J. Plant Production, Mansoura Univ., Vol. 4 (8): 1149 - 1157, 2013

YIELD AND YIELD COMPONENTS OF HYBRID ONE RICE CULTIVAR AS AFFECTED BY IRRIGATION INTERVALS, FERTILIZATION COMBINATIONS AND THEIR INTERACTION

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ABSTRACT

Rice is a very important cereal in Egypt and allover the world. In Egypt, it is a crucial food crop because of shortage in wheat production. Because of water shortage, in Egypt, trials were conducted to find out the effect of water deficit combined with fertilizer combinations on yield and yield components of hybrid one rice cultivar. Two field experiments were carried out at the Experimental Farm of Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt, during 2011 and 2012, rice growing seasons. A split plot design with three replications was used. The main plots were devoted to four irrigation intervals; 3, 6, 9 and 12 days. The sub plots were occupied by seven fertilizer combinations; control (without fertilizer), recommended 100% NPK, 2.10 t/fed. compost, 25 , 50 , 75 , 100 % NPK+ 2.10 t/fed. compost.
All agricultural practices were applied as recommended for rice Hybrid one cultivar. The main results revealed that yield and its components were significantly affected by irrigation intervals. Number of panicles/m² , panicle weight, 1000-grain weight, grain yield (t/fed) and harvest index significantly decreased as irrigation intervals prolonged up to 12 days in both seasons. On the other hand, no significant differences were found between 3-day and 6- day irrigation intervals on yield and yield attributes. The fertilizer combinations had highly significant effect on yield and yield attributes of hybrid one rice cultivar. The highest values of Leaf area index, dry matter weight, plant height, number of panicles/m², panicle weight, 1000-grain weight, grain yield (t/fed) and harvest index were recorded in plots fertilized with full recommended dose of nitrogen (69 kg), phosphorus (15.50 kg) and potassium (24 kg) followed by these fertilized with full dose of NPK without any compost or 75 % recommended dose of NPK + compost. The interaction between irrigation every three days and fertilization with 100 % NPK + compost or 75 % NPK + compost gave the highest values of number of panicles/m², panicle weight,1000-grain weight, grain yield and harvest index.

INTRODUCTION

Rice (*Oryza sativa L*.) is a very important cereal crop in Egypt for consumption and exportation as an important source for foreign currency. Rice productivity is affected by several abiotic factors. Water irrigation and nitrogenous fertilization are abiotic factors affecting rice productivity. Water resources are limited in Egypt, and thus there is a problem to reclaim new lands. So, increase of rice productivity is a main strategy to satisfy the needs of rice consumers. Increasing the intervals between irrigation allows the rice fields to dry for a few days inbetween irrigations. Nour *et al.* (1994), Awad (2001) and El-Refaee *et al*. (2005) found that the grain yield was not affected by irrigation intervals when rice fields are irrigated every four or eight days.

Hybrid rice technology is an innovative breakthrough that can further increase rice production leading to food security in Egypt. Hybrid rice varieties can out-yield conventional modern varieties by 15-30 % even at the same input levels (El-Mowafi *et al.*, 2005 and Abo-Youssef *et al.*, 2005).

Fertilization combinations is crucial to obtain good yield, but the rates of fertilizations should be optimized, and splitting nitrogen fertilizer is an important agronomic practice that minimize losses and increase nitrogen efficiency Abd EL-Wahab *et al.* 2005 , Ebaid and El-Rewainy, 2005 and Gorgy *et al.*, 2011).

The current study aimed to investigate the effect of water stresses and fertilizer combinations on rice yield and components of hybrid one rice cultivar.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, during 2011 and 2012, rice growing seasons to investigate the effect of irrigation intervals and fertilizer combinations on rice yield and yield components of Hybrid one rice cultivar.

A split plot design with three replications was used. The main plots were devoted to four irrigation intervals; 3, 6, 9 and 12 days. The sub plots were occupied by fertilizer combinations; control (without fertilizer), recommended 100% NPK, 2.10 t/fed. Compost, 25, 50, 75 , 100 % NPK+ 2.10 t/fed. Compost each.

The seed bed was ploughed three times, with adding calcium super phosphate (15.50 % P_2o_5) before the third tillage. Then, the seed bed was dry leveled and nitrogen, in the form of urea (46.50% N), was added at a rate of 100 kg N/fed. Nitrogen was divided into two equal doses; the first was added into the dry soil and incorporated just before flooding. The second dose of nitrogen was added 15 days after sowing. The seed bed received zinc sulphate at a rate of 24 kg/fed., and the rice nursery was wet leveled. The rice seeds, previously soaked in water for 24 hours and incubated for additional 24 hours, were sown on May 10th in 2011 and 2012 seasons. The rates of seeds were 10 kg/fed.

The permanent field was prepared by the same way of preparing the nursery. But, the compost was incorporated into the soil before third tillage at a rate of 2.10 t/fed. However, 150 kg nitrogen fertilizer were applied in three splits; 1/3 as basal (incorporated into the soil) just before flooding, 1/3 twenty days after transplanting (about mid- tillering stage) and 1/3 forty days after transplanting. As followed with nursery preparation, calcium super phosphate (15.50 % P_2O_5) at a rate 100 kg/fed. was added before the third tillage. Potassium sulphate (48 % K_2O_5) at a rate 50 kg/fed. was added before the third tillage (first dose) and with the last dose of nitrogen (second dose of potassium) One month after seed sowing, the rice seedlings were pulled out, distributed in the permanent field, and transplanted at 20 **x** 20cm spacing. Five days after flooding, Saturn herbicide was mixed with sand and

broadcasted into the water at a rate of 2 liters/fed. All other cultural practices were undertaken as recommended. Fifteen days after transplanting, treatments of irrigation intervals were carried out. A sample of compost was taken and analyzed to find out its chemical components (Table 1).

Table (1): Some chemical properties of composts rice straw ratio:

C %	N %	C:N Ratio	P %	K %	Fe ppm	Mn ppm	Zn ppm
50.00	1.21	1:41.32	0.37	0.45	4.00	189.00	34.00

Studied Characters;

Plant samples were collected randomly from sub plots to estimate the following characters.

Number of panicles/m^2:

Total number of panicles (productive tillers) in five random hills were counted, and then converted to number of panicles/m^2.

Panicle weight (g):

Average of five weighed panicles was computed, after panicle air drying.

One thousand grain weight (g):

Grain yields (t /fed):

Rice plants of an area of 4m^2 (100 hills) of each experimental plot were manually harvested. The plants were tied, labeled and moved to a floor for air drying for five days. The plants were threshed, and each of rice grain and straw were separately weighed in kilograms and then converted to t/fed.

Harvest index (%):

The harvest index was determined according to Yoshida (1981) by subdividing weight of grain yield (t/fed) (economic yield.) on the total dry weight (weight of grains and straw).

$$\text{Harvest index} = \frac{\text{Economical yield (grain yield)}}{\text{Biological yield (grain+ straw yields)}} \times 100$$

Statistical analysis:

Collected data were subjected to the standard statistical analysis with MSTATC and the differences among the treatments means were compared using Duncans Multiple Range Test at 0.05 p-level (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

1- Effect of irrigation treatments:

Data in Table (2) show the effect of irrigation intervals on rice yield and some yield components. Number of panicles per m^2, panicle weight and 1000-grain weight (Table 2) displayed highly significant differences due to irrigation intervals. Usually, the highest values were detected in plots irrigated every three days, and the lowest values were obtained in plots irrigated every

12 days. No significant differences were found between irrigation every three days and irrigation every six days concerning number of panicle/m² and 1000-grain weight.

Data in Table (2) show that the highest grain yield of rice hybrid one was at 3-day irrigation interval (4.04 and 3.97 t/fed. for two reasons, respectively) followed by that at 6-day (3.44 and 3.39), then at 9-day (2.89 and 2.81), while the lowest grain yield (2.73 and 2.65 t/fed) was obtained at the longest irrigation interval in 2011 and 2012 rice seasons, respectively. The differences were highly significant.

The harvest index took a trend exactly similar to that of grain yield, as the values were greatest at 3-day interval, but lowest at 12-day interval. Some of the current results are in agreement with those of Nour *et al.* (1994) and EL-Refaee *et al.* (2005).

Because of shortage in water requirements in Egypt, rice could be irrigated every six days, instead of three days, to save water. The practice could be recommended if the rice yield was not severely reduced by irrigation every six days. However, this needs an economic study.

2- Fertilizers effect:

Fertilization combinations resulted in highly significant differences within number of panicles/m^2, panicle weight and 1000-grain weight (Table 2).

The greatest numbers of panicles were found in rice plots fertilized with 100% NPK + compost (680 & 672/m^2), followed by those in plots having 100% NPK (679 & 662/m^2), then 75% NPK + compost (663 & 653/m^2) in 2011 and 2012 seasons, respectively. The lowest numbers of panicles were counted in the non-fertilized plots (315 & 338 panicles/m^2), or in the plots fertilized with only compost (404 & 422 panicles/m^2) in the first and second seasons, respectively.

The heaviest panicles (3.65 & 3.60 g/panicle) were found in plots having 100% NPK + compost, followed by those in plots having 100% NPK (3.55 & 3.46). However, the least values (2.52 & 2.45 g) were recorded in the non-fertilized plots, followed by plots having compost (2.70 & 2.70 g) and then, in plots having 25% NPK + compost (3.07 & 3.07 g/panicle) in 2011 and 2012 seasons, respectively. The differences in panicle weight were highly significant affected by fertilizer combinations.

Thousand-grain weight (Table 2) was highest in plots of 100% NPK + compost followed by those in plots having100% NPK. The least values were obtained in the non-fertilized plots, plots of only composts and plots of 25% NPK + compost. The differences in 1000-grain weight were highly significant in both seasons.

Data presented in (Table 2) show the effect of fertilizer combinations on grain yield, and harvest index. The grain yield exhibited highly significant differences due to fertilizer combinations. The greatest values of grain yield were recorded in plots fertilized with 100% NPK + compost followed by those in plots fertilized with 100% NPK, and then 75% NPK + compost. The lowest grain yield were obtained in the non-fertilized plots, or in plots having only compost, and the plots having 25% NPK + compost.

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Differences in harvest indices, due to fertilizer combinations were significant in 2011 season and highly significant in 2012 season. The highest harvest indices (38.10 & 40.07) were calculated in plots fertilized with 75% NPK + compost, followed by those in plots having 100% NPK (38.20 & 39.71), and then, in plots fertilized with 100% NPK + compost (37.10 & 39.76) in the first and second seasons, respectively. The lowest harvest indices were recorded in the non-fertilized plots (35.20 & 35.00) followed by those having only compost, or in plots having 25% NPK compost.

Similar results were found by Ebaid and EL-Rewainy (2005) who indicated that rice cultivars; Giza 178, Sakha 101 and Egyptian Jasmine recorded the highest values of agronomic efficiency at 115 kg N/ha. Also, the obtained results were in agreement with those of Gorgy *et al* (2011) who obtained higher panicle number/hill, panicle weight, number of grains/panicle, 1000-grain weight, grain and straw yields, and harvest index at higher levels of nitrogen.

3- The interaction between irrigation intervals and fertilizer combinations on:

Number of panicles /m²:

Concerning number of panicles /m² (Table 3), the highest values were found in rice plots irrigated every three days and fertilized with 100 % NPK + compost, followed by irrigated every 3-days and fertilized with 100 % NPK (737.33 and 735.33 panicles/m², respectively). The lowest numbers of panicles /m² were recorded in the rice plots irrigated every 12 days without fertilization (298.00 panicles/m²).

Table (3): Effect of interaction between irrigation intervals and fertilization combinations on number of panicles /m² of Hybrid one during 2011 season.

Fertilization combinations	Number of panicles /m² as affected by Irrigation interval			
	3 -day	6 -day	9 -day	12 -day
Control (zero)	324.0 j	326.0 j	313.0 j	298.0 j
100 % N P K (Recommend)	735.3 a	698.0 ab	667.0 bc	618.0 cd
Compost (2.10 t/fed)	448.6 g	441.3 gh	387.6 hi	337.6 ij
25 % NPK+ compost	533.0 ef	519.6 f	509.0 f	495.0 fg
50 % NPK+ compost	602.6 d	591.0 de	533.6 ef	511.3 f
75 % NPK+ compost	728.0 ab	711.3 ab	683.3 ab	531.6 ef
100 %NPK+ compost	737.3 a	709.3 ab	693.6 ab	582.0 de
L S D	55.11			

Means followed by the same letter are not significantly different at the 1 % level.

Grain yield:

Data in Table (4) show that the greatest rice grain yields were obtained from plots irrigated every three days and fertilized with 100% NPK (5.17 & 5.21 t/fed.) for the first and second seasons, respectively. The second rank was obtained in plots irrigated every three days and fertilized with 75% NPK + compost (5.21 & 5.02 t/fed.). However, the lowest grain yields were

recorded in the non-fertilized plots with all irrigation intervals, and in plots irrigated every 12 days with all fertilizer combinations.

Table (4): Effect of interaction between irrigation intervals and fertilization combinations on grain yield of Hybrid one rice cultivar during 2011 and 2012 seasons.

Fertilization combinations	Grain yield (t/fed) as affected by irrigation intervals			
	3 -day	6 -day	9 -day	12 -day
	2011 season			
Control (zero)	2.31 ij	2.12 ij	1.97 jk	1.63 k
100 % NPK (Recommend)	5.17 a	4.03 b	3.25 c-f	3.15 c-g
Compost (2.10 t/fed)	2.85 fgh	2.25 ij	2.21 ij	2.11 ij
25 % NPK+ compost	3.51 cd	3.35 cde	2.77 gh	2.53 hi
50 % NPK+ compost	4.07 b	3.95 b	3.10 d-g	2.98 efg
75 % NPK+ compost	5.21 a	4.23 b	3.41 cd	3.31 cde
100 %NPK+ compost	5.20 a	4.17 b	3.55 c	3.42 cd
L S D	0.374			
	2012 season			
Control (zero)	2.39 h-k	2.09 kl	1.93 l	1.55 m
100 % NPK (Recommend)	5.21 a	3.97 b	3.19 de	3.20 de
Compost (2.10 t/fed)	2.78 fg	2.22 i-l	2.20 j-l	2.07 kl
25 % NPK+ compost	3.45 d	3.37 d	2.56 g-i	2.46 g-j
50 % NPK+ compost	3.98 b	3.81 bc	2.96 ef	2.70 f-h
75 % NPK+ compost	5.02 a	4.11 b	3.33 d	3.21 de
100 %NPK+ compost	4.99 a	4.14 b	3.50 cd	3.36 d
L S D	0.313			

Means followed by the same letter are not significantly different at the 1 % level.

Results of using compost in the current study are in line with those of Gotah *et al* (1985) who proved that using compost resulted in pronounced increases in yield. They attributed yield enhancement to the increases in the availability of nitrogen in the soil which reflected increase in the mineralization of nitrogen in the soil. Similar findings were obtained by Takahashi *et al* (2003) who explained that application of rice straw compost contributed to the improvement of soil fertility and growth promotion.

Conclusion:

From the results of this investigation, it could be concluded that the highest yield was obtained when the rice cultivar hybrid one was irrigated every three (or six days) and fertilized with 100 % NPK (recommended) or 75 % NPK + compost 2.10 (t/ fed).

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تأثير فترات الري ومعدلات مختلفة من التسميد علي المحصول ومكوناته لصنف الأرز هجين مصري واحد

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أجريت تجربتان حقليتان في المزرعة البحثية لمركز البحوث والتدريب في الأرز سخا – كفر الشيخ لدراسة تأثير فترات الري ومعدلات التسميد علي المحصول ومكوناته لصنف الأرز هجين مصري واحد وكان الري كل ٣ , ٦ , ٩, ١٢ يوم وكانت معدلات التسميد هي كنترول (بدون تسميد) , ١٠٠ ٪ من سماد NPK الموصي به , كمبوست بمعدل ٢,١٠ طن/فدان, ٢٥ , ٥٠ , ٧٥ , ١٠٠ ٪ من سماد NPK الموصي به + كمبوست ٢,١٠ طن/فدان.

ويمكن تلخيص النتائج المتحصل عليها فيما يلي

١. أظهرت النتائج وجود فروق معنوية بين معاملات الري المختلفة في معظم صفات المحصول نتيجة تأثرها بمعاملات الري حيث أعطي الري كل ثلاثة أيام أعلي القيم في عدد السنابل /م^2, ووزن السنبلة , ووزن الألف حبة , ومحصول الحبوب والقش وكذلك دليل الحصاد ولم توجد فروق معنوية في معظم الصفات تحت الدراسة بين معاملة الري كل ثلاثة أيام وكل ستة أيام.

٢- أظهرت النتائج وجود فروق معنوية بين معاملات التسميد المختلفة في معظم صفات المحصول حيث سجلت أعلي القيم في عدد السنابل /م^2, ووزن السنبلة , ووزن الألف حبة , ومحصول الحبوب والقش وكذلك دليل الحصاد عند استخدام ١٠٠ ٪ من سمادNPK الموصي به + كمبوست, تلتها المعاملة ١٠٠ ٪ من سماد NPK الموصي به بدون كمبوست ثم المعاملة ٧٥ ٪ من سماد NPK الموصي به + كمبوست , ولم توجد فروق معنوية في معظم الصفات المحصولية تحت الدراسة بين معاملات التسميد الثلاثة السابقة.

٣- كان للتفاعل بين فترات الري ومعاملات التسميد المختلفة أثر معنوي علي معظم صفات المحصول تحت الدراسة حيث أعطي الري كل ثلاثة أيام مع استخدام التسميد بمعدل ١٠٠ ٪ من سماد NPK الموصي به + كمبوست أعلي القيم المتحصل عليها, وتلتها معاملة التسميد ٧٥ ٪ من سماد NPK الموصي به + كمبوست.

التوصية: من النتائج المتحصل عليها خلال الدراسة اتضح أن أعلى محصول لصنف الأرز هجين مصري واحد نتج من المعاملة ١٠٠ ٪ من سماد NPK الموصي به بدون كمبوست ، ثم المعاملة ٧٥ ٪ من سماد NPK الموصي به + كمبوست مع الري كل ثلاثة أيام.

قام بتحكيم البحث

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Table (2): Effect of irrigation intervals and fertilizer combinations on yield and yield components of rice Hybrid one cultivar In the same column, means followed by the same letter are not significantly different at 5% level.

Treatments	No. of panicles/m²		Panicle weight (g)		1000-grain weight (g)		Grain yield (t/fed)		Harvest index	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Irrigation interval										
3 – day	587 a	591 a	3.50 a	3.48 a	25.52 a	26.40 a	4.04 a	3.97 a	40.50 a	41.50 a
6 – day	571 a	577 a	3.25 b	3.15 b	24.44 b	25.70 ab	3.44 b	3.39 b	39.10 a	40.14 ab
9 – day	541 b	532 ab	2.99 c	2.95 bc	22.66 c	24.12 b	2.89 c	2.81 c	34.40 b	36.52 b
12 – day	482 c	482 b	2.87 d	2.82 c	21.77 d	22.03 c	2.73 d	2.65 d	34.30 b	33.27 c
F test	**	*	**	**	**	**	**	**	**	**
Fertilization										
Control (zero)	315 e	338 e	2.52 e	2.45 f	21.99 d	21.73 d	2.01 e	1.99 e	35.20 b	35.00 c
100 % NPK Recommend	679 a	662 a	3.55 a	3.46 ab	24.28 b	25.10 ab	3.90 a	3.89 a	38.20 a	39.17 a
Compost (2.10 t/fed)	404 d	422 d	2.70 d	2.70 e	22.34 d	22.35 d	2.35 d	2.32 d	36.90 ab	36.14 bc
25 % NPK + Compost	514 c	507 c	3.07 c	3.07 d	23.18 c	23.17 c	3.04 c	2.96 c	36.30 ab	37.38 a-c
50 % NPK + Compost	559 b	554 b	3.26 b	3.18 cd	23.45 c	23.45 c	3.52 b	3.36 b	37.80 ab	38.55 ab
75 % NPK + Compost	663 a	653 a	3.33 b	3.36 bc	24.90 a	24.75 b	4.04 a	3.92 a	38.10 ab	40.07 a
100 % NPK + Compost	680 a	672 a	3.65 a	3.60 a	25.05 a	25.92 a	4.08 a	4.00 a	37.10 ab	39.76 a
F test	**	**	**	**	**	**	**	**	*	**
Interaction F test	*	NS	NS	NS	NS	NS	**	**	NS	NS

***, ** and NS indicate P <0.05, P <0.01 and not significant, respectively.**