

THE INFLUENCE OF THE CROPPING YEAR ON THE BAKING QUALITY OF WHEAT IN TERM-EXPERIMENTS

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Introduction

Soil and climatic conditions in our country and the Carpathian Basin are excellent for producing wheat. High yields can be obtained and even the best quality wheat for bread can be produced (Bedő *et al.* 1997).

The roles of certain factors (genetic, ecological, agricultural technology) may vary considerably in the shaping of the quality of wheat. Apart from very extreme cases, the processing of our experimental data proved that the above three factors influenced the baking quality of wheat as follows: variety 21%, ecological conditions 32 % and factors related to agricultural technology 47 % (Pepó and Győri 1997).

Detailed evaluations of Hungary's ecological conditions as regards producing quality wheat were provided by Szániel (1973), Szániel and Nagy (1975), Szabó *et al.* (1987), Szabó (1990). Apart from ecological conditions (weather, soil) the baking quality of wheat is also influenced to a large extent by the supply of fertilizers. On the basis of detailed analyses in term experiments Harmati (1994), Petróczi *et al.* (1998), Petróczi and Gyuris (2002) concluded that high quality wheat can only be produced at adequate fertilizer application.

Key words: winter wheat, baking quality, effect of the cropping year.

Methods

Our term experiment was set up on chernozem soil in Hajdúság in 1983. The experimental site is located at Látókép Experimental Plant in 15 km of Debrecen.

The long-term experiment was set up in four repetitions in a split-plot arrangement where the application of artificial fertilizers refers to the main plot (factor A) and the variety means the subordinate plot (factor B). The basic concept of the experiment was the analyses of the versatile effects of artificial fertilizer application on different wheat varieties as well as the study of nutrient and water management processes taking place in the plant production area.

Results and discussion

Two essential baking properties - wet gluten contents and pharionograph readings - of different wheat varieties were analysed in term experiments by using different fertiliser treatments over the period 1985 – 2003.

As regards these two baking parameters, the effects of the different cropping years had their effects on them in different ways. By applying abundant supplies of nutrients ($N_{300/150}+PK$ treatment) wet gluten contents could be kept in the region of improving quality class (above 32 %) in practically every year although the effect of the cropping year was clear (above 31 %) and ranged between 32.55 and 42.83 % with the exception of cropping years 1989 and 1990. Even in these two years gluten contents were just slightly below the so called improving quality values (30.80 % and 31.25 %). This means that although the differences between the cropping years are there, adequate fertilizer application will produce stable yields with high gluten contents on the average of the varieties. Under deficient nutrient conditions (control treatment) gluten contents revealed much higher ranges of variability in particular years (values of 20.03-33.58 % on the average of the varieties). While adequate fertilization brought about stable and high gluten contents almost irrespective of the cropping year valorigraph values showed much bigger changes under the effects of the different years. The valorigraph readings in the control treatments were 26.4 – 80.0 while at $N_{300/150}+PK$ fertilizer treatment they ranged between 38.6 and 79.9, i.e. despite abundant fertilizer applications considerable

fluctuations were observed in these values. In fact the fluctuations were much bigger than in the case of gluten contents.

The relationship between the weather factors and the quality of winter wheat was over the period 1986-2003 was evaluated by using the principal component analysis. The findings of the major component analyses for gluten contents and valorigraph readings are contained in tables 1 and 2, respectively.

Gluten contents were determined up to 65.7% by the meteorological factors involved in the scope of the study (cumulative own value), which means that with the three background variables the total variance of the system can be interpreted up to two thirds of the total. Factor number I. can be regarded to be the dominant background variable (26.7 % total variance), in the case of which a close correspondence can be established between primarily the mean temperature in July (kernel filling processes) and partly that in May (the formation of the vegetative sink, which later ensures the translocation of nutrients into the grain crop) as well as the gluten contents of the different varieties. The effects of factors II and III are more moderate (total variances of 22.8 %; and 16.2 %). In the case of factor II the more moderate effect on the gluten content is exercised by the precipitation in may and the temperature in July (*table 1*).

Table 1. Principal analyses of wet gluten content
(Debrecen, 1986-2003, all varieties)

Factors	Component is		
	I	II	III
Temperature in June	0,921	0,145	-0,116
Temperature in May	0,698	-0,605	-2,290E-02
Wet gluten	0,418	0,299	5,924E-02
Precipitation in May	-0,175	0,834	-0,334
Temperature in July	0,313	0,575	0,229
Precipitation in June	-0,278	-3,187E-02	0,832
Precipitation in July	0,388	0,311	0,511
Total of Initial	1,866	1,599	1,136
Eigenvalues	26,655	22,849	16,225
Variance %	26,655	49,503	65,728
Cumulative %			

In contrast with the gluten content the valorigraph value is a baking industry parameter that is not only a qualitative but primarily a quantitative one, which expresses the compositions and proportions of the different gluten proteins formed (structural and frame composing filling, small- and large-molecule-weight proteins, etc). As a consequence, the effects of weather factors influencing valorigraph values, to some extent deviated from the finding for gluten contents. The results of the analysis for the principal component conducted for all the varieties reveal that the three background components may be applied to interpret up to 73.8 % of the total variance of the system. Factor I can be considered as the dominant background variable (31.9 % total variance), while the effects of the other two factors are more moderate. At the same time as our investigations revealed the effects of the mean temperatures in May and June had the most significant effects on valorigraph values but these influenced them in a negative way. (*Table 2*).

Table 2. Principal analyses of valorigraph index
(Debrecen, 1986-2003, all varieties)

Factors	Components		
	I	II	III
Temperature in May	0,869	-0,235	-0,130
Temperature in June	0,741	0,567	-0,167
Valorigraph value	-0,683	0,132	-0,262
Temperature in July	0,116	0,668	0,372
Precipitation in May	-0,481	0,637	-9,224E-02
Precipitation in July	0,160	0,509	0,289
Precipitation in June	-8,382E-02	-0,263	0,906
Total of initial Eigenvalues	2,049	1,575	1,165
Variance %	29,278	22,498	16,643
Cumulative %	29,278	51,776	68,419

In the case of the varieties studied it was the valorigraph value deteriorating effect of the precipitation in July indicated in factor III that prevailed.

Conclusions

According to our findings the different cropping years influenced the quality of winter wheat to smaller or larger extents. The effects of the cropping year on gluten contents were much smaller than on valorigraph values. Adequate nutrient supplies ($N_{300/150}+PK$ treatment, 31-43 % gluten on the average of the varieties in the different years) ensured high and stable gluten contents, while valorigraph values were much more significantly influenced by the effects of the cropping years even at very favourable fertilizer treatments (at $N_{300/150}+PK$ treatment it ranged between values 39 [C₁]-80 [A₂]).

The medium strong correlation between the gluten content and the farinograph reading were considerably diverted, modified in the different years. Especially in dry, arid years it was experienced that despite high gluten contents (36-43 %) but supposedly due to the inadequate formation of the gluten structure valorigraph values revealed unfavourable (39-59) trends. According to the principal component analysis the gluten contents were determined by the temperatures in May-July and were modified by the precipitation in May and the temperatures in June in relation to all the varieties. The combined quality indicator, i.e. the valorigraph value reacted to the weather conditions in somewhat different ways than gluten contents did. As regards all the varieties the principal component analysis showed that it was the temperatures in May and July that had the most significant effects on the valorigraph values. High temperatures in these months deteriorated the valorigraph values of the different varieties.

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