

YIELD AND QUALITY OF POTATOES CULTIVATED CONVENTIONALLY AND ECOLOGICALLY ¹

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Introduction

Some of the EU countries increase the part of ecologically cultivated areas. The proportion of ecologically managed areas in the Czech Republic has increased since the 90th. The absence of herbicides, fungicides, insecticides and industrial fertilizers in potato growing results in yield reduction by 30% and more [PRUGAR 2000]. Ecologically cultivated potatoes according to by some authors have a lower content of contaminants, better taste qualities, reduced mechanical damage and improved storage stability. On the other hand according to other authors [e.g. RAYBURN et al. 1995; van GELDER 1991 cit. MAGA 1994] plants cultivated without chemicals sometimes protect themselves against diseases and pests by increasing concentration of some harmful substances (e.g. glycoalkaloids – GA). LESZCZYŃSKI [2002] refers to potato quality influenced by pathogen infestation. Our knowledge about differences in the quality of conventionally and ecologically cultivated potatoes is not full and therefore we focused our research on this issue dealing with some selected quality indicators.

Materials and methods

Precise field experiments were performed at two sites in the Czech Republic during 1995–1997. Seven potato cultivars (Impala, Karin, Agria, Korela, Rosella, Santé, Ornella) were been cultivated ecologically and conventionally at the experimental site of the Czech Agriculture University in Prague – Uhřetěves and of the Potatoe Research Institute in Havlíčkův Brod – Valečov. Ecologically cultivated potatoes in Uhřetěves were put into model crop rotation according to IFOAM farming principles. Conventionally cultivated potatoes were put into common crop rotation at the neighbouring site. In Valečov both options were put into common crop rotation at the same site. Winter wheat was used as a forecrop in all options. Growing technologies differed in fertilization and pesti-

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cide use. Conventional technology was managed according to the state variety testing of Central Institute for Supervising and Testing in Agriculture. Ecological cultivation was different due to the absence of fungicides against phytophthora-fungus (except for two applications of fungicide Kuprikol 50 at Valečov site) and insecticides against Colorado potato beetle. After harvest and three-week healing period the samples were delivered to the laboratories of the Potato Research Institute and Department of Chemistry at the Czech University of Agriculture for analyses. Dry matter content was determined by gravimetric analysis, reducing sugars content by Luff-Schoorl's method, nitrate content by using ion-selective electrode, polyphenol content by spectrophotometer and Folin-Ciocalteu's reagent, GA content by HPLC method.

Results and discussion

Dry matter content

Our results did not confirm the increase of dry matter content in tubers from ecological option as published by GRANSTEDT and KJELLENBERG [1997] and by REMBIAŁKOWSKA [2000]. During 1995 and 1996 differences between variants from our experiment were inconclusive (Tab. 1), in 1997 a higher content of dry matter was obtained in conventional option. The result from 1997 is in accordance with research result of SAWICKA and KUŚ [2002] who found out higher content of dry matter in potatoes from integrated farming system as compared to ecological potatoes. Our results did not confirm the assumption that nitrogen and potassium applied in conventional variant should decrease the dry matter content. This could be because common rates of nitrogen and potassium fertilizers which were applied in our experiments did not significantly change the dry matter content and, on the other hand, a shorter period of ecological variant assimilatory apparatus existency (as a consequence of its damage by Colorado beetle or phytophthorafungus) could result in dry matter decrease in this variant [DIVIŠ, ČURN 1996]. This explains our result of 1997 (lower dry matter content in ecological variant) when potato haulm was prematurely damaged by phytophthorafungus.

Table 1; Tabela 1

Influence of cultivation on qualitative parameters and potato yield
Wpływ uprawy na cechy jakości i na wysokość plonu bulw ziemniaka

Way of growing; System uprawy (Significance; istotne różnice)	Year; Lata			Average Średnia
	1995	1996	1997	
1	2	3	4	5
Dry matter content; Sucha masa (%)				
Conventional; Konwencjonalny	20.74	19.61	22.98	21.11
Ecological; Ekologiczny	20.43	20.07	21.12	20.54
LSD; NIR	0.89**	0.82**	1.58*	0.62**
Reducing sugar content; Cukry redukujące (%)				
Conventional; Konwencjonalny	0.41	0.87	0.37	0.55
Ecological; Ekologiczny	0.33	0.80	0.15	0.43
LSD _{0.05} ; NIR _{0.05}	0.14**	0.12**	0.21*	0.13**

1	2	3	4	5
Nitrate content; Azotany ($\text{mg NO}_3^- \cdot \text{kg}^{-1}$)				
Conventional; Konwencjonalny	215.2	105.1	140.8	153.7
Ecological; Ekologiczny	182.5	98.2	129.5	136.7
LSD _{0.05} ; NIR _{0.05}	37.65	37.30	29.43	27.37
Glycoalkaloid content in cultivar Karin; Glikoalkaloidy u odmiany Karin ($\text{mg} \cdot \text{kg}^{-1}$)				
Conventional; Konwencjonalny	112.6	53.1	65.4	77.0
Ecological; Ekologiczny	157.0	59.2	77.5	97.9
Polyphenol content; Związki fenolowe ($\text{mg} \cdot 100 \text{ g}^{-1}$)				
Conventional; Konwencjonalny	35.8	37.1	37.6	36.9
Ecological; Ekologiczny	52.5	56.1	50.1	53.0
LSD _{0.05} ; NIR _{0.05}	2.75*	5.63*	4.14*	2.63*
Yield; Plon ($\text{t} \cdot \text{ha}^{-1}$)				
Conventional; Konwencjonalny	37.0	55.7	43.9	45.4
Ecological; Ekologiczny	23.1	35.2	29.1	29.1
LSD _{0.05} ; NIR _{0.05}	10.23*	8.41*	4.67*	4.36*

* significant difference; różnice istotne

** non significant; różnice nieistotne

Reducing sugar content

In ecologically cultivated potatoes (in three-years average of results) a trend (inconclusive difference) was observed to lower the content of reducing sugars as compared to conventional option (Tab. 1). This was confirmed by the conclusive result of 1997. Our result is only partially comparable (due to nitrogen fertilization rate) with the findings of PESHIN, SINGH [1999], who noted that intensive nitrogen fertilization can increase the reducing sugar content. DIVIŠ [1996] came to the similar conclusions and in the experiments of SAWICKA and KUŚ [2002] reducing sugars content did not depend on growing option. Contrary HAJŠLOVÁ et al. [1998] found a lower content of reducing sugars in ecological variant. Our result is probably related to the absence of nitrogen fertilization in ecological option because the application of nitrogen fertilizers could participate in the prolongation of growing season and delay of potato physiological maturity lower maturity is related to a higher content of reducing sugars [PUTZ 1995].

Nitrate content

Experiments did not prove any influence of cultivation on the nitrate content, but during all years ecologically cultivated potatoes had a significantly lower nitrate content (Tab. 1). This trend is consistent with published research [e.g. WOESE 1995; PRUGAR et al. 2000; REMBIAŁKOWSKA 2000] that usually report a tendency of a less nitrate content in tubers from ecological variants and often also significant differences. We discovered an important difference in nitrate content for different cultivation methods (close to detection limit) in our experiments in

1995, but during the next two years the differences were much lower. It was probably connected with premature termination of vegetation due to *Phytophthora* fungus infestation in ecological option during 1996 and 1997 when tubers were juvenile and nitrates were partially built into other compounds.

Glycoalkaloid content

Regarding high expenses the sample analyses was performed only for cultivar Karin. Ecologically cultivated potatoes had higher GA content during all years as compared to conventional cultivation, but this trend was significant only in 1995 (Tab. 1). Our nitrogen fertilization rate $100 \text{ kg}\cdot\text{ha}^{-1}$ did not confirm the findings of MONDY, MUNSHI [1990] and ROGOZIŃSKA [1995] that nitrogen fertilization can result in a higher GA content. Our results correspond with findings of other authors [PRUGAR 2000; HAJŠLOVÁ et al. 1998] who also did not prove the influence of growing option on the GA content.

Polyphenol content

Ecologically cultivated potatoes had a higher content of total polyphenols (Tab. 1). Similar results though not always significant was also confirmed by other authors [HAJŠLOVÁ et al. 1998]. The results can be connected with the response of potatoes which were not chemically treated to various stress factors (Colorado beetle and *Phytophthora* infestations).

Yield

Ecologically cultivated potatoes had – as it was expected [PRUGAR 2000] – a lower yield as compared to conventional method (Tab. 1). During the three-years average the decrease amounted to 35.9%, which confirms the data found by BOHM [1999] and PRUGAR [2000]. Significantly lower yields of ecologically cultivated potatoes could be caused by insufficient nutrients reserve in the soil and by inadequate regulation of diseases, pests and also weeds. Different intensity of Colorado beetle and *Phytophthora* infestations resulted in the reduction or destruction of assimilatory apparatus and thus in yield decrease.

Conclusion

Ecologically cultivated potatoes had a significantly lower yield as compared to potatoes from conventional cultivation (by 36%).

Qualitative parameters of ecologically cultivated potatoes (compared to conventionally cultivated potatoes) had these significant and desirable trends: lower reducing sugars content, lower nitrates content. Furthermore ecological option was proved to have a higher total polyphenol content (undesirable in regard to colour changes of pulp and desirable in nutrition as natural antioxidants). Cultivation did not influence the dry matter content and GA content.

Experiments showed that differences in qualitative parameters of ecologi-

cally and conventionally cultivated potatoes depend on the year conditions in relation to phytophthorafungus and Colorado beetle (this determines the duration of assimilation area of ecologically cultivated potatoes) and also in relation to weather conditions (influence utilization of nutrients from fertilizers).

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Key words: potatoes, growing systems, yield, tubers quality

Summary

In the three-year field trials the effect of ecological cultivation of table potatoes (in comparison with conventional cultivation) on the selected factors of tuber quality was estimated. Trials were performed at two localities in the Czech Republic with seven varieties. Based on the statistical evaluation it is evident that the ecological cultivation positively affected nitrate and reducing sugar content. In ecological variant the nitrate content was by 11% lower and reducing saccharide content was by 22% lower as compared to conventional option. Contrary a negative effect of ecological cultivation was determined in total polyphenol content (by 10.2% higher) and yields per ha (by 36% lower). Cultivation method did not significantly affect the dry matter content and glycoalkaloid content.

PLON I JAKOŚĆ ZIEMNIAKÓW UPRAWIANYCH SPOSOBEM KONWENCJONALNYM I EKOLOGICZNYM

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Słowa kluczowe: ziemniaki, system uprawy, plon, jakość bulw

Streszczenie

W trzyletnich badaniach polowych obserwowano wpływ ekologicznej produkcji ziemniaków konsumpcyjnych (w porównaniu z technologią konwencjonalną) na wybrane parametry jakościowe bulw. Badania siedmiu odmian ziemniaków zrealizowano w dwóch gospodarstwach zlokalizowanych w różny regionach Czeskiej Republiki. Z oceny statystycznej uzyskanych wyników wynika, że ekologiczny sposób produkcji ziemniaków ograniczył zawartość azotanów i cukrów redukujących. W ekologicznej produkcji ziemniaków (średnia trzyletnia wszystkich badanych odmian) uzyskano o 11% mniejszą zawartość azotanów i o 22% mniejszą zawartość cukrów redukujących, w stosunku do zawartości uzyskanych w ziemniakach uprawianych konwencjonalnie. Negatywny wpływ, w ekologicznej tech-

nologii produkcji, wystąpił w zawartości związków fenolowych (wzrost zawartości o 10,2%) oraz w plonowaniu (spadek o 36%). Sposób uprawy nie miał istotnego wpływu na zawartość suchej masy i glikoalkaloidów.

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