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RESEARCH ON THE GRAIN YIELD AND ITS QUALITY TRAITS IN SEVERAL WINTER WHEAT (*Triticum aestivum* L.) GENOTYPES GROWN UNDER THE CONDITIONS OF DÂLGA – CĂLĂRAŞI

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Abstract

The breeding programs of hybrid wheat are aimed at increasing the grain yield and ecological plasticity, as well as the stress tolerance to drought and heat that have an unfavourable effect on the harvest quality parameters. As a result, this brings up the question whether or not these hybrids can compete or even replace the wheat cultivars which are considered high in terms of bread-making value. In order to elucidate this question, comparative research was established in the 2014-2015 growing season. The genotypes studied consisted of four winter wheat varieties (cultivars: Dropia, Glosa, Katarina, Mulan) and four hybrids wheat (Hyfi, Hystar, Hywin, Hybiza). The hybrids that clearly produced higher grain yield than the winter wheat varieties. The results of the research have shown that the quality index, the technological indicators of the flour and the rheological attributes of the dough, all eight winter wheat genotypes tested and analysed recorded values that fit into the "very good" category regarding the milling-bakery properties. Of all studied hybrids, the Hyfi hybrid wheat was high to the other hybrids regarding the bread-making suitability.

Key words*: winter wheat, grain yield, hybrid, quality index, bread-making value.*

INTRODUCTION

Considering both the economic importance of wheat production and the special role it plays in human nutrition, the increase of the worldwide wheat production is the current approach and the future trend (Popa et al., 2013; Guta et al., 2015).

Besides the existing trend in increasing wheat yield levels through the use of hybrids, which allows the use of heterosis to meet the increasing global food demands (Longin et al., 2012; Çukadar, 2001), other objectives are being taken into account, such as the introduction on the market of varieties with high protein content, increased nutritional value and high bakery qualities (Kadar et al., 2009).

The emphasis on quality breeding is highlighted by numerous international research and meetings on wheat quality (Has et al., 2010; Cociu, 2014).

Nevertheless, in recent decades it has been found that the progress made in obtaining genotypes with high protein content and high bakery qualities is less obvious than expected due to the fact that wheat breeding activity is directed mainly towards quantitative increase and less towards improving its quality parameters (Hrušková et al., 2012; Luo et al., 2000).

The possibility of developing new winter wheat genotypes by combining high yields and a higher nutritional quality is fully achievable (Egesel et al., 2012), taking into account that quality traits, although strongly influenced by environmental conditions, are also based on a quite wide intraspecific genotypic variability (Mustatea et al., 2003). The evolution of the breeding programs for developing new winter wheat genotypes that are better than the existing ones, involves continued genetic recombination. The number and value of the combinations widely depend on biodiversity and on the value of the already available genes (Yousif et al., 2015).

Knowing the contribution of genetic factors in the phenotypic realization of the quantitative traits is of major importance. Each winter wheat variety has specific genetic particularities such as morphological and physiological traits, grain yield, yield stability, lodging, pre-harvest sprouting, tolerance

diseases, protein content (Săulescu et al., 2010).
The most important quality index are protein content, wet gluten content, dry gluten content, bread final volume and weight, and farinograph measurements (Borghi et al., 1994; Egesel et al., 2012; Dumbrava et al., 2019).
Besides high yield potential, winter wheat genotypes must have high protein content, high nutritive value of the grains, tolerance to unfavourable environmental factors, and tolerance to diseases and pests (Blum, 1996; Longin et al., 2012).
The continuous improvement of crop technologies, the use of high yielding genotypes, with high-quality index adapted to the particular climatic and soil conditions of the various agricultural areas of Romania (Marin et al., 2015) are very important from the economic perspective, as well as for the future destination of the grain yield (Cociu, 2014; Lupu, 2010).
The phytosanitary treatments performed during the vegetation period ensure high expression of the biological yield potential and of the quality index (Cristea et al., 2015).

MATERIALS AND METHODS

Research was carried out in the 2014-2015 growing season on the chernozemic soil specific to the Dâlga area, Călăraşi county, Romania. The comparative study was aimed to analyses the local and foreign winter wheat genotypes (cultivars and hybrids varieties) regarding grain yield, quality index and bread-making value.
In the 2014-2015 agricultural growing season, the total amount of rainfall was 455.7 mm, accumulated from sowing to harvest. During the vegetation period from spring to summer, the amount of rainfall accumulated was 163.5 mm, with 54.8 mm rainfall accumulated in the critical water phase for winter wheat (May-June), and a daily precipitation average of 0.89 mm/day at this stage (Table 1).
The average daily temperature during the vegetative period (from October 2014 until June 2015) was 9.63°C. In these conditions, due to the efficient use of precipitation water under non-irrigation conditions, the tested wheat hybrids achieved yield performances that proved that they were competitive, compared with the best winter wheat varieties cultivated on the Romanian Plain nowadays.

Table 1. Climatic conditions during the 2014-2015 growing season

Month/ Growing Season	2014-2015 Temp. (^{0}C)	Normal average of area (^{0}C)	2014-2015 Rainfall (mm)	Normal average rainfall of area (mm)
October	13.0	12.99	65.6	44.25
November	7.33	7.45	49.0	39.88
December	1.79	1.38	109.0	40.79
January	-0.1	0.04	30.5	40.73
February	3.1	2.08	38.0	26.64
March	6.8	7.29	95.3	32.54
April	12.7	12.06	13.45	34.78
May	19.2	18.15	4.8	58.32
June	22.9	21.38	50.0	69.76
Average/ Amount	9.63	9.20	455.7	387.4

The biological material in this study consisted of four local and foreign winter wheat varieties (cultivars: Dropia, Glosa, Katarina, Mulan) and four wheat hybrids (Hystar, Hyfi, Hywin, Hybiza).
The experiment was mono-factorial and was located in the field according to the randomized blocks method, in three replications, within eight genotypes of winter wheat.
The pre-crop plant was sunflower (*Helianthus annuus* L.). Soil preparation started immediately after harvesting with a disk harrow, followed by plowing at 25 cm in depth. The seedbed cultivator was used after the application of complex chemical fertilizers in a dose of 40 kg N active ingredient (a.i.)/ha and 40 kg P a.i./ha one day before sowing.
Sowing was carried out in the favourable timeframe, i.e. 10th October 2014, with a density sowing of 500 kernels/m^2 for the wheat varieties and 200 kernels/m^2 for the wheat hybrids, at a space of 12.5 cm between rows and 4-5 cm sowing depth.
In spring, as soon as the climatic conditions were favourable for entering the field (30th March 2015), phase fertilization 200 kg/ha of Urea (92 kg N a.i./ha) was administered to the fields, the second phase fertilization 150 kg/ha of Ammonium nitrate (49.5 kg N a.i./ha). Weed control was performed with Mustang (Florasulam 6.25 g/l + 2.4 D EHE 300 g/l) in a dose of 0.6 l/ha and Helmstar 75WG (tribenuron-metil 750 g/kg), in dose of 15 g/ha.

The phytosanitary treatments with fungicide Duet Ultra (310 g/l tiofanat metil + 187 g/l epoxiconazol) in a dose of 0,5 l/ha performed on 4th April 2015. The second fungicide treatment was Amistar Xtra 280 SC (azoxistrobin 200 g/l + ciproconazol 80 g/l) in a dose de 0.5 l/ha combined with insecticide Lamdex 5 EC (Lambda-cihalotrin 50 g/l) in a dose de 0.2 l/ha.

Harvesting was carried out separately for each experimental variant on 8th July 2015. The production and yield of each studied genotype was determined, and average seed samples were taken for laboratory analysis. The analysis was focused on the main physical indicators showing the quality of the harvest, as follows: 1000 seed weight TKW (g) and volumetric weight HM (kg/hl), moisture content M (%); it also included determinations regarding the quality of the raw material for baking, as follows: the technological indicators of the flour and the rheological traits of the dough obtained. The analytical section was performed with the INFRATECTM 1241 grain analyser.

The analysis and the interpretation of the experimental results was based on variance analysis, according to the experimental method of field setting (Săulescu et al., 1967), considering the average of the winter wheat varieties and the average of the analysed wheat hybrids as reference points.

RESULTS AND DISCUSSIONS

The analysis of the yield potential for all the winter wheat genotypes studied (Table 2) showed higher values of the winter wheat hybrids compared to the winter wheat varieties tested. The yield grains registered values ranging from 7386 kg/ha in Dropia to 10137 kg/ha in Mulan, the latter recording the highest yield of all the analysed winter wheat varieties, compared to the average of the varieties taken as control 1 (9139.2 kg/ha).

The analysis of the yield obtained from varieties compared to the average of the hybrids, we noticed a decrease in production with values between 450.8 kg/ha in Mulan and 3201.8 kg/ha in Dropia.

The winter wheat hybrids tested were characterized by high yield compared to the wheat varieties taken as control, with a yield increase between 1070.8 kg/ha and 2051.8 kg/ha. Analysing the grain yield of the four hybrids tested in the experiment, we recorded variations between 10210 kg/ha and 11191 kg/ha, with the Hystar hybrid being the most valuable.

Table 2. Grain yield obtained in winter wheat genotypes, Dâlga area, Călăraşi County

Var. No.	Genotype cultivated	Yield (kg/ha)	(%)	Difference from Control 1 (kg/ha)	Significance	Difference from Control 2 (kg/ha)	Significance
1	GLOSA	9277	102	137.8	-	-1310.8	ooo
2	DROPIA	7386	81	-1753.2	ooo	-3201.8	ooo
3	KATARINA	9757	107	617.8	xx	-830.8	oo
4	MULAN	10137	111	997.8	xxx	-450.8	o
VARIETY AVERAGE (Control 1)		9139.2	100	-	(Ct. 1)	-	
LSD 5% = 357; LSD 1% = 462; LSD 0.1% = 956							
Nr. Crt.	Genotype cultivated	Yield (kg/ha)	(%)	Difference from Control 2 (kg/ha)	Significance	Difference from Control 2 (kg/ha)	Significance
5	HYSTAR	11191	106	603.2	xx	2051.8	xxx
6	HYFI	10554	100	-33.8	-	1414.8	xxx
7	HYWIN	10210	96	-377.8	o	1070.8	xxx
8	HYBIZA	10396	98	-191.8	-	1256.8	xxx
HYBRID AVERAGE (Control 2)		10587.8	100	-	(Ct. 2)	-	
LSD 5% = 233; LSD 1% = 446; LSD 0.1% = 974							

Thousand-kernel weight (TKW) values for the analyzed winter wheat varieties (Table 3) ranged from 42 to 53 g, with the highest value being recorded in Dropia, which is known as one of the most qualitatively valuable variety.
The TKW values for hybrids varied between 43 g in Hywin and 50 g in Hybiza, the latter being very close to the quality of the Dropia variety.
The hectolitre mass (HM) of the grains (Table 3) recorded in the wheat varieties tested ranged between 80 kg/hl in Mulan and 83 kg/hl in Glosa, with higher values in the analysed varieties than in the hybrids. Thus, in the four wheat hybrids tested in the experiment, the hectolitre mass ranged from 77 kg/hl in Hywin and 79 kg/hl in Hystar and Hyfi.

Table 3. Experimental results of physical quality indexes in winter wheat, Dâlga area, Călăraşi County

Genotype cultivated	TKW (g)	(%)	HM (kg/hl)	(%)	Bread-making quality*
GLOSA	49	104	83	102	VG
DROPIA	53	112	82	101	VG
KATARINA	45	95	81	99	VG
MULAN	42	89	80	98	VG
VARIETY AVERAGE (Ct. 1)	47.3	100.0	81.5	100.0	-
HYSTAR	48	101	79	101	VG
HYFI	49	103	79	101	VG
HYWIN	43	91	77	98	VG
HYBIZA	50	105	78	100	VG
HYBRID AVERAGE (Ct.2)	47.5	100.0	78.3	100.0	-

Bread-making quality* SR EN ISO 7971-3: 2010 (VG = very good)

Analysing the bread-making quality of the eight winter wheat genotypes studied (Table 3) they met the baking requirements as they exceeded the minimum amount of hectolitre mass for this purpose, i.e. 75 kg/hl.
In all the wheat variety tested in the experiment, the grain moisture determinations (Table 4) had values ranging from 12 to 14%, i.e. the corresponding limits established for bread-making wheat varieties. The protein content of the grains (Table 4) varied between 11.7% and 14.7%. The average of the regular varieties was higher than the average of the hybrids. Since there was no significant variation between the winter wheat varieties studied, they could be successfully used for bakery purposes.

The determinations related to the starch content of the grain (Table 4) in the wheat varieties ranged between 66.7% and 69.8%, with an average of 67.9%. In the wheat hybrids it varied between 68.6% and 69.9%, with an average starch content of 69.1%, which indicated that the hybrids were higher in quality when compared with the regular varieties.
The wet gluten content of the wheat strains tested in the experiment (Table 4) showed values between 29.7% and 35.9%. Glosa and Dropia contained an exceeding amount of gluten (32%), which included these varieties in the category of "very good" winter wheat variety for bakery purposes. With a wet gluten content ranging between 30.4% and 29.7%, Katarina and Mulan were considered "good"' for this purpose.

Table 4. Moisture, protein and starch content in wheat varieties, Dâlga area, Călăraşi County

Genotype cultivated	Moisture (%)	%	Crude protein (%)	%	Starch (%)	%	Wet Gluten (%)	%
GLOSA	13.4	102	14.0	104	66.7	98	34.6	106
DROPIA	12.9	98	14.7	109	67.0	99	35.9	110
KATARINA	13.3	100	12.9	96	69.8	103	30.4	93
MULAN	13.2	100	12.3	91	68.1	100	29.7	91
VARIETY AVERAGE (Ct. 1)	13.2	100	13.5	100	67.9	100	32.7	100
HYSTAR	12.9	99	12.0	98	69.1	100	27.7	98
HYFI	13.1	101	12.9	106	68.8	99	31.2	110
HYWIN	13.1	101	11.7	96	68.6	99	27.1	96
HYBIZA	12.9	99	12.0	98	69.9	101	27.3	96
HYBRID AVERAGE (Ct. 2)	13.0	100	12.2	100	69.1	100	28.3	100

In the wheat hybrids, the analysed wet gluten content ranged from 27.1% to 31.2%; according to the standards (STAS 6283/1-1983), there were no restrictions for the baking purpose under the threshold of 22%.
The technological indicators of the flour and the rheological characteristics of the dough were interpreted on the basis of the indexes: Grain hardness (endosperm texture), Zeleny Index, deformation index, alveographic parameters - mechanical work (bakery force), etc.

Table 5. Rheological traits of wheat varieties, Dâlga area, Călăraşi County

Var. No.	Genotype cultivated	Grain hardness	%	Zeleny Index (ml)	%	Deflexion Index (mm)	%	Alveographic Mechanical Work W (cm^2)	%
1	GLOSA	52.5	103	72.5	99	6	92	274	112
2	DROPIA	52.6	103	72.0	99	7	108	281	115
3	KATARINA	34.1	67	80.0	110	5	77	217	89
4	MULAN	63.9	126	65.0	89	8	123	204	83
VARIETY AVERAGE (Ct. 1)		50.8	100	72.8	100	6.5	100	244.0	100
5	HYSTAR	24.0	76	66.5	94	5	100	187	97
6	HYFI	39.6	126	75.5	106	5	100	220	114
7	HYWIN	33.2	106	74.5	105	7	140	194	101
8	HYBIZA	28.8	92	67.0	94	3	60	168	87
HYBRID AVERAGE (Ct. 2)		31.4	100	70.9	100	5.0	100	192.3	100

The grain hardness of the winter wheat varieties studied (Table 5) ranged between 34.1 and 63.9 whereas the analysed wheat hybrids recorded values ranging from 24 to 39.6.

The Zeleny test is based on the swelling of wheat flour protein in a specially diluted lactic acid solution and for the Romanian grains the following scale is considered to be appropriate: Category I, over 50; category II, over 50-35.01; Category III, over 35-20.01; category IV, under 20. For the Zeleny index all eight wheat genotypes studied were included in the first class of quality, with values above 50 according to the scale of gradation (Table 5).

Following the determination of the deformation index of the dough (Table 5), the Hybiza hybrid recorded a deformation index of 3 mm, i.e. good but too strong gluten, which requires flour amelioration. In the other genotypes studied in the experiment, this parameter varied between 5 and 13 mm, and thus all were considered "very good" for bakery.

In the winter wheat varieties, the values of the baking strength (Table 5) ranged from 204 to 281, with an average of 244, which included them in the category of flours for manufacturing fast-growing products. In the winter wheat hybrids, the baking power (W) ranged from 168 to 220, with an average of 192.3, with Hyfi recording higher values than the other hybrids tested in terms of baking value.

CONCLUSIONS

Based on the experimental results obtained in the 2014-2015 agricultural growing season, the following conclusions were drawn:

For the productivity potential of the eight winter wheat genotypes studied, the higher value of the hybrids was observed compared to the average of winter wheat varieties tested, i.e. 9139.2 kg/ha.

In terms of productivity, the Mulan variety was higher than the others, with a grain yield of 10137 kg/ha, and the Hystar wheat hybrid recorded a yield of 11191 kg/ha.

Although the tested hybrids recorded higher grain yield than the wheat cultivars varieties, they recorded lower values of physical quality index, 1000 grains weight and volumetric weight, compared to the wheat cultivars varieties studied in the experience.

All the winter wheat genotypes tested during the experiment exceeded the minimum volumetric weight for milling-bakery, i.e. 75 kg/hl, being considered very good for this purpose.

All winter wheat genotypes tested in the experiment had grain moisture values ranging from 12% to 14%, i.e. the corresponding limits for baking wheat.

The protein content of the grains ranged between 12.9% and 13.4%, with no significant variation between the winter wheat genotypes studied, which could be successfully used for bakery purposes.

The starch content ranged from 66.7% to 69.8% in the wheat cultivars varieties and from 68.6% to 69.9% in the hybrids, as the latter were inferior compared with the former.

The wet gluten content of the eight winter wheat genotypes tested in the experiment ranged from 27.1% to 35.9%, thus classifying them as "very good" genotypes for bakery destination.

In terms of the Zeleny index, all eight wheat genotypes studied were included in the first grade of quality, with values above 50 according to grading scale.

According to the deformation index of the dough, in the Hybiza hybrid the deformation index was 3 mm, indicating good but too strong gluten and requiring slight improvement. All the other genotypes showed values between 5 and 13 mm, thus being considered "very good" for the milling-bakery purposes.

The technological indicators of the flour obtained from the grain milling of the eight winter wheat genotypes fell into the category of flours for manufacturing fast-growing products. For the rheological traits of the dough, the winter wheat varieties and hybrids tested during the experiment were part of the "very good" category for bakery purposes.

REFERENCES

Blum, A. (1996). Yield potential and drought resistance: Are they mutually exclusive. In: P. Reynolds et al. (eds.). *Increasing yield potential in wheat: Breaking the barriers*. CIMMYT, Mexico, D.F. 90–100.

Cociu, A.I. (2014). Influence of genotype x tillage interaction on wheat yield, its components and characteristics. *An. I.N.C.D.A. Fundulea*, *LXXXII*. 171–191.

Cristea, M., Cristea, S., Toader, M. (2015). The microflora influence on wheat seeds on the quality indicators. *Lucrări ştiinţifice, 2, Seria Agronomie USAMV Iaşi*, 167–170.

Çukadar, B., Pena, R.J., Ginkel, V.M. (2001). Yield potential and bread-making quality of bread wheat hybrids produced using Genesis, a chemical hybridizing agent. *In Wheat in a Global Environment* (p. 541–550). Springer, Dordrecht.

Egesel, C.Ö., Kahrıman, F., Tümer, A.İ., Çolak, Ç. (2012). Yield and quality characteristics of some foreign bread wheat (*Triticum aestivum* L.) varieties in Turkey. *Romanian Agricultural Research*, *29*, 31–38.

Guță, B.A., Marin, D.I., Carrier, P.L. (2015). Comparative research on several wheat (*Triticum aestivum* L.) genotypes grown under the conditions of Dâlga- Călărași. *AgroLife Scientific Journal, 4*(2).

Has, V., Has, I., Antohe, I., Copândean, A., Nagy, E. (2010). Variability of the grain yield and quality potential of maize hybrids in different FAO maturity groups. *An I.N.C.D.A. Fundulea*, *LXXVIII*(l).

Hrušková, M., Švec, I., Karas, J. (2012). Relations between the grain hardnessand other quality parameters of wheat. *Scientia Agriculturae Bohemica*, *43*(2), 70–77.

Dumbrava, M., Ion, V., Basa, A.G., Dusa, E.M., Epure, L.I. (2019). Study regarding the yield components and the yield quality at some wheat varieties. *Scientific Papers. Series A. Agronomy*, *LXII*(2), 77–82

Kadar, R., Moldovan, V., Moldovan, M. (2009). Genetic progress in breeding of bread-making quality in winter wheat at ARS Turda: opportunities and constrains. *Annual Wheat Newsletter*, *47*, 149–150.

Longin, C.F., Muhleisen, J., Maurer, H.P., Zhang, H., Gowda, M., Reif, J.C. (2012). Hybrid breeding in autogamous cereals. *Theor Appl Genet*, *125*, 1087–1096. doi: 10.1007/s00122-012-1967-7.

Luo, C., Branlard, G., Griffin, W.B., McNeil, D.L. (2000). The Effect of Nitrogen and Sulphur Fertilisation and their Interaction with Genotype on Wheat Glutenins and Quality Parameters. *Journal of Cereal Science*, *31*(2), 185–194.

Lupu, C. (2010). Influence of basic soil tillage on wheat yield and of some soil features at ARDS Secuieni. *An I.N.C.D.A. Fundulea*, *LXXVIII*(2), 79–87.

Marin, D.I., Rusu, T., Ciontu, C., Mihalache, M., Ilie, L., Nistor, E., Bolohan, C. (2015). Influence of soil tillage upon yield of several winter wheat varieties grown in the Ilfov area - Romania. *ProEnvironment*, *8*(22), 136–141.

Mustatea, P., Saulescu, N.N., Ittu, G., Paunescu, G., Stere, I., Tanislav, N., Zamfir, M.C., Voinea, I. (2003). Genetic variation in the resistance of wheat to drought, highlighted in the year 2002. *An I.N.C.D.A. Fundulea*, *LXX,* 8–15.

Borghi, B., Perenzin, M. (1994). Diallel analysis to predict heterosis and combining ability for grain yield, yield components and breadmaking quality in bread wheat (*T. aestivum*). *Theor. Appl. Genet., 89*, 975–981.

Popa, M., Motcă, G. (2013). Genotype influence upon production and quality of wheat grown in Găvanu-Burdea plain. *Scientific Papers*. Series A. Agronomy, *LVI.*

Săulescu, N.A., Săulescu, N.N. (1967). *Câmpul de experienţă*. Edit. Agro-Silvica, Bucuresti.

Săulescu, N. et al. (2010). Diversifying germplasm as a basis of genetic progress in wheat breeding. *An. I.N.C.D.A. Fundulea*, *LXXVIII*(L), 7–20.

Yousif, S.A., Jasim, H., Abas, A.R., Yousef, D.P. (2015). Some Yield Parameters of Wheat Genotypes. *World Academy of Science, 9*(3).