University of Birjand

تنشهای محیطی در علوم زراعی
Environmental Stresses In Crop Sciences
Vol. 14, No. 3, pp. 793-804
Fall 2021
http://dx.doi.org/10.22077/escs.2020.3097.1794

Original article

Comparison of some physiological root traits of bread and durum wheat cultivars under salt conditions

V. Atlassi Pak[1*], O. Bahmani[2]

1. Assistance Professor, Department of Agriculture, Payame Noor University, Tehran, Iran
2. Assistance Professor, Department of Water Sciences and Engineering, Faculty of Agriculture, Bu-Ali Sina University, Hamadan, Iran

Received 11 January 2020; Accepted 10 March 2020

Extended abstract

Introduction

Faster and more extensive root growth is important for good plant growth and such a root system is expected to extract more available soil water in salt conditions. In order to examine root system and some physiological characteristics of four bread wheat contrasting in salt tolerance (Arg, Ofoq, Tajan and Morvarid) and two durum wheat cultivars (Behrang and Shabrang), a greenhouse experiment was conducted with two salinity levels (0 and 13.5 dS/m NaCl) growing in PVC tube. Salt stress decreased root dry weight, shoot dry weight, seminal root length, total root length, root and shoot K+, shoot K+/Na+, root K+/Na+ and tillers and increased root Na+,shoot K+ leaf temperature and chlorophyll content compared to control. Seminal root growth did not affect by salinity stress in Arg andno significant differences was observed between Arg and Shabrang in this aspect. Although, reduction in seminal root length was less in Arg (5%) and Shabrang (32%), but these cultivars had more reduction in total root length by 64% and 68% respectively under saline conditions. Root growth reduction in cultivars was due to osmotic stress of salt solution out of the roots and the values for total root length in bread wheat cultivars was more under salt stress. Finding of this study on root lentgh identify it as one of the valuable index for improved adaptation to osmotic stress in wheat.

Materials and methods

In order to examine root system and some physiological characteristics of four bread wheat contrasting in salt tolerance (Arg, Ofoq, Tajan and Morvarid) and two durum wheat cultivars (Behrang and Shabrang), a greenhouse experiment was conducted with two salinity levels (0 and 150mM NaCl) growing in PVC tube. Treatments were imposed when the leaf 2 was fully expanded. Leaf temperature of plants was acquired in the greenhouse 5 days after imposing the salt treatments. At 21 days after salt treatment plants were harvested and traits were measured. Seminal root length, total root length, Chlorophyll content, K+ and Na+ root, root and shoot dry weight in all cultivars were investigated.

Results

Salt stress decreased root dry weight, shoot dry weight, seminal root length, total root length and increased root Na+, leaf temperature and chlorophyll content compared to control. Seminal root growth did not affect by salinity stress in Arg and no significant differences was observed between Arg and

[*]Correspondent author Vahid Atlassi Pak; E-Mail: v.atlassi@gmail.com.

Shabrang in this aspect. Although, reduction in seminal root length was less in Arg (5%) and Shabrang (32%), but these cultivars had more reduction in total root length by 64% and 68% respectively under saline conditions. Differences in root Na+ concentration between some wheat cultivars were less obvious in 21 days after salt treatments and it seems the roots exposed to salinity were reduced in growth mainly because of the osmotic effect of the salt, rather than a salt-specific or toxic effect. Seminal root length reduction in cultivars was due to osmotic stress of salt solution out of the roots and the values for total root length in bread wheat cultivars was more under salt stress. Shabrang showed the highest and significant increase in leaf temperature among cultivars and the most reduction in shoot dry weigh was observed in this cultivar under salt conditions. In more extended studies, shoot growth was more inhibited than root growth in saline and dry soils, however, in this study, there was little effect on shoot growth. Thus, assimilate supply was not limiting root growth.

Conclusions

The ability of wheat to retain seminal and total root length improved osmotic tolerance and extending root system in salt tolerant cultivars would allow water acquisition from deeper in the soil profile, thus helping to overcome osmotic stress. Results showed that osmotic tolerance may be in bread wheat to the same extent as in durum wheat cultivars and the finding of this study on root traits identify it as one of the valuable index for improved adaptation to osmotic stress in wheat. Under salt conditions or in some wheat cultivars, modification of root water uptake capacity plays a more important role compared with stomatal closure in avoiding stress-induced growth reduction.

***Keywords*:** Branch Root, Salt tolerance, Seminal Roots

Table 1. Physical and chemical characteristic of soil

Sand	Silt	Clay	Organic carbon	EC_e	pH	SAR	Na^+	$Ca^{2+} + Mg^{2+}$
---------- % ----------				dS/m				meq.l^{-1}
60	28	12	0.55	1.98	8.01	0.97	3.5	26.03

Table 2. Mean square analysis of variance of data for measured traits in wheat cultivars under different salinity levels

S.O.V	df	Shoot dry weight	Root dry weight	Seminal root length	Total root length
Salinity (S)	1	0.20^{**}	0.05^{**}	19416^{**}	2624810^{**}
Cultivar (C)	5	0.16^{**}	0.002^{**}	6483^{**}	228253^{**}
S × C	5	0.01^{ns}	0.0006^{ns}	939^{**}	95808^{**}
Error	36	0.008	0.0003	255	22235
CV%		*17*	*19.8*	*16.9*	*16.5*

Table 2. Continued

S.O.V	df	Root Na^+	Root K^+	Leaf temperature	Number of tillers
Salinity (S)	1	320386^{**}	313547^{**}	559^{**}	4.49^{**}
Cultivar (C)	5	1718^{ns}	4075^{**}	10^{**}	1.90^{**}
S × C	5	4627^{**}	1030^{ns}	31^{**}	0.62^{**}
Error	36	885	665	0.87	0.03
CV%		*11.9*	*13.5*	*3.7*	*23.7*

ns: Non-significant, ** and *: significant at 1 and 5% probability level respectively

Table 3. Mean comparison of wheat cultivars under different salinity levels

Treatment	Shoot dry weight	Root dry weight	Root K^+
	----------g----------		µmol.g^{-1} DW
Salinity(mM)			
0	0.61^{a}	0.12^{a}	271^{a}
150	0.48^{b}	0.05^{b}	110^{b}
Cultivar			
Arg	0.40^{d}	0.11^{a}	204^{a}
Ofoq	0.55^{bc}	0.09^{a}	210^{a}
Tajan	0.41^{d}	0.10^{a}	213^{a}
Morvarid	0.49^{cd}	0.09^{a}	187^{ab}
Behrang	0.77^{a}	0.07^{b}	171^{bc}
Shabrang	0.63^{b}	0.07^{b}	158^{c}

Means followed by the same letters for each column and each factor are not significantly different by the LSD test at 5% probability level

Table 4. Means comparison for characteristic of wheat cultivars 3 weeks after exposure to salinity

Cultivar	Salinity	Shoot Dry Weight	Root Dry Weight	Seminal Root Length	Total Root Length	Root Na^+	Root K^+
	mM	----------g----------		----------cm----------		----µmol.g^{-1} DW-----	
Arg	**0**	0.43^{e}	0.16^{a}	126^{b}	1601^{a}	186de	291^{a}
	150	0.38^{e}	0.06^{de}	120^{b}	580de	326^{abc}	118^{cd}
Ofoq	**0**	0.61^{cd}	0.12^{bc}	111^{bc}	1156^{b}	146^{ef}	290^{a}
	150	0.49^{de}	0.07^{d}	57^{fg}	782^{cd}	368^{a}	129^{c}
Tajan	**0**	0.42^{e}	0.13^{b}	105^{bcd}	1278^{b}	130^{f}	295^{a}
	150	0.41^{e}	0.07^{d}	39^{g}	663^{d}	321^{bc}	132^{c}
Morvarid	**0**	0.59^{cd}	0.13^{b}	88de	1354^{b}	157^{ef}	276^{a}
	150	0.39^{e}	0.05^{de}	50^{fg}	610^{d}	311^{c}	99^{cd}
Behrang	**0**	0.85^{a}	0.10^{c}	92^{cd}	916^{c}	210^{d}	260^{a}
	150	0.70^{bc}	0.03^{e}	67^{ef}	343^{f}	295^{c}	82^{d}
Shabrang	**0**	0.77^{ab}	0.11^{bc}	162^{a}	1161^{b}	168^{def}	217^{b}
	150	0.50^{de}	0.04^{e}	111^{bc}	380^{ef}	356^{ab}	99^{cd}

Table 4. Continued

Cultivar	Salinity	Root K^+/Na^+	Leaf Temperature	Shoot Na^+	Shoot K^+	Shoot K^+/Na^+	Number of Tillers
	mM		° C	------µmol.g^{-1} DW------			
Arg	**0**	1.6^{cd}	18.8^{g}	101^{d}	548^{a}	5.5^{a}	1.66^{a}
	150	0.36^{e}	29^{b}	588^{ab}	323^{g}	0.55^{c}	0.75^{c}
Ofoq	**0**	2^{ab}	23.5^{e}	81^{d}	463^{c}	5.7^{a}	0.41^{d}
	150	0.35^{e}	28.7^{bc}	505^{b}	322^{g}	0.65^{c}	….
Tajan	**0**	2.3^{a}	25.3^{d}	89^{d}	473^{bc}	5.5^{a}	1.33^{b}
	150	0.41^{e}	27.8^{bc}	357^{c}	339^{fg}	0.95^{c}	1.50^{ab}
Morvarid	**0**	1.7^{bc}	24.1^{de}	88^{d}	449^{c}	5.5^{a}	1.0^{c}
	150	0.31^{e}	27.8^{bc}	570^{ab}	389^{d}	0.72^{c}	0.16^{ef}
Behrang	**0**	1.24^{d}	20.9^{f}	121^{d}	492^{b}	4.1^{b}	0.41^{de}
	150	0.27^{e}	27.5^{c}	631^{a}	357^{ef}	0.59^{c}	0.16^{ef}
Shabrang	**0**	1.36^{d}	17.7^{g}	129^{d}	456^{c}	3.5^{b}	1.5^{ab}
	150	0.27^{e}	30.6^{a}	630^{a}	373de	0.59^{c}	0.08^{f}

Means followed by the same letters for each trait in each column are not significantly different by the LSD test at 5% probability level

Table 5. Correlation for characteristic traits of wheat cultivars under salt stress

	Traits	1	2	3	4	5	6	7
1	**Shoot dry weight**	1						
2	**Root dry weight**	0.04^{ns}	1					
3	**Total root length**	0.05^{ns}	0.90^{**}	1				
4	**Seminal root length**	0.24^{ns}	0.39^{**}	0.41^{**}	1			
5	**Leaf temperature**	-0.47^{**}	-0.69^{**}	-0.73^{**}	-0.54^{**}	1		
6	**Root Na^+**	-0.31^{*}	-0.73^{**}	-0.77^{**}	-0.46^{**}	0.72^{**}	1	
7	**Root K^+**	0.20^{ns}	0.85^{**}	0.84^{**}	0.42^{**}	-0.68^{**}	-0.8^{**}	1

ns: Non-significant, ** and *: significant at 1 and 5% probability level respectively