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Short Communication

Effect of different irrigation regimes on grain yield of wheat under local conditions of Dera Ghazi Khan

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Abstract

Field trials were conducted to estimate the effect of number of irrigations on yield of wheat crop in the semi arid area of Pakistan at Adaptive Research Farm, Mouza Rakh Chabbri Zareen, D. G. Khan for three consecutive years from 2005-06 to 2007-08. The study comprised of three treatments including four irrigations (T_1) at crown root development, booting, milking and grain development; five irrigations (T_2) at crown root development, tillering, milking, grain development and dough stage and six irrigations (T_3) at crown root development, tillering, milking, grain development, dough stage and at maturity. The results revealed that during the year 2005-06 and 2006-07 the grain yield and yield contributing parameters were significantly higher when crop was irrigated with five irrigations (T_2), while 1000-grains weight, germination count m^{-2} and number of tillers m^{-2} were not affected significantly during the year 2005-06 and 2007-08. The highest grain yield was recorded with five irrigations at different critical growth stages of wheat crop. The possible reason might be availability of more moisture. The results revealed that the application of irrigation at tillering stage played a vital role to increase wheat yield and contrarily the application of irrigation at maturity caused decrease in wheat yield.

Keywords: wheat; yield; irrigations; growth stages

Wheat (*Tritium aestivum L.*), the king of the cereals has been playing pivotal role in the country economy and plays more important role during the prevailing conditions of shortage of food items. Wheat crop has the large acreage among all the field crops. Area and production target of wheat for the year 2008-09 was set at 8610 thousand hectares and 25 million tons, respectively. It was cultivated on an area of 9062 thousand hectares, showing an increase of 5.9 percent over 2007-08 area of 8550 thousand hectares. The size of wheat crop was provisionally estimated at 23.4 million tons, 11.7 percent more than last year crop (2006-07). The main reasons for higher production are: attractive wheat support price of Rs. 950 per 40 kg, before the sowing of crop, significant increases in area under crop, timely rains during December, January and March and other supportive measures like setting a higher wheat procurement target by the public sector and extending fertilizer subsidy to the tune of Rs.32 billion The water availability during Rabi season (for major crop such as wheat), is, however, estimated at 24.9 MAF, which is 31.6 percent less than the normal availability, and 10.7 percent less than the last year's Rabi season (Govt. of Pakistan, 2008-09).

Hence, the water supplies form existing canal irrigation system is not enough to meet the crop water requirement. The water logging and salinity have emerged in the irrigated areas due to continuous seepage and percolation from the canal irrigation system and lack of adequate drainage infrastructures (Kahlown *et al.*, 2002). Consequently, the crop suffers from moisture stress (Tyagi *et al.*, 2003) and to this fact over all low productivity has been traced in many irrigation projects.

Water is essential for every developmental phase starting from seed germination to plant maturation for harvesting the maximum potential of wheat. There is a positive correlation between grain yield and irrigation frequencies (Bajwa e*t al*., 1987). Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cell but also increase the effectiveness of the mineral nutrients applied to the crop (Bajwa *et al*., 1993). Water deficit imposed after planting significantly reduces the plant growth and yield (Harold, 1986).

Normal irrigations are essential for bumper crop production, but when there is scarcity of water, it becomes imperative to differentiate the critical growth stages of the

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crop where irrigation could be missed, without reducing the grain yield significantly (Timsina *et al.,* 1998). Irrigation missing at some critical growth stage some times drastically reduces grain yield (Chauhan *et al.,* 2008) due to lower 1000 grain weight (Bajwa et al., 1993) and lesser number of grains per spike (Hussain, 1996; Akram, 2000). However, number of productive tillers per unit area remains unaffected (Rana, 1976). Similarly, over irrigation also sometimes tends to decrease grain yield instead of increasing yield (Kahlown and Azam, 2002).While at lower depth (30-90 cm) the zero tillage treatment at seedling, 1st tillering, 2nd tillering, booting, anthesis, milk development and maturity stages contained 30.4, 24.15, 25.73, 13.81, 44.2, 32.0, 9.65 mm more water in the soil profile than tillage (Wisal *et al*., 2006). Among the various factors responsible for low yield per hectare, irrigation scheduling is one of the major.

This study was conducted to find out the appropriate number of irrigations for the increase in production of wheat in agro ecological zone of district Dera Ghazi Khan.

To evaluate the effect of number of irrigations at different stages of crop, a series of field experiments were conducted during November, 2005 to April, 2008 at Adaptive Research Farm, Mouza Rakh Chabbri Zareen, D. G. Khan situated at north altitude 29` and 31` and East longitude 69` and 71. As soil of the experimental area was quite uniform, a composite and representative soil sample to a depth of 30 cm was obtained with soil auger, prior to sowing of the crop. Percentage of sand, silt and clay was determined by Bouyoucos hydrometer method using one percent sodium hexametaphosphate as a dispersing agent. Textural class was determined by using the international textural triangle (Moodie *et al.*, 1959). Soil was analyzed for its various chemical properties by using the methods as described by Homer and Pratt (1961). The soil was analyzed for N and K. The soil was sandy clay loam containing 65 % sand, 15 % silt and 20 % clay. Its chemical characteristics included saturation 36 %, pH ranged from 7.5-8.5, EC varied from 5.02 to 7.77 dS m^{-1}, organic matter 0.83 %, total nitrogen 0.083 %, available phosphorous 1 mg kg^{-1}, and available K 125 mg kg^{-1}. The climatic conditions at experimental site were also recorded during the course of research period (Table 1).

The selected fields were precisely leveled and divided into 9 plots each measuring 11 × 23 m^2. Three treatments namely; Four irrigations (T_1) at crown root development, booting, milking and grain development; Five irrigations (T_2) at crown root development, tillering, grain development, milking and dough stage and six irrigations (T_3) crown root development, tillering, grain development, milking, dough stage and at maturity, were applied and tested. Each treatment was repeated three times by using randomized complete block design. One watercourse between the two replications and one path in the middle of the experiment was constructed. Appropriated agronomic practices/operations needed for the crop were made as and where required. The field was irrigated about 10 days before planting wheat. The first irrigation was applied 10 days after crop emergence and the subsequent irrigations were applied as per treatment plan of the experiment.

Table 1. Metrological data observed during Research Period

Month	Temperature (C°)		Humidity (%)	Rainfall (mm)
	Min.	Max.		
YEAR 2005-06				
November, 05	06	28	85	-
December, 05	01	25	80	-
January, 06	02	25	85	-
February, 06	06	29	84	14mm
March, 06	08	30	85	39mm
April, 06	12	44	75	-
YEAR 2006-07				
November, 06	16	24	87	20mm
December, 06	11	17	81	25mm
January, 07	06	16	89	-
February, 07	12	23	84	43mm
March, 07	18	27	84	22.5mm
April, 07	23	37	78	-
YEAR 2007-08				
November, 07	15	25	87	-
December, 07	10	20	75	03mm
January, 08	05	17	85	20mm
February, 08	07	20	80	2.5mm
March, 08	17	30	85	15 mm
April, 08	20	31	76	34 mm

The plant parameters viz. number of tillers m^{-2}, number of grains $spike^{-1}$, 1000 grain weight and grain yield were recorded. Standard procedure was adopted for recording the observations on various yield and yield parameters. The data were analyzed year wise on individual basis and their means were computed. Statistical analyses for ANOVA were carried out by using "MSTAT-C" (Anonymous, 1986) where as the means were compared through LSD test at p 0.05 (Steel *et al.*, 1997).

Productive tillers m^{-2}

The results showed that the number of irrigations significantly influenced the productive tillers (Table 2). Among the treatments, T_2 (Five irrigations) produced maximum number of tillers (220 m^{-2}) in the year 2005-06

and in 2006-07 (228 m^{-2}) and non-significant in the year 2007-08. The more number of tillers may be attributed to adequate moisture supply particularly at tillering stage at T_2. Bajwa *et al.* (1993) observed significant effect on varying levels of irrigations on the number of tillers m^{-2}. However, Rana (1976) reported non-significant effect of irrigations on the total tillers per unit area.

Table 2. Effect of irrigations regimes on number of tillers

Treatment	Number of tillers m^{-2}			
Irrigation	**2005-06**	**2006-07**	**2007-08**	**Mean**
Four	205b	209c	217ns	210.33
Five	220a	228a	209ns	219.00
Six	213a	218b	203ns	211.33
LSD(p<0.05)	7.85	3.82	12.13	

Grains spike^{-1}

The data showed that the number of irrigations significantly influenced the number of grains spike^{-1} (Table 3). Treatment T_2 in the year 2006-07 produced maximum number of grains spike^{-1} (41.00). The same trend was observed in the year 2005-06 for number of grains spike^{-1} (39.00) and 2007-08 (39.00). The maximum number of grains spike^{-1} obtained may be due to suitable moisture available at this treatment. The previous studies also revealed that number of irrigations significantly influenced number of grains spike^{-1} (Hussain, 1996; Akram, 2000).

Table 3. Effect of irrigations regimes on number of grains per spike

Treatment	Number of grains per spike			
Irrigation	**2005-06**	**2006-07**	**2007-08**	**Mean**
Four	36b	37b	37b	36.66
Five	39a	41a	39a	39.66
Six	37ab	39ab	33c	36.33
LSD(p<0.05)	2.62	2.27	1.85	

1000 grains weight

The data regarding 1000-grains weight was significantly affected by the number of irrigations (Table 4). It was revealed that irrigations levels influenced the 1000-grains weight in the year 2006-07 and 2007-08. Bajwa *et al.* (1993) also observed that the different levels of irrigations significantly affected 1000 grain weight. The maximum 1000-grains weight (41 g) was reported in T_2, when the irrigations were applied at crown root development, tillering, grain development, milking and at dough stage as compared to minimum 1000-grains weight (36 g) in T_3 in which the irrigation at maturity produced shriveled grains. Non significant effect was observed in the year 2005-06. The possible reason might be due to initial soil status, which was saline. Timsina *et al.* (1998) and Bajwa *et al*. (1987) also found no clear cut response of 1000- grains weight to moisture regimes.

Table 4. Effect of number of irrigations on 1000 grains weight (g)

Treatment	1000 Grains weight (g)			
Irrigation	**2005-06**	**2006-07**	**2007-08**	**Mean**
Four	35ns	36c	37ab	36.00
Five	38ns	41a	41a	40.00
Six	36ns	38b	36b	37.00
LSD(p<0.05)	9.34	1.31	3.29	

Grain yield (kg ha^{-1})

The grain yield data of all three years reveals significant response to number of irrigations (Table 5). The highest yield (3184.65 kg ha^{-1}) was recorded for T_2 where five irrigations were applied at different critical stages of wheat crop against the minimum yield (2958 kg ha^{-1}) obtained form T_1. The highest grain yield might be obtained due to availability of enough moisture at critical stage of tillering. It could be concluded that tillering is the most important critical stage in the wheat crop regarding requirement of water while the irrigation at maturity caused significant decrease in wheat yield. These results are in conformity with the finding of Bajwa *et al.* (1993), Kahlown and Azam (2002) and Chauhan *et al.* (2008) who stated that application of five irrigations to wheat crop resulted in the highest grain yield. Wajid *et al.* (2007) also described that interaction between cultivar and irrigation levels affecting the response of grain yield to water received was significant.

Table 5. Effect of number of irrigations on grain yield

Treatment	Grain yield Kg ha^{-1}			
Irrigation	**2005-06**	**2006-07**	**2007-08**	**Mean**
Four	2583c	2647c	2958.06b	2729.33
Five	3260a	3437a	3184.65a	3293.88
Six	2837b	2916b	3051.77ab	2934.92
LSD(p<0.05)	202.71	56.64	146.6	

Conclusion

From this study it can be concluded that five irrigations could produce satisfactory positive effects on the yield of wheat crop particularly in saline area of district Dera Ghazi Khan. Hence, five irrigations are recommended at appropriate stages to get maximum grain yield in wheat. The appropriate stages are; crown root development, tillering, grain development, milking, and at dough stage (before maturity). The results also indicated to avoid irrigating the wheat crop during the crop growth period of maturity.

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