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IMPACT OF SOWING DATE OF WHEAT UNDER WATER STRESS IN NORTH NILE DELTA-EGYPT

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ABSTRACT

The present investigation was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The station is sited at 31^{0} -57^{-}/ N latitude and 30^{0}-57^{-} longitude. It has an elevation of about 20 m above sea level and it represents the conditions and circumstances of the middle north Nile Delta.

A field experiment was carried out during the season 2014/2015 to study the effect of number of irrigations and sowing date on wheat yield, its components and some water relationships. A split plot design with four replications was used. Sowing date were 15/11 (D_1), 30/11 (D_2) and 15/12 (D_3) occupied the main plots, while irrigation regime were I_1 = 5 irrigations , I_2 = 4 irrigations and I_3 = 3 irrigations, arranged in sub-plots.

The obtained results can be summarized as follows:

The highest values of water applied and water consumptive use were recorded under (I_1) .On the contrary, the lowest values were recorded under treatment,(I_3).15th November as a sowing date significantly increased grain yield, straw yield, spike length, number of tiller, plant height and 1000 grain weight by 18.6, 17.4, 26.7, 17.8, 9.9 and 20.3 % compared to sowing on 15th December (D_3). Also sowing on 15th November significantly increased water productivity by 27.2 %.

Keywords: wheat, number of irrigation, sowing date, water productivity.

INTRODUCTION

In Egypt, the future of agriculture is hard to project even assuming the continuation of current climate conditions. The task is made all the more difficult by the possibility of significant warming expected to result from the greenhouse effect. Egypt appears to be particularly vulnerable to climate change because of its dependence on the Nile as its primary water source, its large traditional agricultural base, and its long coastline, which is already undergoing both intensifying development and erosion.

Ouda et al., 2005 studied six sowing dates (1st of October, 15th of October, 1st of November, 15th of November, 1st of December, and 30th of December) on wheat yield (sakha 93), in addition to water stress at different growth stages they indicated that sowing wheat in October reduced grain yield by about 10%. Whereas, delay of sowing date till to the end of December decreased yield by about 16%. The highest grain yield was obtained when wheat was sown on the first of December, followed by 15th of November, compared with other sowing dates. Zhang and Oweis, (1999) reported that wheat response to water stress is more sensitive from stem- elongation to booting, followed by anthesis and grain- filling stages.

Eid *et al* 1997 and El-Marsafawy et al 1998 showed that delay of wheat sowing, date up to the end of December reduced wheat yield as a result of high temperature, which reduced season length.

The objective of this work was to

1- evaluate the effects of the sowing date and number of irrigation on yield and water productivity of winter wheat in north Nile Delta in Egypt.
2- determine the optimum sowing date for wheat grown under the condition of North Nile Delta Region.

MATERIALS AND METHODS

The present investigation was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The station is sited at 31^{0} -57^{-}/ N latitude and 30^{0}-57^{-} longitude. It has an elevation of about 20 m above sea level and it represents the conditions and circumstances of the middle north Nile Delta.

Sakha weather data had been recorded daily and their mean monthly values are presented in Table 1.

A split- plot design with four replicates was used. Sowing date occupied the main plots, while irrigation regime arranged in sub-plots. The sowing dates were 15/11 (D_1), 30/11 (D_2) and 15/12 (D_3). Sub plots were devoted to irrigation regime treatments, I_1 = 5 irrigations , I_2 = 4 irrigations and I_3 = 3 irrigations. Harvesting was done in 1/5/2015Each individual plot was 7m × 7.5 m= 52.5 m^2 = 1/80 fed. No. of plots = 3×3×4=36 plots. Soil texture of experimental field was clayey (51.1% clay, 33.4% silt and 15.3% sand) in texture and non-saline, non alkaline. Sowing was done on the 15th , 30th of November and 15th of December All cultural practices were done as recommended by the Egyptian Ministry of Agricultural and Land Reclamation except the two factors of study i.e. irrigation number and sowing date. Wheat grains (*Triticum aestivum L.*) Maser 2. at a rate of 60 $kg.fed^{-1}$ were sown.

Water applied (WA):

Irrigation water was measured by a constructed rectangular weir with a discharge of 0.01654 m^3sec^{-1} at effective head of 10 cm. Water applied (WA) was calculated as mentioned by Giriapa (1983):

$$WA = IW + R + S$$

Where:

Wa = Irrigation water applied,m^3/fed

R = rainfall , m^3/fed

S = Amount of soil moisture contributed to consumptive use from the

soil profile either as stored moisture in root zone and/or that contributed from the shallow groundwater table, m^3/fed

Table (1): Sakha agro-meteorological data during 2014/2015 season.

Seasons	Months	Air temperature (°C)			Relative humidity (%)			Wind speed m s^{-1}	Pan Evap., mm/ day	Rain Mm/ month
		Max.	Min.	Mean	Max.	Min.	Mean			
2014/2015	Nov	24.30	13.79	19.05	87.80	60.50	74.15	0.78	2.77	24.6
	Dec.	22.27	9.72	16.00	88.60	63.50	76.05	0.53	1.72	5.70
	Jan.	18.79	6.46	12.63	88.10	61.10	74.60	0.82	2.70	52.55
	Feb.	19.01	7.65	13.33	86.80	62.70	74.75	0.84	2.90	38.8
	Mar.	22.69	11.69	17.19	82.36	58.82	70.59	1.01	3.23	15.25
	Apr .	25.64	13.70	19.67	78.30	48.50	63.40	1.11	6.07	35.85
	May	30.19	18.79	24.49	77.3	46.1	61.7	1.33	7.15	0.00
										172.75

* **Source: meteorological station at Sakha 31-07' N Latitude, 30-57'E Longitude, N.elevation 6 m.**

Table (2): Mechanical and physical analysis for the experimental site before cultivating the crop.

Soil depth (cm)	Mechanical analysis			Physical characteristics					
	Sand	Silt	Clay	Texture class	Bulk density Mg/m^3	Total porosity %	Field capacity %	PWP %	A.W %
0-15	13.3	32.3	54.4	Clayey	1.26	52.45	46.50	25.69	20.81
15-30	18.2	36.2	45.6	Clayey	1.30	50.94	40.87	21.66	19.21
30-45	20.4	39.4	40.2	Clay loam	1.29	51.32	39.40	20.86	18.54
45-60	19.1	41.5	39.4	Clay loam	1.38	47.92	37.39	19.78	17.61
Mean	17.75	37.35	44.9		1.31	50.66	41.04	21.99	18.51

PWP = Permanent wilting point, AW = Available water, Mg = Mega gram (10^6 g)

Consumptive use (CU)

Soil moisture content was determined gravimetrically as average of two sub-samples of four depths (0-15, 15-30, 30-45, and 45-60 cm) just before and after each irrigation as well as before harvesting for all treatments to determine water consumptive use (Cu) according to Hansen *et al.* (1980).

$$CU = \sum_{i=1}^{n=4} \frac{\theta_2 - \theta_1}{100} \times D \times Bd$$

Where:

CU = Water consumptive use in cm.

D = Soil depth (cm).

Bd = Bulk density, Mgm^{-3} (Mega gram =(10^6 g))

θ_2 = Soil moisture content after irrigation.

θ_1 = Soil moisture content before irrigation.

To monitor water table fluctuation, nine observation wells were installed However, amounts and timing were recorded. Irrigation scheduling for other treatments was based on crop evapotranspiration (ET_c). was calculated from the reference evapotranspiration ET_o and the FAO crop coefficients (Kc) for wheat **(Allen et al., 1998).** ET_0 was calculated using the Penman-Monteith equation.(CROPWAT program) ET_c was computed weekly

Crop water use:

ETc = ETo x Kc

Where:

ETc = crop evapotranspiration or crop water use (mm)

ETo = calculated reference ET for grass (mm) available

Kc = crop coefficient

The reference evapotranspiration (ETo)

ETo was calculated by CROPWAT model v.8.0 (Smith, 1992) based on the agro-metrological data collected for the studied area**.**

Crop coefficient Kc

Values of the Kc were quoted from FAO (Allen *et.al.*, 1998). The four distinct growing stages of growing period are initial (35 days), crop establishment (60 days), mid-season (70 days) and late season (40 days). The corresponding values are 0.4, 0.75, 1.05, and 0.6 respectively. The length of growing stages of wheat identified with respect to (Allen, *et al.*, 1998) .

Contribution of the ground water table (S):

Water movement by capillary rise from water table into active plant root zone is recognized as an important supplementary water resource for irrigation. The contribution of groundwater as percentage of the consumptive use was calculated as follow:

$$S = (ET_c – SMD)$$

Where :

ET_c = Crop evapotranspiration = $ET_0 \times K_c$, mm

SMD = Soil moisture depletion.**,** mm

Fluctuation of ground water table:

In order to establish the diagram of ground water table fluctuation during the growing seasons under wheat crop, a nine observation wells were installed along different treatment. Perforated plastic tube with each observation well was two inches in diameter and two meter long. Daily reading of ground water table was recorded by the aid of a metallic sounder that fixed in a sealed tape to measure the water table depth

Yield and yield components:

number of tillers, length of spike, height of plant, l 000-grain weight , grain and straw yield of wheat at maturity were determined from central area of each subplot to avoid any effect and recorded The grains were separated from the straw, and the grains were weighed. Grain yield was calculated based on the adjustment to grain moisture content of 140 g kg^{-1}. Biomass yield express grain plus straw yields.

Water measurements.

Water productivity (WP) was calculated according to Molden, (1997)

$$WP\ (kg\ m^{-3}\ or\ \$\ m^{-3} = \frac{\text{Output derived from water use } (kg/m^3 \text{ or } \$ /m^3}{\text{Water input } (m^3)}$$

The obtained data were statistically analyzed by analysis of variance, analysis was done according to Gomez and Gomez (1984) .Means of the treatment were compared by the least significant difference (LSD) at 5% level of significance which developed by Waller and Duncan (1969)

RESULTS AND DISCUSSION

Seasonal water applied (Wa)

Under the conditions of the present study, the seasonal water applied (Wa) consists of the three components; irrigation water (IW), rainfall (R) and contribution of water table (S). Wheat as a winter crop received rainfall of 172.7 mm = 725.34 m^3 Water applied decreased with decreasing number of irrigation

Irrigation water (IW):

As shown in Tables (3) & (4) the total number of irrigation events were 5,4 and 3 for I_1 , I_2 , and I_3 respectively, including sowing irrigation. Amounts of irrigation water (IW) are tabulated in Table (3). Mean values of irrigation water were 2172.96, 1826.76 and1538.32 m^3fed^{-1}. for I_1 , I_2 and I_3 respectively as the irrigation treatments. Irrigation water for I_3 treatment was the lowest, and the amount for I_1 treatment was the highest. These data indicate that using three irrigation (I_3 irrigation treatment) saved water by about 29.2% (634.64 m^3) compared with irrigation treatment I_1 (the conventional irrigation), while for sowing date treatments mean values of irrigation water were 2005.44 , 1814.28 and 1718.32 m^3fed^{-1}. for D_1 , D_2 and D_3.

Table (3): Seasonal irrigation (IW), rainfall (R) , contribution from water table (S) , seasonal water applied (Wa)and contribution of ground water as percentage (%) for wheat

Treatments		IWm		R	S	WA	S%
		No	m^3fed^{-1}	m^3fed^{-1}	m^3fed^{-1}	m^3fed^{-1}	
	I_1	5	2355.36	725.34	0	3080.70	0.00
D_1	I_2	4	1922.64	725.34	86.1	2734.08	4.48
	I_3	3	1738.32	712.34	139.82	2590.48	8.04
	I_1	5	2141.76	725.34	0	2867.10	0.00
D_2	I_2	4	1802.76	725.34	94.08	2622.18	5.22
	I_3	3	1498.32	725.34	139.78	2363.44	9.33
	I_1	5	2021.76	725.34	0	2747.10	0.00
D_3	I_2	4	1754.88	725.34	125.96	2606.18	7.18
	I_3	3	1378.32	725.34	200.74	2304.40	14.56

Table (4)Irrigation water in (m^3fed^{-1}) as related to interaction between sowing date and number of irrigation

Treatments	D_1	D_2	D_3	I-mean
I_1	2355.36	2141.76	2021.76	2172.96
I_2	1922.64	1802.76	1754.88	1826.76
I_3	1738.32	1498.32	1378.32	1538.32
D-mean	2005.44	1814.28	1718.32	

Water consumptive use (CU).

Crop consumptive use (CU) was determined directly from the soil moisture depletion (S.M.D) in the effective root zone. Values of seasonal CU in cm are presented in Table (5_a and 5_b) for wheat during the growing season 2014/2015. The obtained results showed that the seasonal CU values were greatly affected by number of irrigation, where CU values decreased with increasing the irrigation interval . Seasonal values of CU were, 42.73, 37.04and 32.51cm for the treatments I_1 , I_2 , and I_3 respectively.**.** Results in Table (5) showed that, values of the CU were higher under D_1 than that under other one . Mean values of CU, were 38.98 , 37.56 and 35.75 cm for D_1 , D_2 and D_3 respectively.

Table (5_a): Contribution of water table(S) to wheat crop Cu (cm) under different treatments in growing season 2014/2015.

Treatments		ETc	S.M.D=CU	ETc-S.M.D= S
	I_1	40.6	43.5	0
D_1	I_2	40.6	38.55	2.05
	I_3	40.6	34.89	5.71
	I_1	40.6	42.8	0
D_2	I_2	40.6	37.36	3.24
	I_3	40.6	32.51	8.09
	I_1	40.6	41.9	0
D_3	I_2	40.6	35.22	5.38
	I_3	40.6	30.13	10.47

Table(5_b) CU (S.M.D) as affected by the interaction between number of irrigation and sowing date

Treatment	D_1	D_2	D_3	I-mean
I_1	43.50	42.80	41.90	42.73
I_2	38.55	37.36	35.22	37.04
I_3	34.89	32.51	30.13	32.51
D-mean	38.98	37.56	35.75	

Fluctuation of water table depth during the growing seasons:

Table (6) represents the obtained results for effects of sowing date and irrigation intervals on maximum and minimum values of water table depth, for each observation well, under each treatment, which indicated the depth of water table reached the lowest value immediately before irrigation. While the maximum water depth reached at 2 days after irrigation. The irrigation interval in these study had strong effect on the behavior of the water table. The average maximum values of water table depth varied between 67 and 78 cm. The corresponding values of the minimum water table depth were 95 and 114 cm. In general, it could be summarized that the fluctuation of water table regime for wheat has the following interactions:

1- No clear effect was observed of various sowing date on the behavior of water table regime
2- Irrigation intervals have a main effect on the regime of water table. The long irrigation interval, the deepest water table was resulted and visa versa.
3- The distance from both the irrigation canal in the north and main surface drain in the south of the experiment area

Table(6):Maximum, Minimum and mean values of water table depth cm. during the growing season2014/2015

Treatments		Observation well	Maxi	Mini.	Mean
	I_1	1	67	98	82.5
D_1	I_2	2	75	104	89.5
	I_3	3	78	109	93.5
	I_1	4	73	95	86.5
D_2	I_2	5	70	105	87.5
	I_3	6	70	110	90
	I_1	7	70	97	83.5
D_3	I_2	8	73	110	91.5
	I_3	9	72	114	93

Contribution of water table (%):

Table (7) represents the contribution of water table to wheat evapotranspiration during the 2014/2015 growing season. Data showed that by increasing irrigation water, less value was obtained. For the maximum irrigation water (treatment I_1) there was no contribution from water table. For the other treatments (I_2 and I_3) average values of contribution are 3.56 and 8.09 cm.

Grain yield (kg fed^{-1}):

Data showed significant effects of different sowing date .The highest grain and straw yields was obtained from D_1(15th November (2568& 6487 kg fed^{-1}) while 15th December, produced the lowest grain and straw yields of (2090 &5356 kg fed^{-1}) Table (8) These results agree with Shahzad *et al.*(2007) which obtained lower grain yield with delay in sowing due to shorter duration of growth and development.

On the other hand, the contribution was increased directly by increasing irrigation intervals. It was mention that under treatments which had relatively important values of water table contribution (I2 and I_3), the corresponding percentage ranged between 7.18 and 14.56 %. These findings are an agreement with those obtained by (Eid 2015)

Table(7) Contribution of ground water table (S) as affected by the interaction between number of irrigation and sowing date

Treatment	D_1	D_2	D_3	I-mean
I_1	0	0	0	0
I_2	2.05	3.24	5.38	3.56
I_3	5.71	8.09	10.47	8.09
D-mean	3.88	5.67	7.93	

Effect of sowing date:

Mean values of grain and straw yields in kg.fed^{-1}of wheat as affected by sowing date are shown in Table (8) Sowing date significantly influenced grain and straw yields per fed. Mean values of grain and straw yields obtained by D_1, D_2 andD_3 sowing date were 2568, 2310 and 2090 & 6487 , 5502 and 5356 kg fed^{-1}respectivily. Values of grain and straw yields under all the irrigation number treatments had the descending order: D_1>D_2>D_3. The decrease percentage In grain and straw yields was (10.0 % and 18.6 % & 15.2 % and 17.4 %) under $D_2$and D_3, respectively, compared with treatment D_1.It means that sowing date in 15th November cause higher increase on grain yield compared with other sowing dates

Effect of irrigation number of wheat on grain yield :

Regarding the effect of the irrigation number treatments on grain and straw yields the five irrigations numbers for (I_1) treatments was greater than the other two treatments. Mean values of grain and straw yields obtained by I_1, I_2 and I_3 irrigation number are 2518, 2313 and 2137 & 6433 , 5679 and 5232 kg fed^{-1}respectivily Table (8) values of grain and straw yields under all the irrigation number treatments had the descending order: $I_1>I_2>I_3$. The decrease percentage on grain and straw yields was (8.1 % and 15.1 % & 11.7 % and 18.6 %) under $I_2$and I_3, respectively, compared with treatment I_1.It means that 5 irrigation number cause higher increase in grain yield compared with other irrigation number treatments.

This occurred under each of the sowing dates.

Effect of interaction between sowing date and irrigation number:

The highest grain and straw yields was obtained by I_1D_1 treatment which gave 2861 &7236 kg fed^{-1}. The lowest yields was obtained by the I_3D_3 treatment which gave 1941&4905 kg fed^{-1} grain and straw yields respectively.

Spike length (cm):

The length of spike plays a vital role in wheat towards the grains $spike^{-1}$ and finally the yield (Shahzad *et al*., 2007). As far as the sowing date is concerned, significant observations were recorded for the spike length. Sowing wheat on 15th November produced the longest and statistically at par spike length of 13.3 cm Table(9).

Table(8)Effect of Sowing date (D) and irrigation number (I) on grain and straw yield of wheat (kg fed^{-1}.) during 2014/2015 growing seasons.

Treatments	Grain yield kg fed^{-1}				Straw yield kg fed^{-1}			
	D_1	D_2	D_3	I-mean	D_1	D_2	D_3	I-mean
I_1	2861a	2434 a	2258 a	2518	7236 a	6144 a	5920 a	6433
I_2	2523 b	2345 b	2072 b	2313	6368 b	5425 b	5243 b	5679
I_3	2320 c	2150 c	1941 c	2137	5856 c	4936 c	4905 c	5232
D-Mean	2568	2310	2090	2323	6487	5502	5356	5782

In a column, followed by a common letter are not significantly different at the 5 level by DMRT

Comparison	S.E.D	LSD (5%)	LSD (1%)	S.E.D	LSD(5)	LSD (1)
2-D means at each I	8.66	20.23	29.80	98.42	220.32	315.72
2-I means at each D	6.00	12.62	17.28	93.58	196.61	369.37

Effect of sowing date:

Mean values of spike length in cm of wheat as affected by sowing date are shown in Table (9) Sowing date significantly influenced spike length. Mean values of spike length obtained by D_1, D_2 and D_3 sowing date are 11.2, 9.2 and 8.2 cm respectively Table (9) values of spike length under all the sowing date treatments had the descending order: $D_1>D_2>D_3$. The decrease percentage on spike length was (17.8 % and 26.7 %) under $D_2$and D_3, respectively, compared with treatment D_1.It means that sowing date in 15th November cause higher increase on spike length compared with other sowing dates.

Effect of irrigation number:

Regarding the effect of irrigation number treatments, spike length was greater with I_1 treatment than the other two irrigation number treatments. This occurred under each of the sowing date .Table (9) show that mean spike length due to irrigation number of I_1, I_2 and I_3 were 11.3, 9.4 and 7.8 cm respectively. Thus the I_1treatment gave the highest yield. I_1 significantly increased spike length by 16.8 and 30.9%compared to I_3.

Effect of interaction between sowing date and irrigation number:

The highest spike length was obtained by I_1D_1 treatment which gave 13.3 cm The lowest spike length was obtained by the I_3D_3 treatment which gave 7.0 cm. Further delay in sowing resulted in shorter spike length. Irrigation number and its interaction with sowing time hade significant effect on spike length (Table-9), however, longer spike length of 13.3 cm was noted on 15th November with five irrigation. Waraich *et al.* (1981) reported that earlier planting resulted in better spike development due to longer growing period.

Number of tillers (m^{-2}):

The economic yield of most of the cereals is determined by the number of tillers. It has the great agronomic importance as this may compensate the difference in number of plants, partially or totally after crop establishment and may allow crop recovery.

Effect of sowing date

Mean values of the number of tillers of wheat as affected by sowing date are shown in Table (9) sowing date significantly influenced the number of tillers. Mean values of the number of tillers obtained by D_1, D_2 andD_3 sowing date are 175.7, 162.3 and 144.4

. respectively Table(9) values of the number of tillers under all the sowing date treatments had the descending order: $D_1>D_2>D_3$. The decrease percentage in the number of tillers was (7.6 % and 17.8 %) under $D_2$and D_3, respectively, compared with treatment D_1.It means that sowing date in 15th November cause higher increase in the number of tillers compared with other sowing dates.

Effect of irrigation number:

Regarding the effect of irrigation number treatments, the number of tillers was greater with I_1 treatment than the other two irrigation the number of tillers. This occurred under each of the sowing date since the interaction between the irrigation number treatment and sowing date was significant Table (9). Mean the number of tillers due to irrigation number of I_1, I_2 and I_3 were 180.0, 159.6 and 142.8 cm respectively .. Thus the I_1 treatment gave the highest yield. I_1 significantly increased the number of tillers by 11.3 and 20.6% compared to I_3.

Effect of interaction between sowing date and irrigation number:

The highest number of tillers was obtained by I_1D_1 treatment which gave 208.3 The lowest number of tillers was obtained by the I_3D_3 treatment which gave 144.4 cm.

Further delay in sowing resulted in lowest number of tillers. Irrigation number and its interaction with sowing time hade significant effect on the number of tillers Table (9), however, highest the number of tillers of 208.3 was noted on 15th November with five irrigation.

Plant height at maturity (cm):

Height of the crop is mainly controlled by the genetic makeup of a genotype and it can also be affected by the environmental factors (Shahzad *et al.*, 2007)

Table (9) Effect of sowing date (D) and irrigation number (I) on spike length (cm) and number of tiller during 2014/2015 growing seasons.

Treatments	Spike length cm				Number of tiller (number)			
	D_1	D_2	D_3	I-mean	D_1	D_2	D_3	I-mean
I_1	13.3 a	11.3 a	9.5 a	11.3	208.3 a	177.3 a	154.5 a	180.0
I_2	11.0 b	9.3 b	8.0 b	9.4	169.3 b	165.3 b	144.3 b	159.6
I_3	9.3 c	7.0 c	7.0 c	7.8	149.5 c	144.3 c	134.5 c	142.8
D-Mean	11.2	9.2	8.2	9.5	175.7	162.3	144.4	160.8

In a column, followed by a common letter are not significantly different at the 5 level by DMRT

Comparison	S.E.D	LSD(5)	LSD (1)	S.E.D	LSD(5)	LSD (1)
2-D means at each I	0.4	0.9	1.3	0.5	1.1	1.5
2-I means at each D	0.4	0.9	1.2	0.4	0.8	1.1

Effect of sowing date

Data showed that plant height differed significantly by sowing date Mean values of the plant height of wheat as affected by sowing date are shown in Table (10) Sowing date significantly influenced the plant height. Mean values of the plant height obtained by D_1, D_2 andD_3 sowing date are 78.2, 72.7 and 70.4cm respectively. values of the plant height under all the sowing date treatments had the descending order: $D_1>D_2>D_3$. The decrease percentage on the number of tillers was (7.0% and 9.9 %) under $D_2$and D_3, respectively, compared with treatment D_1.It means that sowing date in 15th November cause higher increase on plant height compared with other sowing dates.

Effect of irrigation number:

Regarding the effect of irrigation number treatments, plant height was greater with I_1 treatment than the other two irrigation. Mean the plant height due to irrigation number of I_1, I_2 and I_3 were 79.5, 75.8 and 65.9 cm respectively . Thus the I_1 treatment gave the longest plant height. I_1 significantly increased plant height by 6.9 and 17.1% compared to I_3.

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Effect of interaction between sowing date and irrigation number:

The longest plant height was obtained by I_1D_1 treatment which was 87.0 The lowest plant height was obtained by the I_3D_3 treatment which gave 64.3 cm.

The wheat crop sown on 15th November produced the tallest plants of 87.0 cm respectively. In case of irrigation number, the maximum plant height (87.0 cm) was observed with five irrigation number followed by four irrigation number which produced plants of 78.3 cm. has results.

1000-grain weight (g):

Among different sowing dates, the maximum 1000-grain weight (44.3 g) was recorded on 15th November. The minimum 1000-grain weight (35.3 g) was noted on 15th December sowing date. The decrease percentage on 1000-grain weight was (20.3 %) under D_3, compared with treatment D_1 Among number of irrigation, the maximum 1000-grain weight (44.9 g) was obtained when five irrigation was done . The results are in agreement with the findings of Shahzad *et al.* (2007) who also observed that earlier sowing resulted in better development of the grain due to longer growing period

Table (10) Effect of sowing date (D) and irrigation number (I) on plant height (cm) and Weigh of 1000 grain(gm) during 2014/2015 growing season.

Treatments	Plant high(cm)				Weigh of 1000 grain(gm)			
	D_1	D_2	D_3	I-mean	D_1	D_2	D_3	I-mean
I_1	87.0 a	79.3 a	72.3 a	79.5	49.3 a	45.3 a	40.3 a	44.9
I_2	78.3 b	74.5 b	74.5 b	75.8	45.3 b	40.3 b	35.3 b	40.3
I_3	69.3 c	64.3 c	64.3 c	65.9	39.3 c	35.3 c	30.5 c	35.0
D-Mean	78.2	72.7	70.4	72.5	44.3	40.3	35.3	40.1
In a column, followed by a common letter are not significantly different at the 5 level by DMRT								
Comparison		**S.E.D**	**LSD(5)**	**LSD (1)**		**S.E.D**	**LSD(5)**	**LSD (1)**
2-D means at each I		**0.5**	**1.0**	**1.4**		**0.1**	**0.3**	**0.4**
2-I means at each D		**0.5**	**1.1**	**1.4**		**0.1**	**0.2**	**0.3**

Water productivity (WP)

Water productivity is considered as an evaluation parameter of yield per unit of applied water, i.e., WP is a tool for maximizing crop production per each unit of applied water. Water productivity of wheat was evaluated for both grain and straw yield in kg m^{-3}. The data obtained are presented in Tables (11, and 12)

Results showed that amounts of WP_g were 1.16, 1.26and 1.39kg grain m^{-3}resulted from number of irrigation treatments I_1, I_2 and I_3 respectively From the presented data, it is clear that values of WP of wheat differed from one treatment to another as affected by number of irrigation.

Regarding sowing date, Tables (11& 12) reveal that D_1 treatment achieved the highest amounts of water productivity i.e. 1.28kg grain m^{-3} as compared to D_2 and D_3 (1. 29 and 1.24 kg grain m^{-3})

Table (11): Amounts of irrigation water applied, grain yield, straw yield, water productivity of wheat grain (WPg kg m^{-3}) and water productivity of wheat straw (WPs kg m^{-3}) during 2014/2015 growing season

Treatments		**Wa m^3fed^{-1}**	**Grain yield $kgfed^{-1}$**	**Straw yield $kgfed^{-1}$**	**WPg kgm^{-3}**	**WPs kgm^{-3}**
	I_1	2355.36	2861	3921.60	1.21	1.66
D_1	I_2	1922.64	2523	3640.80	1.31	1.89
	I_3	1738.32	2320	3513.60	1.33	2.02
	I_1	2141.76	2434	3326.40	1.14	1.55
D_2	I_2	1802.76	2345	3255.00	1.30	1.81
	I_3	1498.32	2150	3141.60	1.43	2.10
	I_1	2021.76	2258	3132.00	1.12	1.55
D_3	I_2	1754.88	2072	3025.80	1.18	1.72
	I_3	1378.32	1941	2943.00	1.41	2.14

Table (12) water productivity of wheat grain (WPg) and straw(WPs) (kg m^{-3}) as related to interaction between sowing date and number of irrigation in the 2014/2015 growing season.

Treatments	**WPg kgm^{-3}**				**WPs kgm^{-3}**			
	D_1	D_2	D_3	I-mean	D_1	D_2	D_3	I-mean
I_1	1.21	1.14	1.12	1.16	1.66	1.55	1.55	1.59
I_2	1.31	1.30	1.18	1.26	1.89	1.81	1.72	1.81
I_3	1.33	1.43	1.41	1.39	2.02	2.10	2.14	2.09
D-Mean	1.28	1.29	1.24		1.86	1.82	1.80	

CONCLUSION

It could be concluded that irrigation at short intervals (5 irrigations),sowing date on 15th November and variety Masr 2 could produce higher number of tillers, spike length, plant height, 1000-grain weight and straw and grain yield in North Nile Delta-Egypt

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تأثير تاريخ زراعه القمح تحت ظروف الاجهاد المائى فى شمال دلتا النيل- مصر

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اقيمت تجربة حقلية خلال الموسم الزراعى ٢٠١٥/٢٠١٤ فىحقل تجارب قسم بحوث المقننات المائية والرى الحقلى بمحطة البحوث الزراعية بسخا- محافظة كفرالشيخ التى تقع عند خط عرض N / 57^- -57 $31^{0\circ}$ وخط طول 30^0-57 $^-$57 لدراسة تاثير عدد الريات وتاريخ الزراعة على انتاج القمح ومكوناتة وبعض العلاقات المائية وكان تصميم التجربة القطع المنشقة مرة واحدة وكانت المعاملات الرئيسية تاريخ الزراعة D_1 الزراعة فى ١١/١٥ و D_2الزراعة فى ١١/٣٠ و D_3 الزراعة فى ١٢/١٥ وتحت رئيسية عدد الريات I_1 اعطيت خمس ريات و I_2 اعطيت اربع ريات و I_3 اعطيت ثلاث ريات

النتائج التحصل عليها كانت كالتالى:

اعلى كمية مياة رى واستهلاك مائى كانت من نصيب المعاملة I_1 التى رويت خمس مرات اما اقل كمية حققتها المعاملة I_3 التى رويت ثلاث ريات الزراعة فى ١١/١٥ (D1) حققت زيادة معنوية فى محصول الحبوب والقش وطول السنبلة وعدد الفروع وطول النبات ووزن الالف حبة مقدارها ١٨,٦- ١٧,٤-١٧,٧-٢٦,٨-١٧,٨ ٩,٩ و٢٠,٣ % على التوالى ايضا الزراعة فى ١١/١٥ حققت زيادة معنوية فى انتاجية المياة مقدارها ٢٧,٢ %