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DEPENDENCE OF CROP PRODUCTIVITY PARAMETERS AND TECHNOLOGICAL QUALITY INDICATORS ON PARENTAL FORMS

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Abstract. The research was conducted in the 2019-2020 growing season under irrigation conditions. Predecessors was chick pea, sowing was carried out by hand in the third decade of October, each sample was sown in 2 replications on an 1m2 area, mass emergence was observed in the first decade of November. For pre-sowing fertilazition 150 kg of complex fertilizer (nitrophoska), and in the early spring, 250 kg/ha of nitrogen fertilizer at tillering stage (NH4NO3) were applied. In hybridization, the landraces (Sharg, Shiran 5, etc.), newly realized (Goytapa, Zangazur, etc.) local and forigen origin durum wheat varieties were used. In the studies, the yield and technological quality indicators of the fourth generation (F4) hybrid lines and parental forms of 40 varieties of durum wheat were determined on the basis of standard methods, grain vitrouseness (in %), gluten content (in %), Gluten Deformation Index (GDI, device readings) has been studied. In the research year, the varieties wıth complex positive traıts - [Parinj x Turan] x Mirvari, k- ST/2016/13; [Fadda 98 x Garabagh] x Tartar, k- ST/2016/16; [Fadda 98 x Garabagh] x Tartar, k- ST/ 2016/21; Zatino (France) x Turan, k-ST/2016/50; Mirvari x Turan, k-ST/2016/78; Mirvari x Turan, k- ST/2016/86; Garabagh x Mirbashir-50, k- ST/2016/160; v.hordeiforme x (Tartar x Mirvari), k- ST/2016/ 18a hybrid lines were selected and were included in to testing at Jalilabad and Tartar Regional Experimental Stations (RES).

Keywords: *breeding, durum wheat, hybrid lines, productivity, quality indicators.*

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1. Introduction

Grain production is considered to be one of the most important sectors in the economy of our republic. The population's food demand and the development of livestock are closely linked to grain growing. In this regard, special attention is paid to increasing the productivity and quality of grain crops in our country. As a result of new intensive technologies applied in agriculture in recent years, compared to previous years, the productivity of grain crops in the country, including winter wheat, has increased significantly. Thus, in 2000, the yield of winter wheat was 23.7 s/ha; 30.2 s/ha in 2018; in 2019, it increased by positive dynamics with 32.5 s/ha (www.stat.gov.az>agriculture).

Increasing agricultural production does not completely excludes the possibility of extensive development in individual states and different regions of the country. In fact, in the current state of unused lands in the country, it is possible to achieve a faster increase in agricultural production in both intensive and extensive development conditions. The main purpose of intensifying agriculture is to comprehensively meet the growing needs of the population by increasing production and improving its quality (Tamrazov, 2018).

Wheat (*Triticum* L.) is one of the two crops (the other is rice) that is part of the daily food of 35% of the world's population and accounts for more than 40% of global food production.

Demand for wheat is expected to increase by 70 percent in the coming decades (2020-2050) due to a sharp increase in food consumption of global population and income growth (Rosegrant, 2011).

According to the Food and Agriculture Organization of the United Nations (FAO), if in 1950-1985 the annual increase in food production was 30 million tons, in 1985-1995 - 12 million tons, and by 2030 this figure will be 9 million tons approximately. Among the threats to such slowdown are growing regional and international ethnic conflicts, rising global warming, and depletion of land resources (Food Security Program of the Republic of Azerbaijan, 2008-2015).

Wheat also has a strategic importance in ensuring food security in our country. Increasing wheat productivity in the coming decades is one of the most important issues of current agricultural policy to meet the consumption needs of future generations.

It is no accident that in recent years, important decisions have been made at the state level and measures system has been implemented to increase the productivity of agricultural crops in our country.

Strengthening the sustainability of food security, improving the quality of scientific support and education in agriculture and so on in the strategic goals reflected in the "Strategic Roadmap on production and processing of agricultural products in the Republic of Azerbaijan" approved by the Decree of the President of the Republic of Azerbaijan No. 1138 dated December 6, 2016. (Strategic Roadmap for the production and processing of agricultural products in the Republic of Azerbaijan: 2016).

The creation of improved wheat varieties is the main task of wheat breeders, who play an important role in increasing of productivity (Reynolds et al., 2012).

In this regard, it is important to use the proper initial material.

Understanding of the initial material for the breeding was first introduced by academician N.I. Vavilov. In his works, he called the initial material the foundation stone of breeding and noted its special importance in the creation of new productive varieties (Vavilov, 1967; Vavilov, 1985).

The production of high-quality wheat in the world, as well as in Azerbaijan, is one of the most important issues in ensuring food security. Under present-day conditions, food security is the basis of the economic and political position of any country. In solving this problem, the role of new high quality wheat varieties is great. Although the productivity of farms is high, the quality of grain often does not meet the needs of industry. At a time of global climate change, the creation and application of environmentally friendly plastic varieties with high productivity potential, technological and quality indicators and stable yields in all extreme conditions is one of the most pressing issues, and for this purpose the study of initial material is important.

In Azerbaijan, as a result of wheat breeding, especially selection of local populations and valuable genotypes with significant economic characteristics, a number of durum and bread wheat varieties radically different from the initial forms were created, also by using synthetic breeding methods, quite high results were achieved in the republic (Aliyev *et al.*, 2015).

Hybridization is one of the main methods currently used to create new varieties. For hybridization, it is important to choose the right parental forms. In this case, along with the technological and quality indicators of the grain of the parental form, other

economically important treats must be taken into account. Based on the analysis of the literature and our research, it is confirmed that the correct selection of initial materials and their purposeful involvement in hybridization is the basis for the creation of new high-yielding and high-quality varieties in the future.

The objectives of the study were to determine the hybrid lines with proper yield and technological quality indicators in order to create new varieties with high grain quality and productivity parameters.

2. Material and methods

In hybridization, landraces (Sharg, Shiran 5, etc.), newly realized (Goytapa, Zangazur, etc.) local, and geographically distant origin Zatino (French), Karol Odesskaya (Ukraine) and 6 durum wheat varieties were used.

At a time of global climate change, despite their high adaptability, these genotypes are tall. During hybridization, these samples were pollinated with short height varieties (Garagilchig-2, Garabagh, etc.) and backcrossed on the obtained first generation hybrids. The research was conducted in the 2019-2020 growing season under irrigation conditions in the Absheron Supporting Experimental Station (ASES) of the Research Institute of Crop Husbandry. In the studies, the yield and technological quality indicators of the fourth generation (F_4) hybrid lines and parental forms of 40 varieties of durum wheat were determined on the basis of standard methods, grain virtuousness (%), gluten content (%), Gluten Deformation Index (GDI device readings) has been studied (Methods of assessing the technological quality of grain, 1971; Handbook on grain quality, 1977).

Predecessor was chick pea, sowing was carried out by hand in the third decade of October, each sample was sown in 2 replications on an area of $1m^2$, mass emergence was observed in the first decade of November. For presowing fertilization of the experimental field, 150 kg of complex fertilizer (nitrophoska), and in the early spring, 250 kg/ha of nitrogen fertilizer at tillering stage (NH_4NO_3) were applied. During the vegetation period, the samples were irrigated in the booting and milk ripening stages and agro-technical measures, intended for the region, were carried out.

Absheron SES of the Research Institute of Crop Husbandry is located in the central part of the Absheron Peninsula, and the gray-brown soils in the area are less fertile and poorly supplied with basic nutrients and atmospheric precipitations (Movsumov, 2006).

The Absheron Peninsula is included in the list of dry subtropical zones with hot summers, sunny autumns and mild winters. North (Khazri) and southern (Gilavar) winds often blow on the peninsula. Climatic conditions are unstable, as wind speed sometimes reaches 35-40 m / sec. and more. Therefore, the climate of Absheron is very hot, hot and sunny in summer, and mild in winter. Rarely, the air temperature drops to 1.3-5.7 ° C. Average annual precipitation amount consists 220 mm, maximum 250 mm and minimum 200 mm. Relative humidity varies throughout the year, mainly in the range of 60-80% (Vekilova, 2011).

3. Results

The winter and spring temperatures of the research year and the precipitation amount generally corresponds to the average perennial precipitation in the region.

The productivity of the fourth generation (F_4) hybrid lines and parental forms was studied, the hybrid lines were compared with the parental forms, grouped, and the results are presented in the relevant table (Table 1).

During the research years, depending on the genotypes, the productivity of the parental forms used in hybridization varied in the range of 310-650 g.

The productivity of landraces was as fallows: Sharg- 650 g; [Fadda 98 x Garabagh]- 586 g; Tartar-522 g; [Giorgio-12-571 x Parinj]- 310 g; Zatino (France)- 410 g etc., and productivity of hybrid lines changed in the range of 998-300 g.

From hybrid lines- [Fadda 98 x Garabagh] x Tartar, k- ST/2016/17- 998 g; [Fadda 98 x Garabagh] x Tartar, k- ST/2016/20- 956 g; [Fadda 98 x Garabagh] x Tartar, k- ST/2016/21- 938 g; [Fadda 98 x Garabagh] x Tartar, k- ST/2016/23 774 g etc. were high productive from both parental forms, [Garabagh x Tartar-2] x Mirvari, k- ST/2016/65- 300 g; [Garabagh x Tartar-2] x Mirvari, k- ST/2016/66- 320 g; [Turan x Zedoni-3D-56] x Garagilchig 2, k- ST/2016/151- 315 g; [Turan x Zedoni-3D-56] x Garagilchig 2, k- ST/2016/144- 327 g etc.were low productive from both parental forms.

Technological quality indicators of hybrid lines, selected for their biomorphological treats, and resistance to diseases and pests was studied, grouped and given in the Table 1.1000 kernel weight in the parental forms varied in the range of 33.6-56.2 g, and in the hybrid lines it varied in the range of 43.0-57.8 g.

From landraces, Turan- 56,2 g; [Garabagh x Tartar-2]- 55,8 g; Barakatli-95- 55,2 g; Mirvari- 43,4 g etc. have high 1000 kernel weight. In Zatino variety France origin 1000 kernel weight was less (33,6 g), and quality indicators were high. From hybrid lines, [Parinj x Turan] x Mirvari, k- ST/2016/13-57,8 g; [Garabagh x Tartar-2] x Mirvari, k- ST/2016/65- 57,6 g; Garabagh x Mirbashir-50, k- ST/2016/160- 54,0 g, [Fadda 98 x Garabagh] x Tartar, k- ST/2016/17- 43,0 g etc. have high 1000 kernel weight.

Table 1. Productivity and technological-quality indicators of fourth (F4) generation durum wheat hybrids and parental forms

#	Hibryd lines and parental forms	Yield per 1m^2, gr	1000 kernel weight, gr	Vitrouseness, %	Gluten content, %	GDI, d.r.
1.	[Parinj x Turan], ♀	584	47,8	100	30,0	102,7
2.	Mirvari, ♂	365	43,4	74,0	26,4	103,5
3.	[Parinj x Turan] x Mirvari, k-ST/2016/13	**496**	**57,8**	**100**	**30,4**	**96,9**
4.	[Fadda 98 x Garabağh] (Azerbaijan), ♀	586	50,4	80,3	28,0	103,6
5.	Tartar (Azerbaijan), ♂	522	53,8	76,0	20,4	92,8
6.	[Fadda 98 x Garabagh] x Tartar, k-ST/2016/16	**697**	**45,2**	**82,0**	**27,8**	**102,8**
7.	[Fadda 98 x Garabagh] x Tartar, k-ST/2016/17	998	43,0	59,0	22,0	96,0
8.	[Fadda 98 x Garabagh] x Tartar, k-ST/2016/19	852	43,4	53,5	22,8	99,9
9.	[Fadda 98 x Garabagh] x Tartar, k-ST/2016/20	956	44,2	32,5	20,4	98,2
10.	[Fadda 98 x Garabagh] x Tartar, k-ST/2016/21	**938**	**41,8**	**60,5**	**25,8**	**93,3**
11.	[Fadda 98 x Garabagh] x Tartar, k-ST/2016/23	774	47,8	67,5	21,6	95,5
12.	Fadda 98 x Garabagh] x Tartar, k-ST/2016/28	489	48,6	72,5	17,2	94,1
13.	Zatino (France), ♀	420	33,6	100	32,8	96,1
14.	Turan (Azerbaijan), ♂	510	56,2	94,0	36,8	109,0
15.	Zatino (France) x Turan, k-ST/2016/45	460	44,8	78,5	25,6	107,3
16.	Zatino (Fransa) x Turan, k-ST/2016/48	580	45,8	91,0	23,2	101,4
17.	Zatino (Fransa) x Turan, k-ST/2016/50	**594**	**48,2**	**100**	**31,6**	**103,4**
18.	[Garabagh x Tartar-2] (Azerbaijan), ♀	450	55,8	70,6	27,4	103,2
19.	[Garabagh x Tartar-2] x Mirvari, k-ST/2016/65	300	57,6	80,5	26,0	98,0
20.	[Garabagh x Tartar-2] x Mirvari, k-ST/2016/66	320	45,4	75,0	27,6	97,7

21.	Mirvari x Turan, k-ST/2016/78	**640**	**48,0**	**86,0**	**27,5**	**94,9**
22.	Mirvari x Turan, k-ST/2016/86	**524**	**51,8**	**87,5**	**27,8**	**98,7**
23.	[Tartar x Kahraba] (Azerbaijan), ♀	430	50,3	72,8	23,6	103,4
24.	Barakatli-95(Azerbaijan), ♂	460	55,2	78,5	25,2	101,8
25.	[Tartar x Kahraba] x Barakatli-95, k-ST/2016/107	558	51,2	75,0	22,4	94,5
26.	Mirbashir-50 (Azerbaijcan), ♀	445	45,8	92,0	28,0	103,3
27.	Sharq(Azerbaijan), ♂	650	53,8	73,5	27,6	106,6
28.	Mirbashir-50 x Sharq, k- ST/2016/123	584	45,2	80,5	25,6	89,9
29.	Mirbashir-50 x Sharq, k- ST/2016/133	410	46,4	84,0	28,0	99,6
30.	[Turan x Zedoni-3D-56] (Azerbaijan), ♀	365	50,6	95,0	29,4	103,2
31.	Garagılchig 2(Azerbaijan), ♂	370	51,8	100	28,8	107,1
32.	[Turan x Zedoni-3D-56] x Garagılchig 2, k- ST/2016/137	404	56,2	82,0	27,6	105,1
33.	[Turan x Zedoni-3D-56] x Garagılchig 2, k- ST/2016/144	327	53,8	100	30,0	108,4
34.	[Turan x Zedoni-3D-56] x Garagılchig 2, k- ST/2016/147	410	50,4	98,0	26,8	102,7
35.	[Turan x Zedoni-3D-56] x Garagılchig 2, k- ST/2016/151	315	53,2	100	32,0	110,2
36.	[Giorgio-12-571 x Parinj](Azerbaijan), ♀	310	48,7	95,0	29,6	100,4
37.	Garabagh(Azerbaijan), ♂	430	51,8	84,0	25,6	123,1
38.	[Giorgio-12-571 x Parinj] x Garabagh, k- ST/2016/157	355	52,4	100	32,4	110,9
39.	Garabagh x Mirbashir-50, k- ST/2016/160	**648**	**54,0**	**100**	**28,8**	**101,4**
40.	Garagılchig 2 x Barakatli-95, k- ST/2016/169	369	47,8	77,5	26,8	98,1
41.	v.hordeiforme (Azerbaijan), ♀	540	53,4	100	32,2	103,0
43.	(Tartar x Mirvari) (Azerbaijan), ♂	475	48,7	88,4	27,6	100,4
44.	v.hordeiforme x (Tartar x Mirvari), k-ST/2016/18a	**650**	**43,8**	**87,0**	**28,8**	**102,0**
45.	v.hordeiforme x (Tartar x Mirvari), k-ST/2016/19a	525	52,2	86,5	31,2	103,9

Note: d.r. – divice readings

The virtuousness of the grain varies depending on the precipitation amount and the frequency of irrigation. In the studied parental forms, changes in grain virtuousness were found in the range of 72.8-100%, and in hybrid lines in the range of 32.5-100%.

From parental forms- in [Parinj x Turan], Garagilchig 2, Zatino (France) etc. varieties 100%, Mirvari-74,0, Tartar- 76,0 etc., and from hybrid lines [Parinj x Turan] x Mirvari, k- ST/2016/13, Zatino (France) x Turan, k- ST/2016/50, [Turan x Zedoni-3D-56] x Garagilchig 2, k- ST/2016/144 etc. were high and showed 100%, [Fadda 98 x Karabagh] x Tartar, k- ST/2016/20- 32,5%, [Fadda 98 x Garabagh] x Tartar, k-ST/2016/19- 53,5%, [Fadda 98 x Garabagh] x Tartar, k- ST/2016/21-60,5% etc. showed lower indicators.

Gluten is a matrix formed by the combination of hydrated protein particles. Gluten quantity and quality directly determines the quality of baked bread.

Gluten quantity varied in the range of 20,4-36,8% in parental forms, in landraces Turan (36,8%); v.hordeiforme (32,2%); [Parinj x Turan] (30,0%) etc. was high, Tartar (20,4%), [Tartar x Kahraba] (23,6%) etc. was low, in hybrid lines [Giorgio-12-571 x Parinj] x Garabagh, k- ST/2016/157 (32,4%), Zatino (France) x Turan, k-ST/2016/50 (31,6%), [Parinj x Turan] x Mirvari, k- ST/2016/13 (30,4%) etc. was high, Fadda 98 x Garabagh] x Tartar, k- ST/2016/28 (17,2%), [Tartar x Kahraba] x Barakatli-95, k- ST/2016/107 (22,4%) hybrids etc. was low.

Gluten quality is characterized by its elasticity and, along with other indicators, is determined by gluten deformation index (GDI).

From studied parental forms, Tartar (92,8 c.g.), Zatino (France) (96,1 c.g.),(Tartar x Mirvari) (100,4 c.g.) etc., from hybrid lines - [Parinj x Turan] x Mirvari, k- ST/2016/13 (96,9 c.g.), [Fadda 98 x Garabagh] x Tartar, k- ST/2016/17 (96,0 c.g.), [Fadda 98 x Garabagh] x Tartar, k- ST/2016/21 (93,3 c.g.) etc. were characterized by satisfactory low indicator.

Productivity of most of the studied hybrid lines was high (998-594 g/1m^2) and technological quality indicators were low, although some quality indicators were average. Although the productivity in some of the hybrid lines was average, their complex technological-quality indicators were relatively high, and in the future these lines will be used in order to create new varieties with high technological-quality indicators.

Correlation with variable significance between productivity and technological quality indicators in the studied durum wheat hybrids was determined using the SPSS computer software (Sneath, 1973) (Table 2).

Table 2. Correlation between productivity and technological quality indicators of hybrids

	Yield per 1m^2 ,gr	1000 kernel weight, gr	Vitrouseness, %	Gluten content, %	GDI, d.r.
Yield per 1m^2 ,gr	1				
1000 kernel weight, gr	-0,130	1			
Vitrouseness, %	-0,612**	0,029	1		
Gluten content, %	-0,414**	0,051	0,734**	1	
GDI, d.r.	-0,313*	-0,027	0,383	0,451*	1

Note: P = 0.05-reliability, * = less significant correlation, P = 0.01-reliability, ** = moderate correlation.

Insignificant negative (r = -0,130) correlation between productivity and 1000 kernel weight, moderate significant negative correlation between virtuousness and gluten content, (r = -0,414-0,612); less significant negative correlation with GDI (r = -0.313), insignificant correlation between 1000 kernel weight, virtuousness and gluten content (r = 0.029-0.051); negative insignificant (r = -0.027) correlation with GDI, moderate significant correlation between virtuousness and gluten content (r = 0.734), insignificant correlation with GDI (r = 0.383), and less significant (r = 0.451) correlation between gluten content and GDI was determined in hybrid lines.

3. Discussion

Increasing wheat yields will require improving farm production systems and introducing new technology, developing improved wheat varieties, identifying optimal crop rotation and diversification strategies, improving plant protection, and continued support from stakeholders throughout the value including technology providers, processors, manufacturers, and governments (Gan *et al.,* 2003; Hawkesford *et al.,* 2013; Vitale *et al.,* 2019).

It is reported that the world needs to pay attention to the hidden hunger caused by nutritional imbalance. Hidden hunger is a lack of micronutrients, which body needs, as vitamins and dietary components that have a profound effect. Protein energy is very

important in nutrition, and the most effective solution is dietary diversification and increases the amount of protein in the diet (Mammadova *et al.,* 2007).

Exposure of winter wheat to extreme weather conditions during long periods of development makes it more sensitive to climate change (Tack *et al.,* 2015).

As a result of unfavorable weather conditions (low temperature - $\geq 15^0$C, precipitation) during the grain filling stage, productivity and grain quality, especially the amount of protein and gluten, are low.

In some studies it was reported, that when 10-15 mm of precipitation falls during the grain filling stage, the glume on the spike cracks, turns white, and pre-harvest sprouting occurs (Mares & Mrva, 2014; Hasanova *et al.,* 2016).

In literature (Krupnov & Krupnova, 2015) it was stated that, spike diseases (septorium and fusarium) reduce the test weight and 1000 kernel weight, the protein and gluten content. Foliar fungal diseases (leaf spots, various types of rust and powdery mildew) cause a decrease of protein and gluten content, the test weight and 1000 kernel weight, as well as the flour yield.

In some studies it was reported, that in RICH, the breeding material consisted of promising lines and varieties of winter bread and durum wheat were studied and evaluated in irrigated and dry rainfed conditions by using them in hybridization, the varieties as Taraggi, Bayaz, Murov, Murov-4, Farahim, Khudafarin, Ravan, Gomur -74 and others were created. (Abdullayev & Shikhoev, 2000; Khudayev *et al.,* 2018).

In the present study, it was observed hybrid lines with high (998-594 g/1m^2) productivity and average technological quality indicators. Although the productivity in some of the hybrid lines was average, their complex technological-quality indicators were relatively high, and in the future these lines will be used in order to create new varieties with high technological-quality indicators.

The hybrid lines wıth complex positive traıts - [Parinj x Turan] x Mirvari, k-ST/2016/13; [Fadda 98 x Garabagh] x Tartar, k- ST / 2016/16; [Fadda 98 x Garabagh] x Tartar, k- ST/2016/21; Zatino (France) x Turan, k-ST / 2016/50; Mirvari x Turan, k-ST/2016/78; Mirvari x Turan, k- ST/2016/86; Garabagh x Mirbashir-50, k- ST / 2016/160; v.hordeiforme x (Tartar x Mirvari), k- ST/2016/18a were selected.

Correlation with variable significance between productivity and technological quality indicators in the studied durum wheat hybrids was determined.

5. Conclusions

As a result it was concluded that the hybrid lines with high (998-594 g/1m^2) productivity have average technological quality indicators, and the hybrid lines was average productivity have relatively high complex technological-quality indicators. The hybrid lines wıth complex positive traıts - [Parinj x Turan] x Mirvari, k-ST/2016/13; [Fadda 98 x Garabagh] x Tartar, k-ST/2016/16; [Fadda 98 x Garabagh] x Tartar, k-ST/2016/21; Zatino (France) x Turan, k-ST/2016/50; Mirvari x Turan, k-ST/2016/78; Mirvari x Turan, k-ST/2016/86; Garabagh x Mirbashir-50, k-ST/ 2016/160; v.hordeiforme x (Tartar x Mirvari), k-ST/2016/18a were selected in the research year, and in order to create new varieties with high technological qualities and productivity parameters were included into testing at Jalilabad and Tartar Regional Experimental Stations (RES).

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