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CORRELATION BETWEEN THE BREADMAKING PROPERTIES OF COMMON WINTER WHEAT VARIETIES AND SOME AGRONOMICAL FACTORS

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Abstract

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Results are given for the changes of the wet gluten content in flour, the sedimentation value, the physical properties of dough and the breadmaking quality of varieties Aglika, Iveta, Pryaspa, Kristy and Karat (the varieties belong to different quality groups) in relation to major elements of the agronomy practice – crop rotation position and norm of applied nutrients during the period 2004 – 2006. It was found out that the factor fertilization had a stable effect on the sedimentation value of varieties Aglika and Iveta, on the wet gluten in 70 % flour of varieties Aglika, Iveta, Pryaspa and Karat, on the rheological properties of dough of varieties Aglika, Iveta, Pryaspa and Karat, and especially on the bread loaf of variety Aglika. Variety Aglika had the best quality characteristics combined with high responsiveness to improved environmental conditions. Variety Kristy (wheat of medium strength) had the best ecological stability by physical properties of dough and bread loaf. At fertilization with $N_{10}P_{10}$ bread loaf was in high positive correlation with the varietals responsiveness to the growing conditions ($r = +0.82$).

Key words: wheat, genotype, predecessor, fertilization

Introduction

Wheat grain quality can be improved both by breeding means and agronomy practice. While the breeding methods allow accumulation of permanent and changeable favorable conditions, the agronomy practice is a prerequisite for fast effects and for greater flexibility under different environments.

The latest breeding achievements opened possibilities for management of the wheat grain breadmaking properties through changing the different agrotechnical practices. The effect of these practices is characterized by specificity with regard to the variety and its growing conditions; these have been the object of researches of various duration (Nikolova et al, 1995; Philipov, 1995; Koteva et al., 1996; Tsankova, 1997; Rachovsky, 2005).

The testing of a group of varieties in a combination of controllable agrotechnical factors is a way of obtaining more detailed information on the formation of their quality potential under the specific conditions of DAI – General Toshevo. This was the aim of this study.

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Material and Methods

The experimental part included the period 2004-2006 and was performed by the split plot method in 4 replications on harvest area 22.5 m^2. The varieties Aglika, Iveta, Pryaspa, Kristy and Karat (belonging to different quality groups) were grown after three predecessors: bean, sunflower and grain maize. Fertilization was applied according to the predecessor type: $N_0P_0K_0$ and $N_6P_6K_0$ after beans, and $N_0P_0K_0$ and $N_{10}P_{10}K_0$ after sunflower and grain maize. Soil tillage included single disking after harvesting the predecessors and double disking after the main fertilization. Fertilization was manual, phosphorus being applied prior to main soil tillage, and nitrogen – before spring vegetation. The fertilizers used were triple super phosphate and ammonium nitrate. Sowing was done at norm 500 germinating seeds per m^2 within the optimal term.

The mean grain samples from the variants were ground to 70 % flour with milling equipment MLU-202. The following indices were analyzed: sedimentation (according to Pumpyanskiy, 1971), wet gluten yield in 70 % flour (Bulgarian State Standard 13375-88), valorimetric value by pharinograph "Brabender", and bread loaf according to the routine methodology of the Bread Making Quality Laboratory at DAI – General Toshevo. Analysis of variances was applied to determine the effect of the individual factors and their interaction. The individual statistical parameters were determined with the help of Microsoft Excel 2002 and the package SPSS 13.

During the years of investigation the meteorological conditions varied considerably. The spring and summer of 2004 were marked by extreme drought in April (2.2 mm) and high precipitation sums in May (93.7 mm), June (71.2 mm) and July (84.6 mm). The second year of the investigation had higher parameters of the mean temperatures in comparison to those from the previous year; the autumn was dry and the winter – humid. April was a dry month similar to the previous year, and the air temperature and soil moisture values were close to the norm for this region. The meteorological conditions of 2005/2006 were characterized with a humid autumn, cold winter and warm spring. The air temperatures were close to the norm. The maximum amount of rainfalls was in May (94.4 mm) which made the season favorable for yield realization and partially restricted the expression of the quality potential of the varieties.

Results and Discussion

The results from the dispersion analysis revealed significant differences between the varieties concerning sedimentation, wet gluten content in 70 % flour, valorimetric value and bread loaf (Table 1).

The genotype differences with regard to sedimentation and wet gluten were markedly dependent on the year (D), while the variations of pharinographic values and bread loaf depended more on fertilization (C). The effect of the predecessor (B) on the manifestation of the investigated indices was not significant. The significant differences in the valorimetric value and bread loaf were determined by the interaction of the three factors: variety (A) x fertilization (C) x year (D), which allowed their investigation for plasticity and stability with the aim to illustrate the nature and possibility for expression of these varieties (Figures 1, 2, 3 and 4).

The dynamics of the values of the two indices by plasticity and stability was strongly affected by the meteorological conditions and fertilization. By valorimetric value and bread loaf variety Aglika reacted with high responsiveness and phenotype instability under both ways of growing. Fertilization of varieties Iveta and Kristy showed a tendency towards lower changes in the relatively higher values of bread loaf in comparison to the variant N_0P_0. Evidently the nature of combination of different types and levels of the same factors had a significant effect on their interaction within high amplitude of meaning: from strong effects on the valorimetric value and bread loaf (variety Aglika) to their absence (variety Kristy, $N_{10}P_{10}$). Variety Pryaspa, regardless of the way of growing, responded with insignificant changes in the valorimetric values, although there was a wide range of variation after fertilization. Variety Karat, being a low-quality variety

Table 1

Dispersion analysis of main indices according to applied agronomy practices during 2004-2006

Indices / Sources of variation	df	Sedimentation value, ml		Wet gluten yield in 70% flour, %		Valorimeric value, condit. Units		Bread loaf, ml	
		F	Sig.	F	Sig.	F	Sig.	F	Sig.
Variety (A)	4	130.5	0	0.13	0.73	29.55	0	41.93	0
Previouscrop (B)	1	0.9	0.51	1.11	0.42	2.67	0.09	2.1	0.17
Fertilization (C)	1	0.57	0.59	6.71	0.02	2.02	0.18	0.28	0.96
Year (D)	2	0.61	0.75	0.2	0.83	8.89	0	2.48	0.15
A x B	4	36.19	0	62.34	0	1.26	0.36	0.58	0.69
A x C	4	2.05	0.16	1.84	0.21	0.62	0.56	8.45	0.01
A x D	8	0.65	0.64	0.61	0.75	1.39	0.32	1.21	0.35
B x C	1	215.54	0	3.33	0.11	115.69	0	100.35	0
B x D	2	1.16	0.4	16.28	0	16.85	0	0	0.95
C x D	2	1.31	0.32	68.45	0	1.54	0.28	1.5	0.29
A x B x C	4	12.2	0	2.33	0.16	69.64	0	0.2	0.66
A x B x D	8	89.53	0	33.23	0	3.58	0.06	14.17	0
A x C x D	8	21.16	0	0.2	0.66	4.86	0.04	51.28	0
B x C x D	2	3.47	0.06	0.97	0.52	4.66	0.02	0.13	0.88

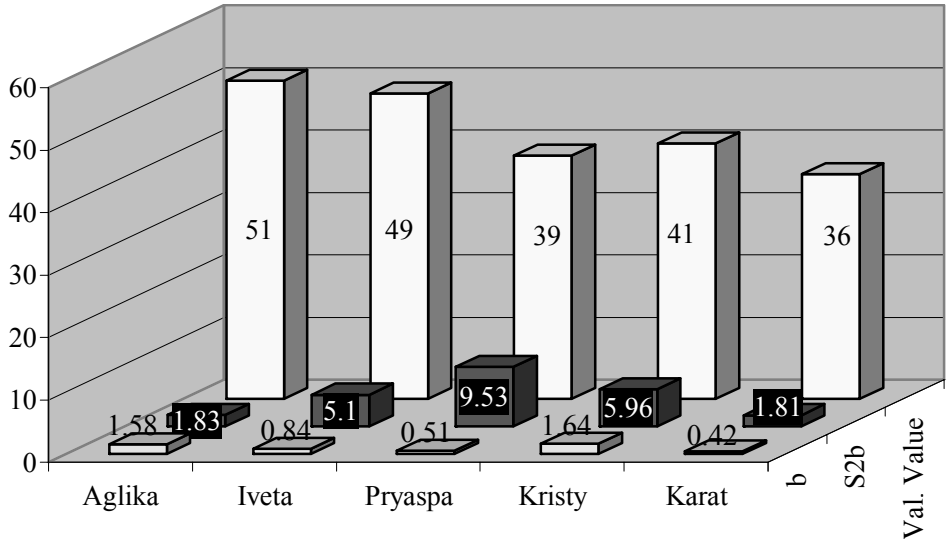

Fig. 1. Plasticity and stability by valorimetric value of the investigated varieties at N_0P_0

with high ecological plasticity (b>1) and instability of bread loaf, is still preferred for its high productivity. The other varieties included in this study (Aglika, Iveta and Pryaspa), which combine in various degrees yield and quality and are widely used in practice, increased their bread loaf against high agro-backgrounds, but lost much of their plasticity due to maintained high level of yield under unlimited environments. Variety Kristy showed passive phenotype reaction with regard to valorimetric value under improved growing conditions

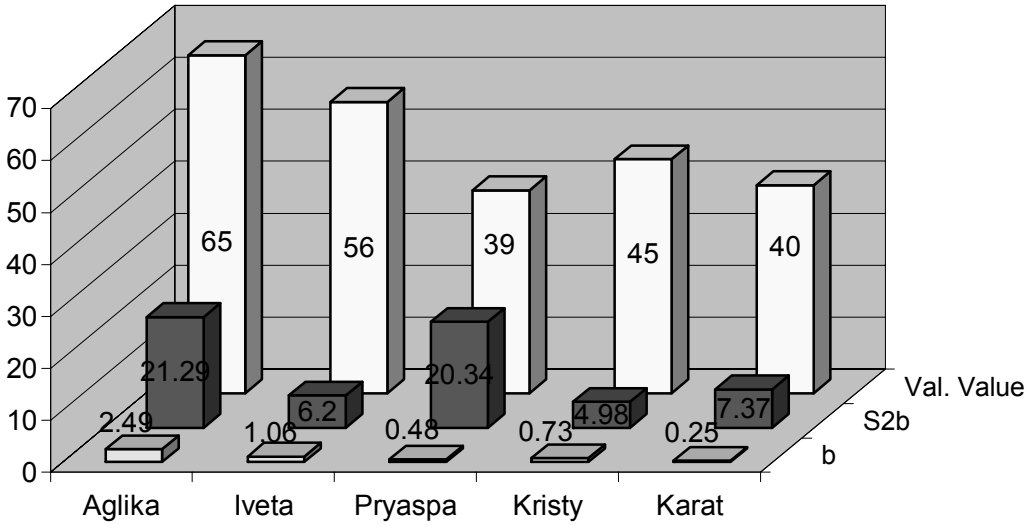

Fig. 2. Plasticity and stability by valorimetric value of the investigated varieties at $N_{10}P_{10}$

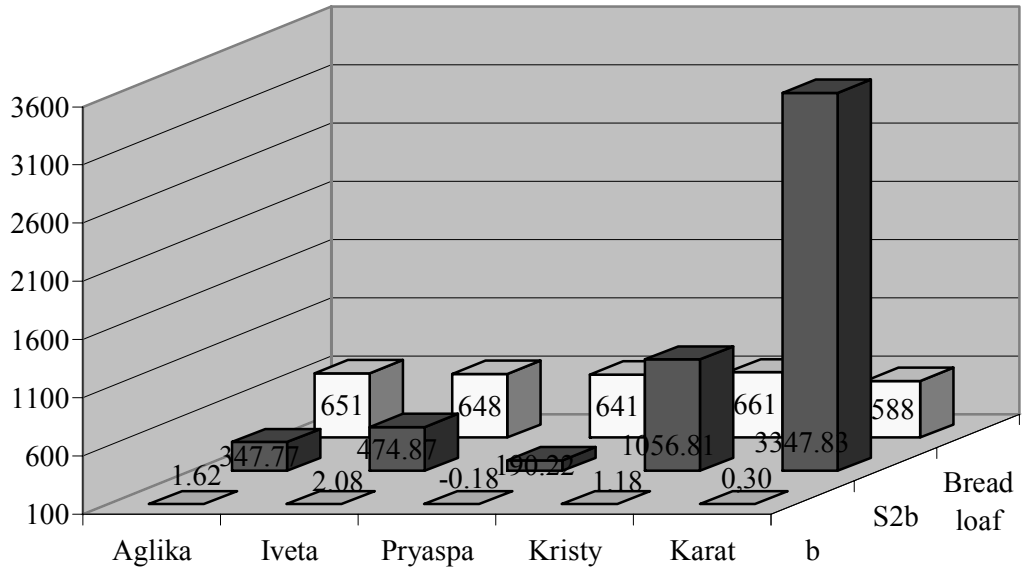

Fig. 3. Plasticity and stability by bread loaf of the investigated varieties at N_0P_0

($N_{10}P_{10}$), but its stability was markedly higher under favorable growing conditions, which makes it a variety of intensive type. This variety has genes which ensure better ecological plasticity than that of the other genotypes. Varieties Aglika, Iveta and Kristy are definitely more suitable for intensive agriculture; they are also more similar by bread loaf. These varieties have increased requirements for mineral nutrition. In spite of the high effect of the applied fertilization on sedimentation, dough resistance, valorimetric value and bread loaf at $N_{10}P_{10}$, mean bread loaf was related a little above the mean with the responsiveness of the varieties (r = +0.68) due to the higher bread loaf in the variant without fertilization of some varieties (Aglika, Iveta and Kristy) (Table 2).

The correlation between plasticity (b) of bread loaf

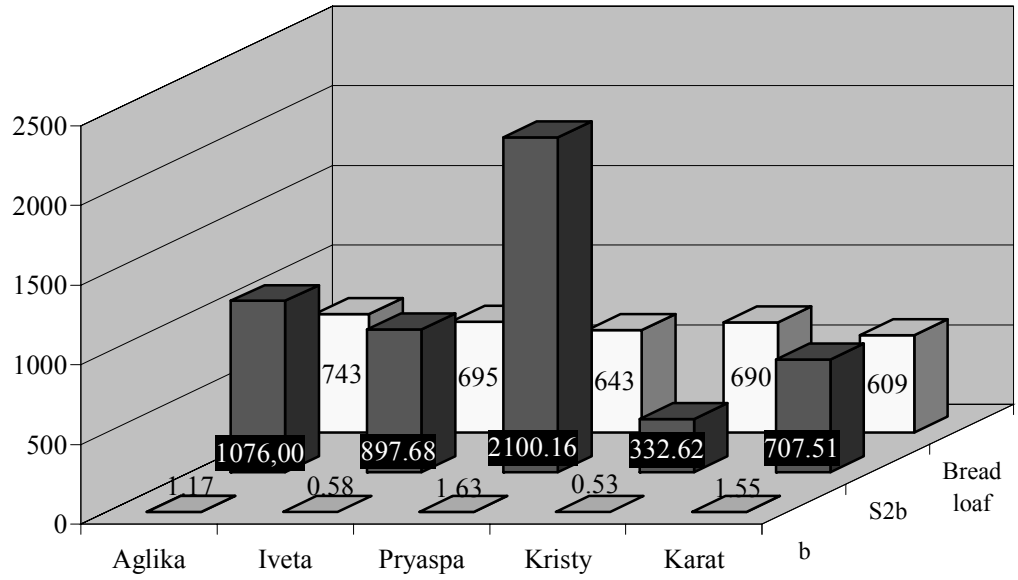

Fig. 4. Plasticity and stability by bread loaf of the investigated varieties at $N_{10}P_{10}$

and bread loaf at N_0P_0 was low (r = +0.32), and between (b) and wet gluten yield in 70 % flour was low and negative (r = -0.02). The used agronomy practices probably affected somehow the positional availability and uptake of nutrients, and caused increase of yield and suppression of sufficient gluten accumulation in the grain; the macro fertilizers might have also been above the optimal for this index. The effect of stability (S^2b) on the investigated indices was negative. The correlation coefficient was within the range of medium and high negative correlation and only wet gluten yield in 70 % flour was slightly negative (r = -0.06). There was a low positive correlation in this trial between wet gluten yield in 70 % flour and bread loaf, as well as between sedimentation and wet gluten and between the rheological indices and wet gluten in flour (r = 0.14ë0.49). To break and improve to some extend the above correlations and to obtain quality with desired correlations further investigations are needed with an emphasis on the level of stability of the environmental factors.

Undoubtedly the used agronomy practices (fertili-

Table 2

Correlation coefficients of plasticity, stability and some main breadmaking indices of flour

Indices	1	2	3	4	5	6	7	8	9
1. b									
2. S^2b	-0.44								
3. Mean bread loaf, ml	0.68	-0.93							
4. Mean bread loaf, N0P0	0.32	-0.97	0.9						
5. Mean bread loaf, N10P10	0.82	-0.83	0.97	0.78					
6. Sedimentation, ml	0.8	-0.63	0.87	0.66	0.91				
7. Wet gluten in 70% flour, %	-0.02	-0.06	0.2	0.3	0.14	0.49			
8. Dough resistance, min	0.93	-0.42	0.73	0.39	0.85	0.93	0.28		
9. Valorimeric value, cond. Un.	0.95	-0.57	0.82	0.53	0.92	0.95	0.24	0.98	

zation in particular) had a positive effect on flour quality under the conditions of intensive agriculture. Their effect was specific with regard to variety and year conditions, and their observance aided the process of quality management.

Conclusions

The wheat varieties tested under conditions of fertilization in crop rotation revealed different realization of their quality potential. The factor fertilization had a stable effect on the sedimentation of varieties Aglika and Iveta, on the amount of wet gluten in 70 % flour of varieties Aglika, Iveta, Pryaspa and Karat, and especially on the bread loaf of variety Aglika.

The values of the breadmaking indices of the varieties were strongly affected by the genotype and fertilization. Variety Aglika had the best quality characteristics combined with high responsiveness to improved environmental conditions. Variety Kristy (wheat of medium strength) demonstrated the best ecological stability by physical properties of dough and bread loaf.

Bread loaf at fertilization with $N_{10}P_{10}$ showed high positive correlation with the varietals responsiveness to the growing conditions (r = +0.82).

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