

## Research Article

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# Impact of irrigation stress on agronomic traits of promising wheat varieties in Tandojam-Pakistan

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### Abstract

A field trial was conducted at Latif Farm, Tandojam Pakistan to study the impact of the irrigation stress on growth and yield traits of promising wheat varieties in Rabi 2016. The experiment was laid out in three replicated Split Plot Design. Three wheat varieties (TD-1, SKD-1 and Imdad-2005) were tested against four irrigation level treatments (five recommended irrigations: 25, 50, 75, 100 and 125 DAS-days after sowing, one irrigation: 25 DAS, two irrigations: 25 and 50 DAS, and three irrigations: 25, 75 and 100 DAS). The results indicated that all growth and yield traits of tested wheat varieties were significantly affected ( $P < 0.05$ ) by the irrigation levels. In terms of yield performance, recommended irrigation proved the best in terms of economic crop which resulted in 398.0 tillers  $m^{-2}$ , 76.2 cm plant height, 54.2 gm seed index (1000-grain weight) and 6368  $kg ha^{-1}$  grain yield. The crop applied with three and two irrigations ranked 2<sup>nd</sup> and 3<sup>rd</sup> in grain yield (5429 and 5301  $kg ha^{-1}$ ) respectively. In case of varieties, Imdad-2005 was ranked 1<sup>st</sup> with 390.5 tillers  $m^{-2}$ , 83.2 cm plant height, 52.4 gm seed index and 5557  $kg ha^{-1}$  grain yield, followed by SKD-1 and TD-1 in grain yield (5209 and 4577  $kg ha^{-1}$ ), respectively. The interaction of variety Imdad-2005 X recommended irrigations produced maximum (6593  $kg ha^{-1}$ ) grain yield. Hence, it is concluded from the results that recommended irrigation proved adequate for achieving desired performance in wheat where all the varieties produced higher grain yield as compared to other levels of irrigation.

**Keywords:** Growth; Irrigation stress; Varieties; Wheat; Yield

### Introduction

Wheat is main staple food of Pakistan grown on area of 8.41 mill ha with annual production of 21.83 million tones and average yield of 2596  $kg ha^{-1}$  [1]. Currently, more emphasis is

being given for the sustainable production of wheat. Wheat is prime weapon to attain food security. A wide range of factors are responsible for economical wheat production, among them drought has been erupted as a

serious threat for low productivity from couple of decades [2]. Water deficiency is the most important environmental stress in the agriculture throughout the world [3]. All growth stages of plant are not equally susceptible to water deficiency, whereas some stages can survive with water shortage and result in severe yield losses. Moisture stress decreases the biomass, tillering percentage, grains spike<sup>-1</sup> and the size of grain when it appears at any stage. So, the all over moisture stress effect depends on its length and intensity [4]. Consequential deficiency in grain yield of wheat has been noticed due to water shortage depending on the growth stages at which wheat crop experiences stress on different growth stages especially before anthesis, which can reduce number of heads and grains<sup>-1</sup> [5, 6]. Although water stress established during later growth stages might additionally cause decrease in number of grains and grain weight [7, 8]. Drought tolerance was defined by [9] who revealed other genotypes compared to the relative yield of a genotype, subjected to same drought stress. A basic approach is to assess the drought tolerance indices. Thus, the drought indices which provide a measure of drought based yield loss under drought conditions as compared to normal conditions have been used for screening drought tolerant wheat genotypes [10]. Similarly, [11] reported that water stress during growth stages of 32-65 days after sowing decreased spikelet fertility, number of grains per ear and grain yield. In a study [12] found that moisture stress greatly affected the biological and economic yield along with significant decrease in harvest index (from 41 in well irrigated to 34 in drought conditions). [13] Studied response of wheat under water stress and found that spike biomass was reduced at anthesis from 58 to 90% compared with control. [14] Investigated the effect of temporary water shortage at different stages and revealed that dry weight & number of

tillers per plant were reduced as compared to control. In another research study carried out in pot experiment, [15] found that wheat sterility was increased by water stress. Similar findings were revealed by [16] who recorded reduction in grain yield by 44%, along with significant reduction in biomass and straw yield per plant. The tiller abortion was more extreme under drought than under well-watered conditions. Similarly [17] reported that water stress especially during terminal and post anthesis stages in bread wheat, decreased grain weight drastically. Reduction in endosperm due to water deficit could be the probable cause for low grain weight. [18] investigated yield parameters of two durum wheat varieties at various growth stages were badly affected by water stress and stated that withholding irrigation at any growth stage adversely affected their yield and yield components. Due to water stress, decrease in pollination was observed and less number of grains formed per head which resulted in decrease of grain yield [16]. Sufficient supply of water before or after anthesis period not only permitted the plants to access the photosynthesis rate but also gave sufficient time to translocation the carbohydrate to grains which improved grain size and grain yield [19]. When drought stress was observed at different growth stages (tillering, booting, heading and grain development stage) reduced growth rate was seen by decrease in irrigation [20]. Availability of sufficient water during growth stages enhanced the crop performance [21]. All growth stages of wheat crop are not consistently susceptible to water shortage. Furthermore, some stages can cope-up with water deficit very well, while others are more sensitive and water deficit at such growth stages may result in specific yield losses. Due to moisture stress reduction in biomass, tillering percentage, grains spike<sup>-1</sup> and grain size may be recorded, so the moisture effect depends on stress length and its intensity [4].

Water stress imposed in later growth stages also decreased number of grain spike<sup>-1</sup> and grain weight [9]. Efficient and fruitful use of water is the most important parameter under water deficit conditions. Moisture stress is well documented on different genotypes of wheat varieties [16]. Therefore there is a need to select those wheat varieties which can mature and produce maximum yield with limited water availability. Current study was therefore carried out to find drought tolerant wheat varieties for drought susceptible areas of Pakistan using optimum amount of water applied at different growth stages and to guess the effect of drought stress in relation to wheat yield under climatic conditions of Tandojam-Pakistan

### Materials and methods

The field experiment to determine the impact of irrigation stress on agronomic traits of promising wheat varieties was conducted at Latif Farm, Tandojam during Rabi 2016. The experiment was conducted on three replicated split plot design, having net plot size of 5 m × 4 m (20 m<sup>2</sup>). All the agronomic practices were followed as per recommendations of Agronomy Section, Agriculture Research Institute, Tandojam. Recommended land preparation operation was completed for equal distribution of irrigations and fertilizer application. Sowing was done with single coulter hand drill. The experiment was divided into Main-plot: Irrigation levels (recommended five irrigations: 25, 50, 75, 100 and 125 DAS-days after sowing, one irrigation: 25 DAS), two irrigations: 25 and 50 DAS, three irrigations: 25, 75 and 100 DAS) and Sub-plot: Varieties (TD-1, SKD-1 and Imdad-2005). The observations recorded were tillers (m<sup>-2</sup>), plant height (cm), seed index (1000-grain weight in gm) and grain yield (kg ha<sup>-1</sup>).

### Statistical analysis

The collected data was statistically analyzed using Statistix 8.1 computer software [22] and

for comparing the effectiveness of treatments, LSD test was applied.

## Results and discussion

### Tillers (m<sup>-2</sup>)

The results (Table 1) with reference to tillers (m<sup>-2</sup>) of the wheat varieties as influenced by different irrigation levels showed that irrigation levels and interaction had significant (P<0.05) effect, whereas varietal effect was non-significant (P>0.05) for tillers (m<sup>-2</sup>). Among irrigation levels, maximum tillers (398.0 m<sup>-2</sup>) were recorded in recommended irrigation: five irrigations (control), followed by three irrigations (25, 75 and 100 days after sowing: DAS) with 389.0 tillers m<sup>-2</sup>, whereas minimum tillers (369.3 m<sup>-2</sup>) were observed in one irrigation (25 DAS). In case of varieties, Imdad-2005 had numerically highest number of tillers (390.5 m<sup>-2</sup>), followed by SKD-1 and TD-1 with 389.5 and 384.5 tillers m<sup>-2</sup>, respectively. In their interaction, significantly maximum tillers (397 m<sup>-2</sup>) were observed in the interaction of Imdad-2005 X recommended irrigation treatment (five irrigations- control).

### Plant height (cm)

The analysis of variance (Table 1) showed that irrigation levels, varietal and interactive effect was significant (P<0.05) on plant height (cm). Among irrigation levels, maximum plant height (76.2 cm) was recorded in recommended irrigation: five irrigations (control), followed by three irrigations (25, 75 and 100 days after sowing: DAS) with 71.0 cm plant height, whereas minimum plant height (64.1 cm) was observed in one irrigation (25 DAS). In case of varieties, Imdad-2005 had significantly highest plant height (83.2 cm), followed by SKD-1 and TD-1 with 66.5 and 58.4 cm plant height, respectively. Regarding interaction, maximal plant height (92.3 cm) was observed in the interaction of wheat variety Imdad-2005 X recommended irrigation treatment: five irrigations (control), followed by the interaction of Imdad-2005 X three irrigations

(25, 75 and 100 DAS) with 90.1 cm plant height while, the minimal plant height (55.2

cm) was noted in the interaction of TD-1 X one irrigation.

**Table 1. Tillers (m<sup>-2</sup>) and plant height (cm) of wheat varieties as affected by irrigation levels**

Irrigation levels	Tillers (m <sup>-2</sup> )				Plant height (cm)			
	Varieties				Varieties			
	TD-1	SKD-1	Imdad-05	Mean	TD-1	SKD-1	Imdad-05	Mean
Five irrigations	396	401	397	398.0	63.7	72.6	92.3	76.2 a
One irrigation	379	370	359	369.3	55.2	62.7	74.2	64.1 c
Two irrigations	376	381	388	381.7	55.4	66.7	76.3	66.1 c
Three irrigations	387	391	389	389.0	59.1	63.9	90.1	71.0 b
Mean	384.5	389.5	390.5	--	58.4 c	66.5 b	83.2 a	--
	Irrigation (I)		Varieties (V)		Irrigation (I)		Varieties (V)	
SE ±	2.2092		2.1985		0.9414		1.7430	
LSD <sub>0.05</sub>	7.6505		--		3.2602		4.4994	

### Seed index (1000-grain weight, gm)

Results regarding seed index (Table 2) indicated that affect for irrigation levels and varieties was significant (P<0.05), whereas interactive effect was non-significant (P>0.05) on seed index. Among irrigation levels, maximum seed index (54.2 gm) was recorded in recommended irrigation treatment: five irrigations (control), followed by three irrigations (25, 75 and 100 days after sowing: DAS) with 51.8 g seed index, whereas minimum seed index (46.6 g) was observed in one irrigation (25 DAS). In case

of varieties, Imdad-2005 had highest seed index (52.2 g), followed by SKD-1 and TD-1 with 51.2 and 48.0 g seed index, respectively. Regarding interaction, maximum seed index (55.7 g) was observed in the interaction of Imdad-2005 X recommended irrigation treatment: five irrigations (control), followed by interaction of TD-1 X recommended irrigation: five irrigations (control) with 54.7 gm seed index while, the minimum seed index (45.0 gm) was observed in the interaction of TD-1 X One irrigation treatment.

**Table 2. Seed index (g) and grain yield (kg ha<sup>-1</sup>) of wheat varieties as affected by irrigation levels**

Irrigation levels	Seed index (g)				Grain yield (kg ha <sup>-1</sup> )			
	Varieties				Varieties			
	TD-1	SKD-1	Imdad-05	Mean	TD-1	SKD-1	Imdad-05	Mean
Five irrigations	52.3	54.7	55.7	54.2 a	6163	6350	6593	6368 a
One irrigation	45.0	46.0	48.7	46.6 c	2540	3503	4036	3359 c
Two irrigations	46.0	50.7	51.0	49.2 bc	4526	5473	5906	5301b
Three irrigations	48.7	53.3	53.3	51.8 ab	5080	5513	5696	5429 b
Mean	48.0 b	51.2 a	52.2 a		4577 b	5209 ab	5557 a	--
	Irrigation (I)		Varieties (V)		Irrigation (I)		Varieties (V)	
SE ±	1.2364		0.8250		449.37		451.29	
LSD <sub>0.05</sub>	3.0255		1.7488		1099.6		956.70	

### Grain yield (kg ha<sup>-1</sup>)

Results of grain yield (kg ha<sup>-1</sup>) illustrated in (Table 2) showed significant (P<0.05) effects on irrigation levels and varieties, whereas interactive effect on grain yield (kg ha<sup>-1</sup>) was again non-significant (P>0.05). In situation of irrigation levels, maximal grain yield (6368 kg ha<sup>-1</sup>) was recorded in recommended irrigation: five irrigations (control), followed by three irrigations (25, 75 and 100 days after sowing: DAS) with 5429 kg ha<sup>-1</sup> grain yield, whereas minimum grain yield (3359 kg ha<sup>-1</sup>) was noted in one irrigation (25 DAS). Among varieties, Imdad-2005 produced highest grain yield (5557 kg ha<sup>-1</sup>), followed by SKD-1 and TD-1 with 5209 and 4577 kg ha<sup>-1</sup> respectively. In the interactive effects, highest grain yield (6593 kg ha<sup>-1</sup>) was achieved in the interaction of Imdad-2005 X recommended irrigation, followed by the interaction of SKD-1 X recommended irrigation with 6353 kg ha<sup>-1</sup> grain yield.

Sufficient irrigation is fundamental requirement of plant for proper growth and yield development. The results revealed that all the growth and yield traits of wheat varieties were significantly (P<0.05) effected by the number of irrigations. On the basis of yield performance, recommended five irrigations proved best for achieving maximum yield of wheat crop, three irrigations (25, 75 and 100 DAS) ranked 2<sup>nd</sup>, two irrigation (25 and 75 DAS) ranked 3<sup>rd</sup> whereas one irrigation (25 DAS) was ranked 4<sup>th</sup>. In case of varieties, Imdad-2005 was ranked 1<sup>st</sup> particularly in grain yield (6058.3 kg ha<sup>-1</sup>). Wheat varieties SKD-1 and TD-1 ranked 2<sup>nd</sup> and 3<sup>rd</sup> in grain yield ha<sup>-1</sup>. However, growth behavior of these varieties did not show linear trend. The results are in accordance with the findings of [23] who revealed that five times irrigation to wheat crop resulted in maximum growth and yield, particularly grain yield in comparison with four and three irrigations. As regards varieties, SKD-1 surpassed all varieties in

traits studied particularly grain yield while TD-1 and Imdad 2005 ranked 2<sup>nd</sup> and 3<sup>rd</sup>, respectively. Similar results were also revealed by [24], who reported that out of eight wheat genotypes (hexaploid), Pak-81, Chakwal-86 and Rawal-87 were affected less in all traits under conditions of different water stress. On the contrary, Uqaab-2000, Inqilab-91, Kohistan-97, and Watan varieties were affected markedly under different irrigation levels for their yield components and yield. Hence, these varieties proved susceptible to conditions of water stress. Similar findings were reported by [25], who stated that with highest irrigation levels and seed rate, the plant population was high which created competition among plants. Similar results were also revealed by [26], who achieved significant results in interaction between irrigation levels and seed rate on wheat. The results of this research are also in line with those of [27] who suggested that three varieties Bezostaja, Sultan and Yildiz were found drought-sensitive and remaining three varieties, Sonmez, Gerek and Altay were noted as drought-tolerant. The increase in plant height, heading date and grain yield observed linear under the impact of irrigation levels. The association between grain yield heading date was negative (r=-0.746). The comparison of findings from the study and results reported from other researchers of the world clearly suggested that water requirement is also associated with soil and climatic condition where the wheat is grown. However, under both cases, either there is shortage of water, or excessiveness of moisture, the crop will respond negatively. Hence, it is quite imperative that well schedules irrigation may be applied, so that optimistic results in wheat are achieved.

### Conclusion

The results concluded that irrigation levels significantly affected growth and yield parameters of wheat varieties. Application of recommended five irrigations surpassed rest

of the irrigation levels by producing maximum grain yield. Among varieties, Imdad-2005 was found most promising with highest grain yield as compared to other varieties. Hence, findings of this study suggested that wheat varieties should preferably be irrigated five times for obtaining maximum grain yield.

#### Authors' contributions

Conceived and designed the experiments: WA Khuhro, MN Kandhro & N Sadiq, Performed the experiments: WA Khuhro & MN Kandhro, Analyzed the data: N Sadiq, NS Naseer & MI Jakhro, Contributed reagents/ materials/ analysis tools: Amanullah, S Ahmed & A Latif, Wrote the paper: WA Khuhro, MN Kandhro & N Sadiq.

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