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COMPARATIVE STUDY CONCERNING THE VARIABILITY OF FEW QUANTITATIVE CHARACTERS OF SOME NEW WHEAT GERMPLASM

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Abstract

An assortment of ten amphidiploids and twenty-five mutant/recombinant new genotypes plus their parental forms of winter wheat were studied for generating information on genetic variability of some quantitative characteristics. Field experiments were conducted at Caracal Agricultural Research and Development Station during 2015-2018. The data wer recorded after harvest and refers to plants height, number of fertile tillers, spike length, number of spikelets/spike, number of grains/spike, grains weight/spike, thousand grains weight and yield.
Analysis of variance revealed significant differences among the category of genotypes for all the characters due mostly to the influence of the climatic conditions of the region. The correlations established between the traits indicate same type of relationships, not very different depending on the method of obtaining of the genotypes and these could help researchers in the process of selection of genotypes with desired traits. For this experiment, it can conclude that some of the experimented material can be used in further breeding programmes. In the category of amphidiploid genotypes higher amplitude of variation was identified especially for yield while for the mutant/recombinant genotypes, characters variability was smaller and correlations were stronger. Also, for this category, values registered for the analised traits were closer to parental forms.

Key words*: variability, correlations, amphidiploid wheat, mutant/recombinant germplasm.*

INTRODUCTION

Wheat is considered to be the most cultivated agricultural crop in the world. In our country, it is cultivated on approx. 25% of the arable land area and 40% of the area sown with cereals. Oltenia is one of the warmest regions of Romania, but where cereal crops still occupy vast areas. The Agricultural Research and Development Station Caracal is operating in a vast fertile area (the soil is clay-lily chernozem), but where climatic conditions are often restrictive (a strong aridization process has been installed in the last 20 to 30 years).

In the context of the expected climate change, the production of future cereals requires genotypes with good adaptability and various forms of resistance. NARDI Fundulea deals with the diversification of the genetic basis of wheat germplasm by using foreign introgreses or the use of appropriate modern techniques. Thus, a series of amphidiploids (introgression lines derived from wheat-derived hybrids x related species) and mutant/recombinant lines (obtained using a specific mutagenic protocol of two wheat genotypes, two irradiation cycles application, hybridization and DH technology using *Zea* system) (Giura A., 2013) and distributed within a research project (ADER 116) for cultivation under various conditions. Crops improved through biotechnology are producing higher yields and of quality (Iancu et al., 2018).

Induced mutations are now being widely used for developing improved crop varieties and for the discovery of genes controlling important traits and understanding the functions and mechanisms of actions of these genes (Singh et al., 2014). According to the federal government of Mutant Variety Database, thousands of new varieties have been created through mutation breeding, either by radiation like gamma rays, thermal neutrons, X-rays or by exposure to certain chemicals.

Consistent efforts are made to improve and/or sustain wheat production and the development of new varieties is based now on the advanced genetics. Amphidiploids are plants created by interspecific or intergeneric hybridization incoporating diploid chromosome complexes of two parental components. Also, the application of mutation techniques has generated a vast amount of genetic variability and is playing a significant role in plant breeding. Mustăţea and

Săulescu (2011) remarked that the grain yield increase in recently created winter wheat varieties was entirely due to an increase in the number of kernels per unit area, while the grain weight showed a negative, but relatively smaller trend.
This paper presents the way of their behavior for several elements of productivity and the types of correlations between them, under ecological conditions specific to the southern part of Romania in order to increase the genetic variability.

MATHERIALS AND METHODS

The biological material was obtained at the Laboratory of Genetics of NARDI Fundulea and was represented by 10 amphidiploid lines and 25 mutant/recombinant lines, as well as their parental forms, Izvor variety and the improved line F00628-34. Amphidiploid lines come from crosses between *T. durum* genotype and *Ae. squarrossa* biotipes (http://www.incda-fundulea.ro/cercet/ader/ader116.pdf).
Field trials were sowed every year in the autumn using randomised blocks method in three replicates at ARDS Caracal (44"7' N latitude 24"21' E longitude, 98 m altitude) on a chernozem soil (pH 7.5-7.7, humus 3.18%) with rape, sun-flower and maize as preceding crop. Standard crop technolgy was applied. At harvest, the analized characters were made for 50 plants and yield was determined by weithering the hole quantity of grains resulted from the plots. Plant height (cm) was measured at maturity stage from ground level up to the tip of spike of main tiller excluding awns. For TKW (g), 1000 seeds were counted randomly by seed counter and weighted by electric balance. The values presented in the tables represent the average of the three years calculated using analysis of variance method and correlation index.
The climate is temperate-continental with mediteranean influences, characterized through alternate frost-defrost winters and 2-6 drought month with maximum precipitation in June and minimum in August-September. The annual average temperature is about 11°C, of January -3...-20° and July from 20 to above 23°C. Rainfall amount during the winter wheat vegetation period (October to July) totalled 477.6 mm in 2015/2016, 457.0 mm in 2016/2017 and 658.4 mm in 2017/2018.

RESULTS AND DISSCUTIONS

Testing these genotypes for high and stable production was the subject of this scientific paper.
Precipitation during the wheat growing season is expected to have a positive impact on wheat yield. Environmental conditions from the experimentation years were suitable for the examined germplasm, excepting the last.
The choice of varieties resistant to thermal stress and water stress (drought or drought-induced drought) plays an important role in the fight against this wheat plant suffering.
Wheat height is a character for which there is a requirement of both dwarf and tall types. Tested amphidiploids proved to be tall and with no resistance to fall. The registered range of 98.40-126.00 cm for plants height (Table 1) was the maximum values comparative with the other categories, 89.00-108.00 cm for mutant/recombinant (Table 3), respectivelly 80.00-97.00 cm for parental forms (Table 5). 7.23% value for variability coefficient indicate a uniformity of plants as concern height. Other characters, registered medium variability (no. of spikelets/spike, spike length, no. of grains/spike and no. of fertile tillers and yield) to large (grains weight/spike). During the three years the mean plant height value for the amphidiploid germplasm was higher both than mutant/recombinat material and the parental forms.
No. of fertile tillers was of 9.53 in average of three years, a mean closer to the one realised by parental forms (9.68) and higher that mutant/recombinat (8.58).
Knežević et al., (2008) apreciate that one of the most important and promising direction in improvement of grain yield of wheat is the long and fertile spike. In this experiment amphidiploid material presented a mean value of 10.40 cm with range between 8.00 and 13.30 cm and medium variability of 13.49%.
Grains weight/spike varied in large limits because the particularity year of 2017-2018, which presented a drought spring and a very wet summer which leaded to the obtaining of smaller, wrinkled and sprouted grains in

harvesting time. Also, this material have longer vegetation period comparative with mutant/recombinat and parental forms. But, grains of amphidiploids proved to be havier and as Mandea et al. (2016) said seed weight and genetic variability their components (length, width, shape, density) and how they react to environmental conditions, can contribute to increased genetic progress in breeding for yield and yield stability.

Table 1. Values for amphidiploids (2015 – 2018)

Character	Mean ± a	Limits		s%
		Min.	Max.	
Plants height (cm)	108.58 ± 7.85	98.40	126.00	7.23
No. of fertile tillers	9.53 ± 1.73	7.10	13.80	18.16
Spike length (cm)	10.40 ± 1.40	8.00	13.30	13.49
No. of spikelets/spike	19.33 ± 2.42	16.20	28.20	12.50
No. of grains/spike	43.37 ± 6.73	32.10	56.60	15.53
Grains weight /spike (g)	2.88 ± 0.79	1.65	4.80	27.46
Thousand grain weight (g)	48.49 ± 5.61	41.52	53.60	11.58
Yield (Kg/ha)	3122.10 ± 1579,16	843.00	5980.00	50.58

The highest values for coefficient of variation was shown by grain yield (50.58%) fallowed by grains weight/spike (27.46%). Most of this variation was produced by the different conditions of the experimentation years.

Sinthetic amphidiploid germplasm indicate wide variation in field conditions. Most of the amphidiploids possess higher grains size, but well dressed and not easiliy beated. On a study with amphidiploids features, Stoyanov H.P. (2014) reported slight variations in morphological and physiological indicators, which highlights their genetic stability and high level of homozygosity. DH lines may increase the genetic variability of winter wheat and can be selected forms with valuable quantitative characters (Iancu et al., 2016)

Correlation studies provide a better understanding of the association of different characters with grain yield (Yousaf et al., 2008).

The experimented yield components indicate varying trends of association among themselves. In the case of amphidiploids, there were identified negative correlations between thousand grain mass and plants length, number of fertile tillers, spike length, number of spikelets/spike, grains number and weight/spike and yield (Table 2).

Height of plants was in positive correlation with spike lenght, number of spikelets/spike and grains weight/spike. Same type of correlations reported Knežević et al. (2008).

Table 2. Correlation indices for amphidiploid germplasm

	Stem length	No. of fertile tillers	Spike length	No. of spikelets/ spike	No. of grains/ spike	Grains weight/ spike	Yield
No. of fertile tillers	0.620						
Spike length	0.969	0.693					
No. of spikeletes/spike	0.919	0.693	0.985				
No. of grains/spike	0.964	0.695	0.985	0.917			
Grains weght/spike	0.986	0.687	0.985	0.945	0.985		
Yield	0.976	0.692	0.980	0.901	0.984	0.987	
TGW	-0.858	-0.649	-0.912	-0.822	-0.938	-0.889	-0.900

P = 0.349 %

In a similar experiment, of three year and 10 locations, some authors sustain that the most of the correlations among the yield components were negative, illustrating the difficulty of combining in the same cultivar high values of more than one component, because of compensation between yield components (Mandea et al., 2019). Same authors suggest that cultivars showing positive or small negative deviations from the regressions between negatively correlated yield components might be useful in breeding for reducing compensations between yield components. It is well known that grain yield is a complex trait and high y influenced both, by genetic factors and environmental variations. Selection, as a breeding method, to be successful depends upon the information on the genetic variability of characters and the association of the morpho-agronomic traits with grain yield.

The mutant/recombinant germplasm exhibited high production capacity and good resistance to the main climate risk factors in the southern area. The average of 7368.10 kg/ha is a fairly high value for the experiment area. The variation limits were between 5571.00 and 8627.00 kg/ha with medium variability (12.07%) (Table 3). The other characters presented lower variability which means that in time these were uniforms.This material might be suitable for drought tolerance breeding because of the better adaptation, behavior concerning the fluctuation of the timing of rain between vegetation period.

Table 3. Values for mutante/recombinant (2015-2018)

Character	Mean ± a	Limits		s%
		Min.	Max.	
Plants height (cm)	94.37 ± 4.56	89.00	108.00	4.83
No. of fertile tillers	8.58 ± 0.732	7.20	10.20	8.47
Spike length (cm)	10.76 ± 0.70	10.00	12.40	6.52
No. of spikelets/spike	20.05 ± 0.99	18.80	22.60	4.95
No. of grains/spike	61.52 ± 3.74	56.20	70.20	6.07
Grains weight /spike (g)	3.09 ± 0.20	2.85	3.54	6.43
Thousand grain weight (g)	37.75 ± 1.97	33.29	40.35	5.22
Yield (Kg/ha)	7368.10 ± 889.34	5571.00	8627.00	12.07

For the mutant/recombinant germplasm, number of fertile tillers per plant had negative correlation with plant height and spike length. Same type of correlation was identified with the other analysed characters, excepting thousand grain weight. Yield was positively correlated with stem and spike length, no. of spikelets/spike, no. of grains/spike and grains weight/spike (Table 4).

Similar results reported Gholizadeh et al. (2017), but in the salinity-stressed environment. In a study as concern response of some new wheat genotypes to nitrogen fertilization and prospects of yield breeding based on yield elements, Iancu et al., 2019 reported highest positive correlations between yield and grain weight/spike, yield and HW and HW and grain weight/spike.

Table 4. Correlation indices for mutant/recombinant germplasm

	Stem length	No. of fertile tillers	Spike length	No. of spikelets/ spike	No. of grains/ spike	Grains weight/ spike	Yield
No. of fertile tillers	-0,651						
Spike length	0,969	-0,573					
No. of spikeletes/spike	0,981	-0,623	0,975				
No. of grains/spike	0,983	-0,642	0,977	0,987			
Grains weght/spike	0,987	-0,679	0,959	0,980	0,985		
Yield	0,953	-0,619	0,931	0,958	0,968	0,967	
TGW	-0,971	0,605	-0,989	-0,977	-0,979	-0,961	-0,926

P = 0.325%

In average for the three years of experimentation, mutant/recombinant material registered superior values comparative with parental forms as concern almost all characters.

Other authors also consider that mutant/recombinant DH lines of wheat can be considered as an interesting material for breeding programs or an important tool for releasing of new genes sources (Dobre et al., 2018).

Parental forms have a good behavior to the diverse climatic conditions of the years. The results demonstrated stability parameters for the tested characters and indicate the these cultivars are stabile in reaction to environment changes.

Table 5. Values for parental forms (2015-2018)

Character	Mean ± a	Limits		s%
		Min.	Max.	
Plants height (cm)	87.63 ± 5.62	80.00	97.00	6.41
No. of fertile tillers	9.68 ± 0.71	9.10	11.00	7.37
Spike length (cm)	9.18 ± 1.16	8.00	10.80	12.63
No. of spikelets/spike	18.10 ± 1.39	16.10	20.40	7.71
No. of grains/spike	52.30 ± 2.88	48.80	56.60	5.50
Grains weight /spike (g)	2.63 ± 0.32	2.24	3.07	12.37
Thousand grain weight (g)	42.90 ± 4.06	38.70	48.55	9.48
Yield (Kg/ha)	6081,83 ± 1412,551	4150.00	7760.00	23,22

Weather conditions are just one part of a the variation. Germplasm reaction to environmental changes was different, but in favorable year conditions, performed better in this area for studied traits so generally speaking it an appreciate that this material is adapted to South Romania conditions and gave stable yields. As Dimitrijević D. et al., (2002) said, adaptability is a natural reaction of genotype in order to survive and reproduce while for agriculture, stability represents desirable reaction of cultivated genotypes.

Also, Racz et al. (2015) stated that a measure to counter the negative effects caused by climatic changes is the creation of new genotypes with better resistance or tolerance to adverse changes or which avoid stresses by the fact that the critical phases of development do not coincide with these conditions. Some triticale varieties and lines bred also by RICIC Funculea and cultivated many years in different climate pattern then were developed indicate yield variability caused by high temperature, and small amounts of precipitations (Butnaru et al., 2014). Another specie with high genetic yield potential, adapted to local condition, but variable depending on rainfall and moisture is groundnut (Soare et al., 2014).

CONCLUSIONS

Experienced biological material can be considered to have superior agronomic features, is well suited to the experimental area compared to other genotypes existing in culture as well as to the expected climate changes.

Althought environmental conditions have bigger influence upon yield components, it can be made a direct selection for grain yield related traits which increases the chance of improving wheat grain yield using this germplasm.

The mutant/recombinant germplasm with the best values indicate the possibility of selecting them as new genotypes which combine the desirable values for yield components.

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