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EFFECT OF DIFFERENT LEVELS OF IRRIGATION ON YIELD AND YIELD COMPONENTS OF WHEAT CULTIVARS

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A field study pertaining to the effect of different levels of irrigation on yield and yield components of wheat cultivars was conducted during 2005-2006 growing season at Agronomic Research Area, University of Agriculture, Faisalabad (31°.25N, 73°.09E). Treatments were three cultivars (AS-2002, SH-2002, Aqab-2000), and five irrigation levels I_1 (irrigation at crown root stage), I_2 (irrigation at crown root + tillering), I_3 (irrigation at crown root + tillering + booting), I_4 (irrigation at crown root + tillering + booting + anthesis), and I_5 (irrigation at crown root + tillering + booting + anthesis + milking). Wheat cultivar AS-2002 recorded highest grain yield (4821.5 kg ha^{-1}) which was significantly higher than the other two cultivars. Wheat crop supplied with five irrigations at crown root + tillering + booting + earing + milking recorded the highest grain yield (5696.8 kg ha^{-1}) which was significantly higher than all the other irrigation levels. At highest irrigation level I_5, cultivars AS-2002 and SH-2002 produced grain yield at par but significantly higher than Aqab-2000. At all the other irrigation levels, cultivar AS-2002 recorded significantly higher grain yield than the other two cultivars.
Keywords: wheat, irrigation, yield and cultivar

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal used as a staple food in Pakistan. In Pakistan, wheat is grown on 9062 thousand hectares and total wheat production is 23421 thousand tones, with an average yield of 2585 kg ha^{-1} (GOP, 2008-09). Despite higher yield potential, average grain yield of wheat in Pakistan is much less than most of the wheat growing countries of the world. Earlier research showed that irrigation consistently increased wheat yield in Pakistan (Hussain *et al*., 1997 and Rahim *et al*., 2007). Moreover, Wajid *et al.* (2002) reported that wheat crop produced highest grain yield by applying irrigation at all definable growth stages. Because irrigation is an expensive input, farmer, agronomist, economist and engineer need to know the response of yield to irrigation. Jamal *et al*. (1996) concluded that grain yield of different wheat cultivars were significantly reduced by water stress at all critical growth stages and greatest reduction was at anthesis stage. Hussain (1997) studied the comparative growth and yield response of seven wheat cultivars and reported that Inqlab-91 produced higher number of grains per spike and grain yield as compared with other cultivars. Furthermore, Jahfari (2004) and Rafique (2004) reported that yield and yield components were significantly increased within different wheat cultivars. Planting of wheat in the irrigated area of Punjab commences in October and continues as late as 31st December. Most of the crop is harvested in April-May. During this span, the normal growth and development of wheat primarily depends upon available irrigation water. The present study was therefore undertaken to examine the yield response of wheat cultivars to irrigation water and to measure the seasonal crop water requirement of different wheat cultivars under variable irrigation water regimes in semiarid conditions.

MATERIALS AND METHODS

The proposed study was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during 2005-06. The experiment was laid out using RCBD with split plot arrangement. Treatments consist of three cultivars (AS-2002, SH-2002, Aqab-2000) which were kept in main plot and five irrigation levels I_1 = irrigation at crown root stage, I_2 = Irrigation at crown root + tillering, I_3 = Irrigation at crown root + tillering +booting, I_4 = Irrigation at crown root + tillering +booting + earing, I_5 = Irrigation at crown root + tillering +booting + earing + milking that were placed in sub plots. Experiment was replicated thrice having plot size of 1.5m x 6m with six rows per plot. The crop was

sown manually with the help of a single row drill @ 100kg seed ha^{-1} in the last week of November 2005. Nitrogen and phosphorus were applied @ 150 and 100 kg ha^{-1}, respectively. Half dose of nitrogen and full dose of phosphorus was applied during seed bed preparation while remaining half dose of nitrogen was applied with first irrigation. Data on plant height, number of fertile tillers, number of spikelets per spike, number of grains per spike, 1000–grain weight, grain yield, straw yield and harvest index were recorded by using standard procedures. Data were analyzed statistically by using Fisher's analysis of variance technique and treatment means were compared by using least significant difference (LSD) test at 5% probability level (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

***Plant height (cm)*:** All varieties improved growth with each irrigation levels but maximum plant height was recorded in Aqab-2000 which was 20.19% more than AS-2002 and 13.61% more than SH-2002. Irrigation levels also differed from one another in affecting plant height. Crop plants irrigated at I_1 recorded significantly shorter plants as compared to plants irrigated at I_2, I_3, I_4 and I_5. Interaction between genotypes and irrigation levels were significant. At I_5, cultivar Aqab-2000 increase plant height 28.58% over I_1 which was at par with I_4 where one irrigation was missed at milking stage for same variety. All cultivars increased plant height by applying irrigation at all critical growth stages which might be due to the variation of genetic character among different cultivars as well as with healthier plant growth with sufficient availability of nutrients having no moisture stress. These results are in line with those of Thompson and Chase (1992) who reported that irrigation treatments significantly influenced plant height.

***Number of tillers (m^{-2})*:** Number of tillers (m^{-2}) for various cultivars differed significantly. The cultivar AS-2002 and SH-2002 produced 14.31%, 7.19% higher number of tillers m^{-2} respectively with regard to Aqab-2000. Crop plants irrigated at I_2 were having significantly less number of tillers m^{-2} as compared to all other treatments. Plants irrigated with treatment I_5 resulted in maximum number of tillers m^{-2}. Treatments I_1 and I_2 were statistically at par. As a combined effect of cultivars and irrigation levels, AS-2002 produced highest number of tillers m^{-2} at full irrigation level (Table 2). This increase in number of tillers per unit area in all cultivars might be due to the sufficient

Table 1. Yield components and grain yield of wheat cultivars as influenced by different irrigation levels

Cultivars	Plant height (cm)	Number of tiller (m^{-2})	No. of spikelets $spike^{-1}$	1000-grain weight (g)	Grain yield (kg ha^{-1});	Harvest index (%)
AS-2002	72.60c	335.93a	16.87b	38.35	4821.53a	33.36
SH-2002	76.80b	315.00b	17.67a	37.23	4521.00b	32.73
Aqab-2000	87.26a	293.86c	17.53a	38.34	4501.80b	33.00
LSD(p=0.05)	3.00	11.34	0.43	-	119.2	-
Irrigation						
I_1	69.11e	278.44d	14.66c	34.55c	2534.44e	27.24c
I_2	74.22d	280.00d	16.77b	35.33c	4474.55d	32.91b
I_3	76.77c	315.88c	18.00ab	38.33b	4983.77c	33.52b
I_4	86.22a	336.667b	18.22a	39.79ab	5417.55b	35.62a
I_5	88.11a	362.22a	19.11a	41.86a	5696.88a	35.93a
LSD(p=0.05)	2.583	9.446	1.226	2.156	99.31	0.9134

Table 2. Combined effect of wheat cultivars and irrigation levels on number of tiller (m^{-2})

Irrigation levels	Cultivars		
	AS-2002	SH-2002	Aqab-2000
I_1	290.00g	282.33gh	263.00i
I_2	287.33g	283.66g	269.00hi
I_3	346.00c	306.66ef	295.00fg
I_4	369.66b	331.66d	308.66e
I_5	386.66a	370.66b	329.33d
LSD (p=0.05)	13.59	13.59	13.59

Table 3. Combined effect of wheat cultivars and irrigation levels on grain yield (kg/ha)

Irrigation levels	Cultivars		
	AS 2002	**SH 2002**	**Aqab 2000**
I_1	2728.66i	2480.00j	2394.66j
I_2	4816.00f	4227.33h	4380.33g
I_3	5230.00e	4811.33f	4910.00f
I_4	5566.00b	5410.00cd	5276.66de
I_5	5767.00a	5776.33a	5547.33bc
LSD (p=0.05)	142.9	142.9	142.9

availability of water at tillering stage with more uptakes of nutrients. Sharif (1999) reported greater than 400 tillers m^{-2} in wheat. McDonald (1984) found that maximum number of tiller was associated with higher number of irrigations.

***Number of spikelets spike^{-1}*:** Maximum percent increase in number of spikelets per spike (4.74% and 3.91%) were recorded by SH-2002, Aqab-2000, respectively that were statistically at par with each other but significantly differ with cultivar AS-2002.
Irrigation treatments also affected the number of spikelets per spike significantly. Treatment I_5 recorded maximum number of spikelets spike^{-1} (30.35%) followed by I_4 (24.28%) as compared with I_1 where only one irrigation was applied. Dencic *et al*. (2000) and shehzadi (1999) concluded that spikelets per spike were more sensitive to drought stress in different wheat cultivars.

***1000-grain weight (g)*:** The 1000-grain weight was non-significant among various cultivars but significant differences in 1000-grain weight were noted among various irrigation treatments (Table 1). Treatment I_5 improved 1000-grain weight over I_4, I_3, I_2 and I_1. Higher 1000 grain weight with full irrigations might be due to the more translocation of photosynthats towards grain due to the sufficient amount of water in root zone. In another hand plants having limited supply of water had produced lighter grain which might be due to the less availability of nutrients from soil solution. Similar results were recorded by Wajid *et al.* (2002) who reported significant effect of irrigation on 1000-grain weight.

***Grain yield (kg ha^{-1})*:** Maximum grain yield was recorded in AS-2002 which was 7.1% more than Aqab-2000 and 6.65% more than SH-2002. Both cultivars i.e., SH-2002 and Aqab-2000 were, however, statistically at par in grain yield (kg ha^{-1}). Among irrigation levels, I_5 increased grain yield (124.78%) followed by I_4 (113.76%) over I_1 treatment (table-I). These results corroborate the findings of Wajid *et al.* (2002) who reported that wheat yield increased with increasing irrigation levels.
Interaction between cultivars and irrigation levels was significant for grain yield (Table 3). At I_5, cultivars AS-2002 and SH-2002 increased yields (111.35% and 132.92%) over I_1 which were statistically at par with each other. The cultivar AS-2002 gave the highest grain yield followed by SH-2002 and Aqab-2000 which were however, statistically at par irrespective of water stress. Highest grain yield in AS-2002 might be due to the increase in number of tillers m^{-2} and with higher 1000- grain weight.

***Harvest index (%)*:** Maximum harvest index (35.93%) was recorded at I_5 that was statistically alike to that (35.62%) achieved at I_4. Minimum harvest index was recorded (27.24%) at I_1. Among cultivars harvest index was appeared to be non significant. Giunata *et al*. (1993), Pannu *et al*. (1996) reported that harvest index of the crop is significantly reduced due to water stress.

CONCLUSION

Results showed that soil moisture stress causes low grain yield, by inducing low 1000- grain weight, number of tillers m^{-2}. Thus, wheat, a staple food, appears to be suffering yield losses due to deficiency of irrigation water at any critical stage. Therefore, wheat grower must be careful about water stress on critical stage which can cause tremendous yield losses. It's also clear that there is a considerable span to exploit the yield potential of wheat cultivars in irrigated area of Pakistan.

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