TESTING THE STABILITY OF GRAIN YIELD AND BREAD-MAKING QUALITY OF WHEAT VARIETIES IN TWO DIFFERENT YEARS

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ABSTRACT

25 winter-type bread wheat genotypes were evaluated in two consecutive years (2010 and 2011) in the nursery of Cereal Research Non-Profit Company (CRNPC) to test the stability of grain yield and quality traits of CRNPC-bred varieties. In spite of the earlier trends the extremely wet 2010 year's grain yield became significantly lower and bread-making quality proved to be poorer than in the dry 2011 year. The most significant reasons of those found to be the very strong disease (mostly leaf rust and *Fusarium*) infection pressure in the highly precipitated 2010 year. Other, minor reasons were water logging stress, and harvest deficits due to the remarkable lodging of wheat. Stability of grain yield and different quality traits (wet gluten content, gluten stability, kernel hardness, farinograph water absorption, farinograph value, *Zeleny*-value, falling number) were evaluated by regression calculations to test the varieties' adaptability to the different year effects. In case of yield, a wide variation was found in stability of grain output. In cases of quality traits, the most sensitive traits were falling number, farinograph water absorption and developing time of dough.

Keywords: Stability of grain yield, stability of bread making quality, leaf rust, fusarium, effect of year

INTRODUCTION

Stability of grain yield and technological (or bread making) quality are crucial points in wheat production. Growing wheat under different conditions makes difficult to produce a predictable yield and quality level. Increasing occurrence of weather anomalies and extremities also extends the necessity for new genotypes with higher adaptation capacity. Different seasons with diverse water supply or disease infestation pressure may change the order of genotypes score in grain yield and quality significantly (CSEUZ ET AL., 2006). Breeders try to answer these challenges by multi-location testing of advanced lines to find the most adaptable ones among the ones with high yield potential and technological quality (CSEUZ ET AL., 2008, FÓNAD ET AL., 2007). In this paper we tried to answer the questions that how can wet years give lower yield and quality, than a dry one, and does our breeding material have ample genetic variation in adaptability.

MATERIAL AND METHOD

25 genotypes (*Table 1*) of winter type bread wheat (*Triticum aestivum* L.) were tested in two consecutive years (2010 and 2011) in the nursery of Cereal Research Non-Profit Co., Szeged – Kecskés (46° 14' 04.50''N; 20° 05' 09.91''E). Growing conditions modelled the conventional wheat technology (best practice without fungicide treatments) which is followed by most farmers in the country, adding 70+70+70 kg of (NPK) basic fertilizer and 120 kg N fertilizer extra at spring time, and applying plant protection treatments

against pests and weeds. For the disease resistance evaluation not any fungicide treatment was applied. In the four replicated field trials the plot sizes were 6.5 m^2 in both years. The seeds of all genotypes were taken from the previous year's variety maintenance plots. To compare not only the yield performance but quality level of the varieties in different years, besides the application of micro testing methods on all the samples (H.I. studies, diameter, thousand kernel mass (TKM), NIR wet gluten, protein content, falling number, Zeleny-tests) we determined flour yield, wet gluten content, gluten elasticity, and farinograph value. In both years we evaluated two times the infestation scores of the two mostly current fungal diseases leaf rust (*Puccinia recondita*) and *Fusarium* head blight (*Fusarium graminearum*) The presence of other wheat diseases like powdery mildew (*Blumeria graminis*) or leaf spots (*Drechslera* and *Septoria* species) did not hit a level of momentous epidemics. After harvest we performed correlation calculations between the disease scores and yield losses and mostly affected quality deficit data. To find the best genotypes in stability of grain yield and quality characters, we made regression calculations among the certain traits' two years values.

Table 1. The most important traits of varieties and variety candidates in the survey

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Number	Code of genotype	Year of registration	Precocity	Quality class	Type of head	Resistance to Blumeria g. (E.g)	Resistance to Puccinia recondita	Resistance to Puccinia graminis	Resistance to Fusarium sps.
1.	GK 12.93	1996	early	milling I	awnless				4,5
2.	GK 03.98	2001	late	milling I	awnless				2,3
3.	GK 34.02	2005	early	improver	awned				3,6
4.	GK 38.02	2005	early	milling I	awnless				2,6
5.	GK 18.03	2006	early	milling I	awnless				2,1
6.	GK 39.06	2009	early	milling I	awned				1,8
7.	GK 16.07	2010	early	milling I	awned				4,4
8.	GK 21.07	2010	early	milling I	awned				2,4
9.	GK 28.07	2010	early	milling I	awnless				1,6
10.	GK 38.07	2010	early	milling I	awnless				2,8
11.	GK 45.06	2010	early	milling I	awnless				3,3
12.	GK 10.08	2011	early	milling I	awnless				3,8
13.	GK 03.09	candidate	early	milling I	awnless				2
14.	GK 04.09	candidate	early	milling I	awnless				2,3
15.	GK 06.09	candidate	early	milling I	awnless				3,3
16.	GK 09.09	candidate	early	improver	awnless				1,7
17.	GK 02.10	candidate	early	milling I	awnless				1
18.	GK 04.10	candidate	early	milling I	awned				2
19.	GK 14.10	candidate	medium	milling I	awnless				2,5
20.	GK 17.10	candidate	medium	milling I	awnless				4
21.	GK 20.10	candidate	medium	milling I	awnless				1,5
22.	GK 41.10	candidate	medium	milling I	awnless				5
23.	GK 42.10	candidate	early	milling I	awnless				3,5
24.	GK 46.10	candidate	early	milling I	awnless				1,5
25.	GK 47.10	candidate	medium	milling I	awnless				4,5

	excellent		good
	medium		poor

RESULTS

Grain yield (*Figure 1*) and grain weight (thousand kernel mass) worked out on a significantly lower level due to the biotic and abiotic stresses in the year 2010. The average grain yield of the 25 wheat genotypes was 4.04 t/ha in the year 2010, while it was 6.59 t/ha in 2011. Not at the same extent but similarly the average thousand kernel mass also was significantly lower in 2010 (31.4 vs. 37.6 g). We have found significant correlation between the two years' grain yield data (*Figure 2*). It shows that most of the tested genotypes can cope with the different environmental factors. All the genotypes present in the upper right part in *Figure 2* have the highest yielding ability and the best adaptability (stability of yields) since they performed over the average in both years. The best grain yield stability was found in the case of varieties GK10.08 (GK Futár), GK28.07 (GK Körös), GK 38.07 (GK Vitorlás) and GK 38.02 (GK Csillag). In the lower right part are the lower yield capacity wheat genotypes with good yield stability under any conditions (extensive wheat varieties). In the left upper corner are the „super intensive" cultivars which have no good adaptability and perform well only under optimal conditions. One part of the left lower corner varieties have a high tolerance to abiotic stresses but yield on a low level, but the other ones have a quite good yielding ability with a very poor adaptability. All of the four categories contain registered varieties and new candidates as well.

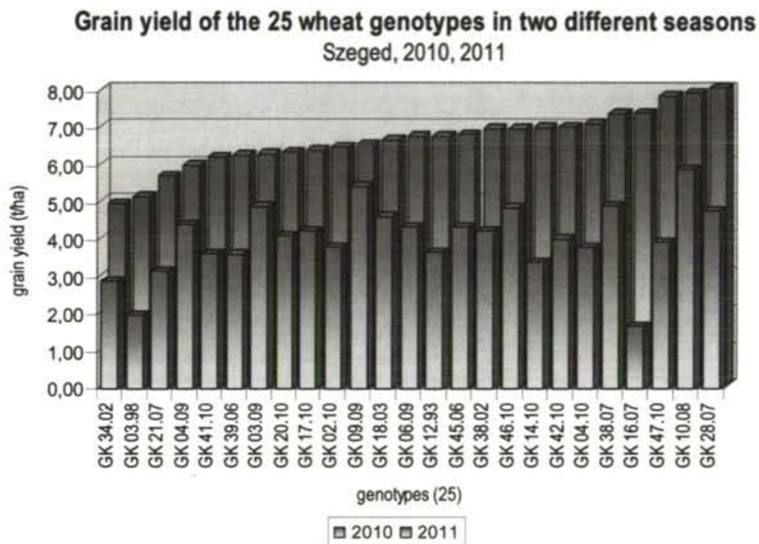

Figure 1. Grain yield of the 25 wheat genotypes under two different weather conditions

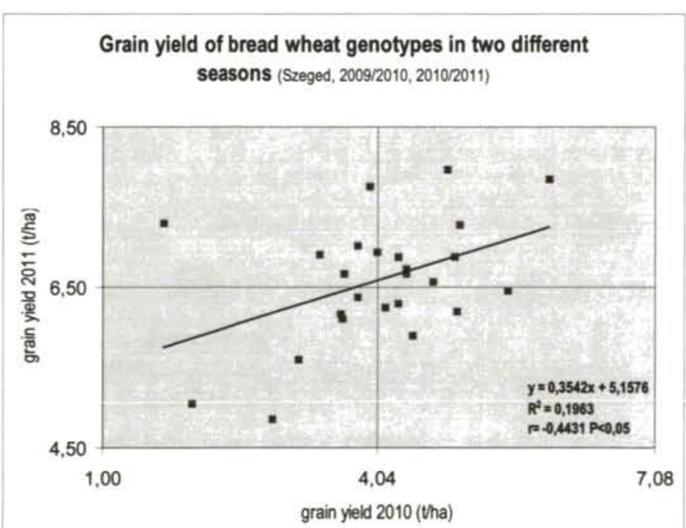

Figure 2. Correlation between grain yield of 25 wheat genotypes in two diverse growing seasons

According to our regression calculations we found a significant, moderately close correlation (r= -0.5842; r=-0.4116) between the change of grain yield and the genotype's leaf rust (*Puccinia recondita*) (*Figure 3*) and head blight (*Fusarium graminearum*)

(*Figure 4*) infection data in 2010. Since these two types of diseases were dominant in our nursery yield loss presumably happened due to the direct and indirect effects of these species.

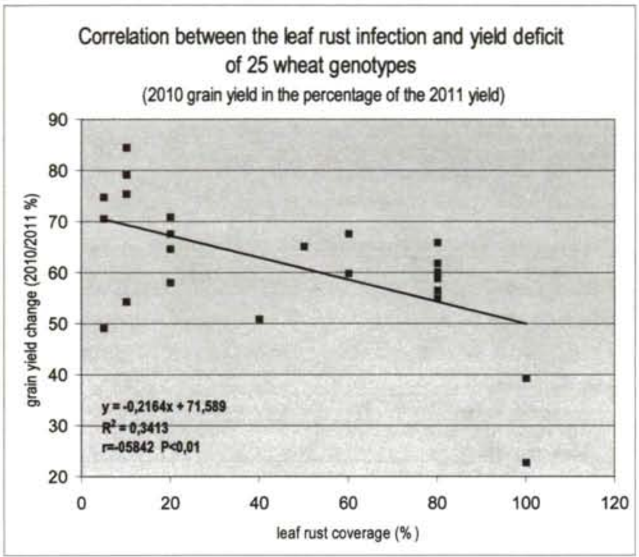

Figure 3. Correlation between leaf rust infection and yield deficit of 25 wheat genotypes

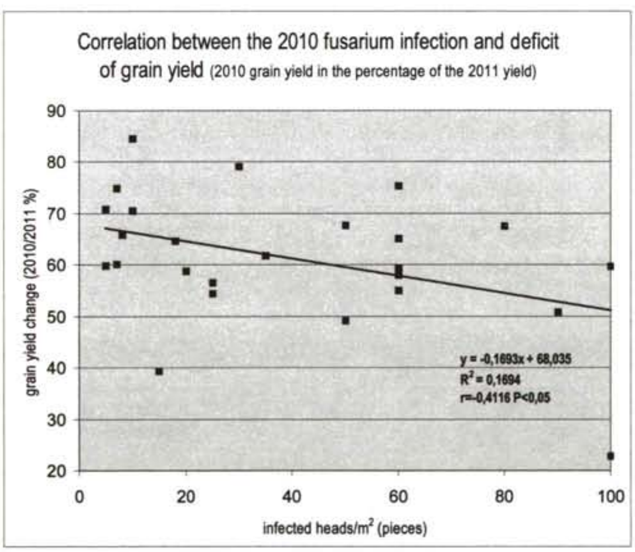

Figure 4. Correlation between fusarium infection and yield deficit of 25 wheat genotypes

In bread making quality we made a comparison between the two years' data, and we found that the most unstable traits were Hagberg-falling number (21% decrease), dough forming time (41.1% shorter in 2010), Farinograph-value (24.7% lower in 2010) and ICC stability which was 46.4% poorer in the wet year. We found significant correlation between the two different years' farinograph value and Hagberg-falling number data (*Figure 5* and *6*). This means that in both traits we have genotypes with a good stability in these characters. Most of the quality traits of variety candidates GK 41.10, GK 42.10 and varieties GK 10.08 (GK

Futár), GK 21.07 (GK Rozi), GK 34.02 (GK Békés) and GK 38.02 (GK Csillag) proved to be more stabile against biotic an abiotic stresses, than the mean of the genotypes tested. On the other hand, no correlation was found between the 2010 year disease infection (leaf rust covering and fusarium-infected spikes per square meter) and the deficit in quality traits (*Table 2*).

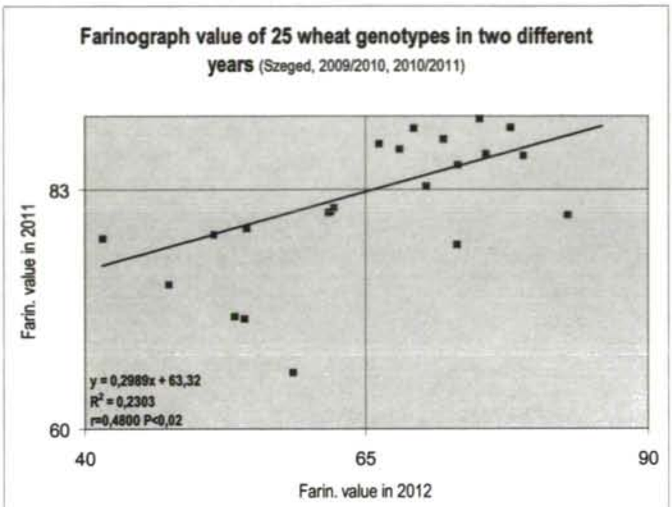

Figure 5. Stability of bread making quality: correlation between the farinograph values of 25 wheat genotypes in two different years

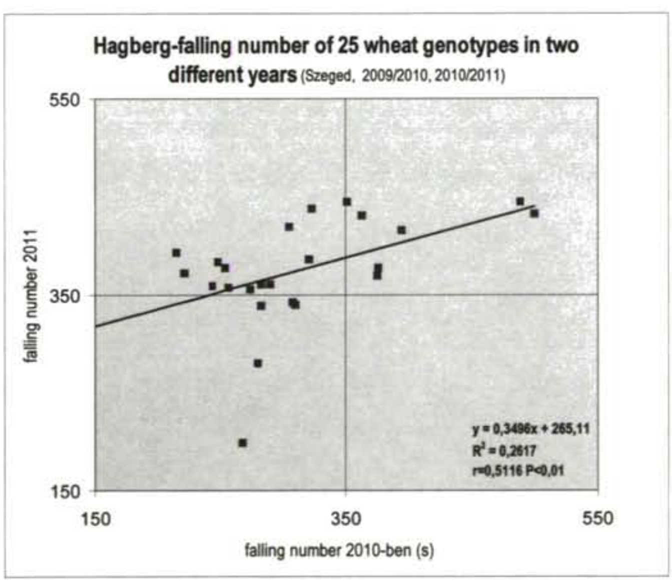

Figure 6. Stability of bread making quality: correlation between the falling number data of 25 wheat genotypes in two different years

Table 2. Correlation between the 2010 fungal disease infection and the change in the most unstable quality traits of 25 wheat genotypes

	Elasticity of gluten (mm)	Forming time of dough	Farinograph value.	ICC stability	Leaf rust coverage	Fusarium head no.
Elasticity of gluten (mm)	1					
Forming time of dough	-0,0425	1				
Farinograph value.	0,1087	0,3696	1			
ICC stability	0,1573	0,1419	0,8983	1,0000		
Leaf rust coverage 2010	**-0,0897**	**-0,1475**	**0,1169**	**0,0060**	1	
Fusarium head no.2010	**-0,0133**	**0,2128**	**0,0986**	**-0,0121**	0,2236	1

CONCLUSIONS

Wheat year 2009/2010 was unfavorable for winter wheat in the most part of Hungary because of the tremendous amount of precipitation and the phytopathology status evolved. In spite of that the next year was an extremely dry one, significant drought stress could not develop in wheat year 2010/2011 due to the soils' high moisture content from the previous year.

Mostly the diseases, namely leaf rust (*Puccinia recondita*) and fusarium head blight (*Fusarium graminearum* and *Fusarium culmorum*) are responsible for the low grain yields of 2010. Minor reasons are water logging stress for the root system and harvest losses due to the remarkable lodgings of wheat. According to our survey we could not prove that deficits in quality characters happened directly to disease infections. It seems that the reasons of quality deficits are complex, and are due to biotic and abiotic environmental stresses as well.

Both in stability of grain yield and stability of bread making quality we found a significant variation among the 25 CRNPC-bred genotypes tested. The best grain yield stability was found in case of GK Futár, GK Körös, GK Vitorlás and GK Csillag, while in the stability of quality best performers were GK 42.10, GK 41.10, GK Csillag and GK Futár.

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