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Effect of Sowing Dates on Yield and Yield Attributes of Rice Genotpes

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ABSTRACT

In order to investigate the effect of sowing dates on rice yield and its components a field experiment was carried out in Randomized Complete Block Design (RCBD) with three replications at the Experimental Farm of Sakha Agricultural Research Station, Sakha, Kafr EL-Sheikh Egypt. 14 rice genotypes were tested at different sowing dates, April 1st, April 15th, May 1st and May 15th during the two successive rice seasons 2017 and 2018. The studied characters were i.e., flag leaf area, chlorophyll content, plant height, number of panicles per hill, number of filled grains per panicle, number of unfilled spikelets per panicle, 1000-grain weight (g), grain yield (t/ha), number of days from sowing to heading and growth degree days. Analysis of variance indicated that rice genotypes were significantly different for all the studied traits. The highest values of grain yield and most of the studied characters were observed under April 15th followed by May 1st sowing dates. Sakha108 and GZ6903-1-2-2-1 produced the highest grain yield followed by IR77510-68-1-3-3.
Keywords: *Oryza sativa*, sowing dates, grain yield, growth degree days

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's most important food crop and energy source for about half of the world's population and ranks second in production after maize, Manjappa and Shailaja, (2014). In Egypt rice is considered as the most popular and important field crop for several reasons: as a staple food after wheat for the Egyptian population, and as a land reclamation crop for improving the productivity of the saline soils widely spread in North delta and coastal area. The exact sowing date for rice is play a vital role in improving its growth and increasing the yield Muhammad *et al.* (2010). The sowing time of rice plant is important for several reasons; firstly it ensures that vegetative growth occurs during a period of satisfactory temperatures and high levels of solar radiation, secondly, the optimum sowing time for each cultivar ensures the cold sensitive stage occurs when the minimum night temperatures are historically the warmest, thirdly, sowing on time guarantees that grain filling occurs when milder autumn temperatures are more likely, hence good grain quality is achieved Farrell *et al.* (2003). Sowing date also has a direct impact on the rate of seedling establishment Tashiro *et al.* (1999). Shah and Bhurer (2005) reported that more number of filled grains/panicle was obtained in the early seeding and declined gradually in the late sowing, delaying sowing decreased the grain and straw yield, harvest index, number of tillers, panicle length, number of grains/panicle and fertility %. Metwally *et al.* (2016) studied the effect of sowing date (15th of April, 1st of May and 15th of May) on grain yield of twenty Egyptian rice genotypes, and infestation by Rajesh *et al.* (2015) they found that sowing date had significant effect on all studied characters. The highest values of most of the studied characters were found in the early sowing date.

The objective of the present investigation is to study the behavior of different rice genotypes at different sowing dates under the Egyptian condition.

MATERIALS AND METHODS

Field experiments were carried out at the Experimental Farm of the Sakha Research Station, Kafr EL-Sheikh Egypt, during the two successive rice seasons 2017 and 2018 to investigate the effect of different sowing dates on yield and its components for some rice genotypes. 14 rice genotypes were used in this study. The name and the origin of those genotypes are presented in Table 1. Sowing dates were 15 th April, 1st, 15 th and 30 th May, respectively in both seasons. The genotypes were set in a Randomized Complete Block design (RCBD) with three replications in every sowing date in both seasons. A combined analysis was used among the four sowing dates in each season for results explanation.

Table 1. Rice genotypes, parentage, type and origin.

NO.	Genotypes	Pedigree	Type	Origin
1	GZ6903-1-2-2-1	GZ 4596-3-4-2/ Suweon 313	Japonica	Egypt
2	GZ7768-10-1-5-2	GZ 5320-5-1-1/ Tainung 70	Japonica	Egypt
3	GZ7971-2-3-6-1	Giza 177/ GZ 5828-3-1-1-1-1	Japonica	Egypt
4	GZ8126-1-3-1-2	GZ 5830-63-1-2/ GZ 5963-1-2-1-1	Japonica	Egypt
5	Sakha108	Sakha 101/ HR5824-B-3-2-3 //Sakha 101	Japonica	Egypt
6	GZ8089-2-1-3-4	GZ 5385-29-3-2/ Gaori	Japonica	Egypt
7	GZ8426-1-3-1-2	AC 1390/ 84-1916	Japonica	Egypt
8	GZ8450-4-2-3-3	GZ 5603-3-2-1/ RYONGY Song14	Japonica	Egypt
9	GZ8450-4-2-3-1-2	GZ 5603-3-2-1/ RYONGY Song14	Japonica	Egypt
10	GZ8479-6-2-3-1	GZ 6214-4-1-1-1-1/ Empssic 104	Japonica	Egypt
11	IR72	Introduced	Indica	Introduced
12	IR77510-68-1-3-3	Introduced	Indica	Introduced
13	IR78525-140-1-1-3	Introduced	Indica	Introduced
14	IR78555-3-2-2-2	Introduced	Indica	Introduced

Nitrogen fertilizer was supplied in the form of Urea (46.5%) in two equal doses as follows i.e., the first dose half as basal application and it was incorporated into the dry soil before flooding, the second dose applied after 30 days of transplanting. Phosphorus at the rate of 36 kg P_2O_5 ha^{-1} was applied as basal application during soil preparation. $ZnSO_4$ containing 22% zinc was applied at 24 kg per hectare just before transplanting to eliminate zinc deficiency. After transplanting, 5cm water depth was maintained in the experimental plots. Weeds were chemically controlled as recommended. Insects and diseases intensively controlled through the rice season to avoid any yield loss. All other agronomic practices were followed as recommended.

The flag leaf area (cm^2), chlorophyll content (SPAD) were measured at complete heading, plant height (cm) at maturity was measured for 5 hills per plot from the soil surface to the tip of the tallest panicle of each hill. Number of panicles per hill was counted for 5 hills from middle rows in each plot, number of filled grains per panicle, number of unfilled spikelets per panicle, 1000-grain weight (g) were measured for 10 main panicles in each plot. Grain yield (t/ha) was determined from inside 5 m^2 in each plot and adjusted to 14 % moisture content and converted to ton per hectare. Number of days from sowing to heading was counted.

The growth degree days (GDD) was calculated according to Parthasarathi *et al*. (2013) using the following formula:

$$GDD = \frac{(Tmax + Tmin)}{2} - Tb$$

Where, Tmax is the Total Maximum Temperature (°C), Tmin is the Total Minimum Temperature (°C) and Tb - Base Temperature (°C). The base temperature is the temperature which the plant cannot grow below it. It varies among the different crops. 10 °C was used in this study as base temperature according to the Sahu (2003).

Daily air temperature data (daily maximum and minimum air temperature) had been collected from 1st of April to 30th of September 2017 and 2018 for the Experimental Farm of Sakha Agricultural Research Station, Sakha, Kafr EL-Sheikh Egypt (Latitude: 31 05' 12", Longitude: 30 56' 49"). Figure 1 presents the average maximum and minimum temperature °C at the different sowing dates in 2017 and 2018.

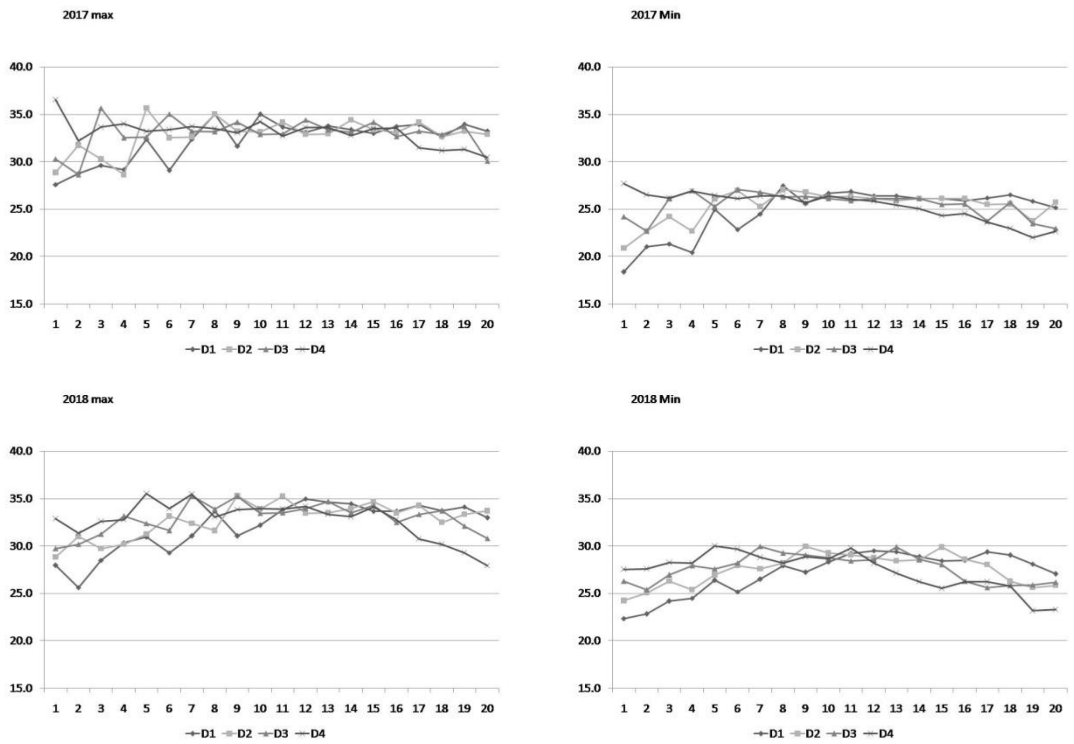

Fig. 1. Average maximum and minimum temperature °C at different sowing dates in 2017 and 2018.

"Genstat 5 Release 3.2 (PC/Windows NT)" computer software was used for the analysis of variance as well as the combined analysis for the different sowing dates. For means comparison, least significant difference (L.S.D.) technique was used according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Flag leaf area (cm^2) and chlorophyll content (SPAD) at complete heading of some rice genotypes under different sowing dates significantly due to the variation of sowing dates as well as the interaction between rice genotypes and sowing dates (Table 2). Sowing different rice genotypes on April 15th produced the highest values of flag leaf area and chlorophyll content without any significant differences with sowing on May 1st. Likewise, early and late sowing dates recorded the lowest values of those characters. Low temperature in early growth stages in first sowing date may retard the development of the rice plants (Fig. 1). Sakha108, IR77510-68-1-3-3 and GZ6903-1-2-2-1 gave significantly higher values of flag leaf area and chlorophyll content than the rest of the genotypes irrespective of the sowing dates.

Regarding to the interaction effect between sowing dates and rice genotypes on flag leaf area, data in Table 3 shows that sowing Sakha 108 on April 15th resulted in highest values of that character. On the other hand, the lowest values were observed when IR72 was sown on 15th of May. Table 4 presents the interaction effect between sowing date and rice genotype on chlorophyll content (SPAD) at complete heading. The rice genotypes GZ6903-1-2-2-1, Sakha108 and IR77510-68-1-3-3 recorded the highest values of chlorophyll content when they were sown on 15th of April.

Table 2 shows also the effect of sowing date on plant height (cm) and number of tillers per hill of tested rice genotypes at harvest. Sowing rice genotypes on April 15th produced the tallest plant while late sowing on May 15th showed the shortest plants irrespectively the genotype. This might be due to the longer vegetative growth phase, which enhanced to increase height. The length of vegetative phase of rice progressively reduced due to delayed planting resulting in short plant height. IR72 gave the highest values of plant height followed by GZ8479-6-2-3-1 and GZ8450-4-2-3-1-2 while, GZ8426-1-3-1-2 recorded the shortest plants whatever the sowing date.

Table 2. Flag leaf area (cm^2), chlorophyll content (SPAD), plant height (cm) and number of tillers/hill of some rice genotypes under different sowing dates in 2017 and 2018.

Treatments	Flag leaf area (cm^2)		Chlorophyll content (SPAD)		Plant height(cm)		No. of tillers/hill	
	2017	2018	2017	2018	2017	2018	2017	2018
Sowing dates								
April 1st	27.22	27.06	37.91	38.57	109.62	108.86	19.98	19.91
April 15th	35.15	34.87	41.89	42.04	115.57	115.04	24.17	24.19
May 1st	32.18	31.87	39.78	40.28	110.68	109.48	22.50	21.10
May 15th	29.20	28.56	37.15	38.28	103.61	103.23	20.80	20.36
LSD 0.05	4.16	3.41	3.85	3.45	4.03	4.01	1.59	1.43
Genotypes:								
GZ6903-1-2-2-1	33.97	33.92	45.91	45.78	102.00	100.31	25.91	24.31
GZ7768-10-1-5-2	29.37	29.21	37.90	39.66	109.00	105.91	21.17	22.07
GZ7971-2-3-6-1	30.06	27.65	38.96	43.13	109.05	108.72	19.00	19.56
GZ8126-1-3-1-2	29.77	29.00	38.54	41.76	104.79	106.78	21.00	22.53
Sakha108	36.93	36.32	45.05	44.54	102.49	100.86	24.58	24.08
GZ8089-2-1-3-4	32.97	32.43	42.11	41.34	108.20	110.00	23.48	22.84
GZ8426-1-3-1-2	27.90	28.03	33.94	35.39	98.17	98.34	20.96	18.29
GZ8450-4-2-3-3	29.90	29.97	40.77	41.24	110.72	109.00	20.12	20.72
GZ8450-4-2-3-1-2	29.33	27.95	38.25	39.37	118.03	116.85	20.58	17.79
GZ8479-6-2-3-1	28.86	29.11	34.74	34.65	124.90	125.53	19.45	20.76
IR72	26.48	26.86	35.98	36.53	134.93	130.22	20.83	18.69
IR77510-68-1-3-3	36.03	35.20	45.19	44.38	104.25	104.23	25.76	23.89
IR78525-140-1-1-3	30.89	31.29	35.27	34.24	110.59	109.72	23.12	21.78
IR78555-3-2-2-2	30.68	31.32	35.95	35.133.43	101.09	101.64	20.13	22.20
LSD 0.05	4.06	3.21	3.48		3.79	3.61	1.12	1.10
Interaction	*	*	**	*	**	**	*	*

Table 3. Flag leaf area (cm^2) at complete heading as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	30.73	38.53	35.65	30.97	30.23	39.08	35.20	31.18
GZ7768-10-1-5-2	25.60	34.18	30.12	27.57	25.33	34.13	29.18	28.21
GZ7971-2-3-6-1	21.73	36.38	33.81	28.33	24.20	33.80	27.48	25.11
GZ8126-1-3-1-2	25.70	33.60	30.97	28.80	25.40	32.93	30.60	27.08
Sakha108	32.53	44.07	38.33	32.77	31.73	43.23	38.57	31.73
GZ8089-2-1-3-4	31.73	36.57	32.17	31.41	30.67	35.71	33.40	29.92
GZ8426-1-3-1-2	24.40	32.77	28.10	26.33	22.60	31.90	31.10	26.50
GZ8450-4-2-3-3	25.57	34.90	32.73	26.41	28.87	32.14	30.15	28.73
GZ8450-4-2-3-1-2	26.37	33.43	30.47	27.03	26.50	30.55	28.09	26.67
GZ8479-6-2-3-1	27.27	30.11	29.87	28.17	27.07	32.97	29.09	27.32
IR72	23.03	30.33	27.44	25.11	24.27	32.79	26.69	23.67
IR77510-68-1-3-3	32.07	38.33	37.23	36.47	31.00	38.43	37.26	34.12
IR78525-140-1-1-3	29.23	34.20	30.74	29.37	29.27	33.84	31.79	30.27
IR78555-3-2-2-2	25.10	34.73	32.83	30.07	21.63	36.70	37.62	29.33
LSD 0.05	3.69				3.11			

Low tillers per hill were noticed in the early sowing date (April 1st) and tillers increased successively with the advancement of sowing date until May 1st and again declined thereafter. Sridevi and Chellamuthu (2015) reported that high temperature provides more rice tiller buds and thereby increases number of tillers per plant. Optimum temperature for rice tillering is 25-31 ºC. The rice tillering rate head for increase as the temperature increases. The rice genotypes GZ6903-1-2-2-1 and IR77510-68-1-3-3 produced significantly highest number of tillers per hill followed by Sakha108 irrespective of planting dates.

Concerning the interaction effect between sowing dates and rice genotypes on plant height at harvest, Data in Table 5 shows that sowing IR72 on 15th of April or on May 1st produced the tallest plant while IR78555-3-2-2-2 plants were the shortest when they were sown on 15th of May. The interaction effect between sowing dates and rice genotypes on number of tillers per hill at harvest is presented in Table 6. The maximum number of tillers per hill was recorded when either Sakha108 or GZ6903-1-2-2-1 was sown on April 15th. Variation in plant height among different rice genotypes under different sowing dates was also observed by Rajesh Khavse *et al.* (2015) and Metwally *et al.* (2016).

Table 4. Chlorophyll content (SPAD) at complete heading as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	44.40	49.10	45.67	44.47	44.97	47.91	45.47	44.77
GZ7768-10-1-5-2	37.87	41.30	37.57	34.87	40.51	41.61	40.63	35.90
GZ7971-2-3-6-1	37.77	40.87	40.83	36.37	43.57	44.03	44.17	40.73
GZ8126-1-3-1-2	38.67	41.63	41.30	32.57	34.45	44.70	44.63	43.26
Sakha108	42.37	48.87	45.47	43.47	43.86	47.33	44.07	42.89
GZ8089-2-1-3-4	40.87	44.10	42.93	40.53	40.02	43.57	41.50	40.27
GZ8426-1-3-1-2	32.83	35.10	34.37	33.44	33.84	39.83	36.10	31.79
GZ8450-4-2-3-3	38.87	44.43	41.35	38.42	40.03	43.61	41.33	39.98
GZ8450-4-2-3-1-2	36.57	40.57	38.27	37.60	37.60	40.13	40.10	39.66
GZ8479-6-2-3-1	32.23	36.93	35.33	34.47	32.61	36.82	35.93	33.23
IR72	34.83	39.67	36.97	32.43	35.09	38.57	37.40	35.05
IR77510-68-1-3-3	44.30	48.50	44.91	43.03	43.76	47.50	44.07	42.17
IR78525-140-1-1-3	34.83	37.30	35.93	33.03	36.37	35.73	32.69	32.16
IR78555-3-2-2-2	34.27	38.10	36.03	35.40	33.33	37.2	35.89	34.09
LSD 0.05	3.44				3.23			

Table 5. Plant height (cm) at harvest as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	98.33	105.67	106.67	97.33	100.00	107.67	102.23	91.33
GZ7768-10-1-5-2	108.33	118.33	108.67	100.67	104.33	112.02	107.63	99.67
GZ7971-2-3-6-1	107.00	112.33	111.00	105.85	105.33	113.23	112.00	104.33
GZ8126-1-3-1-2	100.33	106.33	109.67	102.82	101.67	114.00	110.67	100.78
Sakha108	101.10	108.18	103.33	97.33	100.67	102.33	101.12	99.33
GZ8089-2-1-3-4	112.67	113.67	105.65	100.79	110.33	114.67	106.67	108.33
GZ8426-1-3-1-2	99.33	106.33	94.33	92.67	95.67	102.67	98.33	96.69
GZ8450-4-2-3-3	110.36	115.16	113.67	103.67	112.67	111.33	110.67	101.33
GZ8450-4-2-3-1-2	117.33	121.33	121.11	112.33	114.67	120.67	119.33	112.73
GZ8479-6-2-3-1	128.28	130.67	122.33	118.33	126.67	134.67	125.1	115.67
IR72	130.33	140.33	138.38	130.67	127.67	134.33	132.33	126.53
IR77510-68-1-3-3	102.67	112.33	104.33	97.67	101.33	114.33	104.67	96.60
IR78525-140-1-1-3	110.33	116.67	114.67	100.67	112.33	114.34	109.67	102.53
IR78555-3-2-2-2	108.33	110.67	95.69	89.67	110.67	114.24	92.33	89.33
LSD 0.05	3.55				3.41			

Table 6. Number of tillers per hill at harvest as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	22.67	28.24	27.07	25.67	23.21	27.15	24.21	22.67
GZ7768-10-1-5-2	18.67	21.67	23.00	21.33	21.33	25.27	21.33	20.33
GZ7971-2-3-6-1	15.00	22.67	18.33	20.00	17.33	22.29	20.16	18.44
GZ8126-1-3-1-2	18.00	22.67	23.67	19.67	20.33	26.67	24.67	18.43
Sakha108	22.17	28.31	26.16	21.67	21.67	28.67	24.22	21.77
GZ8089-2-1-3-4	19.67	25.33	24.67	24.25	20.00	24.25	23.67	23.43
GZ8426-1-3-1-2	20.33	23.15	20.67	19.67	19.00	20.33	15.00	18.82
GZ8450-4-2-3-3	18.00	22.67	20.13	19.67	18.33	22.34	21.33	20.87
GZ8450-4-2-3-1-2	17.33	24.00	20.67	20.33	17.33	21.35	12.67	19.80
GZ8479-6-2-3-1	19.33	21.00	19.14	18.33	19.00	23.00	20.12	20.90
IR72	21.33	22.33	20.33	19.33	17.33	20.29	17.33	19.79
IR77510-68-1-3-3	23.33	27.67	26.38	25.67	21.33	27.67	25.42	21.12
IR78525-140-1-1-3	23.67	25.33	24.14	19.33	22.33	24.67	22.00	18.13
IR78555-3-2-2-2	20.24	23.29	20.67	16.33	20.26	24.67	23.33	20.55
LSD 0.05	1.01				1.10			

Data in Tables 7, 8, 9 and 10 shows that significant variations were observed among the studied genotypes in respect of panicle characteristics under the four sowing dates. Sowing rice genotypes on April 15th recorded the highest values of panicle characteristics followed by May 1st. Regarding the variations among the genotypes, longest panicles were observed in the genotype IR77510-68-1-3-3 followed by GZ6903-1-2-2-1 and Sakha108. Sakha108 produced the heaviest panicles followed by IR77510-68-1-3-3 and GZ8089-2-1-3-4. The highest number of branches per panicle was observed with GZ6903-1-2-2-1 followed by IR77510-68-1-3-3.

Table 7. Panicle characteristics of some rice genotypes under different sowing dates in 2017 and 2018.

Treatments	Panicle length (cm)		Panicle weight (g)		Branches No /panicle	
	2017	2018	2017	2018	2017	2018
Sowing dates						
April 1st	19.57	20.09	3.276	3.111	10.95	10.77
April 15th	21.86	21.80	3.638	3.538	11.76	11.80
May 1st	20.73	20.93	3.510	3.377	11.14	11.13
May 15th	19.57	20.01	3.258	3.135	10.47	10.55
LSD 0.05	0.51	0.47	0.267	0.244	0.56	0.58
Genotypes:						
GZ6903-1-2-2-1	21.76	21.27	3.598	3.459	12.54	12.36
GZ7768-10-1-5-2	19.85	20.88	3.473	3.313	10.76	10.83
GZ7971-2-3-6-1	19.76	20.48	3.523	3.365	10.34	10.42
GZ8126-1-3-1-2	19.99	20.38	3.379	3.080	10.42	10.46
Sakha108	21.72	21.64	3.932	3.925	11.89	11.93
GZ8089-2-1-3-4	20.98	21.02	3.747	3.635	11.27	11.19
GZ8426-1-3-1-2	19.62	20.47	3.387	3.181	10.56	10.87
GZ8450-4-2-3-3	20.54	19.98	2.958	3.029	10.70	10.96
GZ8450-4-2-3-1-2	19.13	20.23	3.477	3.188	10.55	10.48
GZ8479-6-2-3-1	18.92	20.10	2.633	2.542	10.43	10.67
IR72	20.07	19.43	3.549	3.348	11.03	10.55
IR77510-68-1-3-3	22.08	22.21	3.790	3.711	12.32	12.17
IR78525-140-1-1-3	20.65	20.83	3.269	3.320	11.77	11.09
IR78555-3-2-2-2	20.97	20.99	3.171	2.966	10.53	10.92
LSD 0.05	0.46	0.41	0.190	0.220	0.51	0.39
Interaction	**	**	*	*	*	**

Table 8. Panicle length (cm) as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	20.33	23.52	23.17	20.00	20.60	23.48	21.02	19.97
GZ7768-10-1-5-2	19.00	21.10	20.87	18.44	21.40	21.23	21.20	19.67
GZ7971-2-3-6-1	19.12	21.33	19.93	18.67	18.93	21.80	21.20	20.00
GZ8126-1-3-1-2	19.12	21.17	20.00	19.67	19.93	20.88	20.50	20.20
Sakha108	20.67	23.60	22.04	20.55	20.53	23.67	21.83	20.53
GZ8089-2-1-3-4	19.20	22.83	21.34	20.54	19.82	22.60	21.24	20.40
GZ8426-1-3-1-2	19.00	21.33	19.47	18.67	19.33	21.70	21.83	19.00
GZ8450-4-2-3-3	19.23	22.70	20.40	19.83	19.57	20.47	20.06	19.80
GZ8450-4-2-3-1-2	18.87	20.26	19.17	18.22	19.80	20.60	20.67	19.85
GZ8479-6-2-3-1	17.90	20.00	19.60	18.17	20.03	20.57	20.40	19.38
IR72	19.33	21.33	20.27	19.33	19.07	20.83	19.07	18.76
IR77510-68-1-3-3	21.05	23.67	22.17	21.43	21.17	23.53	22.20	21.95
IR78525-140-1-1-3	20.67	21.10	20.67	20.17	20.63	21.50	20.67	20.53
IR78555-3-2-2-2	20.50	22.07	21.07	20.25	20.48	22.30	21.07	20.10
LSD 0.05	0.43				0.38			

Concerning the interactions' effects, the longest panicles were produced by the genotypes IR77510-68-1-3-3, Sakha108 and GZ6903-1-2-2-1 under 15th of April Table 8. Sowing Sakha108 or IR77510-68-1-3-3 on 15th of April resulted in highest values of panicle weight (Table 9). On the other hand, the genotype GZ6903-1-2-2-1 recorded the highest values of number of branches per panicle with 15th of April sowing date Table 10.

Table 9. Panicle weight (g) as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	2.997	3.957	3.810	3.627	3.257	3.673	3.617	3.288
GZ7768-10-1-5-2	3.397	3.617	3.582	3.298	2.877	3.540	3.473	3.360
GZ7971-2-3-6-1	3.273	3.684	3.547	3.587	3.473	3.740	3.180	3.065
GZ8126-1-3-1-2	3.417	3.720	3.400	2.980	2.910	3.265	3.115	3.032
Sakha108	3.840	4.289	4.027	3.570	3.752	4.127	4.016	3.803
GZ8089-2-1-3-4	3.697	3.976	3.750	3.563	3.293	3.870	3.718	3.660
GZ8426-1-3-1-2	3.253	3.560	3.497	3.237	3.122	3.377	3.292	2.933
GZ8450-4-2-3-3	2.880	3.003	3.017	2.933	2.769	3.291	3.168	2.886
GZ8450-4-2-3-1-2	3.497	3.663	3.451	3.298	2.849	3.461	3.297	3.145
GZ8479-6-2-3-1	2.187	2.905	3.067	2.373	2.431	2.987	2.610	2.140
IR72	3.387	3.710	3.667	3.433	3.223	3.553	3.379	3.238
IR77510-68-1-3-3	3.670	4.103	3.754	3.632	3.370	4.103	3.760	3.613
IR78525-140-1-1-3	3.403	3.453	3.296	2.923	3.381	3.363	3.403	3.133
IR78555-3-2-2-2	2.967	3.289	3.275	3.153	2.847	3.181	3.247	2.587
LSD 0.05	0.187				0.110			

Table 10. Number of branches per panicle as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	12.67	13.67	12.69	11.12	12.13	13.66	12.33	11.33
GZ7768-10-1-5-2	10.33	11.67	11.00	10.05	10.00	11.67	11.33	10.33
GZ7971-2-3-6-1	10.67	11.01	10.00	9.68	10.33	11.33	10.33	9.67
GZ8126-1-3-1-2	10.33	11.23	10.13	10.00	10.17	11.67	10.33	9.67
Sakha108	12.33	12.67	11.90	10.67	12.13	12.67	11.90	11.00
GZ8089-2-1-3-4	11.00	11.83	11.33	10.90	11.33	12.11	10.67	10.66
GZ8426-1-3-1-2	10.67	11.00	10.89	9.67	10.13	11.67	11.33	10.36
GZ8450-4-2-3-3	10.33	11.12	11.00	10.33	10.67	11.33	11.01	10.82
GZ8450-4-2-3-1-2	10.67	11.33	10.13	10.07	10.36	10.67	10.55	10.33
GZ8479-6-2-3-1	10.20	11.10	10.33	10.08	10.33	11.33	10.67	10.33
IR72	11.01	11.37	11.06	10.67	10.22	11.17	10.67	10.12
IR77510-68-1-3-3	11.36	13.13	12.47	12.33	11.67	12.83	12.16	12.01
IR78525-140-1-1-3	11.06	12.33	12.00	11.67	10.67	11.36	11.23	11.08
IR78555-3-2-2-2	10.60	11.17	11.02	9.33	10.66	11.67	11.33	10.00
LSD 0.05	0.31				0.26			

Data pertaining to the effect of sowing date on number of filled grains per panicle, number of unfilled spikelets per panicle, 1000-grain weight and grain yield of tested rice genotypes are presented in Table 11. Significant variations were detected in respect of the effect of sowing date on number of filled grains per panicle, number of unfilled spikelets per panicle and grain yield. On the other hand, sowing date showed no significant variation in terms of 1000-grain weight. Sowing date 1st of April recorded the highest values of number of filled grains per panicle and grain yield as well as the lowest number of unfilled spikelets per panicle. In contrast plants planted on the fourth sowing date produced the highest number of unfilled spikelets per panicle. LU Chuan-gen *et al.* (2007) reported that rice spikelet fertility is mainly affected by genetic background, the plant physiological characters and climatic factors such as temperature during heading period. The physiological characters affecting the spikelet fertility are starch accumulation, ATP content and stigma activity and so on, which are also affected weightily by the climatic factors. The high sterility may be attributable to failure of fertilization caused by the imperfect splitting of anther or wilting of stigma induced by high temperature Sridevi and Chellamuthu (2015) indicated that grain yield was higher when temperature during ripening stage was relatively low, an effect attributed to a more favorable balance between photosynthesis and respiration.

Table 11. Number of filled grains per panicle, number of unfilled spikelets per panicle, 1000-grain weight (g) and grain yield (t ha^{-1}) of some rice genotypes under different sowing dates in 2017 and 2018.

Treatments	Filled grains /panicle		Unfilled spikelets /panicle		1000-grain weight (g)		grain yield (t ha^{-1})	
	2017	2018	2017	2018	2017	2018	2017	2018
Sowing dates								
April 1st	119.80	118.55	11.20	11.35	25.63	25.52	8.75	8.75
April 15th	127.43	126.66	7.17	8.02	25.56	25.50	9.72	9.56
May 1st	121.60	119.36	8.91	9.02	25.99	26.09	9.25	9.12
May 15th	113.92	111.22	13.14	12.10	26.35	26.44	8.92	8.83
LSD 0.05	5.32	5.61	3.69	3.03	NS	NS	0.45	0.43
Genotypes:								
GZ6903-1-2-2-1	129.96	128.91	7.36	7.24	25.86	25.56	10.59	10.34
GZ7768-10-1-5-2	116.23	115.15	9.26	9.42	26.16	25.98	9.68	9.62
GZ7971-2-3-6-1	111.50	109.23	8.26	9.50	27.91	27.76	8.01	8.05
GZ8126-1-3-1-2	111.41	109.59	10.50	10.24	25.14	25.10	8.18	8.20
Sakha108	130.10	131.15	5.75	6.96	28.81	28.69	10.76	10.48
GZ8089-2-1-3-4	124.89	125.33	9.32	10.50	27.97	28.19	10.05	9.75
GZ8426-1-3-1-2	111.85	117.17	9.27	10.17	27.73	27.88	9.38	9.05
GZ8450-4-2-3-3	121.42	116.35	13.51	14.24	27.08	27.18	9.69	9.60
GZ8450-4-2-3-1-2	122.04	117.78	16.34	16.25	26.88	27.15	8.71	8.63
GZ8479-6-2-3-1	120.40	113.18	11.83	10.58	25.84	25.70	8.15	8.64
IR72	123.94	119.18	9.78	9.97	23.70	23.92	8.56	8.50
IR77510-68-1-3-3	125.37	126.27	10.16	8.77	25.55	25.83	9.98	9.95
IR78525-140-1-1-3	119.09	114.35	13.91	10.82	23.53	23.50	8.05	7.74
IR78555-3-2-2-2	121.41	121.68	6.24	7.05	20.24	19.90	8.46	8.36
LSD 0.05	4.72	4.13	3.31	2.25	0.69	0.61	0.41	0.40
Interaction	*	**	*	*	NS	NS	**	**

The highest number of filled grains per panicle was observed by Sakha108 and GZ6903-1-2-2-1. Similar pattern was also found in terms of grain yield. GZ8450-4-2-3-1-2 recorded the highest number of unfilled spikelets per panicle and Sakha 108 recorded the lowest one. The heaviest 1000-grain weight was recorded by Sakha 108 while IR78555-3-2-2-2 produced the lightest 1000-grain weight. These variations among the genotypes might be due to differential genetic makeup of them.

Since rice yield is dependent on the number of panicles per hill grain weight and number of grains per panicle which were significantly higher in Sakha108 and GZ6903-1-2-2-1 and hence the higher grain yield. Bhat *et al.* (2015) and Metwally *et al.* (2016) have also reported variation in the grain yield of different rice cultivars.

Significant differences were detected due to the interactions' effects of sowing date and genotypes on number of filled grains per panicle, number of unfilled spikelets per panicle and grain yield as presented in Tables 12, 13 and 14. It was observed that highest values of number of filled grains per panicle and grain yield were produced when either GZ6903-1-2-2-1 or Sakha108 was sown on 1st of April. GZ8450-4-2-3-3 produced the highest values of number of unfilled spikelets per panicle under the first sowing date. Sakha108 and IR78555-3-2-2-2 gave the lowest values of number of unfilled spikelets per panicle. LU Chuan-gen *et al.* (2007) indicated that among the climatic factors which affected rice spikelet fertility as well as grain yield, the key factor is air temperature. Similar results were also reported by Metwally *et al.* (2012), Rajesh Khavse *et al.* (2015) and Metwally *et al.* (2016).

Table 12. Number of filled grains per panicle as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	122.20	140.25	132.70	124.70	121.67	138.33	133.33	122.30
GZ7768-10-1-5-2	112.30	125.00	120.60	107.00	110.90	124.70	121.70	103.30
GZ7971-2-3-6-1	115.30	113.67	112.33	104.70	111.00	112.30	110.30	103.30
GZ8126-1-3-1-2	115.00	120.30	106.00	104.33	111.70	121.30	103.70	101.67
Sakha108	127.30	139.10	130.70	123.30	126.40	138.20	132.90	127.10
GZ8089-2-1-3-4	120.90	130.27	126.70	121.70	120.24	131.30	127.07	122.70
GZ8426-1-3-1-2	112.70	119.70	111.67	103.33	118.33	121.70	114.67	113.96
GZ8450-4-2-3-3	125.00	129.33	126.70	104.64	121.70	127.70	124.30	91.70
GZ8450-4-2-3-1-2	117.33	126.07	123.77	121.00	115.70	120.00	116.70	118.70
GZ8479-6-2-3-1	121.00	127.30	117.60	115.70	118.00	128.00	103.00	103.70
IR72	122.27	131.30	126.90	115.30	126.70	130.30	117.00	102.70
IR77510-68-1-3-3	124.33	130.30	126.70	120.13	123.70	130.96	125.70	124.70
IR78525-140-1-1-3	120.30	122.70	118.67	114.67	116.00	120.70	119.70	101.00
IR78555-3-2-2-2	121.30	128.67	121.33	114.33	117.70	127.70	121.00	120.30
LSD 0.05	4.36				4.09			

Table 13. Number of unfilled spikelets per panicle as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	9.76	4.67	6.33	8.67	8.67	5.67	5.33	9.28
GZ7768-10-1-5-2	7.70	4.33	6.67	18.33	10.00	5.67	4.67	17.33
GZ7971-2-3-6-1	9.70	3.33	5.67	14.33	8.67	7.33	8.67	13.33
GZ8126-1-3-1-2	14.00	6.67	9.96	11.36	14.33	6.67	7.67	12.29
Sakha108	7.22	2.33	6.17	7.27	8.67	3.67	7.33	8.17
GZ8089-2-1-3-4	12.27	5.67	6.67	12.67	14.33	7.67	8.67	11.33
GZ8426-1-3-1-2	8.00	7.12	7.63	14.33	6.67	10.33	11.33	12.33
GZ8450-4-2-3-3	20.70	8.48	9.19	15.67	19.67	11.33	12.33	13.63
GZ8450-4-2-3-1-2	17.70	16.33	12.67	18.67	16.33	15.33	16.33	17.00
GZ8479-6-2-3-1	12.11	8.20	12.67	14.33	12.67	8.33	9.15	12.18
IR72	9.70	7.25	8.17	14.00	10.33	8.23	9.63	11.67
IR77510-68-1-3-3	10.30	8.33	10.67	11.33	8.67	7.73	9.33	9.33
IR78525-140-1-1-3	11.30	13.33	15.67	15.33	11.97	8.67	9.43	13.23
IR78555-3-2-2-2	6.30	4.33	6.67	7.66	7.87	5.67	6.33	8.35
LSD 0.05	2.55				2.05			

Table 15 presents number of days to heading of the studied rice genotypes under different sowing dates. Late sowing required minimum days to heading and early sowing needs maximum days for heading. The numbers of days for attaining complete heading stage differed from genotype to other. Shorter period from sowing to heading was required by GZ7971-2-3-6-1 than other genotypes. The maximum numbers of days from sowing to heading were recorded from either IR78555-3-2-2-2 or IR78525-140-1-1-3 under 1st of April sowing date. Air Temperature and day length were an important factor for bringing early heading in late planted plant.

Parthasarathi and Jeyakumar (2013) reported that plant development depends on temperature and requires a specific amount of heat to develop from one point in their life cycle to another, such as from seeding to the harvest stage. Temperature is a key factor for the timing of biological processes, and hence the growth and development of plants. In the current study, the variations in air temperature among the different sowing dates during the growth stages are very clear in Fig.1 Sridevi and Chellamuthu (2015) indicated that higher air temperature (both maximum and minimum) and lower diurnal variation in temperature are more conducive for early heading in rice varieties.

Table 14. Grain yield (t ha^{-1}) as affected by the interaction effect between sowing dates and rice genotypes in 2017 and 2018.

Genotypes	2017				2018			
	April 1st	April 15th	May 1st	May 15th	April 1st	April 15th	May 1st	May 15th
GZ6903-1-2-2-1	9.92	11.31	10.68	10.43	9.47	11.08	10.47	10.35
GZ7768-10-1-5-2	9.06	10.24	10.02	9.41	8.92	10.24	10.33	9.00
GZ7971-2-3-6-1	7.83	8.52	8.25	7.45	7.70	8.34	8.37	7.78
GZ8126-1-3-1-2	7.77	8.68	8.40	7.88	7.96	8.57	8.22	8.06
Sakha108	9.93	11.21	10.98	10.92	9.77	10.93	10.58	10.63
GZ8089-2-1-3-4	9.34	10.62	10.24	9.99	9.93	9.81	9.56	9.71
GZ8426-1-3-1-2	9.14	9.80	9.36	9.20	8.86	9.29	9.13	8.90
GZ8450-4-2-3-3	9.23	10.61	9.52	9.38	9.51	10.46	9.21	9.20
GZ8450-4-2-3-1-2	8.83	9.44	8.48	8.10	8.55	9.09	8.84	8.02
GZ8479-6-2-3-1	8.18	8.72	8.22	7.48	8.25	9.60	8.49	8.22
IR72	8.26	9.10	8.59	8.28	8.75	8.95	8.19	8.10
IR77510-68-1-3-3	8.95	10.63	10.27	10.08	9.52	10.39	10.01	9.87
IR78525-140-1-1-3	7.85	8.35	8.09	7.92	7.09	8.10	8.07	7.71
IR78555-3-2-2-2	8.26	8.81	8.42	8.33	8.20	8.99	8.16	8.09
LSD 0.05	0.38				0.36			

Table 15. Number of days from sowing to heading of some rice genotypes under different sowing dates in 2017 and 2018.

Genotypes	April 1st	April 15th	May 1st	May 15th	G mean
2017					
GZ6903-1-2-2-1	100.67	97.33	94.63	89.33	95.49
GZ7768-10-1-5-2	95.67	92.67	90.63	86.33	91.33
GZ7971-2-3-6-1	90.37	85.67	89.33	86.33	87.93
GZ8126-1-3-1-2	101.33	97.00	95.33	89.33	95.75
Sakha108	103.35	99.67	98.33	86.33	96.92
GZ8089-2-1-3-4	100.05	96.00	95.33	86.33	94.43
GZ8426-1-3-1-2	99.37	95.33	93.33	90.33	94.59
GZ8450-4-2-3-3	93.88	92.00	91.33	90.67	91.97
GZ8450-4-2-3-1-2	105.67	102.33	101.67	94.67	101.09
GZ8479-6-2-3-1	105.77	102.67	101.33	95.67	101.36
IR72	103.35	102.33	101.67	95.67	100.76
IR77510-68-1-3-3	105.68	102.17	101.67	96.33	101.46
IR78525-140-1-1-3	110.67	103.00	99.67	94.67	102.00
IR78555-3-2-2-2	113.20	106.33	99.33	96.33	103.80
Sowing date mean	102.07	98.18	96.68	91.31	
2018					
GZ6903-1-2-2-1	99.53	96.33	94.00	89.33	94.80
GZ7768-10-1-5-2	94.56	91.33	89.33	85.33	90.14
GZ7971-2-3-6-1	89.48	86.33	85.33	82.67	85.95
GZ8126-1-3-1-2	100.73	97.33	95.33	88.33	95.43
Sakha108	101.77	97.67	96.33	85.33	95.28
GZ8089-2-1-3-4	99.89	96.67	95.67	85.67	94.48
GZ8426-1-3-1-2	98.66	95.33	93.33	90.33	94.41
GZ8450-4-2-3-3	92.68	88.67	87.33	84.33	88.25
GZ8450-4-2-3-1-2	104.56	100.33	98.67	94.33	99.47
GZ8479-6-2-3-1	104.71	100.00	99.67	94.70	99.77
IR72	102.89	100.67	99.67	96.33	99.89
IR77510-68-1-3-3	104.55	101.33	100.33	95.67	100.47
IR78525-140-1-1-3	109.48	104.67	98.33	93.67	101.54
IR78555-3-2-2-2	112.78	105.67	97.67	95.33	102.86
Sowing date mean	101.16	97.31	95.07	90.10	

Growing degree days (GDD) of different rice genotypes at the four sowing dates is presented in Table 16. The highest GDD was accumulated by the rice plants sown on 1st of May followed by April 15th. All rice genotypes showed higher GDD from sowing to heading stage in second and third sowing dates than early and late sowing. Generally long duration genotypes recorded higher GDD than short duration genotypes because of their longer life cycle. IR78555-3-2-2-2 accumulated the highest GDD followed by IR77510-68-1-3-3 and IR78525-140-1-1-3. Sowing GZ8450-4-2-3-1-2 on May 1st in the first season accumulated the highest GDD. While in the second season sowing GZ8479-6-2-3-1, IR72 or IR77510-68-1-3-3 on May 1st recorded the highest values of GDD. Rice varietal variations for accumulation of GDD to complete different phenophases had also been reported by Bhat *et al.* (2015) and Rajesh Khavse *et al.* (2015).

Table 16. Growing Degree Days (GDD) of some rice genotypes under different sowing dates in 2017 and 2018.

Genotypes (G)	April 1st	April 15th	May 1st	May 15th	G mean
2017					
GZ6903-1-2-2-1	1821.60	1832.30	1845.70	1781.00	1820.15
GZ7768-10-1-5-2	1723.00	1751.20	1767.50	1723.20	1741.23
GZ7971-2-3-6-1	1603.40	1617.00	1728.80	1723.20	1668.10
GZ8126-1-3-1-2	1821.60	1832.30	1845.70	1781.00	1820.15
Sakha108	1862.60	1894.90	1904.80	1723.20	1846.38
GZ8089-2-1-3-4	1801.70	1813.00	1845.70	1723.20	1795.90
GZ8426-1-3-1-2	1782.80	1792.30	1805.50	1799.80	1795.10
GZ8450-4-2-3-3	1685.40	1730.60	1767.50	1818.50	1750.50
GZ8450-4-2-3-1-2	1919.30	1933.20	1984.50	1895.40	1933.10
GZ8479-6-2-3-1	1919.30	1953.40	1963.90	1914.90	1937.88
IR72	1862.60	1933.20	1984.50	1914.90	1923.80
IR77510-68-1-3-3	1919.30	1933.20	1984.50	1914.90	1937.98
IR78525-140-1-1-3	2018.10	1953.40	1944.10	1895.40	1952.75
IR78555-3-2-2-2	2058.10	2011.60	1923.70	1914.90	1977.08
Sowing date mean	1842.77	1855.83	1878.31	1823.11	
2018					
GZ6903-1-2-2-1	1900.00	1915.50	1934.40	1878.70	1907.15
GZ7768-10-1-5-2	1795.90	1808.90	1826.30	1797.10	1807.05
GZ7971-2-3-6-1	1685.20	1703.00	1737.10	1754.60	1719.98
GZ8126-1-3-1-2	1922.10	1936.30	1954.40	1860.20	1918.25
Sakha108	1941.00	1957.60	1975.90	1797.10	1917.90
GZ8089-2-1-3-4	1900.00	1936.30	1975.90	1816.90	1907.28
GZ8426-1-3-1-2	1878.80	1894.90	1913.60	1898.70	1896.50
GZ8450-4-2-3-3	1752.10	1768.00	1781.50	1776.00	1769.40
GZ8450-4-2-3-1-2	1984.50	2001.90	2040.20	1977.30	2000.98
GZ8479-6-2-3-1	1984.50	2001.90	2061.40	1996.00	2010.95
IR72	1962.90	2023.60	2061.40	2015.30	2015.80
IR77510-68-1-3-3	2006.00	2023.60	2061.40	2015.30	2026.58
IR78525-140-1-1-3	2112.50	2113.60	2018.90	1977.30	2055.58
IR78555-3-2-2-2	2174.30	2134.80	2018.90	1996.00	2081.00
Sowing date mean	1928.56	1944.28	1954.38	1896.89	

Parthasarathi and Jeyakumar (2013) indicated that in rice where the temperature drops from 24 °C to 21 °C a sharp decrease in days to heading occur. A temperature drop by 1 °C leads to 13-day delay in heading. When the temperature increases above 24 °C, days to heading decreases to 91 days at 27 °C and to 86 days at 30 °C. A temperature raise of 1 °C above 24 °C shortens the number of days to heading by less than 2 days.

CONCLUSION

According to the above findings it is concluded that to achieve higher rice grain yield, the sowing date should be adjusted. The optimum sowing date is April 15th followed by May 1st. Sakha108 and GZ6903-1-2-2-1 produced the highest grain yield followed by IR77510-68-1-3-3.

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تاثير مواعيد الزراعة على المحصول ومكوناته لبعض اصناف الارز

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قسم بحوث الارز- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية

اقيمت تجربة حقلية فى قطاعات كاملة العشوائية فى ثلاث مكرارت بمحطة البحوث الزراعية بسخا- كفرالشيخ- مصر لدراسة تاثير مواعيد الزراعة على المحصول ومكوناته فى الارز. اختبر 14 صنف من الارز فى مواعيد زراعة مختلفة ابتدءا من 1 ابريل، 15 ابريل، 1 مايو و 15 مايو اثناء موسمى 2017 و2018 . تم دراسة مساحة ورقة العلم، محتوى الكلورفيل، طول النبات، عدد السنابل بالجورة، عدد الحبوب الممتلئة بالسنبلة وعدد الحبوب الغير ممتلئة بالسنبلة، وزن الالف حبة، محصول الحبوب، عدد الايام من الزراعة وحتى التزهير و درجة النمو خلال ايام الموسم. اظهر تحليل التباين وجود اختلافات معنوية بين الاصناف تحت الدراسة وكذلك صفاتها المدروسة. لوحظ ان اعالى محصول حبوب وكذلك افضل الصفات تم الحصول عليها بموعدى الزراعة 15 ابريل و 1 مايو على التوالى.اعطت الاصناف سخا 108 و جى زد 6903 اعلى محصول حبوب يليها الصنف ار 77510.