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Performance of Different Rice Genotypes under Different Dates of Sowing

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ABSTRACT

The present study was carried out at the Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, during 2017 and 2018 rice growing seasons to study the behaviors of four rice genotypes under three dates of sowing. These rice genotypes were the new Egyptian red rice line NRL 54, Giza 177, Giza 178 and Black rice. The results showed that rice plants sown on May 1st or May 15th surpassed those sown on the late date of sowing (May 30th) in days to heading, plant height, number of tillers/plant, number of panicles/plant, panicle length, panicle weight and grain yield per hectare. While, rice plants sown on May 15th or May 1st surpassed those sown on the late date of sowing (May 30th) in thousand grain weight, number of filled grains/panicle and number of spikelets/panicle. Plants of promising line NRL 54 produced the highest grain yield in the two seasons. While, Black rice variety produced the lowest grain yield in the two seasons. It can be concluded that the first two dates of sowing (1st May and 15th May) were the most suitable dates of sowing. While, the promising rice line NRL 54 can be sown on May 30th without yield reduction. The line NRL 54 is more tolerant to delay in sowing date than Black rice variety. Generally, the rice line NRL 54 could be recommended to be sown from May 1st to May 30th. The tolerance of NRL 54 to late sowing gives it an advantage for time isolation.

***Keywords**:* red rice, sowing dates, grain yield, yield and its attributes, *Oryza sativa* L.

INTRODUCTION

Rice plays an important economic role, being the staple food and the main source of income for many people in agricultural countries, Phan et al. (2018). Rice is one of the most important crops in Egypt. Therefore, several research studies have been conducted to study the effect of sowing dates on rice productivity, Abou khalifa and Awad-allah (2016).

Nowadays, special rices are required to be disseminated to satisfy the needs to high nutritional rice value. From these are Black rice and colored rice. From the colored rice, a genotype was named as red rice in some countries, Masni and Wasli (2019). Cultivated red rice genotype is completely different from the weedy genotype, Masni and Wasli (2019).

Red rice is a source of carbohydrates, proteins, beta-carotene, antioxidants and irons, Becker and Frei (2004) and Ratih Sandrakirana (2016). Global demand for healthy food and high-quality rice has increased recently.

Red rice consumption has increased due to its health benefits. Red rice has met the concepts of productivity and quality that emerged to supply the demands for products that improve the eating pattern of consumers. some food industries are based on red rice, particularly for nutritive food products and baby food products, Masni and Wasli (2019). Antioxidants are the most important properties of red rice. It is used in making breads, colored pasta, vinegar, drugs, and cosmetics, Patindol *et al*. (2006). Procyanidins are the main compounds with antioxidant activity of red rice, Oko *et al.* (2012). As in Malaysia, the limited domestic production of red rice depends on the supply of imported red rice in the country, Masni and Wasli (2019).

The potentiality of different rice varieties varies greatly due to cultivation at different dates, Ganajaxi *et al.* (2001). Also, the optimum time for planting is a major factor in rice productivity. By knowing it, we can indirectly determine the soil temperature and weather conditions appropriate for rice during different stages of development, Ashrafuzzaman *et al.* (2009). A better knowledge of the genetic behavior of rice genotypes under different sowing dates would help to classify and identify varieties that would be grown successfully under late sowing dates. The objective of the present investigation was to study the optimum planting date and genetic behavior of four rice varieties and lines under three sowing dates through the studied characters.

MATERIALS AND METHODS

A field experiment was conducted in 2017 and 2018 seasons at the Farm of Sakha Agricultural Research Station, Kafr El-sheikh, Egypt to study the performance of four rice genotypes, namely; Giza 177, Giza 178, Black rice and NRL 54. NRL 54 is one of developed special rice.

There are two types of this line, colored (red) and white. The white type was cultivated in this experiment along with other genotypes. These four genotypes were sown at three sowing dates, May 1st, May 15th and May 30th. This aimed to investigate the performance of these genotypes under three sowing dates.

The soil of the nurseries was well prepared and fertilized with N, P and K fertilizers as recommended and

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regularly irrigated. The slight wet leveling was done and the pre-germinated seeds were broadcasted. Zinc sulphate was applied immediately before seed broadcasting (seeds were soaked 24 hr and incubated 48 hr). The herbicide, Saturn 50% was applied after 4 days from broadcasting the seeds to control the weeds as recommended RRTC (2011).

The permanent filed area was identified and well prepared, fertilized with single super phosphate (15% P_2O_5) at the rate of 36 P_2O_5/ha, potassium sulphate (48% K_2O) at the rate of 57 K_2O/ha and nitrogen fertilizer in the form of urea (46.5%N) at the rate of 165 kg N/ha for each date of sowing and immediately irrigated. The slight wet leveling was done in each sub-plot. The sub-sub plot size was 15 m^2 (3×5) and the weeds were chemically controlled using Saturn 50% after transplanting as recommended in the three dates of sowing under study in the two seasons.

The randomized complete block design (RCBD) with three replications for sowing date separately.

Monthly temperature is shown in Table 1 according to Sakha Meteorological Station.

Table 1. Mean temperature (maximum and minimum) starting from May, 1 up to October, 30 during 2017 and 2018.

Month	Temperature (^{o}c)			
	2017		2018	
	Max.	Min.	Max.	Min.
May	30.6	25.8	31.2	23.8
June	32.5	28.1	32.6	25.3
July	34.2	29.0	34.2	25.4
August	33.9	28.3	33.9	25.2
September	32.5	25.9	32.8	23.5
October	28.7	24.0	29.5	20.6

Studied characters:

A. Growth characters:

1- Days to heading: determined as number of days from date of sowing up to 50% heading of plants in each plot.

2- Plant height (cm): length of the tallest plant measured from soil surface to the tip of the panicle at maturity.

3- Number of tillers/plant: Five plants were randomly selected from each plot. The number of tillers was counted and the average number of tillers / plant was recorded at harvest.

B-Yield and its attributes:

1- **Number of panicles/plant:** Number of panicles at harvest was counted in five plants, and then the average number per plant was computed.

2- **panicle length (cm)** was measured from the base of panicle up to the tip of the main panicle at complete maturity.

3- **Number of spikelets/panicle:** five panicles were randomly selected from each sub plot and number of spikelets were counted and the average number of spikelets/panicle was calculated.

4- **Panicle weight (g):** the main panicles of five plants were randomly selected from each sub plot and average of panicle weight was calculated.

5- **Spikelet fertility (%):** From each plot, five main panicles were randomly selected before harvesting. Number of filled spikelets were isolated from the total spikelets and the ratio of fertile spikelets (filled grains) were counted and the rest were sterile. Spikelet fertility was calculated according to the following equation :

$$\text{Spikelets fertility (\%)} = \frac{\text{No. of fertile spikelets per panicle}}{\text{No. of total spikelets per panicle}} \times 100$$

6- **Number of filled grains per panicle:** five panicles were randomly selected from each sub plot and number of filled grains per panicle were counted and the average per panicle was calculated.

7- **One thousand grain weight (g):** Weight of one thousand of rough grains was estimated in sub plot after harvesting in grams.

8- **Grain yield (t/ha):** Ten square meters from the center of each plot were manually harvested, then gathered in bundles and left in the field for air dry. The weight of each bundle was recorded (grains + straw). Then, the air dried bundles were mechanically threshed and grain weight per 10 m^2 was recorded. The moisture content was adjusted to 14% moisture using portable moisture meter according to Yoshida (1981). The weight of grain yield were transformed to tons per hectare.

C-Grain quality characters:

Hulling percentage, milling percentage and head rice percentage were estimated according to Adair (1952), using the following equations :

$$\text{Hulling (\%)} = \frac{\text{Brown rice Wt.}}{\text{Rough rice Wt.}} \times 100$$

$$\text{Milling (\%)} = \frac{\text{Milled rice Wt.}}{\text{Rough rice Wt.}} \times 100$$

$$\text{Head rice (\%)} = \frac{\text{Head rice Wt.}}{\text{Rough rice Wt.}} \times 100$$

Statistical analysis:

The obtained data were subjected to analyses of variance according to randomized complete block design (RCBD) with three replications for each sowing date, then the combined analysis among sowing dates was performed to obtain the effect of interaction between sowing dates and rice genotypes, according to Gomez and Gomez (1984). All statistical analyses were performed using "MSTATC" computer software package according to Russell (1986).

RESULTS AND DISCUSSION

A. Growth characters:

1- Days to heading:

Days to heading of rice plants as affected by sowing dates, genotypes and their interaction in 2017 and 2018 seasons are presented in Table 2. Data indicated that days to heading reached to the maximum when the tested genotypes were cultivated on May 1st followed by May 15th, while sowing at May 30th gave the lowest value. Because of the rice plants is short day plants, so rice sowing on long days cause an increase of days to heading. On the other side, rice sowing under short days reduced its duration (number of days to heading). The results were in the same trend in the two studied seasons. The previous results are in close agreement with those obtained by Ningaraju *et al.* (2015), Metwally *et al.* (2016) and Mervat Osman (2019). Plant development depends on temperature and requires a specific amount of heat to develop from one point to another in its life cycle. Temperature is a key factor in the timing of biological processes, and hence the growth and development of plants, Parthasarathi and Jeyakumar (2013). Higher air temperature (maximum and minimum) and lower diurnal variation in temperature are more suitable for early heading in rice varieties, Sridevi and Chellamuthu (2015).

The rice genotypes under study revealed a significant difference on days to heading in the two seasons. Plants of Black rice variety recorded the lowest values of days to heading in the two seasons. While, plants of Giza 178 variety recorded the highest values in the two seasons. As for varietal differences in their number of days to heading, data revealed that Giza 178 rice cultivar gave highest number of days from sowing to heading and came in the first rank followed by NRL 54 rice line, Giza 177 and black rice variety, which came in the second, third and fourth rank, respectively, in the two seasons. It could be attributed to the differences in their genetic structure. These results are similar to those obtained by Ningaraju *et al.* (2015) and Mervat Osman (2019).

Table 2. Number of days to heading, plant height and number of tillers/plant of some rice genotypes as affected by sowing dates in 2017 and 2018 rice seasons

Characters	Days to heading (day)		Plant height (cm)		No. of tillers/plant	
Treatments	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Sowing dates (S)						
May, 1	94.40a	93.040a	108.40a	107.70a	19.85a	19.97a
May, 15	92.05b	90.80b	105.90b	107.10a	18.83b	18.61b
May, 30	90.68c	89.59c	100.40c	102.30b	17.96c	16.43c
L.S.D at 5%	0.64	0.51	1.10	1.21	0.30	0.40
Rice genotypes (G)						
Giza 177	92.02c	90.44c	98.63b	101.50b	18.72b	18.30c
Giza 178	97.52a	95.89a	97.67b	97.08d	22.83a	21.89a
Black rice	84.73d	84.08d	98.90b	99.11c	15.02c	14.49d
NRL 54	95.23b	94.17b	124.40a	125.20a	18.94b	18.65b
L.S.D at 5%	0.68	0.52	1.63	1.47	0.56	0.35
Interaction						
S x G	**	**	**	**	**	**

Number of days from sowing up to heading as affected by the interaction between the tested rice genotypes and heading dates is presented in Table 3. Data revealed that combination of each of the tested genotypes under study with the first date of sowing (May 1st) surpassed both the second and third dates of sowing when combined with the same tested genotypes. The best combination was detected when Giza 178 rice cultivar was sown on May 1st followed by May 15th and May 30th. On contrast, the lowest number of days from sowing to heading was found when black rice variety was sown on May 30th. The other combinations came in between. It can be observed that the duration of black rice was strongly reduced under the last date of sowing (May 30th). The differences in the durations among the tested genotypes under the three dates of sowing under study might be due to genetic background. The previous results are in agreement with those obtained by Ningaraju *et al*. (2015) and Mervat Osman (2019). The growth period showed an increasing trend for early planting dates and a lower trend for late planting dates, Maiti and Sen (2003).

2- Plant height (cm) :

Plant height of the rice genotypes as affected by sowing dates, genotypes and their interaction in 2017 and 2018 seasons are presented in Table 2. Sowing date significantly influenced plant height in the two studied seasons. Rice plants sown on either May 1st or May 15th were taller than those sown on the latest date (May 30th) in the two studied seasons. There were significant differences between sowing at May 1st and May 15th in plant height. It might be due to the exposure of the genotypes to the same climatic condition under the two first dates of sowing.

These findings are in agreement with those reported by Metwally *et al.* (2012) and Mervat Osman (2019). This might be due to the longer vegetative growth stage, which leads to increase the height. The length of the vegetative phase of rice has gradually decreased due to the delay in the date of planting, which led to a decrease in the height of the plant. The studied genotypes revealed significant differences in plant height in the two seasons. Plants of NRL 54 rice restorer line recorded the greatest height. While, plants of Giza 178 variety recorded the lowest ones in the two seasons.

Data in Table 3 clarified that the combinations for each of the tested genotypes with each of different dates of sowing under study tended to cause decreases in plant height under medium and late dates of sowing, except Giza 177 rice variety which gave the tallest plant when combined with medium date of sowing (May 15th). It might be due to the suitability of temperature to that cultivar Giza 177 on May 15th date of sowing for the cell division and elongation, consequently increase the height of Giza 177 compared to other genotypes. The combinations of the other genotypes with the three sowing dates caused a decrease in plant height under medium and late sowing because of the change in the temperature under the different dates of sowing, which cause a reduction in plant height under late sowing because of unsuitable temperature during the vegetative growth stage of Giza 178, Black rice and NRL 54. These findings agree with those reported by Ashrafuzzaman *et al*. (2009) and Bashir *et al*. (2010). Variations in plant height between different rice genotypes under different sowing dates were also obtained by Khavse *et al.* (2015) and Metwally *et al.* (2016).

Table 3. Number of days to heading, plant height and number of tillers/plant as influenced by the interaction between sowing dates and rice genotypes in 2017 and 2018 seasons

Genotype	Days to heading (day)						Plant height (cm)						Number of tellers/plant					
	2017			2018			2017			2018			2017			2018		
	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30
Giza 177	93.67e	92.03f	90.37g	91.67d	90.33e	89.33f	99.6d	102.3c	94.0e	98.0d	106.5c	99.9d	18.4d	19d	18.8d	19.5d	18.4e	17.0f
Giza 178	99.67a	96.03bc	96.87b	98.33a	94.67b	94.67b	103.0c	99.0d	91.0f	99.8d	100.0d	91.4f	24.3a	22.4b	21.8b	24.0a	22.1b	19.6d
Black rice	88.03h	85.03i	81.11j	87.07g	84.10h	81.07i	104.3c	98.3d	94.1e	105.5c	97.6d	94.2e	16.4e	15.3f	13.4g	16.0g	14.9h	12.6i
NRL 54	96.23bc	95.10cd	94.37de	95.10b	94.10bc	93.30c	126.5a	124.2b	122.4b	127.6a	124.2b	123.6b	20.3c	18.7d	17.8d	20.4c	19.1d	16.5fg

3. -Number of tillers/plant:

Number of tillers/plant of the tested rice genotypes as affected by sowing dates, rice genotypes and their interaction in 2017 and 2018 seasons are presented in Table 2. Sowing dates substantially influenced number of tillers/plant in the two seasons. Number of tillers/plant reached to the maximum under May 1st, followed by May 15th, while rice cultivated on May 30th significantly decreased in number of tillers/plant. It might be due to the unsuitable climatic condition specially temperature during vegetative stage when rice was cultivated on May 30th (latest date under study). These finding are in agreement with those of Metwally *et al.* (2016) and Mervat Osman (2019). High temperature provides more rice tiller buds, while, increases number of tillers per plant. Optimum temperature for rice tillering is 25-31ºC. The rice tillering rate increases as the temperature increases, Sridevi and Chellamuthu (2015).

Data in Table 2 indicated that there were significant differences among the tested genotypes in number of tillers/plant in the two studied seasons. Giza 178 cultivar produced the greatest number of tillers/plant followed by NRL 54 rice line in the two seasons. On contrast, Giza 177 gave lower tillers, while, Black rice gave the least tillers per plant. These differences could be attributed to the differences in genotype genetic structure. These findings are in agreement with those of Bashir *et al*. (2010) and Metwally *et al*. (2016).

The interaction between sowing dates and rice genotypes in number of tillers/plant during 2017 and 2018 is presented in Table 3. Data clarified that number of tillers/plant for each of the tested genotypes tended to decrease under May 15th and the latest date of sowing (May 30th) compared with early sowing date (May 1st) when combined with the same tested varieties in the two seasons. This could be attributed to the changes in climatic conditions, specially temperature during the vegetative stage under the different dates of sowing specially the date of May 30th. This because the vegetative growth stage is exposed to the high temperature in June and July, as the temperature ranged between 35 and 40 ˚C that cause a decrease in number of cell division and its elongation. The previous results are in agreement with those obtained by Metwally *et al*. (2012).

B-Yield and its attributes:

1- Number of panicles/plant:

Panicle number/plant of the tested rice genotypes as affected by sowing dates, genotypes and their interaction in 2017 and 2018 seasons are presented in Table 4. Sowing dates substantially influenced panicle number/plant in the two seasons. Rice genotypes sown on the first date (May 1st) and second date (May 15th) produced more panicle number/plant than those sown on the third date which gave the lowest values in this respect in the two studied seasons. These findings are similar to those reported by Bashir *et al*. (2010) and Metwally *et al.* (2012).

The tested rice genotypes significantly varied in panicle number/plant in the two seasons. Giza 178 rice variety produced the highest number of panicles/plant followed by Giza 177 variety, while Black rice variety gave the least panicles per plant in the two studied seasons. The increases in panicle number/plant may be due to increase in tiller number/plant. The interaction between sowing dates and rice genotypes had a significant effect on panicle number/plant in the two seasons (Table 5). Data revealed that combination of each the tested rice genotypes under study with first date (May 1st) surpassed both the second and the third dates of sowing when combined with the same genotypes in number of panicles/plant, except Giza 177. This variety responded more and gave higher number of panicles/plant when cultivated on May 15th in the two studied seasons. The greatest panicle number/plant was obtained by sowing Giza 178 variety on the first date in the two seasons. The lowest panicle number/plant was obtained by found with Black rice variety on the late sowing date in the first and second seasons. The increase in number of panicle/plant for all the tested genotypes under study might be due to the suitable climatic conditions (temperature, relative humidity, number of hours/day and solar radiation) during the different stages of rice, which led to cause an increase in the growth of tillers and panicle primordial initiation, consequently increase number of panicles/plant when the tested genotypes are cultivated during May 1st and May 15th.

Dawadi and Chaudhary (2013) found highly significant number of panicles per meter^2 in early sowing and attributed it to suitable environmental conditions which enabled the plant to improve its growth and development as compared to late sowing dates.

2- Panicle length (cm);

Panicle length of tested rice genotypes as affected by sowing dates, genotypes and their interaction in 2017 and 2018 seasons is presented in Table 4. Sowing dates significantly influenced panicle length in the two seasons. Rice genotypes which sown on May 1st or May 15th produced taller panicles than those sown on the late date of sowing (May 30th) in the two studied seasons. These findings are in agreement with those reported by Metwally *et al*. (2012) and Mervat Osman (2019). Data in the same Table showed that NRL 54 red rice line recorded the highest value of panicle length followed by Giza 178 variety, while Black rice variety recorded the least length of panicle in the two seasons.

Data in Table 5 indicated that combination of rice genotypes with the two first dates of sowing (May 1st and

May 15th) in the length of panicle surpassed May 30th when combined with the same varieties in the two studied seasons. The tallest panicle was found when NRL 54 promising line combined with both May 1st and May 15th without any significant between them, followed by Giza 177 rice variety when combined with the same two dates of sowing (May 1st and May 15th). On the other side, the lowest length of panicle was observed when Black rice cultivated under May 30th. It can be easily observed that there was not any significant differences between the first and second date of sowing when each of the variety was combined with each of the studied date of sowing in the two studied seasons. It could be attributed to the suitable climatic conditions for the growth of panicles under the period of May 1st up to May 15th only then tended to decrease under May 30th.

3- Panicle weight (g);

Data in Table 4 clarified that the weight of panicle tended to decrease under medium and late date of sowing; May 15th and May 30th. The heavier panicles were found under May 1st followed by May 15th while May 30th caused a reduction in weight of panicle. It might be due to the low temperature during the grain filling process as a result to a decrease in photosynthesis and its products (assimilates) when rice is cultivated on late sowing (May 30th). As for varietal differences, data in the same Table (4) indicated that NRL 54 promising line produced the highest weight of panicle followed by Black rice, while Giza 177 gave the least and Giza 178 came in between. It might be due to the differences in their genetic structure. Similar trend was found by Nahar *et al*. (2009).

The interaction between the tested rice genotypes and different dates of sowing in panicle weight in 2017 and 2018 rice seasons is presented in Table 5. Data clarified that cultivation the of genotypes under the first date of sowing (May 1st) surpassed the other dates of sowing and gave the greatest values of the weight of panicle, except Black rice which gave its heavier panicle under May 15th in the two studied seasons. The greatest weight of panicle was obtained when NRL 54 promising line was cultivated on May 1st followed by May 15th. On contrast, the lowest weight of panicle was found when both Giza 177 and Giza 178 rice varieties were cultivated on May 30th. The increase in the weight of panicle when the tested genotypes were cultivated on May 1st and May 15th might be due to the suitable climatic conditions at the period which caused an increase in their growth and photosynthesis with its adequate amount of products (metabolites or amulets) that are translocated to the panicle and completely fill most of spikelets consequently increased weight of panicle per plant. These findings are similar with those reported by Mervat Osman (2019).

Table 4 . Yield and its attributes of some rice genotypes as affected by sowing dates in 2017 and 2018 rice seasons

Treatments	No. Of panicles /plant		Panicle length (cm)		Panicle weight (g)		No. Of spikelets/panicle		Fertility (%)		No. of filled grains panicle		1000-grain Weight (g)		Grain yield (t/ha)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Sowing dates (S)																
May, 1	18.28a	17.86a	24.10a	23.69a	4.74a	4.81a	184.8b	182.5b	91.72c	91.31c	169.3b	166.3b	24.91b	25.32a	10.06a	10.43a
May, 15	17.34b	16.90b	23.87a	23.51a	4.38b	4.41b	190.7a	190.7a	94.66a	95.03a	180.1a	181.6a	25.82a	25.47a	9.83a	9.92b
May, 30	16.32c	15.90c	20.90b	22.40b	3.60c	3.71c	167.4c	164.8c	92.59b	93.17b	154.0c	152.5c	25.40ab	24.20b	8.76b	8.36c
L.S.D at 5%	0.29	0.17	0.39	0.51	0.11	0.26	3.25	5.12	0.7	0.67	4.21	5.44	0.82	0.20	0.69	0.27
Rice genotypes (G)																
Giza 177	17.13b	16.71b	22.32c	22.36c	3.92c	3.28d	134.5d	133.6d	94.52a	94.65a	127.0d	127.6d	28.58a	28.59a	9.97c	9.94c
Giza 178	21.43a	20.91a	23.55b	23.91b	3.49bc	3.53c	182.2b	184.2b	92.57c	93.99b	168.7b	172.9b	21.04d	20.21d	10.37b	10.46b
Black rice	14.27d	13.82c	19.72d	19.96d	3.62b	3.90b	157.0c	152.4c	93.48b	93.19c	146.9c	142.1c	24.76c	24.17c	5.63d	5.29d
NRL 54	16.42c	16.10b	26.24a	26.56a	6.56a	6.52a	250.1a	247.2a	91.4d	90.84d	228.6a	224.6a	27.12b	27.01b	12.24a	12.18a
L.S.D at 5%	0.54	0.56	0.40	0.38	0.25	0.23	3.60	3.35	0.59	0.65	3.91	4.28	0.92	0.25	0.41	0.28
Interaction S x G	**	**	**	**	**	**	**	**	**	**	**	**	*	**	**	**

Table 5. Number of panicles/plant, panicle length and Panicle weight as influenced by the interaction between sowing dates and rice genotypes in 2017 and 2018 seasons

Genotype	No. of panicles/plant						Panicle length (cm)						Panicle weight (g)					
	2017			2018			2017			2018			2017			2018		
	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30
Giza 177	16.7d	17.8c	16.9cd	16.4cd	17.4c	16.3cd	23.27d	22.86d	20.82f	22.61d	22.17d	22.31d	3.64e	3.43e	2.80f	3.65e	3.34ef	2.86g
Giza 178	22.7a	21.1b	205.0b	22.3a	20.6b	19.9b	24.27bc	24.34b	22.03e	24.24c	23.81c	23.68c	4.25e	3.41e	2.82f	4.27d	3.42ef	2.92g
Black rice	15.2ef	14.4f	12.6g	15.2d	14.0e	12.3f	20.95f	20.97f	17.25g	20.67e	21.02e	18.2f	3.72e	4.18d	2.95f	4.17d	4.40d	3.15fg
NRL 54	18.0c	16.0de	15.2ef	17.6c	15.6d	15.1d	27.90a	27.31.a	23.5cd	27.26a	27.02a	25.39b	7.34a	6.52b	5.83c	7.17a	6.48b	5.90c

4- Number of spikelets/panicle;

Number of spikelets per panicle of rice genotypes as influenced by three dates of sowing namely May 1st, May 15th and May 30th is presented in Table 4. Data revealed that cultivation the tested genotypes on May 15th produced the greatest number of spikelets and came in the first rank followed by May 1st, while cultivation rice on May 30th gave the lowest number of spikelets. It might be due to the optimum climatic conditions during flowering period which gave also the tallest panicle (panicle length in Table 6). These results are similar to those obtained by Bashir *et al.* (2010) and Mervat Osman (2019).

As for varietal differences in number of spikelets, data in the same table indicated that NRL 54 rice line gave the highest number of spikelets followed by Giza 178 rice variety, while Giza 177 variety gave the lowest values in this respect in the two studied seasons. This could be attributed to genetic background.

Regarding to the interaction between the tested rice genotypes and different dates of sowing in Table 6, data showed that combination between genotypes under study with the date of May 15th surpassed the other two studied dates and produced the highest number of spikelets, except Giza 178 which gave its highest number of spikelets when combined with May first. It might be due to the suitable temperature and number of hours per day with other climatic conditions during reproductive stage which cause an increase in panicle length consequently increase number of spikelets /panicle. The highest number of spikelets were found when NRL 54 rice line was cultivated under the three dates of sowing followed by Giza 178 when combined with the first date of sowing (May 1st). On the other hand, the lowest number of spikelets was observed when Black rice was cultivated under either May 1st or May 30th. It means that Black rice is sensitive to both day length and temperature. It can be easily observed that the optimum date of sowing was May 15th due to its sensitivity to day length. These findings agree with those obtained by Mervat Osman (2019).

5- Spikelets fertility (%) :

Fertility percentage, number of filled grains/panicle, 1000-grain weight and grain yield (t/ha) of the rice genotypes are presented in Table 4. Data showed that the genotypes sown on May 15th produced the greatest fertility percentage followed by May 30th while May first gave the least fertility percentage in the two studied seasons. The increase in fertility percentage under May 15th might be due to the suitable temperature and day length through the different stags of rice that resulted in optimum growth and enhanced in photosynthesis and its products with adequate amount of metabolites which fill most of the high number of spikelets. In other words, sterility decrease by May 30th. While, on May first the trend tended towards the opposite way. These results are similar to those obtained by Khavse *et al*. (2015) and Metwally *et al*. (2016).

As for the varietal differences, data in the same table indicated that Giza 177 variety produced the greatest fertility percentage followed by Black rice variety because of the low number of spikelets with component enough of metabolites, so the most of spikelets were completely filled. The other tested varieties came in between. These findings are similar with those reported by Nessrin Abd El-hamed (2009) and Mervat Osman (2019). Among the climatic factors that affected the fertility of rice spikelets, in addition to the grain yield, the main factor is air temperature, Chuan-gen *et al.* (2007).

Regarding to the interaction between genotypes and dates of sowing in 2017 and 2018 rice seasons, data in Table 6 revealed that combination of Giza 177 variety with May 30th and Giza 178 variety with May 15th produced the highest fertility percentage followed by Giza 177 and Black rice varieties when combined with May 15th. On contrast, the lowest fertility percentage was found when NRL 54 rice line was combined with May 30th. It may be due to that NRL 54 produced a huge amount of spikelets with less amount of metabolites due to low temperature and short day which cause a decrease in photosynthesis and its metabolites. These findings are in agreement with those reported by Khavse *et al.* (2015), Metwally *et al.* (2016) and Mervat Osman (2019).

6- Number of filled grains per panicle:

Number of filled grains per panicle of the tested rice genotypes as affected by different dates of sowing is presented in Table 4. Data indicated that cultivation the genotypes under study on May 15th was the best date of sowing gave the greatest number of filled grains / panicle, followed by May first, while sowing date of May 30th gave the lowest number of filled grains / panicle and came in the last rank in the two studied seasons. It might be due to the suitable temperature through the different stages of rice specially during filling period which the maximum temperature was 33.9°C and the minimum was 28.3°C. So, the date of sowing (May 15th) is best which came an increase in both filling rate and percentage consequently increase the number of filled grains / panicle. These results are agreement by Metwally *et al*. (2012) and Mervat Osman (2019). Regarding to the varietal differences in number of filled grains/panicle, data in the same table showed that NRL 54 promising line produced the greatest number of filled grains/panicle, followed by Giza 178 rice variety, while Black rice and Giza 177 variety came in the last rank. This could be attributed to the differences in the genetic structure. Variation in number of filled grains/panicle among different rice genotypes under different sowing dates was also found by Metwally *et al.* (2012) and Mervat Osman (2019).

Number of filled grains/panicle as affected by the interaction between rice genotypes and dates of sowing is presented in Table 6. Data indicated that combination of each of the tested rice varieties sown on May 15th produced the highest number of filled grains/panicle followed by May first when combined with the same varieties. On the other side, combination of each of the varieties under study with May 30th gave the lowest values in this respect in the two studied seasons, except Giza 178 variety which gave the highest number of filled grains/panicle under either May 1st or May 15th, while under May 30th gave fewer filled grains. The highest number of filled grains/panicle was found when NRL 54 rice line was sown on May 15th followed by May 1st, while gave its low number of filled grains/panicle when sown on May 30th. On contrast, the lowest number of filled grains/panicle was observed when Giza 177 variety was combined sown on May 30th. The other combinations came in between. The increases in number of filled grains/panicle when the tested genotypes, specially NRL 54 rice line, might be due to the suitable climatic conditions specially temperature (see Table 6) with the effect of the tested dates of sowing in number of filled grains / panicle.

7- One thousand grain weight (g):

Data in Table 4 revealed that 1000-grain weight was significantly affected by the different dates of sowing under study. The date of May 15th produced the greatest 1000- grain weight, followed by May 1st, while the date of May 30th gave the lowest. The increases in 1000- grain weight might be due to the suitable climatic conditions which caused an increase in plant growth (plant canopy) as a result to the increase in photosynthesis and its product (metabolites). The great amount of metabolite translocation to the panicles and completely fill the spikelets consequently increase weight of 1000-grain. Similar trend was found by Nahar *et al*. (2009) and Bashir *et al*. (2010). Concerning to varietal differences in 1000-grain weight, data in the same table indicated that Giza 177 variety produced the greatest weight of 1000-grain followed by NRL 54 promising line. On the other hand, the lowest value of 1000-grain weight was observed with Giza 178 rice variety. This could be ascribed to the differences in the genetic structure of the genotypes under study.

Data in Table 7 showed significant differences in 1000-grain weight due to the interaction between the rice genotypes under study and the tested dates of sowing. Both Giza 177 variety and NRL 54 rice promising line produced the highest 1000-grain weight when sown on the three dates of sowing without any significant differences between them. Also, Black rice variety gave the same value when sown on May 15th followed by the same variety when sown on May 30th. On the other hand, the lowest 1000-grain weight was found when Giza 178 variety was sown on May 15th in the first season of study. Similar trend was found by Nessrin Abd El-hamed (2009) and Bashir *et al*. (2010).

Table 6 . Number of spikelets/panicle, spikelet fertility percentage and number of filled grains panicle as influenced by the interaction between sowing dates and rice genotypes in 2017 and 2018 seasons

Genotype	No. Of spikelets/panicle						Spikelet fertility (%)						No. of filled grains panicle					
	2017			2018			2017			2018			2017			2018		
	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30
Giza 177	138.9f	147.5e	117.2g	135.4f	142.5f	122.8g	91.17fg	95.35bc	97.05a	90.92de	95.98b	97.04ab	126.6f	140.7e	113.8g	123.1fg	140.5e	119.2g
Giza 178	202.6b	189.8c	154.2e	207.6b	190.2c	154.8e	90.0h	96.05ab	91.61ef	89.87ef	98.16a	93.96c	182.4c	182.3c	141.2e	186.6c	186.7c	145.5e
Black rice	148.5e	172.3d	150.3e	140.5f	180.1d	136.5f	94.0d	95cd	91.43ef	93.42c	94.15c	92.00d	139.6e	163.7d	137.4e	131.3f	169.5d	125.6fg
NRL 54	249.4a	253.2a	247.8a	246.4a	249.8a	245.3a	91.68ef	92.24e	90.27gh	91.00d	91.83d	89.67f	228.6ab	233.6a	223.7b	224.3ab	229.5a	220.0b

Table 7. One thousand grain weight and grain yield/plant as influenced by the interaction between sowing dates and rice genotypes in 2017 and 2018 seasons

Genotype	1000-grain weight (g)						Grain yield/plant					
	2017			2018			2017			2018		
	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30
Giza 177	28.36a	29.01a	28.38a	28.55ab	28.93a	28.29b	10.21c	10.25c	9.44d	10.53d	10.34d	8.97e
Giza 178	21.36cd	20.46d	21.30cd	20.56f	20.406f	19.6g	10.23c	11.89b	9.00d	11.24c	11.07c	9.08e
Black rice	22.67c	26.59ab	25.00b	25.00d	25.40d	22.1e	6.77e	5.12f	5.00f	6.83f	4.95g	4.09h
NRL 54	27.23ab	27.19ab	26.90ab	27.15c	27.07c	26.81c	13.04a	12.07b	11.59b	13.12a	12.11b	11.31c

8- Grain yield (t/ha):

Grain yield of different rice genotypes as influenced by various dates of sowing is presented in Table 4. Data indicated that the two first dates (May 1st and May 15th) gave the greatest grain yield, while May 30th gave the lowest value in this respect in the two studied seasons. The increases in grain yield when the tested rice was sown on either May 1st or May 15th could be attributed to the suitable climatic conditions through the different stages of the tested rice genotypes specially temperature which ranged between 30.6 up to 33.9 through May 1st up to August, 30th (See Table 1) resulted in increase the other yield components as number of panicles, panicle length, panicle weight, number of filled grains/panicle and 1000-grain weight, consequently increase grain yield. On the contrast, the decrease in grain yield when cultivation the tested rice genotypes at May 30th might be due to the decrease in the mean temperature which ranged between 32.5°C up to 28.7°C through September and October months (see Table 1). At that time, the photosynthesis and its products (metabolite or assimilates) tended to decrease resulted in a reduction in filling consequently decrease in grain yield. Similar results was obtained by Bashir *et al*. (2010), Metwally *et al*. (2016) and Mervat Osman (2019).

High yield in early sowing was ascribed to increased cumulative mean value of temperature as well as sunshine hours owing early sowing, more number panicles, more number of filled grains/panicle and higher grains weight, Dawadi and Chaudhary (2013).

As for varietal differences in grain yield, data clarified that NRL 54 rice line produced the greatest grain yield, followed by Giza 178 rice variety. On the other side, Black rice produced the lowest grain yield, while Giza 177 variety came in between. This could be attributed to genetic background. Variation in the grain yield of different rice genotypes has been reported by Metwally et al. (2016).

The interaction between the different genotypes and the various dates of sowing is presented in Table 7. Data revealed that cultivation all the tested genotypes on either May 1st, or May 15th gave higher grain yield than the date of May 30th when combined with the same genotypes. It might be due to the suitable climatic conditions specially temperature for all the tested genotypes through its different stages when sowing on either May 1st or May 15th. The greatest grain yield was obtained from NRL 54 rice line when combined with first date of sowing (May 1st), followed by the same variety when cultivated on both May 15th and May 30th as well as Giza 178 when sown on with May 15th without any significant differences among them. While, the lowest value of grain yield was found when Black rice was combined with May 30th. Similar trends were reported by Metwally *et al*. (2012) and Dawadi and Chaudhary (2013).

C-Grain quality characters:

Hulling, milling and head rice percentage of tested genotypes as affected by different dates of sowing are presented in Table (8). Data demonstrated that each of hulling, milling and head rice percentage reached to the maximum values under the last date of sowing (May 30th) and came in the first rank, followed by both May 15th and May 1st which gave nearly the same values in this aspect in the two studied seasons. These results are similar to those obtained by Nessrin Abd El-hamed (2009).

As for varietal differences in hulling, milling and head rice percentage, data in the same table clarified that Giza 177 variety gave the highest values in both hulling and milling percentage followed by NRL 54 rice line, while Black rice variety gave the least in the two seasons.

It can be also observed that Giza 178 variety produced the greatest head rice percentage followed by Giza 177 variety, while Black rice gave the lowest value in this respect in the two studied seasons. It could be attributed to the differences in their genetic constitution. These findings are agreed with the obtained by Nessrin Abd El-hamed (2009).

Data in Table 9 indicated that combination of each of the tested genotypes with the date of May 30th surpassed the other dates of sowing and produced the highest percentage of hulling. The greatest value was found when Giza 177 variety combined with the May 30th followed by May 1st and May 15th when combined with the same variety. On the other side, the lowest hulling percentage was observed when Black rice variety combined with date of May 1st. These results are hold true in the two studied seasons. Variation in the hulling percentage of different rice cultivars have reported by Nessrin Abd El-hamed (2009).

Data in Table 9 revealed that combination of both Giza 177 and NRL 54 with all the tested dates of sowing surpassed either Giza 178 or Black rice when sown under the same dates of sowing. The greatest milling percentage was observed with Giza 177 variety cultivated under May 15th or May 30th without any significant differences between them in the two studied seasons. The increases in both hulling and milling percentages in the grains of Giza 177 variety might be due to the little number of spikelets/panicle with adequate amount of metabolites which cause an increase in filling percentage and result in an increase in the starchy endosperm that minimize the thin and weight of hull consequently increase both hulling and milling percentage. Variation in the milling percentage of different rice cultivars have been reported by Nessrin Abd El-hamed (2009).

Data in Table 9 revealed that combination of Giza 178 when cultivated under the May 30th date of sowing gave the highest values. The greatest head rice percentage was observed Giza 178 variety cultivated under May 30th without any significant differences them in the two studied seasons. The increases in head rice percentage in the grains of Giza 178 variety might be due to the formation of starch layers. If the layer of starch were compacted (without spaces among the layers), so the grain would be more strength, in this case the head rice % well be high. On the other side, the lowest head rice percentage was observed when Black rice variety combined with the three dates of sowing under the study. These results are hold true in the two studied seasons. Variation in the head rice percentage of different rice cultivars have reported by Nessrin Abd El-hamed (2009).

Table 8 . Percentage of hulling, milling and head rice of some rice genotypes as affected by sowing dates in 2017 and 2018 rice seasons

Treatments	Hulling (%)		Milling (%)		Head rice (%)	
	2017	2018	2017	2018	2017	2018
Sowing dates (S)						
May, 1	79.85b	79.67b	70.41b	70.34b	62.16a	61.91b
May, 15	79.74c	79.71b	70.44b	70.27b	62.24a	62.07b
May, 30	80.78a	80.79a	71.21a	70.96a	62.39a	62.43a
L.S.D at 5%	0.36	0.32	0.39	0.44	0.22	0.36
Rice genotypes (G)						
Giza 177	82.85a	82.87a	75.10a	75.14a	64.67b	64.21b
Giza 178	79.56c	79.22c	70.03c	69.94c	65.17a	64.91a
Black rice	77.7d	77.69d	66.61d	66.42d	54.90c	55.62d
NRL 54	80.39b	80.44b	71.00b	70.58b	64.31b	63.80c
L.S.D at 5%	0.46	0.47	0.34	0.36	0.38	0.40
Interaction						
S x G	**	**	**	**	**	**

Table 9 . Percentage of hulling, milling and head rice as affected by the interaction between sowing dates and genotypes in 2017 and 2018 seasons

Genotype	Hulling (%)						Milling (%)						Head rice (%)					
	2017			2018			2017			2018			2017			2018		
	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30	May, 1	May, 15	May, 30
Giza 177	82.39ab	82.29b	83.39a	82.67b	82.44b	83.51a	73.81b	75.74a	75.76a	73.80b	75.60a	76.00a	65.46bc	66.00b	62.54g	65.55b	64.80c	62.29f
Giza 178	79.21ef	78.44fg	81.04c	78.50e	78.16e	81c	69.75e	69.34e	71.01cd	69.62d	69.21d	70.98c	63.95ef	64.88cd	66.68a	63.00e	64.77c	66.96a
Black rice	77.57h	77.87gh	77.65gh	77.63e	77.84e	77.61e	67.27f	65.95h	66.62g	67.21e	65.83f	66.22f	54.83h	54.75h	55.13h	55.10h	55.87g	55.90g
NRL 54	79.77de	80.36cd	81.04c	79.88d	80.41cd	81.02c	70.82d	70.73d	71.45c	70.70c	70.43c	70.62c	64.39de	63.33f	65.21c	63.97d	62.85ef	64.57cd

CONCLUSION

The results of the present study demonstrated that the new Egyptian red rice line NRL 54 varied significantly in most measurements of growth; grain yield, yield attributes and some grain quality traits, in two seasons. The red rice line NRL 54 has the highest values in most of mentioned traits compared to the other tested varieties in the two seasons. It can be concluded that the optimum sowing date of red rice line NRL 54 is May 1st and May 15th. While sowing on May 30th reduced the grain yield of other genotypes, but the red rice line NRL 54 showed tolerance for late sowing compared to other genotypes under this study. Generally the red rice line NRL 54 could be recommended to be sown on May 1st, May 15th and May 30th, furthermore, it could be as an alternation of Black rice, because it tolerates the late sowing, while, Black rice yield is highly reduced by late sowing.

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سلوك تراكيب وراثية مختلفة من الأرز تحت مواعيد زراعة مختلفة

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أجريت هذه الدراسة لدراسة سلوك تراكيب وراثية مختلفة من الأرز تحت مواعيد زراعة مختلفة فى تجربة قطاعات كاملة العشوائية في ثلاثة مكررات في مزرعة مركز البحوث والتدريب في الأرز بمحطة البحوث الزراعية بسخا موسمي 2017 و 2018 . هذه التراكيب هي أول سلالة أرز أحمر وهى السلالة المعيدة للخصوبة الجديدة NRL 54 والصنف جيزة 177 والصنف جيزة 178 وصنف الأرز الأسود. وأظهرت النتائج أن ميعاد الزراعة الأول في الأول من مايو والثاني في منتصف شهر مايو متفوقة عن نتائج الزراعة في الميعاد الثالث في نهاية مايو في صفات عدد الأيام حتى 50 % من طرد الداليات وطول النبات وعدد الفروع بالنبات وعدد الداليات بالنبات وطول الدالية ووزنها ومحصول الحبوب . بينما أظهرت النتائج أن نباتات الأرز المنزرعة في الميعاد الثاني في منتصف مايو والأول في أول مايو كانت متفوقة عن المنزرعة في الميعاد المتأخر (في نهاية شهر مايو) في صفات وزن الألف حبة وعدد الحبوب الممتلئة وعدد السنيبلات بالدالية. نباتات السلالة المبشرة NRL 54 أنتجت أعلى محصول حبوب في موسمي الزراعة. بينما صنف الأرز الأسود أنتج أقل محصول في موسمي الزراعة. ويمكننا تلخيص أن أول ميعادين للزراعة (الأول من مايو ومنتصف مايو) كانا الأفضل لزراعة كل التراكيب الوراثية تحت الدراسة. بينما يمكن زراعة السلالة المبشرة NRL 54 في نهاية شهر مايو مع انخفاض أقل في محصول الحبوب. وأن سلالة الأرز الأحمر الجديدة تتحمل التأخير في الزراعة أكثر من صنف الأرز الأسود. وعموما يمكننا التوصية بزراعة سلالة الأرز الأحمر المبشرة NRL 54 حتى نهاية شهر مايو، مما يعتبر عزل زماني وزراعته في وقت مخالف لزراعة أصناف الأرز بيضاء الحبوب.