IJNES
International Journal of Natural and Engineering Sciences
E-ISSN: 2146-0086 17(3): 87-94, 2023
Research Article

Morphological characterization of diverse wheat genotypes for yield and related traits under drought condition

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(Received: August 14, 2023 / Accepted: September 21, 2023)

Abstract

Wheat is most extensively cultivated cereal crop and utilized as staple food all over the world. Wheat yield decreases duo to various stresses including water stress. Drought stress is most limiting factor influencing wheat yield all over the world. The research was executed in farm area of University of Layyah during growing season 2022-23 to screen various genotypes on the basis of yield and related traits. The trail was performed randomized complete block design (RCBD) that was further divided into three replications. Fourteen genotypes were used in the experiment. Data of spike length (cm), biological yield (g), number of grains per spike and grain yield (g) was collected after maturation. The results shown high variation of all wheat genotypes under control and various drought levels. Highest positive correlation was found between biological yield, number of grains per spike and grain yield. Akbar-2019 and Syn-50 have high grain yield even in stress condition, thus these genotypes can be recommended for general adaptation and can be used in breeding projects to meet ever increasing food demand.

Keywords: wheat, drought, morphology, physiology, yield

Introduction

Wheat is most extensively cultivated cereal crop throughout the globe [1]. Wheat is consumed by one third of world population as staple food and ranks second in mostly cultivated crops [2-3-4]. Wheat grains contribute approximately 21% of food calories in nutrition of more than 4.9 billion people belonging to numerous countries [5]. According to an estimate, globally demand for wheat productivity is predicted to increase by fifty percent by 2050 to meet food demand of highly increasing world population [6]. Wheat production should be increased via enhancing grain yieldto cover high demand of wheat products [7].

Wheat yield potential is decreasing because of environmental factors most essentially abiotic stress involving salinity, heat and drought that adversely effects growth and development of wheat plant. Drought as a major abiotic stress is constraining wheat yield potential throughout the globe [8]. Global warming is expected to be basic reason to induce drought stress [9]. It is predicted that temperature can increase up-to 1.5-5.8 centigrade by 2100[10]. Wheat as most widely grown as staple food is highly exposed to water scarcity resulting in 50-90% yield reduction compared to that of its irrigated potential [11]. Drought is considered to have much negative impact on growth and quantitative traits among all abiotic stresses [12]. When wheat crop faces ambient temperature even for short period of time results in high grain yield loss [13].Drastic environmental changes are main cause of low productivity [14].

Climatic changes has adversely effected 44% of total food production in India [15]. Drought more severely influences reproductive phase than vegetative phase in wheat [16]. Water scarcity adversely influences various morpho- physical traits of wheat plant [17].Drought is complicated trait [18]. It reduces nutrient uptake ability of the plant duo to improper permeability of membrane leading to low root absorbing power [19]. Drought stress majorly influences photosynthetic activity of plant. Chlorophyll degradation directly leads toward high reactive oxygen species (ROS) production [20]. Reactive oxygen species production damages various sub-cellular organelles of plant including chloroplast, membrane lipid and essential metabolic enzymes [21]. Due to drought, photosynthetic active radiations are less absorbed, their efficiency to use reduces and harvest index reduces ultimately reducing plant's yield. Wheat productivity decreases duo to water stress. Drought tolerance can be achieved by screening wheat genotypes under water stress condition. Therefore, current experiment is devoted to screen out various wheat genotypes for grain yield and yield related traits by imposing drought levels. Main purpose is to evaluate high performing genotypes in water deficit condition that can be taken by farmer communities to overcome food shortage.

Materials and Methods

A field experiment was conducted in at university of Layyah during growing season 2022-23. The experiment was performed in randomized complete block design (RCBD) that was replicated thrice. On the availability of genotypes, fourteen wheat genotypes Chakwal-50, Ujala-2016, Akbar-2019, Sehar-2006, Johar-16, Glaxy-2013, Ghazi-2019, Faislabad-2008, Gold -16, Anaj-17, Fakher-e-Bhakkar, Miraj-2008, Syn-50 and As-2002 were used in experiment that were taken from arid zone research institude. Nitrophos and urea fertilizers were applied according to crop requirement. Drought stress was stimulated by skipping irrigations i.e. (in control, irrigations were not skipped. In second treatment, one irrigation was skipped at heading stage. In third treatment, two irrigations were skipped at heading stage).At maturity stage, data of various morphological parameters were collected such as spike length (cm), number of grains per spike, biological yield per plant (grams) and final grain yield (grams).

Data was analyzed using a software, Statistix 8.1. Least significant difference (LSD) check at 5% probability for comparing treatments means. Regression, correlation and pathway analysis were determined using MS EXCEL 2016. Pathway analysis and correlation were evaluated to check how various parameters are correlating to each other [22].

Results and Discussion

The results taken from various morphological parameters are:

Spike length

Analysis of variance (ANOVA) depicted that individual effect of treatment is significant while interactive effect of genotype and treatment is non-significant as all genotypes aren't influenced under drought treatment. The genotypes have shown high variation (Table 1). All genotypes perform well in irrigated condition. As described by Ahmad et al. [23] spike length highly decreased under drought condition. Maximum spike length was observed in Ujala-2016 and Fakhar-e-Bhakkar under drought 2 condition (Figure 1).

Table 1. *Analysis of Variance Table for spike length*

Source	DF	SS	MS	F	P
Replication	2	28.43	14.214		
Genotype	13	26.86	2.066	0.26	0.9956
Treatment	2	437.48	218.738	27.08	0.0000*
Genotype*Treatment	26	55.86	2.148	0.27	0.9998
Error	82	662.24	8.076		
Total	125	1210.86			
Grand Mean	11.762				
CV	24.16				

*=significance level is ≤0.05. S.O.V: Source of Variance, DF: Degree of Freedom, SS: Sum of Square, MS: Mean Square

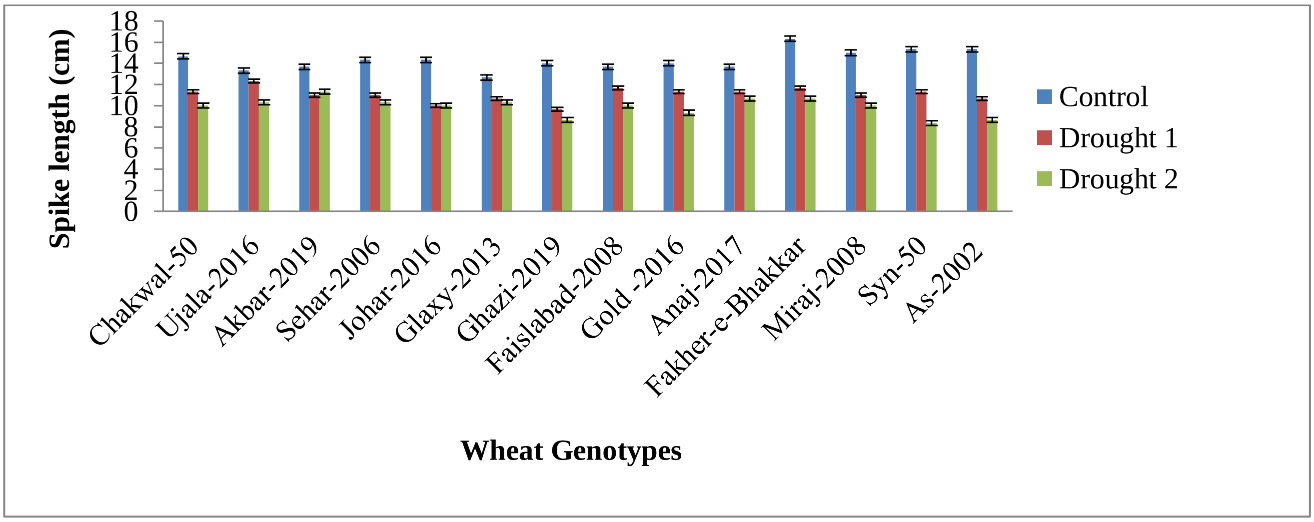

Figure 1. *Effect of drought treatment on spike length of wheat genotypes*

Biological yield

ANOVA shown that biological yield highly influenced under drought application (Table 2). The graph represents that all genotypes highly performed in irrigated condition while Faislabad-2008 and Syn-50 can be considered as well performing in term of biological yield under drought condition (Figure 2).

Table 2. *Analysis of variance table for biological yield*

Source	DF	SS	MS	F	P
Replication	2	1638.62	819.310		
Genotype	13	159.66	12.281	0.48	0.9291
Treatment	2	1265.19	632.595	24.81	0.0000*
Genotype*Treatment	26	333.03	12.809	0.50	0.9752
Error	82	2090.71	25.497		
Total	125	5487.21			
Grand Mean	38.786				
CV	13.02				

*=significance level is ≤0.05. S.O.V: Source of Variance, DF: Degree of Freedom, SS: Sum of Square, MS: Mean Square

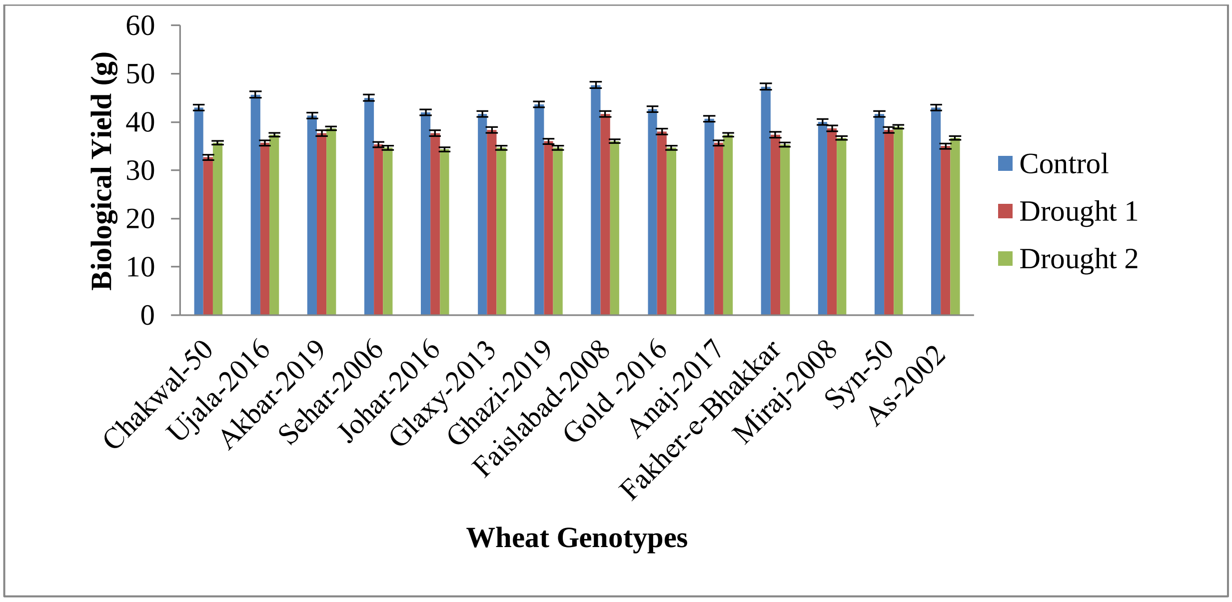

Figure 2. *Effect of drought treatment on biological yield of wheat genotypes*

Grains per spike

ANOVA depicted that grains per spike have shown great variation under drought condition (Table 3).It is already reported by Qaseem et al. [24] number of grains per spike are highly influenced because drought. Chakwal-50 has shown highest performance in irrigated condition but Gold-2016 can be considered as best in sense of grains per spike under water deficit condition (Figure 3).

Table 3. *Analysis of Variance Table for grains per spike*

Source	DF	SS	MS	F	P
Replication	2	2493.9	1246.95		
Genotype	13	715.2	55.02	0.74	0.7193
Treatment	2	2729.2	1364.60	18.34	0.0000*
Genotype*Treatment	26	1667.9	64.15	0.86	0.6560
Error	82	6100.1	74.39		
Total	125	13706.4			
Grand Mean	46.929				
CV	18.38				

*=significance level is ≤0.05. S.O.V: Source of Variance, DF: Degree of Freedom, SS: Sum of Square, MS: Mean Square

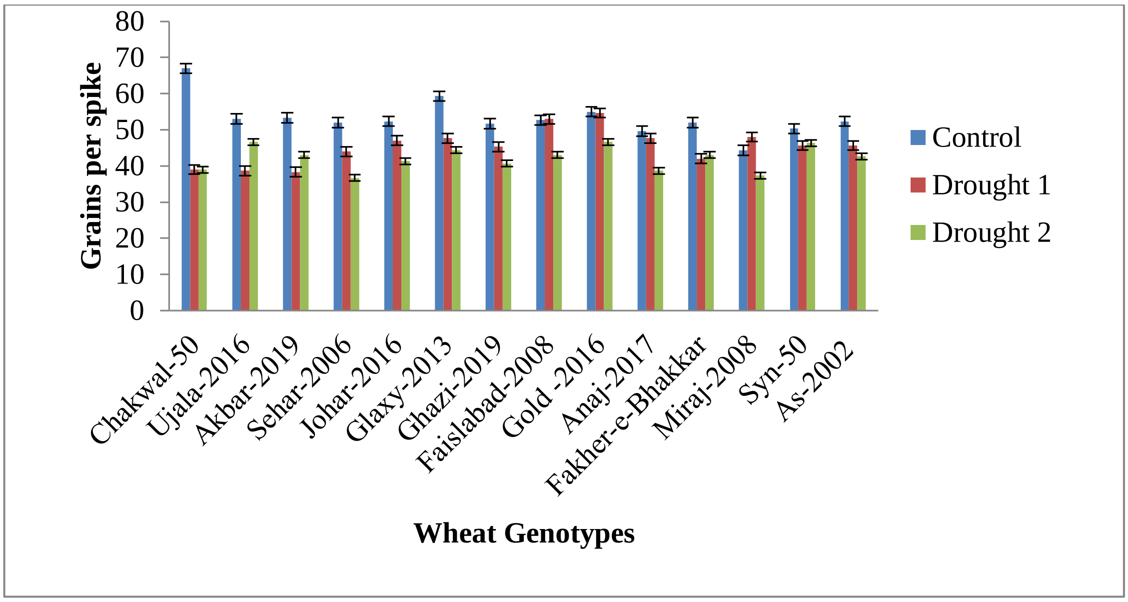

Figure 3. *Effect of drought treatment on grains per spike of wheat genotypes*

Grain yield

ANOVA depicted that individual effect of treatment is significant while individual effect of genotype and interactive effect of genotype and treatment is non-significant as all genotypes are not influenced through drought treatment (Table 4). Grain yield have shown high variation duo to treatment. All genotypes have high performance in irrigated condition (Figure 4). Performance of genotypes decreased because of drought condition. Maximum grain yield was observed in Akbar-2019 and Syn-50 in term of grain yield under drought condition.

Table 4. *Analysis of Variance Table for grain yield*

Source	DF	SS	MS	F	P
Replication	2	123.19	61.595		
Genotype	13	246.93	18.995	1.06	0.4033
Treatment	2	421.00	210.500	11.77	0.0000*
Genotype*Treatment	26	413.00	15.885	0.89	0.6225
Error	82	1466.81	17.888		
Total	125	2670.93			
Grand Mean	13.976				
CV	30.26				

*=significance level is ≤0.05. S.O.V: Source of Variance, DF: Degree of Freedom, SS: Sum of Square, MS: Mean Square

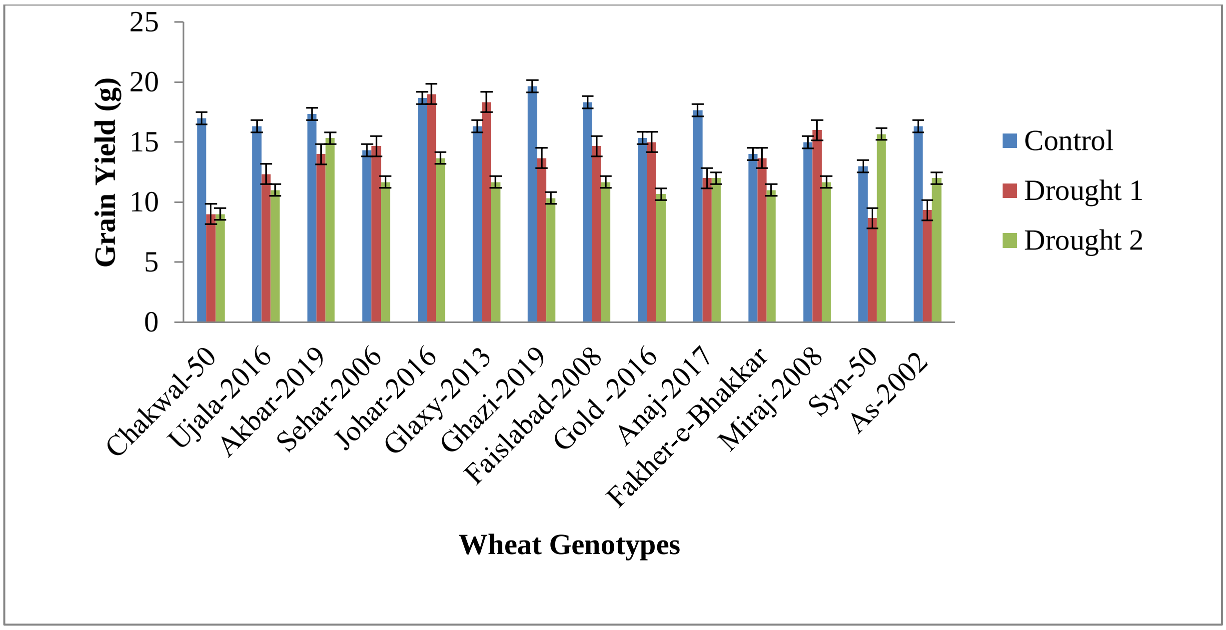

Figure 4. *Effect of drought treatment on grain yield grain yield of wheat genotypes*

Correlation

Correlation is essential term utilized to find positive or negative relationship between morphological traits. All parameters are positively correlated with each other except spike length that is negatively correlated with biological yield (table 5). Grain yield has high positive correlation with grains per spike and biological yield.

Table 5. *Correlation table showing the direct effects of traits on yield of wheat.*

	spike Length	biological yield	grains per spike	grain yield
spike Length	1			
biological yield	-0.0152	1		
grains per spike	0.050304	0.667659	1	
grain yield	0.043423	0.461644	0.37628	1

Path analysis

Pathway analysis is used to find out direct and indirect effect of various parameters to final yield. Results revealed that all traits positively affect final yield i.e., grain yield. The trait, number of spike length is indirectly affecting the yield (table 6). Biological yield has highest direct effect on final yield. Other indirect effects are of number of grains per spike through spike length and biological yield through number of grains per spike and number of grains per spike on the yield.

Table 6. *Path coefficient analysis*

	spike length	biological yield	grains per spike	Total yield
spike Length	0.069144	-0.00405	0.002643	0.067737
biological yield	-0.00105	0.266472	0.035078	0.300499
grains per spike	0.003478	0.177912	0.052539	0.23393

The aim of this experiment is to screen out some wheat genotypes for highly increasing water scarcity, which can be beneficial for human beings to overcome food shortage. It is reported by Farnia and Tork [25] that drought stress lowers yield of cereal components including biological yield and grain yield. Drought at reproductive stage remarkably lowers grain yield. As previously reported by Dhakal [26] that spike length directly affects total grain yield. As reported by Plaut et al [27] that grain filling duration significantly reduces because of drought stress. The results mentioned above have shown high variation in mean of various parameters such as spike length, biological yield, number of grains per spike and grain yield. The material in selected for study shown considerably diversity which is important for breeding point of view. Correlation shown that biological yield and grains per spike positively and significantly correlated with final yield. Therefore, breeding for these traits will increase crop productivity.

Conclusion

The findings of experiment shown that all genotypes have different response to drought. All morphological parameters such as grain yield and yield related traits were found to be useful traits like number of grain per spike and biological yield were found positively correlated with yield. Drought stress at heading stage remarkably lowers grain yield in all genotypes however Akbar-2019 and Syn-50 have shown best performance in term of grain yield even in drought condition. These drought tolerant genotypes could be utilized in breeding programs to make elite genotypes that can invalidate stress effect in drought-prone areas and can meet food demand of ever increasing human population.

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