

Influence of inter-row spacing of winter wheat in organic farming on the grain protein content

Eva Bicanová, Ivana Capouchová, Lucie Krejčířová, Daniela Erhartová, Jiří Petr

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Czech University of Agriculture in Prague, Faculty of Agrobiological Sciences, Food and Natural Resources, Kamýcká 129, Praha-6 Suchbátka, 165 00, Czech Republic, (e-mail: bicanova@af.czu.cz)

Abstract

Protein content in grain of two winter wheat cultivars (*Triticum aestivum* L.) - Ludwig and Sulamit, belonging to the quality class E, grown in organic and conventional farming were studied in the growing seasons of 2004-2005 and 2005-2006. The effects of inter-row distance, seed rate and technique of cultivation on protein content (the basic parameter of technological quality) and grain yield were investigated. In organic farming different types of growth structure (inter-row distances 125, 250 and 370 mm and three sowing rates - 200, 300 and 400 seeds.m⁻²) were used to determine whether the optimisation of the growth structure can stimulate the protein synthesis in grain. In conventional farming classical inter-row distance 125 mm (with the same sowing rates - 200, 300 and 400 seeds.m⁻²) was used for comparison. The results of the experiments showed that grain grown under organic farming had lower protein content than the conventional one grown in 125 mm inter-row distance. However, when the distance between the rows was increased from 125 mm to 375 mm in organic farming, the concentration of grain protein increased significantly: about 0.5 – 1.3 % (depending on variety). As a result, both varieties fulfil the basic parameters for food/baking production. Widening the row spaces did not decrease grain yield.

Key words: organic farming, winter wheat, growth structure, protein content, yield

Introduction

Organic technique of cultivation can have an adverse effect on the technological quality, especially when protein content is an important factor (Moudrý and Prugar, 2002). According to Prugar (1999) organic farming, where it is not allowed to use fertilizers with fast effect, the lack of nitrogen results in lower accumulation of storage protein in grain of winter wheat.

Bread flour must have a relatively high protein content, 11.0% to 13.5%, depending on the type of bread. Under normal growing conditions almost 70% of the variation of the protein content is due to variation in soil fertility and climatic conditions (Bushuk a Bekes, 2002). Also according to Triboi et al. (2000) the most important environmental factor affecting protein content was N supply (fertilisation and site) (63% of total variation).

For wheat under the system of organic farming not using fertilizers, it is necessary to find another way how to increase gluten protein content in grain (except the intensity of cultivation) to improve food, bakery quality. One of the options should be different type of growth structure of winter wheat (wider inter-row distances, different seed rates) than in conventional farming, where it is seeded into narrow drill. Duration and intensity of radiation in the growth strongly influence the creating of grain protein, especially gluten fraction (Petr et al., 1987).

Therefore, basic hypothesis of the experiment comes from this thesis. The objective of this study was to evaluate the effects of different types of growth structure (seed rates, inter-row distances) on protein content in grain and grain yield. In other words to prove opportunity of support synthesis of protein in wheat grain from organic farming by optimisation of growing conditions, especially improvement of light conditions in growth by different type of growth structure.

Material and methods

The trial was conducted in two experimental years 2004/05 and 2005/06 at Experimental station of Depart. of Crop Production of the CUA in Prague-Uhřetěves. For the experiment, two varieties of winter wheat (*Triticum aestivum* L.) Ludwig and Sulamit (group of quality "E") were used in different type of growth structure (three inter-row distances- 125, 250 and 370 mm and three seed rates- 200, 300 and 400 seeds.m²). Inter-row hoeing was used in variants with 250 and 375 mm inter-row distance. For comparison experiments in conventional agriculture were established, but only with one type of inter-row distance- 125 mm, which is commonly used for cereals. In conventional treatments 100 kg N/ha and herbicide were used. Post harvest analysis were focused on the evaluation of protein content in dry matter (ČSN ISO 1871) by Near Infrared Reflectance Spectroscopy (NIRS) and on the determination of yields from each variants.

Results and discussion

The greatest differences between organic and conventionally grown grain in individual qualitative parameters are observed only in protein content (Prugar, 1999). Brümmer (1997) claimed that grain of winter wheat from organic farming has lower protein content approximately about 2-3 % in comparison with conventional grown grain.

This fact was also confirmed in our results, when protein contents in years' average and varieties were statistically different in grain from organic and conventional treatment (Tab. 1). Protein content was higher about 1.2 % than in organic grain.

Also row spacing had statistically confirmative effect on protein content in dry matter of grain from organic treatment (Tab.2). Comparing conventional and organic approach (grains grown in 125 mm inter-row distance) organic grown grain showed statistically significant lower protein content in dry matter about 1,9 % (Fig. 1). Using wider inter-row distances (250 and 375 mm) in organic farming about 0.5-1.3 % protein-content-increase was observed (Fig.1) for Ludwig and Sulamit as well (depending on variety). As a result, both varieties fulfil the basic parameters for food/baking production. Moreover, using 375 mm inter-row distance the protein content was markedly above the limit required by the standard ČSN ISO 1871 (11.5 % protein content). This coincides with results of Hiltbrunner et al. (2005) that show when the distance between the rows was increased from 187.5 mm to 375 mm, the concentration of grain protein increased significantly from 11.7 to 12.7 %.

It can be clearly seen from our results that different growth structure (wider inter-row distance) in organic farming stimulates the protein synthesis in grain as stated before by Petr et al. (1987) and Förster et al. (2004). The higher protein content can be explained by better radiation conditions in growth, higher „aeration“ of growth, that can reduce the assault of fungal diseases which results in longer photosynthetic activity of assimilatory organs of wheat.

Apart from the basic quality, also favourable yield is required for the successful growing of winter wheat in organic farming. Our results showed that the yields from conventional treatment were statistically significantly higher than in organic farming (Tab. 1). Comparing yields from different inter-row distances (Tab. 2) in organic farming, the highest yield 5.86 t.ha⁻¹ was observed by variants from 375 mm inter-row distance. This yield was statistically significantly different from the lowest yield 5.48 t.ha⁻¹ by variant from 250 mm inter-row distance (Tab. 2). It corresponds with results of Hiltbrunner et al. (2005) who observed that widening the row space did not decrease grain yield.

The highest yield was reached with the 400 seeds/m² (Tab.3) by both treatments of cultivation. However, differences in averages of sowing rates 300 and 400 seeds.m² in average of two years were not statistically significant (Tab. 3). The effect of sowing rate on yield was negligible in range 200-400 seeds.m² when using wider inter-row distance in organic farming. In other words, significantly lower sowing rate than commonly used in conventional farming can be used for inter-row distance 250 and 375 mm, respectively. This decrease of sowing rate is independent on grain yield. Similar findings have been published recently by Förster et al. (2004).

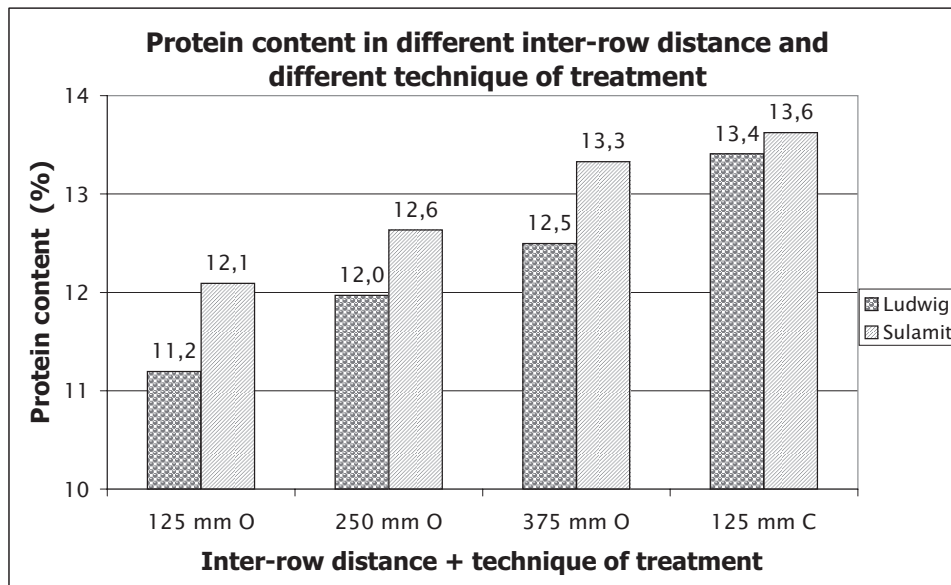


Figure 1. Protein content in different inter-row distance and different technique of treatment

Table 1. Statistical evaluation of the effect of technique of cultivation (in average of years and varieties)

Technique of cultivation	Protein content (%)	Signif.*	Yield (t.ha ⁻¹)	Signif.
Organic	12.28	a	5.70	a
Conventional	13.52	b	7.79	b
HSD _{0,05}	0.2353		0.2127	

*variants with different letter are statistically significantly different

Table 2. Statistical evaluation of the effect of inter-row distance (in average of years and varieties)

Inter-row distance	Protein content (%)	Signif.	Yield (t.ha ⁻¹)	Signif.
125 Organic	11.64	a	5.76	ab
250 Organic	12.30	b	5.48	b
375 Organic	12.91	c	5.86	a
125 Conventional	13.52	d	7.79	c
HSD _{0,05}	0.3791		0.3420	

Table 3. Statistical evaluation of the effect of sowing rate on yield (in average of years and varieties)

Seeding rate (seeds.m ⁻²)	Yield (t.ha ⁻¹)	Signif.
200	5.20	a
300	5.85	b
400	6.06	b
HSD _{0,05}	0.3035	

Conclusions

Comparing organic and conventional treatment, grain grown in organic farming had statistically significant lower protein content in dry matter of grain: about 1.2 %. The concentration of grain protein increased

significantly for about 0.5 – 1.3 % (depending on variety), when the distance between the rows was increased from 125 mm to 375 mm in organic farming. As a result, both varieties fulfil the basic parameters for food/baking production. Widening the row distance did not decrease grain yield. The effect of sowing rate (in range 200-400 seeds.m⁻²) on yield was negligible in inter-row distances 250 and 375 mm. For this reason, lower sowing rate than commonly used in conventional farming can be used for wider inter-row distances in organic farming.

The results of this project have proved that widening of inter-row distance increases the protein content in grain. Therefore it can be recommended to achieve higher baking quality of organically grown wheat.

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