SYNTHETIC AMPHIDIPLOID WHEAT – A POTENTIAL SOURCE OF RAISING QUALITY IMPROVEMENT

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Abstract
Synthetic wheat is from the genetic point of view an amphidiploid which combines the genome of parents. It often exhibits superior characteristics that contribute to the enlargement of genetic variation in breeding programs or in the development of new varieties.
Breeding programs of NARDI Fundulea, the most important agricultural research unit in Romania began to increase genetic variability by incorporating wild genes to exploit the improvement of wheat through crosses with wild ancestors and succeeded in creating lines of synthetic wheat with some higher quality components.
Experimented lines of these programs proved to be an efficient and beneficial source of new genes for common wheat quality from the southern area of Romania.

Keywords: *synthetic amphidiploid wheat, quality, improvement, environment*

INTRODUCTION

Wheat is the most important cultivated plant, with a large food share. The large areas on which it is sown, as well as the attention it enjoys, are due to the high content of the grains in carbohydrates and proteins and the ratio between these substances, corresponding to the requirements of the human body, the long shelf life of the grains and the fact that they can be transported without difficulty, the fact that the plant has great ecological plasticity, being cultivated in areas with very different climates and soils and because of the possibilities of full mechanization of culture.

Wheat is grown in over 100 countries and represents an important trade source.

Wheat grains are used especially for the production of flour, intended for the manufacture of bread - the basic food for a large number of people and provides about 20% of the total calories consumed by humans. Also, wheat grains are used for the manufacture of flour pasta, as raw material for other very different industrial products.

The quality of wheat can have many aspects, perhaps as many, as it has potential uses, but also how many specific technologies are used to process it. The quality of the finished wheat product (flour) depends on a series of elementary characteristics, which, although strongly influenced by environmental conditions, present important genetic differences that can be used in breeding.

Intensive agriculture and conventional breeding led to the loss of genetic diversity and stagnation or decline of yields in cereals even in favorable areas. Some well-known varieties are being replaced by modern materials that can be used as valuable sources of germplasm for meeting the future needs of sustainable agriculture in the context of climate change. Even so, there is concern that their potential is not fully realized. Nardi Fundulea recently tried to realize new material both for yield and improved quality and gave for cultivation in many areas. After some years of experimentation in the Southern part of Romania, in particular, their potential as sources of genes for protein was identified. This new material is represented by some synthetic amphiploid that are hybrid combinations between modern *T. durum* genotypes and several *Aegilops* biotypes to create introgression lines with useful genes transferred from wild species. Synthetic hexaploid wheat was created to explore novel genes that can be used for common wheat improvement (Yang, W. et all., 2009). Synthetic amphidiploid wheat lines have shown resistance to diseases and pests, tolerance to environmental stresses, and some desirable quantitative traits, but also have a large number of unfavorable traits, such as late maturity, taller plants, and difficulty in threshing. The same positive and negative characteristics were reported by Li, J. et all., 2014.

The purpose of this paper was to present results obtained from testing such introgression lines for increased genetic variability, but also for superior quality potential.

MATERIALS AND METHODS

The experiment was carried out between 2015-2018 in the Southern area of Romania (44"7' north latitude and 24"21' east longitude).

Biological material was represented by 10 introgression lines derived from distant hybridizations of wheat x related species (Table 1). The experience was set up after the randomized blocks method, in three replications. Standard wheat crop technology and 250 Kg/ha NPK (20-20-0) were applied every year. The quality components analyzed in this work were determined by reading in infrared (spectroscopic) NIR, using the grain/flour Inframatic Analyzer from Perten Instruments. These were: protein percentage, moisture, Zeleny sedimentation index, grain hardness, and water absorption. The yield was determined by weighting the grains resulting per variant and reported by hectare.

Obtained results were calculated using the method of variance analysis.

Table 1. Biological material

No.	Code	Genealogy		Origin country
		Genotip *T. durum*	*Biotip Ae. squarrossa*	
1	E 1-A	Pandur	Ae. squarrosa typica - 2472	Iran
2	E 5-A	Agedur	Ae. squarrosa strangulata - 2475	Iran
3	E 6-A	Agedur	Ae. squarrosa meyeri - 2530	Iran
4	E 7-A	Elidur	Ae. squarrosa meyeri - 2386	Pakistan
5	E 17-A	Amadur	Ae. squarrosa typica - 2472	Iran
6	E 19-A	Grandur	Ae. squarrosa strangulata - 2377	Iran
7	E 24-A	Condur	Ae. squarrosa strangulata - 2464	Iran
8	E 25-A	Condur	Ae. squarrosa typical - 2472	Iran
9	E 32-A	DDU 297	Ae. squarrosa strangulata - 2569	Kazachstan zone
10	E 35-A	Grandur	Ae. squarrosa strangulata - 2569	Kazachstan zone

Source: Ader 116/2015

RESULTS AND DISCUSSIONS

It is known that crop biodiversity plays an important role in adaptation to the changing environment. Genetic progress in the development of productive and quality varieties has evolved greatly despite the negative correlation between them. The yield obtained by the experienced material varied not only by line and mostly by climatic conditions (fig. 1, 2). Data from table 2 indicate significant differences in yield and a very high variability coefficient. Lines with higher grain protein contents presented lower yields.

Experimented lines proved to be an efficient and beneficial source of new genes for common wheat quality. The amount of protein in the grain is one of the basic components of the baking quality. The quality of bread is mostly related to grain protein content, which varied mostly due to environmental conditions. However, lines can be mentioned that, despite the strong influence of environmental conditions, have a high protein content (E 35-A, E 25-A, E 24-A). When wheat has values of protein content higher than 13%, it has very good quality (Constantinescu Emilia et all., 2021).

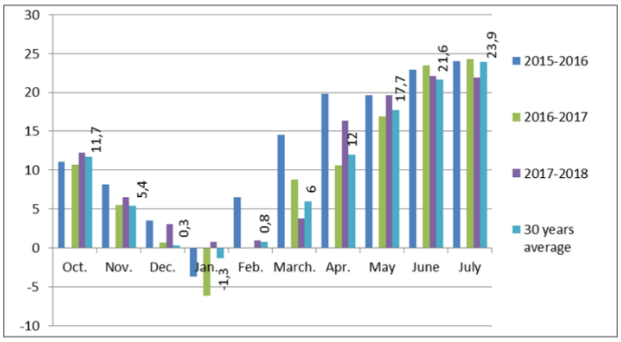

Fig. 1. Temperature

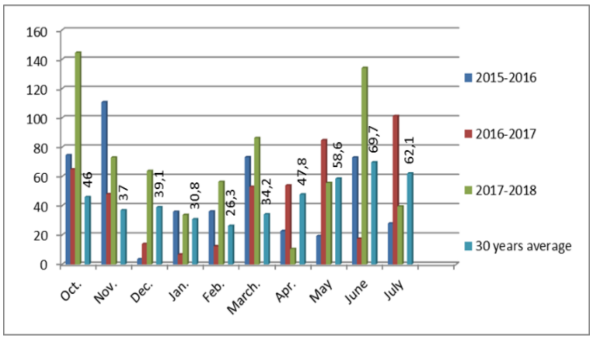

Fig. 2. Precipitation

Table 2. Average values for yield and protein

	Yield (Kg/ha)			Average	Protein (%)			Average
	2015-2016	2016-2017	2017-2018	2015-2018	2015-2016	2016-2017	2017-2018	2015-2018
E1-A	4090	3460	3850	3800.00	13,8	15,5	14,4	14,57
E5-A	4720	3680	3500	3966.67	13,4	16,1	13,8	14,43
E6-A	5800	5650	3740	5063.33	13,0	14,5	15,6	14,37
E7-A	5180	3000	3190	3790.00	13,0	14,2	14,8	14,00
E17-A	5750	4100	3810	4553.33	12,6	13,8	14,0	13,47
E19-A	3830	2970	3240	3346.67	10,6	13,4	14,0	12,67
E24-A	2080	2160	2100	2113.33	14,2	15,6	15,8	15,20
E25-A	3960	3050	2980	3330.00	14,5	16,3	14,8	15,20
E32-A	2920	2350	2600	2623.33	13,4	16,0	16,2	15,20
E35-A	2640	2830	2280	2583.33	15,4	15,7	15,6	15,57
X of the experience	4097	3325	3129	3517.00	13.39	15.11	14.9	14.47
Variance (s^2)	1284.96	1000.59	631.78	-	1.283	1.042	0.855	-
s%	31.36	30.09	20.19	-	9.58	6.90	5.74	-

Introgression of new genes through synthetic backcrosses could contribute to the improvement of the quality of wheat.

The moisture of grains did not vary much, but it can be seen that it is higher in the second year of experimentation because the precipitation fell in the last vegetation period and the variability coefficient presented very small values (Table 3).

Wheat grain moisture plays an important role in grinding and influences the flour yield and the mill process's losses (Matei, Gh. et all., 2014).

Essential for the quality of milling, but also for the quality of the flour in the subsequent processing process, is the hardness of the grain. Wheat with a hard grain requires more energy to grind.

Average values for this indicator vary from 81.8 (2017) to 85.5 (2016) and 88.6 (2018) comparative with 85.30, the average of the three years.
Grain hardness plays an important role in determining baking quality, as it directly influences the hydration capacity of the flour. There was wide variability in grain hardness over the three years. The highest values were registered in 2017-2018 while the lowest was in 2016-2017.

Table 3. Average values for moisture and grain hardness

	Moisture			Average	Hardness			Average
	2015-2016	2016-2017	2017-2018	2015-2018	2015-2016	2016-2017	2017-2018	2015-2018
E1-A	13.0	14.6	13.9	13.83	84	79	89	84.00
E5-A	14.7	15.3	14.4	14.80	83	80	87	83.33
E6-A	15.4	15.5	14.5	15.13	85	81	87	84.33
E7-A	15.4	15.7	14.3	15.13	80	79	88	82.33
E17-A	15.2	15.5	14.4	15.03	83	79	81	81.00
E19-A	14.2	14.8	14.3	14.43	84	81	87	84.00
E24-A	13.9	15.2	14.1	14.40	89	81	91	87.00
E25-A	14.2	14.6	14.3	14.37	87	82	86	85.00
E32-A	13.8	14.8	13.4	14.00	89	87	95	90.33
E35-A	13.5	14.3	14.2	14.00	91	89	95	91.67
X of the experience	14.33	15.03	14.18	14.51	85.5	81.8	88.6	85.30
Variance (s^2)	0.83	0.47	0.32	-	3.408	3.458	4.222	-
s%	5.76	3.14	2.27	-	3.99	4.23	4.76	-

The Zeleny index can express the quality of wheat baking. NIR analyzer of the grains indicated values for this index in higher limits (Table 4) depending on line and year. Higher values were registered in 2018 compared with 2016 and 2017.

Table 4. Average values for Zeleny index and water absorption

	Zeleny index			Average	Water abs.			Average
	2015-2016	2016-2017	2017-2018	2015-2018	2015-2016	2016-2017	2017-2018	2015-2018
E1-A	28.8	24.6	36.6	30.00	62.0	62.2	63.1	62.43
E5-A	28.4	34.0	36.7	33.03	61.5	57.6	63.5	60.87
E6-A	37.7	26.6	37.2	33.83	61.3	60.9	65.1	62.43
E7-A	31.8	23.1	38.5	31.13	61.4	63.4	65.5	63.43
E17-A	33.1	31.2	47.1	37.13	63.1	64.8	62.4	63.43
E19-A	34.2	25.9	37.6	32.57	62.5	61.6	62.8	62.30
E24-A	31.2	28.5	36.4	32.03	62.1	62.8	63.5	62.80
E25-A	35.6	42.2	55.2	44.33	62.0	61.4	62.9	62.10
E32-A	46.3	45.4	55.2	48.97	62.2	57.6	59.4	59.73
E35-A	48.2	47.3	49.5	48.33	60.9	61.6	62.4	61.63
X of the experience	35.53	32.88	43	37.14	61.9	61.39	63,06	62.12
Variance (s^2)	6.81	8.99	7.92	-	0.643	2.294	1.662	-
s%	19.17	27.34	18.41	-	1.04	3.74	2.64	-

Zeleny values between 31,4 - 65,2 ml were reported by Marinciu and Șerban (2018) in a genetic material becoming also from the first links of a breeding program and they recommend NIR technique be used as a tool in the selection of winter wheat breeding lines with improved quality.

For bakers, protein content helps to anticipate water absorption and dough development time during processing and production, because a high content requires more water and a longer mixing time in order for the dough to obtain the optimal consistency.

Increased water absorption represents value to bakers because they add more water to the flour, thus increasing product yield and shelf-life (Lee et al., 2005).

Wheat quality is determined by the combination of several parameters. The different eco-pedoclimatic conditions of the years of experimentation can influence the yield and accumulation of protein through variations in temperature and precipitation, especially during the filling period of grains.

Table 5. Correlations between analyzed characters (2015-2016)

	Yield (Kg/ha)	Protein (%)	Moisture (%)	Hardness	Zeleny (ml)	Water abs.
Yield						
Protein	-0,429					
Moisture	0,776*	-0,406				
Hardness	-0,799	0,596	-0,610			
Zeleny	-0,391	0,325	-0,230	0,707*		
Water abs.	0,094	-0,524	0,017	-0,183	-0,286	

Table 6. Correlations between analyzed characters (2016-2017)

	Yield (Kg/ha)	Protein (%)	Moisture (%)	Hardness	Zeleny (ml)	Water abs.
Yield						
Protein	-0,339					
Moisture	0,439	-0,471				
Hardness	-0,373	0,429	-0,637			
Zeleny	-0,343	0,633	-0,603	0,851**		
Water abs.	0,072	-0,574	0,231	-0,416	-0,459	

Table 7. Correlations between analyzed characters (2017-2018)

	Yield (Kg/ha)	Protein (%)	Moisture (%)	Hardness	Zeleny (ml)	Water abs.
Yield						
Protein	-0,669					
Moisture	0,385	-0,516				
Hardness	-0,732	0,739*	-0,676			
Zeleny	-0,346	0,344	-0,397	0,230		
Water abs.	0,336	-0,258	0,755*	-0,414	-0,683	

Correlations were calculated between the quality parameters determined each year and were mostly negative. Among positive correlations, hardness and protein content can be mentioned as hardness and Zeleny, water absorption - moisture, and moisture - yield.
Considerable research in the past decade has been devoted to novel techniques and methodologies in wheat biotechnology. The integration of novel techniques and methods into wheat breeding programs is necessary to facilitate continued and accelerated progress in producing new wheat lines. Innovative plant breeding techniques partially respond to current challenges.

CONCLUSIONS

These amphidiploid lines although does not have high yield potential, present adaptability under different growing conditions and proved to be genetically stable in terms of quality.
The genotype and environment present similar importance for the determination of the quality characteristics.

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