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COMPARATIVE RESEARCH WITH SEVERAL DH MUTANT/RECOMBINANT WHEAT LINES CULTIVATED UNDER THE SOUTH ROMANIA CONDITIONS

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Abstract

This research was carried out in 2017-2019 period under the soil-climate conditions of Agricultural Research and Development Station - ARDS Caracal and included several DH mutant/recombinant winter wheat lines. The experiment was set up after randomized blocks method in three replications. The main goal of the research was to identify new competitive winter wheat lines with improved resistance for the new specific conditions of the South Romania. During the research observations, determinations and measurements concerning morphological, productivity and quality characters were made. The analysis of the average data indicated that DH mutant/recombinant winter wheat lines can easily adapt to the cultivation conditions from experimented areal. Regarding productivity, experimented material presented superiority in terms compared with the average of known varieties used as control. The obtained results also showed genetic value of some mutant/recombinant wheat lines, which in addition to productivity present high quality.

Key words: *Triticum aestivum L., DH mutant/recombinant lines, yield, quality.*

INTRODUCTION

Diversification of genetic variability obtained as a result of mutations is an important factor in genetic progress of cultivated species. In plants, mutations have played a key role in their formation and adaptation to various areas and environmental conditions.

After the discovery of the mutagenic effect of X-rays in the early twentieth century and later of other physical and chemical mutagens, the natural genome of potentially useful variability of cultivated species was completed with artificially induced variability. Its inclusion in selection programs has made it possible to obtain valuable forms in a relatively short period of time. Many of these mutant forms have been and are used directly in cultivation as new varieties and others have been shown to be important sources of genes in various breeding programs.

The integration of the novel techniques and methods into wheat breeding programs is necessary to accelerated progress in producing of new wheat genotypes (Panita et al., 2020).

To National Agricultural Research and Development Institute - NARDI Fundulea, mutagenesis research has been initiated in order to diversify genetic variability for a number of agronomic traits. Mutant cultivars obtained so far are relatively few compared to those obtained by classical breeding, but interest in mutagenesis is growing, at least in some species, given the possibilities offered by the progress of genomics research to identify new genes produced under the action of factors mutagens (Giura, 2011). Also, by applying a specific mutagenic protocol at two wheat genotypes noted for superior agronomic properties and two irradiation cycles application, hybridization and DH technology (Barbu (Dobre) et al., 2018a) it were obtained new DH lines of wheat which proved to be more adapted than the existing genotypes in cultivation and climatic changes.

Mutagenic experiments carried out at NARDI Fundulea with traditional varieties, as well as with more modern cultivars of various sources, have led to hundreds of mutant lines. The better ones were included in a nationwide network of trials, with the aim of evaluating their agronomic potential.

The current perspective of increasing global temperature needs progress in breeding for heat tolerance and this is dependent on identification of more diverse gene sources (Giura et al., 2019).

Considering the great economic interest of wheat to all regions of the country, the average yield per hectare in Romania has the lowest level in the EU, even it is on a nationwide upward trend in the last years (Medelete et al., 2018). For this reason it is necessary to obtain new genotypes with high productive potential and increased adaptability to various environmental conditions. In this purpose the best mutant/recombinant lines were further tested in a series of trials conducted under a wide range of environments. They were compared with two standard genotypes: "Izvor" and "F00628-34". The trials started in 2015 and were carried out for three years at 6 locations. Izvor is a variety cultivated in the South part of Romania being known as drought tolerant and with high yielding ability in dry years because is carrying or recessive allele (controlling osmotic adjustment) on 7A chromosome (Banica et al, 2008), while improved line F00628-34 has a higher yield potential in areas without water stress and carries 1AL/1RS translocation (Saulescu et al., 2011).

In the South areas of Romania climate is drier in last years and the new wheat genotiypes has to perform in these condition and be able to offer a good answer to fertilizers applied. The new mutant/recombinant lines of wheat which were studied the gradual increase of doses of nitrogen fertilization is reflected by the increases in all grain yield components (Iancu et al., 2019).

The aim of this paper was to evaluate some quantitative characters of some DH mutant/recombinant wheat lines cultivated in South area in order to identify new genotypes or an interesting breeding material.

MATERIALS AND METHODS

Thirteen mutant/recombinant wheat lines developed at NARDI Fundulea were evaluated along two wheat genotypes for some quantitative and qualitative characteristics in the South Romania climatic conditions. DH lines obtained via maize hybridization are the most useful for research studies and for the breeding of new wheat cultivars (Ciulca et al., 2020).

These were sown in the field on a chernozem soil, medium rich in nutrient and with a humus content which varied between 3-4% (Matei et al., 2020), in the last decade of October after randomized blocks method in three replicates. Determinations were made during vegetation period and after harvesting. The interpretation of the results was based on variance analysis and Pearson corelation. Protein, starch and fibers content were determined using a Perten Infrared Analyzer. TKW and seeds weight was measured by an electronic caliper (100 randomly grains of each wheat line).

Data were statistically analyzed and means were compared by least significant differences (LSD), P = 0.05%.

RESULTS AND DISCUSSIONS

The climatic conditions during this research could be characterized as almost normal for the South region with values of temperatures higher than multiannual (Table 1) and precipitations which totaled 448 mm in 2017-2018 and 387.5 mm in 2018-2019 (Table 2).

The results concerning the rising density varied from 480 pl./m^2 (Bi II 40) to 600 pl./m^2 (Ai II 233) comparative with 496 pl./m^2 (Izvor variety) and 528 pl./m^2 (F00628-34 line) while harvest density presented values between 640 pl./m^2 (Bi I 40) and 800 pl./m^2 (Bi II 111) comparative with 680 pl./m^2 (Izvor) and 780 pl./m^2 (F00628-34) or 540.80 pl./m^2, respectively 706,40 pl./m^2 average of the experiment (Table 3).

For the DH mutant/recombinant lines taken under study, stem length presented values from 80.5 cm (Bi II 69) to 92 cm (Bi II 127). This higher limit was also registered for one control, F00628-34 line, while the other control, Izvor variety registered a smaller values of 88 cm.

The results concerning the spike length varied from 5.5 cm (Bi II 110) to 9.5 cm (Ai II 212) which emphasized a clear superiority comparative both with other lines, control and average of the experiment.

Analyzing yield potential of the mutant/recombinant wheat lines, it can be noticed the superiority of Bi II 40 line (7154 kg/ha) compared with Bi II 110 (4742 kg/ha) or average of the experiment (5945.27 kg/ha) and even the two controls Izvor (6437 kg/ha) and F00628-34 (6358.5 kg/ha).

Table 1. The variation of the temperatures and deviations from the multiannual values

Year \ Month		Oct.	Nov.	Dec.	Jan.	Feb.	March.	Apr.	May	June	July	Average
2017-2018	Value	12.1	6.5	3.1	0.8	1.00	3.8	16.1	19.6	22.1	21.9	10.70
	Deviation	0.9	1.2	2.9	-0.1	-0.4	-2.2	4.6	2.1	0.8	-1.3	0.85
2018-2019	Value	13.8	5.1	0.2	0.5	3.20	9.1	12	17.1	22.8	23.1	10.69
	Deviation	2.6	-0.2	0	-0.4	1.8	3.1	0.5	-0.4	1.5	-0.1	0.84
Multianual		11.2	5.3	0.2	0.9	1.40	6	11.5	17.5	21.3	23.2	9.85

Table 2. The variation of precipitation and deviations from the multiannual values

Year \ Month		Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July	Sum
2017-2018	Value	56	48	14	6.8	12.4	53	54	84.8	17.6	101.4	448.00
	Deviation	15.6	-4.4	-32.7	-31.3	-25.5	12.2	2.1	21.1	14.7	46.9	18.70
2018-2019	Value	7.4	46.8	53.4	38.6	14.2	25.2	44.4	69	28.5	60	387.50
	Deviation	-33	-5.6	6.7	0.5	-23.7	-15.6	-7.5	5.3	25.6	5.5	-41.80
Multianual		40.4	52.4	46.7	38.1	37.9	40.8	51.9	63.7	2.9	54.5	429.30

Table 3. Average data for the analyzed characteristics (2017-2019)

Genotype	Rising density (pl./m^2)	Harvest density (spike/m^2)	Stem length (cm)	Spike length (cm)	Yield (kg/ha)
Ai II 212	548cde	712efg	88.5abc	9.5a	5978.5bcd
Ai II 233	600a	688gh	84.5defg	8.5b	5535.0def
Ai II 236	536ef	664hij	85.5cdef	8.5b	5687.0def
Bi I 40	504gh	640j	88.5abcd	8.5b	5894.0cde
Bi II 40	480h	640j	83.0fg	7.5c	7154.0a
Bi II 57	572bc	664hij	84.5defg	9.5a	5880.5cde
Bi II 58	544def	728def	84.0efg	7.5c	6350.5bc
Bi II 69	548cde	752bcd	80.5g	7.5c	6448.5b
Bi II 82	536ef	696fgh	92.0a	8.5b	6402.5b
Bi II 109	572cd	768abc	91.5ab	8.5b	5324.0f
Bi II 110	584ab	736cde	85.5cdef	5.5d	4742.0g
Bi II 111	556cd	800a	86.0bcdef	6.5d	5458.5ef
Bi II 127	508g	648ij	92.0a	8.5b	5528.5def
Izvor (Ct.)	496h	680ghi	88.0abcde	8.5b	6437.0b
F00628-34 (Ct.)	528fg	780ab	92.0a	8.5b	6358.5bc
Average	540.80	706.40	87.07	8.10	5945.27
Std. deviation	33.81	52.37	3.64	1.06	596.87
C%	6.25	7.41	4.19	13.03	10.04
Min	480.00	640.00	80.50	5.50	4742.00
Max	600.00	800.00	92.00	9.50	7154.00
LSD 5%	27.11	35.01	4.18	0.89	501.57

So, in the rather fertile and dry soils of the Southern area (350-500 mm rainfall), DH mutant/recombinant wheat lines have to manage lately, so that often these present relatively short straw (80-90 cm), early maturing, rapid waxless.

Thousand grain weight (TGW) as the main physical indices of the quality were lower in some lines compared to the two controls and average of the experiments but it was also lines with higher values (Table 4). Thus, TGW varied between 37.45 g (Bi II 109) and 47.55 g

(Bi II 40). Similar values of those mentioned in this experiment reported Dobre (2016) in a set of 85 mutant/recombinant DH lines of winter wheat, and Ciulca et al. (2020).

The HW of grains for the DH mutant/ recombinant lines recorded values between 70.85 kg/hl (Bi II 127) and 73.35 kg/hl (Ai II 236). In the case of controls, Izvor variety presented 71.95 kg/hl while F00628-34 line proved superiority, registering the highest value 73.50 kg/hl. Average of the experimented presented a value of 72.21 kg/hl.

Table 4. Average data for the analyzed characteristics (2017-2019)

Genotype	TGW (g)	HW (Kg/hl)	Protein (%)	Starch (%)	Fibers (%)
Ai II 212	40.85de	72.15bc	12.80e	73.6c	15.50fg
Ai II 233	43.20b	72.35b	12.95d	73.2f	15.95de
Ai II 236	43.35b	73.35a	13.05cd	74.3b	14.20i
Bi I 40	44.75ab	73.15a	12.50f	74.9a	15.30gh
Bi II 40	47.55a	71.95b	13.05cd	73.4d	15.45fgh
Bi II 57	40.15def	72.15bc	12.50f	73.4df	16.85ab
Bi II 58	43.60b	71.85bc	13.10c	72.7h	15.30gh
Bi II 69	42.65bcd	73.15a	12.45f	74.2b	17.00a
Bi II 82	39.65ef	72.05bc	13.40b	74.1b	15.70efg
Bi II 109	37.45f	71.85bc	13.65a	73.0g	16.40bcd
Bi II 110	39.75def	71.15d	13.50b	72.2i	15.85ef
Bi II 111	42.75bc	71.75c	12.95d	72.7h	15.40fgh
Bi II 127	40.10def	70.85d	13.10c	72.0j	16.10de
Izvor (Ct.)	41.00cde	71.95bc	12.40f	73.3ef	14.95h
F00628-34 (Ct.)	40.05def	73.50a	11.90h	74.9a	16.35cd
Average	41.79	72.21	12.89	73.46	15.75
Std. deviation	2.52	0.77	0.47	2.26	0.73
C%	6.03	1.07	3.64	5.28	4.63
Min	37.45	70.85	11.90	72	14.20
Max	47.55	73.50	13.65	74.9	17.00
LSD	3.02	0.52	0.11	0.19	0.49

In terms of protein content it was identified lines with higher content such as: Bi II 109 (13.65%), Bi II 110 (13.50%), Bi II 58 (13.10%). These lines overcome the control and the average of experiment and confirm the genetic potential for high quality.

As concern starch content, minimum value was 72%, registered by Bi II 127 line while the maximum value was 74.9%, registered by Bi I 40 and F00628-34 lines. Izvor variety registered 73.3% while the average of the experiment was 73.46%. Panita et al., (2020) sustain that lines with higher grain protein contents presented lower starch percent.

Fibers content varied between 14.20 (Ai II 236) and 17.00% (Bi II 69), with 14.95% Izvor variety, 16.35% F00628-34 and 15.75% average of the experiment.

For all analyzed characteristics C% presented values under 10% which means small variability, an exception making spike length which recorded 13%.

Evaluation of DH mutant/recombinant forms is necessary in order to speed the advancement of those who is carrying superior traits (Dobre et al., 2018b). Selection of new genotypes with desirable traits from the genetic diversity is crucial for the adaptability and survival of wheat under climate fluctuations, which are expected to become a major constraint for plants potential in the future. Lines such as Bi II 40, Bi II 58 and Bi II 82 combine well yield capacity with protein and even starch content.

It was also establish the correlations between the analyzed characteristics, knowing these can streamline the selection process to improve plant performance (Table 5). According to Taulemesse et al. (2016), the quality and productivity are negatively correlated, but this association is often caused by the influence of environmental conditions. This experiment indicates this negative correlation with protein (-0.535), but not in starch content (0.659). Also, starch content presented a positive correlation with HW (0.926). Yield is positive correlated with rising density (0.659) and harvest density (0.643).

Table 5. Correlations between the analyzed characteristics (2017-2019)

Characters	Rising density (pl./m^2)	Harvest density (pl./m^2)	Stem length (cm)	Spike length (cm)	Yield (kg/ha)	Harvest humidity (%)	TGW (g)	HW (kg/hl)	Protein (%)	Starch (%)
Harvest density (pl./m^2)	0.465**									
Stem length (cm)	-0.181^{ns}	0.062^{ns}								
Spike length (cm)	-0.142^{ns}	-0.405**	0.360*							
Yield (kg/ha)	0.659**	0.643**	-0.181^{ns}	0.476**						
Harvest humidity (%)	0.362*	-0.373*	-0.165^{ns}	-0.162^{ns}	-0.572**					
TGW (g)	-0.431**	-0.407**	-0.613**	-0.183^{ns}	-0.492**	-0.056^{ns}				
HW (kg/hl)	-0.489**	0.486**	-0.141^{ns}	0.322*	0.346*	-0.019^{ns}	0.573**			
Protein (%)	0.308*	0.003^{ns}	0.086^{ns}	-0.343*	-0.535**	0.143^{ns}	-0.581**	-0.619**		
Starch (%)	-0.270^{ns}	-0.077^{ns}	0.069^{ns}	0.417**	0.659**	-0.090*	0.212^{ns}	0.926**	-0.587**	
Fibers (%)	0.377*	0.312*	-0.020^{ns}	0.071^{ns}	-0.053^{ns}	0.049^{ns}	-0.418**	-0.059^{ns}	-0.163^{ns}	-0.058^{ns}

P 5% = 0.310; P 1% = 0.400

In ARDS Caracal conditions it can ensure high production capacity and quality of grain in other species like sorghum, which is proving to be a species with real capacities of extension due to its adaptability in this area (Matei et al., 2020).

Meteorological data sustain that the average air temperature has risen by 2-3^{0}C, in the case of summer, in regions in the south of the country. The mutant/recombinant lines should be earliness and also the control genotypes so that the ideal type for Southern conditions to be rather early than late in order to better cope with the environmental characteristics and provide the necessary duration of time for optimal yield.

The assessment of quantitative and qualitative components of mutants/recombinant lines that overcome the control varieties is obvious even in the different environment conditions from the experiment period.

Under the South conditions, some tested DH mutant/recombinant lines (Bi II 40, Bi II 58, Bi II 69, Bi II 82) proved to be able to adapt and the obtained data for the agronomic characteristics analyzed, as assessed in several years of field evaluation indicate a common, remarkable feature which is the much improved resistance to higher temperature, a slight-to-highly improved yielding ability in altered heating time. DH mutant/recombinant lines taken into study proved a stable and high genetic potential, significantly superior comparative with controls and could be considered as an interesting material for future breeding programs. Exploitation and utilization of superior genes and multiple variations can be helpful approaches for improving wheat production (Daniel et al., 2018).

CONCLUSIONS

The experimental results obtained for the mutant/recombinant wheat during the experimental period 2017-2019 showed that best yield were established to Bi II 40 (7154 kg/ha), Bi II 69 (6448.5 kg/ha) and Bi II 82 (6402.5 kg/ha) lines. First two overcome the average of the controls, 6437.0 kg/ha Izvor variety and 6358.5 kg/ha F00628-34 line.

Best protein content in the DH mutant/recombinant lines was established to Bi II 109, Bi II 110 and Ai II 236 with values higher than 13%.

Under the South of Romania conditions, some of tested DH mutant/recombinant lines proved to be able to adapt to these, registering superior values of TGW, HW, protein content and improved yield capacity. These lines can be used as valuable genetic material in wheat breeding.

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