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Full Length Research Paper

Performance of Some Rice Varieties under Different Irrigation Regimes

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Two field experiments were conducted at the Experimental and Research Center, faculty of agriculture, Benha University, Egypt, during 2016 and 2017 seasons to study the performance of five rice varieties namely: Sakha 104, Sakha 105, Sakha 106, Giza 177 and GZ 7576 (short grain Japonica genotype) under three irrigation regimes i.e., flooding (F), saturation (S), and flooding up to panicle initiation + saturation (F+S), on growth, yield and its components. The most important results obtained showed that, all growth characters as well as yield and its components were significantly affected by the irrigation treatments. The highest values were recorded under flooding irrigation (F) for both seasons, followed by flooding up to panicle initiation + saturation for the rest of season (F+S). On the other hand, number of days to maximum tillering (MT), panicle initiation (PI) and 50% heading (HD) were gradually decreased with saturation irrigation (S) for both seasons and F+S treatments. Rice varieties were significantly affected by all the studied characters.GZ 7576 genotype was the earliest varieties in MT trait, whereas, Sakha 105 variety was the earliest varieties in PI trait, while, Sakha 106 variety was the earliest varieties in HD trait. In contrast, Sakha 104 was the latest variety in MT and PI traits. Sakha 106 significantly surpassed the other 4 varieties in most characters, followed by Sakha 104 with significant difference between them. Effect of the interaction between irrigation regimes and rice varieties showed highly significant for PI, HD, plant height, number of panicles hill^{-1}, number of tillers m^{-2}, number of panicles m^{-2}, number of grains panicle, biological yield fed^{-1}and grain yield fed^{-1}. Generally, (F) irrigation treatment under Sakha 106 or Sakha 104 varieties recorded the highest values for these traits. Significant positive correlation was detected between grain yield fed^{-1} and each of number. of tillers hill^{-1}, plant height, number of panicles hill^{-1}, number, of grains panicle, panicle length, panicle weight, 1000-grain weight and biological yield fed^{-1}.

Keywords: Rice, Varieties, Irrigation regimes, Growth, Yield and its components.

INTRODUCTION

RICE (*Oryza sativa L.*) crop is a main crop among the different cultivated crops under Egyptian condition and all over the world. Rice is, after cotton, the second most important export crop for Egypt. About 0.5 million hectares are planted annually, giving a total production of some 6.1

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million tones. In Egypt, conventional irrigation method of rice consumes greater amounts of water, putting rice in the first demand among the grown summer crops, including sugar cane, maize and cotton. The highest water demand is more likely over to the highest water management of rice lines which was more than 6000 m^3 fed^{-1}, and the increased in its cultivated area which exceeded 2.0 million fed, during the last year few years. The total high water use by rice causes certain difficulties which negatively affect yields of summer thirsty crops. Egypt is completely depending on water from River Nile (55.5 Milliar 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 regimes, use of early rice varieties.

Several researchers showed that the different irrigation regimes were differences significantly on growth, yield and yield components of rice. Similar information reported by **Ebaid and El-refaee (2007); Joseph *et al.*** (2008); Singh and Batta (2008); Juraimi *et al,* (2009), Okasha *et al,* (2009a); Okasha *et al,* (2009b);Abu and Malgwi (2011), Juraimi *et al,* (2011), Boopathi *et al*, (2013); Sabar and Arif (2014)and Raumjit and Wichitparp (2014).

Several rice varieties of different ideal types are spreading all over the world. Thereafter, it could be expected that the rice varietal variation was detected in many studies such as AbouKhalifa (2001),Khawshi *et al*, (2003), Abou El-Hassan *et al*, (2006), El-Kalla *et al*, (2006), El-Bably *et al*, (2007),Mobasser *et al*, (2007), AbouKhalifa, (2012), Alam *et al,* (2012), Mondal and Puteh (2013), Islam *et al*,(2014) and Haque and Pervin (2015).

The current study aims to investigate the effect of irrigation regimes on growth, yield and its attributes of five rice varieties at Moshtohor conditions.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental and Research Center, Fac. Agric., Moshtohor, Benha Univ., Kalubia Governorate, Egypt, in the two successive seasons 2016and 2017 to study the performance of five rice varieties namely: Sakha 104, Sakha 105, Sakha 106, Giza 177 and GZ 7576 (short grain Japonica genotype) under three irrigation regimes i.e., flooding for all season (F), saturation for all season(S) and flooding up to panicle initiation+saturation for the rest of season (F+S)-on growth, yield and its attributes. The tested five rice varieties are characterized to maturity time 135 days for Sakha 104 variety only and 125 days for the other varieties. The soil was clay in texture with a pH value of 7.78, 7.81 and an organic matter content of 1.81, 1.67% and available N of 58, 50 ppm during the two growing seasons, respectively.

Agricultural Practices

In both seasons, proceeded crop was wheat. Seedbed of the nursery, area of 350 m^2 for 1 fed was well prepared and fertilized with calcium super phosphate (15.5% P_2O_5) at 100 kg fed^{-1} before ploughing. Rice grains for all varieties were soaked in running water for 48 hr., and then incubated for another 48 hr. before seeding and 10 kg fed^{-1} of zinc sulphate was added. Seeds were manually broadcasted in the nursery on April 20th, at 60 kg fed^{-1} nursery. Two weeks after sowing, 40 kg N fed^{-1} 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^{-1} was added to the dry soil before ploughing. Flushing irrigation was done. Nitrogen in the form of urea (46% N) at the rate 70 Kg N was added (according to the recommendation) three equal splits, 1/3 as basal and incorporated in to dry soil immediately before flooding, 1/3 was applied 30 days after transplanting and 1/3 was applied as top dressing 7 days before panicle initiation. Transplanting of seedlings from nursery to the permanent field was done 30 days after sowing, which transplanted in hills spaced 20X20 cm for all rice varieties, as three plants $hill^{-1}$. Irrigation was withheld 15 days before harvest. Harvest was carried out according to each variety duration. All remainder agricultural practices were carried out as usual.

Experimental design:

A split plot design with four replicates was used. The main plots were randomly devoted to irrigation regimes, while rice varieties were distributed at the sub plots. Randomization was considered in all cases. Plot area was 10.5 m^2 (3x3.5m).

Studied attributes:

The number of days from sowing to maximum tillering (MT), panicle initiation (PI) and 50% heading (HD) was recorded for each variety. After 100% heading, plant height (cm), No. of tillers $hill^{-1}$ and No. of tillers m^{-2}were taken from the sub plot at random during the growing seasons. At harvest, No. of panicles $hill^{-1}$, No. of panicles m^{-2}, panicle length (cm), No. of grains $panical^{-1}$ and panicle weight (g) were measured. Biological yield (t fed^{-1}) was recorded from the harvested area of sub plot. Grain yield (t fed^{-1}) was calculated on the base of yield $plot^{-1}$ then fed^{-1}. Air dried plants were mechanically threshed and grain yield was estimated and adjusted to 14 % moisture content. Grain samples from each sub plot were taken to determine 1000 grains weight. Straw yield (t fed^{-1}) was estimated using the same term used for grain yield estimation. Harvest index was determined according to Yoshida (1981) by subdividing weight of grain yield (t fed^{-1}) on the total biomass according to the following formula: Harvest index=

Table 1. Mean squares values and significance for growth, yield and its attributesof rice varieties in 2016, 2017 seasons and their combined analysis

S.O.V	d.f	MT (day)	PI (day)	HD (day)	Plant height (cm)	No. of tillers hill^{-1}	No. of tillers m^{-2}	No. of panicles hill^{-1}	No. of panicles m^{-2}
2016 season									
R	2	4.82**	2.15	5.75	3.756	1.09*	13.156**	4.622	9.600
IR	2	16.02**	26.28**	44.82**	23.089**	14.49**	191.62**	19.756*	285.8**
Err.(a)	4	0.15	1.15	1.95	0.589	0.12	0.68	1.156	10.40
V	4	233.14**	282.72**	407.6**	263.44**	14.09**	1369.1**	24.69**	667.8**
IR x V	8	0.57	0.87	1.71**	0.728**	0.406	12.789**	1.422**	26.80**
Err.(b)	24	0.85	0.65	0.50	0.200	0.500	3.039	0.394	2.467
2017 season									
R	2	0.28	0.46	3.800	6.156**	0.956*	10.422	0.422	15.356**
IR	2	3.35	27.80**	14.46*	41.489**	15.089**	390.76**	15.02**	240.69**
Err.(a)	4	1.02	0.76	1.06	0.056	0.056	2.122	0.689	0.656
V	4	267.72**	315.14**	459.4**	283.86**	11.478**	1218.2**	25.19**	671.44**
IR x V	8	0.35	2.16**	1.16**	1.072	0.478	7.894**	1.022**	21.83**
Err.(b)	24	0.27	0.30	0.311	0.617	0.328	1.611	0.128	1.500
Combined analysis									
Years	1	67.60**	65.87**	76.54**	41.34**	54.44**	1416.1**	62.50**	298.84**
Y x R	4	2.55*	1.31	4.778	4.956**	1.022**	11.789**	2.522	12.478
IR	2	16.944**	54.01**	52.21**	62.40**	28.433**	554.74**	33.14**	525.38**
Y x IR	2	2.43	0.07	7.078*	2.178*	1.144**	27.63**	1.633	1.111
Err.(a)	8	0.58	0.961	1.511	0.322	0.089	1.406	0.922	5.528
V	4	499.91**	596.13**	866.1**	546.6**	25.122**	2573.5**	49.82**	1320.9**
Y x V	4	0.96	1.73*	0.906	0.678	0.444	13.79**	0.056	18.289**
IR x V	8	0.34	2.46**	2.433**	1.372**	0.322	15.56**	2.089**	40.697**
YxIRxV	8	0.58	0.56	0.439	0.428	0.561	5.12*	0.356	7.931**
Err.(b)	48	0.56	0.48	0.406	0.408	0.414	2.32	0.261	1.983

S.O.V	d.f	Panicle length (cm)	No. of grains panicle	Panicle weight (g)	1000-grain weight	Biological yield (t fed^{-1})	Grain yield (t fed^{-1})	Straw yield (kg fed^{-1})	Harvest index
2016 season									
R	2	0.16	62.60**	0.014	2.54*	0.10	0.08**	0.14	13.82*
IR	2	16.54**	181.4**	0.49**	20.0**	2.77**	1.18**	0.41	23.18**
Err.(a)	4	0.13	1.60	0.009	0.32	0.100	0.003	0.07	0.98
V	4	10.54**	109.7**	0.60**	19.5**	3.77**	0.45**	1.62**	7.84**
IR x V	8	0.48**	4.28**	0.001	0.24*	0.04*	0.004	0.03	0.98
Err.(b)	24	0.07	0.90	0.006	0.08	0.01	0.003	0.02	1.17
2017 season									
R	2	0.71	5.95	0.05*	0.64	0.10	0.15**	0.17	18.35*
IR	2	11.44**	86.02**	0.33**	4.76	1.26*	0.87**	0.04**	26.03**
Err.(a)	4	0.35	3.25	0.004	2.67	0.07	0.002	0.06	1.03
V	4	11.73**	110.9**	0.66**	24.3**	2.55**	0.67**	0.62**	1.96**

Table 1 Continue

IR x V	8	0.04	6.77**	0.005	2.13	0.01*	0.01**	0.01	1.29*
Err.(b)	24	0.12	0.82	0.004	2.46	0.005	0.002	0.01	0.43
Combined analysis									
Years	1	20.93**	332.5**	0.83**	28.45**	2.98**	0.39**	1.27**	0.61
Y x R	4	0.43	34.28**	0.03*	1.59	0.10	0.12**	0.16	16.09**
IR	2	27.73**	257.7**	0.82**	19.54**	3.86**	2.05**	0.32*	43.99**
Y x IR	2	0.24	9.67	0.008	5.29	0.16	0.016*	0.13	5.21*
Err.(a)	8	0.24	2.42	0.006	1.49	0.08	0.003	0.06	1.01
V	4	21.68**	218.7**	1.26**	42.96**	6.25**	1.11**	2.11**	2.80*
Y x V	4	0.59**	1.96	0.002	0.88	0.07**	0.02**	0.13**	7.01**
IR x V	8	0.18	10.55**	0.002	1.27	0.03**	0.01**	0.01	0.47
YxIRxV	8	0.34**	0.51	0.004	1.10	0.02*	0.005	0.02	1.81*
Err.(b)	48	0.10	0.86	0.005	1.27	0.01	0.002	0.01	0.80

***and ** significant at 5% and 1% level of probability, respectively R=replications V=varieties IR=irrigation regimes**

Grain yield/ Biological yield x100. 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*, (1980) as follows:

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

Q = Water discharge, m^3hr^{-1}.

0.0138 and 3.6 = constant values, where 3.6 was added for obtaining Q in m^3 hr^{-1}.

h= Water height or pressure head (cm).

Water use efficiency (WUE) was determined according to Hansen *et al,* (1980) as follows:

WUE = Rice grain yield kg/total water input m^3.

Water saved m^3 fed^{-1} and grain yield reduction percentage were calculated for each irrigation treatment compared with flooding irrigation for all season.

Statistical analysis

Analysis of variance was done for the obtained data of each season separately and combined analysis according to Snedecor and Cochran (1980), the means and interaction compared according to the least significant difference (L.S.D) at 5%.The data were analyzed statistically following sub plot design by MSTAT-C computer package developed by Russell (1986). Simple correlation and coefficient of determination were computed between the above mentioned characters as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Effect of mean squares

Analyses of variances for all traits in each season as well as the combined analysis are presented in **Table (1)**. Test of homogeneity revealed that the error variance for the two seasons were homogenous, therefore combined analysis was processed. Year's mean squares were highly significant for all the studied traits except for harvest index was not significant. Irrigation regimes mean squares were highly significant for all traits in both seasons as well as the combined data except for 1000 grains weight were not significant in the second season only. Rice varieties mean squares were significant for all traits in both seasons and the combined data. The interaction between years and irrigation regimes mean squares was not significant for all of the studied characters except No. of day from sowing to 50% heading (HD), plant height, No. of tillers $hill^{-1}$, No. of tillers m^{-2}, grain yield fed^{-1}andharvest index were significant.

The interaction between years and rice varieties mean squares was significant for number of days from sowing to panicle initiation (PI),No. of tillers m^{-2}, No. of panicles m^{-2},panicle length, biological yield fed^{-1},grain yield fed^{-1}, straw yield fed^{-1} and harvest index. The interaction between years, irrigation regimes and rice varieties mean squares were not significant for all of the studied characters except No. of panicles m^{-2},panicle length, biological yield $fed^{-1}$and harvest index.

Table (2): Effect of growing season on growth, yield and its attributes of rice

Traits / Seasons	MT (day)	PI (day)	HD (day)	Plant height (cm)	No. of tillers $hill^{-1}$	No. of tillers m^{-2}	No. of panicles $hill^{-1}$	No. of panicles m^{-2}
2016	49.04	54.56	89.02	104.11	22.51	464.84	18.58	451.20
2017	50.78	56.27	90.87	102.75	20.96	456.91	16.91	447.55
F test	**	**	**	**	**	**	**	**
Traits / Seasons	**Panicle length (cm)**	**No. of grains panicle**	**Panicle weight (g)**	**1000-grain weight (g)**	**Biological yield (t fed^{-1})**	**Grain yield (t fed^{-1})**	**Straw yield (kg fed^{-1})**	**Harvest index**
2016	21.10	124.47	3.30	25.98	8.96	4.00	4.97	44.75
2017	20.13	120.62	3.10	24.86	8.60	3.86	4.73	44.91
F test	**	**	**	**	**	**	**	**NS**

***and ** significant at 5% and 1% level of probability, respectively NS=no significance**

Table 3. Effect of irrigation regimes and varieties on some growth characters of rice plants (Combined analysis of 2016 and 2017 seasons)

Treatments	MT (day)	PI (day)	HD (day)	Plant height (cm)	No. of tillers $hill^{-1}$	No. of tillers m^{-2}
Irri. Regimes						
F	50.63	56.93	91.47	104.63	22.63	465.20
S	49.13	54.40	89.23	101.83	20.70	456.60
F+S	49.97	54.90	89.13	103.83	21.87	460.83
L.S.D at 5%	**0.45**	**0.58**	**0.73**	**0.33**	**0.17**	**0.70**
Varieties						
Sakha 104	56.00	62.94	99.61	113.06	22.72	478.06
Sakha 105	45.89	50.56	85.22	101.44	21.94	460.72
Sakha 106	47.56	51.61	83.39	102.78	22.94	466.00
GZ 7576	44.94	51.67	86.72	99.67	20.22	448.17
Giza 177	55.17	60.28	94.78	100.22	20.83	451.44
L.S.D at 5%	**0.50**	**0.46**	**0.42**	**0.42**	**0.43**	**1.02**

F=flooding for all season, S=saturation for all season, F+S=flooding up to panicle initiation+saturation for the rest of season

- Effect of growing seasons:

Data in **Table (2)** showed significant seasonal effects for all of the studied characters except harvest index. High values for all characters were detected in the first season compared with the second season except number of days from sowing to maximum tillering (MT), panicle initiation (PI), 50% heading (HD)and harvest index. It could be concluded that the increase of grain yield and other characters in the first season may be due to accompanied with high percentage for organic matter and total N in the experimental soil in the first season compared with the second season.

- Effect of irrigation regimes:

Growth characters:

Results in **Table (3)** showed that number of days from sowing to maximum tillering (MT), panicle initiation (PI), 50% heading (HD),plant height (cm), No. of tillers $hill^{-1}$ and No. of tillers m^{-2}were significantly affected by the irrigation treatments in combined analysis. The highest values were recorded under continuous flooding irrigation for all season(F), followed by flooding up to panicle initiation+saturation for the rest of season(F+S). F treatment significantly increased plant height, No. of tillers $hill^{-1}$ and No. of tillers m^{-2} by 2.75 and 0.77%, 9.32 and

Table 4. Effect of irrigation regimes and varieties on yield and its attributes of rice (Combined analysis of 2016 and 2017 seasons)

Treatments	No. of panicles hill^{-1}	No. of panicles m^{-2}	Panicle length (cm)	No. of grains panicle	Panicle weight (g)	1000-grain weight (g)	Biological yield (t fed^{-1})	Grain yield (t fed^{-1})	Straw yield (kg fed^{-1})	Harvest index
Irri. Regimes										
F	18.67	453.13	21.35	124.67	3.36	26.09	9.13	4.17	4.96	45.71
S	16.60	444.87	19.52	119.20	3.03	24.52	8.41	3.65	4.76	43.45
F+S	17.97	450.13	20.96	123.77	3.22	25.65	8.81	3.98	4.83	45.33
L.S.D at 5%	**0.57**	**1.40**	**0.29**	**0.92**	**0.04**	**0.72**	**0.17**	**0.03**	**0.15**	**0.59**
Varieties										
Sakha 104	18.67	451.00	21.76	123.39	3.40	26.74	9.26	4.10	5.16	44.29
Sakha 105	17.89	451.78	20.52	122.56	3.19	25.62	8.83	3.96	4.86	44.82
Sakha 106	19.89	460.67	21.54	127.61	3.49	27.05	9.38	4.20	5.18	44.76
GZ 7576	15.67	437.22	19.05	118.06	2.82	23.56	7.93	3.56	4.36	44.88
Giza 177	16.61	446.22	20.19	121.11	3.10	24.14	8.51	3.84	4.67	45.40
L.S.D at 5%	**0.34**	**0.94**	**0.22**	**0.62**	**0.05**	**0.75**	**0.07**	**0.03**	**0.07**	**0.60**

F= flooding for all season, S= saturation for all season, F+S= flooding up to panicle initiation+saturation for the rest of season

3.48%, 1.88 and 0.95% compared with saturation for all season (S) and F+S treatments respectively. On the other hand, MT, PI and HD traits were gradually decreased with S and F+S treatments. These results held true in this connection. Since, water shortage restricted growth via reducing exhibitor hormones and increasing inhibitor hormones resulted decreasing cell division leading to reducing panicle formation peromidia. This may be due to the decreasing moisture content in root zone for along period, which adversely affected cell division, elongation and vegetative growth. It seemed that sufficient watering as with flooding irrigation for all season may promoted the biological processes in the plant cells, such as cell division, expansion and enlargement. These data are in agreement with those reported by Ebaid and El-refaee (2007); Okasha *et al,* (2009a);Abu and Malgwi (2011),Juraimi *et al,* (2011), Boopathi *et al*, (2013); Sabar and Arif (2014) and Raumjit and Wichitparp (2014).

Yield and yield components:

Grain yield and its components were significantly affected by irrigation treatments in combined analysis **(Table 4)**. With all traits, significant decrease from F irrigation treatment to S irrigation treatment was observed. The largest values of No. of panicles hill^{-1} (18.67 panicle), No. of panicles m^{-2}(453.13 panicle),panicle length (21.35 cm),No. of grains panicle (124.67 grain), panicle weight (3.36 g), 1000-grain weight (26.09 g),biological yieldfed^{-1}(9.13 t),grain yieldfed^{-1}(4.17 t),straw yieldfed^{-1}(4.96 t) and harvest index (45.71)resulted from F irrigation treatment, while the smallest values of these traits resulted from S irrigation treatment. These results revealed that the reduction in yield components can be expected as plants are exposed to water deficit. Besides, available water enhanced the production and transporting of dry matter content to the panicle resulting in more grain weight. Also, this could be attributed to larger yield components, such as No. of panicles hill^{-1},No. of panicles m^{-2},panicle length, No. of grains panicle, panicle weight and 1000-grain weight under F irrigation treatment than S irrigation treatment. These results were consistent with those obtained by Ebaid and El-refaee (2007);Joseph *et al.* (2008); Singh and Batta (2008); Juraimi *et al,* (2009), Okasha *et al,* (2009b); Abu and Malgwi (2011), Juraimi *et al,* (2011), Boopathi *et al*, (2013);Sabar and Arif (2014) and Raumjit and Wichitparp (2014).

-Performance of rice varieties:

Growth characters:

Rice varieties were significantly affected on number of days from sowing to maximum tillering (MT), panicle initiation (PI), 50% heading (PI),plant height (cm), No. of tillers hill^{-1} and No. of tillers m^{-2} in combined analysis **(Table 3).**GZ 7576 genotype was the earliest varieties in MT (44.94 day) and recorded significant differences when compared with the 4 varieties, whereas, Sakha 105 variety was the earliest varieties in PI (50.56 day) and recorded significant differences when compared with the 4 varieties, while, Sakha 106 variety was the earliest varieties in HD (83.39 day) and recorded significant differences when compared with the 4 varieties. In contrast, Sakha 104 variety was the latest variety in MT (56.00 day), PI (62.94 day) and HD (99.61 day) with significant differences compared with other varieties. The highest values of plant height (113.06 cm), No. of tillers hill^{-1} (22.94 tiller) and No. of tillers m^{-2}(478.06 tiller) were obtained by Sakha 104, Sakha 106 and Sakha 104 varieties, respectively, whereas, the lowest values of these traits were obtained by GZ 7576 genotype. The differences between the varieties of rice under studies could be due to the variation in the genetical make up and their interaction with the environmental conditions prevailing during their growth. These results are highly matching with those obtained by Abou Khalifa (2001),El-Kalla *et al*, (2006), El-Bably *et al*, (2007), Abou Khalifa, (2012), Mondal and Puteh(2013) andIslam *et al,* (2014).

The results in Table (4) showed great differences in No. of panicles hill^{-1},No. of panicles m^{-2},panicle length, No. of grains panicle, panicle weight, 1000-grain weight, biological yieldfed^{-1},grain yieldfed^{-1},straw yieldfed^{-1}and harvest index in combined analysis among the 5 rice varieties. Sakha 106 variety significantly surpassed the other 4varieties in these characters except panicle length and harvest index, followed by Sakha 104 variety as the second rank with significant difference between them except panicle length and straw yieldfed^{-1}. The highest values of No. of panicles hill^{-1}(19.89 panicle),No. of panicles m^{-2} (460.67 panicle),No. of grains panicle (127.61 grain), panicle weight (3.49 g), 1000-grain weight (27.05 g),biological yieldfed^{-1}(9.38 t),grain yieldfed^{-1}(4.20 t) and straw yieldfed^{-1}(5.18 t) were obtained by Sakha 106 variety. The present results are a good and clear evident for the superiority of Sakha 106 variety and indicate the role of selecting the best rice varieties for increasing grain production of rice. The results are expected since Sakha 106 variety as well as Sakha 104 variety was superior than the other varieties in growth characters and yield components. Such finding is confirmed by AbouKhalifa (2001),Khawshi *et al*, (2003), Abou El-Hassan *et al*, (2006), El-Kalla *et al*, (2006), El-Bably *et al*, (2007),Mobasser *et al*, (2007), AbouKhalifa, (2012),Alam *et al,* (2012), Mondal and Puteh(2013), Islam *et al,* (2014) and Haque and Pervin (2015). indicated marked differences among rice varieties and genotypes in yield and yield components.

-Interaction effect:

The effect of the interaction showed highly significant for No. of days to panicle initiation (PI) and 50% heading (HD), plant height, No. of panicles hill^{-1}**,**No. of tillers m^{-2}**,**No. of panicles m^{-2},No. of grains panicle, biological yield fed^{-1}and grain yield fed^{-1}in combined analysis **(Table 5)**. Concerning the interaction between irrigation regimes and rice varieties, results in **Table (5)** indicated that continuous saturation irrigation for all season (S) under Sakha105varietywas earlier PI (48.83 day), while continuous flooding irrigation up to panicle initiation+saturation for the rest of season (F+S)under Sakha106variety was earlier HD (81.67 day). On the other hand, Sakha 104variety under continuous flooding irrigation for all season was the latest in PI(64.67 day)and HD(48.83 day) traits. Continuous flooding irrigation for all season under Sakha 104variety recorded the highest values of plant height (115.00 cm) and No. of tillers m^{-2} (482.17tiller), while continuous flooding irrigation up to panicle initiation+saturation for the rest of season (F+S)under Sakha 104variety gave the highest value for No. of panicles m^{-2} (462.50 panicle). Sakha106varietyunder continuous flooding irrigation for all season recorded the highest values for No. of panicles hill^{-1} (21.33 panicle), No. of grains panicle (131.50 grain), biological yield fed^{-1}(9.78 t)and grain yield fed^{-1}(4.46 t).In contrast, continuous saturation irrigation for all season (S) under GZ 7576 genotype gave the lowest values of plant height(98.00cm),No. of panicles hill^{-1}(14.67 panicle)**,**No. of tillers m^{-2}(445.33 tiller)**,**No. of panicles m^{-2}(432.83 panicle), No. of grains panicle(115.67 grain), biological yield fed^{-1}(7.67 t)and grain yield fed^{-1}(3.30 t).Similar findings were also obtained by Okasha *et al,* (2009) and Raumjit and Wichitparp (2014).

<u>-Simple correlation analysis:</u>

The simple correlation coefficients between grain yield fed^{-1} and main yield components in the combined over two seasons **(Table 6)**. Highly significant positive phenotypic correlation values between grain yield fed^{-1} and each of other traits namely, No. of tillers hill^{-1}, plant height, No. of panicles hill^{-1}, No. of grains panicle, panicle length, panicle weight, 1000-grain weight and biological yield fed^{-1}with r values being0.822, 0.545, 0.850, 0.809, 0.906, 0.921, 0.739 and 0.905respectively.Significant positive and highly correlation coefficient values were detected between biological yield fed^{-1} and each of No. of tillers hill^{-1},plant height, No. of panicles hill^{-1}, No. of grains panicle, panicle length, panicle weight and 1000-grain weight. These results indicate that **h**igh biological yield fed^{-1} would be due to increasing in these traits. Significant positive and highly correlation coefficients were detected between 1000-grain weight and each of No. of tillers hill^{-1},plant height, No. of panicles hill^{-1}, No. of grains panicle, panicle length and panicle weight. This result indicates that of selection for these traits would be due to increasing heavy 1000-grain weight. Significant positive and highly correlation coefficients were detected between panicle weight and each of No. of tillers hill^{-1},plant height, No. of panicles hill^{-1}, No. of grains panicle and panicle length. This result indicates that of selection for these traits would be

Table 5. Effect of the interaction between irrigation regimes and varieties on growth, yield and its attributes of rice (over the combined analysis)

Treatments		PI	HD	Plant height (cm)	No. of panicles hill^{-1}	No. of tillers m^{-2}	No. of panicles m^{-2}	No. of grains panicle	Biological yield (t fed^{-1})	Grain yield (t fed^{-1})
F	Sakha 104	64.67	100.67	115.00	19.17	482.17	459.83	124.17	9.62	4.35
	Sakha 105	52.17	86.67	102.50	19.17	463.83	454.33	125.00	9.23	4.22
	Sakha 106	52.83	85.33	104.00	21.33	471.50	462.33	131.50	9.78	4.46
	GZ 7576	53.33	88.33	100.67	16.50	451.83	439.83	119.50	8.15	3.73
	Giza 177	61.67	96.33	101.00	17.17	456.67	449.33	123.16	8.86	4.10
S	Sakha 104	62.33	98.33	110.67	17.00	475.67	443.00	121.50	8.83	3.80
	Sakha 105	48.83	84.67	100.17	16.50	456.00	448.67	119.00	8.45	3.68
	Sakha 106	50.67	83.17	101.33	19.00	460.33	457.17	122.00	8.95	3.90
	GZ 7576	51.33	85.67	98.00	14.67	445.33	432.83	115.67	7.67	3.30
	Giza 177	58.83	94.33	99.00	15.83	445.67	442.67	117.83	8.15	3.58
F+S	Sakha 104	61.83	99.83	113.50	19.83	476.33	450.17	124.50	9.32	4.15
	Sakha 105	50.67	84.33	101.67	18.00	462.33	452.33	123.67	8.82	3.98
	Sakha 106	51.33	81.67	103.00	19.33	466.17	462.50	129.33	9.42	4.25
	GZ 7576	50.33	86.17	100.33	15.83	447.33	439.00	119.00	7.97	3.65
	Giza 177	60.33	93.67	100.67	16.83	452.00	446.67	122.33	8.53	3.85
L.S.D at 5%		**0.80**	**0.73**	**0.74**	**0.59**	**1.76**	**1.63**	**1.07**	**0.12**	**0.05**

F= flooding for all season, S= saturation for all season, F+S= flooding up to panicle initiation+saturation for the rest of season

Table 6. Correlation coefficient between grain yield and some its attributes of rice varieties (combined data of the two seasons)

Characters	1	2	3	4	5	6	7	8
Y-Grain yield fed^{-1}	0.822**	0.545**	0.850**	0.809**	0.906**	0.921**	0.739**	0.905**
1- No. of tillers hill^{-1}	1.000	0.567**	0.875**	0.789**	0.862**	0.854**	0.703**	0.844**
2- Plant height		1.000	0.498**	0.349**	0.671**	0.610**	0.556**	0.633**
3- No. of panicles hill^{-1}			1.000	0.810**	0.841**	0.889**	0.771**	0.866**
4- No. of grains panicle				1.000	0.796**	0.828**	0.693**	0.819**
5- Panicle length					1.000	0.912**	0.762**	0.916**
6- Panicle weight						1.000	0.808**	0.946**
7- 1000-grain weight							1.000	0.809**
8- Biological yield fed^{-1}								1.000

Table 7. Water relations and grain yield reduction (%) as affected by irrigation regimes and rice varieties. (Average of two seasons)

Water relations	Irrigation regimes	Rice varieties					Mean
		Sakha 104	Sakha 105	Sakha 106	GZ 7576	Giza 177	
Water applied m^3 fed^{-1}	F	6120	5815	5503	5503	5815	5751.2
	S	4455	4233	4020	4020	4233	4192.2
	F+S	5010	4760	4500	4500	4760	4706.0
Mean		5195	4936	4674	4674	4936	4883.1
Water saved (%)	F	--	--	--	--	--	--
	S	27.20	27.20	26.95	26.95	27.20	27.10
	F+S	18.13	18.14	18.23	18.23	18.14	18.17
Mean		22.67	22.66	22.59	22.59	22.66	22.64
Grain yield reduction (%)	F	--	--	--	--	--	--
	S	12.64	12.80	12.56	11.53	12.68	12.44
	F+S	4.60	5.69	4.71	2.14	6.10	4.65
Mean		8.62	9.25	8.65	6.85	9.39	8.55
Water use efficiency (WUE) kg m^{-3}	F	0.71	0.73	0.81	0.68	0.71	0.73
	S	0.85	0.87	0.97	0.82	0.85	0.87
	F+S	0.83	0.84	0.94	0.81	0.81	0.85
Mean		0.80	0.81	0.91	0.77	0.79	0.82

F= flooding for all season, S= saturation for all season, F+S= flooding up to panicle initiation+saturation for the rest of season

due to increasing panicle weight. Also positive and highly significant relationships were found between panicle length and each of No. of tillers $hill^{-1}$,plant height, No. of panicles $hill^{-1}$ and No. of grains panicle, as well as, between No. of grains panicle and each of No. of tillers $hill^{-1}$,plant height and No. of panicles $hill^{-1}$.

Generally the simple correlation coefficients between each two traits were estimated as well as the association between grain yield fed^{-1} and main yield components gives very useful information for increased production of rice varieties and the plant breeder who wants to incorporate desirable characters.

-Water relationship:

The amount of irrigation water used m^3 fed^{-1} throughout the season, water saved percentage and grain yield reduction as well as water use efficiency are presented in **Table (7)**. Results showed that continuous flooding irrigation for all season (F), continuous flooding irrigation up to panicle initiation+saturation for the rest of season (F+S) and continuous saturation irrigation for all season (S) tended to decrease the amount of water used from 5751.2 to 4706.0 and 4192.2 m^3 fed^{-1}, respectively.

Under F treatment decreased the water used from 6120 to 5503 m^3 fed^{-1} for Sakha 104 and Sakha 106, consequently water was saved by 10.08%. Water saved S and F+S treatments compared to F was 27.10 and 18.17% with corresponding grain yield reduction of 12.44 and 4.65% for S and F+S treatments, respectively. F+S treatment under GZ 7576 genotype saved about 18.23% from water used with only 2.14% reduction in grain yield. The amounts of water saved due to irrigation regimes ranged from 18.13% recorded by F+S treatment under Sakha 104 variety, to 27.20% recorded by S treatment under Sakha 104 and/or Sakha 105 and/or Giza 177 varieties. Concerning water use efficiency (WUE) values for different aspects. Obviously, WUE was the highest by S treatment (**0.87** kg m^{-3}). Regarding the effect of rice varieties on water use efficiency, data observed that increased WUE from 0.77 to 0.91 kg m^{-3} by GZ 7576 genotype and Sakha 106 variety, respectively.

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