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TESTING WINTER WHEAT LINES CREATED AT THE AGRICULTURAL RESEARCH STATION OF PODU-ILOAIEI, IAŞI COUNTY

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ABSTRACT – During 2005-2007, at the Agricultural Research and Development Station of Podu-Iloaiei, Iaşi County, a site with different climatic conditions, the following wheat lines were tested: PI-2344-98, PI-2801-98, PI-2487-99, PI-2322-00, PI-2726-99, PI-2557-01, PI-2416-95, PI-2657-99 and PI-2561-99, compared to the Fundulea 4 control. On this biological material, we have determined some physiological features and quantitative traits, production capacity, correlations between productivity and production elements. Under various climatic conditions, the lowest obtained yield was of 13 q/ha in PI-2657-99 and PI-2561-99 lines, in 2007, and the highest yield was of 72 q/ha in PI-2344-98 line, followed by PI-2801-98 line, with a yield of 71 q/ha, obtained in 2006. In most of the wheat lines, the mean yield on the three experiencing years was higher than the control, the distinctively significant yield increases reaching 9 q/ha (24%) in PI-2344-98 and PI-2726-99 lines. As concerns the number of spikes/m^2, PI-2344-98 and PI-2726-99 lines had very significant yield increases, followed by PI-2487-99, PI-2322-00 and PI-2561-99 lines, with significant yield increases. As compared to the interaction genotype x environment, we have obtained statistically significant assured differences in PI-2726-99 line. The number of grains/ spike had higher statistically assured values against Fundulea 4 control in PI-2487-99 line. On average of three years, the 1000-grain weight had higher values against the control, the PI-2416-95 line being found on the first place (43.0 g). Compared to the V×A interaction, we did not get significant differences for the number of grains/spike and the 1000-grain weight, the tested genotypes reacting similarly to the change of climatic conditions at the experiencing period. The dependence between the studied traits and the production capacity was shown in most of cases by statistically assured positive correlations. The obtained results have demonstrated the success of PI-2344-98 and PI-2726-99 lines in the process of variety creation, corresponding to the objectives followed by wheat breeding at the Agricultural Research and Development Station of Podu-Iloaiei.

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Key words: wheat genotypes, physiological characteristics, quantitative traits, phenotypical correlations, genetic structure, germplasm source

REZUMAT – Testarea unor linii de grâu comun de toamnă create la S.C.D.A.Podu-Iloaiei, jud. Iaşi. In perioada 2005-2007, cu condiţii climatice foarte diferite, la S.C.D.A.Podu-Iloaiei, jud. Iaşi, s-au experimentat liniile de grâu comun de toamnă; PI-2344-98, PI-2801-98, PI-2487-99, PI-2322-00, PI-2726-99, PI-2557-01, PI-2416-95, PI-2657-99, PI-2561-99, comparativ cu soiul martor Fundulea 4. La acest material biologic s-au determinat unele însuşiri fiziologice şi caractere cantitative, capacitatea de producţie şi corelaţiile dintre elementele de productivitate şi producţie. În condiţiile unei diversităţi a condiţiilor climatice, producţia minimă obţinută a fost de 13 q/ha la liniile PI-2657-99 şi PI-2561-99 în anul 2007, iar cea maximă de 72 q/ha la linia PI-2344-98, urmată de linia PI-2801-98, cu o producţie de 71 q/ha în anul 2006. Producţia medie pe trei ani de experimentare la majoritatea liniilor de griu a fost superioară soiului martor, sporurile distinct semnificative ajungând până la 9 q/ha (24%) la liniile PI-2344-98 şi PI-2726-99. Pentru numărul de spice/m^2, liniile PI-2344-98 şi PI-2726-99 au prezentat sporuri asigurate statistic la nivel foarte semnificativ, urmate de liniile PI-2487-99, PI-2322-00, PI-2561-99, cu sporuri semnificative. Faţă de interacţiunea genotip×mediu s-au obţinut diferenţe asigurate statistic la linia PI-2726-99. Numărul de boabe/spic a avut valori superioare asigurate statistic faţă de soiul martor Fundulea 4 la linia PI-2487-99. Masa a 1000 de boabe, in medie pe trei ani, a avut valori superioare soiului martor, linia PI-2416-95 situîndu-se pe primul loc (43,0 g). Faţă de interacţiunea V×A nu s-au obţinut diferenţe semnificative pentru caracterele numărul de boabe/spic şi masa a 1000 de boabe, genotipurile testate reacţionând asemănător la modificarea condiţiilor climatice în perioada de experimentare. Dependenţa dintre caracterele studiate şi capacitatea de producţie s-a manifestat prin corelaţii pozitive asigurate statistic în majoritatea cazurilor. Rezultatele obţinute pledează pentru utilizarea liniilor PI-2344-98 şi PI-2726-99 ca forme parentale în procesul de creare a soiurilor, fiind corespunzătoare obiectivelor urmărite in lucrările de ameliorarea grâului la S.C.D.A. Podu-Iloaiei.

Cuvinte cheie: genotipuri de grâu, însuşiri fiziologice, caractere cantitative, corelaţii fenotipice, structura genetică, sursa de germoplasmă

INTRODUCTION

In order to achieve many specific objectives, wheat breeding requires a remarkable genetic diversity, the base for the future progress (Ioan and Ciolpan, 1997; Săulescu, 1975). Choosing the parental forms for a breeding programme is complex, requiring a general view on the potential utility of different genotypes, based on knowing their general characteristics and understanding the complex relations within and between different groups of wheat varieties (Ceapoiu, 1984). As concerns the productivity, the genetic differences between lines or varieties may be shown by the mean yields obtained in more years. Irrespective of species, variety or vegetal form, the yield production is a very complex hereditary trait. Two types of characteristics (morphological and physiological) contribute at its achievement (Mureşan, 1967).

This paper presents the results of testing some wheat lines, created at the Agricultural Research and Development Station of Podu-Iloaiei, in order to use them as germplasm source for wheat breeding in the area of Moldavia.

MATERIALS AND METHODS

During 2005-2007, at the Agricultural Research and Development Station of Podu-Iloaiei, Iasi County, a high number of winter wheat lines and varieties was tested, of which we present the results obtained in lines PI-2344-98,PI-2801-98, PI-2487-99, PI-2322-00, PI-2726-99, PI-2557-01, PI-2416-95, PI-2657-99 and PI-2561-99, against the Fundulea 4 control. The trial was set up on a Cambic Chernozem, according to the method of Latin rectangle, with three replicates on the harvestable area of $5m^2$. Every year, at each replicate, we have determined the number of spikes/m^2, the 1000-grain weight and the crop yield. The capitalization of the experimental results was done by the analysis of variance and the Duncan Test. The observations carried out during the vegetation period and the production data are presented by mean values. The correlation degree between the analysed traits was estimated by the correlation coefficients.

As climate, the experiencing years were different as concerns the rainfall amount and spreading during the vegetation period and the thermal regime. In the crop year 2004-2005, rainfall exceeded the multiannual mean by 38.8 l/m^2 in April and by 47.4 l/m^2 in May. Temperatures were high with great differences from day to night, favouring the leaf diseases and having negative influences on the grain yield. The crop year 2005/2006 was the most favourable one of the three testing years and the rainfall amount registered from sowing until plant physiological maturity was of 482 mm; it was uneven spread. The mean values of temperatures were close to the multiannual mean. The water deficit registered during the wheat vegetation period (106.2 mm in May and June) and the high temperatures with maximums of 35.5-38^0 C in air and 66^0 C in soil, accompanied by wind, characterize the crop year 2006/2007 as being extremely unfavourable for winter wheat growing, which is also reflected by the extremely low values of the determined traits.

RESULTS AND DISCUSSION

For the specific conditions of Moldavia, the resistance to wintering and leaf diseases has directly conditioned the achievement of high productions. The physiological characteristics, estimated by the observations conducted during vegetation, gave a complete image of the value of the studied wheat lines on the high adaptability to environment conditions and yield stability (*Table 1*).

The growing rate, determined in spring, in the phenological phase of straw lengthening, did not differentiate the studied lines from the control variety, all the investigated biological material having a good growth rate (marks 3-5).

The resistance to wintering, marked according to the degree of leaf mass at the beginning of summer, has shown that most of the wheat lines were resistant to this damaging factor (marks 1-3). The resistance to the leaf disease attack was good. The experimental lines had a mean resistance to the attack of *Erysiphe*

graminis, sp.tritici. Septoriosis, produced by *Septoria tritici,* was present in all the experiencing years, having different intensities. The marks of the resistance to this disease were between 4.0 (PI-2487-99 and PI-2657-99 lines) and 6.0 (PI-2561-99 line). *Puccinia recondita* was present in the years 2005 and 2006, with low attack intensity, while the PI-2801-98 line proved to be the most resistant one (2.5).

Table 1 - Some physiological characteristics of tested wheat lines (on the average of 2005-2007)

Genotype	Growth rate (*)	Resistance to (*) :				Vegetation period against the control (+/-days)
		Wintering	Powdery mildew	Septoriosis	Brown rot	
Fundulea 4	3.5	4.0	4.5	5.5	5.5	0
PI-2344-98	3.0	1.0	4.0	5.5	4.0	0
PI-2801-98	5.0	2.0	4.5	4.5	2.5	-1
PI-2487-99	4.0	3.0	5.0	4.0	3.0	-2
PI-2322-00	3.0	1.0	4.0	5.5	4.5	0
PI-2726-99	3.5	1.0	3.0	5.5	5.0	-3
PI-2557-01	3.0	2.0	3.5	5.5	5.0	0
PI-2416-95	3.0	1.0	3.0	5.0	3.5	-1
PI-2657-99	3.5	1.0	3.5	4.0	3.0	+1
PI-2561-99	3.5	1.0	4.5	6.0	5.0	0

* Notation in FAO scale: 1= very resistant … 9 = very susceptible

As concerns the earliness, determined according to the duration of vegetation period, the analysed wheat lines were not clearly differentiated against the control variety, having an almost equal vegetation period, excepting the PI-2726-99 line, which reached ripeness three days earlier than the control.

Under favourable vegetation conditions, an important role in increasing crop yield was the yield of a spike, and under unfavourable ones, the density of fertile spikes per area unit (Ceapoiu, 1972). For obtaining a suggestive image on the morphological differentiation between the tested wheat lines, we have done an analysis on the significance of differences against the error and the V×A interaction, for number of spikes/m^2, number of grains/spike, 1000-grain weight and grain yield, as compared to the Fundulea 4 control.

As concerns the number of spikes/m^2, against the control, PI-2344-98 and PI-2726-99 lines have shown superiority, having very significant statistically assured yield increases, followed by PI-2487-99, PI-2322-00 and PI-2561-99 lines, with significant differences (*Table 2*).

No statistically assured differences were obtained as compared to the interaction between genotype x years, demonstrating that the climatic conditions, different from one year to another, could modify the number of spikes/m^2 in the

tested wheat lines, excepting the PI-2726-99 line, at which the difference against the V×A interaction was significant. The line presents the safety of this trait stability, irrespective of the climatic conditions of the crop year. The analysis of variation limits has shown values close to the normal denseness in all the lines, in the year with favourable climatic conditions, and has shown that PI-2344-98 and PI-2726-99 lines had the highest number of spikes/m^2 under unfavourable climatic conditions, with positive effect on yield capacity.

Table 2 - Number of spikes / m^2 in tested wheat lines (on the average of 2005 – 2007)

Genotype	Spikes/m^2 (no.)	Variation limits (no.)	Compared to the control:		Significance compared to:	
			%	dif.(no.)	error	V × A
Fundulea 4	335	181-417	100	0		
PI-2344-98	404	224-537	121	69	***	
PI-2801-98	343	189-500	102	8		
PI-2487-99	376	216-500	112	41	*	
PI2322-00	385	209-514	115	50	*	
PI-2726-99	414	236-539	124	79	***	*
PI-2557-01	370	155-505	110	35		
PI-2416-95	361	179-498	108	26		
PI-2657-99	348	169-479	104	13		
PI-2561-99	384	168-510	115	49	*	

Error; $LSD_{5\%}$ = 38; $LSD_{1\%}$ = 50; $LSD_{0.1\%}$ = 66;
V × A; $LSD_{5\%}$ = 72; $LSD_{1\%}$ = 99; $LSD_{0.1\%}$ = 134

As concerns the number of grains/spike, the obtained yield increases were between 3% - 15% against the control, in PI-2726-99, PI-2801-98, PI-2344-98 and PI-2487-99 lines (*Table 3*).

Table 3 - Number of grains/spike in the tested experimental lines (on the average of 2005-2007)

Genotype	Grains/spike (no.)	Variation limits (no.)	Compared to the control:		Significance compared to:	
			%	dif. (no.)	error	V × A
Fundulea 4	33	24-38	100	0		
PI-2344-98	36	30-39	109	3		
PI-2801-98	34	32-36	103	1		
PI-2487-99	38	37-38	115	5	*	
PI-2322-00	29	26-31	88	-4		
PI-2726-99	34	30-38	103	1		
PI-2557-01	32	29-34	97	-1		
PI-2416-95	31	26-35	94	-2		
PI-2657-99	32	23-37	97	-1		
PI-2561-99	33	28-37	100	0		

Error; $LSD_{5\%}$ = 5; $LSD_{1\%}$ = 6; $LSD_{0.1\%}$ = 7;
V × A; $LSD_{5\%}$ = 7; $LSD_{1\%}$ = 8; $LSD_{0.1\%}$ = 10;

Against the control, the statistically assured difference in the PI-2487-99 line, as well as the steadiness of this production component (37-38 grains/spike), have shown the superiority of this line for this trait. As compared to the V×A interaction, no statistically assured differences were found, proving that the climatic conditions could change this trait from one year to another.

As concerns the 1000-grain weight, the PI-2416-95 line was found on the first place with a mean value of 43.0 g, the obtained yield increase against Fundulea 4 control being statistically assured at significant level (*Table 4*). The PI-2322-00 line, with a mean of 35.0 g, was significantly inferior to the control variety. The significance to the V×A interaction showed the opportunity that this trait could be modified, as influenced by different climatic conditions in all the tested wheat lines; the differences were not statistically assured.

Table 4 - The 1000-grain weight in the tested experimental lines (average 2005-2007)

Genotype	1000-grain weight (g)	Variation limits (g)	Compared to the control:		Significance compared to:	
			%	dif. (g)	error	V × A
Fundulea 4	39.0	34.5- 44.5	100	0		
PI-2344-98	40.5	34.5- 46.5	104	1.5		
PI-2801-98	37.0	33.5- 40.5	95	-2.0		
PI-2487-99	37.5	30.5- 45.2	96	-1.5		
PI-2322-00	35.0	30.0- 37.5	90	-4.0	0	
PI-2726-99	39.0	35.0- 41.5	100	0		
PI-2557-01	37.0	30.0- 41.5	95	-2.0		
PI-2416-95	43.0	39.0- 49.5	110	4.0	*	
PI-2657-99	39.0	35.0- 42.5	100	0		
PI-2561-99	36.5	30.5- 40.5	94	-2.5		

Error; $LSD_{5\%}$ =4.0; $LSD_{1\%}$ =6.0; $LSD_{0.1\%}$ = 8.0
V × A; $LSD_{5\%}$ = 8.0; $LSD_{1\%}$ = 11.0; $LSD_{0.1\%}$ =15.0

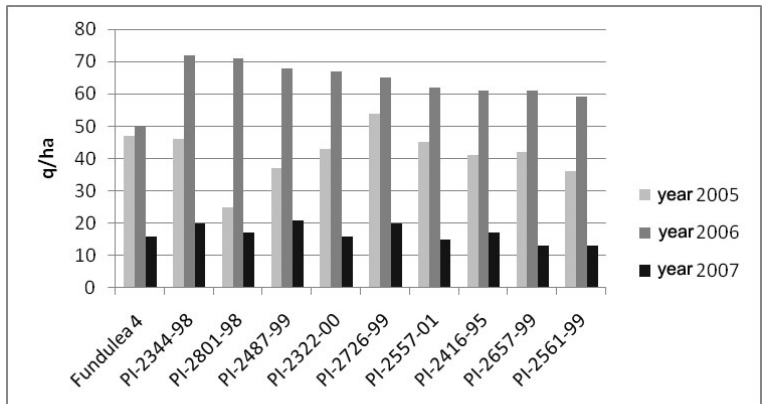

Figure 1 - Mean annual yields in wheat (2005-2007)

Due to the diversity of the climatic conditions during the three years of testing, the obtained yields have varied highly. The lowest yield was of 13 q/ha in PI-2657-99 and PI-2561-99 lines in 2007, while the highest one was of 72 q/ha in the PI-2344-98 line, followed by the PI-2801-98 line, with a yield of 71 q/ha, in 2006 (*Figure 1*).

As concerns the yield on the average of three years, most of the wheat lines exceeded the yield of 37 q/ha, obtained by the Fundulea 4 control, with yield increases until 9 q/ha (24%) in PI-2344-98 and PI-2726-99 lines, statistically assured yield increases at the significantly distinctive level (*Table 5*).

Table 5 - The grain yield obtained in the tested winter wheat lines (average 2005-2007)

Genotype	Mean q/ha	Variation limits (q/ha)	Compared to the control:		Significance compared to:	
			%	Dif. (q/ha)	error	V × A
Fundulea 4	37	16-50	100	0		
PI-2344-98	46	20-72	124	9	**	*
PI-2801-98	38	17-71	103	1		
PI-2487-99	42	21-68	114	5		
PI-2322-00	42	16-67	114	5		
PI-2726-99	46	20-65	124	9	**	*
PI-2557-01	41	15-62	111	4		
PI-2416-95	40	17-61	108	3		
PI-2657-99	39	13-61	105	2		
PI-2561-99	36	13-59	97	-1		

Error; $LSD_{5\%}$ =7; $LSD_{1\%}$ =8; $LSD_{0.1\%}$ = 11
V × A; $LSD_{5\%}$ = 8; $LSD_{1\%}$ = 12; $LSD_{0.1\%}$ = 17

Although the variations of climatic conditions were higher from one year to another, the grain yields obtained in PI-2344-98 and PI-2726-99 lines will be higher even in the future, the significance to the V×A interaction being statistically assured.

The multiple comparisons between the tested wheat genotypes pointed out the superiority of PI-2344-99 and PI-2726-99 lines against all the genotypes, the differences being significant (*Table 6*). From the viewpoint of the mean obtained yields, PI-2487-99 and PI-2322-00 were superior to PI-2561-99, PI-2801-98 lines and to the Fundulea 4 variety. As mean yields, the PI-2557-01 was superior to the PI-2561-99 line and the Fundulea 4 variety, while the PI-2416-95 was superior to the PI-2561-99 line.

Table 6 -The mean wheat yield obtained during 2005 – 2007 (Duncan Test)

Genotype	Difference towards the variant on the following position									
	Yield q/ha	10	9	8	7	6	5	4	3	2
PI-2344-98	46	10* 4.0	9* 4.0	8* 3.98	7* 3.95	6* 3.9	5* 3.84	4* 3.75	4* 3.6	0 3.46
PI-2726-99	46	10* 4.0	9* 3.98	8* 3.95	7* 3.9	6* 3.84	5* 3.75	4* 3.6	4* 3.46	
PI-2487-99	42	6* 3.98	5* 3.95	4* 3.9	3 3.84	2 3.75	1 3.6	0 3.46		
PI-2322-00	42	6* 3.95	5* 3.9	4* 3.84	3 3.75	2 3.6	1 3.46	0		
PI-2557-01	41	5* 3.9	4* 3.84	3 3.75	2 3.6	1 3.46				
PI-2416-95	40	4* 3.84	3 3.75	2 3.6	1 3.46					
PI-2657-99	39	3 3.75	2 3.6	1 3.46						
PI-2801-98	38	1 3.6	2 3.46							
Fundulea 4	37	1 3.46								
PI-2561-99	36									

The direct dependence of the production on its component elements is influenced by the ecological conditions and the specific conditions of the year. The phenotypical correlations between grain yield and number of spikes/m^2, number of grains/spike and 1000-grain weight pointed out some specific features determined by the genetic structure, typical of each studied wheat line (Ceapoiu, 1972). In tested wheat lines, the dependence between the analysed traits was shown by statistically assured positive correlations, in most of cases. In PI-2726-99, PI-2557-01 and PI-2561-99 lines, as well as in the Fundulea 4 variety, the correlation coefficients had high values (r=0.88; r=0.87; r=0.80; r=0.94) and were distinctively significant, showing that a high number of spikes/m^2 contributes greatly to the achievement of the grain yield per ha (*Table 7*).

The correlations between grain yield and number of grains/spike had statistically assured positive values in most of the tested wheat lines, pointing out the important role of the number of grains/spike in yield achievement. The 1000-grain weight, an important indicator of yield capacity, is positively and significantly associated to the grain yield in most of the wheat lines, showing the major contribution of this trait to a high yield.

Table 7 - **Correlation between yield and studied quantitative traits (on the average of 2005 – 2007)**

Genotype	Correlated traits		
	Yield × no. of spikes/m^2	Yield × no. of grain number/spike	Yield × 1000-grain weight
Fundulea 4	0.94**	0.39	0.89**
PI-2344-98	0.68*	0.91**	0.50
PI-2801-98	0.79*	0.98**	-0.01
PI-2487-99	0.47	0.15	0.92**
PI-2322-00	0.61	-0.03	0.83**
PI-2726-99	0.88**	0.96**	0.96**
PI-2557-01	0.87**	0.98**	0.94**
PI-2416-95	0.73*	0.96**	0.73*
PI-2657-99	0.74*	0.96**	0.93**
PI-2561-99	0.80**	0.98**	0.92**

$P_{5\%}$ =0.67; $P_{1\%}$ = 0.80

CONCLUSIONS

The analysed biological material was resistant to wintering conditions and to the attack of leaf diseases that were present during 2005-2007. The PI-2726-99 line was noticed especially by earliness against the Fundulea 4 control. PI-2344-98 and PI-2726-99 winter wheat lines were noticed by their high productive potential with statistically assured yield increases of 9 q/ha, against the Fundulea 4 control. The method of multiple comparisons also emphasized PI-2344-98 and PI-2726-99 lines, having significant differences compared to the other studied lines as concerns the biological production. As concerns yield, these lines were statistically superior to the rest of tested biological material. Their productive superiority shows them as a valuable germplasm source in the future breeding works on this trait.

The number of spikes/m^2, an important element of productivity, was superior to the control in PI-2344-98 and PI-2726-99 lines, which were also characterized by a very good resistance to wintering. The number of grains/spike and the 1000-grain weight had higher values than the Fundulea 4 variety in PI-2344-98 and PI-2726-99 lines, but statistically non-assured ones. Significant differences were found in PI-2487-99 for the number of grains/spike and in PI-2416-95 for the 1000-grain weight. The analysed genotypes reacted similarly at the modification of environment conditions, the V x A interaction being insignificant.

The high positive values of statistically assured correlation coefficients between grain yield, number of grains/ spike and 1000-grain weight show that when using PI-2726-99, PI-2557-01, PI-2657-99 and PI-2561-99 in the selection

process for improving the number of grains/spike and the 1000-grain weight, an increase in the grain yield may be obtained.

The results obtained after testing the nine winter wheat lines plead for using PI-2344-99 and PI-2726-99 as parental forms in the process of variety creation, corresponding to the objectives followed by wheat breeding works at the Agricultural Research and Development Station of Podu-Iloaiei, Iasi County.

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