Evaluation of Grain Quality Characteristics of Wheat (*Triticum aestivum*) Under Irrigation and Water Stress Conditions

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Abstract
The continuing global population growth will definitely increase food demand. The coming decades will create a great challenge to feed 9 billion plus peoples with the aim to provide food to everybody on this globe. The future of crop production will definitely face problems like water stress, salinity, heat, unexpected rainfall as well as the over-exploitation of land, water and energy. Wheat contributes 13.7% to the value addition in Pakistani agriculture, so the quality of wheat bestows chaptti, cakes and biscuits. The present study was, therefore, identified the quality of differential responses exhibited by wheat varieties in twin experiments, one under normal irrigated conditions and another under water stress conditions (simulated by totally withholding irrigation after sowing). The genetic analysis provides useful information that water stress condition favored low moisture contents and maximum production of protein in wheat grains. The findings support comprehensive breeding programs aimed to combine superior genotypes and crosses so as to develop new varieties for water stressed areas.

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Introduction

The versatilities of wheat plant in its cultivation and behavior have made it possible to fulfill the provision of protein for a large segment of the society. The global shaking food security situation has converted the scientist attention towards the micro management in wheat plant. Food security situation is mainly disturbed in the developing countries due to severe or mild drought as well as biotic stresses that remained a invariable and effervescent dilemma to limit the food production process. Wheat contributes 13.7% to the value added in agriculture in Pakistan, so the quality of wheat bestows chaptti, cakes and biscuits. (Agricultural Statistics of Pakistan) 2017-18. Water stress is one of the most important among the abiotic stresses, which is generally adjunct to heat particularly in prolonged dry season that seriously manipulates the crop output. Most of the breeding programs have usually attempted to monitor and to find out the ways for the remediation of adverse effects of onset of water stress to ensure the sustainable agriculture as well as to maintain the quality parameters of the wheat crop (Aheer et al, 2007).

Under water stress most of the plants try to lower their osmotic potential by accumulating some compounds such as amino acids, sugar alcohols and organic acids which diverted the global attention towards the suspicions of water stress and found water stress as blessing in disguise to increase in proteins, ash and gluten content in wheat grains. Keeping in view of these capable properties the present research was initiated to check the genotypic behavior on their grain quality under water stress condition.

Materials and Methods

The study was conducted in the research area, the Department of Plant Breeding and Genetics, University College of Agriculture, University of Sargodha, Pakistan. After putting all precautionary measures, the female parent plants were hand emasculated. The water stress tolerant wheat genotypes (Sehar-2006, Chakwal-86, Shafaq-2006, Kohistan-97, Fsd-2008, Inqlab-91) were crossed with the drought susceptible lines (V08172, MH-97, Punjab-81) by using line × tester mating design. The representative quality traits like moisture percentage and protein percentage were evaluated. All agronomic and precautionary measures were taken. The F1 seeds along with parents were sown in next cropping season under normal irrigation and water stress conditions by using Randomized Complete Block Design (RCBD) with three replications. The soil of selected site was analyzed and found loamy with pH 7.70. The data were then analyzed by using technical analysis of variance by Steel et al., (1997). The characters presenting significant differences were analyzed as Kempthorne,

(1957) have shown that the method of "Line × tester" to get genetic information.

Results and Discussion

Physio-chemical properties of wheat grains under normal irrigation and water stress conditions

In dealing with quality parameters, the wheat breeder always faced many complex factors. A wheat variety suitable for one purpose may be unsatisfactory for another. In order to evaluate the quality, the best yielding genotypes were evaluated under both irrigation regimes (normal irrigation and water stress condition). Yield was considered as yard stick and the higher yielding genotypes were selected under normal irrigation condition (Table 1). Then these varieties and their respective crosses were grown under both water stress and irrigation conditions. Data were subjected to the analysis of variance. The analysis of variance (ANOVA) results showed highly significant differences in all quality parameters among genotypes under both irrigation levels depicting that water stress has played its role to create high variability for the characters (like moisture percentage, ash content, crude fat, crude protein percentage and gluten content) (Table 2).

The Mean values of quality traits of 10 high yielding wheat genotypes under normal and water stress irrigation conditions. (Table.2). The cross combination Kohistan-97xV08172 revealed maximum yield, however the maximum protein percentage was shown by the cross combination Kohistan-97x MH-97 under irrigated condition (Table 2). Under water stress condition the yield and moisture percentage was decreased while the protein percentage was maximized in all genotypes under study. The genotype Seher-2006 revealed maximum yield, however the maximum protein percentage was shown by the genotype Chakwal-86. (Table 2). The positions of the genotypes changed were due to the shortage of water. Similar findings have shown by Fenn et al., (1994) who concluded that any decline and deterioration in the quality of wheat is caused by non genetic factors such as changes in environment. Previous experiments conducted under dry land and irrigated conditions revealed that genotype was the only factor that consistently affected the

Table 1: Mean squares values of quality traits by Analysis of variance (ANOVA) of 10 high yielding wheat genotypes /crosses under normal irrigation and water stress conditions

S.O.V	df	Moisture (%)	Moisture (%)	Crude protein (%)	Crude protein (%)
		Normal	*Water stress*	*Normal*	*Water stress*
Replication	2	0.002NS	0.002 NS	0.080 NS	0.057 NS
Genotypes	9	0.081**	0.143**	0.968**	0.468**
Error	18	0.003	0.002	0.051	0.021

Number of replicates: 2
SOV: Standard of Variance

Table 2: Mean values of quality traits of 10 high yielding wheat genotypes /crosses under normal irrigation conditions

Genotypes/crosses	Yield	Yield	Moisture (%)	Moisture (%)	Crude protein (%)	Crude protein (%)
	Normal	Water stress	Normal	Water stress	Normal	Water stress
Kohistan-97	27.85	21.10	11.44^{de}	10.44^{g}	12.11^{c}	12.41^{e}
Sehar-2006	27.81	21.30	11.39^{e}	11.32^{e}	12.37^{c}	13.37^{bcd}
Chakwal-86	24.60	15.70	11.82^{a}	11.87^{c}	12.14^{b}	13.94^{a}
Kohistan-97xV08172	26.40	18.83	11.70^{b}	11.20^{e}	12.50^{a}	13.05^{cd}
Kohistan-97x MH-97	27.91	18.33	11.75^{b}	11.55^{b}	12.80^{a}	13.49^{b}
Chakwal-86x MH-97	25.10	15.87	11.55^{b}	11.25^{d}	12.70^{a}	13.28^{bc}
Inqlab-91x MH-97	25.87	17.47	11.65^{b}	11.15^{f}	12.10^{b}	13.19^{bcd}
Shafaq-2006x Punjab-81	25.90	18.83	11.67^{b}	11.67^{a}	12.78^{a}	13.45^{b}
Sehar-2006x MH-97	23.20	13.03	11.61^{c}	11.51^{b}	12.70^{a}	12.92^{d}
Sehar-2006x Punjab-81	23.43	14.55	11.69^{bc}	11.29^{d}	12.11^{b}	13.26^{bc}

Values with same superscript letters are not significantly different

various quality traits. The water stress has played a key role to reduce the moisture percentage and fat, while it increased protein, ash and gluten contents. Similar findings have also been shown by Noorka and Teixeira da Silva. (2012).

In this study, water stress decisively changed the normal quality measures of wheat. A paradigm shift in wheat quality traits due to water stress was observed and the results are in line with the earlier findings shown by (Noorka and Teixeira da Silva. 2012). The findings of present study revealed that sustainable and comprehensive breeding programs endeavored to mingle high yielding genotypes and crosses with increased protein percentage is need of hour to fulfill the nutritional needs with minimum water availability. The globe needs genotypes that can tolerate water stress without sacrificing quantitative traits but enhancing wheat quality. The promising results observed in present plant material offered good prospects, which will obviously, need a paradigm shift in local as well as global agricultural policies.

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