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Results regarding drought and heat tolerance of some Romanian winter wheat genotypes obtained at NARDI Fundulea

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INTRODUCTION

Drought and heat are phenomena that increasingly affect Romanian agriculture. Bread wheat (*Triticum aestivum L.*) is one of the most important field crops in Romania, being cultivated on more than 2.2 million hectares last year. Heat and drought episodes are becoming more frequent during the grain filling period, which is one of the most important stages in wheat development for high yield and baking quality. "The rate of reduction in grain weight" it's often used as an indicator of how well a plant is coping with stress, a smaller reduction in seed weight generally indicates better tolerance to the stressor.

MATERIAL AND METHOD

81 contrasting winter wheat genotypes were sown in two repetitions (control and treated), with two rows from each genotype for drought test. To intensify the water stress process at the leaves level, the plants were treated, 15 days after anthesis, with 1% potassium iodide as a chemical desiccant. The rate of reduction in grain weight (%) was determined , this method simulates a situation where grain filling no longer occurs through current photosynthesis in the leaves but relies solely on using reserves from the stem.

Another set of 57 wheat genotypes was exposed to high temperatures under controlled conditions in laboratory, at seedling stage to assess their potential for tolerance to high temperatures. Seven seeds were selected from each genotype for the "Control" and 7 seeds for the "Drought" treatment, placed in muslin bags, and sterilized with bleach (hypochlorite) for 15 minutes. They were then rinsed with water and placed on filter paper to germinate. The seeds were placed in a growth chamber for 7 days at 25°C with water, after that the control seeds were removed from the chamber, leaving only the drought treatment seeds. The following temperature regime: without light for 1 hour at 35°C; 2 hours at 25°C;1 hour at 45°C.
Afterward, the chamber was stopped, and the seeds were left for an additional 30 minutes with the door closed, followed by another 30 minutes with the door slightly open. Cooling was done gradually. Finally, both the "Control" and "Drought" seeds were returned to the chamber at 25°C for another 7 days. After this period, the seeds were analyzed. The results are expressed as percentages relative to the values obtained for the control genotype.

RESULTS AND DISCUSSIONS

Inducing water stress at the leaf level with a 1% potassium iodide solution for 81 contrasting wheat genotypes highlighted that all genotypes that exhibited a reduction in seed weight of less than 9%—similar to the control variety Drysdale (a wheat variety known in the scientific literature for its drought and heat tolerance)—demonstrated high drought tolerance. Among these are FDL FAGUR, 17054G1-07, ABUND-1A, 19148G0-2, 16131G1-1, FDL EVIDENT, VOINIC, FDL ABUND, 20099GP1, 17217G1-08, IZVOR, 17051G1-05, KUKRI, Simnic 1412, 19290G0-2, ABUND-1R, 19284G0-2, FDL EMISAR.
KASP (Kompetitive Allele Specific PCR) technique show that Drysdale, FDL FAGUR, FDL EVIDENT, and 17217G1-08 confirm the presence of genes associated with resistance to drought and heat.

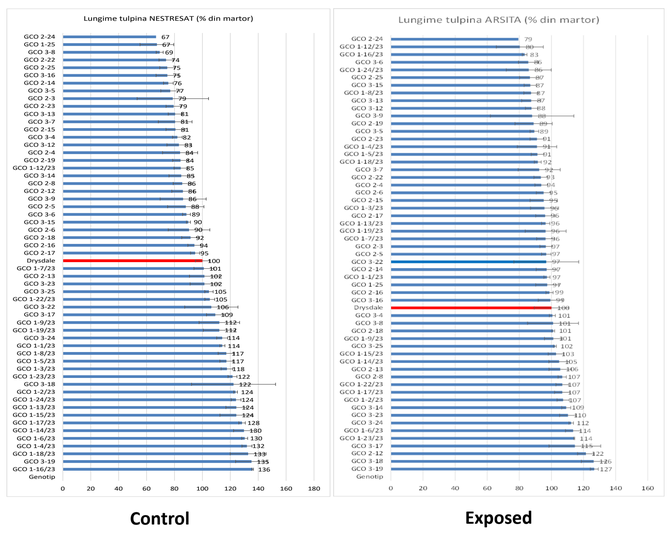
Nr Crt.	Denumire	Rata de reducere a greutăţii boabelor (%)	Nr Crt.	Denumire	Rata de reducere a greutăţii boabelor (%)
1	A 4-10	4	42	LOVRIN 9Z	14
2	FDL FAGUR	4	43	FDL DARNIC	14
3	17054G1-07	5	44	17077G5-06	14
4	ABUND-1A	5	45	17077G5-07	14
5	BOGDANAwx	6	46	20217G3	14
6	19148G0-2	6	47	17077G5-09	15
7	16131G1-1	6	48	19084G0-4	16
8	VOINIC	6	49	OTILIA	16
9	FDL EVIDENT	7	50	20203G3	16
10	FDL ABUND	7	51	19296G0-3	17
11	20099GP1	7	52	BIHARIA	17
12	17217G1-08	8	53	19313G0-2	17
13	IZVOR	8	54	17217G1-09	17
14	MIRANDA FDL	8	55	19225G0-3	17
15	17051G1-05	8	56	19084G0-1	17
16	KUKRI	8	57	20203G1	18
17	Simnic 1412	9	58	CEZAR	18
18	19290G0-2	9	59	20212G3	19
19	ABUND-1R	9	60	19073G0-4	19
20	19284G0-2	9	61	PITAR	19
21	FDL EMISAR	9	62	17312G1-042	19
22	IULIA	9	63	Anapurna	20
23	DRYSDALE	9	64	17312G1-01	21
24	amestecDARNIC OR	10	65	19368G0-1	21
25	GIZA 160	10	66	19303G0-1	21
26	URSITA	10	67	17282G1-01	22
27	19100G0-4	10	68	19384G0-4	22
28	OBIWAN	11	69	LOVRIN 90	22
29	20213G4	11	70	17208G1-04	22
30	Simnic 1619	12	71	19389G0-2	23
31	19061G0-4	12	72	17217G1-02	24
32	19301G0-3	12	73	20210G1	24
33	CARO	13	74	FDL AMURG	24
34	17077G5-011	13	75	19386G0-1	25
35	17243G2-04	13	76	17312G1-032	26
36	FDL COLUMNA	13	77	GLOSA	26
37	19239G0-1	13	78	19367G0-1	27
38	amestecDarnic non	13	79	19321G0-4	27
39	FDL CONSECVENT	13	80	17312G1-034	29
40	19251G0-3	13	81	19378G0-3	49
41	19230G0-1	14			

The rate of reduction in grain weight (%) for 81 contrasting wheat genotypes

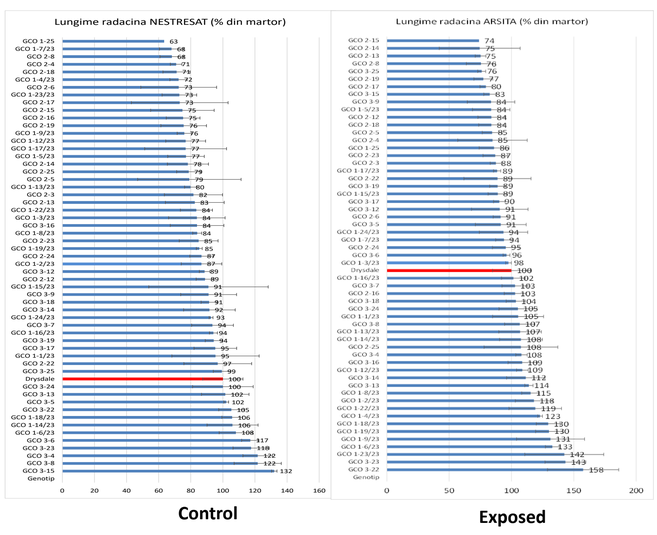
Nr	Nume	Or KASP 2024	Or Secv603	Or WMC596	Or WMC603	Or (pe mark vechi	Dreb-B1	Drought-DE106	TaBAS-B1 (del1)	1FEH w3	TaPPH-7A	SNRK 2.9-5A	SNRK 2.9 5A1	SNRK 2.9-5A2	GL-BS00060097 (4A)	PHH-BS0022104 (1B)	PHH-BS00094057 (3A)	BS00064980 (5A)	Yld-BS00036472 (4A)	Tukri_c2706_1424 (4A)	TaDRO-5A	Rht-B1-SNP	Rht8	Caliiate (Glu A1)	Caliiate (Glu-D1)	NAM-SNP1	NAM-SNP2	NAM-A1
1	COLUMNA	+		+??			B1b	G	B1b	W	A	Hap-5A-3	C	C	A	A	C	G	C	G	A	B1b	Rht8	2	Dx5Dy10	T*	del	d*
2	CONSECVENT	-		+	+	or+	B1b	G	B1b	W	G	Hap-5A-3	C	C	G	A	C	G	C	G	A	B1b		2	Dx5Dy10	T*	del	d*
3	EVIDENT	H	+		+		B1b	G	B1a	H	H	Hap-5A-3	C	C	H	G	C	H?	C	H	A	H	NU	2	Dx5Dy10	H	H	H
4	COMPLICE	-					B1a	A	B1a	W	G	Hap-5A-1	T	A	A	G	C	A	T	G	C	B1b	NU	null	Dx5Dy10	T	del	d
5	FAGUR	-					B1b	G	B1a	W	G	Hap-5A-3	C	C	A	A	C	G	C	G	A	B1b		2	Dx5Dy10	T	del	d
6	OTILIA	-					B1b	G	B1b	W	G	Hap-5A-3	C	C	G	A	C	G	C	H	A	B1b		2	Dx5Dy10	T	del	d
7	FDL CONCURENT	-	+	+	+	or+	B1b	G	B1b	W	G	Hap-5A-3	C	C	G	A	C	G	C	G	A	B1b		2	Dx5Dy10	T	del	d
8	Drysdale vechi	+					B1a	A	B1a	K	A	Hap-5A-1	T	A	A	G	A	A	T	A	A	B1a		1	Dx5Dy10	no/H???	A	???
9	17217G1-02	-	+				B1b	G	B1b	W	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10	T	del	d
10	17217G1-08	-	+				B1b	G	B1a	W	G?	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10	T	del	d
11	17217G1-09	-	+				B1b	G	B1a	W	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10	T	del	d
12	17077G5-011	+		+	+	or+	B1b	G	B1b	K	G	Hap-5A-3	C	C	A	A	no	G	C	A	A	B1b		2	Dx5Dy10	T	del	d
13	17077G5-06	+		+	+	or+	B1b	G	B1b	K	G	Hap-5A-3	C	C	A	A	no	G	C	A	A	B1b		2	Dx5Dy10	H	H	H
14	17077G5-07	+		+	+	or+	B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	no	G	C	A	A	B1b		2	Dx5Dy10	H	H	H
15	17077G5-09	+		+	+	or+	B1b	G	B1b	K	G	Hap-5A-3	C	C	A	A	A?	G	C	A	A	B1b		2	Dx5Dy10	C	A	a
16	17312G1-01	H?		H??	+?	or?	B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		null	Dx5Dy10			
17	17312G1-032	-					B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		null	Dx5Dy10			
18	17312G1-034	H?	+?	H??	+?	or?	B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		null	Dx5Dy10			
19	17312G1-042	+		+	*		B1b	G	B1b	K	A	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10			
20	17051G1-02						B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10			
21	17051G1-05						B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	A	G	C	A	A	B1b		2	Dx5Dy10			
22	17054G1-07						B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10			
23	17243G2-04	+			*		B1b	G	B1b	K	A	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10	T*	del	d
24	17282G1-01						B1a	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b	Rht8	null	Dx5Dy10			
25	17208G1-04	+		+			B1a	G	B1a	K	A	Hap-5A-3	C	C	A	A	C	A	C	G	A	B1b		null	Dx5Dy10			
26	20099GP1						H	G	B1b	H	A	Hap-5A-3	C	C	G	A	A?	H?	C	H	A	B1b		2	Dx5Dy10	T	H/del?	H
27	OBIWAN						B1a	A	B1a	W	G	Hap-5A-3	C	C	A	G	C	A	C	G	A	B1b		null	DX2DY12			
28	16131G1-1						B1a	A	B1a	W	G	Hap-5A-3	C	C	A	A	C	G	C	G	A	B1a	nu	null	Dx5Dy10			
29	19073G0-4	-	+???		+?		B1b	G	H	W	G	Hap-5A-3	C	C	G	A	C	G	C	H	A	B1b		1	Dx5Dy10			
30	19084G0-4	H?/-?	+?				B1b	G	B1b	K	H	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10			
31	19230G0-1						H	G	NA	NA	NA	Hap-5A-3??	C	NA	G	A	C	G	C	H	A	na		2	Dx5Dy10	na	na	na
32	19296G0-3						B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	A	G	C	A	A	B1b		1	Dx5Dy10			
33	19367G0-1	-	+	+			B1b	G	B1b	W	G	Hap-5A-3	C	C	G	A	C	G	C	G	A	B1b		1	Dx5Dy10	T	A	c
34	19368G0-1	H	H??		H?		B1b	G	H	H	H	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10	T	del	d
35	19378G0-3	-	+	+			B1b	A	B1b	W	G	Hap-5A-3	C	C	G	G	C	G	C	A	A	B1b		2	DX2DY12			
36	19386G0-1						B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	C	B1b		2	Dx5Dy10			
37	19389G0-2						B1b	G	B1b	K	G	Hap-5A-3	C	C	G	A	C	G	C	A	A	B1b		2	Dx5Dy10			
38	20210G1						B1a	G	H	H	G	Hap-5A-3	C	C	G	G	C	G	C	G	A	B1b		2	Dx5Dy10			
39	20212G3						B1b?/H?	G	H	H	A	Hap-5A-3	C	C		G	C	H?	C	G	A	B1b		null	Dx5Dy10			

Genotyping profiles obtained by KASP (Kompetitive Allele Specific PCR) and SSR techniques

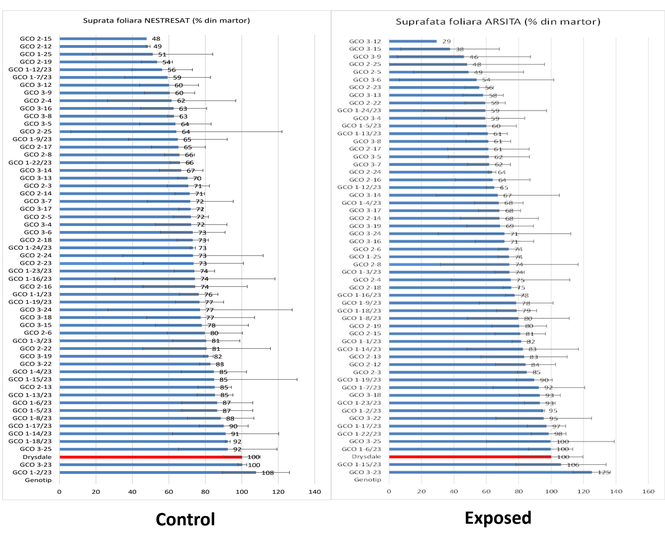
Drought: *TaDreb-B1* (provides resistance against drought stress); *1 FEH-w3* (associated with higher TGW under drought stress); *TaPPH-7A* (associated with TGW and chlorophyll content at grain-filling stage under drought stress); *TaSnRK 2.9-5A* (associated with TGW under drought conditions), *TaDRO-5A* (associated with root architecture).
Heat: *TaBAS-B1* (involved in chlorophyll content of flag leaf post-anthesis and TGW, through chlorophyll protection against chloroplast damage).



The genotypes GCO 3-19 (19340G2), GCO 3-18 (19340G1), GCO 1-23 (BOGDANAwx), and GCO 3-24 (19095G7) exhibited a **seedling length** increase of over 10% higher than the Drysdale control, both under normal conditions and under drought stress conditions.



Regarding **root growth** in the absence and presence of drought stress, the following genotypes stand out: GCO 3-15 (19387G2), GCO 3-8 (19122G1), GCO 3-4 (19023G6), GCO 3-23 (19440G1), GCO 3-6 (19023G19), and, respectively, GCO 3-22 (19440G3), GCO 3-23 (19440G1), GCO 1-23 (BOGDANAwx), GCO 1-6 (15339G3-1) and GCO 1-9 (16272G1-1).



The genotypes GCO 1-15 (19227G5) and GCO 3-23 (19440G1), had a larger **leaf area** compared to the control.

CONCLUSIONS

- Among the genotypes tested for drought tolerance FDL FAGUR, 17054G1-07, ABUND-1A, 19148G0-2, 16131G1-1, FDL EVIDENT, VOINIC, FDL ABUND, 20099GP1, 17217G1-08, IZVOR, 17051G1-05, KUKRI, Simnic 1412, 19290G0-2, ABUND-1R, 19284G0-2 and FDL EMISAR show above-average tolerance.
- More than 15 winter wheat genotypes stood out after performing the heat stress tolerance test out of the 56 analyzed.
- KASP (Kompetitive Allele Specific PCR) technique show that Drysdale, FDL FAGUR, FDL EVIDENT, and 17217G1-08 confirm the presence of genes associated with resistance to drought and heat.

The results are part of the project : **"Creation and diversification of winter wheat germplasm with quantitative, qualitative, agronomic traits, and adaptation to changing agro-environmental conditions in Romania"**, project code ADER 1.1.1/20.07.2023, phase 2/2024 (SECTORIAL PLAN ADER 2023-2026).