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ANALYZING THE POTENTIAL OF SPRING WHEAT (*Triticum aestivum* L.) ACCESSIONS FOR WATER DEFICIT CONSTRAINT

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Wheat is an ancient small grain cereal with pretty valuable nutrition. The high throughput nutrition makes it an essential part of human life. Wheat is also a staple grain food. Its demand is rising day to date. The wheat is facing water deficiency to sustain its production. The sustainability in its production has becoming confronted due to biotic and abiotic climatic hazards. The shortfall of water in world is rising due to climatic fluctuations. The present study was proposed to screen out valued genotypes of wheat from the present stocks to prepare drought tolerant material against the water deficit milieu. Five potential lines viz., 9618, 9508, 9797, 9493, 10111 and three approved varieties Bakhar-2002, BARS-2009, Chakwal-86 were identified as drought tolerant parents with diverse genetic background. These genotypes performed excellent for seedlings traits. Drought caused significant reduction e.g. 29.93 % in root length, 18.10 % in shoot length, 12.69 % in root to shoot ratio, 40 % in fresh weight, 36.6 % in dry weight and 13.69 % in relative water content. The traits viz., root length, fresh weight and relative water content showed maximum reduction under drought. So the selection of best performing genotypes on the base of root length, fresh weight and relative water content proved as good selection criterion for screening against drought.

Keywords: Drought tolerant, valued genotypes, water deficit milieu.

INTRODUCTION

Wheat is a traditional crop among small grain cereals which belongs to grass family *Poaceae*. Wheat (*Triticum aestivum* L.) is an excellent crop that contributes 55% carbohydrate and 20.0% proteins of human need (Acevedo *et al*., 2002). Wheat has great nutritional importance in world-wide (Ginkel and Ortiz, 2018). Globally wheat is cultivated more than 20% of land and ranked third among grain cereals after maize and rice (FAOSTAT, 2018). Stipulate for wheat production is going up with every passing year due to sky-scraping population rise. So, there is need to enhance production up to 70% by 2050 (Godfray *et al*., 2010). Wheat is considered as a major dietary food in Pakistan. Wheat is consumed 65.0% as human food, 21.0% as livestock feed, 8.1% as seed purpose and 6.0% for industrial use (Hussain *et al*., 2018). The starch and gluten of wheat have also great economic values. Wheat is used as raw material in manufacturing of beers, beverages, biofuels, noodles, cakes, breads and chappati (Neill, 2002; Hemdane *et al*., 2016; Barak, 2018). Wheat contributes 8.7% in value addition in agriculture & 1.7% to GDP. While it shows increase in area of cultivation by 1.7% every year (Pakistan Economic Survey, 2019-20). The projected wheat yield in Pakistan for year 2020-21 is forecasted 25.7 million-metric-tons which is six percent higher than the 24.3 million-metric-tons of previous year 2019-20 (USDA, 2020). The yield stability depends on the climate. While natural systems and agricultural production has been significantly affected by climate change (Arunanondchai *et al*., 2018). Global warming is the key factor of climatic change which enhances the abiotic stresses of ecosystem (Kanojia and Dijkwel, 2018). The drought is a major abiotic stress for crop production and it will rise in future (Oliveria *et al*., 2013; Basal and Szabo, 2020).

Drought stress is referred to shortage of essential moisture level for crop stand. Wheat is more prone to drought stress (Zhang *et al*., 2016). Wheat is a drought sensitive cereal which showed reduction in yield and physiological pathways (Wakchaure *et al*., 2016). Drought affects the wheat production and caused significant yield losses (Pradhan *et al*., 2012). The moisture scarcity linked with leaf senescene (Yang *et al*., 2003), damage to photosynthetic system (Farooq *et al*., 2009), pollen viability (Cattivelli *et al*., 2008), translocation rate (Asada, 2006) and poor seed setting (Nawaz *et al*., 2013). The drought stress at seedling phase caused reduction in shoot related traits (Reynolds *et al*., 2001: Huang *et al*., 2013). The moisture stress at seedling phase linked with the reduction of root parameters (Richards *et al*., 2007). The seedling traits showed great reduction under drought stress (Noorka *et al*., 2007; Sahin *et al*., 2019; Qamar *et al*., 2020).

Improvement in wheat cultivars by selection of drought tolerant genotypes is a renowned strategy for drought prone conditions (Tariq *et al*., 2013; Qadir *et al*., 2019). The selection of drought tolerant genotypes on the base of seedling parameters is a useful technique (Mitra, 2001). Early selection in wheat on seedling parameters is a good strategy for drought tolerance (Araus *et al*., 2002; Bayoumi *et al*., 2008). Variation exists in germplasm for drought tolerance can be used to incorporate stress tolerance genes in modern cultivars of wheat (Reynolds *et al.*, 2005). The present study was designed to address the drought problem in spring wheat and identification of good performing genotypes for seedling traits under drought regime.

MATERIALS AND METHODS

Thirty diverse genotypes of wheat were randomly selected from accessible germplasm stocks of University of Agriculture, Faisalabad (UAF) and Ayub Agricultural Research Institute (AARI). The experiment was established in the greenhouse of Plant Breeding Department of University of Agriculture, Faisalabad (UAF) in November 2016. Genotypes were sown by using completely randomized design under factorial with three replications. Polythene bags (30 × 15 cm) ¾ part filled with sandy loam soil was used. For each genotype 3 bags were sown under normal and 3 bags were sown under drought stress to obtain triplicate data. Five seeds were sown in each polythene bag. The normal genotypes were watered 110 ml each bag which was 100% field capacity, while genotypes sown in drought block were watered 55 ml each bag which was 50% of field capacity. The field capacity was estimated by using following formula;

$$F.C = Ww - Dw / Dw \times 100$$

The irrigation was applied after every six days and experiment was maintained up to four weeks. The data recorded after four weeks of planting. The attributes subjected under study were viz., root length (cm), shoot length (cm), root to shoot ratio (%), fresh weight (g), dry weight (g) and relative water content (%). The root length was calculated with ruler from the tip of root to the point attachment with shoot. Shoot length was recorded with ruler from base of shoot to the tip of shoot. Fresh weight of seedlings was taken by pulling out and freshly take the weight of whole seedling by digital weight balance. While dry weights of seedlings were calculated after 72 hour oven drying. The root to shoot ratio was estimated by using formula;Root/Shoot ratio = Root length / Shoot length × 100

The relative water content was estimated by using formula;

$$RWC = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

The statistix 8.1 software was used for significance test (Steel *et al.*, 1997). The diversity among genotypes was estimated by using cluster analysis. The accessions were named accordingly (Table 1).

Table 1. Names of wheat accessions

Code	Names	Code	Names
G1	FSD-2008	G16	Bathoor-2008
G2	9618	G17	moomal-2002
G3	Shafaq-2006	G18	9610
G4	9508	G19	BARS-2009
G5	Galaxy-2013	G20	9930
G6	Uqab-2000	G21	Chakwal-86
G7	Lasani-2008	G22	9517
G8	9797	G23	AARI-2011
G9	Ufaq-2002	G24	Aas-2011
G10	Millat-2011	G25	Fareed-2006
G11	BWL-1418	G26	9493
G12	MH-97	G27	9516-1
G13	Bakhar-2002	G28	Watan
G14	Anmool-91	G29	Pasban-90
G15	Manthar-2003	G30	10111

RESULTS

The significant differences were recorded for seedling traits (Table 2). The genotypes and treatment effects were highly significant ($P<0.01$), whereas interaction between genotype and treatment was also significant ($P<0.05$).

Drought stress showed negative effect on the seedling traits. Drought caused significant decline in mean performance of seedling traits e.g., 29.93 % in root length, 18.10 % in shoot length, 12.69 % in root to shoot ratio, 40 % in fresh weight, 36.6 % in dry weight and 13.69 % in relative water content (Table 3). Genotype G8 (9797), G21 (Chakwal-86) and G13

Table 2. Mean square values for ANOVA (analysis of Variance)

S.O.V	D.f	RL	SL	R/S %	FW	DW	RWC
Replication	2	0.061	0.013	0.00008	0.0134	0.0052	4.91
Genotypes	29	57.900**	27.980**	0.11250**	0.0516**	0.0214**	156.84**
Treatment	1	829.470**	778.750**	0.29440**	6.2700**	1.8220**	5002.28**
G×T	29	10.160*	2.880**	0.01350*	0.0230	0.0060*	4.43*
Error	145	2.044	0.584	0.00270	0.0110	0.0036	1.35
Total	179						

** = significant at $P<0.01$, * = significant at $P<0.05$, s.o.v = source of variance, d.f = degree of freedom, RL = root length (cm), SL = shoot length (cm), R/S % = root to shoot ratio, FW = fresh weight, DW = dry weight, RWC = relative water content

Table 3. Statistics of 30 spring wheat accessions for seedling traits under normal and drought regime.

Traits	Conditions	Minimum	Maximum	Mean	SE	SD	LSD	CVg	CVp	CVe	G.A %
RL	Normal	6.90	23.00	14.70	0.12	4.22	0.32	28.77	28.79	1.00	50.32
	Drought	6.20	15.30	10.30	0.09	2.21	0.24	21.23	21.25	1.06	37.10
SL	Normal	18.90	27.10	23.20	0.08	2.20	0.21	9.53	9.54	0.42	16.65
	Drought	15.00	25.10	19.00	0.08	2.32	0.21	12.18	12.19	0.51	21.29
R/S %	Normal	0.29	0.93	0.63	0.03	0.17	0.07	26.39	26.41	1.22	46.13
	Drought	0.28	0.77	0.55	0.01	0.12	0.02	21.73	21.77	1.31	37.96
FW	Normal	0.80	1.20	1.00	0.08	0.15	0.24	10.34	15.10	11.01	12.38
	Drought	0.50	0.90	0.60	0.05	0.11	0.13	15.96	18.77	9.89	23.73
DW	Normal	0.20	0.60	0.30	0.06	0.10	0.16	19.96	28.36	10.14	24.59
	Drought	0.13	0.40	0.19	0.02	0.05	0.04	24.81	27.65	12.21	38.96
RWC	Normal	63.90	83.00	72.65	0.72	5.31	1.91	7.21	7.31	1.21	12.44
	Drought	54.20	74.10	62.70	0.77	5.16	2.04	8.17	8.31	1.52	14.06

RL = root length, SL = shoot length, R/S % = root to shoot ratio, FW = fresh weight, DW = dry weight, RWC = relative water content.

(Bakhar-2002) showed maximum root length respectively 23.0 cm, 22.7 cm, 21.2 cm under control and 15.30 cm, 13.1 cm, 12.9 cm under drought regime (Table 3). Genotype G4 (9508), G30 (10111) and G19 (BARS-2009) showed maximum performance for shoot length respectively 27.10 cm, 23.9 cm, 21.4 cm under control and 25.10 cm, 20.1 cm, 19.7 cm under drought stress. For root to shoot ratio, genotypes G8 (9797) and G26 (9493) showed maximum root to ratio respectively 0.63 %, 0.59 % under control and 0.55 %, 0.53% under drought stress. Highest fresh and dry weight 1.20 g, 0.60 g respectively under normal and 0.90 g, 0.40 g respectively drought was observed in genotype G26 (9493). Maximum relative water content 83.0 % under normal and 74.10 % under drought was observed in G2 (9618).

The genetic diversity of eight genotypes viz., G2 (9618), G4 (9508), G8 (9797), G13 (Bakhar-2002), G19 (BARS-2009), G21 (Chakwal-86), G26 (9493) and G30 (10111) among thirty were addressed by the cluster analysis. Investigation of cluster analysis revealed five genotypes fall in first cluster which was the smallest cluster (Figure 1). The second cluster was the largest cluster having sixteen genotypes in it. Whereas, nine genotypes were present in third cluster. The cluster analysis revealed the diversity in the material (Fig. 1). The identified material was recommended for future research.

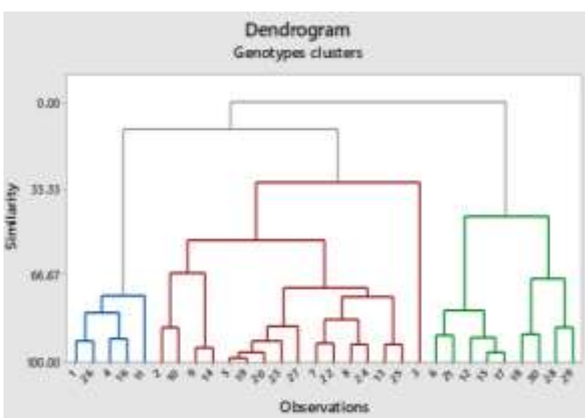

Figure 1. Diversity graph of spring wheat accessions.

DISCUSSION

Drought stress affects plant growth adversely (Wahid *et al*., 2007). Under water stress plant adjusts itself by changing physiological mechanisms (Chaves *et al*., 2009). All the genotypes showed reduction in the root length under drought milieu. The reduction of root length in wheat under water deficit environment was also reported earlier (Singh *et al*., 2000; Wasson *et al*., 2012). The drought caused significant reduction of root length at seedling growth phase (Ullah *et al*., 2014). Similar finding for root length was also reported (Mahmood *et al*., 2004; Chachar *et al*., 2014). Shoot length has crucial role in plant growth (Taiz and Zeiger, 2014). High shoot length is a good signature of plant growth. The shoot length behaved negatively in response to drought stress and all the genotypes showed reduction in shoot length. Drought stress caused significant decline of shoot length (Moayedi *et al*., 2009; Ahmad *et al*., 2013). Similar findings for shoot length were also observed (Kamran *et al*., 2009; Bibi *et al*., 2010; Khan *et al*., 2002). Root to shoot % ratio is a good parameter for screening genotypes under water deficit condition. Genotypes showed decline in root to shoot ratio under drought milieu. Moisture stress caused great decline in the root to shoot ratio at seedling phase (Khan *et al*., 2013). Similar findings for root to shoot ratio was also reported (Khan *et al*., 2010). Fresh weight is good parameter for normal plant growth. The reduction in fresh weight is an indicator of moisture stress (Khakwani *et al*., 2011). The fresh weight of all the genotypes showed great reduction under the drought milieu. The significant reduction of fresh weight was noticed under water deficit condition (Mahmood *et al*., 2004; Allozi and Alrawashdeh, 2014). The dry weight of genotypes showed decline under the moisture stress. The drought caused reduction the dry weight of wheat genotypes (Ghodsia *et al*., 2008). The reduction in dry weight of wheat genotypes was earlier reported (Awan *et al*., 2007; Ahmad *et al*., 2007). Genotypes showed negative behavior for relative water content under drought stress. Plants under drought stress were prone to reduction for relative water contents (Cornic, 2000). The significant reduction in relative water content under drought was also reported in wheat (Bayoumi *et al*., 2008; Ahmad *et al*., 2013).

Conclusion: The screening of wheat genotypes at seedling stage is very fruitful approach for drought tolerance. The used material showed great diversity. The genotype 9797 showed minimum decline for root length and root to shoot ratio under drought milieu. While genotype 9394 showed minimum decline for fresh and dry weight under drought stress. Genotype 9618 was identified as best performer for relative water content under drought regime. The seedling traits viz., root length, fresh weight, and relative water content showed more reduction under drought stress. So, the selection of genotypes on the base of root length, fresh weight and relative water content under drought is a good criterion for drought tolerance.

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