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EFFECT OF IRRIGATION SCHEDULING AND SOWING DATE ON WATER RELATION, YIELD AND YIELD COMPONENTS FOR WHEAT CROP GROWN IN MIDDLE EGYPT (GIZA REGION)

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ABSTRACT

A field experiment was executed during the two successive seasons of 2010/2011 and 2011/2012 at Giza Agriculture. Research. Station to identify the most effective coefficient of daily pan evaporation accumulation selected from (1.25,1.00 and 0.75) evaporation pan coefficient (EPC) in scheduling irrigation for wheat cultivar Sakha 93 under three sowing date at 20th November (S_1) , 10th December (S_2) and 30th December (S_3) in order to evaluate best sowing date to maximize crop and water productivity. The number of applied irrigations and water consumptive use (CU) were increased as the value of EPC increased and, CU differed significantly due to sowing date , with plant sown in10thDecember consumed more water than the other sowing date. The lowest Water Use Efficiency (WUE) was recorded under 1.25 EPC comparable to the other tested EPC values and values of WUE differed due to sowing date, which the S_1 gave the lowest WUE while S3 obtained the highest value. The plant height, grain weight spike^{-1}, grain weight m^{-2} and 1000-grain weight were significantly affected due to the adopted irrigation regimes and generally, tended to increase as EPC increased. Grain and straw yields tended to increase with increasing EPC. The highest grain yield was obtained with 1.25 EPC and was lower with the other EPC treatments particularly with straw yield. All of agronomic yields and yield components were increased when wheat crop planted in 10th December and decreased with delaying sowing date . The maximum values of yields and their components were given by planted wheat cultivar Sakha 93 in10th December and irrigating when pan evaporation accumulation rech1.25 EPC.

keywords: Sowing date, scheduling irrigation, evaporation pan , wheat yield.

INTRODUCTION

Wheat (*Triticum aestivum L.)* belongs to the tribe Triti-ceae which is one of the largest and most important tribes in the Poaceae family Dewey (1984). It is grown on 200 million hectares over wide world countries with an average yield is around 2.7 t ha^{-1} with high variability among countries and regions. The highest average yields are obtained in Western Europe, with more than 8 t·ha^{-1}, in contrast to less than 1 t·ha^{-1} in countries in Central/West Asia and North Africa Rajaram and Braun (2009). In Egypt, wheat commonly known as king of cereal crops used as a major food crop. Its cultivated area reached about 2.9 million feddan (fed = 0.42 hectares) with an average produced of 18.1 ardab per feddan of grain (ardab = 150 kg) (FAO 2008). But this local production dose not meet the consumption owing to the increased population with limited cultivated area as well as water resources El-Shaer *et al.* (1997) and Eid *et al.* (1999). Therefore, Egypt would have to find new ways to increase agriculture productivity as an essential national target to fill the gap between production and consumption of wheat. This goal could be achieved by growing more high-yielding cultivars and enhancing the agronomic factors which limited wheat production by some adopted scenarios such as management irrigation and fertilizer application as well as identify affective date of sowing. Planting date is one of the most important agronomic factors involved in producing high yielding small grain cereal crops, which affects the timing and duration of the vegetative and reproductive stages . Qasim *et al.* (2008), Hozayn and Abd El-Monem (2010) stated that the highest values of some vegetative characters, yield attributes and grain yield as well as enhancement in biological and economic yield were occurred when wheat was planted earlier. Mohammed and Agit (2013) found a significant affect of sowing date on yield and yield components , whereas delaying sowing date to late December, decreased all yield and yield components .The reduction in wheat grain yield and its attributes with delaying sowing date was as a result of exposure plants to high temperature, which reduces season length ((Ishag, 1990; Naceur et al., 1999; Abd El-Monem, 2007; Mostafa et al.,2009). Yield reduction in wheat under heat stress could be caused by accelerating phase's development, accelerated senescence, increased respiration, reduced photosynthesis and inhibition of starch synthesis in developing kernels (Hamam and Khaled, 2009).Irrigation water has to be added timely and sufficiently (with least losses). This is difficult to achieve in old arable lands in Egypt. One of most efficient irrigation technical methods which does this is scheduling irrigation using evaporation pan. Early in USA, Jensen and Midleton (1965) carried out studies scheduling crop irrigation via daily records of evaporation pan. In this respect,. Abdel-Ghani et al., (1994), Shahin and Mosa (1994) , Pandey et al (2001) stated that exposing wheat crop to high moisture stress was associated with a decrease in seasonal consumptive use. Khalil *et al.* (2005) stated that irrigating wheat at 1.2 evaporation pan coefficient (EPC) in Upper Egypt (Shandaweel) recorded the highest water consumptive uses (CU) in comparison with 0.8 and 1.0 EPC, with CU values of 1582, 1797 and 2216 m^3 fed^{-1}, for 0.8, 1.0 and 1.2 EPC, respectively, however 0.8 EPC gave the highest water use efficiency (WUE). Salem *et al.* (2006) in the Delta region of Egypt (Bahteem) reported that CU and WUE for wheat were highest with 1.2 EPC more than either 0.8 or 1.0 EPC.

With respect to crop productivity as a function for soil moisture availability during the growing season, Mohamed and Tammam (1999), Sidrak (2003) and Moussa and Abdel-Maksoud (2004) reported that the number of spikes/m^2, 1000-grain weight, straw and grain yields decreased due to irrigation after higher soil moisture depletion.. El-Marsafawy (2000) and Rayan *et al.* (2000) found that the highest values of grain yield were obtained when wheat crop irrigated at 1.0 evaporation pan coefficient (EPC) compared with 0.6 and 1.4 EPC. El-Sabbagh et al (2002) in Egypt and Metin Sezen and Attila Yazar (2006) in the arid Southeast Anatolia of Turkey, recorded that short irrigation intervals (7, 14 and 21 days) increased plant height, spike length, number of spikes/m^2, number and weight of grain/spike, 1000- grain weight, harvest index and straw and grain yields compared with prolonged irrigation intervals (35 days).

The main objective of the present trial is to determine the most effective irrigation regimes (by scheduling irrigation using accumulation evaporation pan coefficient method) under different sowing date in order to obtain improved water use, yield and yield components for wheat cultivar Sakha 93.

MATERIALS AND METHODS

Two field experiments were carried out at Giza Agricultural Research Station, ARC, Egypt, during 2010/2011 and 2011/2012 growing seasons to study the effect of irrigation scheduling and sowing date on water relation, yield and yield components for wheat grown in middle Egypt. The experiment was laid out in a split - plot factorial design with three replicates. The plot area was 28.0 m^2 (4 x 7 m). The main plots were devoted to irrigation pan coefficient treatments and the sub plots were assigned to the sowing date treatments.

The experimental factors and treatments were as follows:

Factor A (Main plots) : irrigation regime (evaporation pan coefficient "EPC"):

I1=1.25 EPC.
I2=1.00 EPC.
I3=0.75 EPC.

Factor B (Sub plots): Sowing dates:

S1= Base sowing date (20^{th} November)
S2= Sowing on (10^{th} December
S3=Sowing on 30^{th} December

100 kg superphosphate (15.5 P_2O_5)/fed was added during seedbed preparation. Wheat seeds of the variety Sakha 93 were broadcasted by hand at a rate of 60 kg fed^{-1} (=143kg ha^{-1}), and the borders were reconstructed. Sufficient NK was applied during growing season to insure optimum plants growth according to governmental enforced . Application was done in two equal splits; the first was applied before the life irrigation (El- Mohayah irrigation) and the second one after 21 days from the first one. All other practices were applied as adopted in the area. Plants were manually harvested on the last week of May in both seasons. Irrigation was practiced according to the cumulative values of the daily evaporation records from class A pan establish in Giza Research Station for the different irrigation treatments. Weather Data used in calculating potential water consumptive use were collected from Agro-meteorological Giza Station (Latitude: 30^o;03^-, Longitude: 31^o:13^- Elevation: 18.6) during the growing seasons and listed in Table (1) . Particle size distribution according to (Gee and Bauder, 1986) and the chemical analyses of soil, i.e. total N was determined according to (Bremner and Mulvaney 1982), available P (Olsen et al.,1954), total K (Hesse, 1972), EC (Richards,1959) and pH (McLean, 1982). Field capacity was determined according to (Cassel and Nielsen, 1986). wilting point was determined according to (Stakman and Vanderhas 1962). Available water was calculated from the values of field capacity and wilting point. Bulk density was determined according to (Blake and Hartge, 1986a).

Table (1): Some meteorological data at Giza Agriculture Research Station in 2010/2011 and 2011/2012 seasons

Season	2010/2011							
Month	T max	T min	WS	RH	RF	SS	WS	E p
November	30.1	16.5	3.4	51.2	0	7	268	2.5
December	24.3	12.0	3.7	48.5	0	7	280	2.3
January	20.9	9.8	2.8	58.3	1.8	7.9	353	2.1
February	22.5	10.2	3.6	49.1	2	8.6	441	2.6
Mar	26.1	10.5	4.2	42.6	1.2	9.6	519	4.2
Apr	30.0	14.4	4.1	37.2	1.2	10.8	585	5.1
May	35.0	18.0	4.4	34.0	0.2	8.5	408	6.5
Mean	27.0	13.0	3.7	45.8	6.4	8	408	3.6
2011/2012								
November	24.1	13.5	3.3	57.3	0.8	7	268	2.4
December	21.2	10.2	3.2	57.8	1.9	7	280	2.2
January	17.9	7.7	3.7	57.6	4	7.9	353	2.0
February	20.3	8.1	3.8	50.0	7.6	8.6	441	2.4
Mar	24.2	9.5	4.4	45.8	2	9.6	519	3.9
Apr	32.9	14.9	4.3	30.6	0	10.8	585	5.3
May	37.0	18.5	4.4	30.7	0	8.5	408	6.8
Mean	25.4	11.8	3.9	47.1	16.3	8.5	407.7	3.6

T max and T min = maximum and minimum temperatures, °C ; WS= wind speed Km/day ; RF = rain fall, mm ; SS = actual sun shine, hr ; SR = solar radiation, cal/cm^2/day, Ep= Evaporation pan ,mm

Table (2):Soil moisture constants (% by weight) and bulk density (gcm^{-3}) of soil site of Giza Agricultural Research Station.

Depth, cm	Field capacity	Wilting point	Available water	Bulk density
00-15	41.9	18.6	23.24	1.15
15-30	33.7	17.5	16.18	1.20
30-45	28.4	16.9	11.46	1.22
45-60	28.1	16.5	11.51	1.28

Table (3): Some physical and chemical properties of the soil .

Particle-size distribution Soil fraction	Content %
Coarse sand	2.91
Fine sand	13.40
Silt	30.51
Clay	53.18
Textural class	Clay
Soil chemical analyses	Content
Organic matter	1.80%
Available N (KCl-extract)	40. 0 mg kg^{-1}
Available P (Na - bicarbonate extract)	19.0 mg kg^{-1}
Available K (NH4 - a acetate extract)	304 mg kg^{-1}
pH (1:2.5, soil: water suspension)	7.4

The results were presented and discussed as follow:

A-Water relations:

1-Actual water consumptive use 'CU' (Actual evapotranspiration):

Water consumptive use was determined via soil samples from the sub plots just before each irrigation and 48 h later besides at harvest, in 15 cm segments along the 60 cm depth of the soil. The CU was calculated according to Israelsen and Hansen (1962) as follows:

$$CU = (Q_2 - Q_1) \times ERZD \times Bd$$

Where:

CU = actual consumptive use (in mm)
ERZD = effective root zoon depth. (in mm)
Bd = bulk density of soil (g cm^{-3})
Q_2 = the soil moisture two days after irrigation (% w/w).
Q_1 = the soil moisture before next irrigation (% w/w).

2- Water use effcicincy (WUE)

Water use efficiency in the present work, refers to the amount of wheat grains (kg) produced due to 1 m^3 of water consumed, estimated according to **Vites (1965)** as follows: -

$$WUE = \frac{\text{Grain yield (kg/fed)}}{\text{Seasonal ET } (m^3\text{/fed})}$$

B- Growth, yield and some yield attributes:

At harvest, the plants of each entire sub-plot were sampled in order to determine plant height, straw and grain yields. The number of spikes / m^2 was determined by counting all spikes per square meter selected in random from each sub-plot Ten spikes were randomly taken, from each sub-plot, and weight of grains / spike and 1000-grain weight were determined, then plots were harvested and yields were measured. Data of growth, yield and yield components were subjected to statistical analysis of variance as described by Sendecor and Cochoran (1980).

RESULTS AND DISCUSSION

1.Water relations

Actual water consumptive use (Actual evapotranspiration (Eta)

Evapotranspiration is the combination of two processes, evaporation and transpiration. Evaporation is direct evaporation of water from the soil surface and/or from the plant surface. Transpiration is the flow of water vapor from the interior of the plant to the atmosphere (Jones et al, 1984).

Results in Table 4 show that, seasonal water consumptive use ETa was increased as EPC value increased since the ETa value under the 1.25 EPC treatment was increased by 10.66 and 35.90 % more than those under 1.00 and 0.75 EPC treatments, respectively in the first season. In the second season, similar trend was observed with increased reached to 8.52 and 30.82%, respectively, for 1.25 EPC treatment compared to1.00 and 0.75 EPC treatments .Two seasons results reveal that, regardless of sowing date, water consumptive use was increased as EPC value increased. These results may be attributed to increased number of irrigations and the soil moisture was more available for extraction by plant roots and as well as soil surface evaporation. These results are in the harmony with those obtained by Rayan et al (1999) and Moussa and Abdel-Maksoud (2004). Recently **(Eman** and Ryad 2013) reported that increasing irrigation intervals from 10 up to 15 and 20 days decreases CU for wheat grow in sandy soil at AL Arish region .

Table (4): Seasonal water consumptive use (mm) of wheat cultivar Sakha 93 as affected by irrigation regime and sowing date at Giza region in 2010/2011and 2011/2012 seasons.

Irrigation regime	2010/2011 season				2011/2012 season			
	Sowing Date*							
	S_1	S_2	S_3	Average	S_1	S_2	S_3	Average
Water consumptive use (mm)								
1.2 EPC	462	405	348	405	442	375	329	382
1.0 EPC	418	369	311	366	401	351	303	352
0.75 EPC	338	302	277	298	323	299	285	292
Average	406	359	312	356	389	342	306	342

Where: S_1, S_2 and $S_{3=}$ sowing on 20th November, 10th December and 30th December ,respectively and EPC; evaporation pan coefficient

With respect to sowing date, results indicate that maximum seasonal CU values were 406 mm was recorded for early sowing date S_1 (sowing on 20th November) as compared with other both sowing date; S_2 and S_3, respectively since the increased reach to 13.09 and 30.13 % for ; S_2 and S_3 in the first season . However in second season, similar trained was found with maximum CU value being 389 mm for S_1 treatment, with an increases reach to 13.76 and 27.15 % for the same respective sowing date treatments. These results indicate that ETa values increased with early sowing date, whereas delaying sowing date gradually decrease CU values. The may be due to shortage growing season under delayed sowing date caused in minimize develop roots growth as well as decrease water uptake by plant. These results are in a good agreement with those obtained by (Hussien *et al.* 1990) who reported that sowing wheat at late November in (20th and 28th) generally increases crop CU values when compared by swing at December .

Water Use Efficiency (WUE):

Values of water use efficiency as recorded in Table 5 indicate that irrigation at 0.75 evaporation pan coefficient gave the maximum water use efficiency of 5.85 kg grains mm-1 water in 2010/2011 season. The minimum value being 5.47 kg grains mm-1 was recorded with 1.25 EPC treatment. In 2011/2012 season, the same trend was found whit maximum value of 5.56 kg grains mm-1 resulted from 0.75 EPC treatment, whereas the minimum value was 5.40 kg grains /mm obtained with 1.25 EPC treatment. The two-season results indicate that WUE increased with decreasing number of irrigation during growing season according to irrigating at low level of evaporation pan coefficient. These results are in harmony with those reported by EL-Marsafawy (2000) who found that the highest WUE value for wheat was achieved as irrigation practiced according to 1.0 EPC.

Table (5): Water use efficiency (kg grain mm^{-1} fed^{-1}) of wheat cultivar Sakha 93 as affected by irrigation regime and sowing date at Giza region in 2010/2011and 2011/2012 seasons.

Irrigation Regime	2010/2011 season				2011/2012 season			
	Sowing dates							
	S_1	S_2	S_3	Average	S_1	S_2	S_3	Average
	Water use efficiency (kg grains /mm water							
1.25 EPC	4.99	5.65	5.89	5.47	4.98	5.68	5.64	5.40
1.00 EPC	5.28	5.78	6.15	5.69	5.27	5.70	5.79	5.56
0.75 EPC	4.67	5.90	6.74	5.85	4.79	5.70	6.16	5.72
Average	4.98	5.78	6.26	5.67	5.01	5.70	5.86	5.56

Where: S_1, S_2 and $S_{3=}$ sowing on 20th November, 10th December and 30th December ,respectively and EPC= evaporation pan coefficient

Results in table 5 indicate the highest value of water use efficiency 6.26 and 5.86 -kg grain/mm/fed was obtained with sowing plant at 30th December (S_3) for both growing season. However the lowest one (of 4.98 and 5.01 -kg grain/mm/fed) were obtained with sowing plant at 20th November (S_1). It is clear that both season results reveal that delaying sowing date to end of December increased WUE to a maximum value compared to other tow sowing date. It could be stated that Delaying sowing date for the almost a month could reduce the water consumed by the plant due to shortening of growing season duration if associated with the appropriate yield production of the crop, will be increased water use efficiency of wheat. The results are in harmony with those obtained by (Rayan , *et al.* 1999) and (Ouda et al 2005).

2. Growth, yield and some yield attributes:

Plant height:

Data in Table 6 reveal that significant effect was found on plant height due to irrigation regime in both seasons of study. The tallest plants was (94.0 cm season1and 100.0 cm season2), respectively was obtained under irrigating according to 1.25 pan evaporation coefficient (EPC), while the shortest plants were 81.0 and 83.0 cm resulted from irrigating at 0.75 EPC treatment, and this was true in the two seasons study. These results are in agreement with those of (Eman and Ryad 2013) who stated that irrigating wheat plant at short intervals every 10 days (18 irrigation) led to the tallest plant height .Data also show that, there are significant differences among sowing date to influence plant height trait in both seasons. The highest values of 92.0 (season1) and 96.0-cm (season2) were obtained with S_2 while the lowest values of 84.0 and 88.0 cm were recorded with both S_1 and S_3 treatments. Average plant height was significantly increased by 8.7 and 8.0 % with S2 as compared with S_3 for two season respectively. The interaction between irrigation regimes and sowing date was significant to alter such trait in both seasons, and the tallest plants were obtained for irrigated according to 1.25 EPC combined with S_2 (sowing date at 10th December). This effect may be due to maximum develop and elongation of roots under normal condition of environmental of wheat (suitable degrees growing days, zero point of growth, photosynthesis) thus using water and nutrient more efficiently resulting taller plants. These results are in harmony with those obtained by Qasim *et al.* (2008), El-Gizawy (2009) and Hamam and Khaled (2009) whom concluded that, sowing at favorable date where heat units and metabolites stored in favorable sowing date caused taller plants, vigorous growth and taller spikes.

Grain weight /spike:

The average values of grain weight /spike as recorded in Table 6 indicate that increasing EPC value caused significant increase in grain weight/ spike. The highest average values of 3.0 (season1) and 3.4g (season2) were obtained when plants received irrigation at 1.25 EPC, and the lowest average value of 2.4 g for each season was obtained at 0.75 EPC. This trend may be due to more available soil moisture under high level of EPC (1.25) resulting in increased water and nutrients uptake and hence enhancing grain weight /spike. These results are in agreement with those obtained by El-Sabbagh et al (2002), Moussa and Abdel-Maksoud (2004) and (Eman and Ryad 2013). Regarding sowing date, results show a positive significant effect on grain weight /skip. The highest values of 2.9 g (season1) and 3.2 g (season2) were obtained with sowing plants at 10th December (S_2) while the lowest values accompanied planting at 30th December (S_3) were 2.4 g (season1) and 2.6 g (season2).

Table (6): Plant height (cm), grain weight./spike (g) and grain weight /m² (g) of wheat crop as affected by irrigation regime, sowing date and their interaction at Giza region in 2010 /2011 and 2011/2012 seasons.

Irrigation regime	Sowing date	Plant height (cm)			Grain weigh. /spike(g)			Grain weight /m² (g)		
		2010 /2011	2011 /2012	Average	2010 /2011	2011 /2012	Average	2010 /2011	2011 /2012	Average
1.25 EPC	S_1	95	100	98	3	3.5	3.3	610.7	610.9	610.8
	S_2	98	105	102	3.3	3.7	3.5	614.9	615.9	615.4
	S_3	89	95	92	2.7	2.9	2.8	568.8	586.5	577.7
	Average	94	100	97	3	3.4	3.2	598.1	604.4	601.3
1.00 EPC	S_1	87	97	92	2.4	3.2	2.8	535.8	585.8	560.8
	S_2	92	99	96	3	3.3	3.2	543.5	605.5	574.5
	S_3	85	89	87	2.4	2.7	2.6	511.2	570.5	540.9
	Average	88	95	92	2.7	3.1	2.9	530.1	587.3	558.7
0.75 EPC	S_1	85	84	85	2.5	2.6	2.6	531.7	528.7	530.2
	S_2	81	84	83	2.5	2.4	2.5	521.6	513.3	517.5
	S_3	77	81	79	2.2	2.2	2.2	468.5	485.7	477.1
	Average	81	83	82	2.4	2.4	2.4	507.3	509.2	508.3
Average S_1		88	94	91	2.6	3	2.8	556.1	570.0	563
Average S_2		92	96	94	2.9	3.2	3.1	563.4	583.4	573
Average S_3		84	88	86	2.4	2.6	2.5	516.2	547.6	532
L.S.D at 5 %	**irrigation**	2.67	9.94		0.27	0.10		20.55	12.83	
	N- levels	1.30	6.08		0.16	0.12		19.43	14.71	
	Interaction	2.25	2.21.		N S	0.20		N. S.	N. S.	

Where: S_1, S_2 and S_3= sowing on 20th November, 10th December and 30th December ,respectively and EPC= evaporation pan coefficient

Average of grain weight/spike were decreased by 8.7 and 8.3 % with S_3 as compared S_1 in first and second season, respectively. These results could be attributed to the appropriate weather conditions prevailing during growth season, which in turn increased yield components These results are in agreement with those obtained by Pandey et al (2001), Qasim *et al.* (2008) and Hozayn and Abd El-Monem (2010) whom report that delaying sowing date for 30 or 60 day reduce grain weight/spike by 1.54 and 31.65% respectively .

Regarding the interaction between irrigation and sowing date on grain weight/spike, there was a significant effect in the second season only. The maximum values of 3.7 and 3.3 g/ spike were obtained from the interaction between 1.25 EPC x S_2 in first and second season respectively. However the lowest value of 2.4 g/ spike gained from the interaction between 0.75 EPC x S_3 for the same respective seasons.

Grain weight /m^2 (g):

Data in Table (6) indicate that grain weight m^{-2} was significantly and regularly increased with increasing irrigation treatments in the two seasons. The highest values were 598.1 and 606.4 g obtained from irrigation at 1.25 evaporation pan coefficient in the first and second seasons, respectively. However, the lowest values were 507.3 and 509.2 g obtained from irrigation at 0.75 EPC for the same respective seasons. Respect to both season results, it could be concluded that frequent irrigation caused an increase in grain weight/m^2. This might be attributed to positive effect of more available moisture at grain filling which increase the starch content and organic compounds in wheat plants. These results agree with those obtained by Rayan et al (2000), Sidrak (2003) and Salem *et al.* (2006). Data also show that the adopted sowing date significantly affected the grain weight/m^2 in the two seasons. The highest values of 563.4 (season1) and 583.4g (season2) were obtained with S^2, while lowest values of 516.2 g(season1) and 547.6 (season2) were found with S^3 treatment. Average grain weight/m_2 was decreased by 9.14 and 6.45 % with delaying sowing date from 10th to 30th of December for both growing seasons. These results in the harmony with those obtained by Ouda et al.(2005), Hamam and Khaled (2009).The interaction results reveal that none- significant effect was found between different treatments. The maximum values of 615.9 g m^{-2} (season 1) and 614.9 g m^{-2} (season2) were obtained by 1.25 EPC +S2 and the lowest values of 468.5 g m^{-2} (season 1) and 485.7 g m^{-2} (season2) were gained by 0.75 EPC + S3.

The 1000-grain weight (g):

As shown in Table 7 the 1000-grain weight was influenced significantly by the irrigation regimes in the two studied seasons. The highest values of 41.0 -g (season1) and 41.9 g in (season2) resulted under irrigation at 1.25 EPC. Comparable value are 38.8 and 35.1g for 0.0.75 EPC in season1 and season2, respectively. These results are in agreement with those obtained by El-Kalla *et al.* (1995) and Moussa and Abdel-Maksoud (2004) who reported that the 1000-grain weight tended to decrease as soil moisture availability decreased .The differences in the values of the 1000-grain weight among the sowing date were significant in both growing seasons. The highest values of 39.8 (season1) and 40.5 g (season2) were obtained with sowing plant at 10th December (S_2), while the lowest ones of 35.0 and 37.3 in season1 and season2, respectively were recorded with sowing plant at 30th December (S_3). Results reveal that planting wheat crop in early December significantly increased the 1000-grain weight values. These results are in harmony with those obtained by and Hozayn and Abd El-Monem (2010) whom concluded that, delaying the date of sowing from 23th November to 30th December induced significant reduction being 14.39 and 26.84% for 1000-grain weight, respectively. significant interaction effect was found in both seasons. The maximum values were 43.3 and 43.1 g obtained from the treatment at 1.25 EPC + S2 in the first and second growing season respectively. The lowest values of 32.0 and 33.1g were obtained from the treatment at 0.75 EPC + S_3 for the same respective seasons.

Straw yield (kg fed^{-1})

Data in Table 7 show that irrigation treatments significantly affected straw yield in both seasons. The highest values of 2561 kg fed^{-1} (season1) and 2264 kg fed^{-1} (season 2) were obtained from irrigating at 1.25 EPC treatment, then tended to decrease as irrigation was scheduled at 1.00 and 0.75 EPC. Increases due to 1.25 over 0.75 EPC were 46.65 and 44.05 % for the same respective seasons. This reflects the effect on growth attributes and number of productive tillers.

Table (7): 1000- g rain weight (g) straw and grain yield (kg fed^{-1}) of wheat crop as affected by irrigation regime, sowing date and their interaction at Giza region in 2010/2011 and 2011/2012 seasons.

Irrigation regime	Sowing date	1000-grain weight (g)			grain yield (kg /fed)			straw yield (kg /fed))		
		2010 /2011	2011 /2012	Average	2010 /2011	2011 /2012	Average	2010 /2011	2011 /2012	Average
1.25 EPC	S_1	42.6	42.2	42.5	2344	2516	2430	2539	2341	2440
	S_2	43.3	43.1	43.2	2422	2539	2481	2775	2478	2627
	S_3	37.1	40.5	38.8	2041	2256	2149	2369	1972	2171
	Average	41.0	41.9	41.5	2269	2437	2353	2561	2264	2412
1.00 EPC	S_1	39.4	41.0	40.3	2174	2542	2358	2396	2132	2264
	S_2	42.2	41.1	41.7	2297	2578	2438	2517	2120	2319
	S_3	35.6	38.3	37.1	1796	2143	1969	2004	1607	1806
	Average	39.1	40.2	39.7	2089	2421	2255	2306	1953	2130
0.75 EPC	S_1	34.2	34.8	34.5	1876	1959	1917	1617	1612	1615
	S_2	34.9	37.3	36.1	1932	2053	1992	2009	1887	1948
	S_3	32.2	33.1	32.7	1701	1737	1719	1613	1216	1415
	Average	33.8	35.1	34.4	1836	1916	1877	1746	1572	1659
Average S_1		38.9	39.4	39.2	2132	2339	2235	2121	2184	2028
Average S_2		39.8	40.5	40.2	2217	2390	2303	2467	2434	2162
Average S_3		35.0	37.3	36.1	1846	2045	1946	2126	1995	1598
L.S.D at 5 %	**irrigation**	9.67	19.16		150.97	155.33		238.24	113.50	
	N- levels	7.32	13.48		95.27	70.81		147.54	58.10	
	Interaction	N.S.	N.S.		118.44	N.S.		263.67	124.70	

Where: S_1, S_2 and S_3= sowing on 20th November, 10th December and 30th December ,respectively and EPC; evaporation pan coefficient

These finding are similar to those obtained by Laura et al (2008). Regarding the effect of sowing date, results show a significant effect on straw yield with average values of 2121, 2467, and 2126 for S1, S_2 and S_3, respectively for the first season. Comparable average values for the second season are 2184, 2434, and 1995 for the same respective treatments. The average increases for straw yields of S_2 over the yield of S_3 for the two seasons are 23.58 and 27.19 %, respectively. These results are in full agreement with those reported by Singh and Pal (2003), Ouda *et al.* (2005) , Hozayn and Abd El-Monem (2010) whom reported that, delaying the date of sowing from 23th November to30th December induced significant reduction being 33.40% for straw yield. There was significant interaction between irrigation regime and sowing date ; the interaction is shown when the decreases which occurred with the decreases in EPC was particularly considerable under conditions of sowing date at suitable time.

Grain yield (kg fed^{-1})

The results in Table 7 show that the grain yield was significantly influenced due to irrigation regimes in the two growing seasons. Wheat grain yield was higher as the plants were irrigated at 1.25 EPC with an increases reached to 8.00 and 23.58 % for EPC 1.25 over the 1.00 and 0.75 EPC treatments, respectively, in the first season. In the second season both 1.25 EPC and 1.00 EPC were very much similar, but 1.25 EPC surpassed the 0.75 EPC by 15.63 %. The superiority of the 1.25 EPC shows that sufficient irrigation increased grain yield for wheat crop. This trend reflects the importance of soil water to increase plant nutrient availability in soil solution as well as capacity of wheat in photosynthesis and consequent improved all growth factor and yield components , which led to increased production of grain yield. On other hand, results may prove that water stress is one of the main environmental factors, which negatively affect yield production by increasing water pressure around plant roots and due to reduction of water and nutrient uptake. These results are in harmony with those obtained by Amin (2003) and Metin Sezen et al.,(2006) who stated that wheat crop in the arid region for three growing season showed highest average grain yields at the highest irrigation level. Recently, El-Adady et al.(2009 and (Eman and Ryad 2013) they reported that the reduction in growth and yield components due to water stress during grain filling might have been due to the inhibition in photosynthesis efficieny under insufficient water. Sowing date had a significant effect on grain yield as shown in Table 9. Average value was higher as the plants were sowed in 10th of December , with increases of 3.98 and 20.01 % more than those planted in 20th November (S_1) or 30th December (S_3), for season1 and 2.18 and 16.87 % in season2, for the same respective treatments. This may be attributed to the association of suitable weather condition with vigorous vegetative growth and deep green color, which relate to carbohydrate utilization. In this respect Ouda *et al.* (2005) reported delaying sowing wheat from early to late December reduced season length, resulting in a reduction in grain, straw and biological yields. Moreover, Abd El-Monem (2007) and Mostafa *et al.* (2009) concluded that exposure of wheat plants to high temperature stress due to late cultivation cold led to reducing the vegetative and reproductive phases in wheat,and consequently reduce grain, straw and biological yields compared to plants sown at normal date These results are in agreement with those obtained by

Hamam and Khaled (2009), Hozayn and Abd El-Monem(2010)and (Eman and Ryad 2013). There was a significant interaction effect was found in the first season between irrigation regime and sowing date. The favorite interaction was found between irrigation at 1.25 EPC and sown plant in 10^{th} December in both growing seasons.

In conclusion, under Giza area conditions, it is advisable to cultivate Sakha93 wheat cultivar with irrigation according to 1.00 EPC and sowing in late November or early December since most of growth, yield and yield components traits and water use efficiency were enhanced with such treatment.

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تأثير جدولة الري و مواعيد الزراعة على النمو , الانتاجية وكفاءة استعمال المياه لنباتات القمح النامية تحت ظروف منطقة مصر الوسطى

نعمة الله يوسف عثمان , هيثم محمد سالم شحاتة[2]ورانيا جمال الدين محمد هلال[1]
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أقيمت تجربة حقلية بمحطة البحوث الزراعية بالجيزة خلال موسمي 2011/2012و 2012/2013لدراسة تأثير جدولة ا لرى باستخدام بيانات معامل وعاء البخر (0.75 - 01.0- 1.25) وثلاث مواعيد زراعة (20 نوفمبر 10 ديسمبر و30 ديسمبر), على العلاقات المائية و النمو و المحصول لصنف القمح سخا 93 وأظهرت النتائج يلى :

أزاد عدد الريات و كذا الاستهلاك المائي بزيادة قيمة معامل وعاء البخر حيث سجل معامل البخر 1.25 اعلى قيمة تحت كل مواعيد الزراعة .كما اختلفت قيمة الاستهلاك المائي معنويا بمواعيد الزراعة حيث سجلت النباتات المزروعة 20 نوفمبر أعلى القيم للاستهلاك المائي .

افضل قيمة لإنتاجية وحدة المياه كانت عند زراعة محصول القمح فى 30 ديسمبر ورى النباتات بمعامل بخر 0.75 بينما انخفضت قيمة انتاجية وحدة المياه انخفاض طفيف بزيادة معامل البخر التراكمى حتى EPC 1.00 وتبكير الزراعة .

تأثرت قيم طول النبات , وزن حبوب /السنبلة وزن حبوب /م 2 وزن ال 1000حبة معنويا بمعاملات الرى واتجهت للزيادة مع زيادة قيمة معامل وعاء البخر القياسي.

محصول الحبوب للفدان والمحصول البيولوجي اتجهت للزيادة معنويا بزيادة معامل وعاء البخر القياسي حيث سجل الري عند 1.25معامل بخر أعلي القيم فى الموسم الاول بينما تقاربت قيم محصول الحبوب لكلا من 1.25 , 1.00 معامل بخر وذلك فى الموسم الثانى.

تأثرت قيم النمو والمحصول ومكونات المحصول تأثيرا معنويا بمواعيد الزراعة حيث سجلت النتائج أعلي القيم عند زراعة النباتات 10 ديسمبر مقارنة بمعاديى الزراعة الاخرين خلال موسمي النمو

بعض صفات النمو و المحصول و كذا مكوناته تأثرت بتفاعل مستويات الري ومواعيد الزراعة وسجلت افضل القيم عند زراعة المحصول 10 ديسمبر ورى النباتات بمعامل بخر قيمته 1.25 فى الموسم الاول و 1.00 فى الموسم الثانى ..

تحت ظروف منطقة الجيزة ، ينصح بزراعة محصول القمح صنف جيزة 93 فى الثلث الاول من ديسمبر مع جدولة الري من خلال البيانات اليومية لوعاء البخر القياسي بمعامل قيمته 1.00 وذلك لزيادة المحصول و تحسين كفاءة استخدام مياه الري .