

Analysis of excised leaves water loss in winter wheat

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Abstract Genetic improvements of crops involve selection of suitable plants in segregating populations from a cross. Selecting wheat genotypes with better adaptation to water stress should increase the productivity of wheat. Rate of water loss from excised leaf bestowed drought resistance in wheat by a mechanism of low water loss rate through leaf cuticles. This trait is moderately heritable, and can be easily determined.

The objective of the present study was to evaluate the RWC for characterization of drought tolerance as an early stage screening criterion. The studied biological material consisted of seven wheat varieties with different genetic and ecologic origin, along with their 21 one-way crosses.

The effects of parents and crosses were significant for leaf water loss, this indicated the presence of variability among hybrids and their parents, for this trait. Also, the effects of environment were significant, because water losses from excised leaves are influenced by their initial water content. This suggested that the magnitude of differences in genotypes was sufficient to provide some scope for selecting traits for improvement in drought tolerance of wheat genotypes.

The lowest values of heterosis for this character have been observed in hybrids: Turda 2000 x Apache; Alex x Apullum; GKKapos x Alex; Turda 2000 x Alex; Xenon x Alex, which proves a high drought tolerance compared to parental forms, and can be considered for drought tolerance improvement in winter wheat.

Key words

winter wheat, leaf water loss, drought tolerance

Development of drought tolerant genotypes is one of the most important alternatives in terms of global warming and water deficit. Drought tolerance consists of ability of crop to growth and production under water deficit conditions. A long term drought stress on plants metabolic reactions associates with, plant growth stage, water storage capacity of soil and physiological aspects of plants. Genetic improvements of crops involve selection of suitable plants in segregating populations from a cross [7]. Selecting wheat genotypes with better adaptation to water stress should increase the productivity of wheat [9].

Efficient screening techniques applicable at early stage of plant growth have been dire need of plant breeders to eliminate the unwanted material and focus un promising genotypes. Certain physiological parameters which confer drought resistance in plants have been identified for screening the genotypes [1]. There are number of plant traits like relative water content (RWC), excised leaf water loss (ELWL), stomatal frequency, stomatal size, osmotic adjustment etc., which are related to drought resistance

Rate of water loss from excised leaf bestowed drought resistance in wheat by a mechanism of low

water loss rate through leaf cuticles. Therefore differences among genotypes for rate of water loss, which presumably is an estimate of cuticular transpiration rate, could be used for screening wheat genotypes against drought resistance [3; 10; 8]. This trait is moderately heritable [4], and can be easily determined. Following excision, stomates close and after 20 to 30 min rate of water loss enters a linear phase that lasts for several hours [6].

Material and Method

Seven wheat varieties with different genetic and ecologic origin, along with their 21 one-way crosses, were studied in a randomized block design with three replications.

To determine ELWL the penultimate leaf of each randomly selected plant were sampled. The leaves were placed in polythene bags and transported to the laboratory as quickly as possible in order to minimize water losses due to evaporation. The leaves were weighed at three stages, immediately after sampling (fresh weight), then dried in an incubator at 28 °C at 50% R.H. for 6 h, and then dried again in an oven for

24 h at 70 °C as proposed by Clarke (1987). ELWL was calculated from the following formula: $ELWL = [(Fresh\ weight * Weight\ after\ 6\ h) - (Fresh\ weight * Dry\ weight)] * 100$

The determination of differences significance between the studied cultivars and crosses, the processing of obtained experimental data was performed using variance analysis and *t* test according to Ciulca, 2006.

Results and Discussions

On regarding the water loss from excised leaves for F₁ hybrids, only in the case of three crosses (Fundulea 4 x GKKapos; Fundulea 4 x Alex, Xenon x Turda 2000) positive values of “trans” heterosis have

been observed, which proves that these hybrids show a lower drought tolerance compared to parental forms. The crosses (Fundulea 4 x Turda 2000, Fundulea 4 x Apullum) intermediate to the parental forms, have achieved higher values of this trait comparing to mid parent.

Compared with the parents mean the crosses of this F₁ generation showed an amplitude of 42.62 % for excised-leaf water loss, while the average values of "cis" heterosis were negativ (-7.89 %) and the "trans" heterosis were 7.46 %. The lowest values of heterosis for this character have been observed in hybrids: Turda 2000 x Apache; Alex x Apullum; GKKapos x Alex; Turda 200 x Alex; Xenon x Alex, which proves a high drought tolerance compared to parental forms.

Table 1

Express manner of the excised-leaf water loss in F₁ hybrids

Number of studied hybrids	Number and proportion (%) of F ₁ hybrids				Range to parents mean (%)	Mean Heterosis (%)	
	Superior to parents	Intermediary between parents		Inferior to parents		“cis”	“trans”
		Above the mean	Below the mean				
21	3 (14.28%)	2 (9.52%)	-	16(76.20%)	68.98 – 111.60	92.11	107.46

Concerning the express manner of the excised-leaf water loss it is noted that 24% of the hybrids have achieved a higher dehydration to parental forms average. The highest heterosis index values were made by hybrids: Fundulea 4 x GKKapos (10.78) si Xenon x Turda 2000 (8.66), combinations in which there were no significant differences between the

parental forms in terms of this trait. The lowest values of heterosis index, correlated with a reduced capacity of leaves dehydration on the background of close values between the parental forms were recorded in hybrids: Turda 2000 x Apache (-33.66); Apache x Apullum (-19.16) și Turda 2000 x Apullum (-8.14).

Table 2

Heterosis index for leaf water loss in F₁ hybrids

Genitors	Fundulea 4	Xenon	GKKapos	Turda 2000	Alex	Apache	Apullum
Fundulea 4	-	-1.25	10.78	0.27	2.82	-3.31	0.11
Xenon		-	-1.98	8.66	-1.55	-1.58	-4.23
GKKapos			-	-3.23	-3.55	-4.24	-1.10
Turda 2000				-	-1.69	-33.66	-8.14
Alex					-	-1.41	-2.66
Apache						-	-19.16
Apullum							-

Data form table 3a indicates that hybrids variance submit high and significant values, having the largest weight in the total variance, suggesting the existence of real differences between the studied hybrids, in terms of this character.

Also, the significant amount of repetitions variance reveals that the expression of dehydration leaves ability in studied hybrid combinations were significantly influenced by experimental conditions.

Table 3

a) Variance analysis for leaf water loss in F₁ hybrids

Variability source	SS	DF	MS	F Test
Total	4837.23	65		
Repetitions	200.41	2	100.21	F = 3.56*
Hybrids	3454.96	21	164.52	F = 5.85**
Error	1181.86	42	28.14	

b) Estimative values and the significance of differences between F₁ hybrids concerning leaf water loss

No.	Hybrids	LWL (%)		Relative value (%)	Difference/Significance
		$\bar{x} \pm s_{\bar{x}}$	s %		
1	Hybrids Mean	70.78±1.23	3.02	100.00	Control
2	Fundulea 4 x Xenon	72.39±1.08	2.58	102.27	1.61
3	Fundulea 4 x GKKapos	81.38±3.14	6.68	114.97	10.60*
4	Fundulea 4 x Turda 2000	78.08±2.91	6.46	110.31	7.30
5	Fundulea 4 x Alex	82.46±3.84	8.07	116.49	11.67*
6	Fundulea 4 x Apache	67.72±3.23	8.27	95.67	-3.06
7	Fundulea 4 x Apullum	76.88±1.81	4.07	108.61	6.10
8	Xenon x GKKapos	70.69±0.54	1.32	99.87	-0.09
9	Xenon x Turda 2000	84.09±4.67	9.62	118.80	13.31**
10	Xenon x Alex	64.97±2.53	6.75	91.79	-5.81
11	Xenon x Apache	76.75±4.18	9.42	108.43	5.97
12	Xenon x Apullum	71.72±1.07	2.59	101.32	0.94
13	GKKapos x Turda 2000	67.83±1.98	5.05	95.82	-2.96
14	GKKapos x Alex	61.57±1.00	2.81	86.99	-9.21 ⁰
15	GKKapos x Apache	67.52±4.30	11.03	95.39	-3.26
16	GKKapos x Apullum	74.77±3.00	6.95	105.63	3.99
17	Turda2000 x Alex	64.61±4.63	12.42	91.28	-6.17
18	Turda2000 x Apache	54.16±3.12	9.98	76.52	-16.62 ⁰⁰⁰
19	Turda2000 x Apullum	69.69±1.04	2.58	98.45	-1.10
20	Alex x Apache	67.09±1.03	2.66	94.78	-3.70
21	Alex x Apullum	60.61±6.37	18.20	85.63	-10.17 ⁰
22	Apache x Apullum	71.47±5.24	12.70	100.96	0.68

LSD_{5%} = 8.73 LSD_{1%} = 11.68 LSD_{0.1%} = 15.32

The studied hybrids have recorded values of this character ranging from 54.16 % in Turda 2000 x Apache to 84.09 % for Xenon x Turda2000, with variation amplitude of 29.93%, against a low inter-genotypic variability. Intra-genotypic variability was generally low for most combinations except hybrids: Alex x Apullum, Apache x Apullum, GKKapos x Apache, Turda 2000 x Alex, where a medium variability was observed.

Compared with the experience mean according to data presented in table 3b, it is noted that

48% of hybrid combinations have achieved a higher leaf water loss. The highest values of this character and also significant increases to experience mean were observed in crosses: Xenon x Turda 2000 (13.31*); Fundulea 4 x Alex (11.67*); Fundulea 4 x GKKapos (10.60*). A lower significant water loss ability to experience mean, submitted the hybrids: Turda 2000 x Apache (-16.62⁰⁰⁰); Alex x Apullum (-10.17⁰); GKKapos x Alex (9.21⁰), which can be considered for drought tolerance improvement in winter wheat.

Table 4

The significance of differences between groups of F₁ hybrids with the same recurrent parent concerning leaf water loss

No.	Recurrent parent		Fundulea 4	Xenon	GKKapos	Turda 2000	Alex	Apache	Apullum
	F ₁ Mean		76.43	73.44	70.57	70.39	66.89	67.45	70.86
1	Fundulea 4	76.43		2.99	5.86	6.04	9.54*	8.98*	5.57
2	Xenon	73.44			2.86	3.05	6.55	5.98	2.58
3	GKKapos	70.57				0.19	3.69	3.12	-0.28
4	Turda 2000	70.39					3.50	2.93	-0.47
5	Alex	66.89						-0.57	-3.97
6	Apache	67.45							-3.40
7	Apullum	70.86							

LSD _{5%}	LSD _{1%}	LSD _{0.1%}
8.26	11.08	14.60

Taking into account the groups of hybrids with the same recurrent parent is observed that the highest water loss from the excised-leaves shows the hybrids of varieties: Fundulea 4 and Xenon, while the hybrids of

varieties Alex and Apache exhibit a low leaves water loss. Only the differences observed between the groups of hybrids Fundulea 4 against the hybrids of Alex and Apache reached the level of statistical assurance.

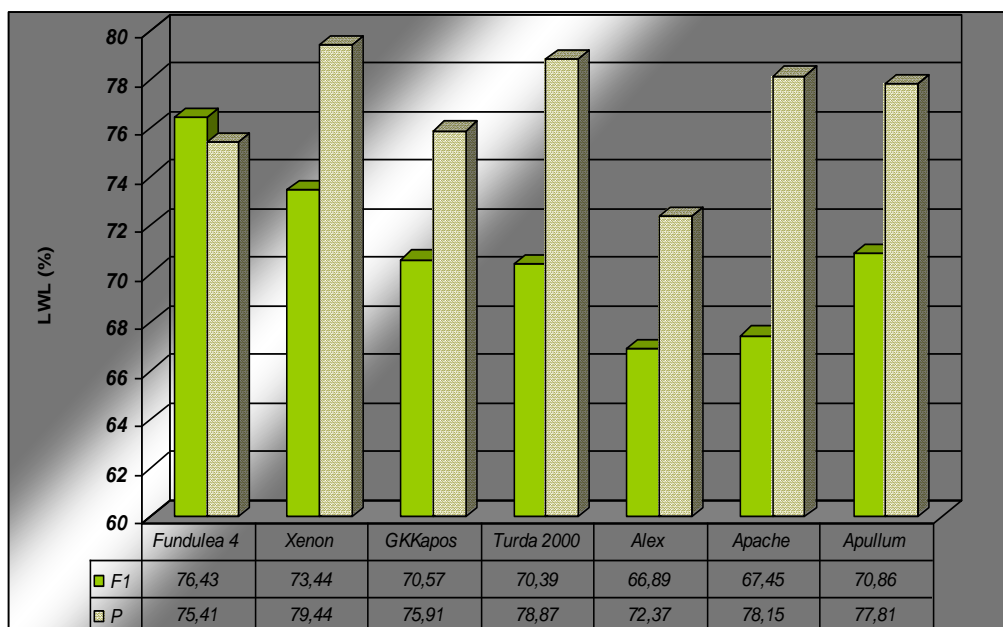


Fig .1. Leaf water loss for groups of F₁ hybrids with the same recurrent parent

In comparison with the recurrent parent, only the hybrids of variety Fundulea 4 showed a higher value of excised-leaves water loss, but the difference have not reached the level of statistical assurance. The hybrids of all other varieties show a lower significant leaves water loss against the recurrent parent. It is suggested that the hybrids of crosses from these varieties are expected to produce desirable segregants under drought stress. But involvement of high genotype-environment interactions should also be taken into account.

Conclusions

The effects of parents and crosses were significant for leaf water loss, this indicated the presence of variability among hybrids and their parents, for this trait. Also, the effects of environment were significant, because water losses from excised leaves are influenced by their initial water content. This suggested that the magnitude of differences in genotypes was sufficient to provide some scope for selecting traits for improvement in drought tolerance of wheat genotypes.

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