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RESPONSE OF WHEAT TO IRRIGATION IN SANDY SOILS

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ABSTRACT: Two field experiments were conducted at Ismailia Agricultural Research station in 2000/2001 and 2001/2002 seasons, to study the effect of some irrigation treatments on yield and yield components and protein percentage of grain well as some water relations of Gemmeiza 9 wheat variety. Nine irrigation treatments represent the combination between three irrigation intervals i.e. 5, 10 and 15 days both at heading and maturity.

Results indicated that significant differences between irrigation treatments for plant height, number of spikes/m^2, number of grains/ spike, 1000 – grain weight and grain and straw yield/fed. Irrigation of wheat at long intervals (15 days) decreased yield and its components than irrigation at short intervals (5 days) in sandy soils. Results also, indicated that increasing water stress at any development stage led to increased grain crude protein percentage of wheat plants.

Results showed that increasing irrigation interval of wheat led to decreased seasonal, monthly and daily consumptive use and water use efficiency. It was shown that irrigation of wheat at 5 days intervals during the growing season gave the highest grain yield/fed. and water use efficiency in both seasons.

INTRODUCTION

Wheat (Triticum aestivum, L) is the main food crop in Egypt as in many other parts of the world. Egypt suffered a considerable gab between its national production and consumption. To solve this problem, invading deserts to be cultivated to wheat became a must. Due to the scanty of irrigation water, development of drought tolerant cultivars and investigating the proper cultural practices specially irrigation and fertilization

in the new cultivated area should have great attention. Most of this area is desert and have limited quantity and quality of water irrigation. Many researchers proved the importance of irrigation treatment to maximize wheat productivity. Schneider et al. (1969) found that timing of irrigation was as important as total quantity of water applied.

Sayed (1982), Metwally et al. (1984) and Jensen and Moganesen (1985) reported that grain of wheat yield was reduced when water stress was applied at any stage of development. Also, Lat (1985) and Masoud (1986) revealed that the grain yield of wheat was affected by number of irrigations. Abd El-Rahim et al. (1989) indicated that water deficit at growth and flowering stage affected spike number/m^2, 1000-grain weight and grain yield/fed. Mosaad et al. (1990),Ghauhan (1991) and Heggy et al. (1993) pointed out that irrigation of wheat at long intervals decreased number of tillers / plant, spike number / plant and dry matter/plant than irrigation at short intervals. Also, Farah et al. (1993), Fardad and Pessarakli (1995) and Sadek (2001) obtained the highest grain yield from the shortest irrigation interval of 10 days which was 30% higher than that obtained by irrigating every 14 days throughout the season. Abd El hamed et al. (1986), found that the percentage of protein in wheat grains increased as water supply increased. El-Emery et al. (1994), indicated that the increase in the rate of water supply decreased crude protein percentage of wheat grain. Abderrazak et al. (1995) reported that lack of irrigation at heading, grain formation and during maturation of wheat significantly reduced average protein content and total protein yield. Proffitt et al. (1986) postulated that at low frequency irrigation, plants remaining under water stress used less water and produced law grain with law WUE indices.

Sharma et. al. (1990) reported that water use efficiency of winter wheat was highest under well irrigation condition comparing with under water stress conditions comparing with under water stress conditions. Also, Yousef and Eid (1999), concluded that the irrigation at 30% available soil moisture depletion gave the highest water use efficiency alues, i.e. . . 1.004 and 0.998 kg

grains/m^3 water consumed in the two successive seasons. The present investigation aimed to study the effect of irrigation treatments on yield, and yield component of wheat production in sandy soils.

MATERIALS AND METHODS.

The field experiments were carried out at Ismailia Agricultural Research Station, in 2000/2001 and 2001/2002 seasons, to study the effect of irrigation intervals on yield, yield components and protein percentage of grain as well as some water relations of wheat (*triticum aestivum l.*) variety Gemmeiza 9.

Soil texture was sandy. Mechanical analysis of the soil of the experimental site according to the standard method of Arnold (1986) are presented in the Table (1).

The experiment was laid out in a randomized complete block design with three replication. Each experiment included nine irrigation treatments as follows:

1- Irrigation every 5 days until maturity.
2- Irrigation every 10 days until maturity.
3- Irrigation every 15 days until maturity.
4- Irrigation every 5 days until heading stage and every 10 days until maturity.
5- Irrigation every 5 days until heading stage and every 15 days until maturity.
6- Irrigation every 10 days until heading stage and every 5 days until maturity.
7- Irrigation every 10 days until heading stage and every 15 days until maturity.
8- Irrigation every 15 days until heading stage and every 5 days until maturity.
9- Irrigation every 15 days until heading stage and every 10 days until maturity.

The irrigation treatments were applied after 21 days from sowing. The surface irrigation system was used, stopping irrigation was after 135 days from sowing in the two seasons and harvesting time was time after 148 and 145 days from sowing in the first and second seasons, respectively.

Phosphorus fertilizer at the rate of 30 kg P_2O_5 / fed. as calcium superphosphate (15.5 % P_2O_5) and potassium fertilizer at the rate of 24 kg K_2O/fed. as potassium sulphate (48 % K_2O) were applied during land preparation.The area

of plot was 21 m^2 (30 raws x 0.2 m apart x 3.5 m long) . Sowing dates 21 and 25 of November in the first and second seasons, respectively. Nitrogen fertilizer was added at the rate of 100 kg N/fed. in the form of ammonium nitrate (33.5 % N) and divided into four portion, at sowing, and after 15, 30 and 60 days from sowing date under the rates 10 , 20 , 30 , and 40 kg N/fed., respectively.

Studied characters

1- Number of spikes/m^2. calculated by counting all spikes / m^2 selected at random from each plot

At harvesting ten individual plants were chosen at random from the middle rows of each plot in the both seasons and the following data were recorded.

2- Plant height (cm).

3-Number of grains / spike.

4-Seed index (1000 grain weight in grams) .

The plants of each plot were cut to determine:

5-Grain yield / fed . (ardab)

6-Straw yield / fed. (ton)

7-Grain crude protein percentage was determined by the micro kjeldahl method according to A.O.A.C (1970).

WATER RELATIONS

Moisture content and water consumptive use (CU) per unit area was calculated according to the equation described by Israelson and Hansen (1962).

The physical properties of experimental soil site, i.e. field capacity, wilting point, available moisture and bulk density were determined and recorded in Table (2).

Consumptive use was determined for all irrigation treatments from sowing until harvesting. The measured consumptive use between irrigation treatments was divided by the number of days to obtain the daily water use. The sum of daily rates in each month is the monthly value from which seasonal water consumptive use was obtained.

Water consumptive use per unit area was calculated according to the equation described by Israelson and Hansen (1962) as follow:

$Cu = D \times Bd \times (e2 - e_1)/100$

where:

Cu= water consumptive use (ET) in mm.

D = Soil depth (cm).

Bd = Bulk density in gm/cm^3.

e_1, e_2 = Soil moisture content before and after each irrigation, respectively.

Water use efficiency (W.U.E). Water use efficiency in kg/m^3 was

Table (1): Mechanical analysis of the soil of the experimental site in the 2000/2001 and 2001/2002 seasons.

Mechanical Analysis		
	2000/2001	**2001/2002**
Coarse sand (%)	60	58
Fine sand (%)	37	39
Silt (%)	1.3	1.5
Clay (%)	1.0	1.0
O.M (%)	0.1	0.1
Texture class	sand	sand

Table (2): physical properties of the experimental soil site in 2000/2001 and 2001/2002 seasons.

Depth in (cm)	Field Capacity (%)		Wilting Point (%)		Available Moisture (%)		Bulk density (g/cm^3)	
	2000 2001	2001 2002	2000 2001	2001 2002	2000 2001	2001 2002	2000 2001	2001 2002
0-15	6.92	6.89	1.70	1.68	5.22	5.21	1.66	1.63
15-30	6.12	6.12	1.22	1.21	4.90	4.91	1.54	1.56
30-45	7.85	7.81	1.73	1.69	6.12	6.12	1.65	1.68
45-60	7.71	7.66	1.76	1.71	5.95	5.95	1.66	1.65

calculated for different treatments by the following.

W.U.E =Grain yield kg/fed./Water consumption in m^3/fed.

Data obtained were analyzed according to Snedecor and Cochran (1967) and the treatment means compared by the least significant differences test (L.S.D.) at 5 % level.

RESULTS AND DISCUSSION

Effect of irrigation treatments on yield, yield components and protein percentage of grain of wheat variety Gemmeiza 9 in 2000/2001 and 2001/2002 seasons are presented in Table (3).

Results showed that the effects of irrigation treatments on plant height, number of spikes/m^2, number of grains/spike, seed index and grain and straw yield/fed. as well as crude protein percentage were significant in both seasons.

The highest values in plant height, number of spikes/m^2, number of grains/spike, seed index and grain and straw yield/fed. were 124.66, 384.33, 53.66, 48.60, 13.25 and 2.98 in the first season and 129.33, 391.33, 56.66, 49.20, 12.74 and 3.03 in the second season, respectively, were obtained from the first irrigation treatment (irrigation every 5 days during the growth stages). The lowest values in plant height, number of spikes/m^3, number of grains/spike, seed index and grain and straw yield/fed. were 76.33, 268.66, 24.66, 38.10, 6.13 and 0.97 in the first season and 76.00, 271.00, 25.00, 37.80, 5.66 and 0.99 in the second season, respectively, were produced from the third irrigation treatment.

The highest grain crude protein percentage was 12.23 and 12.70 was obtained from the third irrigation treatment in the two seasons, respectively, while the lowest value of protein percentage was 10.37 and 10.63 gained from the first irrigation treatment in 2000/2001 and 2001/2002 seasons, respectively.

From these results it could be concluded that high soil moisture deficit by irrigating every 15 days during different stages, would also reduce the capacity of plant in building up metabolites and this might account in turn to depression of photosynthetic efficiency of the leaves with consequent reduction in yield of wheat and its components. Similar results were reported by Abd El-Rahim et al. (1989), Fardad and Pessarakli (1995) and Sadek (2001).

Water relations:

Table (3): Effect of irrigation treatments on plant height, number of spikes/m^2, number of grains/spike, seed index, grain and straw yield/fed . and grain crude protein percentage of wheat in 2000/2001 and 2001/2002 seasons.

Irrigation treatments	Plant height (cm)		Number of spikes/m^2		Number of grains/spike		Seed index (g)		Grain yield/fed. (ardab)		Straw yield/fed. (ton)		Protein percentage	
	2000/2001	2001/2002	2000/2001	2001/2002	2000/2001	2001/2002	2000/2001	2001/2002	2000/2001	2001/2002	2000/2001	2001/2002	2000/2001	2001/2002
1 (5)days	124.66	129.33	384.33	391.33	53.66	56.66	48.60	49.20	13.25	12.74	2.98	3.03	10.37	10.63
2 (10) days	102.00	104.33	344.00	350.66	39.66	40.33	42.85	44.56	9.65	8.62	1.97	2.00	11.67	11.80
3 (15) days	76.33	76.00	268.66	271.00	24.66	25.00	38.10	37.80	6.13	5.66	0.97	0.99	12.23	12.70
4 (5 +10) days	109.00	111.00	347.33	355.00	42.66	43.66	42.78	44.86	10.17	9.89	2.17	2.21	11.23	11.07
5 (5 +15) days	93.00	94.33	328.00	338.33	36.33	37.00	41.61	42.32	7.27	7.00	1.49	1.52	11.47	12.13
6 (10 +5) days	117.00	118.66	364.00	368.00	47.00	48.33	43.87	45.83	11.03	10.14	2.48	2.49	10.63	11.50
7 (10 +15)days	83.00	83.33	297.66	299.33	30.33	31.00	40.70	42.07	6.17	6.83	1.28	1.30	11.93	12.27
8 (15 + 5) days	87.00	88.00	307.00	315.00	33.33	34.33	40.31	41.55	7.21	7.59	1.66	1.70	11.57	11.70
9 (15 +10)days	78.33	79.66	283.00	283.33	27.66	28.00	39.02	39.05	6.18	6.26	1.12	1.10	11.83	11.90
L.S.D at 5 % for	3.53	4.92	5.23	9.39	6.05	5.32	1.31	1.08	0.73	1.23	0.15	0.15	1.13	0.87

Consumptive use: results recorded in Tables (4-5) indicated that daily, monthly and seasonal water consumptive use increased with increasing number of irrigation in both seasons. The results showed also that seasonal rates varied widely between 2215.30 and 1253.0 m^3/fed. in first season and between 2213.90 and 1206.10 in the second seasons, respectively. The highest values of water consumptive use were gained from the first irrigation treatment (irrigation every 5 days during the growing season), while the lowest values of water consumptive use were consumed by third irrigation treatment (irrigation every 15 days during the growing season). It seem that water use by wheat was lower in the first season, compared with those recorded from the second one. This may be related to the differences in climatic factors from year to year. This trend reveals that the increase in water consumptive use depends on the available soil moisture in the root zone. The obtained data are due to availability of soil moisture for plants as well as to high evaporation opportunity from wet soil surface (irrigation of wheat at short intervals) compared with dry one (irrigation of wheat at long intervals). In this respect, Shaw and Laing (1965) pointed out that under stress conditions, transpiration is reduced when water deficit reached a critical value characteristic for the species, turgor induced changes in stomatal aperture which caused a reduction in transpiration to prevent or limit desiccation rather than to maintain flow at the level of evaporation demand.

In this connection Jensen (1968) indicated that crops such as small grains would not necessarily require the same amount of water when grown at different regions.

Burman, et al. (1980) defined water consumptive use or evapotranspiration as the evaporation of water from soil plus transpiration of liquid water through plant tissues expressed as the latent heat transfer per unit area of its equivalent depth of water unit area.

Water use efficiency:

Water use efficiency in an important measure used to reflect the effect of crop management with respect to water that has been used. The values of water use efficiency could be increased by increasing crop yield or decreasing evapotranspiration and/or by both

Table (4): Daily, monthly and seasonal evapotranspiration (m^3) and water use efficiency (kg wheat/m^3 water consumed) in 2000/2001 season.

Irrigation treatments		Nov. 9	Des. 31	Janu. 31	Feb. 29	March 31	April 17	Seasonal rates m^3	Seasonal daily rate m^3	Number of irrigation/season	Water use efficiency W.U.E
5 all days	M. Rate	77.8	407.1	446.2	541.4	553.5	189.3	2215.3	14.97	28	0.89 kg/m^3
	D. Rate	8.64	13.13	14.39	18.67	17.85	11.14				
5&10 days	M. Rate	77.8	407.1	446.2	423.6	389.1	132.0	1875.8	12.67	21	0.81kg/m^3
	D. Rate	8.64	13.13	14.39	14.61	12055	7.76				
5&15 days	M. Rate	77.8	407.1	446.2	385.3	340.8	108.9	1766.1	11.93	19	0.61kg/m^3
	D. Rate	8.64	13.13	14.39	13.29	10.99	6.41				
10 all days	M. Rate	77.8	306.1	338.4	392.0	425.4	143.4	1683.1	1.37	14	0.86 kg/m^3
	D. Rate	8.64	9.87	10.92	13.52	13.72	8.44				
10&5 days	M. Rate	77.8	306.1	338.4	479.2	514.9	176.9	1893.1	12 .79	22	0.87 kg/m^3
	D. Rate	8.64	9.87	10.92	16.52	16.61	10.41				
10&15 days	M. Rate	77.8	306.1	338.4	296.9	293.0	101.3	1413.5	9.55	11	0.65 kg/m^3
	D. Rate	8.64	9.87	10.92	10.24	9.45	5.96				
15 all days	M. Rate	77.8	238.5	260.8	280.7	289.8	105.4	1253.0	8.47	9	0.73 kg/m^3
	D. Rate	8.64	7.69	8.41	9.68	9.35	6.20				
15&5 days	M. Rate	77.8	238.5	260.8	413.2	443.0	157.9	1591.2	10.75	20	0.67 kg/m^3
	D. Rate	8.64	7.69	8.41	14.25	14.29	9.29				
15&10 days	M. Rate	77.8	238.5	260.8	300.9	293.6	109.4	1281.0	8.66	11	0.72 kg/m^3
	D. Rate	8.64	7.69	8.41	10.38	9.47	6.44				

Sowing date 21/ 11/ 2000.

First of heading date after 75, 70 and 65 days from sowing for irrigation every 5, 10 and 15 days until maturity, respectively.

Table (5): Daily, monthly and seasonal evapotranspiration (m^3) and water use efficiency (kg wheat/m^3 water consumed) in 2001/2002 season.

Irrigation treatments		Nov. 5	Des. 31	Janu. 31	Feb. 28	March 31	April 17	Seasonal rates m^3	Seasonal daily rate m^3	Number of irrigation/season	Water use efficiency W.U.E
5 all days	M. Rate	60.8	420.6	460.9	506.5	576.4	188.7	2213.9	15.26	27	0.86 kg/m^3
	D. Rate	12.16	13.57	14.86	18.09	18.59	9.93				
5&10 days	M. Rate	60.8	420.6	460.9	407.3	297.7	156.2	1803.5	12.43	21	0.82 kg/m^3
	D. Rate	12.16	13.57	14.86	14.55	9.60	8.22				
5&15 days	M. Rate	60.8	420.6	460.9	363.2	248.4	110.6	1664.5	11.47	19	0.63 kg/m^3
	D. Rate	12.16	13.57	14.86	12.97	8.01	5.82				
10 all days	M. Rate	60.8	290.3	300.2	368.3	380.9	156.8	1557.3	10.74	14	0.83 kg/m^3
	D. Rate	12.16	9.36	9.68	13.15	12.29	8.25				
10&5 days	M. Rate	60.8	290.3	300.2	470.7	495.3	166.6	1783.9	12.30	21	0.85 Kg/m^3
	D. Rate	12.16	9.36	9.68	16.81	15.98	8.77				
10&15 days	M. Rate	60.8	290.3	300.2	322.2	271.5	89.6	1334.6	9.20	11	0.76 kg/m^3
	D. Rate	12.16	9.36	9.68	11.51	8.76	4.72				
15 all days	M. Rate	60.8	211.7	231.7	287.9	296.5	117.5	1206.1	8.31	9	0.70 Kg/m^3
	D. Rate	12.16	6.83	7.47	10.28	9.56	6.18				
15&5 days	M. Rate	60.8	211.7	231.7	416.0	478.0	146.3	1544.5	10.65	19	0.73 kg/m^3
	D. Rate	12.16	6.83	7.47	14.86	15.42	7.7				
15&10 days	M. Rate	60.8	211.7	231.7	311.5	318.1	121.9	1255.7	8.66	11	0.74 kg/m^3
	D. Rate	12.16	6.83	7.47	11.13	10.26	6.42				

Sawing date 25/ 11/ 2001.
First of heading date after 75, 70 and 65 days from sowing for irrigation every 5, 10 and 15 days until maturity, respectively.

water use efficiency expressed as kg grain of wheat yield/m^3 of water consumed as affected by irrigation treatments in the two seasons are presented in Tables (4-5).

The results showed that water use efficiency rates varied widely between 00.89, 00.61 kg/$m^3$and 00.86, 00.63 kg/m^3 in the first and second seasons, respectively.

The highest value of water use efficiency was produced from the first irrigation treatment (irrigation every 5 days until maturity), while the lowest value of water use efficiency was obtained from fifth irrigation treatment (irrigation every 5 days until heading stage and every 15 days until maturity) in the two winter growing seasons.

These results may prove the importance of maintaining soil moisture at short irrigation intervals for maximum production of dry matter in wheat thereby higher water use efficiency values.

On the contrary, severe soil moisture at a long irrigation intervals (water stress), reduced plant growth more than water consumption which resulted in lower water use efficiency values.

In this connection, Miseha, (1983) concluded that plants subjected to sever water deficit are smaller than those subjected to moist or moderate water level. Reduced cell turger is most important reason for reduced plan size. Plant turgidity is important in relation to the opening and closing of stomata.

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استجابة القمح للري في الأراضي الرملية

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أجريت تجربتان حقليتان بمحطة البحوث الزراعية بالإسماعيلية خلال موسمي ٢٠٠٠/٢٠٠١و ٢٠٠١/٢٠٠٢ لدراسة تأثير معاملات الري على النمو و المحصول و مكوناته و نسبة البروتين في الحبوب لصنف القمح جميزة ٩.

معاملات الري:-

١- الري كل ٥ يوم حتى النضج.
٢- الري كل ١٠ يوم حتى النضج.
٣- الري كل ١٥ يوم حتى النضج.
٤- الري كل ٥ يوم حتى طرد السنابل ثم كل ١٠ يوم حتى النضج.
٥- الري كل ٥ يوم حتى طرد السنابل ثم كل ١٥ يوم حتى النضج.
٦- الري كل ١٠ يوم حتى طرد السنابل ثم كل ٥ يوم حتى النضج.
٧- الري كل ١٠ يوم حتى طرد السنابل ثم كل ١٥ يوم حتى النضج.
٨- الري كل ١٥ يوم حتى طرد السنابل ثم كل ٥ يوم حتى النضج.
٩- الري كل ١٥ يوم حتى طرد السنابل ثم كل ١٠ يوم حتى النضج.

استخدم تصميم القطاعات الكاملة العشوائية في ثلاث مكررات.

و تتلخص النتائج المتحصل عليها فيما يلي:-

١- أظهرت النتائج اختلافات معنوية بين معاملات الري حيث أدى تطبيق الري كل ٥ أيام حتى النضج إلى زيادة معنوية في طول النبات، عدد السنابل في المتر المربع و عدد حبوب السنبلة و وزن ١٠٠٠ حبة و محصول الحبوب/ فدان و كذلك محصول القش/ فدان بالمقارنة بالمعاملات الأخرى المدروسة في الموسمين.

٢- أدى تطبيق معامله الري كل ١٥ يوم حتى النضج إلى زيادة معنوية في نسبة البروتين في حبوب القمح بالمقارنة بالمعاملات الأخرى المدروسة في كلا الموسمين

٣- زاد الاستهلاك المائي (اليومي – الشهري – الموسمي) للنبات عند تطبيق معاملة الري كل ٥ أيام حتى النضج بينما قل الأستهلاك المائي للنبات عند تطبيق معاملة الري كل ١٥ يوم حتى النضج.

٤- زادت كفاءة استخدام مياه الري عند تطبيق معاملة الري كل ٥ أيام عن باقي المعاملات الأخرى تحت الدراسة.

عموما: توضح نتائج هذا البحث أن ري القمح كل ٥ أيام أدى إلى زيادة محصول الحبوب وأيضا كفاءة استخدام مياة الري في الأراضي الرملية.