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THE INFLUENCE OF FERTILIZATION AND SOWING RATE WINTER WHEAT BAKING QUALITY

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Summary

From two year (1997-1998) field experiments realised on plots of the Experimental Basis of the Faculty of Agronomy on the Slovak Agricultural University in Nitra results, that assessed production factors (fertilization, sowing rate) have had a highly significant, res. significant influence on the technological quality in winter wheat and hard wheat grain (wet gluten content, volume weight, 1000-kernels weight, grain hyaliness, content of yellow pigments in the flour). The fertilization level assigned for the final yield of 5 tons and corresponding straw amount + Voba Unihum –N (full fertilizer rate - without regard to the soil nutrients supply) and the sowing rate of 2.5 mil, germinable seeds per hectare were often manifested in our experiments as the most suitable ones. Highly significant year influence with an year variability on the wet gluten content of 19.3% (hard wheat) and 35.3% (winter wheat), grain vitreousness 7.2% (winter wheat) and 11.3% (hard wheat), and 27.3% in the yellow pigments content (hard wheat) on the technological quality parameters were stated.

Keywords: fertilization, seed rate, technological quality, yield

Introduction

Besides the economical effectiveness also requirements on the quality of cereals are rising more and more in the market economy conditions. The biggest attention in the research and praxis of wheat for food purposes is paid to the problems of technological quality, which can be assessed according to the milling properties (milling suitability, grain hardiness, 1000-grain weight, etc.) and baking quality, especially gluten content and quality (PETR, 1999 and others). As to the less traditional wheat (*Triticum durum Desf.*) use in the non-egg pasta production with rising consumption in Slovakia it is important to take into account also the dough value which is can be assessed (besides the parameters of technological quality in hard wheat according to the STN – Slovak Technical Norm) according to the content of yellow pigments (ZALABAI, 1995).
The technological quality of winter wheat is a complex genetically determined value, i.e. by the variety and agroecological conditions
The aim of this work follows these facts and it was to analysed the influence of some cultivation factors on some technological quality in the summer and hard wheat, grain.

Material and methods

There problems were solved in 1997-1998 in the Department of Crop Production on the Slovak Agricultural University in Nitra, Slovakia in frame of the field polyfactor experiments in a maize production area, semiarid subarea belonging to a very warm agroclimatic area of an altitude 201m above sea level, and an average year temperature of 9.6 ^{o}C. Temperature of the evaluated period was almost normal (from 9.2 ^{o}C in 1997 to 10.8 ^{o}C in 1998) and precipitation were in 1997 almost at the normal level (94% of the normal level) and the year 1998 was extremely dry (69.6% of the normal precipitation level). The experimental plots were situated on medium heavy luvisols with low acid reaction, and a medium supply of phosphorus, good supply on potassium and humus content raging from 1.78% to 2.21%. Into trials were involved BREA /the winter form of a summer wheat/ and VENDUR /hard wheat, winter form/, three involved sowing rates (I. – 2.5 mil. germinating seeds per hectare, II. – seed rate recommended for single varieties by breeder, III. – 5.0 germinable seeds per hectare), four fertilization variants (a – nonfertilized control variant, b – reduced fertilizer rate + Microbion, c – rationalised fertilizer rate according to the Method of Diagnostics (MICHALÍK, LOŽEK, 1985), d – full fertilizer rate + Voba Unihum – N without regard to the soil nutrients supply – total 193.1 t.ha^{-1}).
We've evaluated the following technological quality parameters in the wheat grain (wet gluten content, gluten quality – gluten swelling, gluten extensibility, volume weight, 1000-kernels weight, yellow pigments content in the flour – in hard wheat only). The parameters on technological quality were stated according to methodics published in STN No. 46 11 00 – 2 (winter wheat) and STN No. 46 11 00 – 3 (hard wheat).

Results and discussion

The highest influence on the wheat grain quality from the point of view of food production plays the nutrition and fertilization which can be expressed also by two-year results of field trials (1997-1998) in winter form of a summer wheat (BREA variety) and a winter form of a hard wheat (VENDUR variety).

According to average results on baking quality parameters - the wet gluten content (tab. 1) related to different fertilization levels follows a positive, highly significant influence of fertilization on the wet gluten content (26.7% and 24.0%) in both wheat species. The highest values was stated in variant "d" (fertilization without regard to the soil nutrients supply - full fertilizer rate + Voba Unihum – N) when increase of the gluten amount compare with the control variant was 14.8% (winter wheat) and 12.8% (hard wheat) which was referred also by MUCHOVÁ (1989), KARABÍNOVÁ, PROCHÁZKOVÁ (1994) and others. Highly significant differences due to various fertilization levels were stated also in milling quality parameters (volume weight, 1000-kernels weight and grain vitreousness), the influence of different fertilization levels was positive but it have had a various tendency according in individual wheat species. The highest volume weight value (808.5 $g.l^{-1}$) in winter wheat was determined in variant "d" and the highest 1000-kernels weight (47.2%) and grain hyaliness (92.1%) in variant „c" (rationalised fertilizer rate), when differences comparing to the control variant ranged from 1.5% to 9.4%. The highest volume weight value (768 $g.l^{-1}$) in hard wheat was determined in variant "b" (reduced fertilizer rate + Microbion) and the highest value of grain hyaliness in variant „d" with an increase by 0.8% and 6.7% comparing with the control variant. Differences in evaluated characteristics on the milling quality of winter wheat were highly significant.

In order to assess the pasting properties of the hard wheat grain ZALABAI (1995) proposed to determine the content of yellow pigments (tab. 1) which influence the final product colour essentially. Following our results there was anexpressive increasing in the yellow pigments content due to single fertilization levels, the highest value were determined in variant "c" with an increase of 23.8% comparing with the control variant.

Another important factor influencing the technological quality formation is the seed rate evincing via the stand light regime (tab. 2). The content of wet gluten was determined by applied seed rates highly significant in winter wheat and significant in hard wheat, the highest wet gluten amount in both wheat species was stated at low sowing rates (2.5 mil. germinable seeds per hectare) when probably the most suitable conditions for protein biosynthesis were achieved (PRUGAR et. al. 1977).

Between species there were stated statistically significant differences in the technological quality parameters (without regard to the fertilization and sowing rate) when for two years higher values in average on wet gluten content and volume weight were stated in winter wheat with an increasing of 11.7% or 5.2% comparing with hard wheat values. Stated a higher hyaliness value (92.6%) and higher 1000-kernels weight (50.2 g) There was a higher hyaliness volue (92,6%) and higher 1000 kernels weight (50,2 g) stated which is for 3.8%, res. 6.8% higher comparing with winter wheat values. These values correlate with STN hard wheat requirements.

From our experimental results is stated that the most important reason for variability in technological quality parameters was the weather course in particular year confirmed by highly significant differences in evaluated characteristics (tab. 3). More favourable conditions for protein synthesis were stated in 1997 when the wet gluten content in winter wheat was higher then 35.3% and also 19.3% in the hard one. Compared with 1998 was in 1997 was the grain hyaliness higher for 7.2% in winter wheat and 11.3% in hard wheat, and the yellow pigments content for 27.3%. Similar results about the year influence on technological quality parameters are referred also by MUCHOVÁ (1989), ZALABAI (1995) and others.

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Table 1: *Influence of the fertilization on the technological quality parameters in the winter and hard wheat grain (for 1997-1998 in average)*

Wheat species	fertilization variant	yield of grain ($t.ha^{-1}$)	wet gluten content (%)	weight ($g.l^{-1}$)	1000-grain weight (g)	vitreousness (%)	yellow pigment content ($mg.kg^{-1}$ flour)
Triticum aestivum (BREA)	a	7,37	23,17	803,17	47,18	83,87	-
	b	8,55	23,83	806,50	47,18	89,17	-
	c	8,57	26,33	805,50	47,20	92,14	-
	d	8,53	26,67	808,50	46,48	91,79	-
	average	8,25	25,00	805,92	47,01	89,24	-
Triticum durum (VENDUR)	a	6,09	18,67	762,83	52,50	88,65	3,06
	b	7,29	20,00	768,00	49,67	92,73	3,62
	c	7,45	22,50	766,00	50,43	94,34	3,79
	d	7,51	24,00	766,17	48,23	94,56	3,68
	average	7,08	21,29	765,75	50,21	92,57	3,54

Table 2: *Influence of the seed rate on the technological quality parameters in the winter and hard wheat grain (for 1997-1998 in average)*

Wheat species	sowing rate	yield of grain ($t.ha^{-1}$)	wet gluten content (%)	weight ($g.l^{-1}$)	1000-grain weight (g)	vitreousness (%)	yellow pigment content ($mg.kg^{-1}$ flour)
Triticum aestivum (BREA)	I.	8,57	25,50	806,00	47,59	90,01	-
	II.	7,99	24,63	806,88	46,78	88,23	-
	III.	8,20	24,88	804,88	46,68	89,49	-
	average	8,25	25,00	805,92	47,01	89,24	-
Triticum durum (Vendur)	I.	7,40	21,63	767,50	50,24	93,13	3,27
	II.	7,00	21,00	766,63	50,11	92,76	3,85
	III.	6,85	21,25	763,13	50,28	91,82	3,50
	average	7,08	21,29	765,75	50,21	92,57	3,54

Table 3: Mathematically and statistical evaluation on the influence of investigated factors on the technological quality parameters

Wheat species	source of variability	F calculated				
		yield of grain	wet gluten content	weight	1000-kernels weight	hyialiness
Triticum aestivum (BREA)	year (A)	$107,48^{++}$	$5586,21^{++}$	$723,46^{++}$	$114,84^{++}$	$78,83^{++}$
	fertilization (B)	$13,92^{++}$	$307,13^{++}$	$7,86^{++}$	$26,66^{++}$	$29,72^{++}$
	sowing rate (C)	$5,02^{+}$	$26,90^{++}$	$2,07^{-}$	$73,51^{++}$	$2,25^{-}$
	repetition (D)	$0,73^{-}$	$0,04^{-}$	$0,12^{-}$	$0,05^{-}$	$0,08^{-}$
	interaction					
	A x B	$1,31^{-}$	$59,77^{++}$	$3,51^{+}$	$2,35^{-}$	$1,13^{-}$
	A x C	$3,24^{+}$	$2,07^{-}$	$47,79^{++}$	$13,16^{++}$	$5,06^{+}$
	B x C	$0,91^{-}$	$11,26^{++}$	$5,65^{++}$	$12,93^{++}$	$2,89^{+}$
Triticum durum (VENDUR)	year (A)	$324,32^{++}$	$409,09^{++}$	$398,53^{++}$	$513,83^{++}$	$275,02^{++}$
	fertilization (B)	$30,12^{++}$	$168,28^{++}$	$9,33^{++}$	$52,52^{++}$	$20,83^{++}$
	sowing rate (C)	$8,22^{++}$	$3,84^{+}$	$15,33^{++}$	$0,15^{-}$	$1,69^{-}$
	repetition (D)	$0,38^{-}$	$0,03^{-}$	$0,85^{-}$	$0,06^{-}$	$0,76^{-}$
	interaction					
	A x B	$3,77^{+}$	$121,41^{++}$	$53,93^{++}$	$3,61^{-}$	$4,75^{++}$
	A x C	$25,93^{++}$	$1,82^{-}$	$121,63^{++}$	$3,02^{-}$	$2,80^{-}$
	B x C	$1,20^{-}$	$2,22^{-}$	$3,29^{+}$	$2,22^{-}$	$3,77^{++}$

Table 4: Limit values

Wheat species	source of variability	yield of grain	wet gluten content	weight	1000-kernels weight	hyaliness
Triticum aestivum (BREA)	year Hd 0,05	0,31	0,20	1,62	0,14	1,42
	Hd 0,01	0,41	0,27	2,17	0,19	1,90
	fertilization Hd 0,05	0,58	0,38	3,05	0,26	2,66
	Hd 0,01	0,72	0,47	3,77	0,32	3,29
	sowing rate Hd 0,05	0,46	0,30	2,40	0,20	2,09
	Hd 0,01	0,58	0,38	3,04	0,26	2,65
Triticum Durum (VENDUR)	year Hd 0,05	0,25	0,38	1,43	0,50	1,21
	Hd 0,01	0,34	0,50	1,92	0,67	1,63
	fertilization Hd 0,05	0,47	0,70	2,69	0,93	2,28
	Hd 0,01	0,58	0,87	3,33	1,16	2,82
	sowing rate Hd 0,05	0,37	0,55	2,11	0,73	1,79
	Hd 0,01	0,47	0,70	2,68	0,93	2,27