Academia Journal of Agricultural Research 7(5): 115-120, April 2019
DOI: 10.15413/ajar.2019.0111
ISSN: 2315-7739

Research Paper

Performance of bread wheat *(Triticum aestivum* L.) genotypes in normal, drought prone and salinity medicated environments for diversity and steadiness

Accepted 7th February, 2019

ABSTRACT

Three discrete trials were passed out under normal environment (E1), drought prone environment (E2) and salt stressed medicated environments (E3). The pooled analysis of variance for dignified traits of nineteen genotypes directed that environments were diversed and there were significant difference in genotypic retaliation across environments. Positive correlation of yield with normalized difference vegetation index at booting stage (stay green) and negative correlation with canopy temperature at booting stage (cooler canopy) in all environments advocated these as a dynamic yard stick for screening genotypes in the three environments. Relative water content of all genotypes significantly declined in E2 and E3 as compared with E1 at anthesis stage. Toward the yield stability of genotypes, E-1 was comparatively high contributor (discriminating) whereas E-3 was low contributor (least discriminating). Two genotypes were alike while three were unalike from the others due to their distance. Five genotypes stood winner in environment E1, two in E2 while three in E3. In all environments, two genotypes stayed adopted and stable, four stood adaptable with premier yield, two persisted stable with high yield, two existed stable by stumpy yield while all others presented no significant upshot. This nature of valuation will support in evolving new high yielding wheat varieties resistant to salinity and drought resilient.

Muhammad Zulkiffal*, Javed Ahmed, Aneela Ahsan, Saima Gulnaz, Muhammad Abdullah, Muhammad Musa, Abdullah, Amina Kanwal and Nadeem Ahmed

Ayub Agricultural Research Institute, Faisalabad, Pakistan.

*Corresponding author. E-mail: zulkiffal@yahoo.com. Tel: 00923339836982.

Key words: Normal, drought, salinity, environments, diversity, steadiness, bread wheat.

INTRODUCTION

Among many stresses, salinity and drought have an intense impact on crop phenology as they trim down wheat productivity and shrink global food security. For the mounting inhabitants, salinity or drought stresses has postured a foremost contest for upholding world diet deliveries due to forfeiture of cultivated land. In the existing domain, roughly 20 % of the irrigated land is pretentious by salinity and 43% by drought which total constitute an area of areas of 60 and 10.5 million km^2, correspondingly (Pooja et al; 2015).

In Pakistan, the pressures of food security policies are mainly on wheat production. The country is no alien to the bearings of climate stresses. In Pakistan, among the 20.8 million hectares of cultivable land, 5.33 million hectares are affected by salinity and 15 million hectares by drought. Punjab (50%), Sindh (40%) and Baluchistan (9%) provinces are overwhelmed by numerous categories of salinity, while due to drought, Punjab (15%), Sindh (54%), Khyber Pakhtunkhwa (56%) and Baluchistan (55%) are fringed by rainfed agriculture. In the country, the yearly cost of crop fatalities from salinity ranged from Rs15 to 55billion and
from drought Rs. 90 to100 billion (Amin et al., 2017, Mujtaba et al., 2002).

In understanding the genetic rheostat and consistency of drought and salt tolerance in main crops, numeral revisions have been testified which showed that salinity tolerant species could also be drought tolerant and vice versa since there are some mutual features among salinity and drought stresses in plants. Excluding for the ionic constituent in the cells of plants underneath salt stress, both stresses enforce cellular thirst, which grounds osmotic hassle and elimination of water from the cytoplasm into the intercellular space (Xuekun et al., 2014).

Hence, there is an imperative objective that both stresses should be pondered together for traits having the main impact on yield by exploiting genetic stability and reliability for wheat yield maximized by dissecting genotypes by environment interaction against the adverse effects of normal, saline and drought prone surroundings. This nature of assessment will support in developing new high yielding, resistant to salinity and drought robust wheat varieties.

MATERIALS AND METHODS

Three distinct tryouts were carried out under normal environment (E1), drought prone environment (E2) and salt stressed medicated environments (E3) at Wheat Research Institute, Faisalabad, Pakistan in randomized completed block design in 3 replications with the plot size of 2.5 m × 2 m rows. Salt stress medicated experiment was sown by applying irrigation with an electrical conductivity (EC)of 1 to 1.5 dS m^{-1}(non saline) until midjointing stage and later, it was irrigated using saline water by maintaining EC from 10 to 15 dS m^{-1}. While the third normal set was irrigated (1 to 1.5 dS m^{-1}) at tillering, booting and grain filling stage. All standard agronomic practices were implemented. Data on morpho-physiological traits viz., days to heading (50%), days to maturity (50%), normalized difference vegetation index (NDVI), canopy temperature, °C (CT), relative water content (RWC), and yield (kg ha^{-1}) were recorded. RWC was calculated at anthesis stage using the formula:

RWC(%)=[(Leaf fresh weight-Leaf dry weight)/(Leaf turgid weight-Leaf dry weight)]*100

EC was measured at 40 cm depth using a portable EC meter at fortnightly interval. For CT, data were recorded with LT.300 6th Sense Infrared Thermometer (IRT) and for recording the value of NDVI, green seeker (handheld-505) was used. Both CT and NDVI readings were taken at booting stage during sunny days with least wind speed at noon time during 11 am to 1 pm when the dew had dried off from the plant canopy. The two years (2016-17 and 2017-18) data were assembled and the average of two interpretations was calculated for use in future statistical scrutiny using statistical software packages of SPSS version 12, STATISTICA version 5.0 (Sneath et al., 2014) and multi environment trial analysis (META-R) (Alvarado et al., 2015).

RESULTS AND DISCUSSION

The pooled analysis of variance for measured traits (Table 1) showed that genotypic differences except N-BT and C-BT which were found significant ($P \leq 0.05$) demonstrated the existence of adequate variability to recognize latent genotypes. For the primary portion of the divergence, influence of environment was liable mainly on MD (89.3 %), HD (81.2%) and Yld (72.2%) trailed by EXG absolutely on C-BT (28.2%), N-BT (26.2%) and RWC (23.7%). The outsized environmental and EXG sum of square directed that environments were diversed and there were substantial difference in genotypic comeback across environments.

Correlation decoration

A simple correlation revealed significant relationships between 6 characters of 19 genotypes in 3 environments (Table 2). The positive correlation of yield with N-BT and negative correlation with HD and C-BT in all environments were establish which supported that these traits are vital for reliable selection of high yielding genotypes. Zulkiffal et al. (2018) also stated positive correlations of yield with NDVI and negative correlation with CT at booting and anthesis stages of wheat. A significant positive association of yield with N-BT suggested that genotypes with high chlorophyll content at booting phase had higher yield and can be used as an active yard stick for screening genotypes in 3 environments owing to the stay green existence. (Marta et al., 2012). The negative correlation of C-BT with the yield is due to the fact that NDVI values declined while CT increased which resulted in terminal heat stress, as the growth period progressed. Connected to adaptation beneath stress, cooler canopies recuperate metabolic and functional heroines; therefore, CT at is a decent indicator for genotypic fitness against stressed environments and this trait can be used as a choice component for evolving drought and saline stress lenient genotypes. Reynolds et al. (2001) found the same interrelation for N-BT and C-BT. Further, the mentioned that these attributing traits are very important contributors to total yield. In E1, N-BT had positive relationship with HD and MD while this trait was positively significant in the other two environments. Early heading genotypes usually accomplished well in misery environments by upholding period and rate of heading and maturity days and by absconding drought and salt stresses during grain filling phase. Position illumination can be done likewise.

RWC of all genotypes was significantly decreased in E2

Table 1: Pooled analysis of variance and interface proportion for exalted traits of wheat accessions in three environments.

SOV	DF	HD	MD	N-BT	C-BT	RWC	Yld
E	2	3443.7** 81.2	3125.2** 89.3	0.6054* 51.7	510.9* 58.5	2210.3** 56.9	53.432** 72.2
G	18	11.7** 10.6	5.2** 4.5	0.0114** 22.1	6.0** 12.7	7.3** 19.4	0.684** 15.3
EXG	36	7.6* 8.1	4.4** 6.1	0.0091* 26.2	7.1* 28.8	9.4** 23.7	0.301** 12.5
Residual	-	3.10 0	1.01 0	0.0017 0	1.91 0	0.63 0	0.021 0

The upper values specify sum of squares and the lower values designate explained disparity (%),HD, MD, N-BT, C-BT, RWC, Yld, E and G indicates, heading days, maturity days, normalized vegetation index at booting, canopy temperature at booting (C^0), relative water contents (%), yield ($Kgha^{-1}$), environments and genotypes, respectively.
* = P ≤ 0.05,**= P ≤ 0.01were highly significant (P ≤ 0.01).

Table 2: Correlation matrix for traits studied of wheat accessions in three environments.

Variable	HD	MD	N-BT	C-BT	RWC	Yld
HD	1					
MD	0.11 0.09 0.21	1				
N-BT	0.03 0.16* 0.14*	0.19 0.45* 0.48*	1			
C-BT	0.11 0.26 0.35	-0.19 -0.29 -1.30	-0.21 -0.25 0.28	1		
RWC	0.18 -0.21 -0.14	0.14 -0.19 -0.18	0.15 0.11 0.23	0.14 -0.19 0.18	1	
Yld	-0.09 -0.10 -0.19	-0.18 0.05 0.29	0.52* 0.28* 0.16*	-0.27 -0.04 -0.09	0.25 0.33** 0.37*.	1

* = P ≤ 0.05, **= P ≤ 0.01 while higher value specify (E1), central (E2) and lower (E3).

and E3 as compared with E1 at anthesis stage. In E2, the decreased in RWC was in genotypes 17 (34.9 %), 19 (38.3) while the reduction in all other was more than 50%. In E3, the RWC decline was in genotypes 2 (30.9%) and 14(28.9%), whereas the reduction in all other was more than 40%. Similarly, for the same traits the reduction in E1 was found in genotypes 12(22.4%), 4 (20.9%) and 9 (19.4%) while the lessening in all other was more than 30%. These results signify that the genotypes which retain RWC are found to be high yielder in their respective environments because the amount of RWC decreases with increasing drought (highly significant) and salinity (significant). Salima et al. (2010) also reported similar attachment while working on drought and salinity.

Steadiness visualization

The biplot was constructed for yield trait to screen the genotypes plus genotype by environment effects in three

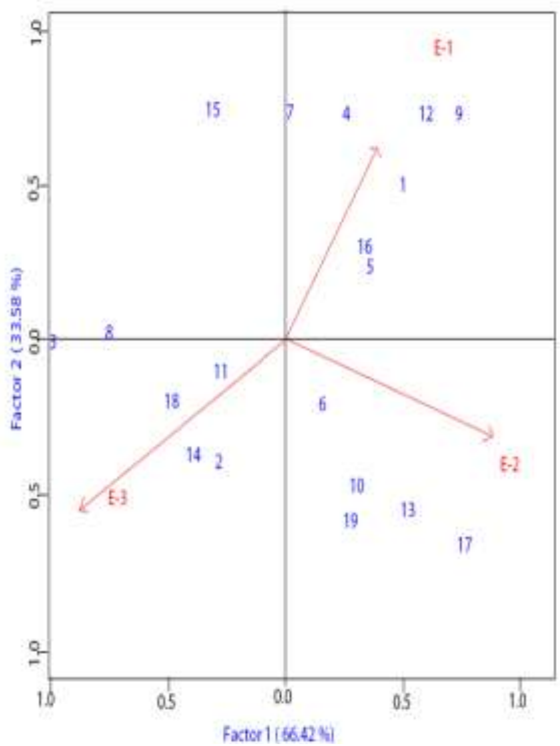

Figure 1: Biplot awarding the yield performance of different genotypes in three environments.

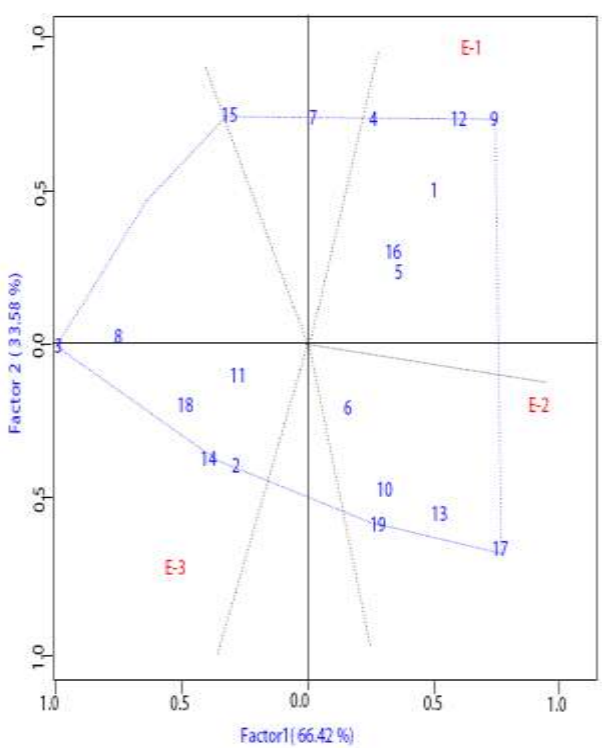

Figure 2: The polygon view (which-on-where) of genotypes yield performance in three environments.

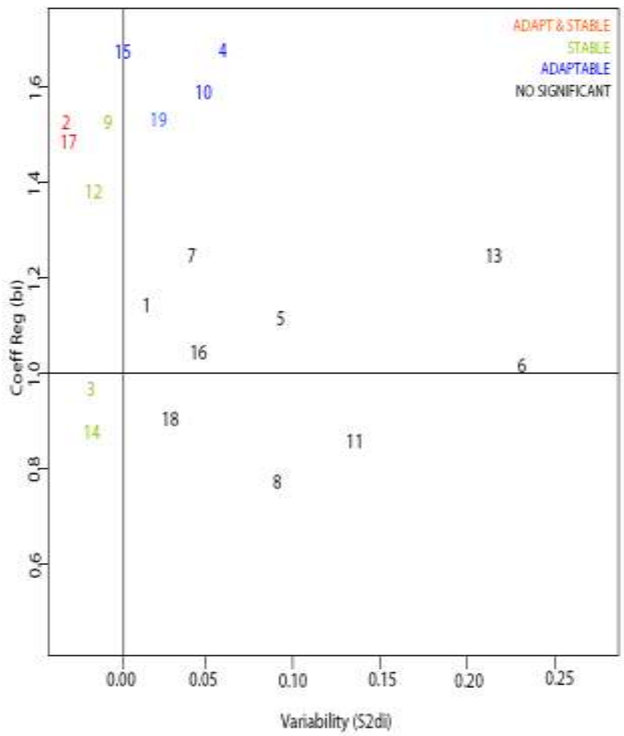

Figure 3: Genotypes yield performance based on regression coefficient and deviation from regression in three environments.

willful environments. The biplot elucidated 66.42% (PC1) and33.58% (PC2) of disparity (Figure 1). In the explicit environment cosine of the angle and the span of the vectors appraisals the magnitude of the correlation and the angle (above or below average) defines the trail of the interface. For instance, E1 and E3 were an acute angle, consequently these were initiated to be positively correlated, E2 and E1 were somewhat negatively correlated owing to their obtuse angle existence while there was no correlation between E3 and E1(right angle). E-1 was relatively high contributor (discriminating), whereas E-3 was low contributor (least discriminating) toward the stability of genotypes for yield as signposted by the shorter and longer distances between their pointer and foundation, respectively. Ezatollah et al. (2012) also testified normal environment as a high yielder and consistence for different genotypes. If the angle between its vector and the environment's vector is lesser than 90°, the recital of a genotype in an environment is better than medium. Thus it is lower than average if the angle is greater than the 90°, and it is nearby average if the angle is about 90° (Kanduset et al., 2010). For example, genotype 17 was overhead average in entire environments (acute angles) while 3 was under middling in whole environments (obtuse angles). The distance among genotypes guesses match and contrast between them. Genotypes 16 and 5 are similar while 17, 9 and 3 were unalike from the others due to their separate distance. This variation was due to the discrepancy in average yield or/and in interface with the environment.

For couple wise judgment and to visualize the interaction framework between environment and genotypes, a polygon was drawn by vertical streaks among the genotypes which are farthest from the biplot origin in such a way that all other genotypes are confined inside the polygon (Figure 2). The equality lines divide the biplot into sectors, and vertex genotypes (winning genotypes) are specifically suitable to corresponding environments. For instance, genotypes 9, 12, 4, 7 and 15 stood victor in environment E1, 17 and 9 in E2, while 2, 14 and 3 in E3.

Another thought in stability steadiness is stuck on coefficient of regression and deviation from regression. The genotypes with bi values upper than 1 had superior yield and lesser value of Sd^2 specified great level of stability. In all environments, 2 and 17 stayed adopted and stable, 4, 15, 10 and 19 stood adaptable with premier yield, 9 and 12 remained stable with high yield, 14 and 3 existed stable by stumpy yield, while all others presented no significant upshot (Figure 3).

CONCLUSION

1. The present fallouts investigation showed that due to the

positive correlation of yield with N-BT (stay green) and negative correlation with C-BT (cooler canopy) in all environments, these attributing traits are very imperative contributors to overall yield and could be used as an effective benchmark for screening and evolving drought and salinity tolerant wheat varieties. The genotypes which retain RWC were found to be high yielder in their respective environments because the amount of RWC decreases with increasing drought and salinity.

2. Genotypes 9, 12, 4, 7 and 15 stood victor in environment E1, 17 and 9 in E2, while 2, 14 and 3 in E3. Similarly, in all environments 2 and 17 stayed adopted and stable, 4, 15, 10, 19 stood adaptable with premier yield, 9, 12 remained stable with high yield, 14, 3 existed stable by stumpy yield, while all others presented no significant upshot.

3. As a consequence of climate resilient and food safety, drought and salinity tolerant genotypes can be used as genetic reserve for introgression into high yielding wheat cultivars for enterprising growing drought and salinity stresses.

REFERENCES

Alvarado G, Lopez M, Vargas M, PachecoA, Rodríguez F, Burgueno J, Crossa J (2015). META-R (Multi Environment Trial Analysis with R for Windows) Version 5.0 International Maize and Wheat Improvement Center. http://hdl. handle .net /11529/10201.

Amin A (2017). Effort on salinity isn't worth its salt.The business and finance weekly. Published in Dawn, July 17th, 2017. https://www.dawn.com/news/1345805.

Ezatollah F, Hooshmand S, Bita J (2012). GGE biplot analysis of adaptation in wheat substitution lines. Int. J. Agric. Crop Sci. 4(13): 877-881.

Kandus MMD, Almorza RR, Salerno JC (2010). Statistical methods for evaluating the genotype by environment interaction in Maize (*Zea mays* L). Inter. J. Exp. Bot. 79(26): 39-46.

Martha SL, Matthew PR (2012). Stay-green in spring wheat can be determined by spectral reflectance measurements (NDVI) independently from phenology. J. Exp. Bot. 63 (10): 3798-3798. Doi: 10.1093/jxb/ers071.

Mujtaba SM, Alam SM (2002). Drought phenomenon crop growth.The industry and economics weekly. Published in Pakistan & Gulf Economist.

Pooja S, Rajesh K (2014). Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi J. Biol. Sci. 22(2): 123-131.

Reynolds M, Geema M, Julie M, Hans B (2015). Proceedings of the International TRIGO (Wheat) Yield Potential Workshop 24-26 March 2015. CIMMYT, Cd. Obregón, Sonora, Mexico.

Salima Y, Maria DS, Jordi V, Jose LA (2010). Effect of salinity and water stress during the reproductive stage on growth, ion concentrations, $\Delta^{13}C$, and $\delta^{15}N$ of durum wheat and related amphiploids. J. Exp. Bot. 61(13): 3529-3542. doi:10.1093/jxb/erq184.

Sneath PHA,Sokal RR (2014). Numerical taxonomy-the principles and practice of numerical classification. Taylor and Francis Publishing Ltd. pp. 263-268.

Xuekun Z,Guangyuan L,Weihua LXZ, Feng L, Takeshi N (2014). Recent progress in drought and salt tolerance studies in *Brassica* crops. Breed. Sci. 64(1): 60-73. doi:10.1270/jsbbs.64.60.

Zulkiffal M, Saima G, Javed A, Aziz R, Muhammad M, Abdullah, M, Javaid MM, Jaffar S (2018). Morphological diversity valuation of exotic and advanced lines of bread wheat (*Triticum aestivum L.)* via multivariate analysis. Inter. J. Agron. Agric. Res. 13(2): 149-156.

Cite this article as:

Zulkiffal M, Ahmed J, Ahsan A, Gulnaz S, Abdullah M, Abdullah MM, Kanwal A , Ahmed N (2019). Performance of bread wheat (*Triticum aestivum* L.) genotypes in normal, drought prone and salinity medicated environments for diversity and steadiness. Acad. J. Agric. Res. 7(5): 115-120.

Submit your manuscript at
http://www.academiapublishing.org/journals/ajar