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Influence of Irrigation Intervals, Some Cultivars and Plant Spacing on Growth, Yield and its Components in Rice Part (2) Yield and Yield Components

[1]Okasha E.M., [1]M.A.A. Abdou, [2]A.A. El-Ganayni and [3]W.M. EL-Khoby

[1]Water Relations and Field Irrigation Dept., National Research Centre, Dokki, Egypt.
[2]Agronomy Dept., Fac. Agric., Cairo Univ., Giza, Egypt.
[3]Rice Research and Training Center, Filed Crops Research Institute, ARC, Egypt.

Abstract: A two-year experiment was carried out on rice (*Oryza sativa* L.), during 2006 (S1) and 2007 (S2), at the Rice Research and Training Center (RRTC) at Sakha, Kafr El-Sheikh Governorate, Egypt. The trail included three factors, viz. irrigation intervals (6 "I-6", 9 "I-9" and 12 "I-12" days), three rice cultivars (Sakha 101"Sk-101", Sakha 103 "Sk-103" and Sakha 104 "Sk-104") and three plant spacing (15x15 "Ps1", 15x20 "Ps2" and 15x25 "Ps3" cm). A split-split plot design was used. Experimental plot area was 15 m^2. Eight traits were studied. Water use efficiency was estimated. Simple correlation coefficients were calculated. Curve estimation was performed too. The obtained results in both seasons showed the following: Significant differences were detected in all traits as respects the studied three factors. Concerning irrigation effect, a general trend was observed in most traits, where the I-6 significantly exceeded I-9 which surpassed I-12. An opposite trend was observed with sterility% and 1000 grain weight. The highest grain yield/fed. was 4.52 in S1 and 4.17 ton in S2. Among cultivars, Sk-101 was the superior one in most cases followed by Sk-103 then Sk-104, such superior cultivar yielded 4.27 and 4.23 ton grain/fed. in S1 and S2, respectively. Sakha-104 gave the pronounced straw yield/fed., viz 9.85 ton in S1 and 9.04 ton in S2. According to spacing, the narrowest one 15x15 cm "Ps1" outyielded the other two spacings, such superior spacing treatment produced 4.49 and 4.12 ton/fed. in S1 and S2, respectively. The 1000 grain weight was the highest when planting was practised at wider spacing (15x25 cm). For first order interactions, significancy was shown with irrigation x cultivar in four traits including grain yield/fed. The combination I-6xSk-101 yielded 5.31 in S1 and 4.74 ton/fed in S2. For irrigation x spacing interaction, significant differences were obtained also in the same four traits previously mentioned, with minor deviation. The (I-6xPs1) yielded the pronounced grain yield/fed., viz 5.59 in S1 and 4.62 ton in S2. The first order interaction showed its highest significant grain yield by Sk-101xPs1 which yielded 5.28 in S1 and 4.69 ton/fed. in S2. The second order interaction showed insignificant effects with all aspects. Water use efficiency was significantly affected by the three main factors and the first order interaction irrigation x cultivar only. The pronounced treatments previously mentioned produced the highest WUE. Correlation was highly significant in all aspects. It was positive in most cases. However, the correlation of sterility% and 1000 grain weight with other traits was negative. Curve estimation illustrated that the relation between grain yield and total applied water was a quadratic one in both seasons.

Key words: Rice, irrigation intervals, cultivars, plant spacing, yield and yield components.

INTRODUCTION

In Egypt, conventional irrigation method of rice consumes greater water, putting rice in the first demand among summer crops, including sugar cane, maize and cotton. The high demand by rice lies in high water applying/fed., i.e. more than 6000 m^3 as well as the increased rice cultivated area which exceeded 2.0 million fed., in the last few years.

The total high water use by rice causes certain difficulties which negatively affect yields of summer thirsty crops. FAOSTAT,[1] stated that the Egyptian total consumption, production and export of milled rice were 3.28, 3.74 and 1.07 million ton, respectively. Egypt is completely depending on water from River Nile (55.5 Milliard m^3, yearly). Rice alone consumes about 25% of such water. No doubt, the Government rightly intends to reduce rice growing areas by almost 50% of its current area, as a wise step to achieve better water management.

The successful fit policy of water saving depends on some factors including lengthening irrigation

Corresponding Author: Dr. El-Sayed Moustafa Okasha, Water Relations and Field Irrigation Dept., National Research Centre, Dokki, Egypt.
E-mail: okasha_662000@yahoo.com

interval, use of early rice cultivars and good weed control. Several researchers showed that rice can normally grow with high yield under shallow water depth than under deep one. In this respect, Mosalem *et al*,[2] Abou Khalifa,[3] and El-Sharkawy *et al*,[4] reported that continuous flooding irrigation every three days resulted in highest grain yield without significant difference with irrigation every 6 days. Egyptian rice cultivars produced higher yield when water control of soil is kept near saturation throughout the growing season [5].

Irrigation interval was prolonged in the assay of Abou Khalifa *et al*,[6] to 4-7 days. They concluded that such interval surpassed the others in the term of grain yield production. The interval of 6-days gave reasonable production of rice grain and most of its components, as mentioned by Ibrahim *et al*,[7,8] Mosalem *et al*,[2] El-Kalla *et al*,[9] as well as El-Bably *et al*,[10]. On the other hand, lengthening irrigation interval over 6 days considerably reduced grain yield and most of yield components. Prolonging irrigation interval causes a degree of water stress, which is considered, in studies of Vivekanandan *et al*,[11] and Sarvestani *et al*,[12], as negative effects on grain yield. Water stress begins through 8-12 days. However, some investigators estimated water stress after 8 days, El-Refaee *et al*,[13] 9 and 12 days, Mosalem *et al*,[2] and 10 days[6]. In addition, Nour *et al*,[14] considered 12-day interval as the successful procedure to save water without remarkable reduction in grain yield.

The cultivars are the pass word of pronounced crop production, expressing different phenotypes. Such differences characterize the cultivar to be more suitable for certain purpose than other one. Several rice cultivars, with different ideal types spread all over the world. Thereafter, it could be expected that the rice varietal variation was detected in many studies such as [3,9,10,15/19]. Generally, such variation is attributed to the different genetic structure, however the hybrids vary than inbreds [13,20,21]. Some authors attributed varietals variation to crop duration[22]. In contrast, varietals variation was absent in the assay of Kadum *et al*,[23] and Sarvestani *et al*,[12]. Some studies confirmed the superiority of Sk-101 over Giza 177, Abou El-Hassan *et al*,[19]and Sk-104[24]. In addition, Abd El-Maksoud,[25] pointed out that Sk-103 out yielded Sk-104 in respect of yield and most yield components. Oppositely, Sk-104 exceeded Sk-103 in its yield, El-Refaee *et al,*[26] as well as [27].

Plant spacing had a significant role on irrigation regime. Wider spacing increases the evaporation from the soil surface and consequently increases evapotranspiration. It may also enhance the growth of accompanied weeds which consume water as or higher than rice itself. Varying reports on the effect of spacing show its dependence on some factors including cultivar (tillering ability) and soil fertility. The wider spacing, (20x20 cm) and more were recommendable in many studies, of them Gupta and Sharma,[28], Mishra *et al*,[21], Intikhab *et al*,[29] as well as[30]. Oppositely, many investigators believed in the value of narrower spacing (15x15 cm) and less. The list of such believers includes[15,18,22,28,31,32,33].

The interaction between irrigation and varieties is a good establishment as was observed in the studies of [11,23,34]. In Egypt, Abou El-Hassan *et al*,[19] found insignificant interaction between irrigation and cultivars. Oppositely, El-Refaee *et al*,[26] found positive interaction between 3-day interval and both Sk-101 and Sk-104. Abou El-Hassan *et al*,[19] found similar interaction between 6 days interval and Sk-101 cv. He added that such effect saved 8.6% of irrigation water. El-Kalla *et al*,[9] pointed out that Sk-104 cultivar was more tolerant to prolonging irrigation interval.

As regards the interaction between cultivar and spacing, Lourduraj,[35] reported that the yield of low tillering cultivar declined as plant spacing increased from (15x15 to 25x25 cm) and in reverse. He added that medium duration cultivars achieve maximum yield by (20x10 cm) spacing. With this point, Nayak and Patra,[22] found that a cultivar with 100 days duration requires (10x10 cm) spacing, while a cultivar with 135 days duration needs a spacing of (15x10 cm). Khawshi *et al*,[15] concluded similar trends. Also, Badawi and Ghanem,[5] reported that plant spacing depended upon the variety and its tillering ability. However a variety with low ability can grow in narrow spacing and inverse. In addition, Guatam *et al*,[20] and Mishra *et al,*[21] reported that a certain variety needs certain spacing.

The current study aims to investigate the effect of irrigation intervals, spacing of transplanting on the yield and some yield components of three newly rice cultivars. The final target was to develop a combination among the three factors giving good features and high rice yield.

MATERIALS AND METHODS

A two-year experiment was running in Rice Research and Training Center (RRTC) Sakha, Kafr El-Sheikh Governorate, Egypt in 2006 (S1) and 2007 (S2). The study involved three rice cultivars, three irrigation intervals and three plant spacing.

In both seasons, samples for soil analyses were taken from the layer 0.0-30.0 cm depth. Such samples were tested in the laboratory, according to Black,[36]. The chemical and physical properties of the soil are presented in (Table, 1).

Treatments: Three irrigation intervals, three cultivars and three plant spacing were tested as follows:

A-Irrigation intervals:	B- Cultivars:	C-Plant spacing:
1-irrigation every 6 days, I-6.	1- Sakha 101, Sk-101.	1- (15x15 cm), Ps1.
2-irrigation every 9 days, I-9.	2- Sakha 103, Sk-103.	2- (15x20 cm), Ps2.
3-irrigation every 12 days, I-12.	3- Sakha 104, Sk-104.	3- (15x25 cm), Ps3.

Table 1: Some chemical and physical properties of soil, average over the two seasons.

Chemical analysis				Physical analysis	
pH	8.1	Available K (ppm)	412.50	Sand %	12.95
EC ds/m	2.0	Available Zn (ppm)	0.85	Silt %	32.90
Organic matter%	1.9	Available Fe (ppm)	2.45	Clay %	54.15
Available N (ppm).	17.0	Available Mn (ppm)	3.35	Soil Texture	Clay
Available P (ppm).	16.5				

Agricultural Practices: In both seasons, preceded crop was Egyptian clover. Seedbed of the nursery, area of 350 m^2 for 1 fed. (1 fed. = 4200.78 m^2) was well prepared and fertilized with calcium super phosphate (15.5% P_2O_5) at 100 kg/fed. before ploughing. Rice commercial grains of the three cultivars were soaked in running water for 48 hr., then incubated for another 48 hr. Before seeding, 10 kg/fed. of zinc sulphate were added. Seeds were handly broadcasted in the nursery on April 20th, at 60 kg/nursery. At 7 days age, weeds were chemically controlled by Saturn 50% (Thiobencarb) at 2 litres dissolved in 100 litres of water/fed. and sprayed by a knapsack sprayer. Two weeks after sowing, a rate of 40 kg N/fed. was added at once as urea (46% N). Before transplanting, permanent field was well prepared, calcium super phosphate 15.5% P_2O_5 at rate 100 kg/fed. was added to the dry soil before ploughing. Flushing irrigation was done. Nitrogen as urea (46% N) was applied in two rates, two-thirds in dry soil before transplanting and the remainder third at panicle initiation. Transplanting of seedlings from nursery to permanent field was done 25 days after sowing. Planting was spaced at the tested spacing, as three plants/hill. After four days, weeds were controlled by Saturn 50% as previously mentioned. Irrigation was withheld 15 days before harvest. Harvest was carried out according to each cultivar duration. All remainder agricultural practices were carried out as usual.

The tested three cultivars are characterized as short grain, resistant to blight disease and 72% milling. Such cultivars differ in grain yield (more than 5.0, 4.0-4.5 and 4.0–5.0 ton/fed.) and to maturity time (135, 125 and 135 days), for Sk-101, Sk-103 and Sk-104, respectively.

Irrigation discharge was adjusted by using triangular weirs (V notch). The height of flowing water was fixed at 30 cm. Water discharge was counted according to the equation of Hansen *et al*,[37] as follows:

$Q = 0.0138 \times h^{2.5} \times 3.6$ where:

Q = Water discharge, m^3/hr.

0.0138 and 3.6 = constant values, where 3.6 was added for obtaining Q in m^3/hr.

h= Water height or pressure head (cm).

The used irrigation regime is illustrated in (Table, 2).

Experimental Design: A split-split plot design with three replicates was used. The main plots were devoted to irrigation intervals, the sub-ones were occupied by cultivars, while spacing were distributed at the sub-sub plots. Randomization was considered in all cases. Plot area was 15.0 m^2 (3x5) m.

Studied Topics:

A-plant Traits: At the end of the season, a random sample from the inner part of each experimental plot was taken. Eight traits were studied on that sample as follows:

1-No. of panicles/m^2.
2-Sterility %.
3-No. of spikelets $x10^{-3}/m^2$.
4-No. of grains/panicle.
5-1000-grain weight (g).
6-Straw yield, (ton/fed.) was calculated on the base of yield/plot then per fed..
7-Grain yield, (ton/fed.) was calculated on the base of yield/plot then per fed..
8-Harvest index %

$$= \frac{\text{Grain yield (ton/fed.)}}{\text{Grain yield (ton/fed.)} + \text{Straw yield (ton/fed.)}} \times 100,$$

(Wilcox,[38]).

B-water Relationship: Water use efficiency (W.U.E, Kg/m^3) was calculated according to Vites,[39] as follows.

$$\text{W.U.E (Kg/m}^3\text{)} = \left(\frac{\text{Grain yield, Kg/fed.}}{\text{TAW, m}^3\text{/fed.}}\right).$$

Table 2: Irrigation intervals (days), total applied water (m^3/fed.), number of irrigations and quantity of one irrigation (m^3/fed.).

Irrigation interval (days)	Total applied water (TAW) (m^3/fed.) *	Number of irrigations	Quantity of one irrigation (m^3/fed.)
I-6	5000**	16	312.5
I-9	4500**	10	450.0
I-12	4000	8	500.0

*Without flushing irrigation.
** The quantities were reduced by 312.5 and 450.0 m^3/fed. with respect to Sk-103 cv, for its short duration, i.e. 125 days.

Statistical Analysis: In both seasons, data were subjected to analysis of variance. Means were compared by Duncan's,[40] multiple range test at a 0.05 level of significance. Simple correlation coefficients were estimated among every trait and all the remainder seven ones. Coefficients of correlation were tested at a 0.01 level of significance. All statistical procedures were performed as described by Snedecor and Cochran,[41] as well as[42].

RESULTS AND DISCUSSION

I-Analysis of Variance:

A: Main Effects:

1-irrigation Effect: Table (3) gives the means off all studied traits as affected by irrigation intervals. In the two seasons, it is clear that all traits were significantly affected by irrigation treatments. A certain tendency was detected. However, the highest values were recorded on I-6 followed by I-9 then I-12 days. This means that the most abundant irrigation, i.e. 5000 m^3/fed. promoted the growth and yield of rice. While lengthening irrigation interval to 12 days gave the poorest products. It was obtained in Part 1 of the present study, Okasha *et al*,[43] that enough watering enhanced growth features such as plant height, leave area index, chlorophyll content, No. of panicles/plant and panicle length. Such positive effects were turn in No. of panicles/m^2 and produced its highest value, viz. 458.12 in S1 and 439.16 in S2. Moreover, abundant watering reduced sterility%, through enhancing pollination. Thereafter, it was shown that the lowest sterilities, viz 10.39 in S1 and 10.84 in S2 were produced by I-6. While the highest ones were recorded on I-12 treatment (14.26 and 13.90% in S1 and S2, respectively). In addition, it seemed that abundant moisture within the rice plant (self pollinated crop) during heading phase supported successful pollination and consequently reduced sterility% Abd Allah *et al*,[44] reported that sterility is greatly affected by revealing environments. It is matter of fact that abundant water promotes and secures fertilization and hence increase the No of spikletes/m^2. Pronounced values of such trait were $84.89x10^3$ in S1 and 77.71 $x10^3$ in S2. The present results did not differ from those found by El-Bably *et al*,[10]. Enough watering as a reducer of sterility and raising pollination in spikeletes completed its positive role on No. of grains/panicle. Such latter trait increased by I-6 to 193.96 in S1 and 188.67 in S2. The present findings are in good convenient with Abou Khalifa *et al*,[45]. Such progressive effects may encourage panicles formation, with higher numbers of spikelets and grains/panicle. The 1000 grain weight is negatively correlated with No. of grains/panicle. Thereafter, the former traits increase on the expanse of the latter one and in reverse. Thus, the heaviest grains were recorded when lengthening irrigation interval because of their good filling.

Such heaviest grains were formed without competition to each other. In addition, the irrigation intervals I-6, I-9 and I-12 yielded grain as 22.35, 23.87 and 25.25 g in S1 and 21.75, 23.47 and 24.65 g in S2, respectively. Mosalem *et al*,[2] as well as Abou Khalifa *et al*,[45] approached similar results. As regards straw yield/fed., it was observed that I-6, I-9 and I-12 intervals produced 9.37, 9.13 and 8.35 ton/fed. in S1 and 9.03, 8.29 and 7.51 ton/fed. in S2, respectively. This means that highest irrigation amount of 5000 m^3/fed. (I-6) gave the highest straw yield. Plant height, leaf area index, No. of panicles/plant and panicle length are makers of straw yield. Such makers were found in positive relation with increasing watering quantity as mentioned in Part (1) of the present study[43]. Consequently, no surprising herein that higher water supplies promoted straw yield/fed. The present results confirmed those reported by many authors of them [13].

Table (4) gives the obtained means of the studied traits as affected by irrigation intervals in the two seasons. In the first season, I-6 and I-12 days yielded 4.52, 3.90 and 2.48 ton/fed. and 4.17, 3.74 and 3.25 ton/fed. in S2, respectively. It seemed that short interval (I-6) secured the required water for good growth mentioned in the first part of the study [43]. Moreover such positive progressive value were turn in yield component which provided them to grain yield/fed. Abou Khalifa *et al*,[45] found similar results. In contrast, Kadum *et al*,[23] found insignificant effect due to watering on rice grain yield.

2-Cultivars Effect: Table (3,4) includes the means of the studied traits of the three cultivars in S1 and S2. It is obvious that significant responses were observed with all aspects. Mostly Sk-101 cultivar significantly

Table 3: No. of panicles/m^2, sterility %, No. of spikelets$x10^{-3}$/m^2 and No. of grains/panicle as affected by irrigation intervals, cultivars and plant spacing and their interactions in the two seasons.

Treatments	No. of panicles/m^2				Sterility %				No. of spikelets $x10^{-3}$/m^2				No. of grains/panicle			
	S1		S2		S1		S2		S1		S2		S1		S2	
I-6	458.12	a	439.16	a	10.39	c	10.84	c	84.98	a	77.71	a	193.96	a	188.67	a
I-9	401.40	b	418.25	b	12.17	b	12.46	b	70.55	b	69.90	b	174.68	b	168.64	b
I-12	335.50	c	338.91	c	14.26	a	13.90	a	52.24	c	49.80	c	146.87	c	140.18	c
Sk-101	492.24	a	488.22	a	11.60	c	11.34	c	87.22	a	79.32	a	184.17	a	177.52	a
Sk-103	329.39	c	342.48	c	12.19	b	12.12	b	57.21	c	57.02	c	172.38	b	166.05	b
Sk-104	373.40	b	365.63	b	13.03	a	13.74	a	63.34	b	61.06	b	158.97	c	153.92	c
Ps1	475.86	a	489.80	a	10.73	b	11.06	c	85.72	a	84.14	a	187.29	a	180.62	a
Ps2	383.32	b	369.30	b	12.95	a	12.42	b	65.11	b	59.59	b	169.30	b	163.97	b
Ps3	335.84	c	337.23	c	13.15	a	13.73	a	56.94	c	53.68	c	158.92	c	152.90	c
I-6xSk-101	566.11	a	537.67	a	9.82		9.92		107.02	a	93.68	a	207.88		201.97	
I-6xSk-103	378.82	e	377.17	d	10.32		10.60		70.20	d	67.34	d	194.56		188.91	
I-6xSk-104	429.44	c	402.66	c	11.03		12.01		77.72	c	72.11	c	179.43		175.12	
I-9xSk-101	496.02	b	512.06	b	11.51		11.40		88.86	b	84.26	b	187.22		180.53	
I-9xSk-103	331.92	f	359.21	e	12.09		12.18		58.28	f	60.57	f	175.23		168.86	
I-9xSk-104	376.27	e	383.48	d	12.93		13.81		64.52	e	64.86	e	161.60		156.53	
I-12xSk-101	414.58	d	414.92	c	13.47		12.72		65.79	e	60.04	f	157.41		150.06	
I-12xSk-103	277.42	h	291.06	g	14.16		13.59		43.16	h	43.16	h	147.33		140.37	
I-12xSk-104	314.49	g	310.73	f	15.14		15.40		47.78	g	46.21	g	135.87		130.11	
I-6xPs1	547.28	a	539.41	a	9.08		9.67		105.18	a	99.36	a	211.40		205.49	
I-6xPs2	440.85	c	406.70	c	10.96		10.86		79.88	c	70.37	c	191.09		186.55	
I-6xPs3	386.25	d	371.38	de	11.13		12.00		69.87	d	63.39	d	179.38		173.96	
I-9xPs1	479.52	b	513.72	b	10.64		11.11		87.33	b	89.37	b	190.39		183.68	
I-9xPs2	386.27	d	387.33	d	12.84		12.48		66.33	e	63.29	d	172.10		166.75	
I-9xPs3	338.42	e	353.70	e	13.04		13.79		58.01	f	57.02	e	161.55		155.49	
I-12xPs1	400.79	d	416.27	c	12.47		12.40		64.66	e	63.68	d	160.08		152.68	
I-12xPs2	322.84	e	313.85	f	15.04		13.92		49.11	g	45.10	f	144.70		138.61	
I-12xPs3	282.86	f	286.60	g	15.27		15.39		42.95	h	40.63	g	135.83		129.25	
Sk-101xPs1	588.03	a	599.66	a	10.14		10.12		107.96		101.43	a	200.73		193.35	
Sk-101xPs2	473.67	b	452.13	b	12.23		11.36		81.99		71.83	c	181.45		175.53	
Sk-101xPs3	415.01	d	412.86	c	12.42		12.56		71.71		64.71	d	170.33		163.68	

Table 3: Continue

Sk-103xPs1	393.49	e	420.66	c	10.66	10.81	70.82	72.91	c	187.88	180.85
Sk-103xPs2	316.97	g	317.16	e	12.86	12.13	53.78	51.64	f	169.83	164.18
Sk-103xPs3	277.71	h	289.62	f	13.06	13.42	47.04	46.52	g	159.42	153.10
Sk-104xPs1	446.06	c	449.09	b	11.40	12.25	78.40	78.07	b	173.26	167.65
Sk-104xPs2	359.32	f	338.60	d	13.75	13.76	59.54	55.29	e	156.62	152.19
Sk-104xPs3	314.81	g	309.19	e	13.96	15.21	52.08	49.81	f	147.02	141.92

Table 4: 1000-grain weight (g), straw yield (ton/fed.), grain yield (ton/fed.), harvest index, and W.U.E Kg/m^3 as affected by irrigation intervals, cultivars and plant spacing and their interactions in the two seasons.

Treatments	1000-grain weight (g)				Straw yield (ton/fed.)				Grain yield (ton/fed.)				Harvest index %				W.U.E Kg/m^3			
	S1		S2		S1		S2		S1		S2		S1		S2		S1		S2	
I-6	22.35	c	21.75	c	9.73	a	9.03	a	4.52	a	4.17	a	31.64	a	31.90	a	0.88	b	0.81	b
I-9	23.87 a	b	23.47	b	9.13	b	8.29	b	3.90	b	3.74	b	29.89	b	31.38	b	0.90	a	0.86	
I-12	25.25	a	24.65	a	8.35	c	7.51	c	2.48	c	3.25	c	22.94	c	30.52	c	0.65	c	0.86	a
Sk-101	22.44	c	22.63	b	8.30	c	7.50	c	4.27	a	4.23	a	33.39	a	36.26	a	0.93	a	0.94	a
Sk-103	23.43	b	22.77	b	9.06	b	8.29	b	3.56	b	3.70	b	27.74	b	31.07	b	0.83	b	0.87	b
Sk-104	25.61	a	24.47	a	9.85	a	9.04	a	3.07	c	3.23	c	23.36	c	26.48	c	0.67	c	0.72	c
Ps1	22.30	c	22.08	c	10.55	a	9.71	a	4.49	a	4.12	a	29.48	a	29.81	c	1.00	a	0.93	a
Ps2	23.74	b	23.26	b	9.41	b	8.57	b	3.53	b	3.73	b	26.97	c	30.34	b	0.79	b	0.84	b
Ps3	25.43	a	24.54	a	7.25	c	6.54	c	2.88	c	3.32	c	28.04	b	33.66	a	0.64	c	0.75	c
I-6xSk-101	21.05		21.13		8.90		8.18		5.31	a	4.74	a	37.25	a	36.95	a	1.01	a	0.90	c
I-6xSk-103	21.98		21.26		9.72		9.04		4.43	c	4.15	c	31.22	c	31.71	d	0.90	c	0.84	d
I-6xSk-104	24.02		22.85		10.57		9.86		3.82	d	3.62	e	26.46	f	27.06	g	0.73	e	0.69	f
I-9xSk-101	22.48		22.81		8.35		7.51		4.58	b	4.25	b	35.33	b	36.38	b	1.02	a	0.95	b
I-9xSk-103	23.48		22.95		9.12		8.30		3.83	d	3.72	d	29.47	d	31.18	e	0.94	b	0.92	c
I-9xSk-104	25.66		24.66		9.91		9.06		3.30	e	3.24	f	24.87	g	26.59	h	0.73	e	0.72	e
I-12xSk-101	23.78		23.96		7.64		6.81		2.92	f	3.70	de	27.57	e	35.44	c	0.77	d	0.97	a
I-12xSk-103	24.83		24.10		8.34		7.52		2.43	g	3.24	f	22.53	h	30.31	f	0.64	f	0.85	d
I-12xSk-104	27.14		25.90		9.07		8.21		2.10	h	2.82	g	18.73	i	25.81	i	0.55	g	0.74	e
I-6xPs1	20.92		20.62		11.32		10.59		5.59	a	4.62		33.06	a	30.43	f	1.09	a	0.90	
I-6xPs2	22.27		21.72		10.09		9.35		4.39	c	4.18		30.36	d	30.96	d	0.86	b	0.81	
I-6xPs3	23.86		22.92		7.78		7.14		3.58	e	3.72		31.51	b	34.33	a	0.70	d	0.72	
I-9xPs1	22.35		22.25		10.62		9.73		4.82	b	4.14		31.26	c	29.93	g	1.11	a	0.96	
I-9xPs2	23.79		23.44		9.47		8.59		3.79	d	3.75		28.65	f	30.45	e	0.87	b	0.86	
I-9xPs3	25.49		24.73		7.30		6.55		3.09	f	3.33		29.76	e	33.77	b	0.71	d	0.77	
I-12xPs1	23.64		23.37		9.71		8.82		3.07	f	3.60		24.10	g	29.08	i	0.81	c	0.95	

Table 4: Continue

I-12xPs2	25.16	24.62	8.66	7.78	2.41	g	3.26	21.89	i	29.60	h	0.64	e	0.86
I-12xPs3	26.95	25.98	6.67	5.94	1.97	h	2.90	22.84	h	32.87	c	0.52	f	0.76
Sk-101xPs1	21.01	21.45	9.65	8.80	5.28	a	4.69	34.84	a	34.69	c	1.15	a	1.04
Sk-101xPs2	22.35	22.60	8.61	7.77	4.15	c	4.24	32.07	c	35.26	b	0.91	c	0.94
Sk-101xPs3	23.95	23.85	6.63	5.93	3.38	e	3.77	33.24	b	38.83	a	0.74	e	0.84
Sk-103xPs1	21.94	21.58	10.54	9.73	4.41	b	4.10	29.06	d	29.60	f	1.02	b	0.97
Sk-103xPs2	23.34	22.74	9.40	8.59	3.47	e	3.71	26.54	f	30.13	e	0.81	d	0.87
Sk-103xPs3	25.01	23.99	7.24	6.55	2.82	f	3.30	27.62	e	33.48	d	0.66	f	0.78
Sk-104xPs1	23.97	23.20	11.46	10.61	3.80	d	3.57	24.54	g	25.16	i	0.83	d	0.79
Sk-104xPs2	25.51	24.44	10.22	9.36	2.98	f	3.23	22.28	i	25.62	h	0.65	f	0.72
Sk-104xPs3	27.34	25.79	7.88	7.15	2.43	g	2.88	23.25	h	28.67	g	0.53	g	0.64

surpassed the other two cultivars, except with sterility%, 1000 grain weight and straw yield, where the lowest values were observed on such cultivar sterility % where Sk-101 expressed the lowest sterility %, i.e. 11.61% in S1 and 11.34% in S2. The results confirmed the findings of Abou Khalifa *et al*,[46]. It is well known that Sk-101 is the superior cultivar over the Egyptian ones. In the previous part of the present study, Okasha *et al*,[43] named the growth features enhancing grain yield/plant in leaf area index, total chlorophyll, No. of panicle and panicle length. However, the present study is the second part of such investigation, no surprise herein that yield components were better with Sk-101 too. Thus, it seemed that yield components benefited the positive effects of growth traits and turned them into grain yield/fed. of Sk-101 viz., 4.27 and 4.23 ton/fed. in S1 and S2, respectively. In addition, superiority in favour to Sk-103 over Sk-104 was measured on some components including grain yield itself. However, grain yields of Sk-103 were 3.56 in S1 and 3.70 ton/fed. in S2. While those of Sk-104 were 3.07 in S1 and 3.23 ton/fed in S2. In addition, Sk-104 significantly exceeded Sk-103 with most yield components, including straw yield, viz in S1 (9.85) and S2 (9.04) ton/fed. Many researchers reported the superiority of Sk-101, of them [19,47]. The excess of Sk-104 over Sk-103 was found by different authors of them [6,26,27]. But Abd El-Maksoud,[25] found superiority in favour to Sk-103 over Sk-104.

3-Spacing Effect: Means of the studied traits as affected by spacing in the two seasons are included in Table (3,4). Significancy of the obtained differences were calculated on all aspects. Narrow spacing (15x15 cm) gave the highest significant products with all aspects, except sterility % and 1000 grain weight. The obtained values of 1000 grain weight were 22.30 and 22.08 g in S1 and S2, respectively. In seemed that the narrow spacing produced higher number of stands and consequently high No. of panicles/m^2. No dought that higher stands and panicles give higher straw yield/fed. In addition, No. of penicles/m^2 is a main maker of grain yield/fed., the former could be automatically expected by narrow spacing. Many authors believed in the positive value of narrowing spacing of them [31,32,33]. The superiority of 1000 kernel weight in wider spacing may be attributed to the good growth for single plants under wider spacing. The present results are in good convenience with the findings of Intikhab *et al*,[29] as well as [38].

B- First Order Interaction:

1- Irrigation x Cultivars: Table (3-4) present the obtained means of the studied traits as affected by the interaction irrigations x cultivar. It was obtained that highest significant values were detected only with (I-6x Sk-101) on No. of panicles/m^2, No. of spikelets/m^2, grain yield/fed. and harvest index, in the two seasons. This means that each level of Sk-101 significantly interacted with I-6 as respects the previous four traits. In addition, the treatments I-12x either Sk-103 or Sk-104 achieved the lowest values in all traits. Such results confirm the superior value of I-6 interval and Sk-101 treatments, as previously explained. Abou Khalifa,[3] reported the value of Sk-101xI-3 interval for producing higher yield and some yield components Vivekanandan *et al*,[11] stated that adaptability of available soil moisture (ASM) was exhibited by certain cultivars El-Kalla *et al*,[9] found significant effect due to the interaction on all trait. Singh and Choudhury,[34] agreed with similar trends. Kadum *et al*,[23] reported significancy on No. of tillering/m^2 and sterility %.

2- Irrigation x Spacing: Means of the studied traits as affected by irrigation x spacing interactions in the two seasons are given in Table (3,4). In the two seasons, only No. of panicles/m^2, No. of spikelets/m^2 and harvest index were significantly affected by the interaction. Grain yield/fed. was significantly affected only in the first season producing 5.59 ton/fed. by I-6x Ps1. Such interaction also achieved the highest values on most traits, especially those which were significantly affected.

3- Cultivars x Spacing: Table (3,4) declare the obtained means of the studied traits as affected by cultivar x spacing interactions in the two seasons. It is obvious that No. of panicles/m^2 and harvest index in the two seasons, No. of spikelets/m^2 in S2 and grain yield in S1 were the only traits significantly responded to the interactions. The (Sk-101xPs1) interaction highly yielded the highest values in most of the reminder traits. The highest grain yield/fed. for the mentioned interaction in S1 was 5.28 ton, it seemed that such grain yield benefited No. of panicles/m^2, as well as No. of spikelets/panicle to produce its superior value. Pawar *et al*,[18] found no significant effect due to (irrigation x spacing) interaction. Some authors contribute the success of such interaction to the cultivar it self and its tillering ability [5,35]. Some pointed to cultivar duration [22]. Guatam *et al*,[20] and Mishra *et al*,[21] and generalized that a certain variety needs certain spacing.

C-Second Order Interaction: Data did not show any significant differences as a result of the combination among the three factors, in the two seasons, except harvest index in S1. The value herein 38.79%. Harvest index is a ratio usually does not exceed the unit half value, where the numerator is occupied by grain yield, while the denominator is devoted to the summation of grain yield + straw yield. Thereafter, the percentage of harvest index is lesser than 50%. In other words greater harvest index % means greater grain yield versus the straw one. It was observed, in spite of the absence of significance, that the interaction (I-6 x Sk10 x Ps1) gave the highest grain yield, viz 6.57 and 5.25 ton/fed. in S1 and S2, respectively.

II- Water Relationships:

Water Use Efficiency, WUE: Table (4) presents the obtained WUE values for different aspects. Obviously, WUE was the greatest by I-9 (0.9 – 0.86), Sk-101 (0.93-0.94) and Ps1 (1.0 – 0.93) kg/m^3 in S1 and S2, respectively. The superiority of WUE with I-9 could be attributed to the middle TAW (4500 m^3/fed.). While the super WUE of Sk-101 as well as Ps1 could be attributed to the pronounced grain yield in the numerator in Vites, [39] equation. Abou Khalifa,[3] reported that I-3 produced the highest utilization efficiency, followed by I-6. El-Khoby *et al*,[47] reported that Sk-101 gave the highest WUE, consuming 1181 mm.

As regards the interactions, it was observed that the cultivars Sk-101 successfully interacted with all irrigation interval to produce remarkable WUE which were ranged between 0.77 to 1.02 kg/m^3, which were produced from Sk-101xI-12 and I-9, respectively. All estimations in such cases increased because of the pronounced grain yield of such cultivar.

Similarly it was noticed that I-6 or I-9 combined with the closer spacing (15x15 cm) produced the considerable WUE in the two season where the lowest and highest WUE were 1.09 and 1.11 kg/m^3. Such two limits were produced by I-6xand I-9xPs1, respectively. Such pronounced WUE could be attributed to grain yield/fed. rather that TAW.

Similarly, Sk-101 x Ps1 gave the greatest WUE among the other combinations in the interaction in S1, i.e. 1.15 kg/m^3. Herein also the numerator played the most important role for increasing WUE. It was expected that water use efficiency could be greater with a combination included I-9xSk-01xPs1.

III-Correlation: Table (5) represents simple correlation coefficients among each trait and the other ones in the two seasons. It is clear in the first seasons that all coefficient values were highly significant except that between straw yield and harvest index, i.e. -0.14. Most of simple correlation coefficients were positive. The negative signs were detected on the correlation of sterility% with all traits except 1000 grain weight. The latter trait was negatively correlated with all traits. Such results could understand where sterility% and 1000 grain weight were affected by treatments in different direction to other traits. In the second season, similar results were obtained, with a very minor deviation where the only insignificant correlation coefficient was detected between straw yield/fed. and WUE, i.e. 0.16. These results refer, in general, to the high strong link, regardless the correlation sign, among yield and all of its components. Also WUE was shown in strong correlation with most variables.

Iv-curve Estimation: Figure (1) illustrate the relation between grain yield (ton/fed.) and total applied water (m3/fed.) in the two seasons. It is so clear that grain yield/fed. gradually increased as total applied water increased. But the curve analysis showed that the relation between the two variables was a quadratic one either in the first or the second season. The obtained equation of the first season was $Y=-37.68+0.0164X-0.0000016X^2$. In the second season, the equation was $Y=-2.83+0.002X-0.00000012X^2$.

Table 5: Simple correlation coefficients (r), among each trait and the other ones in the two seasons.

Seasons	Traits	No. of panicles /m2	Sterility %	No. of spikelets/ m2x10-3	Number of grains/ panicle	1000-grain weight (g)	Straw yield (ton/fed.)	Grain yield (ton/fed.)	Harvest index %
2006	Sterility %	-0.70 **							
	No. of spikelets/m2x10-3	0.98 **	-0.80 **						
	Number of grains/panicle	0.82 **	-0.90 **	0.88 **					
	1000-grain weight (g)	-0.71 **	0.88 **	-0.77 **	-0.90 **				
	Straw yield (ton/fed.)	0.36 **	-0.38 **	0.36 **	0.39 **	-0.34 **			
	Grain yield (ton/fed.)	0.84 **	-0.89 **	0.91 **	0.97 **	-0.87 **	0.42 **		
	Harvest index %	0.69 **	-0.77 **	0.77 **	0.82 **	-0.76 **	-0.14 N.S	0.82 **	
	W.U.E Kg/m3	0.78 **	-0.78 **	0.83 **	0.91 **	-0.81 **	0.42 **	0.94 **	0.76 **
2007	Sterility %	-0.72 **							
	No. of spikelets/m2x10-3	0.97 **	-0.80 **						
	Number of grains/panicle	0.81 **	-0.94 **	0.89 **					
	1000-grain weight (g)	-0.61 **	0.97 **	-0.70 **	-0.87 **				
	Straw yield (ton/fed.)	0.37 **	-0.40 **	0.46 **	0.43 **	-0.43 **			
	Grain yield (ton/fed.)	0.86 **	-0.89 **	0.85 **	0.93 **	-0.81 **	0.29 **		
	Harvest index %	0.32 **	-0.33 **	0.23 *	0.32 **	-0.24 *	-0.68 **	0.49 **	
	W.U.E Kg/m3	0.65 **	-0.56 **	0.55 **	0.57 **	-0.44 **	0.16 N.S	0.78 **	0.43 **

**: Correlation is significant at 0.01 level.
*: Correlation is significant at 0.05 level.
NS: insignificant at 0.05 level.

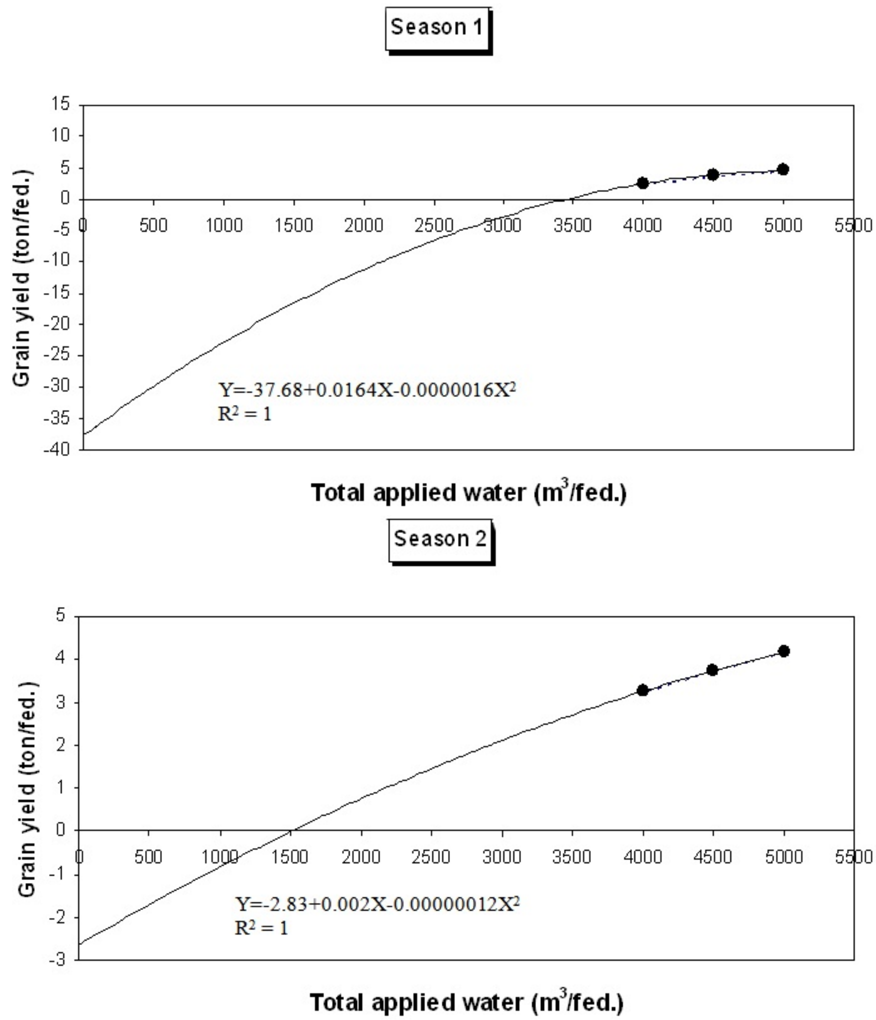

Fig. 1: Relation between grain yield (ton/fed.) and total applied water (m^3/fed.) in the two seasons.

REFERENCES

1. FAOSTAT, 2005. FAO Statistical Database. available at faostat.external.fao.org/faostat.
2. Mosalem, M.E., F.N. Mahrous, I.S. El-Refaee and F.A. Sorour, 1998. Effect of irrigation interval and potassium fertilization level on growth, yield and quality of rice. Annals of Agricultural Science, Cairo, (Special issue): 663-678.
3. Abou Khalifa, A.A., 2001. Response of some rice varieties to nitrogen fertilizer application under different irrigation intervals. Ph.D. Thesis Department of agronomy & Agricultural Mechanization Faculty of agriculture, Moshtohor, Zagazig University, Banha Branch.
4. EL-Sharkawi, H.M., B. Zayed, T. Honna and S. Yamamoto, 2006. Chemical Compositions and Salinity Development in Paddy Soil as Affected by Irrigation Intervals of Mixed Water under Saline Soil. Pakistan Journal of Biological Sciences, 9(4): 741-745.
5. Badawi, T.A. and S.A. Ghanem, 2004. Water use efficiency in rice Culture. Agricultural Research Center, Giza (Egypt). Cahiers Options Méditerranéennes, vol. 40.
6. Abou Khalifa, A.A., A.K.M. Salem and I.S. EL-Refaee, 2005. Effect of irrigation intervals and nitrogen sources on yield, sugar and starch content of rice. Egypt. J. Agron., 27(2): 113-123.
7. Ibrahim, M.A.M., S.A. El-Gohary and M.A.M. Rezk, 1988. Preliminary studies towards effective water management in Kafr El-Sheikh Governorate. Alex Eng. J., Alexandria Univ., 27: 19-36.
8. Ibrahim, M.A.M., S.A. E1-Gohary, L.S. Willardson and D.V. Sisson, 1995. Irrigation interval effects on rice production in the Nile Delta. Irrig. Sci., 16: 29-33.

9. El-Kalla, S.E., A.M. El-Said, A.A.M. Abd El-Rahman and A.M.S. Kishk, 2006. Response of rice cultivars to irrigation intervals and some organic fertilizer treatments in newly reclaimed soils. Agric. Sci., Mansoura Univ., 31: 5547-5555.
10. El-Bably, A.Z., A.A.A. Allah and M.I. Meleha, 2007. Influence of field submergence depths on rice productivity in North Delta, Egypt. Alexandria Journal of Agricultural Research, 52(2): 29-35.
11. Vivekanandan, P., V. Veerabadran and A. Sheeba, 2005. Identification of rice (*Oryza sativa* L) genotypes for aerobic condition under different water regimes. Indian Journal of Genetics and Plant Breeding, 65(4): 287-289.
12. Sarvestani, Z.T., H. Pirdashti, S.A.M.M. Sanavy and H. Balouchi, 2008. Study of water stress effects in different growth stages on yield and yield components of different rice (*Oryza sativa* L.) cultivars. Pakistan Journal of Biological Sciences, 11(10): 1303-1309.
13. El-Refaee, I.S., A. El-Azeem, T. Badawi and A. O. Bastawisi, 2005. Effect on yield and water productivity due to management and application of nitrogen for hybrid and inbred rice. Transactions of the 19th International Congress on Irrigation and Drainage, Beijing, China, Vol 1A: Improving water and land management for increasing efficiency in irrigated agriculture.P1.18.
14. Nour, M.A., A.E. Abd El-Wahab and F.N. Mahrous, 1994. Effect of water stress at different growth stages on rice yield and contributing variables. Rice Research and Training Center. 1996. Annual Agronomy Report.
15. Khawshi, D.G., N.G. Zode, S.L. Borkar and U.R. Dongarwar, 2003. Response of scented varieties of paddy (*Oryza sativa* L) to spacing in Eastern Vidarbha Zone of Maharashtra. Annals of Plant Physiology, 17(1): 81-83.
16. Aidy, I.R., A.T. Badawi, M.S. Balal, M.A. Maximos, A.A. El-Hissewy, A.E. Draz, A.O. Bastawisi, M.A. Shata, A.A. El-Kady, H.F. El-Mowafi, A.B. Al-Abd, F.N. Mahrous, A.M. El-Serafi, S.M. Hassan, M.R. Sehly, S.M. El-Wahsh and M.A. El-Chiaty, 2004. Giza 177: the first early maturing rice variety in Egypt. Egyptian Journal of Agricultural Research, 82(1): 1-12.
17. Asghari, J., M.M. Sharifi and M.R. Alizadeh, 2004. Effect of intrarow spacing on weed density and yield of mechanically transplanted rice (*Oryza sativa* L.). Iranian Journal of Agricultural Sciences, 35(3): 631-641.
18. Pawar, W.S., V.S. Shinde and U.R. Dongarwar, 2005. Scented rice varieties as influenced by different spacing in Vidarbha zone of Maharashtra cultivated varieties. Oryza, 42(1): 73-47.
19. Abou El-Hassan, W.H., Y. Kitamura, K. Hasegawa, S.L. Yang and H. Solomon, 2006. Water management using drainage water and its impact on irrigated rice in the Delta region of Egypt. Eightth International Conference on Dryland Development, 25-28 February 2006, Beijing, China.
20. Gautam, A.K., B.N. Mishra and P.K. Mishra, 2005. Influence of plant spacing and levels of nitrogen on grain yield and nitrogen uptake of inbred and hybrid aromatic rice. Annals of Agricultural Research, 26(3): 421-423.
21. Mishra, B.N.N.C. Sarkar, P.K. Mishra and A.K. Gautam, 2005. Effect of graded levels of nitrogen and plant spacing on grain yield and quality of aromatic rice. Annals of Agricultural Research, 26(3): 402-405.
22. Nayak, B.C. and A.K. Patra, 2001. Effect of spacing on rice (*Oryza sativa* L) varieties of various duration under irrigated condition. Indian Journal of Agronomy, 46(3): 449-452.
23. Kadum, A.A., S. Yousif, F. Jabir, J. Ulaywi and H. Kadum, 2008. Effect of irrigation treatments on the growth and yield of two rice cultivars Amber Baghdad and Amber Munathera. Dirasat. Agricultural Sciences, 35(3): 97-102.
24. RRTC "Rice Research and Training Center" 2003. The 8th National Rice Program workshop. March.
25. Abd El-Maksoud, M.F., 2008. Effect of levels and splitting of N-fertilization on growth, yield components, yield and grain quality of some rice cultivars. Research Journal of Agriculture and Biological Sciences, 4(5): 392-398.
26. El-Refaee, I.S., A.T. Badawi, A.E. Abd El-Wahab and B.A. Zayed, 2004. Effect of water deficit and time of nitrogen application on yield and water productivity of rice (*Oryza sativa* L.). Available at http://www.icarda.org/Publications/8th-ICDD-AbstractsBook/Theme10.
27. Fawzi, A.T. and A.T. Badawi, 2006. Challenges and opportunities for sustainable increase of rice production in the Near East region. International Rice Commission Newsletter, 55: 0538-9550.
28. Gupta, A.K. and R.S. Sharma, 1991. Effect of plant spacing and fertility level on grain yield of early medium indica rice (*Oryza sativa*). Indian Journal of Agronomy, 36: 223-225.
29. Intikhab Syed, Haq, S.A., Bilal Ahmad and F.A. Khan, 2007. Effect of planting direction and row spacing on growth, yield and yield attributes of basmati rice (*Oryza sativa* L.). Environment and Ecology, 25(2): 457-459.
30. Sultan, T. and M. Kaleem, 2008. Effect of different plant spacing on yield and yield attributes of different hybrid varieties of rice (*Oryza sativa* L.). Environment and Ecology, 26(2A): 892-893.

31. Srinivasan, K. and S. Purushothaman, 1990. Effect of plant spacing on ratoon rice performance. International Rice Research Newsletter, 15: 4, 21.
32. Zayed, B.A., I.S. EL-Refaee, R.N. Gorgy and A.A.M. Abd El-Rahman, 2005. Effect of sowing dates, plant spacing and nitrogen levels on growth and yield of rice under saline soil. The 11th Conference of Agronomy, Dept., Fac. Agric., Assiut Univ., pp: 265-283.
33. Salem, A.K.M., 2006. Effect of nitrogen levels, plant spacing and time of farmyard manure application on the productivity of rice. Journal of Applied Sciences Research, 2(11): 980-987.
34. Singh, A.K. and B.U. Choudhury, 2007. Performance of rice (*Oryza sativa* L (planted on raised-bed under different soil-moisture tensions. Indian Journal of Agronomy, 52(4): 305-310.
35. Lourduraj, A.C., 1999. Influence of planting geometry and spacing on the growth and yield of rice-a review. Agricultural Reviews (Karnal), 20(3/4): 199-202.
36. Black, G.A., 1965. Methods of soil analysis. American. Soc. Agron. Inc. Pub. Madison, Wisconsin, USA.
37. Hansen, V.E., O.W. Israelsen and G.E. Stringham, 1980. Irrigation principles and practices. 4th ed. John Willey & Sons Inc. USA.Hare.
38. Wilcox, J.R., 1974. Response of three soybean strains to equidistance spacings. Agron. J., 66: 409–412.
39. Vites, F.G. Jr., 1965. Increasing water use efficiency by soil management. Amer. Soc. Agron., Madison, Wise, 259-274.
40. Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1 - 42.
41. Snedecor, G.W. and W.G. Cochran, 1981. Statistical methods.7th ed. Iowa state Univ. Press., Ames, Iowa, U.S.A.
42. Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for agricultural research. John Wiley & Sons, Inc. New York, USA.
43. Okasha, E.M., A.A. El-Ganayni, M.A.A. Abdou and W.M. EL-Khoby, 2009. Influence of irrigation intervals, some cultivars and plant spacing on growth, yield and its components in rice. Part (1) vegetative growth. Res. J. Agric. & Biol. Sci. (in press).
44. Abd Allah, A.A., A.M. El-Ekhtyar, W.M. El-Khoby and A.S. Abd El-Lateef, 2009. Studies on the induction of new genetic variability for quantitative traits by gamma rays in rice (*Oryza sativa* L.) (in press).
45. Abou Khalifa, A.A, A.E. Abd El-Wahab, A.M. El-Ekhtyar and B.A. Zaed, 2007. Response of some hybrid rice varieties to irrigation intervals under different dates of sowing. African Crop Science Conference Proceedings, 8: 67-74.
46. Abou Khalifa, A.A. and W. EL-Khoby and E.M. Okasha, 2009. Effect of sowing dates and seed rates on some rice varieties. African Journal of Agr. Res, 4(3).
47. El-Khoby, W.M., A.A. Abd Allah, E.M. Okasha and A.Z. El-Bably, 2008. Producing more rice with less water using alternative planting methods in North Delta, Egypt (in press).