row distance were carried out two mechanical weeding. The buckwheat was harvested in the time when 2/3 of achenes were mature. Analysis of variance (ANOVA) and the Tukey HSD test were used for statistical evaluation. Differences at P=0.05 were statistically significant.

Results

In the Tab. 1 are shown average values of all obtained data. From the result is clear that no statistically significant differences were found out only in the case of yield influenced by inter-row distances. In our trials, buckwheat yield was significantly influenced by year. The biggest yield was obtained in 2007 in the case of both varieties. However, the weight of thousand achenes (WTA) was the lowest in this year. On the other hand, the lowest yield was got in 2009 when the biggest achenes were found out. Statistically significant differences were also found out in cultivation practice. The bigger yield and WTA were taken in plots cultivated under organic farming practice. In both system of growing, Špačinská 1 possessed the bigger yield than Pyra, but with the smaller achenes. The inter-row distance influenced only the size of achenes. The bigger achenes were obtained in the wider inter-row distance (37.5 cm) in both growing systems. However, the differences between yields influenced by inter-row distance was around 100 kg, no statistically significant differences were found out. More detailed results are shown in Fig.2 and Fig.3.

Tab. 1: Statistical evaluation of common buckwheat growing (2007–2009)

		Yield (t/ha)	WTA (g)
year	2007	4.18±0.52c	27.50±0.85a
	2008	3.34±0.56b	27.50±0.85a
	2009	2.14±0.43a	29.22±0.96b
cultivation practice	organic	3.32±0.99b	28.23±1.23b
	conventional	3.12±0.97a	27.92±1.16a
variety	Pyra	3.05±0.90a	28.22±1.11b
	Špačinská 1	3.39±1.03b	27.92±1.27a
inter-row distance	12.5	3.17±0.99a	27.92±1.43a
	37.5	3.27±0.98a	28.22±0.90b

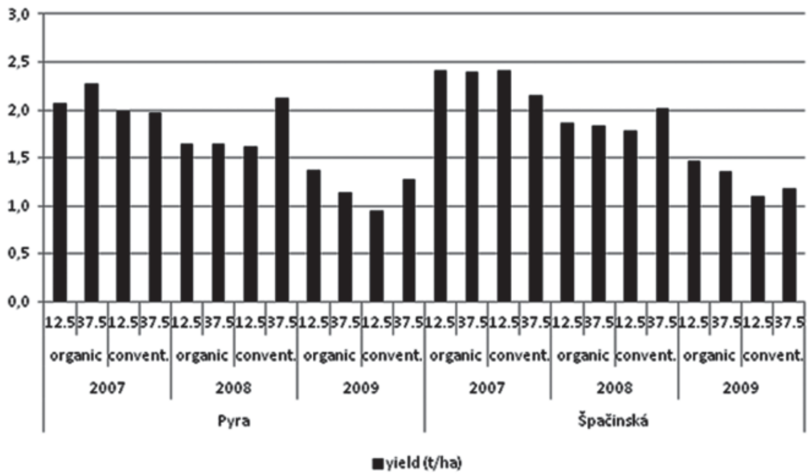


Fig. 2: Yield of common buckwheat achene (t/ha) in both inter-row distances (12.5 and 37.5 cm)

Conclusion

From the result is clear that year, cultivation practice (organic vs. conventional, two different inter-row distance) and also variety had statistically significant influence on achene yield and weight of thousand achenes. No statistically significant differences were found out only in the case of yield influenced by inter-row distances. We can concluded, that common buckwheat is one of most perspective crop for organic farming. In the wider inter-row distances we can obtain bigger achenes and the same yield level as in the case of narrower inter-row distance. Wider inter-row distances are better for weed control.

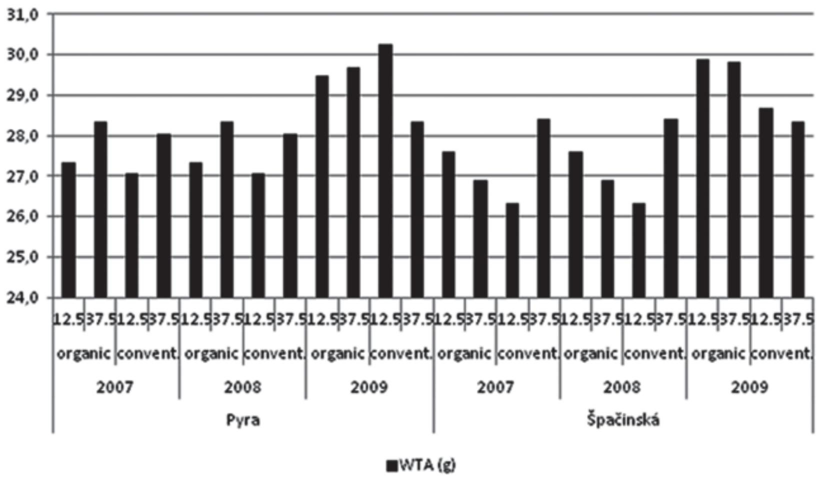


Fig. 3: Thousand achene weight of common buckwheat (g) in both inter-row distances (12.5 and 37.5 cm)

Acknowledgments

This paper was supported by MZe 00027006004 and MZe NAZV QG50034

References

- Kalinová J., Vrchotová N. (2011): The influence of organic and conventional crop management, variety and year on the yield and flavonoid level in common buckwheat groats. Food Chemistry 127:602–608
- Campbell, C. G. (1997): Buckwheat. *Fagopyrum esculentum* Moench. Promoting the conservation and use of underutilized and neglected crops. 19. Institute of Plant Genetics and Crop Plant Research, International Plant Genetic Resources Institute, Rome, Italy. 95 p.
- Michalová, A. (2003): Buckwheat in the Czech and Slovak Republic. In Kreft, I., Kwang Jin Chang, Yong Soon Choi, Cheol Ho Park (eds.): Ethnobotany of Buckwheat, Jinsol Publishing, 154 p.
- Janovská D., Kalinová J., Michalová A. (2008): Metodika pěstování pohanky obecné v ekologickém a konvenčním zemědělství. Metodika pro praxi, Výzkumný ústav rostlinné výroby, v.v.i. 18 p.

THE POSSIBILITY OF USE OF *TRICHODERMA ASPERELLUM* IN ORGANIC FIELD PRODUCTION

KOWALSKA, J.[1]

Key words: *Alternaria* spp., *Botrytis cinerea*, *Phytoptora infestans*, *Trichoderma asperellum*, potato crops, WOSR

Abstract

The hypothesis was tested, whether Trichoderma asperellum can be used as competitive microorganism to Alternaria spp., Botrytis cinerea and Phytophtora infestans. The potential to limitation of diseases symptoms and to increase on development plants was assessed. The results indicate that the efficiency of tested commercial product (Trifender WP®) is different depending on the fungal pathogens. T. asperellum can effective limit the symptoms of Alternaria spp on pods and Botrytis cinerea on leaves of winter oilseed rape (WOSR). Increase of mean number of branches, total yield and thousand grain weight were noted. In potato after 10 foliar applications, T. asperellum effected in limitation of symptoms of potato late blight (in 50 %) and significantly increasing of total yield, especially for later variety of potato. Higher dose of Trifender WP at 200g ha^{-1} was effective.

Introduction

In the development of organic agriculture plant protection has an important position. In production are used also beneficial microorganisms, which can stimulate natural mechanisms of plants to defence and can increase development of plants. These beneficial microorganisms compete with plant pathogens. It is a nature-friendly, ecological approach and it can be introduced in organic system of food production (Harman et al., 2004; Kowalska 2010). Among antagonistic microorganisms the most common are the fungi from *Trichoderma* genera (Hermosa et al., 2000). Trichomil® (Trichodex) based on *Trichoderma harzianum* strain RK1 is one from products purposed to agriculture practice. It is used by way of incrustation on seeds. In the later period, it protects both the risosphere and vegetative plant parts. This product can be used in liquid form to the vegetative and generative plant organs (Drimal, 2003). Other product – Supresivit® is based also on *T. harzianum*. It is effective against a number of phytopathogens fungi. According to literature data, it was registered in1993 and was allowed for the treatment of peas seeds against pathogens that caused the falling of young plants and for the treatment of substrates for ornamental plants and trees against the same pathogens. In 1995 the registration was extended for the treatment wood tree seeds and for substrates for wood trees. The possibility of using it for vegetable seeds and for application on the surface of granular mineral fertilizers for wheat, barley, maize and rape was extended in 2000 (Nesrsta, 2003). In presented paper was involved Trifender WP® based on *T. asperellum* T1. The main objective of research was evaluation of *T. asperellum* as growth promoter: (i) the influence on development and pathogens of winter

[1] J.Kowalska@iorpib.poznan.pl

oilseed rape, (ii) the control effects of *T. asperellum* on *Phytophtora infestans* in potato, (iii) the influence of *Trichoderma* treatments on yielding.

Materials and methods

Trifender WP is a microbial plant growth promoter with spores of the fungus *T. asperellum* at a number of $5x10^8$ of spores isolate T1 (NCAIM 68/2006) per gram. (Biovéd Co., Hungary). It is high vitality, after 7 months of storage the number of spores was not changed. The effects of foliar treatments of *T. asperellum* on WOSR in a two-year experiment were tested in a split-plot-design with four replicates at the experimental organic farm of the Institute of Plant Protection. Treatments with water suspension were made at concentration 200 g and 500 l water ha^{-1} at beginning of vegetation season (spring), at the flowering and at the end of flowering time (BBCH 61, 65). Symptoms of diseases (as a percentage area of plant damaged by pathogens – *Botrytis cinerea* and *Alternaria* spp.) were observed during BBCH 84 on ten pods and plants collected from each plot (May and June). Yield and thousand grain weight were noted. *Meligethes aeneus* was controlled by two foliar treatments with spinosad made at the evening time. In this same scheme of plots were performed potato trials, with Tajfun and Impala var. Treatments during vegetations of potato were made in different schemes. The product was applied to the soil at dose 1kg ha^{-1}, in spraying was used dose 100g ha^{-1}, 600 l water ha^{-1}, 4 or 10 times during vegetation, respectively for variety. Application before planting was performed only for Impala (very early and susceptible cultivar for potato blight). Untreated plots or treated with copper (2 kg of Miedzian 50 WP) was established to compare. In field trials were assessed the symptoms of potato late blight on leaves and stalks. Ten plants in five localizations of each plot were selected to assessment. Total yield was noted. Colorado potato beetles were controlled by one treatment with spinosad at dosage 25 s.a. per hectare.

Results

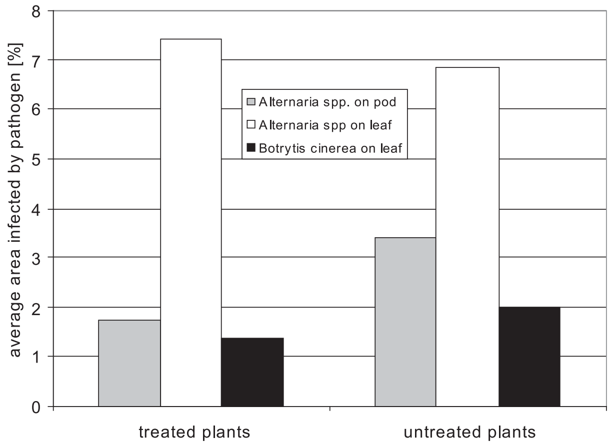
The possibility of using of *T. asperellum* in growing of winter oilseed rape

The leaves from treated plants were infected by *B. cinerea* in 31.5 % fewer comparing to untreated, in case of *Alternaria* spp. on the pods was observed decreasing of infected area in 48.5 %. Differences between presence of alternariose on leaves were not observed.

Tab. 2: Influence of *T. asperellum* on development of plant and the yield of WOSR

Combination	Mean number of branches/plant	Mean number of pods/plant	Mean total yield/plot [kg]	Mean thousand grain weight/plot [g]
Trifender WP (200g ha^{-1})	9,47*	31,12	4,22*	6,46*
Untreated	7,52	28,47	3,21	5,45

For treated plants increase of parameters yielding and better development of plants were observed.



Four replicates per each combination (1 plot = 16,5m^2), assessment was made on 10 plants selected from every plot.

Fig. 1: Influence of ***T. asperellum*** on diseases symptoms on WOSR

The possibility of using of *T. asperellum* in growing of potato

Tab. 3: Mean percentage of area plant infected by *P. infestans* (%) and yield (kg) according to combination of experiments

Variety/ Observation date	Trifender WP area plant infected (%)/ yield (kg)	Copper area plant infected (%)/ yield (kg)	Untreated
Impala/ 16.08.2010	10,6 %/ 23,8 kg	11,2 %/ 21,8 kg	not assessed
Tajfun/ 30.08.2010	25,4 % */ 45 kg *	not assessed	50,8 %/ 12 kg

Yield is collected from 10 plants from each plot, * significant for P<0.05

On the plants var. "Impala" was noted that control of potato late blight was similar in comparing to copper treatments. Yields from both treated and untreated plants were insignificantly different. In case with later variety "Tajfun" treated with many foliar treatments was observed significantly higher yield compare to untreated plots (increase in 73.3 %) and decrease of area plants infected by *P. infestans* in 50 %.

Discussion

In organic production control of diseases is usually carried out by the application of copper and sulfur fungicides. The control of potato late blight is based on copper applications. The dosage of copper is limited, generally to 6 kg, for organic farmer associations of Germany or in "Demeter" only 3 kg/ha/year. The hypothesis that *Trichoderma* spp. can be useful in protection of plants was confirmed in many papers. The biopreparation Supresivit was applied as a dressing mixed with mineral fertilizers: NPK, ammonium nitrate with limestone and ammonium nitrate and ammonium sulphate. Experimental plots with spring barley, winter wheat, winter oil rape, maize and potatoes were fertilized with the mixtures of the biopreparation (1 g, 0.5 g and 0.1 g per 1 kg of fertilizer). *T. harzianum* suppressed pathogenic fungi at the concentration 0,5 g of Supresivit per 1 kg of the fertilizer and higher ones. The plants from treated plots had lower infestation – decreasing about 5–15 % superficial infestation: tan spot of barley – yellow leaf spot on cereals and leaf blotch of barley, winter wheat – leaf spot of wheat, tan spot of wheat, take-all etc., winter oil-seed rape – black leg and collar rot, potatoes – blight fungus etc. Simultaneously the effect on higher yields was observed (Hỳsek et al., 2002). The isolates belonged to *T. harzianum, T. hamatum, T. longibrachiatum, T. atroviridae, T. koningii* caused decrease of growth rate of *Leptospheria maculans* causing stem canker of cricifers. Species of *Trichoderma* differed in hyperparasitic effects towards *Leptospheria* sp. (Dawidziuk et al., 2008). Also other pathogens causing diseases of WOSR are controlled by mycoparasitic fungus. *Microsphaeropsis ochracea* applied two times in vegetation of WOSR caused lower levels of *Sclerotinia scleriotorum* infestation (Stadler et al., 2008). These results indicate that hypothesis using microorganisms in protection plants could be confirmed.

Conclusions

Foliar treatments on WORS effected in better development of plants and limitation of symptoms diseases. Effect on *Alternaria* spp on leaves were not observed. In potato plants, application to the soil and four foliar treatments effected in limitation of symptoms of *P. infestans* in similar way compare to copper treatment. Ten foliar spraying effected in 50 % fewer area plants infected by blind of potato in comparing to untreated plants. More frequently treatments would be successful management. It is very important that effects of treatments with microorganisms are strongly affected by weather conditions.

Acknowledgments

Research were supported by the Polish Ministry of Agriculture and Rural Development.

References

- Dawidziuk A., Popiel D., Jędryczka M. 2008. The influence of *Trichoderma* species on *Leptosphaeria maculans* and *L. biglobosa* growth on agar media and in oilseed rape plants. p. 8, Abstracts IOBC oilseed rape meeting, Reunion

- *Drimal J. 2003. Low-risk preparations for plant protection in organic agriculture. p.19, 5th European Summer Academy on Organic Farming. Abstract Proceedings Bořivoj Šarapatka (Ed.) 29. 6 –1. 7. 2005, Lednice, Czech Republic, pp.41*
- Harman G.E., Howell C.R., Viterbo A., Chet I., Lorito M., 2004 *Trichoderma* species – opportunistic, avirulent plant symbionts. Nature reviews Microbiology 2:43–56
- Hermosa M.R., Grondona I., Iturriaga A.E., Diaz-Minguez J.M., Castro C., Monte E., Garcia-Acha I. 2000. Molecular characterization and identification of biocontrol isolates of *Trichoderma* spp. Appl. Environ. Microbiol. 66: 1890–1898.
- Hỳsek J., Vach M., Brožová J., Sychrová E., Civínová M., Nedělník J., Hrubỳ J. 2002. The influence of the application of mineral fertilizers with the biopreparation Supresivit (*Trichoderma harzianum*) on the health and the yield of different crops. Archives of Phytopathology and Plant Protection. 35 (2): 115 – 124
- Kowalska J. 2010. The use of natural substances and microorganisms in organic potatoes production, p: 41–53, In: The impact of organic production methods on the vegetable product quality. (ed.) Ewa Rembiałkowska ISBN 978–83–7583–212–9, pp.263
- Nesrsta M. 2003. Trichoderma for biological control of fungal plant pathogens. p. 20, 5th European Summer Academy on Organic Farming. Abstract Proceedings Bořivoj Šarapatka (Ed.) 29. 6 –1. 7. 2005, Lednice, Czech Republic, pp.41
- Stadler M., Koopman B. Tiedemann A. 2008. Biocontrol of Sclerotinia sclerotiorum and Verticilllium longisporum by the mycoparasitic fungus Microsphaeropsis ochracea. p. 45, Abstracts IOBC oilseed rape meeting, Reunion

QUALITY OF POTATOES FROM DIFFERENT FARMING SYSTEMS

KRTKOVA, V., SCHULZOVA, V., NOVOTNA, H.[1], DVORAK, P.[2], HAJSLOVA, J.[1]

Key words: Potatoes, Growing system, Secondary metabolites, Natural toxicants

Abstract

Increasing public concern about environment and human health reflects in growing consumers´ interest in organic food. In order to have a free and informed choice between organic and conventional foods, an objective assessment of a product quality based on a sound scientific knowledge is needed. The aim of this project was an investigation of the influence of growing conditions on the potato (Solanum tuberosum) quality. Two traditional varieties (Katka and Finka) were grown at two different localities in Czech Republic. To determine a possible inter-annual variability, the experiments were performed on crops over a period of three consecutive years (2008 – 2010). The monitored parameters included biologically active compounds (chlorogenic acid, reducing sugars, amino acids, vitamin C etc.) and also toxic secondary metabolites (total glycoalkaloids and calystegines). Levels of these biologically active compounds depended mainly on the variety and climatic conditions such as year of farming, but the type of a cultivation system did not play a significant role. The currently investigated natural toxic alkaloids calystegines were found at higher concentration levels than the natural toxicants glycoalkaloides, monitoring of which is required by legislation.

Introduction

At present time, a demand for organic product has increased. To ensure the quality of the final produce, different strategies have to be employed in order to comply with strict requirements of GAP; essential part of which is a regular monitoring and/or quality checking of food commodities.

Contaminants content (pesticide residues, heavy metals, nitrates, etc.) must be significantly lower or absent in organically grown products. However, under certain circumstances, natural toxic compounds may from (e.g. glycoalkaloids) as a natural plants defence against diseases and vermin.

Potatoes (*Solanum tuberosum*) represent one of the world's major agricultural crops and are grown in approximately 80 % of all countries worldwide. Potatoes are major, inexpensive and low-fat food source providing energy, high-quality protein, fibre and vitamins. Potatoes produce biologically active secondary metabolites, which may have both adverse and beneficial effects in the diet. Plant secondary metabolites play different roles in plant biochemistry and physiology and include calystegines alkaloids, glycoalkaloids, protease inhibitors, lectins, phenolic compounds and chlorophyll.

Glycoalkaloids (GAs) are steroidal glycosides. The major GAs produced by the common potato are α – solanine and α – chaconine, having a trisaccharide moiety, which represent about 95 % of

[1] Department of Food Chemistry and Analysis, Institute of Chemical Technology, Prague, Czech Republic

[2] Department of Quality of Agricultural Products, Czech University of Life Sciences Prague, Czech Republic

the total glycoalkaloids. The main toxic action of glycoalkaloids is inhibition of blood and brain cholinesterase and disruption and damage of membranes in the gastrointestinal tract. Hygienic limit expressed as sum of α–solanine, α–chaconine and α–tomatine is 200 mg/kg. Typically, glycoalkaloid levels in potatoes range from 30 to 120 mg/kg.

Calystegines are hydroxylated nortropane alkaloids derived from the tropane alkaloid biosynthetic pathway. They are strong glycosidase inhibitors and occur in vegetables such as potatoes, tomatoes, and cabbage. Calystegines accumulation in root cultures was described as increasing with carbohydrate availability. The total calystegines (TCLs) content is usually calculated as the sum of calystegine A_3, B_2 and B_4.

Samples and analytical methods

The two potato varieties Katka (K) and Finka (F) used in this study were grown at two localities: Praha Uhřiněves (L1) and Leškovice (L2). Potato tubers used in this study were grown under different conditions: organic (according to principles of International Federation of Organic Agriculture Movements) and conventional farming system, protection against Colorado beetle and moulds and mulching. Mulching (mulch textile and plant mulch) is a natural process, which can be used as an effectual protection of agricultural products. Usually mulch is a layer of organic material, which covers a soil surface.

The purity of α – solanine and α –chaconine standards were ≥ 95 %. Ammonium acetate for LC-MS and HPLC grade acetonitrile and methanol were supplied from Sigma-Aldrich (Germany). Water was purified with the use of Milli-Q system (Millipore, Eschborn, Germany). The UHPLC analyses were performed using an Acquity UltraPerformance LC system (Waters, USA) equipped with an HILIC Atlantis® Silica column (100 x 3 mm I.D., 3 µm particle size, Waters, USA) maintained at 30 °C. The mobile phase was consisted of acetonitril (A) and 0.005 M ammonium acetate in Mili-Q water (B). The UHPLC system was connected to a 5500 QTRAP tandem mass spectrometer (AB SCIEX, Canada), equipped with a Turbo VTM ion source operated in positive mode.

Potato tubers were homogenised and shaken in 50 % aqueous methanol for 30 min at room temperature. The homogenate was then filtered through Büchner funnel. An aliquot of potato extract was filtered though a PTFE membrane (5µm) and analysed using UHPLC system couple with mass spectrometry (MS) detection equipped with QTrap tandem mass spectrometer.

Chemometric analysis: Linear discriminant analysis (LDA) was performed employing the software package statistiXL version 1.8 (2008) (statistiXL, Brodway-Nedlends, Australia).

Results

In this study, two different potato varieties were investigated over the period of three consecutive crop years (2008 – 2010). Hygienic limit for glycoalkaloids content was not exceeded in either of farming system. Higher average content of TGAs was in the variety Katka (Figure 1). Higher levels of TGAs were observed in conventional tubers (Figure 2). Low average levels of the total calystegines (TCLs) were found in potato tubers from conventional farming system, shown in Figure 2. Increased levels were detected in potato tubers of the variety Katka from locality Praha Uhřiněves (Figure 1). The differences were not statistically significant (t-test, $\alpha = 0.05$).

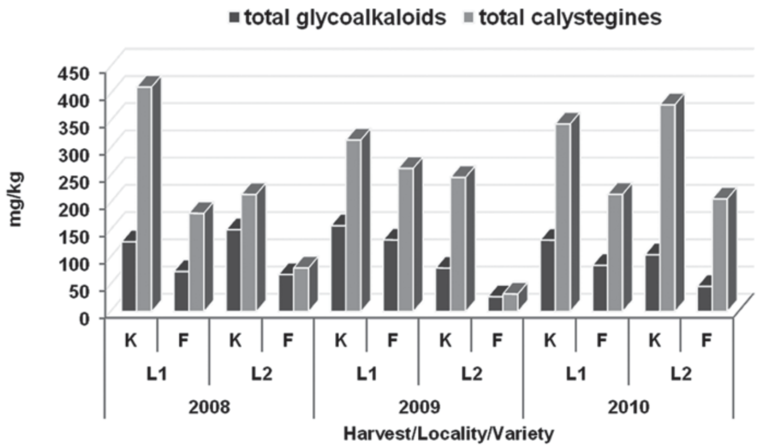


Fig. 1: Average glycoalkaloids and calystegines content in tested potato varieties Katka (K) and Finka (F) – localities Praha Uhřiněves (L1) and Leškovice (L2)

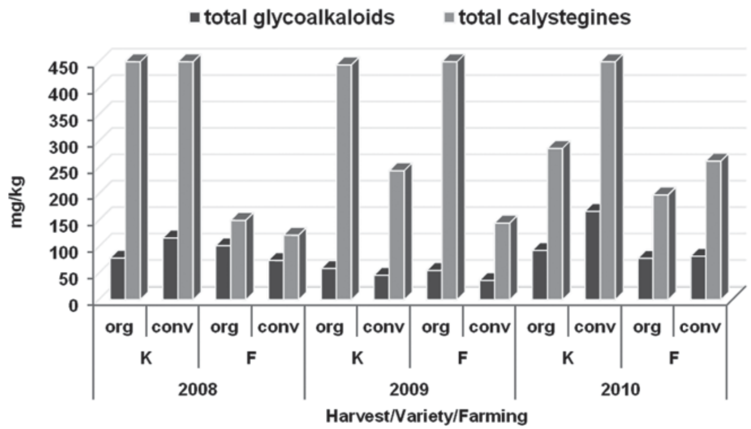


Fig. 2: Average glycoalkaloids and calystegines content in tested potato varieties produced in organic (org) and conventional (conv) farming systems – locality Praha Uhřiněves

Slightly higher content of vitamin C was measured in potato tubers sampled in year 2010. Increased levels of chlorogenic acid were investigated in the variety Katka. Higher levels of reducing sugars were found in conventional potato tubers. These differences were not statistically significant (t-test, $\alpha = 0.05$).

Linear Discriminant Analysis (LDA) was employed for evaluation of the data set. Recognition and prediction ability was tested by classification the analysis for individual variety, locality, farming system, and a year of farming. It was only possible to classify individual samples into the separate groups according to crop year (recognition ability 100 %, prediction ability was only 50 %).

Mean levels of assessed parameters in crop years 2008 – 2010 in the varieties Katka and Finka in both tested localities are summarized in Table 1.

Tab. 1: Average levels of assessed parameters in year 2008 – 2010 varieties Katka and Finka in two localities

	Locality	*Variety*	*dry weight (%)*	*reducing sugars (g/kg)*	*vitamin C (mg/kg)*	*amino acids (g/kg)*	*chlorogenic acid (mg/kg)*	*total glycoalcaloids (mg/kg)*	*total calystegines (mg/kg)*
2008	L1	K	20	3	112	*	190	128	412
		F	19	3	105	*	109	74	180
	L2	K	17	4	89	*	265	150	215
		F	15	8	63	*	187	68	80
2009	L1	K	21	3	149	2	137	158	315
		F	18	4	130	2	113	131	263
	L2	K	17	2	143	5	127	80	246
		F	15	4	113	4	78	27	32
2010	L1	K	22	2	194	4	192	131	344
		F	22	3	183	4	188	85	215
	L2	K	21	2	148	5	127	104	379
		F	18	2	132	5	87	46	207

*No analysed in year 2008
L1…Praha Uhřiněves, L2…Leškovice, K…Katka, F…Finka

Conclusions

Climatic changes, geographical locations and potato variety belong to the most important factors influencing the quality of potatoes compared to farming system. The farming strategy (organic vs. conventional) did not have significant (t-test, $\alpha = 0.05$) influence on the levels of tested parameters (vitamin C, reducing sugars, TGAs, TCLs). Using of the mulch improved the quality of potato tubers, where higher content of vitamin C and chlorogenic acid was observed compared to the control variant.

The levels of natural toxicants glycoalkaloids were relatively low. The sum of three main calystegines was higher than that of α-solanine and α-chaconine, in some samples more than three times. However, no correlation was observed between the levels of these alkaloid groups.

Although the toxicity of calystegines for humans has not been fully assessed yet, the health risk for consumers due to dietary exposure should be taken into consideration.

Acknowledgments

This study was carried out within the project NAZV QH82149 supported by Ministry of Agriculture of the Czech Republic; project MSM No. 6046137305 and specific university research (MSMT no. 21/2010) supported by the Ministry of Education, Youth and Sports of the Czech Republic.

References

- Friedman, M., Roitman, J. N. (2003): Glycolkaloids and calystegines content of eight potato cultivars. J. Agric. Food Chemistry. 51: 2964–2973.
- Dvořák, P., Hamouz, K., Hajšlová, J., Schulzová, V., Tomášek, J., Kuchtová, P. (2009): Mulč v pěstitelské technologii ekologicky pěstovaných brambor. Úroda, vědecká příloha. 12: 151 – 158.
- Rupich, J., Rehurkova, J., Boon, P.E. (2009): Probabilistic modelling of exposure doses and implications for health risk characterization: Glycoalkaloids from potatoes. Food and Chemical Toxicology. 47: 2899–2905.
- Knuthsen, P., Jensen, U., Schmidt, B., Larsen, I.K. (2009): Glycoalkaloids in potatoes: Content of glycoalkaloids in potatoes for consumption. Journal of Food Composition and Analysis. 22: 577–581.

THE COMPARISON OF CONVENTIONAL BEEF PRODUCTION AND BIO-PRODUCTION USING THE METHOD OF LIFE CYCLE ASSESSMENT

PLCH, R.[1,2], JIROUŠKOVÁ, Z.[1], CUDLÍN, P.[2] & MOUDRÝ, J. SR.[1]

Key words: conventional and bio-production, beef, LCA method

Abstract

The farming methods (intensification, extensification) and related used technologies result in emission load to the environment as regard the non-renewable energy resources, utilisation of agricultural land and numbers of animals under breeding. This work is focused on quantification of the emission load to the environment within the production of beef under the conditions of conventional and organic farming in the Czech Republic. The production of bio-beef causes higher emission load to the environment when compared to the conventional production.

Introduction

Under conditions of the Czech Republic, agriculture is the third greatest production activity when the production of CO_2-e (carbon dioxide equivalent) emissions in the atmosphere is considered. The share of the total emissions reaches 6.1 % (in 2008). Among the most important sources of greenhouse gases are numbered the enteric fermentation emissions (CH_4), barnyard manures management (CH_4 and N_2O) and agricultural land emissions (N_2O) (CHMI, 2010).

The goal of this work is to quantify the emission load to the environment resulting from the production of conventional beef and bio-beef under the conditions of the Czech Republic.

Materials and methods

The framework defined for the quantification of the environmental load resulting from beef production is shown in the Figure 1. The calculation includes emissions from consumed feedstuffs production, fossil fuels, electricity, cattle enteric fermentation (CH_4), barnyard manures management (CH_4, direct and indirect N_2O emissions). The calculation was carried out using the SimaPro 7.1 software with the ReCiPe 2008 method and the methodology IPCC 2006 (Dong H. et al., 2006). The environmental load of the beef production was realized for whole life cycle of an animal, i.e. since its birth to slaughtering (fattening time takes 377 days for conventional production and 210 days for bio-production).

The assessment of the beef environmental load were created in two model alternatives for conditions of the Czech Republic – i) Conventional production, ii) Bio-production. A basic

1 University of South Bohemia in České Budějovice, Studentská 13, 370 04 České Budějovice, E-mail: radek.plch@atlas.cz

2 Global Change Research Centre AS CR, v.v.i., Bělidla 986/4a, 603 00 Brno

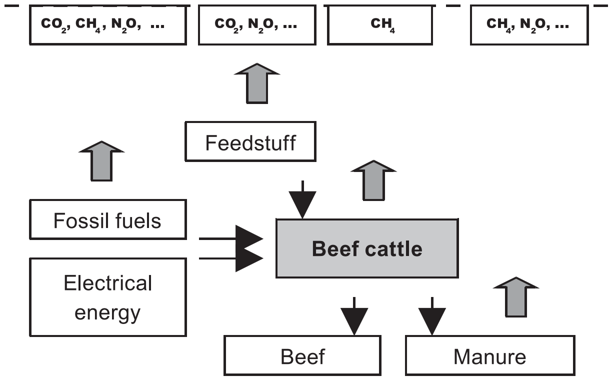


Fig. 1: The framework for the environmental load assessment

description of the both mentioned alternatives is shown in the Table 1. In the Czech Republic, most of organic farms have livestock for beef production on pasture (from spring to autumn) where calves suck milk from cows.

Tab. 1: Input data for the beef conventional and bio-production

	Units	Conventional production	Bio-production
Fattening time	days	377	210
Slaughter weight	kg	450	245
Meat production	kg	241	131
Slaughter yield	average in %	53.5	53.5

Total consumption of fossil fuels (non-renewable resources) was 181.5 litres for conventional production and 104.1 litres for bio-production.

Feeding rates were separately set for each animal age category and compared according to the content of dry matter, NEL, NEV, PDIE, PDIN, Ca, P, N-substances and eventually also the content of fibre and micronutrients. The aim was to ensure a sufficient or slightly excessive (up to 30 %) amount of all necessary substances in the feedstuff (Sommer A., 1994). For the conventional production is the yearlong feeding rate set for feeding in stables. For organic production are set two feeding rates, winter rate and summer rate partially based on grazing (Table 2).

Tab. 2: The amount of feedstuff for conventional and organic beef production (t/production expressed in dry matter content)

	Units	Feedstuff	Conventional production	Bio-production
Raughage	t / production	grass silage	0.804	0.276
	t / production	maize silage	0.328	
	t / production	hay		0.228
	t / production	straw	0.079	
	t / production	grazing growth		0.099
Grain fodders	t / production		0.940	0.054
Others	t / production	cow milk		0.216

Results

The conventional beef production causes lower emission load to the environment than the bio-production. Emissions of the conventional beef production reached 11.5 kg CO_2-e/kg of meat, bio-production reached 24.4 kg CO_2-e/kg of meat (Figure 2.).

In the case of conventional production the major emissions were caused by the enteric fermentation (4.4 kg CO_2-e/kg of meat), feedstuff production (3.1 kg CO_2-e/kg of meat), fossil fuels and electricity (2.2 kg CO_2-e/kg of meat) and the management of barnyard manures (1.8 kg CO_2-e/kg of meat). The most important part of the bio-beef production emissions made production of feedstuff (18.6 kg CO_2-e/kg of meat), consumption of fossil fuels and electricity (2.3 kg CO_2-e/kg of meat), enteric fermentation (1.6 kg CO_2-e/kg of meat) and the management of barnyard manures (1.6 kg CO_2-e/kg of meat). The conventional production is based on a yearlong feeding rate, while the feeding rate for organic production is divided into a summer and a winter feeding rate. The influence of feedstuff in bio-production is markedly affected by the breeding technology. Calves come on pastures in spring and the most important component of their feeding rate creates milk from cows. The production of this feeding milk itself causes another load to the environment within the bio-beef production (in this case expressed in kg CO_2-e) (Figure 2.).

Discussion

According to available literature sources the emission load for beef production reaches quite a wide range of values. An overview published for example Peters G. M. et al. (2010). Bio-beef production in Belgium reaches emission load of 10.1 kg CO_2-e/kg of meat; in the USA 10.4 kg CO_2-e/kg of meat; in Sweden 15.6 kg CO_2-e/kg of meat; Canada 19.6 kg CO_2-e/kg of meat; Japan 25.5 kg CO_2-e/kg of meat. When the comparison of conventional and bio-production in United Kingdom was done, the results proved higher emission load within the bio-production (17.5 kg CO_2-e/kg of meat) than the conventional production (15.2 kg CO_2-e/kg of meat). Quite the opposite results were achieved in Ireland (24.5 kg CO_2-e/kg of meat within the conventional production and 20.9 kg CO_2-e/kg of meat within the bio-production). In the case of our study of beef production in the Czech Republic, there is an evident influence of the breeding technology and feeding rates on the emission load (within the bio-production alternative this feeding rate is mainly represents by the production of feeding milk). In the case of the the conventional

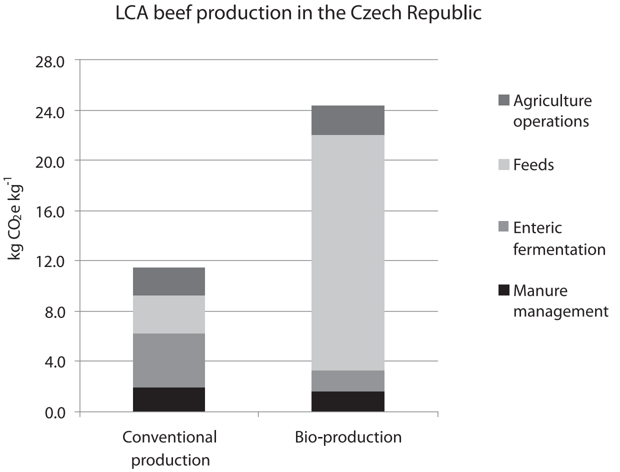


Fig. 2: Environmental load of beef production in the Czech Republic

production, the feeding milk consumption was not taken into account, because it is very low, when compared to other plant production feedstuff. Within the bio-beef production this situation is quite different, because beef cattle is permanently kept on pastures and the calves suck milk through the whole fattening season.

Conclusions

Emissions of the conventional beef production reached 11.5 kg CO_2-e/kg of meat, bio-production reached 24.4 kg CO_2-e/kg of meat. In the case of conventional production is the highest amount of emissions caused by the enteric fermentation (4.4 kg CO_2-e/kg of meat) and the production of feedstuff (3.1 kg CO_2-e/kg of meat). The most important amount of emissions within the bio-production make feedstuff production (18.6 kg CO_2-e/kg of meat), fossil fuels and electricity consumption (2.3 kg CO_2-e/kg of meat). An important impact on the amount of emissions within the beef production under both farming systems represent feeding rates.

Acknowledgments

This research study was supported by the European territorial co-operation Austria-Czech Republic 2007–2013, the Project EUS M00080– Sustainable kitchen and by Research Plan of the GCRC of the AS CR AVOZ60870520.

References

- CHMI (2010): National Greenhouse Gas Inventory Report of the Czech Republic, Prague.

- Dong H., Mangino J., McAllister T. A., Hatfield J. L., Johnson D. E., Lassey K. R., Aparecida de Lima M., Romanovskaya A. (2006): Volume 10 – Emissions from livestock and manure management, In: IPCC Guidelines for National Greenhouse Gas Inventories.
- Peters G. M., Rowley H. V., Wiedemann S., Tucker R., Short M. D., Schulz M. (2010): Red meat Production in Australia: Life Cycle Assessment and Comparison with Overseas Studies. Environ. Sci. Technol. 44:1327–1332.
- Sommer A. (1994): Potřeba živin a tabulky výživné hodnoty krmiv pro přežvýkavce. 1.vyd. Pohořelice, ČZS VÚVZ, 196 s. ISBN 80–901–5981–8 (In Czech).

EVALUATION OF MICROBIOLOGICAL CONTAMINATION OF SAGE (*SALVIA OFFICINALIS* L.) AND LEMON BALM (*MELISSA OFFICINALIS* L.) HERBS

SEIDLER-ŁOŻYKOWSKA, K., KARPIŃSKA, E., KĘDZIA, B.[1]

Key words: microbiological contamination, sage, lemon balm, herb

Abstract

In 2008–2010 the microbiological purity of lemon balm and sage herbs originated from organic cultivation was evaluated. Number of aerobic bacteria, number of yeasts and moulds, number of ***Escherichia coli*** *and* ***Salmonella*** *were estimated in the dried herbs. Additionally, the number of intestine bacteria from family* ***Enterobacteriaceae*** *was evaluated. The tested herbs were contaminated in the different rate depending of their origin. All of the investigated herbs were below the level of standard contamination for the raw material treated with hot water (4A) (European Pharmacopoeia, 2008). Although, according to standard 4B (the raw material do not treated with hot water) contamination of most of the analyzed herbs was transgressed. After 8 months of storage the decrease of contamination of all the analyzed herbs was observed.*

Introduction

The introduction of medicinal plants into organic cultivation will help to obtain the high quality raw materials for pharmaceutical industry and other purposes as cosmetic production, or forage supplement for animals, which can enhance their well-being (Trzaskoś, 1997). Therefore, control of the quality of organically produced raw materials is crucial for their utilisation. Evaluation done by Habán and Otepka (2007) and Seidler-Łożykowska et al. (2008) confirmed the good quality of the tested organic herbs of peppermint, yarrow, marigold, lemon balm, sage and thyme as a suitable for industry utilisation.

Materials and methods

The raw materials of sage (*Salvia officinalis* L.) and lemon balm (*Melissa officinalis* L.) taken to microbiological evaluation, originated from the organic field experiments. In 2008, the experiments were established as a randomized complete block design in three repetitions, in four certified organic fields and two conventional fields, which were treated as a control. The fields (organic and conventional) were located in different parts of Poland: Jary (N51°17′ E16°52′), Paszków (N50°36′ E16°52′), Plewiska (N52°21′ E16°48′), Słońsk (N52°33′ E14°48′). Every year, in 2008–2010 herbs of sage and lemon balm were collected by hand, and then dried in natural conditions, in shaded and well ventilated place. The representative samples were taken from the dried raw materials of sage and lemon balm.

[1] Institute of Natural Fibres and Medicinal Plants, Wojska Polskiego 71B, 60–630 Poznań, Poland

In Microbiology Laboratory of Institute the evaluation of raw material microbiological purity was carried out following European Pharmacopoeia VI (2008) standards for raw materials treated with hot water (4A) and for raw materials do not treated with hot water (4B). Number of aerobic bacteria, number of yeasts and moulds, number of *Escherichia coli* and *Salmonella* were estimated in dried herb. Additionally the number of intestine bacteria from family *Enterobacteriaceae* was evaluated. Investigations were done after drying, then after 8 months of herb storage in darkness and room temperature.

Results

The analysis of microbiological purity of the analyzed herbal raw materials of sage and lemon balm showed a great diversification of microbial contamination depending on herb origin (tab. 1–2). The most contaminated herb of sage originated from both, organic and conventional cultivations from Plewiska, while the most contaminated herb of lemon balm was obtained in Słońsk. The analysis done after drying showed that this herb even contained *Eschericha coli*. All herbs characterized low contamination of yeasts and moulds.

All of the investigated herbs were below the level of standard contamination for the raw material treated with hot water (4A) (E. Ph., 2008). Although, according to standard 4B most of the analyzed herbs must be condemned because of too high contamination: sage from Plewiska and Słońsk, lemon balm from Słońsk (*Escherichia coli* content) and all herbs from Paszków which were characterized by high content of *Enterobacteriaceae*.

After storage number of aerobic bacteria in 1 g of sage herb was diminished from 51 % (Paszków organic) to 95 % (Plewiska, both experiments). Number of yeasts and moulds decreased from 11 % (Plewiska control) to 50 % (Plewiska organic, Słońsk), while the number of *Enterobacteriaceae* decresed from 22 % (Słońsk) to 97 % (Plewiska organic).

Tab. 1: Microbiological contamination of sage herb after drying and 8 months of storage

location	Aerobic bacteria in1g		Yeasts and moulds in 1g		Number of *Enterobacteriaceae* in 1g		Number of *E. coli* in 1g	Number of *Salmonella* in 10g
	After drying	8m.	After drying	8m.	After drying	8m.		
Plewiska Organic	154.000	8.100	160	80	106.000	3.000	N	N
Plewiska Control	270.000	12.450	90	80	28.000	3.450	N	N
Paszków Organic	9.000	4.400	70	50	130	80	N	N
Paszków Control	-	-	-	-	-	-	-	-
Słońsk	119.800	8.000	210	110	7.850	6.100	N	N
Jary	1.700	700	120	70	530	270	N	N
Standard 4A	10.000.000		100.000		-		100	-
Standard 4B	100.000		10.000		1.000		0	0

Tab. 2: Microbiological contamination of lemon balm herb after drying and 8 months of storage

location	Aerobic bacteria in1g		Yeasts and moulds in 1g		Number of Enterobacteriaceae in 1g		Number of E. coli in 1g		Number of *Salmonella* in 10g
	After drying	8m.	After drying	8m.	After drying	8m.			
Plewiska Organic	3.100	1.500	160	60	80	40	N		N
Plewiska Control	580	530	160	50	300	40	N		N
Paszków Organic	44.000	60	240	10	3.800	20	N		N
Paszków Control	55.000	400	110	10	24.400	230	N		N
Słońsk	310.000	4.300	500	145	31.000	600	10	N	N
Jary	1.300	1.200	140	10	10	10	N		N
Standard 4A	10.000.000		100.000		-		100		-
Standard 4B	100.000		10.000		1.000		0		0

Likewise, after storage of lemon balm herb the number of aerobic bacteria in 1 g, diminished from 8 % (Plewiska control) to 99 % (Paszków, both experiments). Whereas, number of yeasts and moulds decreased from 62 % (Plewiska organic) to 93 % (Jary), and number of *Enterobacteriaceae* decreased from 50 % (Plewiska organic) to 99 % (Paszków, both experiments).

Discussion

Soil and organic fertilization are the main sources of microbiological contamination of raw material [Kędzia 1999]. The investigated herbs of sage and lemon balm were contaminated in different rates. The similar results obtained Seidler-Łożykowska (2009) when examined basil herb before and after storage. According to Kędzia (1999) there are two main reasons of decreasing of herb contamination during storage: 1. bacteria have different susceptibility for dryness and 2. plant active substances (esp. essential oil, anthocyanins and tannins) have strong effect on raw material microbes. Contamination of raw material organically produced should be controlled, especially for *Escherichia coli* and *Enterobacteriaceae* content, following the fact that organic manure is a basic type of fertilization.

Conclusions

1. The origin of the tested herbs determined their microbiological contamination in the different rate.
2. Some herbs did not fulfill the requirements for raw materials do not treated with hot water (4B).
3. The decrease of contamination of all the analyzed herbs was observed after eight months of storage.
4. Microbiological contamination of organic raw materials should be controlled following the fact that organic manure is a basic type of fertilization.

Acknowledgments

Project was financed by Polish Ministry of Agriculture and Rural Development

References

- 1. European Pharmacopoeia 6th ed. (2008): Councile of Europe, Strasbourg, 680 p.
- 2. Haban M., Otepka P. (2007): Organically cultivated medicinal plants and their quality analysis. Proceeding of conference "Organic farming 2007": 143–145.
- 3. Kędzia B., (1999): Badania nad zanieczyszczeniem surowców zielarskich drobnoustrojami. Habilitation Thesis, Institute of Medicinal Plants, Poznań, Poland.
- 4. Seidler-Łożykowska K., Golcz A., Kozik E., Wójcik J. (2008): Quality of thyme herb (*Thymus vulgaris* L.) from organic cultivation. Proceeding of II Conference ISOFAR, Modena, vol.1:600–603.
- 5. Seidler-Łożykowska K., Mordalski R., Kucharski W., Golcz A., Kozik E., Wójcik J. (2009): Economic and qualitative value of the raw material of chosen species of medicinal plants from organic farming. Acta Sci. Pol., Agricultura 8 (3): 29–35.
- 6. Trzaskoś M. (1997): Rola ziół w runi trwałych użytków zielonych. Z. Probl. Post. Nauk Rol. 453:339–348.

REQUIREMENTS ON PROPERTIES AND CHARACTERS OF WHEAT SPECIES GROWN IN ORGANIC SYSTEM

STEHNO, Z.[1], KONVALINA, P.[2], CAPOUCHOVÁ, I.[3] JANOVSKÁ D.[1], KÁŠ M.[1] & POŠTOVÁ, A.[1]

Key words: wheat species; organic farming; biological characters; quality

Abstract

With the aim to compare suitability of wheat species for organic cultivation, there were evaluated spring forms of spelt, emmer, einkorn and common wheat on the fields certified for organic farming. Particular attention was paid to the characters valuable for organic growing system. Einkorn and alternative forms of common wheat had more prostrate tufts, suitable for competitiveness to weeds, than emmer, spelt and check varieties of common wheat. Longer distance of spike from flag leaf was observed in einkorn and common wheat. Higher number of days from flowering to ripeness (grain filling period) was identified in einkorn, spelt and alternative common wheat. Index of lodging of tested wheat species was very similar except check varieties with higher resistance to lodging. Hulled wheat species contained higher proportions of crude protein and wet gluten than common wheat. However, bread making properties were not so suitable. Only spelt approached common wheat in most bread making parameters.

Introduction

The importance of spring cereals in systems of organic farming is rising because of widening of crop diversity on arable land and demand for bio products on the market. For example, the present production of spelt in Australia is 4 000 tons but markets currently exist for 10 000 tons (Neeson 2011). Growing of spring wheat, especially *T. spelta, T. diccocum* and *T. monococcum* is still underestimated. Main benefit of wheat spring forms from the view of farming technique is decrement of risk of winter freeze injury. The further advantage of these species is high content of nutritional substances in grain The grains contain more crude protein than the grains of modern varieties (Marconi et al. 1999); wholemeal flour is a valuable source of dietary fibre, cellulose and hemicellulose, and it contains high quantities of minerals (Marconi and Cubadda 2005).

1 Crop Research Institute, Drnovská 507, 161 06 Praha 6-Ruzyně, Czech Republic, E-Mails stehno@vurv.cz, janovska@vurv.cz, kas@vurv.cz and postova@vurv.cz, Internet www.vurv.cz

2 University of South Bohemia, Branišovská 31, 370 05 České Budějovice, Czech Republic E-mail konvalina@zf.jcu.cz, Internet www.zf.jcu.cz

3 Czech University of Life Sciences, Kamýcká 129, 165 21 Praha 6 – Suchdol, Czech Republic E-mail capouchova@af.czu.cz, Internet www.af.czu.cz/cs/

Materials and methods

With the aim to compare suitability of wheat species for organic cultivation, there were evaluated spring forms of spelt, emmer, einkorn and common wheat on the fields certified for organic farming. Wheat genetic resources were selected from the Czech gene bank. Testing was arranged in the same way (3 replications, plots size 4.5 m^2, row spacing 12.5 cm) in three localities – Prague-Ruzyně; Úhříněves and České Budějovice in 2010. Characters clustered into three groups (morphological, agronomical and product quality) were evaluated according to the Descriptor list for genus *Triticum* (Bareš et al., 1985) Particular attention was paid to the characters valuable for organic growing system as e.g. tuft shape, lodging resistance, distance between flag leaf and spike, disease resistance and grain quality.

Results

Organic growing of wheat requires different manifestation of some characters what comes from different way of cultivation. The tuft shape should be dropping till prostrate (scored 5 to 9) to cover soil surface in the initial phases of development and to increase competitiveness to weeds. According to our results the einkorn (*T. monococcum*) and alternative forms of common wheat had more prostrate tufts (tab. 1). The distance of spike from flag leaf influences transfer of diseases to spike. Longer distance was observed in einkorn and common wheat. Plant high is frequently connected with lodging resistance. Data in the tab. 1 demonstrate reduction in plant high of 'modern' common wheat varieties.

Tab. 1: Selected morphological and agronomical characters – average from 3 localities

Species	tuft shape (index)	leaf position before heading (index)	internode length flag leaf – spike (cm)	plant high (cm)	grain filling period (days)	powdery mildew (index)	lodging before harvest (index)
Triticum monococcum L.							
average	6,6	2,2	29,5	113,1	33,4	9	6,4
V.C.	10,7	14,9	18,8	2,8	11,8	0	55,8
Triticum dicoccon Schrank							
average	3,3	2,6	25,3	122	29,8	9	6,2
V.C.	1,7	42,9	15,7	13,9	11,8	0,6	43,4
Triticum spelta L.							
average	3,2	3,6	27,2	123,4	32	8,9	6,5
V.C.	18,3	23,4	22,1	4,7	13	1,3	52,2
Triticum aestivum L. – alternative forms							
average	5,7	3,1	29,2	117,6	32	8	6,4
V.C.	35,3	8,5	20	7,9	8,1	17,3	59,9
Triticum aestivum L. – check varieties							
average	2,7	3,9	29,6	96,6	30,4	8,8	7,3
V.C.	25,2	42,2	38,8	21	22,3	3,3	38,5

Grain filling period (from flowering to ripeness) is important for grain formation (Nass, Reiser, 1975); consequently for kernel weight (TKW) and grain yield. Higher number of days from flowering to ripeness was identified in einkorn, spelt and alternative common wheat (tab. 1). In general, the hulled wheat species (einkorn, emmer and spelt) had slightly higher resistance to powdery mildew. Index of lodging was very similar except check varieties with higher resistance to lodging.

Tab 2: Grain yield and basic quality parameters – average data from 3 localities

Species	grain yield (t/ha)	crude protein content (%)	wet gluten content (%)	Gluten Index	Zeleny sedimenta-tion (ml)
Triticum monococcum L.					
average	1,92	16,09	41,61	15,17	18,13
V.C.	82,3	8,83	29,14	21,95	20,48
Triticum dicoccon Schrank					
average	1,88	17,32	47,83	23,18	18,75
V.C..	80,3	7,93	4,93	19,82	1,89
Triticum spelta L.					
average	2,26	16,76	46,52	44	39,86
V.C.	81,9	10,09	15,06	15,21	0
Triticum aestivum L. – alternative forms					
average	1,76	14,16	36,75	45,58	45,38
V.C..	72,8	17,31	24,12	7,61	24,54
Triticum aestivum L. – check varieties					
average	2,8	13,82	32,72	67	43,5
V.C.	86,1	14,77	20,87	21,68	19,51

V.C. – variation coefficient

Estimated grain yield of tested spelt samples was highest but did not reached level of check common wheat varieties (2.8 t/ha).

Quality of organic products is very important even more than conventional ones. Hulled wheat species contain usually higher proportion of protein than common wheat (Oliviera J.A., 2001) what was confirmed also in this case (Tab. 2). Also wet gluten content was higher than in common wheat samples. However, bread making properties, determined by gluten index and Zeleny sedimentation were not as suitable as in common wheat. Only spelt approached common wheat in most bread making parameters.

Discussion

Dropping and prostrated tuft shape enables fast coverage of the land just after the emergence of the crop (Kruepl et al., 2006) and increases its competitiveness to weeds (Wolfe et al., 2008). Such manifestation of the trait was identified mainly in einkorn. Longer distance spike – flag leaf, highly heritable trait (Fu and Somers, 2009), was determined in the same species. The rate of grain filling and the length of the grain filling period may be important in determining the final grain yield of spring wheat (Nass and Reiser, 1975). Nevertheless, there are differences among wheat species. Realisation of yield potential is frequently influenced by lodging of the crop.

High grain quality of spelt and emmer and digestibility of products from them is described by many authors (e.g. Piergiovanni et al. 1996, Moudry and Dvoracek, 1999 and others).

Conclusions

Einkorn (*T. monococcum*) and alternative forms of common wheat had more prostrate tufts, suitable for competitiveness to weeds, than emmer, spelt and check varieties of common wheat.

Longer distance of spike from flag leaf was observed in einkorn and common wheat.

Higher number of days from flowering to ripeness (grain filling period) was identified in einkorn, spelt and alternative common wheat.

Index of lodging of tested wheat species was very similar except check varieties with higher resistance to lodging.

Hulled wheat species contained higher proportions of crude protein and wet gluten than common wheat. However, bread making properties were not so suitable. Only spelt approached common wheat in most bread making parameters.

Acknowledgments

The research has been supported by the Czech Ministry of Agriculture (projects QH 82272 and MZE0002700604)

References

- Bareš I., Sehnalová J., Vlasák M., Vlach M., Kryštof Z., Amler P., Malý J., Beránek V. (1985): Descriptor list genus *Triticum* L. VURV Praha Genetické zdroje No. 25; 78 p.
- Fu Y, Somers D. (2009) Genome-Wide Reduction of Genetic Diversity in Wheat Breeding Crop Sci 49: 161–168.
- Kruepl C., Hoad S., Davies K., Bertholdsson N.O., Paolini R. (2006): Weed competitivness, In: Handbook cereal variety testing for organic low input agriculture. COST860-SUSVAR, Risø National Laboratory, Denmark, pp. W1-W16
- Marconi M., Cubadda R. (2005): Emmer wheat.In Abdel-Aal E-SM, Wood P (eds.): Speciality Grains for Food and Feed. Minnesota, American Association of Cereal Chemists Inc., pp. 63–108.
- Marconi E., Carcea M., Graziano M., Cubadda R. (1999): Kernel properties and pasta-making quality of five European spelt wheat (*Triticum spelta* L.) cultivars. Cereal Chem 76: 25–29.
- Moudry, J, and Dvoracek, V. (1999): Chemical composition of grain of different spelt varieties (*Triticum spelta* L.). Rostlinna Vyroba 45:533:538.
- Nass H. G., Reiser B. (1975): Grain filling period and grain yield relationships in spring wheat. Canadian J. of Plant Sciences 55: 673–678.
- Neeson R. (2011): Organic spelt production. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/380784/Organic-spelt-production.pdf
- Oliviera J.A. (2001): North Spanish emmer and spelt wheat landraces: agronomical and grain quality characteristic evaluation. Plant genetic resources newsletter, 125:16–20

- Piergiovanni A. R., Laghetti G., and Perrino P. (1996) Characteristics of Meal from Hulled Wheats (*Triticum dicoccon* Schrank and *T spelta* L.): An Evaluation of Selected Accessions, Cereal Chemistry Vol. 73, No. 6, 1996
- Wolfe M.S., Baresel J.P., Deslaux D., GoldringerI., Hoad S., Kovacs G., Löschenberger F., Miedaner T., Ostergard H., Lammerts Van Bueren E.T., (2008): Developments in breeding cereals for organic agriculture, Euphytica, 163: 323–346

TOTAL PHENOLIC CONTENT (TPC) OF THE GRAIN OF WHEAT X SPELT HYBRIDS AND THEIR PARENTAL FORMS

SUCHOWILSKA, E.*, WIWART, M., GRABAN, Ł., LAJSZNER, W.[1]

Key words: spelt, common wheat, hybrids, phenolic content

Abstract

The total phenolic content (TPC) of the grain of 24 hybrids from single crosses between three spring wheat cultivars (Torka, Zebra, Kontesa) and five spring spelt strains (S10, S11, S12, S13, S14) was studied as compared with their parental forms. TPC ranged from 3 300 mg kg^{-1} (Torka x S11 cross) to 5 443 mg kg^{-1} (S11 strain). Average TPC was significantly lower in common wheat varieties (4 125 mg kg^{-1}) than in spelt grain (4 768 mg kg^{-1}). The grain of hybrids whose maternal form was spelt contained significantly more phenols (4 467 mg kg^{-1}) than the grain of hybrids resulting from reciprocal crossing (4 169 mg kg^{-1}). The obtained results suggest that the TPC of grain may be inherited cytoplasmatically.

Introduction

Spelt wheat (*Triticum aestivum* subsp. *spelta*) is an old European crop that has been grown for centuries in several countries of Central Europe (e.g. Belgium, Germany, Austria, Slovenia, and the northern parts of Italy). Spelt cultivation has been declining for many years, but recent interest in the use of spelt in organic food production has led to a resurgence in its popularity. Cereals play an important part in human nutrition. Consumed on a large scale, they may provide a wide range of nutrients and biologically active compounds (Zuchowski et al 2011). Among secondary metabolites present in cereal grains, a particular role is played by phenolic compounds which determine plant pathogen resistance, thus increasing the microbiological safety of grain. Phenolic compounds are involved in cell wall lignification, and lignified cell walls create an effective barrier to pathogen invasion and slow down the diffusion of mycotoxins (Siranidou et al. 2002). Common wheat varieties differ with respect to the profile of phenolic derivatives of benzoic acid, cinnamic acid, free flavonols and flavones. Due to their antioxidant properties, dietary phenolic compounds may provide health benefits associated with a reduced risk of chronic diseases (Liu 2007). They are known to inhibit neoplastic transformation, prevent rheumatoid arthritis, heart diseases and degenerative changes leading to neurological disorders and premature aging (Macheix et al., 1990, Xu et al., 2000). Spelt grain contains also phytosterols which decrease cholesterol levels. The grain of contemporary high-yielding wheat varieties has a low content of nutrients that determine high nutritional value (protein with a desirable amino acid profile, microelements, dietary fiber) and health-promoting properties (mostly phytosterols and phenolic compounds). Spelt grain is a rich source of the above substances. Despite its health benefits, spelt has a number of undesirable

[1] University of Warmia and Mazury in Olsztyn, Department of Plant Breeding and Seed Production, sq. Lodzki 3/425, 10–727 Olsztyn, Poland, e-mail: ela.suchowilska@uwm.edu.pl, Internet www.uwm.edu.pl/khrin

attributes, including low threshing efficiency and relatively high susceptibility to lodging. The high genetic similarity between spelt and common wheat supports the development of hybrids which may become valuable cereal crops in the near future.

The objective of this study was to determine the total phenolic content (TPC) of the grain of wheat x spelt hybrids and their parental forms.

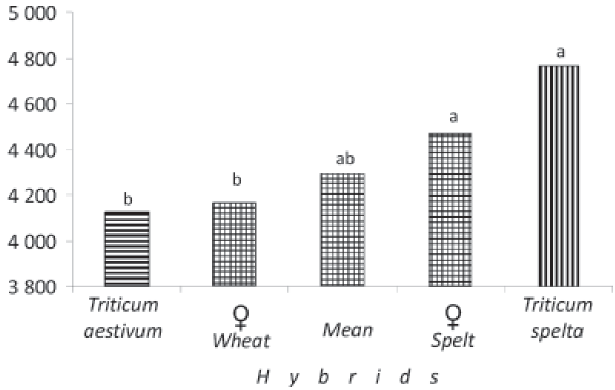
Materials and methods

The experimental materials comprised the grain of 24 wheat x spelt hybrids, three spring wheat cultivars (Torka, Zebra, Kontesa) and five spring spelt strains (S10, S11, S12, S13,S14), which constituted their parental forms. Grain samples were ground in a laboratory mill, and 1 g analytical samples of each form were extracted with 25 ml MeOH containing 1 % HCL, for 24 h at 24°C. The procedure was repeated twice. The metanolic extracts were centrifuged at 4000 n min^{-1} for 15 min and the supernatants were pooled and stored at 4°C (Shen et al. 2009). TPC was assayed by the Folin-Ciocalteu colorimetric method with slight modification (Bao et al. 2005, Cai et al. 2004). Briefly, aliquots (1.0 mL) of appropriately diluted extracts or standard solutions were mixed with 0.5 mL 0.5 N Folin–Ciocalteu reagent, and the reaction was neutralized with saturated sodium carbonate (75 g l^{-1}). The absorbance of the resulting blue color was recorded using a spectrophotometer (Helios γ, Thermo Electron Corporation) after incubation for 2 h at 23°C. A calibration curve was prepared using a ferrulic acid solution. TPC was expressed as milligrams of ferulic acid equivalent (mg FEA) per 100 g of grain dry weigh. The obtained results were analyzed using the ANOVA procedure, and the significance of differences between mean values was estimated by the multiple Student-Newman-Keuls test.

Results and discussion

The grain of the studied hybrids and their parental forms differed considerably with regard to TPC (Fig. 1).

The grain of *T. aestivum* contained significantly less phenolic compounds, compared with spelt grain (4 125 mg kg^{-1} vs. 4 768 mg kg^{-1}), and the TPC of *T. spelta* strains varied widely (from 3 804 mg kg^{-1} in S12 to 5 443 mg kg^{-1} in S11). Hybrid grain contained intermediate concentrations of phenolic compounds, in comparison with parental forms (from 3 300 mg kg^{-1} to 4 934 mg kg^{-1}). The grain of hybrids whose maternal form was spelt had a significantly higher TPC (4 467 mg kg^{-1}) than the grain of hybrids whose maternal form was common wheat (4 169 mg kg^{-1}). This seems to suggest that the TPC of wheat and spelt grain may be inherited cytoplasmatically. Thus, *T. spelta* should be used as the maternal form in breeding programs aimed at developing wheat-spelt hybrids with a high TPC of grain. Although it could lead to passing on the undesirable traits of spelt (in particular low threshing efficiency and susceptibility to lodging) to hybrids, our previous experience shows that the risk can be largely reduced by proper selection.



(a, b – the values denoted by the same letter do not differ significantly at p<=0.01)

Fig. 1: Mean TPC (mg kg^{-1}) of the grain of wheat x spelt hybrids and their parental forms

Acknowledgments

This work has been financed by the Ministry of Science and Higher Education, with funds allocated for scientific research in 2011, Iuventus Plus research program, IP2010 039870 (agreement no. 0398/P01/2010/70).

References

- Bao J.S., Cai Y., Sun M., Wang G.Y., Corke H. (2005): Anthocyanins, flavonols, and free radical scavenging activity of Chinese bayberry (Myrica rubra) extracts and their color properties and stability, J Agric Food Chem 53: 2327–2332.
- Cai Y.Z., Luo Q., Sun M., Corke H. (2004): Antioxidant activity and phenolic compounds of 112 traditional Chinese medicinal plants associated with anticancer, Life Sci 74:2157–2184.
- Shen Y., Liang J., Xiao P., Lu Y., Bao J. (2009): Total phenolics, flavonoids, antioxidant capacity in rice grain and their relations to grain color, size and weight. J Cereal Sci 49:106–111.
- Liu R.H. (2007): Whole grain phytochemicals and health. J Cereal Sci. 46: 207–219.
- Zuchowski J., Jonczyk K., Pecio L., Oleszek W. (2011): Phenolic acid concentrations in organically and conventionally cultivated spring and winter wheat. J Sci Food Agric 91 (6): 1089–1095.
- Siranidou E., Kang Z., Buchenauer H. (2002): Studies on symptom development, phenolic compounds and morphological defence responses in wheat cultivars differing in resistance to *Fusarium* Head Blight. J. Phytopathol. 150: 200–2008.
- Macheix, J.-J., Fleuriet, A., Billot, J. (1990): Fruit Phenolics. CRC Press, Boca Raton, FL.
- Xu H. X., Wan M., Dong H., But P. P. H., Foo L. Y. (2000): Inhibitory activity of flavonoids and tannins against HIV-1 protease. Biol Pharmaceut Bull 23: 1072 – 1076

TECHNOLOGICAL QUALITY OF MINOR SPRING WHEAT SPECIES FROM ORGANIC FARMING AND POSSIBILITIES OF THEIR UTILIZATION

ŠKEŘÍKOVÁ, A.[1], CAPOUCHOVÁ, I.[1], KONVALINA, P.[2], STEHNO, Z.[3]

Key words: minor wheat species, quality, organic farming

Abstract

A collection of einkorn, emmer and spring form of spelt wheat landraces and other genetic resources from the Gene Bank of CRI Prague-Ruzyně, was evaluated with the view of baking quality parameters and suitability for organic farming. The samples originate from exact field small-plot trials under the organic farming conditions of two experimental sites (Prague-Uhříněves and České Budějovice).There were similar trends in individual quality parameters on both experimental sites – the highest crude protein content in grain dry matter (17–18 % in average) and a relatively low variation coefficient (VC 6–13 %) were found in the spelt and emmer groups of various genetic resources, the lowest crude protein content in grain dry matter (12–14 %) in the reference cultivars of common wheat. In contrast, minor wheat species, especially emmer and einkorn, reached very low values of Gluten Index (7–14 %) and Zeleny test (12–18 ml); VC of einkorn and emmer were high (VC 47–58 % in GI and 24–58 % in Zeleny test). Reference cultivars of common wheat reached values of GI between 67–72 %; Zeleny test 44–46 ml.

Introduction

In relation to the expansion of organic farming, the interest in non-traditional, minor or alternative crops is increasing among farmers. Some species of *Triticum* genus – *T. monococcum* (einkorn), *T. dicoccon* (emmer) and *T. spelta* (spelt) are examples of these minor crops. In accordance with increasing requirements for food diversity and good quality of foodstuff products, the interest of consumers in these wheat species is still increasing (Dotlačil, 2002).

Collection, evaluation and utilization of genetic resources of wheat has a long tradition in the Czech Republic. The wheat collection is the biggest one among plant genetic resources in the Czech Gene Bank. Collected samples of wheat genetic resources are multiplied and tested for their properties and characters. Accessions suitable for their use in breeding or agricultural practice can be selected based on the available information (Stehno et al., 2005).

[1] Czech University of Life Sciences (CULS) Prague, 165 21 Prague 6 – Suchdol, Czech Republic, E-Mail Skerikova@af.czu.cz, Capouchova@af.czu.cz, Internet www.czu.cz

[2] University of South Bohemia, Studentská 13, 370 05 České Budějovice, Czech Republic, E-mail Konvalina@zf.jcu.cz, Internet www.jcu.cz

[3] Crop Research Institute Prague, Drnovská 507, 161 00 Praha 6 – Ruzyně, E-Mail Stehno@vurv.cz, Internet www.vurv.cz

This study reports the basic quality parameters of landraces and other genetic resources of einkorn, emmer and spring form of spelt wheat, which are the part of collection of the Gene Bank of CRI (Crop Research Institute) in Prague.

Materials and methods

Seed samples of the collection of einkorn, emmer and spring form of spelt wheat were obtained from the Gene Bank of CRI Prague-Ruzyně (tab. 1) and cultivated during the experimental years 2009 – 2010 in exact small field plot trials in two experimental sites: Prague-Uhříněves (295 m above sea level, average annual temperature 8.3°C, sum of precipitation 575 mm) and České Budějovice (388 m above sea level, average temperature 8.2°C, sum of precipitation 620 mm). As reference cultivars two spring cultivars of common wheat were used: cultivar SW Kadrilj (SWE) and the older cultivar Jara (CSK). Experiments were carried out in organic growing systems; pea was a preceding crop in site Prague-Uhříněves, lucerne (alfalfa) in site České Budějovice.

Post-harvest quality traits were assessed by standard methods: crude protein content in grain dry matter (Kjeldahl method, ČSN ISO 1871), wet gluten content in grain dry matter and Gluten Index (ČSN ISO 5531), applied on Glutomatic 2200, Zeleny test (ČSN ISO 5529) and falling number (ČSN ISO 3093).

Tab. 1: List of evaluated wheat landraces and other genetic resources

Einkorn wheat	Emmer wheat	Spelt wheat
T. monococcum (GEO)	Rudico (CZE)	*T. spelta* Ruzyně (CSK)
T. monococcum (ALB)	May-Emmer (CHE)	*T. spelta* Tabor 1 (CSK)
Schwedisches Einkorn (SWE)	*T. dicoccon* Tapioszele (HUN)	*T. spelta* Tabor 2 (CSK)
T. monococcum No. 8910 (DNK)	*T. dicoccon* Dagestan (RUS)	*T. spelta* VIR St. Petersburg (CSK)
	T. dicoccon Palestine (ISR)	*T. spelta* Bílá jarní (CSK)
	Weisser Sommer (DEU)	*T. spelta* Kew (GBR)
	T. dicoccon Brno (CSK)	*T. spelta* No. 8930 (DNK)
	T. dicoccon Tabor (CSK)	

Results

It is evident from our results (tab. 2–3), that all evaluated minor wheat species are rich in crude protein and wet gluten in grain dry matter and superior to the reference cultivars of common wheat. The differences between the evaluated genetic resources were not very high (especially in crude protein content), resulting in low values of VC (variation coefficient).

Both, the Zeleny test and the Gluten Index indicate the baking quality of gluten. The evaluated minor wheat species, especially einkorn and emmer, reached considerably lower values of these parameters in comparison with the reference cultivars of common wheat. Spelt was intermediate regarding Zeleny test and GI, but still relatively close to the reference cultivars. We found high variability between wheat cultivars regarding Zeleny and GI values indicating a high potential for selection of gluten quality, whereas crude protein and wet gluten content did not show differences relevant for further selection.

Tab. 2: Grain quality parameters of the minor wheat species collection (experimental site Prague-Uhříněves, average of 2009–2010)

Parameter	Crude protein content (%)	Wet gluten content (%)	Gluten Index (%)	Zeleny test (ml)	Falling number (s)
Einkorn wheat					
Mean, SD*	17.6 ± 1.4	41.8 ± 9.2	9.4 ± 5.4	18.2 ± 8.5	282.9 ± 73.3
VC**	5.7	22.0	57.4	46.7	25.9
Emmer wheat					
Mean, SD*	17.7 ± 2.3	42.4 ± 8.1	14.1 ± 7.6	15.7 ± 5.5	253.4 ± 98.2
VC**	13.0	19.1	53.9	35.0	38.8
Spelt wheat					
Mean, SD*	18.1 ± 1.8	49.2 ± 7.8	32.0 ± 10.8	35.3 ± 8.1	342.6 ± 44.3
VC**	9.9	15.9	33.8	22.9	12.9
Reference cultivars of common wheat					
Mean, SD*	12.2 ± 1.5	28.8 ± 7.3	72.3 ± 17.3	44.1 ± 7.7	389.0 ± 1.4
VC**	12.3	25.3	23.9	17.5	0.4

*SD = Standard deviation; ** VC = Variation coefficient

Tab. 3: Grain quality parameters of the minor wheat species collection (experimental site České Budějovice, average of 2009–2010)

Parameter	Crude protein content (%)	Wet gluten content (%)	Gluten Index (%)	Zeleny test (ml)	Falling number (s)
Einkorn wheat					
Mean, SD*	16.1 ± 2.2	40.1 ± 9.0	7.5 ± 3.6	11.9 ± 7.0	302.0 ± 48.4
VC**	13.7	22.4	48.0	58.8	16.0
Emmer wheat					
Mean, SD*	17.7 ± 1.9	40.9 ± 6.4	12.4 ± 7.4	12.3 ± 3.0	276.4 ± 81.7
VC**	10.7	15.6	59.7	24.4	29.6
Spelt wheat					
Mean, SD*	17.3 ± 1.1	46.6 ± 3.6	39.1 ± 18.8	30.7 ± 8.0	303.6 ± 52.7
VC**	6.4	7.7	22.5	26.1	17.4
Reference cultivars of common wheat					
Mean, SD*	14.7 ± 1.3	36.8 ± 6.9	66.8 ± 7.3	46.0 ± 12.0	293.3 ± 72.6
VC**	8.9	18.8	10.9	26.1	24.8

*SD = Standard deviation; ** VC = Variation coefficient

Falling number reached in average high values in all evaluated wheat species and exceeded the minimum requirements for falling number of bread wheat – min. 220 s (according to the Czech standard – ČSN ISO 3093).

Discussion

Our results indicate higher values of crude protein content and wet gluten content in the minor wheat species compared to reference cultivars of common wheat. This is in accordance with observations of many authors, for example Michalová et al. (2003). They reported that crude protein content in grain dry matter of hulled wheat varied generally from 15 to 19 % and wet gluten content varied from 36 to 49 %. Bojňanská, Frančáková (2002) determined wet gluten content in several spelt cultivars in average of 37.1 %.

The low values of the Zeleny test and Gluten Index of minor wheat species, especially of emmer and einkorn, indicate a low potential for use of as proofing dough. According to Konvalina et al. (2008), gluten of emmer is too low and it is thus not suitable for bakery processing. Emmer flour is, however, suitable for production of many kinds of non-proofing products (Marconi, Cubadda, 2005).

Conclusions

The minor wheat species evaluated in this study maintained their typical character of qualitative parameters, e.g. high crude protein content and wet gluten content in grain in the organic farming system without use of mineral fertilizers and pesticides However, the poor gluten quality (indicated by low values of Zeleny test and Gluten Index suggest the main uses in non-proofing and wholemeal products.

Acknowledgments

Supported by the research projects NAZV QH82272 and MSM 6046070901.

References

- Bojňanská, T., Frančáková, H. (2002): The use of spelt wheat (*Triticum spelta* L.) for baking applications. Plant Production, 48 (4): 147–152
- Dotlačil, L. (2002): Genetické zdroje a jejich význam pro šlechtění rostlin a setrvalý rozvoj zemědělství. (Genetic resources and their importance for plant breeding and sustainable development of agriculture). Genetické zdroje 87:1–5
- Konvalina, P., Moudrý, J.jr., Moudrý, J. (2008): Quality parameters of emmer wheat landraces. J. of Central European Agriculture, 9 (3): 539–546
- Marconi, M., Cubadda, R. (2005): Emmer wheat. In: Abdel-Aal, E.S.M., Wood, P. (Eds.): Speciality Grains for Food and Feed. Amer. Assoc. of cereal Chemists, Inc. St. Paul, Minnesota, U.SA, pp. 63–108
- Michalová, A., Vala, M., Gabrovská, D., Vaculová, K., Hutař, M. (2003): Kvalita minoritních obilnin a pseudoobilnin. (Quality of minor cereals and pseudocereals). Proc. of conference "Quality of Crop production: Present Situation and Perspectives", CRI Prague-Ruzyně, pp. 177–183
- Stehno, Z., Dotlačil, L., Faberová, I. Bareš, I. (2005): Development and structure of wheat collection in the Research Institute of crop Production, Prague. Czech J. Genet. Plant Breed., Spec. Issue, 41:198–200

ORGANIC METHODS OF FLAX PROTECTION AGAINST FUSARIUM WILT

K. WIELGUSZ, K. HELLER[1]

Key words: flax, *Fusarium* wilt, chitosans, biopreparations

Abstract

Studies on the development of efficacious organic methods of plant protection against Fusarium wilt of flax were undertaken by the Plant Protection Laboratory at the Institute of Natural Fibres and Medicinal Plants in Poznań. Pot experiments were conducted where Polyversum (i.a. Pythium oligandrum), EM (Effective Microorganisms) and different forms of chitosan were used as seed dressing or plant spraying. The experiment tested the effectiveness of preparations in protecting against fusarium wilt of flax. The most effective were the following preparations: microcrystalline chitosan and chitosan acetate, both at the concentration 0,1 %, oligomeric chitosan 0.25 % and Polyversum used for seed dressing, EM-A used for seed dressing at the rate of 80 cm^3/kg of seeds.

Introduction

Organic plant protection is paving with difficulty the way for being commonly used in practice, which is connected with the influence of many different factors on its effectiveness. Mainly environmental conditions, the type of a pathogen or even plant species can be mentioned here [1,2]. Despite these difficulties, effective and efficient organic methods of plant protection should be looked for.

Taking into account flax healthiness of both fibre and oil cultivars, the largest problem is the disease induced by fungi from genus *Fusarium*, which occurs on the majority of plantations in Poland and other countries [3].

Studies on the development of efficacious methods of organic plant protection against *Fusarium* wilt of flax have been undertaken by the Plant Protection of Natural Fibres and Medicinal Plants in Poznań. Laboratory at the Institute Following the worldwide advance in the field of plant protection against diseases, an attempt has been made to solve this problem by using „biopreparations" with different spectra of action:

1. biopreparations on the basis of microorganisms (bacteria, fungi), which are antagonistic in relation to pathogen
2. biopreparations activating plant protection mechanism Systemic Activated Resistance (SAR)

[1] Institute of Natural Fibres and Medicinal Plants, Wojska Polskiego 71 B, 60 – 630 Poznań, Poland, e-mail: katarzyna.wielgusz@iwnirz.pl

Methods

The organic preparations mentioned earlier were examined in the preliminary pot experiments with the aim to select the most effective ones, which are being tested now in the field trials.

Pot experiments were conducted in 2006 – 2008 in the vegetation hall of the Experimental Department of the INF&PM in Pętkowo. The fiber flax cultivar Alba susceptible to fusarium wilt was used for the studies.

Individual biopreparations were tested at different rates or concentrations for seed dressing or plant spraying in the period of flax vegetation. The biopreparation rates, application and concentration are presented in the table below (Table 1).

Tab. 1: Applications, rates, concentrations and years of experiment of tested preparations.

Preparations	Application	Rate	Concentration
Polyversum	For seed dressing	5g/kg 8g/kg	
E-M A	For seed dressing	40 cm^3/kg 50 cm^3/kg 80 cm^3/kg	
EM-5	For plant spraying	300 dm^3 of water per 1 ha	1:30 1:50 1:80
Chitosan acetate	For seed dressing	120 cm^3/kg	0.01 % 0.1 % 0.5 %
Microcrystalline chitosan	For seed dressing	120 cm^3/kg	0.01 % 0.1 % 0.5 %
Chitosan oligomers	For seed dressing	120 cm^3/kg	0.125 % 0.25 %

The control combination was constituted by flax seeds not treated by any preparation.

The studies were carried out in 4 replications, with each pot sown with 30 seeds. The soil in the pots was inoculated with a mixture of several species of *Fusarium* fungi isolated from the infected flax. The inoculum was presented by wheat seeds overgrown with fungi: *F.oxysporum* f. sp. *lini, F. culmorum, F. avenaceum, F. gibbosum and F. sambucinum*. 30 cm^3 inoculum was added to each pot.

Observations were conducted during the vegetative phase of plant growth, healthy and infected plants were counted at four developmental stages of flax. In combinations, where biopreparations were used for seed dressing, the percentage of healthy plants were counted by referring the number of healthy plants at the phase of green capsule to the number of healthy plants after the emergence.

Results

A comparison of the biopreparations Polyversum, EM-A, EM-5, which are based on microorganisms acting antagonistically in relation to *Fusarium* has showed that the most effective of them was Polyversum, (fig. 1).

Among a group of chitosans the best effects were obtained using chitosan oligomers at the concentration of 0.25 % for seed dressing, microcrystalline chitosan at the concentration of 0.1 % and chitosan acetate at the concentration 0,1 % (fig. 2).

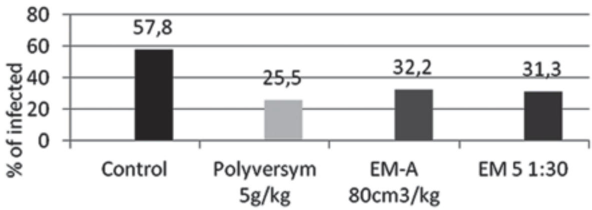


Fig. 1: The effect of biopreparations which are based on microorganisms acting antagonistically in relation to *Fusarium* on health condition of flax.

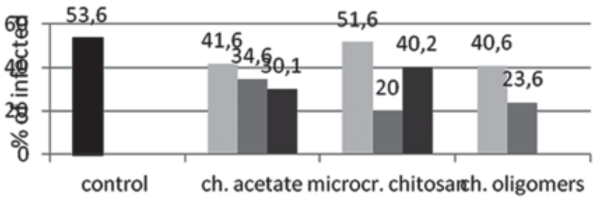


Fig. 2: The effect of Chitosans applied as seed dressing on health condition of flax (average for 3 years)

Discussion

The effectiveness of the biopreparations under the study depended mostly on the way, doses and date of their application. A better effect was obtained for preparations applied for seed dressing. The highest dose does not always give the best results, which was confirmed by these studies and many other experiments [2,3]. Application of biological methods to protect the flax and other plants against disease increases the market value of crops [4,5]. Reduction of infected plants by 30 % is comparable with efficiency of conventional fungicides [6].The effectiveness of biological preparations is much more dependent on weather conditions, and therefore field experiments should be carried out at least for three seasons what will allow for assessment of the preparation effect.

Conclusions

All studied biopreparations used in flax protection against fusarium wilt had a positive effect on the plant health (under partially – controlled conditions – pot experiments)

The most effective in flax protection from fusarium wilt were the following preparations: microcrystalline chitosan and chitosan acetate, both at the concentration 0,1 %, oligomeric chitosan 0.25 % and Polyversum used for seed dressing, EM-A used for seed dressing at the rate of 80 cm^3/kg of seeds.

The action of the described preparations in flax protection against fusariose should be checked out under field conditions.

References

- Orlikowski L.B. 1995. Studieson the biological control of *Phytophtora cryptogea* Pethybr. et Laff. II Effectiveness of *Trichoderma* and *Gliocladium* spp. in the control of *Phytophtora* foot rot of gerbera. J. Phytopathol. 143: 341–343.
- Walker Simons M., Hedwiger L.A., Ryan C.A.1983. Chitosan and pectic polysaccharides both induced the accumulation of the antifungal phytoalexin pisatin in pea pods and antinutrient proteinase inhibitors in tomato leaves.
- Benhamou N., Theriault G. 1992. Treatment with Chitosan enhances resistance of tomato plants to the crown and root rot pathogen *Fusarium oxysporum* f. sp. *radicis-lycopersici*. Phytopathological and Molecular Plant Pathology 41: 33–52
- Cook R.J.Backer K. F. 1983. The Nature and Practice of Biological Control of Plant Pathogenesis. St. Paul. Minesota: American Phytopathological Society, 539 pp.
- Higa T., Parr.F. 1994. Beneficial and Effective Microorganisms for a Sustainable Agriculture and Environment. In: International Nature Farming Research Center, 1994, Atami, Japan, 16 P.
- Allan C.R., Hadwiger L.A. 1979. The fungicidal effect of chitosan on fungi of varying cell wall composition. Exp. Mycol. 3:285–287.

Organizers:

Partners:

Professional partners:

In cooperation with the following organizations:

Bioforsk, Bio Forschung Austria, FiBL International,
Institute of Chemical Technology Prague, ISOFAR, ZALF Münchenberg DE

3rd Scientific Conference

ISBN 978-80-87371-12-1