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EFFECT OF DIFFERENT IRRIGATION FREQUIENCIES ON GROWTH AND YIELD OF DIFFERENT WHEAT GENOTYPES IN SINDH

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ABSTRACT:- Irrigation at critical growth stages could improve wheat yield significantly. A study was conducted during 2000–2002 to determine effect of different irrigation levels on growth and yield of different wheat genotypes in the province of Sindh. The trial was laid out in split block design at Wheat Research Institute, Sindh, Sakrand, in which four irrigation treatments I_3 (irrigation at crown root, booting and soft dough stage), I_4 (irrigation at crown root, tillering, booting and soft dough stage), I_5 (irrigation at crown root, tillering, booting, anthesis and soft dough stage) and I_6 (irrigation at crown root, tillering, booting, anthesis, soft dough and hard dough stage) were in blocks and six wheat genotypes; V–7001, V–7002, V–7004, NARC–9 and CO–9043 and Abadgar–93 were planted. Number of irrigation did not have any significant effect on plant height, whereas plant height was affected significantly in different cultivars. Application of five irrigations at different wheat growth stages resulted in higher spike length, higher number of grains and wheat grain yield. Wheat variety Abadgar–93 and V–7004, had taller plants in comparison with cultivars NARC–9 and V–7004 however, wheat grain yield was not affected significantly among different cultivars.

Key Words: Wheat; Genotypes; Irrigation; Yield; Growth Stages; Pakistan.

INTRODUCTION

In Sindh province of Pakistan, wheat is planted on nearly one million hectare. Because of lower rainfall during growing season, wheat crop requires irrigation water for its growth in Sindh. During the last five years, average wheat grain yield in the province were in the range of 2500 –3400 kg ha^{-1}, that was well below than the potential yield of modern wheat varieties (GoP, 2009). Wheat productivity is low due to improper tillage operations, late sowing, imbalance use of fertilizer, scarcity of water and inefficient irrigation water management (Khan, 2003).

Water requirements for wheat crop vary from 180mm to 420mm (Blasubramaniyan and Palaniappan, 2001) depending upon location, soil and environmental conditions (Miholyfalvy, 1974). Due to hot weather, consumptive irrigation water requirement for wheat is 375 mm in Sindh (Mahar et al., 1990). Application of six irrigations improved wheat grain yield in comparison with less irrigations under semi arid conditions of Faisalabad (Wajid et al., 2002). Application of 4 - 5 irrigations significantly increased grain weight per plant and 1000 grain weight that resulted in significantly higher grain yield (Samo, 1980; Jamal et al., 1987) than three irrigations. Increasing number of irrigations improved plant height and grain yield (Prasher and Mukhtar, 1962). However, Rajput et al. (1994) reported that the grain yield did not differ significantly due to irrigation frequencies and maximum grain yield was obtained with 5 irrigations.

Crown root initiation in wheat was the most critical stage for irrigation and water shortage at this stage reduced the grain yield by 27% (Cheema et al., 1973). Number of tillers improved with irrigation at Crown root stage and better grain yield was recorded with irrigation at crown root and boot stage (Bajwa et al., 1993).Wheat grain yield decreased when wheat plants were subjected to water stress at tillering, heading, milk – ripe and dough stage (Aniklyew, 1970; Shetaia and El-Gawad 1995). Yazal et al. (1994) also reported that withholding irrigation either at milky, heading, boot-

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ing or tillering stage decrease wheat grain yield. Accordingly, wheat yield can be increased by applying irrigation at milk and dough stages (Gill and Singh, 1980).

Wheat variety Sonalika performed well with only three irrigations at Crown root initiation, late tillering and peak flowering stage than other genotypes (Nayak and Sengupta, 1981). In another study, SH- 2002 was the top yielder among the four cultivars tested (AS-2002, SH-2002, Inqlab-91 and Uqab- 02) at each level of irrigation (Mahmood and Ahmad, 2005). Wheat genotype 00183 had significantly higher grain yield during both years of study due to its significantly more number of spikelets per spike and grains per spike (Akram et al., 2009). According to Mangan et al. (2008), short duration wheat cultivar Sarsabz had more grain yield under four to five irrigation levels in comparison with Kiran-95 and local wheat. However, local wheat, Thori had highest plant height under maximum levels of irrigation.

Due to shortage of irrigation water and warm weather during wheat growth period in the province of Sindh, it is important to manage irrigation water in such a way that grain yield is not reduced. The objective of this study was to determine effect of different irrigation levels on growth and yield of different wheat genotypes in the province of Sindh.

MATERIALS AND METHODS

The experiment was conducted at Wheat Research Institute, Sakrand, District Nawabshah, Sindh during wheat growing seasons of 2000-01 and 2001-02. The study area was fallow during *kharif* season. Land preparation included disking, leveling and plowing. At this point soaking irrigation was applied and seed bed was prepared with cultivator and rotavator at optimum moisture level. The 50 kg ha^{-1} of N and 65 kg ha^{-1} P was applied in the form of urea and DAP at planting. Remaining 50 kg ha^{-1} of N was applied at first irrigation. Wheat planting was completed on November 17, 2000 and November 20, 2001 with seed rate of 125 kg ha^{-1} with the help of single coulter hand drill and maintaining row to row distance of 20 cm in 1.85m × 6.46 m.

The trial was laid out in Split Block Design, in which four irrigation treatments were in blocks and six wheat cultivars were randomized in each block with four replications. Levels of irrigations included I_3 (irrigation at crown root stage , booting stage and dough stage), I_4 (irrigations at crown root stage , tillering stage , booting stage and milky stage), I_5 (irrigations at crown root stage , tillering stage , booting stage , anthesis stage and milky stage) and I_6 (irrigations at crown root stage , tillering stage , booting stage , anthesis stage , milky stage and dough stage). Wheat cultivars included five improved advance lines, V-7001, V-7002, V-7004, NARC-9 and CO-9043 and one commercial wheat variety, Abadgar-93. Pre planting irrigation was of 100 mm and post planting irrigation was of 75 mm each. First post planting irrigation was applied 21 days after sowing at crown root stage. Afterwards, irrigation was applied at respective growth stage. Herbicide (Buctril – super) was applied to control weeds after first irrigation. Days to heading and days to maturity were recorded. At maturity, data was recorded from each sub plot plant height, number of tillers per plant, spike length, number of grains per spike and grain weight per spike, 1000 grain weight and total seed yield per hectare was recorded. The data were analyzed statistically using Duncan's new multiple range test following Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Number of irrigation did not have any significant effect on plant height (Table 1) which was in conformity with the findings of Buriro et al. (1990) that plant height was not affected by irrigation frequencies as it was the characteristic of cultivar/genotype (Table 3).

Tillering in wheat plants improved significantly with an additional irrigation applied during tillering stage in I_4, I_5 and I_6 as compared to irrigation applied only at the

Table 1. Effect of different irrigation schemes on wheat growth and yield in Sindh

Irrigation	Plant height (cm)	Tillers plant^{-1} (No)	Spike length (cm)	Grains spike^{-1} (No)	Grain weight spike^{-1} (g)	1000 grain weight (g)	Grain yield (kg ha^{-1})
I_3	89 a	4.9 b	10.4 b	42.9 b	1.65 b	43.29 a	3387 d
I_4	91 a	5.4 a	10.4 b	45.5 a	1.77 ab	41.93 a	4084 c
I_5	91 a	5.5 a	11.3 a	45.2 a	1.79 ab	41.76 a	5089 a
I_6	90 a	5.4 a	10.4 b	45.9 a	1.91 a	42.63 a	4520 b

Means followed by same letter in a column do not differ significantly at P = 0.05

time of crown root initiation stage in I_3. (Table 1). These observations are in agreement with Sawati et al. (1985) who reported that higher levels of irrigation had favorable effect on the tillering capacity while in lower levels of irrigation resulted in considerable reduction in number of tillers.

Spike length was significantly higher with five irrigations in comparison with other irrigation treatments. However, significantly higher number of grains per spike were observed with I_4, I_5 and I_6 in comparison with I_3. Grain weight per spike improved significantly with addition of irrigation during grain filling. The results were in confirmation with Robins and Domingo (1962), Salvic (1966) and Hassan et al. (1987) that reduction in grains per spike resulted from water stress at anthesis and booting stages.

Wheat grain yield was higher with five irrigations followed with 6, 4 and 3 irrigations. There was 20%, 50% and 33% increase in wheat grain yield with I_4, I_5 and I_6, respectively in comparison with I_3 irrigation treatment. Because of rising temperature (Table 2) after wheat heading, irrigation at anthesis stage in addition to soft dough stage have more pronounced effect on wheat yield with I_5 and I_6 (Table 1). Wheat grain yield improved with five irrigations in comparison with four and three irrigations (Seif et al., 1984; El-Gawad et al., 1993; Eid and Yousif, 1994; Shetaia and El-Gawad, 1995; Sharaan et al., 2000; Kheir et al., 2001) due to increase in spikes m^2, spike weight, number and weight of grains per spike and number of fertile spikelets per spike (Behar and Sharma, 1991).

Data from the trial including the grain yield and yield characters of different wheat genotypes showed that plant height was significantly different in cultivars (Table 3). Wheat variety Abadgar-93 (97 cm) and V-7002 (93 cm) had taller plants (97cm) in comparison with cultivars NARC-9 (87cm) and V-7004 (87cm).

Table 2. Air temperature (°C) during wheat growing season at Sukkhur

Month	Minimum	Maximum	Mean
2000-01			
October	21.1	37.4	29.3
November	15.5	29.4	22.5
December	10.6	25.7	18.2
January	8.2	23.4	15.8
February	11.3	27.3	19.3
March	16.9	32.9	24.9
April	22.3	38.5	30.4
2001-02			
October	22.0	36.0	29.0
November	16.0	31.1	23.5
December	11.8	26.7	19.2
January	8.5	23.9	16.2
February	10.9	25.5	18.2
March	17.2	33.1	25.1
April	24.5	40.0	32.2

Average number of tillers per plant was not different among different cultivars under study. All the cultivars had same tillering capacity as the number of tillers per plant was not significantly different among cultivars (Table 3). Spike length, spikelets per spike, grains per spike, grain weight per spike and thousand grain weights were significantly higher with cultivar V-7004 in comparison with other wheat cultivars. Heading in wheat cultivar V-7004 started earlier, so there was more time available for grain filling and that resulted in significantly higher 1000-grain weight in this cultivar. Wheat grain

Table 3. Growth and yield of different wheat cultivars in Sindh

Variety	Days to heading	Days to maturity	Plant height (cm)	Tillers plant^{-1}	Spike length (cm)	Grains spike^{-1}	Grain weight spike^{-1} (g)	1000 grain weight	Grain yield (kg ha^{-1})
Abadgar-93	83 b	136 b	97 a	5.4 a	10.2 b	44.6 bc	1.77 b	42.4 b	4286 a
V-7001	81 c	138 a	91 bc	5.4 a	10.2 b	45.4 bc	1.79 b	42.7 ab	4305 a
V-7002	79 d	130 e	93 b	5.5 a	10.4 b	46.2 b	1.86 ab	41.5 bc	4419 a
V-7004	77 e	130 e	87 d	5.1 a	12.5 a	49.7 a	2.07 a	44.8 a	4249 a
NARC-9	88 a	134 d	87 d	5.3 a	10.3 b	40.5 d	1.52 c	39.8 c	4214 a
CO9043	75 f	135 c	89 cd	5. 3 a	10.3 b	42.7 cd	1.69 bc	43.3 ab	4146 a

Means followed by same letter in a column do not differ significantly at P = 0.05

yield was not significantly different among different cultivars.

Based on two-year trial, the results revealed that maximum wheat yield in Sindh could be achieved with five irrigations at different growth stages such as crown root stage, tillering stage, booting stage, anthesis stage and soft dough stage. Because of hot temperature after heading, irrigation at anthesis and soft dough stages improved wheat grain yield. In addition, wheat genotype V-7004 seem to be a good, high yielding and short duration wheat genotype that suits this part of Sindh.

LITERATURE CITED

Afzal, M. 1980. Effect of different fertilizers and irrigations on the growth and yield of wheat variety (Pak – 70). M.Sc. Thesis. Sindh Agriculture University, Tandojam, Hyderabad.

Akram, H. M. Sattar, A. Nadeem, M. A. and Ali, A. 2009. Performance of wheat genotypes under mixed cropping system. J. Agric.Res. 47(2): 137-142.

Aniklyew, U.V. and Pekpayew, A.A. 1970. The effect of insufficient soil moisture on developing winter wheat. Vyestist Akad Navuk Byelorus SSR Syer Biyul Navuk, 3:40-44. (Biolog. Abstr. 52 (5) : 2451 ; 1971).

Bajwa, M. A. Chaudhry, M. H. and Sattar, A. 1993. Influence of different irrigations regimes on yield and yield components of wheat . Pakistan J. Agric. Res. 14 (4): 361–365.

Balasubramaniyan, P. and Palaniappan, S.P. 2001. Principles and practices of Agronomy. Agrobios, Jodhpur, India.

Behar, U.K. and Sharma, K.C. 1991. Effect of irrigation and fertility levels on yield of wheat in Tarai. Orissa J. Agric. Res. 4: 30 – 132.

Buriro, U.A. Arian, M. R. Kumbhar, A.M. and Jamro, G.H. 1990. Effect of different irrigation frequencies on the yield and yield components of wheat cultivars. Sarhad J. Agric. 6 (3): 209 – 211.

Cheema, S.S. Dhingra, K. K. and Gill, G. S. 1973. Effect of missing irrigation on the growth of dwarf wheat. J. Res. Punjab Agric. Univ. 10 (1): 41 – 44.

Eid, R.A. and Yousif, M.R. 1994. Water use and yield of wheat in relation to drought conditions and P fertilization. Egyptian J. Appl. Sci. 9 :546–560.

El–Gawad, A. Nour, A. A. El–Din, A.A. Ashoub, M. and Kashabah, M.A. 1993. Studies on consumptive use and irrigation scheduling in relation to nitrogen fertilization on wheat. II. Response of wheat yield and its attributes. Ann. Agric. Sci. (Ain Shams Univ.). 38: 173–185.

Gill, R.S. and Singh, H. 1980 . Time of last irrigation to dwarf wheat as affected by different levels of nitrogen. Indian J. Agron. 25 (2) : 313 – 314 .

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures in Agricultural Research. 2nd Edn. Willey, New york.

Governement of Pakistan. 2009. Pakistan Statistical Yearbook 2009. Federal Bureau of Statistics, Ministry of Economic Affairs and Statistics, Government of Pakistan, Islamabad.

Hassan, U.A. Ogunelela, V.B. and Singh, T.D. 1987. Agronomic performance of wheat (*Triticum aestivum* L.) as influ-

enced by moisture stress at various growth stages and seeding rates. J. Agron. Crop Sci.158 (3): 172 – 180.

Jamal, M. Karim, M. and Shah, P. 1987. Irrigation requirement of semi – dwarf wheat varieties in Peshawar. Pakistan J. Agric. Res. 8 (2): 133–137.

Kheir, S.A. Abo-EL-Kheir, M.S.A. and EL-Zeiny, H.A. 2001. Response of some wheat cultivars to water stress imposed at certain growth stages . Egyptian J. Appl. Sci. 16: 82-98.

Khan, M. A. 2003. Wheat crop management for yield maximization. Agriculture Department, Lahore.

Mahar, A. Bashir, A. Chandio, A. and Memon, Z. 1990 . Irrigation scheduling for wheat and cotton under rotation delivery system. J. Drainage and Reclamation, 2(1): 9-14.

Mangan, B. N. Tunio, S. D. Sial, M. A. Abro S. A. and Rajper, S. 2008. Effect of drought on yield and yield components of wheat. Pakistan J. Agric., Agril. Engg. Vet. Sci. 24 (1): 14-19.

Mahmood, N. and Ahmad, R. N. 2005. Determination of Water Requirements and Response of Wheat to Irrigation at Different Soil Moisture Depletion Levels. Int. J. Agric. Bio. 7(5): 812–815.

Miholyfalvy, I. 1974. The water requirement / utilization of winter wheat. Field Crop Abstr. 27 (1): 498 – 499.

Nayak, R.L. and Sengupta, A. K. 1981. Scheduling irrigation to dwarf wheat on the basis of critical stages of growth under West Bengal conditions. Indian Agric. 25 (2): 119 – 124.

Prashar, G.R.K. and Mukhtar, S. 1962. Soil moisture studies and the effect of varying levels of irrigation and fertilizer on wheat. Indian Agron. J. 33 (2): 57 – 93.

Rajput, M.K.K. Ansari, A.H. Rao, K.A. and Shaikh, Z.M. 1994. Influence of irrigation frequencies on the growth and grain yield of bread wheat (*Triticum aestivum*) varieties. Pakistan J. Agric. Sci. 10 (1-2) : 64-69 .

Robins, J.S. and Domingo, C.E. 1962. Moisture and nitrogen effects on irrigated spring wheat. Agron. J. 54: 135 – 138.

Salvic, B. 1966. Responses of grasses and cereals to water. In: . Milthorpe, F. L. and Ivis, J. D. (eds.) Growth of Cereals and Grasses : London. p. 227-240.

Samo, M.U. 1980. Effect of irrigation scheduling on wheat (Pak-70) variety. M.Sc Thesis. Sindh Agriculture University, Tandojam, Hyderabad.

Sawati, M. S. Rahmat, H. and Afsar, J. 1985. Response of wheat (*Triticum aestivum* L.) cultivars to different levels of water stress. Sarhad J. Agri. 1 (2): 295 – 304.

Seif, M.N. Metwally, M.A. Badawi, A.Y. Tawadros, M.W. and Serry, A. 1984. Effect of drought conditions at different stages of wheat growth. Agric. Res. Rev. 62 (4 A): 27 – 37.

Sharaan, A.N. Abd El – Samie, F.S. and Abd El-Gawad, I.A. 2000. Response of wheat varieties (*Triticum aestivum* L.) to some environmental influence: Effect of planting date and drought at different plant stages on yield and its components. In: Proc. 9th Conf. Agron. Minofiya Univ., Egypt. p: 1-5.

Shetaia, A. and El-Gawad, A. 1995. Growth, yield and yield attributes of wheat in relation to N- fertilization and withholding irrigation at different stages of growth. Ann. Agric. Sci. (Ain Shan University).40: 195-211.

Wajid, A. Hussain, A. Ahmed, M. M. and Waris, M. 2002. Influence of sowing date and irrigation levels on growth and grain yield of wheat. Pakistan J. Agric. Sci. 39 (1): 22-24.

Yazal, S. E. Metwally, M.N. Badawi, A.Y. Tawdros, H.W. and Serry, A. 1994. Effect of drought conditions at different stages of wheat growth. Agric. Res. Rev. 62: 24-38.