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Research Article/Araştırma Makalesi

SUSTAINABILITY OF BULGARIAN AND TURKISH VARIETIES AND LINES OF WINTER BARLEY TO ABIOTIC STRESS

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Abstract: Cold resistance, drought resistance and water and temperature regime of 43 Bulgarian and Turkish winter barley varieties and lines were determined in field and laboratory conditions during the period 2005-2009. 50% of the study material was found to have a good and high resistance to cold. The highest coefficient of drought resistance was found in 9 of the studied lines. Among the tested winter barley varieties and lines those with high and medium cold resistance were found to dominate the study group. The highest biological drought tolerance are Bulgarian lines DRF 206-2 and DRT 279-2 and the Turkish lines AVD-24 and MB-A 51. These lines may be included in the breeding program to create varieties with high resistance to cold and drought resistance.

Key words: Barley, cold resistance, drought resistance.

Bulgar ve Türk Kışlık Arpa Çeşit ve Hatlarının Abiyotik Stres Koşullarında Sürdürülebilirliği

Özet: 2005-2009 arası dönemde gerçekleştirilen bu çalışmada 43 Bulgaristan ve Türkiye kışlık arpa çeşit ve hatlarının soğuk toleransı, kuraklık toleransı ve su ve sıcaklık rejimleri arazi ve laboratuar ortamında belirlenmiştir. Çalışmada kullanılan materyalin %50'sinin soğuğa karşı yüksek dirence sahip oldukları tespit edilmiştir. E yüksek kuraklık direnci katsayısı çalışılan arpa hatlarının 9 tanesinde belirlenmiştir. Test edilen kışlık arpa varyeve ve hatları arasında yüksek ve orta derecede soğuk direncine sahip olanların çalışılan grup içinde baskın oldukları belirlenmiştir. En yüksek biyolojik kuraklık toleransı olan hatların Bulgaristan hatları olan DRF 206-2 ve DRT 279-2 ile Türkiye hatları olan AVD-24 ve MB-A 51 olduğu bulunmuştur. Bu hatların, soğuğa karşı yüksek direnç ve kuraklık toleransına sahip çeşitlerin elde edileceği üretim programlarına dahil edilebilecek hatlar oldukları sonucuna varılmıştır.

Anahtar Kelimeler: Arpa, soğuk direnci, kuraklık direnci.

Introduction

Study of the sustainability of Bulgarian and Turkish barley varieties and lines to abiotic factors has important practical and theoretical importance. This allows the selection of reliable sources to create a high drought tolerance and cold tolerance (Genchev 1995). Creating such barley varieties will maintain the level of yield and grain quality in this type of abiotic stress.

The aim of this study was to explore new sources of genetic barley originating in Bulgaria and Turkey in order to create a starting material with high resistance to cold and drought tolerance.

Material and Methods

Cold resistance and drought tolerance of 43 varieties and lines of two and multiple row winter barley which grown at the Institute of Agriculture - Karnobat, Bulgaria and Thrace Agricultural Research Institute - Edirne, Turkey were determined during the period of 2005-2009.

The cold resistance of the material was determined by the method of Koch (1975) after direct refrigeration plants at -10°, -12º and -14ºC for 24 hours. LT_{50} was determined.

The biological drought tolerance was defined in the studies varieties and lines through a set of physiological indicators such as water content in the leaves, water holding capacity, residual water deficit and output of electrolytes and the coefficient of drought tolerance was calculated based on these parameters (Valchev 1995).

The effects of drought on water and temperature regime of the plants in the seed was studied (Valchev *et al.* 2014).

Table 1. Cold resistance of winter varieties and lines.

№	Variety/line	Origin	% alive plants under the influence with t (°C)				LT_{50}	Group
			-10	-12	-14	mean		
1.	Sladoran	S	90	72	54	72	-14.4	III
2.	Balkan 96	Tr	90	70	48	69	-13.8	IV-III
3.	Burgaz	Tr	94	70	54	73	-14.5	III
4.	Bolayir	Tr	88	66	48	67	-13.8	IV
5.	Lord	Tr	96	74	52	74	-14.2	III
6.	AVD-19	Tr	96	74	50	73	-14.0	III
7.	AVD-24	Tr	86	64	44	65	-13.4	IV
8.	AVD-25	Tr	84	62	44	63	-13.3	IV
9.	ABVD-4	Tr	86	66	30	61	-12.9	IV
10.	ABVD-7	Tr	98	74	48	73	-13.8	III
11.	ABVD-10	Tr	100	76	48	75	-13.8	III
12.	ABVD-11	Tr	88	64	38	63	-13.1	IV
13.	MB-A 51	Tr	90	64	36	63	-13.0	IV
14.	DRF 206-2	Bg	96	72	54	74	-14.4	III
15.	CRF 302-2	Bg	100	76	56	77	-14.6	III-II
16.	PG 4365	Bg	96	68	52	72	-14.2	III
17.	K 2419-03	Bg	100	72	58	77	-15.1	III-II
18.	K 2538-01	Bg	100	70	56	75	-14.8	III
19.	Obzor	Bg	100	64	30	65	-12.8	IV
20.	Perun	Bg	100	68	42	70	-13.4	IV-III
21.	CRT 272-1	Bg	100	68	48	72	-13.8	III
22.	DRT 103-2	Bg	98	66	50	71	-14.0	III
23.	DRT 198-1	Bg	98	70	40	69	-13.3	IV-III
24.	L 4384	Bg	96	64	48	69	-13.8	IV-III
25.	Veslets	Bg	100	74	56	77	-14.7	III-II
26.	CRF 47	Bg	100	76	52	76	-14.2	III
27.	CRF 259	Bg	100	74	56	77	-14.7	III-II
28.	CRF 292	Bg	100	72	56	76	-14.7	III
29.	CRF 146 b	Bg	100	74	56	77	-14.7	III-II
30.	PG 4437	Bg	98	66	40	68	-13.2	IV
31.	CRT 171	Bg	100	70	46	72	-13.7	III
32.	CRT 1-1	Bg	100	72	54	75	-14.4	III
33.	DRT 061	Bg	98	68	50	72	-14.0	III
34.	DRT 136	Bg	100	70	52	74	-14.2	III
35.	DRT 279-2	Bg	98	68	56	74	-15.0	III
36.	Arda	Tr	98	68	52	75	-14.2	III
37.	AVVD-7	Tr	98	68	48	71	-13.8	III
38.	AVD-11	Tr	96	66	50	71	-14.0	III
39.	AVD-12	Tr	100	70	52	74	-14.2	III
40.	AVD-21	Tr	98	72	46	72	-13.7	III
41.	AVD-22	Tr	100	70	48	73	-13.8	III
42.	AVD-23	Tr	100	66	40	69	-13.2	IV-III
43.	ABVD-8	Tr	98	68	42	69	-13.4	IV-III

Results and Discussion

The resistance of the barley varieties at low subzero temperatures is important in order to be able to obtain high yields.

The data on cold resistance of varieties and lines were shown in Table 1. Four from the 43 material studied have high cold resistance and belong to group II-III of the standard scale in cold tolerance of barley (level Pamina and Dominator – Table 2). Most of the studied lines (23 lines) are in group III level Dominator, 6 are in group IV-III middle cold resistance and 8 are in group IV with a low cold tolerance.

Laboratory testing of biological indicators for drought tolerance of water content in the leaves, water holding capacity, residual water deficit and output of electrolytes were performed during the study (Table 3). Based on the coefficient of drought resistance the studied lines were differentiated into groups. The highest coefficient of drought tolerance were found in 9 lines, including 6 Bulgarian selection created in the direction in drought tolerance, 2 Turkish and one six row line from Bulgaria.

The line with the highest drought tolerance was found to be DRF 206-2. Most of the studied lines were placed in the group with an average drought tolerance (26 accession). This group included most of the Bulgarian lines and standard varieties in the study. An exception is

Table 2. Standard scale for cold resistance of barley.

Variety	Variety type	% alive plants under the influence with t (°C)				LT_{50}	Group
		-10	-12	-14	mean		
1. Pamina	pall	100	90	61	81	-15.1°C	II
2. Dominator	pall	100	75	41	72	-13.5°C	III
3. Utta	pall	90	71	31	64	-13.0°C	IV
4. Miraj	pall	57	56	17	44	-12.3°C	V
5. Cenader	pall	41	39	0	30	-11.2°C	VI
6. Actacus	pall	43	28	0	25	-10.6°C	VII

Table 3. Drought resistance of winter barley varieties and lines.

№	Variety/line	Water content of leaves (%)	Water holding capacity (%)	Residual water deficit (%)	Output of electrolytes	Drought resistance coefficient
Good drought resistance						
1.	DRF 206-2	67.98	42	10.04	4.7	5 875
2.	DRT 279-2	67.08	48	17.41	3.7	4 998
3.	DRT 198-1	63.09	40	18.26	3.4	4 064
4.	DRT 103-2	68.31	40	18.84	3.6	4 050
5.	AVD-24	66.80	46	13.91	5.5	4 016
6.	DRT 061	64.45	46	15.23	5.2	3 743
7.	K 2419-03	65.50	42	15.25	4.9	3 681
8.	DRT 136	68.56	44	16.51	5.0	3 654
9.	MB-A51	70.21	44	19.78	4.3	3 632
Middle drought resistance						
10.	CRF 292	69.25	36	15.84	4.5	3 497
11.	K 2538-01	66.63	42	16.75	4.8	3 480
12.	CRF 259	71.35	36	16.75	4.6	3 457
13.	ABVD-11	70.08	44	18.35	4.9	3 429
14.	PG 4437	70.08	36	18.25	4.2	3 291
15.	CRF 146 b	70.65	36	16.23	4.9	3 198
16.	CRT 1-1	65.78	38	15.78	5.0	3 133
17.	Veslets	69.45	38	19.25	4.4	3 115
18.	AVD-25	65.83	46	20.95	4.7	3 075
19.	CRF 47	68.74	48	19.94	5.4	3 064
20.	Sladoran	69.02	46	16.58	6.3	3 039
21.	CRF 302-2	67.90	42	15.04	6.3	3 009
22.	ABVD-4	63.09	46	18..67	5.8	2 680
23.	AVD-11	61.17	44	33.91	3.0	2 645
24.	Balkan-96	67.22	46	17.57	6.8	2 588
25.	ABVD-10	66.29	46	17.77	6.7	2 561
26.	Burgaz	74.79	46	19.06	7.2	2 506
27.	Lord	64.42	46	18.15	6.6	2 473
28.	ABVD-7	65.47	44	35.33	3.3	2 470
29.	Bolayir	69.56	46	19.25	6.8	2 444
30.	Perun	64.23	40	17.09	6.3	2 386
31.	AVD-21	61.18	44	33.18	3.6	2 261
32.	CRT 272-1	63.18	40	17.18	6.6	2 234
33.	PG-4365	67.06	42	23.87	5.4	2 185
34.	L 4384	56.56	36	21.22	4.4	2 180
35.	Arda	56.38	38	18.90	5.2	2 179
Low drought resistance						
36.	CRT 171	63.86	40	22.86	5.6	1 996
37.	ABVD-7	62.00	46	26.66	5.4	1 981
38.	AVD-12	60.47	44	39.01	3.7	1 843
39.	AVD-23	56.95	50	39.63	4.2	1 710
40.	Obzor	64.40	42	27.07	6.1	1 638
41.	AVD-22	59.15	44	42.99	3.8	1 593
42.	AVD-19	63.76	46	34.62	5.7	1 486
43.	ABVD-8	56.78	50	48.33	4.3	1 366

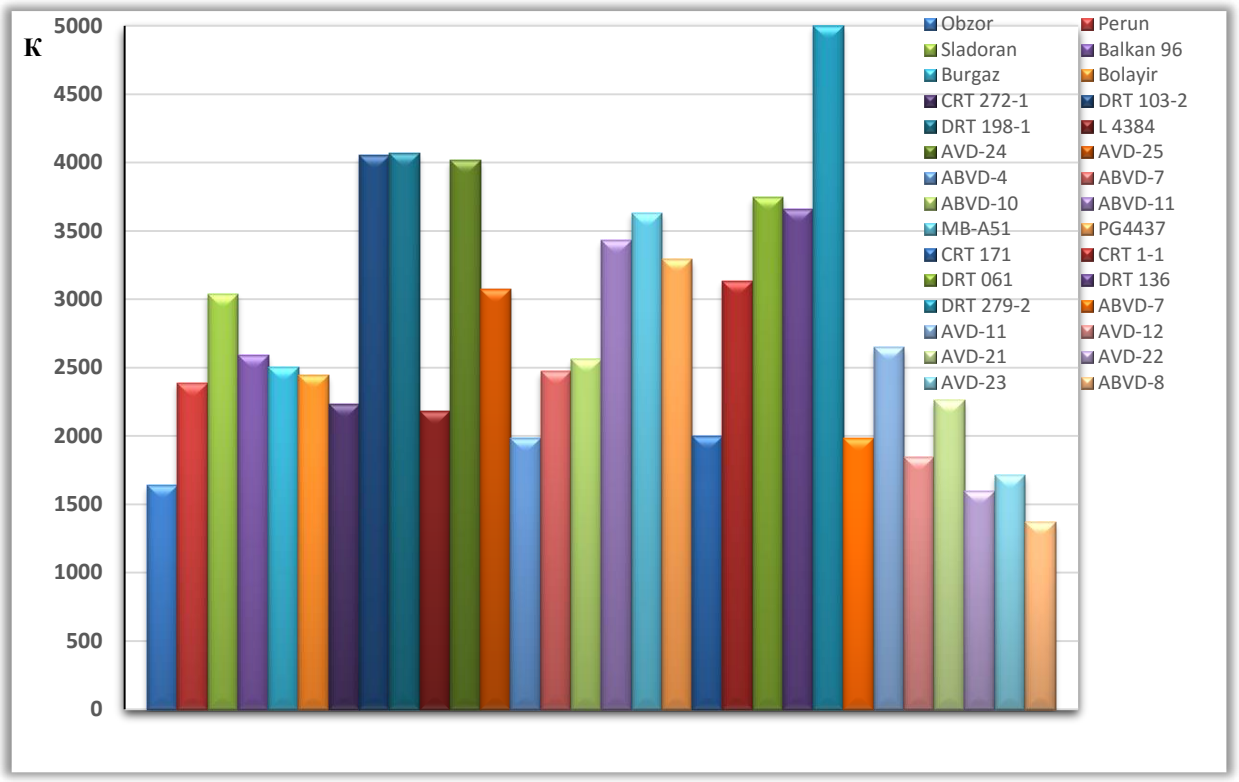

Figure 1. Drought resistance coefficient of two row barley varieties and lines.

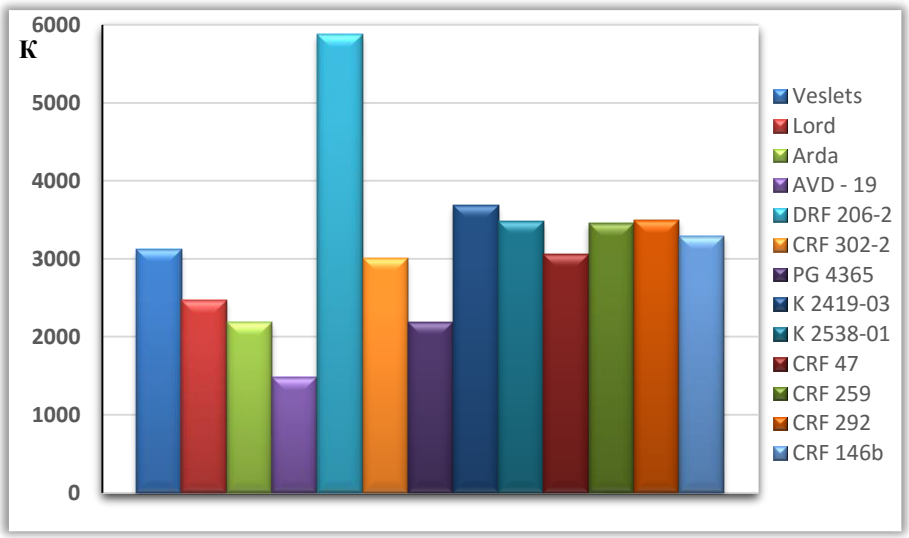

Figure 2. Drought resistance coefficient of feed barley varieties and lines

the variety of Obzor, which is in the group III with low drought tolerance which includes 6 Turkish and one Bulgarian lines. Figs. 1 and 2 give a visual indication of drought tolerance of the studied samples based on their coefficients of drought tolerance

The behavior of crop plants in relation to water and temperature regime in drought conditions were determined (Table 4). Conditions under which it was committed reporting are:

- Air temperature +22.3°C
- Relative humidity 38%
- Soil temperature outside crop 25 cm depth +16.0°C
- Temperature of the soil surface +33.2°C.

Lowest temperature in the soil (11.0°C) was reported in two lines, AVD-25 and CRT 272-1. Lowest surface temperature of crop plants was maintained by K 2538-01 and CRF 146-b (14.6°C). Lowest temperature inside the crop is supported by K-line 2538-01 (13.4°C). Thirteen of

Table 4. Water and temperature regime of crop barley varieties and lines under drought conditions.

№	Variety/line	Temperature at the soil in the crop 25 cm depth (°C)	Temperature of the surface of the crop (°C)	Temperature inside the crop (°C)	Relative humidity within the crop (%)
1.	Obzor	12.0	20.2	19.6	40.0
2.	Perun	14.0	21.4	19.8	41.0
3.	Sladoran	13.0	21.0	19.6	40.0
4.	Balkan 96	12.0	20.6	19.2	41.0
5.	Burgaz	13.0	21.4	20.6	41.0
6.	Bolayir	14.0	19.2	18.8	40.0
7.	AVD – 24	12.0	22.2	21.6	41.0
8.	AVD – 25	11.0	16.9	16.4	38.0
9.	ABVD – 4	13.0	16.4	14.4	38.0
10.	ABVD – 7	12.0	16.8	16.4	40.0
11.	ABVD – 10	14.0	16.2	16.2	40.0
12.	ABVD – 11	12.0	16.4	16.6	39.0
13.	MB-A 51	12.0	16.2	15.8	38.0
14.	CRT 272-1	11.0	16.2	16.6	40.0
15.	DRT 103-2	13.0	16.6	16.2	41.0
16.	DRT 198-1	13.0	16.6	16.2	41.0
17.	L 4384	13.0	16.2	15.8	41.0
18.	PG 4437	12.0	17.4	16.8	40.0
19.	CRT 171	12.0	17.4	16.6	41.0
20.	CRT 1-1	12.0	16.6	16.0	41.0
21.	DRT 061	12.0	16.2	15.8	41.0
22.	DRT 136	13.0	16.4	15.0	41.0
23.	DRT 279-2	13.0	16.0	15.4	41.0
24.	ABVD – 7	13.0	16.2	15.6	40.0
25.	AVD -11	13.0	16.6	15.6	41.0
26.	AVD – 12	12.0	16.2	14.8	40.0
27.	AVD – 21	12.0	16.8	15.4	40.0
28.	AVD – 22	13.0	15.8	15.8	39.0
29.	AVD – 23	13.0	15.6	15.2	39.0
30.	ABVD – 8	14.0	15.6	14.8	39.0
31.	Veslets	13.0	15.4	14.8	39.0
32.	Lord	13.0	15.6	15.0	39.0
33.	Arda	13.0	15.6	15.2	38.0
34.	AVD – 19	13.0	15.8	14.8	37.0
35.	DRF 206-2	13.0	15.6	14.2	38.0
36.	CRF 302-2	13.0	15.4	14.8	37.0
37.	PG 4365	14.0	15.2	14.6	38.0
38.	K 2419-03	12.0	15.8	14.6	37.0
39.	K 2538-01	12.0	14.6	13.4	37.0
40.	CRF 47	12.0	15.8	14.4	37.0
41.	CRF 259	13.0	15.0	14.6	37.0
42.	CRF 292	13.0	15.2	14.2	37.0
43.	CRF 146b	12.0	14.6	13.8	36.0

the tested varieties and lines maintain 41.0% relative humidity in the crop. These data provide information about the response of the varieties and lines individually in water and heat stress, and the correlation between temperature and relative humidity.

Conclusion

It was found that among the studied varieties and lines large numbers possess high resistance to these kinds of abiotic stress. With high cold resistance are: Burgaz, CRF 302-2, K 2538-01, Veslets, CRF 259, CRF 292, CRF 146 b and DRT 279-2. With high drought resistance are: DRF 206-2, DRT 279-2, DRT 198-1, DRT 103-2, AVD-24, DRT 061, K 2419-03, DRT 136, MB-A 51. They can successfully be included as sources of high resistance in these two areas in the breeding programs of Institute of Agriculture - Karnobat, Bulgaria and Trakya Agricultural Institute - Edirne, Turkey.

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References

1. Genchev, D. 1995. Assessment of tolerance to stress factors in breeding materials of kidney beans (*Phaseolus vulgaris* L.). *Bulgarien Journal of Agricultural Science*, 1(4): 415-422.

2. Koch, H. D. 1975. Barley cold resistance. *Third workshop on topic* 7, KOS, Odessa, Ukraine, 102-104.

3. Valchev, D. 1995. *Physiological and agronomic characteristics of drought tolerance in barley and possibilities for its regulation*. Agricultural Academy, Sofia, Dissertation, 73 pp.

4. Valchev, D., Gocheva, M. & Valcheva D. 2014. Influence of drought on some physiological parameters in spring barley. *Scientific works*, 3(1): 54-58.