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RICE VARIETIES AS AFFECTED WITH DIFFERENT IRRIGATION PERIODS AND SUBMERGED DEPTHS IN THE NORTH NILE DELTA REGION

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ABSTRACT

A field experiment was conducted at Sakha Agricultural Research Station Farm during the two growing seasons 2013 and 2014 to study the he effect of irrigation period, depth and cultivar on yield and water parameters for rice *(Oryza sativa L.)*. The site located at Kafr EL Sheikh Governorate, Middle North of the Nile Delta. Two irrigation period treatments; 6 days (P_1) and 12 days (P_2) were tested. Three irrigation depths; irrigation till 3cm above soil surface (ASS) (D_1), irrigation depth till 5cm ASS (D_2) and the traditional till 7cm ASS (D_3) were tested. Three rice cultivars; Giza 177 (V_1), Sakha 101 (V_2) and Orabi (V_3) were tested. The important findings could be summarized as follows:

The highest values of irrigation water applied and then water duty were recorded under control treatment e.g. irrigation every 6 days and 7 cm depths (irrigation without any stress during the growing season, interaction between P_1D_3). On the contrary, the lowest values were recorded under interaction between P_2D_1 (every 12 days irrigation interval and 3cm depth during the growing season). The mean value of productivity irrigation water was increased under prolonged irrigation interval of 12 days plants comparing with other treatments. The highest mean values were recorded under interaction between P_2D_1 but the lowest mean values were recorded under interaction between P_1D_3 (highest water applied treatment)

The mean values for grain yield was significantly affected with irrigation period, depth and verities. For two periods, irrigation till 5cm (D_2) recorded the highest grain yield 4246.7 kg fed^{-1}, and 4394.3 kg fed.$^{-1}$ under 6 days as irrigation interval, and 2894.4 kg fed^{-1}., and 2866.6 kg fed^{-1} under 12 days as irrigation interval in the first season and second seasons respectively. Orabi 1 recorded the highest values of grain yield under overall period and depth of water. Yield components of rice; 1000 grain weight g., biological yield kg., straw yield kg., grain straw ratio and sterility % were decreased under water stress treatments in the second period (P_2) as compared with P_1, for water depths; D_1 compared with D_2 in the two period. For varieties, biological yield kg., and grain straw ratio only showed significant effect. Regarding, all studied growth parameters; panicle Length and plant height were increased with increasing irrigation water applied.

Moreover, water saving from interaction between P_1D_2 which increased yield with 7% with water saving with 16-18% as comparing with P_1D_3 (highest water applied treatment).

Keywords: - irrigation period, watering level, rice varieties and productivity of irrigation water

INTRODUCTION

Whereas the available fresh water resources in the world are constant and the population is continually increasing, the available water per capita will continue to decrease resulting in water scarcity or stress in some areas. Water is one of the most important inputs for the production of crops. So, one of the technology options that can help farmers cope with water scarcity at the field level how to maximize water use efficiency by crops to increase crop production in order to narrowing the food gap between consumptions and production. Water affects the performance of crops not only directly but also indirectly by influencing the availability of nutrients, the timing of cultural operation….etc.

The Egyptian water share from the main water source of River Nile is limited by 55.5 x 10^9 $m^3 year^{-1}$ which is not enough to meet the demand of all sectors. About 80-85% of the Egyptian water supply is used in agricultural sector. So, the necessity to rationalize the use of irrigation water becomes a must.

When irrigation water is available, Egypt has one of the most favorable climate conditions for rice production. With the rice area being fully irrigated, there are no real problems of drought or flooding. The only adverse problem is soil salinity and occasional alkalinity that, to varying degrees, affect about 30% of the rice area.

Rice (*Oryza sativa* L.) is a major staple food for the world's population with about two-thirds of the total rice production grown under irrigation. Rice is not only the staple food for nearly two-thirds the world's population most of them live in the developing countries. Which occupies one third of the world's total area population, but also a key source of employment and income for the rural people planted by cereals and provides 35-60 percent of the calories consumed by 2.7 billion people. Rice is the most widely grown crop under irrigation. (Guera *et al.*, 1998)

In Egypt for instance, potential water saving induced by the use of short-season rice varieties is in the order of 305 mm (13%) in comparison with long-season rice. The new genotypes such as Giza 177 and Sakha 101 can save about 10 to 15% of the irrigation water, which corresponds to 1.4 billion m^3 a year FAO (2003).

El-Refaee *et al.* (2005) investigated the productivity of two Egyptian rice cultivars, namely SK 2025H (hybrid) and Sakha 104 (inbred), which cultivated at Sakha, Kafr El-Sheikh, Egypt. The study comprised four irrigation regimes:- continuous flooding, continuous saturation, irrigation every 6 and 8 days. All stated irrigation regimes were subjected to six time application of nitrogen. The main results showed that most growth attributes significantly decreased as irrigation intervals were increased up to 8 days. Continuous flooding consumed the highest amount of irrigation water. Furthermore, continuous saturation recorded the highest water productivity and minimum yield reduction with a higher amount of water saving comparing with other irrigation treatments. Generally, the superiority of hybrid rice of SK 2025H in grain yield might be attributed to the improved plant-type characteristics such as dry matter production, LAI, and panicle grain weight.

Mehla et al. (2006) indicated that the highest grain yield was obtained under continuous submergence (I_1) followed by irrigation one day after disappearance of standing water (I_2) and irrigation three days after disappearance of standing water (I_3). However, there was no significant difference between the yields and nutrient uptake at I_1 and I_2 water regimes. The amount of water used was highest in I_1 treatment followed by I_2 and I_3 water regimes. The differences in rice yield and nutrient uptake were not significant between I_1 and I_2 but later resulted in 8 to 11% savings in water.

Sarkar (2006) reported that imposition of intermittent ponding in the early crop stage only can improve water use efficiency without significant decrease in yield, and shallow intense puddling by power tiller Rotavator can improve both water-use efficiency and grain yield.

FAO (2010) has downgraded its forecast of paddy production in Egypt by 1.5 million tons to 4.5 million tons (3.1 million tones, milled basis), to reflect a smaller area than previously anticipated. According to official assessments, plantings of the summer crop, which account for nearly all of production, contracted to 450, 800 hectare this season (2010), 22 percent below an already low extension of 576, 000 hectare in 2009 and nearly 40 percent under the 745, 000 hectare high in 2008. The retrenchment would be in line with a Government set target to limit rice cultivation to 1.1 million feddans (462, 000 hectares), which authorities estimate would allow between 5 and 6 million cubic meters of water to be saved for other purposes.

Kukal *et al.* (2010) obtained highlights of that the irrigation water use when practising the resource conservation technologies under different irrigation scenarios. The intermittent irrigation scheduling on the basis of soil matric tension (16 kPa at 20 cm depth) could save irrigation water by 30%, that yield was recorded 6.43 ton /ha. in traditional irrigation (2day interval irrigation) and gave approximately the same yield and save 31%(102.8cm) of water. Irrigation at 16±2 kPa soil matric suction helped save 30–35% irrigation water compared to that used with the 2-day interval irrigation. Applying water with half furrow depth could help in improving irrigation water productivity. The water balance for direct-seeded rice needs to be computed under different irrigation scenarios to achieve highest irrigation water productivity.

Qureshi *et al.* (2006) pointed out that the global rice demand in 2020 will increase by 35% at the level of 1995. Inversely, water availability for agriculture sector will decrease. Therefore, water allocations for rice crop need to be strictly reviewed and efficient irrigation methods need to be introduced. Among different innovative approaches and production methods, direct dry seeded rice is viewed as a good option for improving water use efficiency in the rice production systems. The present study compares the water productivity of traditional rice with direct dry seeded rice. The study was the average amount of irrigation water applied to direct dry seeded rice was 865 mm as compared to 1130 mm for traditional rice indicating a water savings of 23% in the case of direct dry seeding method. The study results indicate that direct dry seeding method is more efficient in water saving as compared to traditional method.

The current study, therefore, was undertaken to identify the effects of water intervals, depths on some rice varieties yield and its components, producing more rice grain with minimizing water requirement i.e. increasing water productivity in the area of rice production.

MATERIALS AND METHODS

A field experiment was conducted at Sakha Agricultural Research Station Farm, during the two growing season of 2013and 2014 to study the effect of irrigation depth and its period under different varieties on yield and water parameters for rice. The site located at Kafr EL Sheikh Governorate (Middle North of the Nile Delta), which located at (31^{-} 07° N Latitude, 30^{-} 57° longitude) with an elevation of about 6 meters above sea level

Data presented in Table 1 which reveal some meteorological parameters during the studied period, recorded from Sakha Agro-meteorological Station. The meteorological parameters, include; air temperature (T., °C), relative humidity (RH, %), wind speed (U_2, Km / day at 2 m height) and evaporation pan (Ep, mm).

Table1. Some ago-meteorological elements in the first and second seasons of rice 2013, 2014.

Months	T (°c)			RH (%)			U_2	Pan
	Max.	Min.	Mean	Max.	Min.	Mean	m Sec^{-1}	Evap. ($mmday^{-1}$)
				2013 season				
May	31.43	21.85	26.64	75.03	45.78	60.41	1.20	6.35
June	32.44	23.97	28.21	74.63	51.27	62.95	1.34	6.61
July	32.32	24.31	28.32	79.57	54.70	67.14	1.28	6.11
Aug.	33.79	24.72	29.29	83.63	60.52	72.08	1.04	5.13
Sep.	32.50	22.93	27.72	81.00	56.6	68.80	1.01	3.82
				2014 season				
May	30.47	19.57	25.02	77.20	48.60	62.90	1.14	5.87
June	32.65	20.60	26.63	86.23	52.30	69.27	0.95	6.56
July	33.15	23.64	28.40	83.19	55.11	69.15	1.13	7.73
Aug.	34.10	21.80	27.95	92.40	53.50	72.95	1.15	8.14
Sep.	32.49	20.76	26.63	87.57	52.20	69.89	1.03	6.65

*** Source: Agro meteorological station at Sakha 31^{0}-07' N Latitude, 30^{0}-57'E Longitude, N. elevation 6 m.**

Soil particle size distribution and bulk density were determined as described by Klute (1986). Field capacity, permanent wilting point and available water characters were determined according to James (1988). Chemical characteristics of soil were determined as described by Jackson (1973) and all data are presented in Table, 2.

Table 2 Particle size distributions, bulk density, some both soil-water constants and chemical soil properties of the experimental site (mean of 2013 and 2014 seasons)

Soil layer (cm)	Particle size distribution			Textural class	Bulk density (Kgm^{-3})	Soil- water constant		
	Sand%	Silt%	Clay%			F.C* (%,wt/wt)	P.W.P** (%,wt/wt)	A.W*** (%,wt/wt)
0-15	11.20	29.30	59.50	Clay	1.16	44.50	23.50	21.00
15-30	15.80	29.60	54.60	Clay	1.17	43.00	22.60	20.40
30-45	17.50	29.90	52.60	Clay	1.18	42.60	22.10	20.50
45-60	18.11	31.40	50.49	Clay	1.21	41.50	21.30	20.20
Mean	15.65	30.05	54.30	Clay	1.18	42.90	22.38	20.52

Chemical Soil characteristics

	pH	EC	Soluble cations, $meqL^{-1}$				Soluble anions, $meqL^{-1}$			
		dSm^{-1}	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
0-15	7.87	2.48	4.50	5.12	14.30	0.61	-	9.30	4.23	11.00
15-30	8.00	2.60	4.10	6.50	15.00	0.38	-	8.90	9.20	7.88
30-45	8.10	3.10	3.88	5.90	20.80	0.36	-	11.40	12.60	6.94
45-60	8.16	2.76	5.10	7.60	14.60	0.41	-	10.12	13.30	4.29
Mean	8.03	2.74	4.40	6.28	16.17	0.44	-	9.93	9.83	7.53

FC* = Field capacity, PWP = Permanent wilting point and AW*** = Available soil water**

The site of the experiment was ploughed twice by using chisel plougher. A disk harrow was also used to find a suitable size of aggregates and then, the soil was leveled. The field of the experiment area was divided into 54 plots, each plot was 52.5 m^2 (7.5 X 7) = 1/80 fed., and isolated from the other to prevent horizontal water movement. Field preparation and nursery practices were performed according to the traditional local rice management.

The amounts of fertilizers were applied for each variety according to recommendations of Rice Research& Training Center (RRTC) Field Crops Research Institute, Agricultural Research Center (ARC). Nitrogen fertilizer as urea form (46.5% N), where the recommendation nitrogen requirements for three varieties are 60 nitrogen unit / fed. For Giza 177 was splitted in the two doses (2/3 dose was applied during land preparation and the second dose was applied after transplanting with 25 days). The phosphates fertilizer was applied in the two seasons during tillage implementation as the recommended dose of 100 kg single superphosphate (15.5 P_2O_5/ fed.). The potassium fertilizer was applied in the two seasons as recommended dose 50 Kg K_2O was splitted in to two doses (1/2 was applied during land preparation and the second dose 1/2 was applied after transplanting by 45 days).

Experimental layout:-

All agricultural practices for rice crop were implemented according to the technical recommendations of RRTC, ARC.

The treatments under study:-

P-The main plot was allocated to irrigation period:-

P_1 – Irrigation every 6 days.
P_2 – Irrigation every 12 days

D-The sub-plot was for irrigation water level:-

D_1- Irrigation till 3 cm depth of I.W.
D_2 - Irrigation till 5 cm depth of I.W.
D_3 - Irrigation till 7 cm depth of I.W.

V-The sub sub-plot was for rice variety:-

V_1: Variety (Giza 177).
V_2: Variety (Sakha 101).
V_3: Variety (Orabi 1).

Irrigation water (I.W):

Irrigation water was controlled and measured by rectangular weir and water was distributed by spills inserted beneath the bank of each irrigated furrows set. Applied irrigation water was determined according to Michael, (1978) as follows:

$$Q = 1.84\ LH^{1.5}$$

Where:

Q = Water discharge, m^3sec^{-1},
L = width of weir, cm
H = the head above weir crest, cm

Productivity of irrigation water (PIW, Kg m^{-3})

Productivity of irrigation water (PIW) was calculated according to Ali *et al* (2007).

$$PIW = \frac{Y}{I}$$

Where

PIW = productivity of irrigation water (Kg m^{-3}),
Y = yield kg fed^{-1}, and
I = irrigation water applied (m^3 fed^{-1}).

- Studied plant parameters:

1. Plant height, cm
2. Length of Panicle, cm

Panicle length of rice plant from ring of hairs at the junction of the peduncle of the main culm to the tib of the most distal grains.

3. 1000 grain weight, g
4. Total number of filled grains / panicle
5. Total number of unfilled grains / panicle
6. Percentage of sterility%
7. Biological yield.
8. Grain yield (ton fed^{-1}.)
9. Straw yield (ton fed^{-1}.)
10. Grain / Straw ratio

Data were statistically analyzed according to the technique of analysis of variance (ANOVA) as published by Gomez and Gomez (1984). Means of the treatments were compared using Least Significant Difference (LSD) at 5% level of significance as developed by Waller and Duncan (1969).

RESULTS AND DISCUSSION

1. Irrigation water applied.

Water applied for nursery (≈ 30 days), land preparation which included puddling, transplanting 2-3 common watering till establishment of rice plants were recorded and equaled (1760 and 1690 m^3 fed^{-1} in the first and second seasons, respectively). This period was about 42 days, and then watering treatments were applied.

Table (3) showed also the seasonal values of irrigation water applied (W.A) for rice crop. The highest values 6780 m^3 fed^{-1} (161.4 cm) and 6685 m^3 fed^{-1} (159.2 cm), were recorded for $P_1D_3V_3$ in the first and second seasons, respectively. While, the lowest values were recorded under $P_2D_1V_1$ in the two seasons with values 2775 m^3 fed^{-1} (66.1 cm) and 2690 m^3 fed^{-1} (64.0 cm) in the first and second seasons, respectively.

Irrigation water applied for different treatments during both years is given in Table 3. Compare with short duration variety (V_1) irrigation water applied was about 7-10% less than that in moderate duration variety (V_2 and V_3) under the same depth and period. While, the irrigation treatment P_2, water applied was less 35-40% compare with P_1 under the same depth and variety.

Compared to the highest irrigation of the traditional depth (D_3), the D_2 water management regime reduced water use by 17-18 % in the two seasons, while for D_1 water use was reduced by 29.0- 33.5 % in the two seasons. This result is in line with the results obtained by Mostafazadeh-Fard *et al*., (2010) who reported that decreasing the depth of ponded water on the soil surface in irrigated rice reduced the water use by about 23 %. The use of modern irrigation techniques can also lead to water savings of more than 50 % (Saleth and Dinar, 2008).

For water duty, irrigation with D_2 in the first period P_1 recoded that about 1cm depth above soil surface all the season and gave the highest grain yield values. Decreasing the water duty with 18-20 % for D_1 under same period decreased rice grain yield by 15-18%. On the other hand, increasing water duty to 16-18% for D_3 (as traditional) decrease grain yield with about 7% as compared to D_2 irrigation depth (Table 3 and 4).

Table 3. Seasonal water applied (m^3/fed.), water duty (m^3/fed./day) and water productivity (kg/m^3) of rice in the two growing seasons.

Irr.* Period	Irr.** Depth	Var.***	Water applied, season m^3/ fed.		cm		Grow. Seas. day		Water duty, day m^3/ fed.	
			1st Season	2nd Season	1st eason	2nd Season	1st Season	2nd Season	1nd Season	2st Season
6 days (P_1)	D_1	V_1	4140.0	3990	98.6	95.0	122.0	120.0	33.93	33.25
		V_2	4460.0	4350	106.2	103.6	133.0	129.0	33.53	33.72
		V_3	4620.0	4570	110.0	108.8	133.0	129.0	34.74	35.43
	Mean D_1		4406.0	4303.0	104.9	102.5	129.3	126.0	34.07	34.13
	D_2	V_1	5180.0	5100.0	123. 3	121.4	122	120	42.46	43.16
		V_2	5360.0	5400.0	127.6	128.6	133	129	40.30	41.55
		V_3	5570.0	5600.0	132.6	133.3	133	129	41.88	43.41
	Mean D_2		5370.0	5366.6	127.8	127.7	129.3	126.0	41.54	42.71
	D_3	V_1	6310.0	6220.0	150.2	148.1	122	120	51.72	51.83
		V_2	6590.0	6495.0	156.9	154.6	133	129	49.55	50.35
		V_3	6780.0	6685.0	161.4	159.2	133	129	50.98	51.82
	Mean D_3		6560.0	6466.7	156.2	154.0	129.3	126.0	50.75	51.33
Mean P_1			5445.6	5378.8	128.8	128.1	129.3	126.0	42.12	42.72
12 days (P_2)	D_1	V_1	2775.0	2690.0	66.07	64.05	122	120	22.75	22.42
		V_2	2810.0	2740.0	66.90	65.24	133	129	21.13	21.24
		V_3	3100.0	3020.0	73.81	71.90	133	129	23.30	23.41
	Mean D_1		2895.0	2816.6	68.93	67.06	129.3	126.0	22.39	22.36
	D_2	V_1	3180.0	3010.0	75.71	71.67	122	120	26.07	25.08
		V_2	3440.0	3510.0	81.90	83.57	133	129	25.86	27.21
		V_3	3540.0	3595.0	84.29	85.59	133	129	26.61	27.87
	Mean D_2		3386.3	3371.7	80.63	80.28	129.3	126.0	26.18	26.72
	D_3	V_1	3795.0	3725.0	90.36	88.69	122	120	31.11	31.04
		V_2	3965.0	3895.0	94.40	92.74	133	129	29.82	30.19
		V_3	4250.0	4165.0	101.19	99.16	133	129	31.95	32.28
	Mean D_3		4228.3	3928.3	95.32	93.53	129.3	126.0	30.96	31.17
Mean P_2			3503.2	3372.1	81.63	80.29	129.3	126.0	26.51	26.57

***irrigation period , ** irrigation depth and *** varieties**

D_1: Irrigation till 3 cm depth of I.W., D_2: Irrigation till 5 cm depth of I.W. and D_3: Irrigation till 7 cm depth of I.W.

V_1: Variety (Giza 177), V_2: Variety (Sakha 101) and V_3: Variety (Orabi 1)

2. Effect of irrigation period, depth and varieties on Yield and crop water productivity

Grain yield Kg/ fed.:

The effect of irrigation treatments on grain yield was significant in both years (Table 4). In the irrigation treatment P_2, grain yield was less 28-31% than that in P_1 in the two seasons under the same depth and variety. In addition, irrigation till 3 cm depth (D_1) grain yield was less by 15-18 and 9-12 % than that in D_2 and D_3, respectively under the same period P_1. On the other hand the same trend was found in the second period P_2.

Grain yield values was highly significantly affected by D_2 under the same period and variety, the highest values 4866.7 and 4740.0 kg/ fed., was recorded under $P_1D_2V_3$in the first and second seasons respectively. Grain yield were decreased under the same period and over different depth, In this sense, Darwesh (2011) in the same area stated that the irrigation at 75% of traditional (3 inches) recorded the highest rice yield.

Comparatively yield reduction values of V_3 recorded the highest grain yield with significantly values under the same period and irrigation depth as compared with V_1 and V_2.

The interaction between irrigation period, submerged depth treatments and varieties caused significant effect; plants watered by $P_1D_2V_3$ gave the highest values for grain yield, but the lowest values were recorded under $P_2D_1V_1$ and other in between.

Table 4. Effect of irrigation period, depth and varieties on grain yield, 1000 grain weight and productivity of irrigation water

Irrigation period	Irrigation depth	Varieties	Grain yield, kg fed^{-1}		1000 grain weight, g		Productivity of irrigation water kg m^{-3}	
			1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
6 days (P_1)	D_1	V_1	3193.3	3163.3	25.03	24.70	0.77	0.79
		V_2	3566.7	3860.0	24.80	26.83	0.80	0.89
		V_3	3680.0	4133.3	24.80	26.70	0.80	0.90
	Mean D_1		3480.0	3718.9	24.88	26.08	0.79	0.86
	D_2	V_1	3266.7	3803.3	28.12	26.53	0.63	0.75
		V_2	4606.7	4640.0	27.83	27.30	0.86	0.86
		V_3	4866.7	4740.0	27.46	28.00	0.87	0.85
	Mean D_2		4246.7	4394.3	27.80	27.28	0.79	0.82
	D_3	V_1	3560.0	3871.3	27.86	26.26	0.56	0.62
		V_2	3993.3	4100.0	27.10	27.46	0.61	0.63
		V_3	4330.0	4340.0	27.20	27.53	0.64	0.65
	Mean D_3		3961.1	4103.8	27.39	27.08	0.60	0.63
	Mean P_1		3895.9	4072.3	26.69	26.81	0.73	0.77
12 days (P_2)	D_1	V_1	2386.7	2433.3	20.36	19.40	0.95	0.90
		V_2	2580.0	2633.3	20.96	20.73	0.92	0.96
		V_3	2806.7	2913.0	17.66	19.43	0.91	0.96
	Mean D_1		2591.1	2659.9	19.66	19.85	0.93	0.94
	D_2	V_1	2613.3	2653.3	21.23	20.10	0.82	0.88
		V_2	2930.0	2883.3	22.86	22.83	0.85	0.82
		V_3	3140.0	3063.3	21.36	20.60	0.89	0.85
	Mean D_2		2894.4	2866.6	21.82	21.18	0.85	0.85
	D_3	V_1	2650.0	2700.0	21.13	21.30	0.70	0.72
		V_2	2896.7	2830.0	22.60	20.63	0.68	0.68
		V_3	3105.0	3045.0	21.00	19.66	0.73	0.73
	Mean D_1		2883.9	2858.3	19.13	20.19	0.70	0.71
	Mean P_2		2789.8	2794.9	21.02	20.41	0.83	0.83
	LSD $_{0.05}$		6.839	7.640	10.282	11.106	0.0521	0.0435
F test		P	**	***	*	*	*	**
		D	**	***	NS	NS	**	**
		V	***	***	NS	NS	**	*
		P*D	*	***	NS	NS	*	**
		P*V	*	**	NS	NS	**	**
		D*V	*	NS	NS	NS	**	**
		P*D*V	NS	*	NS	NS	*	*

D_1: Irrigation till 3 cm depth of I.W., D_2: Irrigation till 5 cm depth of I.W. and D_3: Irrigation till 7 cm depth of I.W.
V_1: Variety (Giza 177), V_2: Variety (Sakha 101) and V_3: Variety (Orabi 1)
***, **, *** and NS: significant at $p \le 0.05, 0.01, 0.001$or not significant, respectively. Means separated at $P \le 0.05$, LSD test.**

1000 grain weight, g:

1000 grain weight is significantly influenced by irrigation period treatments (Table 4). The highest and the lowest 1000 grain weight, g., was obtained, with treatment P_1 (26.69 and 26.81 g.) and P_2 (21.02 and 20.41g.) for first and second seasons, respectively.

Regarding the effect of irrigation depth on 1000 grain weight, data presented in Table (5) reveal that treatment (D_2) under irrigation every 6 days gave the highest weight of 1000 grain in both seasons of 2013 and 2014, respectively (27.80 and 27.28 g). These results are in harmony with the finding of Moursi (2002) and Darwesh (2011).

So, it could be stated that 1000 grain weight is might be affected by; irrigation depth, period and variety. Under this study in both seasons data of Table (5) indicated that no interaction effect on 1000 grains weight due to irrigation depth x variety, irrigation period x irrigation depth interaction, irrigation period x variety and irrigation depth- variety x irrigation period.

Productivity of irrigation water kg m^{-3}:

The water productivity associated with the different period and depth of irrigation regimes are presented in Table (4).

The water productivity was seen to be (12 and 7%) higher with 12 days interval (P_2) under different water applications compared with 6 days interval (P_1). Indeed, water productivity means the amount of rice produced per unit of several greater water applied with long interval, the increasing in water productivity of P_2 was resulted from decreasing water input rather than increasing yield. With depths D_1 (3cm) having the highest average water productivity (0.86 and 0.94 kg.m^{-3}), followed by D_2 (0.82 and 0.85 kg.m^{-3}), all better than D_3 (0.63 and 0.75 kg.m^{-3}) in the first and second season respectively. Regarding this trait of water productivity, Tuong and Bouman (2003) stated that crop water productivity (CWP) of rice ranges between 0.6 and 1.6 kgm^{-3} for lowland rice conditions.

So, under this study in both seasons it could be noticed that productivity of irrigation water is might be affected by; irrigation period, depth and variety. Data in the same Table (5) illustrated that; irrigation depth-variety interactions, irrigation depth – period interaction, irrigation period- variety interaction and irrigation period – variety - irrigation depth significantly affect productivity of irrigation water.

Also, a positive linear relationship was determined between irrigation water applied and total grain yield and 1000 grain weight. In productivity of irrigation water by rice plant was reduced linearly as irrigation water increased (Fig,1).

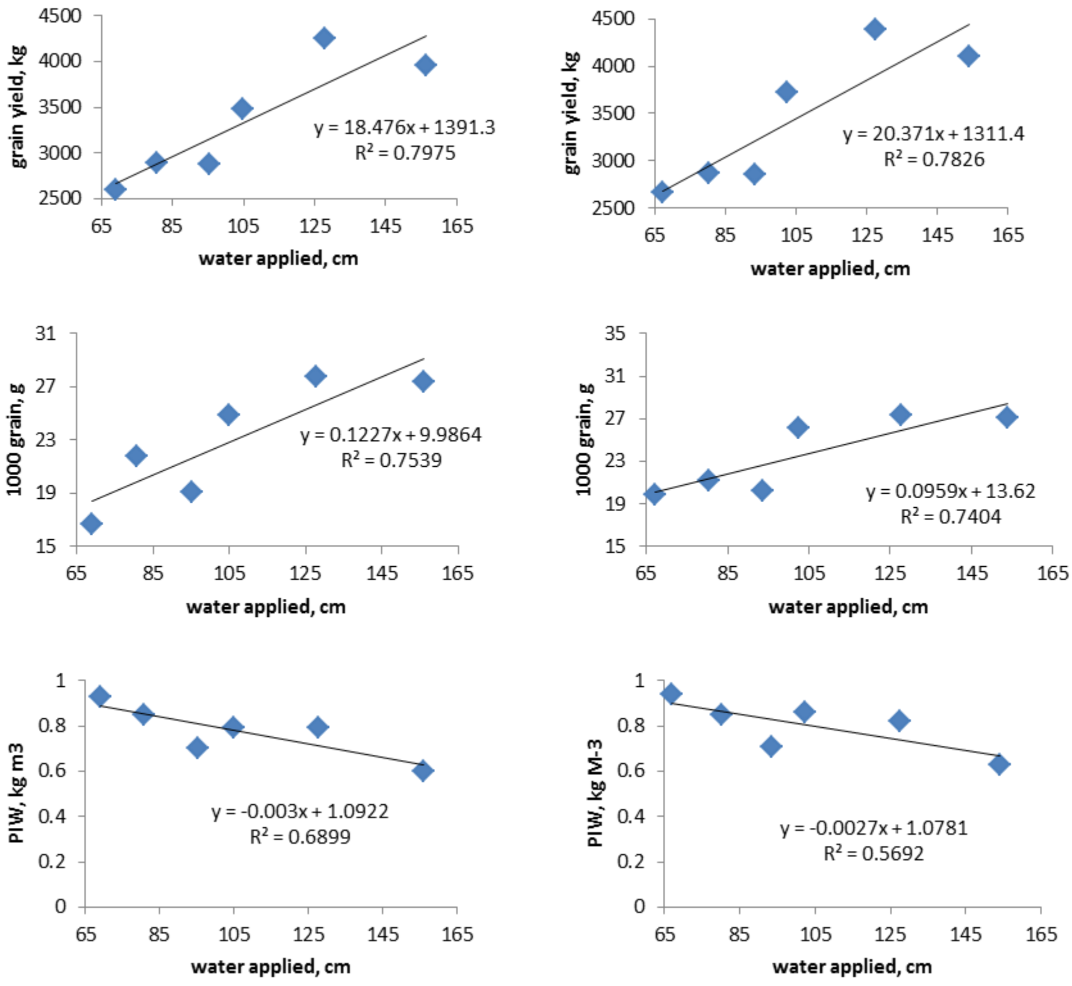

Fig.1. Correlation between irrigation water applied, cm and grain yield, 1000grain weight and productivity of irrigation water in the two growing seasons.

3. Effect of irrigation period, depth and rice varieties on yield components

Biological yield (Kg fed^{-1}):

There were clear and significant differences in this characteristic as seen in Table 5. The averages of highest biological yield were (8498.9 and 8726.0 kg fed^{-1}) with 6 days interval, while the lowest was (6602.7 and 6662.7 kg fed^{-1}) with 12 day interval in the first and second seasons, respectively. This result may be attributed to the better growth condition with more nutrients caused high grain weight and tillers number above ground biomass. Similar result was reported by Azarpour et al.,(2011) they mentioned that the highest biological yield was obtained by more interval irrigation.

In addition for depths, irrigation till 5cm (D_2) showed the highest values in the two seasons under the same period over different verities. The varieties showed their own differences in this characteristic, Orabi 1 variety (V_2) recorded the average highest biological yield. This was probably caused by genetic factor rather than cultural practices.

The interaction between the irrigation period, submerged depth and varieties as shown in the table, also affected biological yield significantly except the triple overlap which showed no significant effect.

Table 5. Effect of irrigation period, depth and varieties on biological, straw yield and grain /straw ratio of rice in the two growing seasons.

Irrigation Period	Irrigation depth	Varieties	Biological yield		Straw yield		Grain / straw ratio	
			1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
6 days (P_1)	D_1	V_1	7680.0	7565.0	4486.7	4401.6	0.71	0.72
		V_2	8070.0	8250.0	4490.0	4390.0	0.79	0.88
		V_3	8240.0	8856.7	4560.0	4723.3	0.85	0.89
	Mean D_1		7996.7	8223.9	4512.3	4505.0	0.78	0.83
	D_2	V_1	8090.0	8490.0	4823.3	4716.7	0.67	0.81
		V_2	9513.3	9463.3	4906.7	4823.3	0.94	0.96
		V_3	9273.3	9200.0	4403.3	4460.0	1.11	1.06
	Mean D_2		8958.9	9051.1	4711.1	4666.7	0.91	0.94
	D_3	V_1	7783.0	8376.3	4363.3	4505.0	0.82	0.85
		V_2	8576.6	9033.3	4916.7	4933.3	0.81	0.83
		V_3	9263.3	9300.0	4933.3	4960.0	0.88	0.87
	Mean D_3		8541.0	8903.2	4737.8	4799.3	0.84	0.85
	Mean P_1		8498.9	8726.0	4653.7	4657.0	0.84	0.87
12 days (P_2)	D_1	V_1	6233.3	6323.3	3846.6	3623.3	0.62	0.74
		V_2	6356.7	6396.7	3776.7	3763.3	0.68	0.70
		V_3	6553.3	6653.3	3746.7	3740.0	0.76	0.79
	Mean D_1		6381.1	6457.8	3790.0	3708.3	0.67	0.74
	D_2	V_1	6420.0	6386.7	3806.7	3733.3	0.69	0.71
		V_2	6903.3	6956.7	3970.0	4073.3	0.74	0.71
		V_3	6973.3	7176.7	3833.3	3786.7	0.82	0.81
	Mean D_2		6765.3	6840.0	3870.0	3864.3	0.75	0.74
	D_3	V_1	6098.3	6283.3	3448.3	3850.0	0.64	0.63
		V_2	6976.7	6820.0	4080.0	3990.0	0.71	0.71
		V_3	6910.0	6968.3	3805.0	3923.3	0.82	0.77
	Mean D_3		6661.7	6690.3	3777.6	3921.1	0.72	0.70`
	Mean P_2		6602.7	6662.7	3812.5	3831.3	0.71	0.73
	$LSD_{0.05}$		7.833	7.840	7.839	7.383	0.049	0.057
F test		P	**	**	**	**	NS	**
		D	**	**	NS	NS	NS	NS
		V	***	***	NS	NS	**	**
		P*D	*	*	NS	NS	NS	NS
		P*V	*	*	NS	NS	NS	NS
		D*V	*	*	NS	NS	NS	NS
		P*D*V	NS	NS	NS	NS	NS	NS

D_1: Irrigation till 3 cm depth of I.W., D_2: Irrigation till 5 cm depth of I.W. and D_3: Irrigation till 7 cm depth of I.W.
V_1: Variety (Giza 177), V_2: Variety (Sakha 101) and V_3: Variety (Orabi 1)
***, **, *** and NS: significant at $p \leq 0.05$, 0.01, 0.001or not significant, respectively. Means separated at $P \leq 0.05$, LSD test.**

Straw yield Kg fed^{-1}:

Data tabulated in Table (5) showed that the water period has a significant effect on straw yield of rice crop during the two seasons. Results indicated that P_1 under all depths and varieties gave the greatest yield in the two seasons; the values are 3895.9 and 4072.3 kg fed^{-1}, in the first and second seasons respectively.

Regarding irrigation depth has effect on straw yield; D_3 gave the highest straw yield 4737.8 and 4799.3 kg fed^{-1}, under irrigation with 12 day interval P_1, comparing with the other two treatments but irrigation with D_2 gave 99% and 97% from D_3 in the first and second seasons, respectively. On the other hand, the same trend in the second period P_2. This result is supported by Moursi (2002) and Nader-Pirmoradian et al. (2004) they stated that rice straw was increased with increasing irrigation water.

So, it could be noticed that straw yield is might be affected with; irrigation period, depth and variety. Data in the same Table illustrated that irrigation depth-variety interaction, irrigation depth – period interaction, irrigation period- variety interaction and irrigation period – variety - irrigation depth did not reach significance effect on rice straw yield under this study in both seasons.

Grain / straw ratio:

Regarding irrigation period in the first season, (Table 5) shows the highest values of rice grain straw ratio (0.84) is obtained under P_1, and the corresponding value is 0.87 in the second season.

In addition, irrigation depth was significantly affected this trait, in first season values are obtained under D_2 and the lowest values are assigned under D_1 under the two periods and the three varieties. This result was confirmed with that of Moursi (2002)

Concerning variety the highest values were recorded under V_3 and the lowest values are assigned for V_1 under overall irrigation periods and depth. These findings are in a great agreement with those obtained by Darwesh (2011).

So, it could be advised that grain /straw ratio is might be affected by; irrigation period, depth and variety, with no effect on the interaction among the studied treatments.

Biological, straw yield and grain straw ratio is positive linear relationship correlated with irrigation water applied as it is shown in Fig 2. These equations show that, the relationship between applied irrigation water and yield components adjectives more reliable in the two seasons.

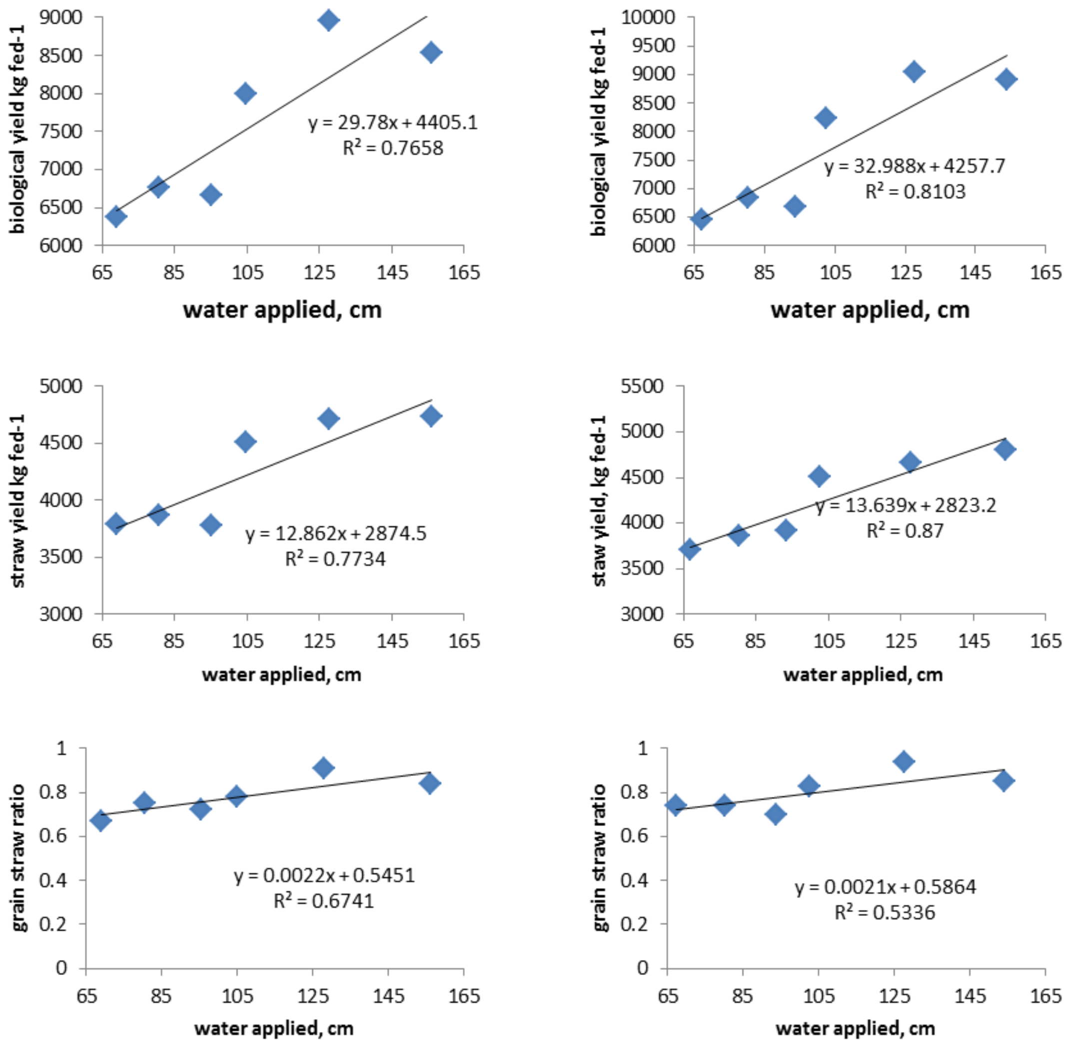

Fig.2. Correlation between irrigation water applied, cm and biological yield, straw yield and grain straw ratio in the two growing seasons.

Total number of filled grain panicle^{-1}:

Investigation on total number of filled grain panicle^{-1} revealed that there was significant effect of irrigation period (Table 6). Irrigation with 6 days interval (P_1) produces the highest total number of filled grains panicle^{-1} (103.13 and 103.35) and the lowest total number of filled grains panicle^{-1} (90.85 and 85.84) was recorded from (P_2) in the first and second seasons respectively under any irrigation depth and variety. This might be attributed to better root development in short period (P_1) of sprouted seed which produced healthy panicles with higher number of filled grains.

Table 6. Effect of irrigation period, depth and varieties on total number of filled, unfilled grain panicle^{-1} and sterility %.

Irrigation period	Irrigation depth	Varieties	Total number of filled grains panicle^{-1}		Total number of unfilled grains panicle^{-1}		Percentage of sterility%	
			1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
6 days (P_1)	D_1	V_1	96.66	109.8	3.66	4.66	3.40	4.06
		V_2	96.43	100.43	5.83	6.50	5.52	6.22
		V_3	107.33	97.00	6.33	7.66	5.57	6.81
	Mean D_1		100.14	102.41	5.27	6.27	4.83	5.70
	D_1	V_1	104.76	111.8	4.56	6.03	4.57	5.09
		V_2	99.33	97.9	4.33	5.83	4.22	5.40
		V_3	106.57	105.33	2.00	3.50	1.83	3.48
	Mean D_2		103.55	105.01	3.63	5.12	3.54	4.66
	D_3	V_1	98.73	91.53	3.46	4.67	3.38	4.89
		V_2	105.46	99.00	4.56	6.07	4.17	6.11
		V_3	112.90	117.33	5.50	7.00	4.47	5.57
	Mean D_3		105.70	102.62	4.51	5.91	4.01	5.52
	Mean P_1		103.13	103.35	4.47	5.77	4.13	5.29
12 days (P_2)	D_1	V_1	94.56	84.63	17.90	19.83	15.93	19.04
		V_2	95.00	80.23	19.50	21.00	17.08	20.80
		V_3	93.33	86.33	20.33	22.17	17.82	20.47
	Mean D_1		94.30	83.73	19.23	21.0	16.94	20.10
	D_2	V_1	87.33	89.23	15.33	17.83	14.89	16.66
		V_2	91.00	88.56	16.33	18.00	15.22	16.91
		V_3	80.90	80.00	13.83	15.83	14.62	16.68
	Mean D_2		86.41	85.93	15.16	17.22	14.91	16.75
	D_3	V_1	89.56	82.00	13.63	15.60	13.23	16.00
		V_2	96.00	88.56	18.23	19.67	15.74	18.08
		V_3	90.33	93.00	14.33	15.5	13.68	14.27
	Mean D_3		91.85	87.85	15.40	16.92	14.22	16.12
	Mean P_2		90.85	85.84	16.60	18.38	15.36	17.66
	$LSD_{0.05}$		15.183	17.496	4.273	10.282	3.444	3.178
F test		P	*	**	*	**	**	***
		D	NS	NS	NS	NS	*	*
		V	NS	NS	NS	NS	NS	NS
		P*D	NS	NS	NS	NS	NS	NS
		P*V	NS	NS	NS	NS	NS	NS
		D*V	NS	NS	NS	NS	NS	NS
		P*D*V	NS	NS	NS	NS	NS	NS

D_1: Irrigation till 3 cm depth of I.W., D_2: Irrigation till 5 cm depth of I.W. and D_3: Irrigation till 7 cm depth of I.W.
V_1: Variety (Giza 177), V_2: Variety (Sakha 101) and V_3: Variety (Orabi 1)
***, **, *** and NS: significant at $p \leq 0.05$, 0.01, 0.001or not significant, respectively. Means separated at $P \leq 0.05$, LSD test.**

On the other hand, total number of filled grain panicle^{-1} revealed that there were insignificant difference between all irrigation depths and varieties in the two seasons. Data in the same Table also showed that, all interactions have no significant effect on total number of filled grain panicle^{-1} in the two seasons.

Total number of unfilled grain panicle^{-1}:

Total number of unfilled grain panicle^{-1} takes the opposite direction to number of filled grain; there was significant effect with irrigation period (Table 6). Irrigation with 12 days interval (P_2) produces the highest total number of unfilled grains panicle^{-1} (16.60 and 18.38) and the lowest total number of unfilled grains panicle^{-1} (4.47 and 5.77) was recorded from (P_1) in the first and second seasons respectively under any irrigation depth and variety.

Regarding the effect of irrigation depths and varieties in the two seasons on number of unfilled grain panicle^{-1}, data showed that there were no significant differences. Data in the same table also showed that, all interactions between treatments had no significant effect on total number of unfilled grains panicle^{-1} in the two seasons.

Percentage of sterility %:

Data in Table 7 indicate that the sterility ratio significantly affected by irrigation period. Average of highest sterility ratio (15.36 and 17.66%) was obtained with 12 days interval, while the lowest sterility ratio (4.13 and 5.29%) was obtained with 6 days interval.

This result may be attributed to the nutrients availability for plants due to microorganism's activities in soil and also greater heading of leaves in 6 day interval irrigation than other irrigation treatments. Similar results was reported by Azarpour et al.(2011), they found higher sterility ratio when irrigation interval exceeded 5 days.

In addition, irrigation depths showed a significant effect in the two seasons, the highest values (16.94 and 20.10 %) were recorded under D_1 in the second period interval (P_2). These results were confirmed by Moursi (2002) and Darwesh (2011).

Data in the same Table also showed that, all interactions have no significant effect among in the two seasons.

Total number of filled, unfilled grain and sterility % showed positive correlation with irrigation water applied. The correlation coefficient values were 0.7104 and 0.7162 for filled grain and 0.7379 and 0.734 for unfilled grain and 0.7492 and 0.7293 for sterility in the first and second seasons, respectively.

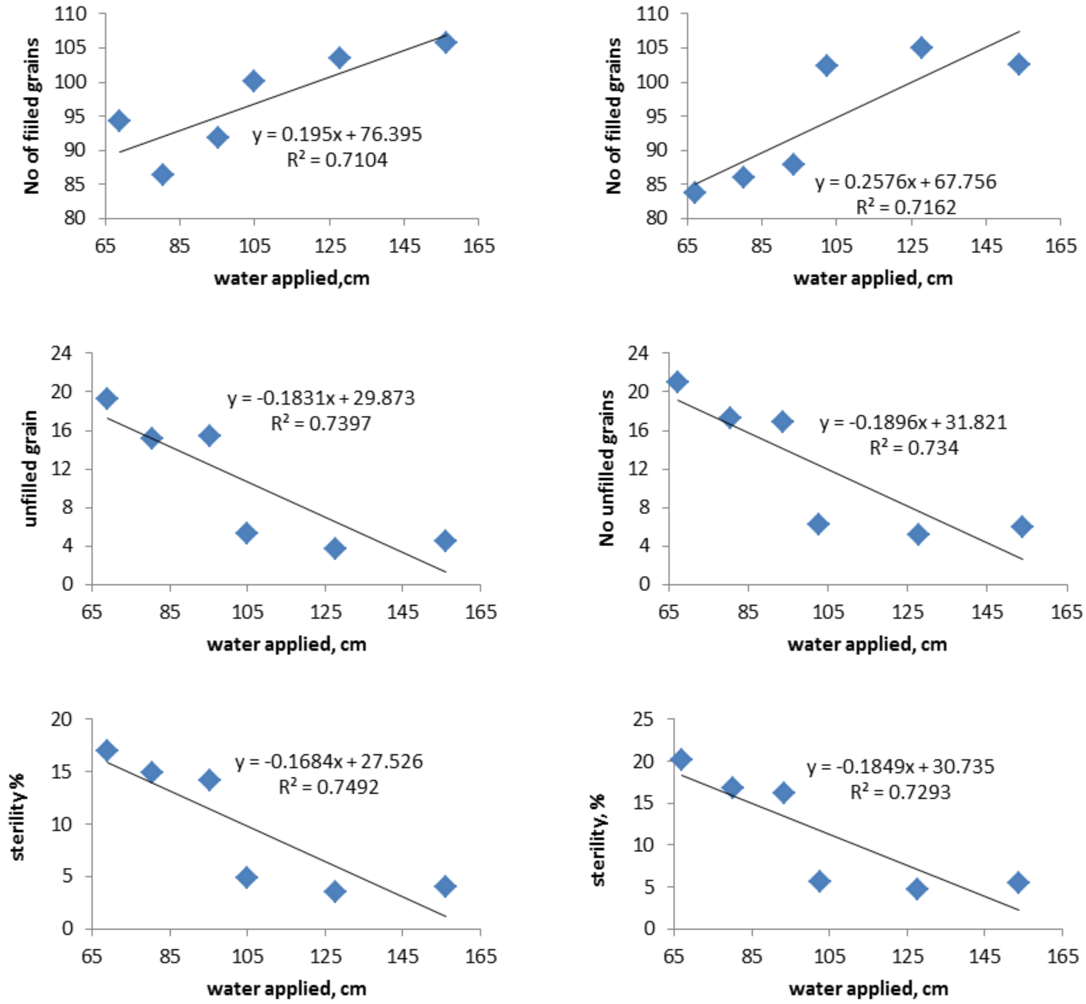

Fig.3. Correlation between irrigation water applied, cm and number of filled, unfilled grains and sterility in the two growing seasons.

4. Effect of irrigation period, depth and rice varieties on some growth parameters

Grain weight panicle^{-1}

Regarding the effect of irrigation period on grain weight panicle^{-1} in the first and second seasons, as shown in Table 7 the highest value of grain weight panicle^{-1} (2.77 and 2.82 g) are obtained under P_1 (irrigation every 6 days), and the lowest value (2.26 and 2.23g) is assigned for P_2 (irrigation every 12 days).

In addition, water depth has no significant effect in this trait, where grain weight panicle^{-1} were increased with increasing irrigation depth, this result was supported by Moursi (2002) and Darwesh (2011)

Concerning varieties showed insignificant effect where the highest values were exerted with V_3 in the first period (P_1) and the lowest values were also obtained at V_3 in the second period (P_2).

So, it could be noticed that grain weight panicle^{-1} is might be affected by; irrigation period, depth and variety. The interaction between irrigation period-varieties showed significant effect in the two seasons, but another interaction showed no significant effect in the two seasons.

Table 7. Effect of irrigation period, depth and varieties on grain weight panicle^{-1}, length of panicle and plant height.

Irrigation period	Irrigation depth	Varieties	Grain weight panicle^{-1} 1st Season	Grain weight panicle^{-1} 2nd Season	Length of Panicle, cm 1st Season	Length of Panicle, cm 2nd Season	Plant height, cm 1st Season	Plant height, cm 2nd Season
6 days (P_1)	D_1	V_1	2.60	2.53	18.66	20.86	82.5	80.66
		V_2	2.53	2.70	20.83	19.53	80.76	87.53
		V_3	2.53	2.76	19.36	19.83	78.80	77.33
	Mean D_1		2.55	2.66	19.62	20.07	80.67	81.84
	D_2	V_1	2.83	2.90	21.00	19.46	77.33	87.66
		V_2	2.70	2.80	20.10	20.53	82.00	73.90
		V_3	3.00	3.06	21.50	19.10	75.50	80.03
	Mean D_2		2.84	2.92	19.62	20.87	78.28	80.53
	D_3	V_1	2.93	2.73	20.56	19.86	77.23	79.43
		V_2	2.90	2.86	22.36	21.70	87.83	79.90
		V_3	2.93	3.07	22.20	23.56	80.66	86.30
	Mean D_3		2.92	2.89	21.71	21.71	81.91	81.95
	Mean P_1		2.77	2.82	20.32	20.88	80.26	81.44
12 days (P_2)	D_1	V_1	2.36	2.0	16.60	19.66	75.63	71.26
		V_2	2.36	2.3	17.53	18.80	80.85	85.00
		V_3	1.96	2.16	17.83	16.73	79.53	78.23
	Mean D_1		2.23	2.30	17.32	18.40	78.63	78.16
	D_2	V_1	2.26	2.13	19.26	16.13	74.66	83.46
		V_2	2.50	2.46	21.00	19.40	76.66	72.43
		V_3	2.03	2.10	17.83	19.16	76.00	76.56
	Mean D_2		2.26	2.23	19.36	18.23	75.77	77.48
	D_3	V_1	2.20	2.40	18.56	19.63	82.00	85.00
		V_2	2.33	2.30	20.46	20.20	82.16	82.66
		V_3	2.33	2.20	20.83	17.56	81.3	81.43
	Mean D_1		2.29	2.30	19.95	19.13	81.82	83.03
	Mean P_2		2.26	2.23	18.88	18.59	78.74	79.56
	$LSD_{0.05}$		0.361	0.411	2.227	1.898	9.441	10.844
F test		P	*	*	NS	NS	*	NS
		D	NS	NS	NS	NS	*	NS
		V	NS	NS	NS	NS	*	NS
		P*D	NS	NS	*	*	NS	NS
		P*V	*	*	**	**	NS	NS
		D*V	NS	NS	**	**	NS	*
		P*D*V	NS	NS	NS	NS	*	**

D_1: Irrigation till 3 cm depth of I.W., D_2: Irrigation till 5 cm depth of I.W. and D_3: Irrigation till 7 cm depth of I.W.
V_1: Variety (Giza 177), V_2: Variety (Sakha 101) and V_3: Variety (Orabi 1)
***, **, *** and NS: significant at $p \leq 0.05$, 0.01, 0.001or not significant, respectively. Means separated at $P \leq 0.05$, LSD test.**

Panicle length, cm:

There were clear differences but not reached the significance level in panicle length, cm as seen in table 6. The averages of highest length of panicle were (20.32 and 20.88 cm) with 6 days irrigation interval, while the lowest were (18.88 and 18.59 cm) with 12 days irrigation interval. For irrigation depth and verities as in irrigation period they found differences but they are not significant.

The interaction between the irrigation period, depth and varieties as shown in the same Table, also had significant effect on panicle length except the triple overlap showed significant effect.

Plant height, cm:

Under different water management (depth and period) treatments. Plant height varied from 75.8 to 82.0 cm, the water management regime significantly affects plant height. There was a significant interaction effect between water management regime and variety on plant height. Plant height was higher for D_2 under all varieties and period and the lowest values recorded under the lowest irrigation depth D_1, these results are in agreement with Juraimi *et al.*, (2009) they reported that reduced depth of water enhances weed emergence and significantly reduces the height of the rice plant.

Sakha 101 (V_2) recorded with significantly affect the values of plant height under all water management.

So, it could be advised that plant height cm is might be affected by; irrigation period, depth and variety, with no effect on the interaction among the studied treatments except the triple overlap showed significant effect.

Regarding growth parameters; grain weight per panicle^{-1}(g) and length of panicle (cm) in relation to irrigation water applied, but plant height (cm) showed low correlation to irrigation water applied (Fig 4).

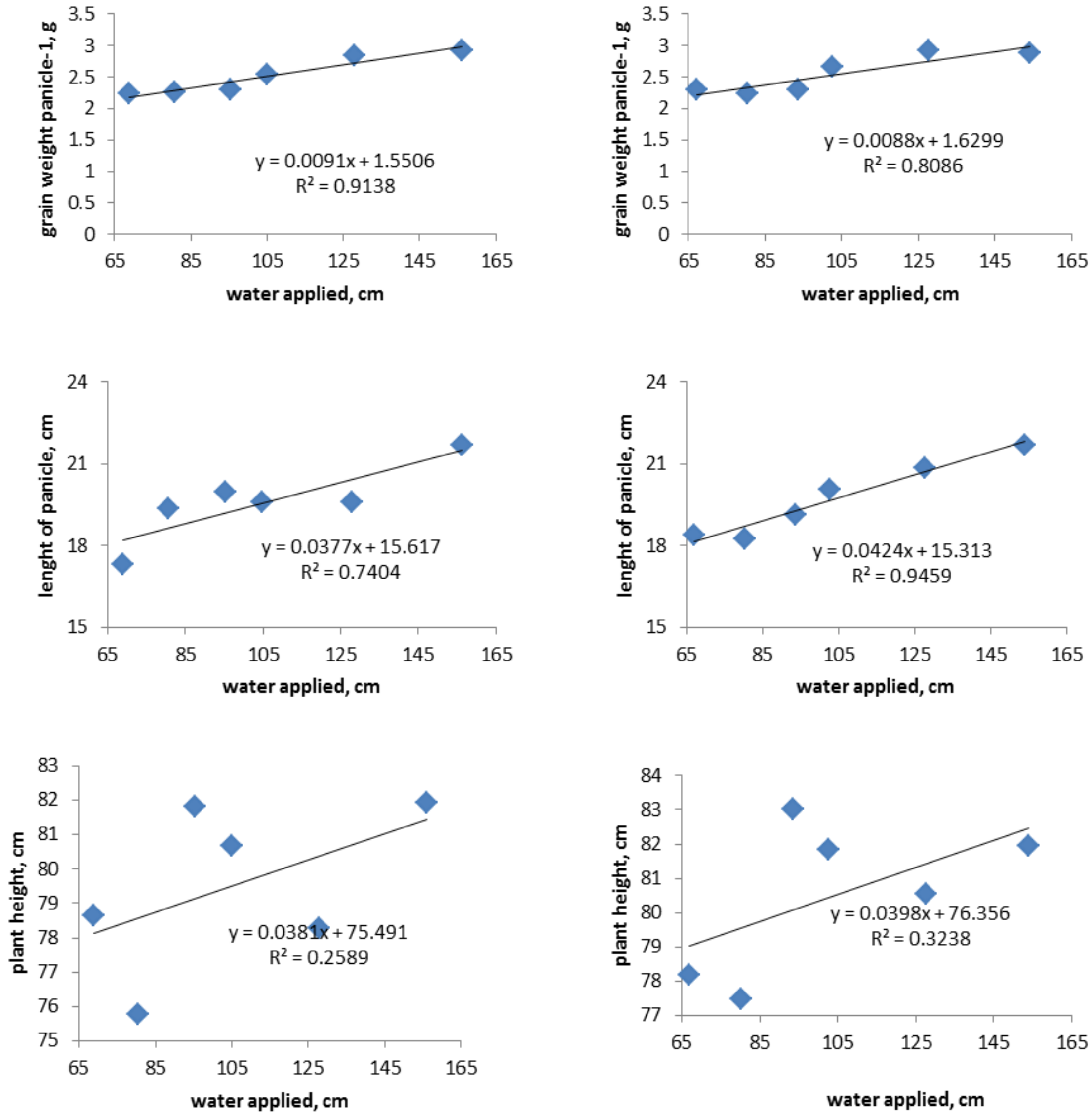

Fig.4. Correlation between irrigation water applied, cm and grain weight panicle^{-1}, panicle and plant height in the two growing seasons.

CONCLUSION

Rice production significantly depends on most of the time on the depth of irrigation water; irrigation every 6 days interval and 5cm depth gave the highest grain yield and saving water by 17% (≈ 1150 m^3 fed^{-1},) with an a verage in the two growing seasons as compared with 7cm as traditional depth under the same period. Meaningfully, an average of 1265 million m^3 could be saved at the national level (1.1 million fed.). Under the present study, irrigation each 12 days and 7 cm water depths (P_2D_1) resulted in about 40% reduction in crop yield. Therefore, it is advisable to conduct further study taking into account watering each 9 days for example. If water productivity is given priority, the grain yield per unit of applied water is much higher of water issues with 12 days interval, but it gave considerably lower grain rice production. This means that there is a great potential scope for rice production in the future. This will not only enhance food security but water security as well. It is still necessary to have more studies for better understanding of rice reaction to irrigation period and depth.

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استجابة بعض أصناف الأرز لفترات ري وأعماق غمر مختلفة في منطقة شمال دلتا النيل

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أجريت تجربة حقلية بمحطة البحوث الزراعية بسخا- محافظة كفرالشيخ خلال موسمي الدراسة 2013 , 2014بهدف دراسة تأثير فترات وأعماق الري و كذالك الأصناف المختلفة على بعض العلاقات المائية وكذلك المحصول ومكوناته لبعض أصناف محصول الأرز ، وذلك بهدف تحقيق أقصى كفاءة استعمال للمياه للمحصول تحت الدراسة في منطقة وسط شمال الدلتا .

التصميم الإحصائي للتجربة :

التجربه وزعت معاملاتها في تصميم تجريبى فى قطع منشقة مرتين كمايلي:-

أ- المعاملات الرئيسية (فترات الري):-

1- الري كل 6 أيام
2- الري كل 12 يوم

ب- المعاملات التحت رئيسية (اعماق الري):-

1- الري حتي 3 سم عمق ماء فوق سطح التربة
2- الري حتي 5 سم عمق ماء فوق سطح التربة
3- الري حتي 7 سم عمق ماء فوق سطح التربة

ج- المعاملات التحت تحت رئيسيه (الأصناف):-

1- جيزه 177
2- سخا 101
3- عرابي

وكانت المعاملات السابق ذكرها موزعه في ثلاث مكررات.

أهم النتائج المتحصل عليها يمكن تلخصيها فيما يلى:

بالنسبة لكمية مياه الري المضافة سجلت المعاملة التي تروي كل 6 أيام بعمق ري 7سم أعلي القيم وهي تمثل الري التقليدي بدون إجهاد وعلي النقيض أن معاملة الري كل 12 يوم بعمق 3سم سجلت اقل القيم وهو أعلي إجهاد مائي. وحقق التفاعل بين الري كل 6 أيام بعمق 5سم أعلي محصول بزيادة بلغت 7% في المحصول مع توفير من 16-18 % من ماء الري مقارنة بالري بدون إجهاد مائي.ارتفعت القيمة المتوسطة لإنتاجية وحدة المياه بالتفاعل بين الري كل 12 يوم بعمق ري 3سم مقارنة مع المعاملات الأخرى. وسجلت أعلى القيم المتوسطة تحت التفاعل بين P_2D_1 في حين أن اقل القيم المتوسطة تم تسجيلها تحت التفاعل بين P_1D_3 (أعلى كمية مياه المضافة).

سجل محصول الحبوب فروقا معنوية كبيرة متأثرا بعمق وفترة الري والصنف حيث سجل عمق الري 5 سم أعلي القيم في الموسمين تحت فترتي الري وكانت متوسطات القيم 4246.7 و 4394.3 كجم /فدان تحت فترة الري كل 6 أيام والقيم المقابلة تحت فترة الري 12 يوم كانت 2894.4 و 2866.6 كجم / فدان في الموسم الأول والثاني علي الترتيب. ومن ناحية أخري فان زيادة المياه المضافة حتي 7 سم (16-18 %) أدت الي نقص المحصول بمعدل 7% مقارنة بعمق الي 5 سم تحت نفس الفترة. في حين سجل الصنف عرابي 1 أعلي القيم تحت كل من فترات و أعماق الري المختلفة. بالنسبة لمكونات المحصول من وزن 1000 حبة و محصول القش والمحصول البيولوجي ونسبة القش للحبوب ونسبة العقم تأثرت بشكل كبير بفترات الري وكذالك عمق الري 3سم مقارنة بالاعماق الاخري في حين لم تسجل فروق معنوية بين عمقي الري 5 و7 سم. ايضا بالنسبة للاصناف سجل المحصول البيولوجي ونسبة القش للحبوب فروق معنوية في حين لم تسجل اي فروق معنوية للصفات الاخري. فيما يتعلق بالصفات النبات من طول النبات وطول السنبلة وجد انها تزداد بزيادة عمق مياه الري.

وعليه فتوصي الدراسة بـ ري محصول الأرز في منطقة شمال وسط دلتا النيل سواء للاصناف القصيرة أوالمتوسطة العمر كل 6 أيام كفترة ري وبعمق 5 سم ارتفاع فوق سطح الارض في كل رية. ومن ناحية اخري فان تحت ظروف ندرة المياه التي تواجه مصر حاليا وفي المستقبل وقد وجد أيضا أن الري كل 12 يوم وعلي عمق 7 سم فوق سطح الارض أدي الي خفض المحصول ال اكثر من 40 % وبالتالي فأنه ينصح باجراء دراسات علي فترة ري كل 9 يوم. كما توصي الدراسة باجراء مزيد من الدراسات الحقلية لري الأرز في المنطقة موضع الدراسة.