Scientific Papers. Series A. Agronomy, Vol. LXI, No. 1, 2018
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

ANALYSIS OF SOME QUALITY COMPONENTS TO FEW AMPHIDIPLOID LINES OF WHEAT

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Abstract

Data presented in this experiment was conducted to evaluate some quality components of 10 amphidiploid lines of wheat comparative to their parental forms in order to identify new desirable genotypes or sources of variability. Two consecutive years (2015-2017) was carried out field trials in South Romania. Results for analyzed characters (protein and starch content, hectoliter mass, humidity, grain hardness and water absorbtion) were registered as average for experimentation period. Standard deviation and the coefficient of variability analysis for the mentioned characters revealed that for protein, there is significant variation. Most of the amphidiploid lines of wheat possessed higher levels of protein or starch comparative with parental forms. Highest protein content recorded E35-A line, while higher values of starch presented E19-A line. Also, higher values for hectoliter mass presented E1-A and E5-A lines while most of them registered same values as parental forms for grain hardness or smaller. As a conclusion, E35-A line combined successfully almost all characters and the present study demonstrated high quality characteristics of the amphidiploid lines of wheat in combination with other agronomic desirable characters.

***Key words**: quality components, wheat, amphidiploid lines, variability.*

INTRODUCTION

The increase of the global population and the continuous demand for food requires also an increase in the rate of progress for breeding gains in major food crops like wheat. Its popularity is caused by wide adaptation to diverse environmental conditions and presence of a strong storage protein complex. Genetic improvement of wheat has received considerable attention over the last years and it seems that doubled haploid technology succeeded to bring considerable increases in the efficiency of the breeding programs by returning fully homozygous lines from priority crosses within a single year comparative with conventional one.

Practical aspects of double haploids breeding have been demonstrated by the production of valuable breeding lines and new cultivars. Wheat genotypes developed by this method, both by anther-culture and maize induction systems have been released for cultivation in all continents. The first DH wheat cultivars with haploid origin from Romania were Faur and Glosa, registered in 2004, respectively 2005 (Săulescu et al., 2012). Glosa occupy around 35 percent from total cultivated area with wheat (http://agrointel.ro).

The hard work made by NARDI Fundulea researchers leaded to the creation of new material using DH technology in winter wheat. In modern research of genetics, haploid and DH populations are biological materials for a large area of domains: induction of mutations to haploid level, genomic and proteomic studies, introgression of useful genes from wild germplasm, genetic transformation to haploid level etc. (Verzea et al., 2007).

Research in crop genetics as concern improvements in quality it stared long time ago and plant breeding continues to make use of genetics and new molecular techniques in order to boost crop performance. There were made some effort to identify and utilize molecular markers related with the industrial quality characters such as grain hardness and protein content etc. (Giroux, Morris, 1998). Bread wheat should have high protein concentration and quality. Wheat grain protein concentration can range from 8 to 20% depending upon genotype and environment (Wieser, Kieffer, 2001).

The objective of this experiment was to evaluate the behavior of 10 amphidiploids lines as concern some quality components.

MATERIALS AND METHODS

Ten amphidiploids of winter wheat lines were cultivated in the experimental field from Agricultural Research and Development Station Caracal of University of Craiova (44^0 06' N, 24^0 21' E and 98 m altitude) in 2015-2017. Sowing was made in last decade of October and the harvest was made in the first 10 days of July. A completely randomized block design was used in three repetitions and standard agronomic practices were followed. These lines represent diverse agronomic types of DH wheat and under geographical origin of these biological material, these became from National Agricultural Research and Development Fundulea.

Quality parameters were analyzed as follows: protein and starch content, grains hardness and water absorbtion were determined by an Inframatic Analyzer. The determination of hectoliter mass was made using hectoliter balance. From the statistical parameters which characterizes well the variability, it were calculated the average values, standard deviation, limits of variation and variability coefficient. The obtained results for the variation amplitude for the two years are presented in tables and figures.

RESULTS AND DISCUSSIONS

Gil et al., 2011, and Hristov et al., 2010, says wheat variety is the most important factor which influences wheat quality parameters. So that careful selection and appropriate use of the currently available genotypes may be an effective way to improve wheat quality (Zhang et al., 2004b).

One of the most important wheat quality characteristics is the protein content of the grains. From the table 1 it can notice that the variation of the protein content presented values between 10.70% and 17.20% with an average of 14.69% for the 10 experienced amphidiploid lines while the parental forms limits ranged from 12.20% to 13.00% with the average of 12.60%.

The coefficients of variability, by their values, indicate a medium variability of the amphidiploid lines or small for parental forms in terms of protein content. The distribution of the registered values by the experimented winter wheat genotypes as concern protein content is shown in figure 1.

By comparing the variability parameter values for amphidiploid genotypes with those registered by parental forms, it can see that there is an important variability of genotypic nature for the protein content at lines level. The magnitude of this variability is illustrated by the wider variation amplitude for the 10 lines comparative with parental forms.

The useful portion of this variability is located between the average protein content and the upper limit. From this portion, valuable lines for protein content have been identified. Thus, in 2015-2016, among the lines with the highest protein content are: E35-A, E25-A, E24-A with protein content of 15.6%; 14.8% and respectively 14.6%, while in 2016-2017 high protein content (17.2%, 16.9% and 16.6%) were: E32-A, E24-A and E35-A lines. It highlights the E35-A line with high content in protein content in both years of experimentation (Figure 1).

A similar variability for this character was reported by Dobre et al. (2016) by studying 524 mutant/recombinant DH wheat genotypes and their parental forms. They obtained variability for protein content between 11 and 19.5%. Pasha et al. (2010) sustain that the major determinants of wheat quality are endosperm texture and protein content. Endosperm texture has a profound effect on milling, baking and end-use quality.

Starch is the most important cereal polysaccharide (Parker, Ring, 2001). In wheat, starch is the most abundant component present in the grain endosperm (Lineback, Rasper, 1988). It is also a useful component, constituting a source of calories for the body; all cereals have a high content (56-76%) of starch. The amount of starch is influenced by climatic conditions and nitrogen in the soil, while the quality of starch is determined by genetic factors. Table 1 show that the variation of starch content recorded values between 68.20% and 79.60% with an average of 71.24 for the 10 experimental lines and for the parental forms, the limits ranged from 70.60% to 74.90% with an average of 72.93%. The variability coefficients indicate a small variability both for amphidiploid lines and the parental forms with respect to the starch content. The distribution of the values obtained by the experimented autumn wheat genotypes for starch content is shown in Figure 2. By comparing the variability parameter values for amphidiploid genotypes with those of parental forms, it can see that at the level of the lines there is a rather small variability for the starch content. The variability coefficient values are 3.53% for the amphidiploid lines and 2.43% for the parental forms.

In 2015-2016, the lines with the highest starch content include: E19-A, E32-A, E24-A, with a starch content of 79.6%; 74.1, 72.8% , while in 2016-2017 starch high strand lines (72.2%, 71.6% and 70.5%, respectively) were: E17-A, E7-A and E6-A. It highlights E17-A line with high stability in starch content in both years of experimentation (Figure 2).

Table 1. Parameters of variability for protein and starch content in the amphidiploid lines and parental forms (2015-2017)

Population		**Content of proteins** (%)		**Content of starch** (%)	
		10 synthetic amphiploids	2 parental forms	10 synthetic amphiploids	2 parental forms
Average		14,69	12,60	71,24	72,93
Standard deviation		1,63	0,37	2,52	1,77
Amplitude of variation	Minim	10,70	12,20	68,20	70,60
	Maxim	17,20	13,00	79,60	74,90
Coefficient of variability		11,10	2,90	3,53	2,43

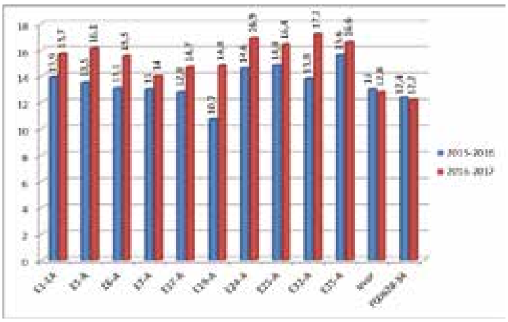

Figure 1. Variability of protein content (%)

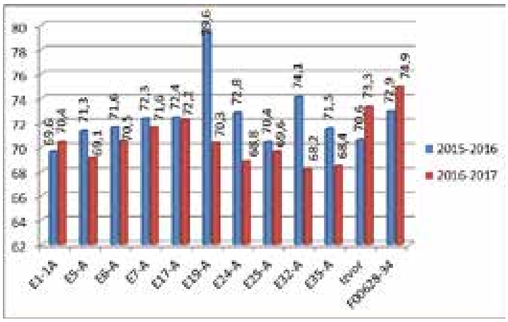

Figure 2. Variability of starch content (%)

Climate variability and extreme events can be also an important factor for yield quality. Protein content of wheat grain has been shown to respond to changes in the mean and variability of temperature and rainfall (Porter, Semenov, 2005).

High-temperature, extremes during grain filling can affect the protein content of wheat grain (Hurkman et al., 2009).

Both conventional and molecular improvement will be valid means of increasing wheat quality, which can be helped by efficient quality analysis technologies such as infrared spectrophotometric technology and molecular marker technology for gene analysis inflates quality. Quantitative location mapping (QTL) associated with grain characteristics and flour quality at wheat lines grown under contrasting environmental conditions could be a genetic potential for use of quality control (Sun et al., 2010; Zhao et al., 2010).

The hectoliter mass is another studied character. It is ranked as an element of appreciation of grain quality and a high hectoliter mass indicates a quality seed (Table 2).

Some lines have exceeded the average of experience for this character, while other lines have fallen below its value. The variability parameters ranged from 68.70 to 78.70 kg/hl. Thus, the average of the experience was 74.51 kg/hl with a standard deviation of 2.75. The coefficient of fairly small variability (3-4%) indicates a more narrow variability for this character. The data in the table 2 indicates variability in the volumetric weight from 76.90 to 80.70 kg/hl for parental forms.

These results on the variability of the hectoliter mass in the 10 amphidiploid lines, respectively the parental wheat forms, are inferior to those obtained by Dobre et al., 2016 in some mutant/recombinant wheat lines and similar to those reported by Girma Fana et al., 2012, which studied the response of quality parameters at different experimental locations of some durum wheat cultivars subjected to different rates of nitrogen and phosphorus fertilization.

The best time to harvest wheat is at full maturity, when grain humidity has reached 14-15%. Thus, the harvesters work without the loss of grains in the vegetal remains, the grains do not break, their cleaning can be easily adjusted and can be stored in good conditions, without the need for drying interventions. The optimal harvesting time of wheat is about 5-8 days (http://www.agrotechjdr.ro).

Wheat grain moisture is negatively correlated with the degree of protein storage (Johansson et al., 2008). Dry cereal moisture varies between 10-20%, with a normality threshold of about 14%; the importance of moisture is maximal in the storage phase.

The variability parameters for parental patterns ranged between 12.00 - 13.30%, with an average experience of 12.68% and a standard deviation of 0.54. The coefficient of variability is rather small (4.24%), indicating a reduced variability for this character. For experimental amphidiploid lines, the variability parameters for harvest humidity ranged between 10-12.20% and an average of 10.88% and a standard deviation of 0.67. The coefficient of variability showed small value of 6.16%. It is noted that the average amphidiploid line is lower than that of parental forms, which shows that these lines had very dry grains at the time of harvesting. Figure 4 presents the values obtained for this character and it can see that in the second year these are much lower than the first year and this is due to the much higher temperatures in June 2016 that forced the grain to mature.

Table 2. Parameters of variability for hectoliter mass and humidity at harvest for the amphidiploid lines and parental forms (2015 - 2017)

Population		Hectoliter mass (kg/hl)		Humidity (%)	
		10 synthetic amphiploids	2 parental forms	10 synthetic amphiploids	2 parental forms
Average		74,51	79,20	10,88	12,68
Standard deviation		2,75	1,62	0,67	0,54
Amplitude of variation	Minim	68,70	76,90	10,00	12,00
	Maxim	78,70	80,70	12,20	13,30
Coefficient of variability		3,69	2,04	6,16	4,24

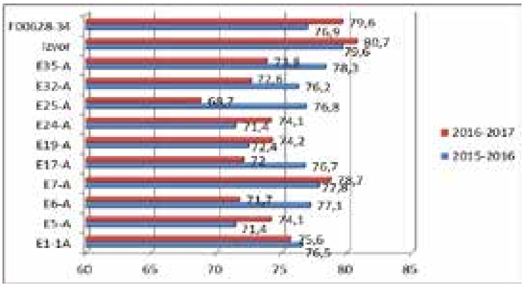

Figure 3. Variability of hectoliter mass (kg/hl)

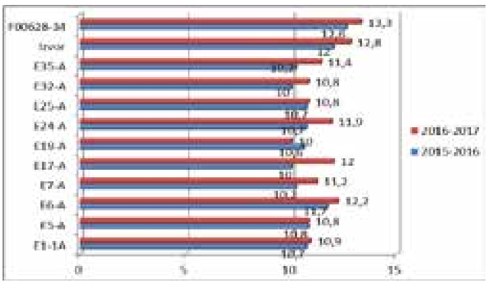

Figure 4. Variability of humidity at harvest (%)

Grain strength or hardness is a property that is indicative of how cereals resist handling, preparation and processing operations. Grain hardness is also an important criterion for assessing the energy demand for the grinder.

The variability parameters for parental patterns ranged from 80.00 to 83.00% with an average experience of 81.50% and a standard deviation of 1.29. The coefficient of variability is rather small (1.58%) which indicates a low variability for this character. For experimental amphi-diploid lines, variability parameters for grain hardness ranged between 78.00 - 82.00% and an average of 80.00% and a standard deviation of 0.97. The coefficient of variability showed a small value of 1.58%. It is found that the average amphidiploid lines is lower than that of parental forms, which shows that these lines have less harsh grains compared to parental forms (Table 3). From the Figure 5 it is observed that in the agricultural year 2015-2016, the values obtained for this character are much lower than those of the agricultural year 2016-2017.

Hardness or softness of wheat grain is inherited and controlled by a single locus referred to as hardness (Ha), which comprises three genes (Pin a, Pin b and Gsp-1) within a region of about 82.000 bp (Chantret et al., 2005). The hard wheat possess the recessive or mutated form (ha) while soft wheat have the prominent or wild type form (Ha) (Gazza et al., 2005; Bhave, Morris., 2008a). The registered values for hardness obtained in this experience are similar to those obtained by Ai-Ling Choy et al., 2015, which analized 84 varieties of wheat in different areas as concern the relationship between milling yield and grain hardness. Pasha et al., 2010, said that wheat with high content of protein tend to be hard. In this way line E35-A combine well the mentioned characteristics.

Parameters of water absorption variability in the two years of experimentation for parental forms ranged between 60.30 - 64.20%, with an average experience of 61.90% and a standard deviation of 1.85. The coefficient of variability is quite small (2.99%) which indicates a reduced variability for this character. Amphi-diploid lines variability for water absorption ranged between 59.40 - 63.30% and an average of 61.39% and a standard deviation of 1.23. Variability coefficient had a reduced value of 2.01%. It is found that the average of amphidiploid lines is lower than that of parental forms (table 3). Figure 6 shows that in the agricultural year 2015-2016, the values obtained for this character are higher than those of the agricultural year 2016-2017, with few exceptions.

Table 3. Parameters of variability for a grains hardness and water absorbtion
for the amphidiploid lines and parental forms (2015 - 2017)

		Grain hardness (%)		Water absorbtion (%)	
Population		10 synthetic amphiploids	2 parental forms	10 synthetic amphiploids	2 parental forms
Average		80,00	81,50	61,39	61,90
Standard deviation		0,97	1,29	1,23	1,85
Amplitude of variation	Minim	78,00	80,00	59,40	60,30
	Maxim	82,00	83,00	63,30	64,20
Coefficient of variability		1,58	1,58	2,01	2,99

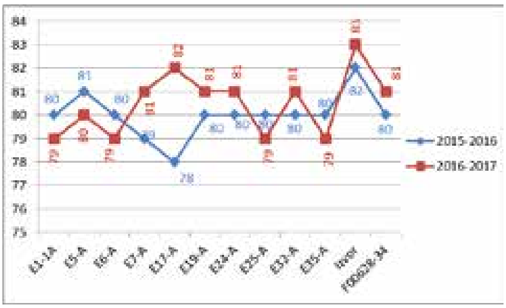

Figure 5. Variability of grains hardness (%)

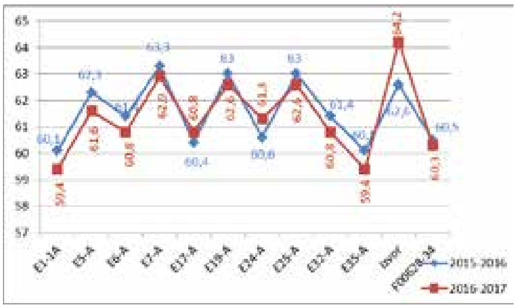

Figure 6. Variability of water absorbtion (%)

CONCLUSIONS

During this experiment some amphidiploids lines produced by NARDI Fundulea, which are actually synthetic common winter wheat, E35-A, A19-A, E1-A, E5-A, with higher values for some of the analyzed parameters and their potentially useful variation could represent valuable gene source which can be incor-porated into future wheat breeding programs and other genetic studies.

ACKNOWLEDGEMENT

This research work was carried out with the support of Ministry of Agriculture and Rural Development and also was financed from Project ADER 1.1.6/2015.

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