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Hybrid Rice Seed Production as Affected by Sowing Dates, Seedling Ages and Male Rows Direction

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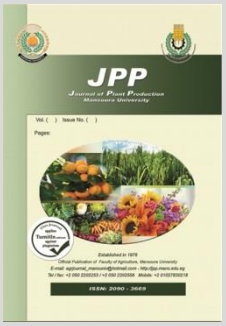

ABSTRACT

Two field experiments were conducted at the Experimental Farm of Sakha Agricultural Research Station, Kafr EL Sheikh, Egypt during 2018 and 2019 rice growing seasons, to study the effect of three sowing dates viz; April 20th, May 5th and May 20th, three seedling ages namely; 20, 30 and 40 days and male rows direction; one and two directions on out crossing of hybrid rice seed production of the CMS line IR69625A crossed by the male line Giza 178R. Split-split plot design with three replications was used. The main plots were devoted to the sowing dates, while the seedling ages were arranged in the sub plots and male rows direction were arranged in the sub-sub plots. The results showed that the interaction between sowing dates and seedling ages had a significant effect on number of days to 50% heading, plant height (cm), panicle length (cm) and panicle exertion (%), however, these traits didn't significantly affected by male rows direction. On the other hand, panicle weight (g), number of filled grains panicle^{-1}, seed set (%), harvest index (%) and seed yield (t ha^{-1}) were significantly affected by sowing dates, seedling ages and male rows direction. The interactions among sowing dates, seedling ages and male rows direction had highly significant effect on seed yield. The highest values of seed yields were obtained when rice plants were sowing on April, 20 with seedling age 20 days in two rows direction during 2018 and 2019 seasons.

Keywords: Hybrid, Rice, (CMS), Sowing dates, seed set.

INTRODUCTION

In Egypt, the average yield of rice increased due to high yielding rice varieties in the 1990 and the use of hetorosis, which increased rice production by 25–30 per cent to meet the needs of the growing population. It seems hard given last season's small difference between yield potential and real yield (10.5 t ha^{-1}). The use of heterosis in hybrid rice, which appears to be a practical approach for Egypt, is one of the available technologies for increasing yields above the current ceiling (Bastawisi *et al.*, 1998).

In Egypt, the annual rice-cropped area is nearly one-fifth of the total area. According to statistics from the Ministry of Agriculture during 2008, cytoplasmic male sterile (CMS) lines are used to develop the popular three-line system (Bastawisi *et al.*, 2002).

Seed yields in China have reached 2.5-2.7 t ha^{-1} and approximately 1-1.5 t ha^{-1} outside of China in commercial seed production sites (Virmani, 2003). Zaman *et al.* (2002) observed that some of the important components of seed production package, which need optimization, are sowing date, isolation distance, parental lines synchronization, planting pattern, ideal row ratios, ideal row directions, proper dose of applied GA_3 and plant density. Up to date, farmers are used to cultivate different local varieties or inbred particularly in the unfavorable conditions across the country, many of these rice varieties cannot perform well under stress conditions. Therefore, it is very important for plant breeder to have an information about yield contributing parameters for development of hybrid rice varieties which increased yield potential. Significant losses in seed set percentage were observed due to high temperature ensuring the role of optimum sowing date.

Recently, climate changeability is considered to be one of the main factors for annual crop variability and productivity in all ecosystems. Temperature and daytime duration may also have influenced crop growth and development as well as yield response of different varieties to different environments. Modifying sowing dates has a direct effect on both the picture and thermo cycle and thus has a significant influence on the production of dry matter partitioning (Patel *et al.*, 2013).

Since the planting date has an impact on the genetic output of rice in the use of environmental resources, choosing the correct planting date is of great importance for optimum rice productivity (Rahman *et al.*, 2010). As a factor influencing the yield-related properties of rice, the environmental condition differs at various planting dates. Rudall (1994) is well documented on the relationship between the environmental condition and yield-related plant properties.

To achieve maximum paddy yield, planting at the optimal time is required. Owing to crop sterility and lower number of successful tillers (Nazir, 1994), very early or very late planting caused yield losses. Optimum sowing date ensures that vegetative growth occurs in a time of high solar radiation levels and satisfactory temperature, and ensures that grain filling occurs during water, while maintaining sound in our climate. In addition, the abundant use of fertilizers has a residual effect on soil and the environment (Farrell *et al.*, 2003).

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Variety is the main factor in achieving higher yields of rice, depending on variations in genotypic background, input requirements and prevailing ecological conditions throughout the growing season (BRRI, 2003). Sowing time for highly productive rice generally depends on life span, photoperiod sensitivity, temperature, rainfall and other environmental factors.

Under Egyptian conditions, both day length and average temperature have significant effects on rice yield during the various growth stages. Therefore the planting date plays an important role in Egypt's rice production (RRTC, 2002). Delaying planting date decreased chlorophyll content, indexing of the leaf area and production of dry matter. Furthermore, delaying the planting date by two-four weeks considerably reduced the period from planting to flowering (El-Khoby, 2004).

The purpose of this investigation was to research the impact of sowing dates, seedling ages and direction of male rows and their interaction on growth characteristics and yield components on production of hybrid rice seeds.

MATERIALS AND METHODS

Two field experiments were conducted at the Farm of Sakha Agricultural Research Station, Egypt, during 2018 and 2019 rice summer seasons. The study includes three sowing dates (April 20th, May 5th and May 20th), three seedling ages (20, 30 and 40 days) and male rows direction (one and two directions). The used parents were CMS line IR69625A crossed by the male line Giza 178R. A split split-plot design with three replications was used. The main plots were devoted to sowing dates, while seedling ages were arranged in the sub plots and male rows direction were arranged in the sub-sub plots. Isolation space of 100 m was considered for CMS seed production. Moreover, the experimental field was surrounded by an additional 20 rows of R lines to avoid any possibility of cross pollination. Rice seeds at the rate of 20 kg ha^{-1} (15 kg from the CMS Line IR69625A and 5 Kg from the male Line (Giza 178 R) were soaked in fresh water for 24 hours, then drained and incubated for 48 hours to hasten early germination. The nursery seedbed was well ploughed and dry leveled. Phosphorous fertilizer was added in the form of single super phosphate (15.5% P_2O_5) at the rate of 240 kg ha^{-1} before tillage. Nitrogen in the form of urea (46% N) at the rate of 165 kg N ha^{-1} was added. Zinc sulphate (22 % Zn) at the rate of 25 kg ha^{-1} was added after puddling and before planting. Soil chemical properties of the experiment sites are presented in Table (1).

Table 1. Soil chemical properties of experimental sites during 2018 and 2019 seasons during 2018 and 2019 seasons.

						Cations and anions meq L^{-1} (soil paste)						
season	**pH**	**Ec dsm^{-1}**	**OM%**	**N%**	**P ppm**	**Ca^{+2}**	**Mg^{+2}**	**K^{+}**	**Na^{+}**	**HCO^{-3}**	**Cl^{-}**	**SO4^{-2}**
2018	8.09	2.74	1.56	0.063	12.11	9.65	5.38	1.42	12.81	8.30	17.85	3.15
2019	8.12	2.55	1.59	0.066	11.92	9.41	4.52	1.48	12.40	7.80	17.00	3.12

The CMS line IR69625A (female parent) was sown six days earlier than the male parent Giza 178 R. To get a proper synchronization of flowering, R and A line were transplanted by 2 seedlings hill^{-1}. Row direction was perpendicular to wind direction. The row spacing maintained for R-R, R-A and A-A lines were 20, 30, and 15 cm, respectively. Hill spacing for both R and A lines were maintained at 15 cm. Every main plot was isolated by plastic barrier (2.5m height) to avoid any pollen grain movement from treatment to another. Using knapsack sprayer for every plot. 300g ha^{-1} of GA_3 were add to CMS line in two times; first spray (40 % of GA_3) when A and R line was at 15-20 % heading and the second spray (60 % of GA_3) was applied when A and R line was at 35-40 % heading, which, (five days after heading). Spray was dissolved in a small amount of ethanol alcohol (70 %) and then it mixed with 50 litters of water, according to Prabagaran and Ponnuswamy (1997). Supplementary pollination was done by shaking the pollen parents (R line) with bamboo sticks. This operation was done 2-3 times in between 9.5 am to 12.30 noon for a period of 10 days. The crop was harvested when 80 % of the grains became golden yellow in color. Grains were sun-dried and adjusted at 14% moisture content to estimate grain yield.

Data in Table 2 showed that the characteristics of cytoplasmic male sterile (CMS) line which was used in current trail.

Data were collected as following; days to heading, plant height (cm), panicle length (cm), panicle exertion (%), panicle weight (g), seed set (%), number of filled grains panicle^{-1}, seed yield (t ha^{-1}), and harvest index (%).

Table 2. Characteristics of cytoplasmic male sterile (CMS) line used for the experiment.

CMS	**characteristics**
IR 69625A	Wild abortive (WA) CMS line
Origin	IRRI
Days to 50 % heading	105 day
Plant height	102 cm
Grain shape	medium grain

Panicle exertion percentage was estimated according to the following formula:

Panicle exsertion % = (Exerted panicle length cm ÷ Panicle length cm) × 100

Seed set percentage was calculated according to the following formula:

Seed set % = (Number of filled grains panicle^{-1} ÷ Total spikelet number panicle^{-1}) × 100

The data were collected according to Standard Evaluation System of IRRI (2014) for all the studied characters. All cultural practices were practiced as recommended. The data were analyzed following the ANOVA technique according to Gomez and Gomez (1984) and the mean differences were compared by the Duncan's Multiple Range Test (Duncan, 1955) using a statistical computer package of COSTAT.

The appropriate environment conditions of temperature, humidity and wind speed from April 10th to 30 Sept 2018 and 2019 seasons for the experimental sites (Latitude: 31 05' 12", Longitude: 30 56' 49"), which affected on the different growth and yield characteristics were shown in Table 3.

Table 3. Average of maximum and minimum wind velocity, relative humidity and air temperature every ten days from April to September during 2018 and 2019 seasons.

Date	Wind Velocity km/24 hr		RH%				Air Temperature			
			1.30 PM		7.30 AM		Min		Max	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
10 April	93.8	89.3	54	44	81.8	82	13.29	18.79	25.31	30.2
20 April	87.3	90.9	49	42.9	79.5	86.7	18	16.17	25.2	28.89
30 April	105.9	81.1	42.5	38.6	73.6	76	15.4	20.89	27.53	31.01
Mean	95.7	87.1	48.5	41.8	78.3	81.6	13.7	18.62	25.64	30.03
10 May	105.2	94.6	47.5	46.9	80.3	76	17.27	20.98	29.15	28.8
20 May	124.5	96.2	44.6	41.5	79.2	65.6	18.38	24.36	30.32	32.53
30 May	114	100.1	46.3	48.9	72.5	71.4	20.71	22.93	31.1	29.72
Mean	114.6	97	46.1	45.8	77.3	71	18.79	22.81	30.19	30.4
10 June	99.3	91.2	50.6	43.5	79.1	67.3	20.19	26.7	30.03	33.4
20 June	103.9	130.4	52.3	44.3	80.2	76	22.05	25.5	31.45	33.1
30 June	113.3	116.8	50.7	52.1	77	83.9	21.98	26.8	31.09	34.2
Mean	105.3	112.8	51.2	46.6	78.8	75.7	21.4	26.3	30.85	33.6
10 July	114.1	109.9	53.5	57.5	82.8	83.4	21.8	26.5	31.3	33.9
20 July	90.1	99.1	57.6	54.2	88.4	83	22	25.9	33.4	33.7
30 July	87.6	107.4	51.8	58.6	87.4	81.7	23.3	26	34.3	32.9
Mean	97.3	105.5	54.3	56.8	85.2	82.7	22.4	26.1	33	33.7
10 Aug.	84.6	87.9	52.5	57.6	83.5	84.8	26.2	26.2	35.9	34.3
20 Aug.	93.2	93	51.6	56.8	81.6	83.1	25.5	26.3	35.5	33
30 Aug.	95.9	97.6	51.1	54.4	86.4	85	23.3	25.5	33.9	33.9
Mean	91.2	92.8	51.7	56.3	83.8	84.3	25	26	35.1	33.6
10 Sep.	84.6	86.8	52.5	53.7	83.5	85.4	26.2	24.3	35.9	33.27
20 Sep.	93.2	94.2	51.6	51.3	81.6	82.6	25.5	24.93	35.5	33.42
30 Sep.	95.9	104.3	51.1	50.3	86.4	81.4	23.3	23.63	33.9	31.09
Mean	91.2	95.1	51.7	51.8	83.8	83.1	25	24.3	35.1	32.6

RESULTS AND DISCUSSION

Effect of sowing dates, seedling ages and male rows direction as well as their interaction on days to heading at 50%, plant height, panicle length and panicle exertion characters are given in Table 4.

Effect of sowing dates:

The effect of sowing dates had significant effected on days to heading at 50%, plant height, panicle length and panicle exertion in both seasons. The sowing date of April 20th gave the longest duration of heading date (111.06 and 111.64 days), the tallest plants (111.12 and 113.43 cm), the longest panicles (23.99 and 24.26 cm) and the highest value of panicle exertion (57.5 and 58.79 %) during 2018 and 2019 seasons, respectively. On the other hand, the sowing date of May 20th gave the shortest duration of heading date (104.87 and 104.86 days), the shortest plants (97.74 and 100.40 cm), the shortest panicle length (22.17 and 22.34 cm) and the lowest value of panicle exertion (50.51 and 51.06 %) in 2018 and 2019 seasons, respectively. When photosensitive varieties are transplanted very early, their vegetative growth has increased, resulting in increased plant height and leaf growth. Such variety is sensitive to lodging when transplanted early, due to increased plant height, as a consequence the yield of grain from such a crop is significantly reduced. On the other hand, when planting was later beyond the optimum time, the progress of grain is very meager, resulting in more developed grains and eventually a drastic decrease in grain yield (Reddy *et al.*, 2006). It will also shorten rice vegetative phase by delaying the sowing date beyond the first of June. A shorter vegetative period means less carbohydrate and mineral accumulation in the various plant organs which will in turn be translated into panicle. Therefore low yields are expected. Similar conclusion was previously drawn by Nahar *et al.* (2009). These results are in agreement with those reported by Zhu *et al.* (1998). Similar results were also found by Bastawisi *et al.* (1998) and Sridhar *et al.* (2002). Also, Hamad (2017) studied the effect of sowing dates and wind direction for Cytoplasmic Male Sterility (A) lines on seed production of hybrid rice and he came to same results.

Effect of seedling ages:

The various studied of seedling ages had a significant effect on days to heading at 50%, plant height, panicle length and panicle exertion in both seasons, (Table 3). The seedling age of 40 days old gave the longest days to heading at 50% (111.91 and 112.01 days). While, the seedling age 20 days produced the tallest plants (109.06 and 111.38 cm), the longest panicles (23.34 and 23.54 cm), the highest mean of panicle exertion (55.36 and 56.43 %) in 2018 and 2019 seasons, respectively. But, the seedling age 20 days old produced the shortest days to heading at 50% (103.90 and 105.24 days). While, the seedling age 40 days old recorded the shortest plants (102.14 and 105.09 cm), the shortest panicle length (22.80 and 23.08 cm), the lowest mean of panicle exertion (52.60 and 53.66 %) in 2018 and 2019 seasons, respectively. These results are in agreement with those reported by Bastawisi *et al.* (1998) and Zhu *et al.* (1998).

Effect of male rows direction:

The effect of male rows direction on days to 50% heading, plant height, panicle length and panicle exertion was not significant during 2018 and 2019 seasons, (Table 4).

Interaction effect:

The interaction was not significant for days to 50% heading, plant height, panicle length and panicle exertion, except that, the interaction effect between sowing dates and seedling ages was high significantly for these traits in the first and second seasons.

The results in Table 5 indicated that the interaction between the sowing dates and seedling ages had a significant effect on days to heading at 50%, plant height, panicle length and panicle exertion during both seasons. The sowing date April 20th with the seedling age 40 days produced the highest values of heading date (115.33 and 115.41 days) in 2018 and 2019 seasons, respectively. While, the sowing date April 20th under the seedling age 20 days produced the highest values of plant height (114.35 and 116.36 cm), panicle length (24.38 and 24.54 cm) and panicle exertion (58.61 and 59.32 %) in 2018 and 2019 seasons, respectively. While, the sowing date

May 20th with the seedling age 20 days produced short duration of days to heading at 50% (100.23 and 102.10 days). On the other hand, the sowing date of May 20th with the seedling age 40 days produced the lowest values of plant height (95.42 and 97.37 cm), panicle length (22.06 and 22.16 cm) and panicle exertion (48.56 and 48.82 %) in 2018 and 2019 seasons, respectively. Similar results were also found by Biradarpatil and Shekhargouda (2006). Also these results are in agreement with Waghmode *et al.* (2008).

Table 4. Effect of sowing dates, seedling ages, male rows direction and their interactions on plant characteristics during 2018 and 2019 seasons.

Main effect and interaction	Days to heading at 50 %		Plant height (cm)		Panicle length (cm)		Panicle exertion (%)	
	2018	2019	2018	2019	2018	2019	2018	2019
Sowing dates (S)								
April 20th	111.06a	111.64a	111.12a	113.43a	23.99a	24.26a	57.73a	58.79a
May 5th	107.92b	108.91b	108.14b	110.70b	23.03b	23.25b	54.17b	55.32b
May 20th	104.87c	104.86c	97.74c	100.40c	22.17c	22.34c	50.51c	51.06c
F-test	**	**	**	**	**	**	**	**
Seedling ages (G)								
20 days	103.90c	105.24c	109.06a	111.38a	23.34a	23.54a	55.36a	56.43a
30 days	108.03b	108.16b	105.84b	108.06b	23.09b	23.24b	54.44b	55.09b
40 days	111.91a	112.01a	102.14c	105.09c	22.80c	23.08c	52.6c	53.66c
F-test	**	**	**	**	**	**	**	**
male direction (R)								
One direction	107.94	108.46	105.68	108.28	23.08	23.29	54.14	55.06
Two directions	107.95	108.48	105.64	108.23	2307	23.26	54.12	55.01
F-test	NS	NS	NS	NS	NS	NS	NS	NS
Interaction								
S × G	**	**	**	**	**	**	**	**
S × R	NS	NS	NS	NS	NS	NS	NS	NS
G × R	NS	NS	NS	NS	NS	NS	NS	NS
S × G × R	NS	NS	NS	NS	NS	NS	NS	NS

**** High significant at the 1% level of probability, NS: not significant.**

Table 5. Effect of interaction between sowing dates and seedling ages on panicle characteristics and yield for CMS line during 2018 and 2019 seasons.

Sowing dates	Seedling Ages	Days to heading at 50 %		Plant height (cm)		Panicle length (cm)		Panicle exertion (%)	
		2018	2019	2018	2019	2018	2019	2018	2019
April 20th	20 days	107.32f	108.28e	114.35a	116.36a	24.38a	24.54a	58.61a	59.32a
	30 days	110.53c	111.25c	111.51c	113.50c	24.06b	24.19b	58.40b	59.03b
	40 days	115.33a	115.41a	107.1e	110.42d	23.54c	24.05c	56.19c	58.03c
May 5th	20 days	104.17h	105.34f	112.54b	114.31b	23.21d	23.56d	55.30d	56.81d
	30 days	108.32e	109.06d	108.47d	11031d	23.05e	23.19e	54.15e	55.05e
	40 days	111.28b	112.34b	103.38f	107.49e	22.81f	23.03f	53.05f	54.12f
May 20th	20 days	100.23i	102.10h	100.26g	103.48f	22.42g	22.54g	52.18g	53.16g
	30 days	105.25g	104.18g	97.56h	100.38g	22.18h	22.32h	50.78h	51.18h
	40 days	109.14d	108.31e	95.42i	97.37h	22.06h	22.16i	48.56i	48.82i

Effect of sowing dates, seedling ages, male rows direction and their interactions on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield characters are given in Table 6.

Effect sowing dates:

The tested sowing dates had high significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield during 2018 and 2019 seasons. The early sowing date of April 20th produced the highest values of panicle weight (2.77 and 2.99 g), seed set (34.63 and 35.23 %), number of filled grains panicle^{-1} (49.68 and 51.91), harvest index % (19.09 and 19.94) and seed yield (2.304 and 2.372 t ha^{-1}) in 2018 and 2019 seasons, respectively. By contrast, the sowing date May, 20 produced the lowest values of panicle weight (2.03 and 2.05 g), seed set (29.39 and 30.01 %), number of filled grains panicle^{-1} (38.29 and 39.98), harvest index (16.02 and 16.71 %) and seed yield (1.312 and 1.359 t ha^{-1}) in both seasons, respectively. Similar results were also found by Abdel-Hafez *et al.* (2005). they studied the effect of sowing date and growth regulators on rice hybrid seed quality and seedling characters.

Effect of seedling ages:

The effect of seedling ages had high significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield in both seasons (Table 6). The seedling age of 20 days gave the highest values of panicle weight (2.72 and 2.81g), seed set percentage (33.47 and 34.01 %), number of filled grains panicle^{-1} (48.01 and 50.17), harvest index (18.60 and 19.55 %) and seed yield (2.012 and 2.115 t ha^{-1}) in the first and the second seasons, respectively. While, the seedling age of 40 days produced the lowest values of panicle weight (2.15 and 2.23 g), seed set (30.45 and 31.19 %), number of filled grains panicle^{-1} (39.89 and 41.69) and seed yield (1.602 and 1.808 t ha^{-1}) in both seasons, respectively. Faghani *et al.* (2011) found that the significant effect of seedling age on tillering pattern, maximum tillers hill^{-1} (16.3) were recorded by transplanting 25 days old seedlings while 35 days old seedlings gave minimum tillers hill^{-1} (15.3). On the other side, Molla (2002) found that, twenty-eight days old seedling produced more tillers, panicles m-^{2} and grain yield than 21- day's old seedling.

Effect of male rows direction:

The effect of male rows direction on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield was high significant in 2018 and 2019 seasons, (Table 6). The two mal rows direction recorded the highest values of panicle weight (2.77 and 2.87 g), seed set percentage (33.46 and 34.03 %), number of filled grains panicle^{-1} (46.19 and 48.19

panicle^{-1}), harvest index (18.03 and 18.90 %) and seed yield (2.056 and 2.123 t ha^{-1}) in 2018 and 2019 seasons, respectively. While, the one direction of male parent produced the lowest values of panicle weight (2.16 and 2.17 g), seed set (30.90 and 31.45 %), number of filled grains panicle^{-1} (42.52 and 44.25 panicle^{-1}), harvest index (17.19 and 17.82) and seed yield (1.615 and 1.887 t ha^{-1}) in both seasons, respectively. The results are in agreement with those reported by Selim *et al.* (2018).

Interaction effect:

The interaction had high significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield in both seasons.

Table 6. Effect of sowing dates, seedling ages, male rows direction and their interactions on Panicle characteristics during 2018 and 2019 seasons.

Main effect and interaction	Panicle weight (g)		Seed set (%)		Filled grains panicle^{-1}		Harvest index (%)		Seed yield (t ha^{-1})	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Sowing dates (S)										
April 20th	2.77a	2.99a	34.63a	35.23a	49.68a	51.91a	19.09a	19.94a	2.304a	2.372a
May 5th	2.59b	2.53b	32.53b	32.98b	45.07b	46.78b	17.71b	18.43b	1.890b	2.283b
May 20th	2.03c	2.05c	29.39c	30.01c	38.29c	39.98c	16.02c	16.71c	1.312c	1.359c
F-test	**	**	**	**	**	**	**	**	**	**
Seedling ages (G)										
20 days	2.72a	2.81a	33.47a	34.01a	48.01a	50.17a	18.60a	19.55a	2.012a	2.115a
30 days	2.53b	2.53b	32.44b	33.02b	45.15b	46.82b	17.91b	18.56b	1.893b	2.093b
40 days	2.15c	2.23c	30.45c	31.19c	39.89c	41.69c	16.31c	16.97c	1.602c	1.808c
F-test	**	**	**	**	**	**	**	**	**	**
male direction (R)										
One direction	2.16b	2.17b	30.90b	31.45b	42.52b	44.25b	17.19b	17.82b	1.615b	1.887b
Two directions	2.77a	2.87a	33.46a	34.03a	46.19	48.19a	18.03a	18.90a	2.056a	2.123a
F-test	**	**	**	**	**	**	**	**	**	**
Interaction										
S × G	**	**	**	**	**	**	**	**	**	**
S × R	**	**	**	**	**	**	**	**	**	**
G × R	**	**	**	**	**	**	**	**	**	**
S × G × R	**	**	**	**	**	**	**	**	**	**

**** High significant at the 1% level of probability.**

The results in Table 7 showed that the interaction between sowing dates and seedling ages had significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield in the first and second seasons. The sowing date of April 20th with seedling age of 20 days produced the highest values of panicle weight (2.98 and 3.37 g), seed set (35.43 and 36.20 %), number of filled grains panicle^{-1} (54.50 and 57.79 panicle^{-1}) , harvest index (20.99 and 22.13 %) and seed yield (2.492 and 2.609 t ha^{-1}) in both seasons, respectively. While, the sowing date of May 20th with seedling age of 40 days produced the lowest values of panicle weight (1.52 and 1.66 g), seed set (26.47 and 27.43 %), number of filled grains panicle^{-1} (30.74 and 32.33 panicle^{-1}), harvest index (13.94 and 17.58 %) and seed yield (1.232 and 1.268 t ha^{-1}) in 2018 and 2019 seasons, respectively. Abo Youssef and Draz (2004) studied the effect of sowing date on productivity of hybrid rice seeds under Egyptian conditions.

Table 7. Effect of interaction between sowing dates and seedling ages on panicle characteristics and yield during 2018 and 2019 seasons.

Sowing dates	Seedling Ages	Panicle weight (g)		Seed set (%)		Filled grains panicle^{-1}		Harvest index (%)		Seed yield (t ha^{-1})	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
April 20th	20 days	2.98a	3.37a	35.43a	36.20a	54.50a	57.79a	20.99a	22.13a	2.492a	2.609a
	30 days	2.83b	3.03b	34.36b	34.99b	48.13b	49.33b	18.44b	19.10b	2.403b	2.443c
	40 days	2.51e	2.59c	34.10c	34.48c	46.42c	48.59c	17.86c	18.59d	2.018d	2.064f
May 5th	20 days	2.79c	2.59c	33.27d	33.76d	46.59c	48.01e	17.42d	18.49e	2.140c	2.205d
	30 days	2.55d	2.56c	32.95e	33.54e	46.11d	48.19d	18.56b	19.04c	1.975d	2.555b
	40 days	2.44f	2.43d	31.36g	31.65g	42.52f	44.15g	17.15d	17.75g	1.557e	2.091e
May 20th	20 days	2.41f	2.48c	31.7f	32.09f	42.95e	44.68f	17.39d	18.01f	1.405f	1.464g
	30 days	2.91g	2.00e	30.02h	30.52h	41.20g	42.94h	16.73e	17.53h	1.300g	1.346h
	40 days	1.52h	1.66f	26.47i	27.43i	30.74h	32.33i	13.94f	17.58i	1.232h	1.268i

The results in Table 8 showed that the interaction between the sowing dates and male rows direction had significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield in 2018 and 2019 seasons. The sowing date of April 20th with two directions of male parent rows produced the highest values of panicle weight (3.05 and 3.41 g), seed set (36.57 and 37.10 %), number of filled grains panicle^{-1} (51.80 and 54.65), harvest index (19.63 and 20.85 5) and seed yield (2.586 and 2.668 t ha^{-1}) in both seasons. Meanwhile, the sowing date of May 20th with one direction of male parent produced the lowest values of panicle weight (1.73 and 1.70 g), seed set (28.85 and 29.57), number of filled grains panicle^{-1} (36.89 and 38.85), harvest index (15.98 and 16.64 %) and seed yield (1.241 and 1.302 t ha^{-1}) during 2018 and 2019 seasons, respectively. Similar results were also found by Zaman *et al.* (2002). Also, Abo Youssef *et al.* (2005) came to similar results.

The results in Table 9 showed that the interaction between the seedling ages and male rows direction had a significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield in both seasons. The seedling age of 20 days under two mal rows directions produced the highest values of panicle weight (2.97 and 3.22 g), seed set (35.07 and 35.65 %), number of filled grains panicle^{-1} (50.54 and 53.19 panicle^{-1}), harvest index (19.06 and 20.11 %) and seed yield (2.266 and 2.361 t ha^{-1}) in both seasons, respectively. While, the seedling age of 40 days with

one directions produced the lowest values of panicle weight (1.81 and1.87 g), seed set (29.80 and 30.64 %), number of filled grains panicle^{-1} (39.04 and 41.11), harvest index (16.20 and 16.75 %) and seed yield (1.480 and 1.505 t ha^{-1}) during 2018 and 2019 seasons, respectively. Similar results were also found by Akram *et al.* (2007).

Table 8. Effect of interaction between sowing dates and male rows direction on panicle characteristics and yield during 2018 and 2019 seasons.

Sowing dates	Male direction	Panicle weight (g)		Seed set (%)		Filled grains panicle^{-1}		Harvest index (%)		Seed yield (t ha^{1})	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
April 20th	One direction	2.49c	2.58c	32.69c	33.36c	47.05c	48.80c	18.39b	19.01c	2.023c	2.284b
	Two directions	3.05a	3.41a	36.57a	37.10a	51.80a	54.65a	19.63a	20.85a	2.586a	2.668a
May 5th	One direction	2.27e	2.22e	31.17d	31.42d	43.08d	44.76d	17.03c	17.75d	1.579d	2.075c
	Two directions	2.91b	2.83b	33.88b	34.54b	47.56b	49.16b	18.56b	19.10b	2.202b	2.283b
May 20th	One direction	1.73f	1.70f	28.85f	29.57f	36.89f	38.85f	15.98d	16.64f	1.241f	1.302e
	Two directions	2.34d	2.39d	29.94e	30.45e	39.69e	41.12e	16.05d	16.74e	1.382e	1.416d

Table 9. Effect of interaction between seedling ages and male rows direction on panicle characteristics and yield during 2018 and 2019 seasons.

Seedling ages	Male direction	Panicle weight (g)		Seed set (%)		Filled grain panicle^{-1}		Harvest index (%)		Seed yield (t ha^{-1})	
		2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
20 days	One direction	2.47c	2.40d	31.86c	32.39c	45.49c	47.13c	18.14c	18.98c	1.758c	1.981c
	Two directions	2.97a	3.22a	35.07a	35.65a	50.54a	53.19a	19.06a	20.11a	2.266a	2.361a
30 days	One direction	2.20d	2.23e	31.05e	31.33e	43.02d	44.52d	17.13d	17.72d	1.606d	1.824e
	Two directions	2.83	2.83b	33.84b	34.71b	47.27b	49.12b	18.69b	19.39b	2.180b	2.248b
40 days	One direction	1.81e	1.87f	29.80f	30.64f	39.04f	41.11f	16.20e	16.75f	1.480e	1.505f
	Two directions	2.50c	2.58c	31.49d	31.73d	40.75e	42.27e	16.32e	17.20e	1.724c	1.856d

The results in Table 10 showed that the interaction among the sowing dates , the seedling ages and male rows direction had a significant effect on panicle weight, seed set, number of filled grains panicle^{-1}, harvest index and seed yield in both seasons.

The results in Table 10 indicated that, the sowing dates of April 20th with the 20 days seedling age under two mal rows direction induced the highest values of panicle weight (3.14 and 3.85 g), seed set (37.60 and 38.24 %), number of filled grain panicle (58.60 and 63.34 panicle^{-1}), harvest index (21.81 and 23.23 %) and seed yield (2.664 and 2.790 t ha^{-1}) in 2018 and 2019 seasons, respectively. On the other hand, the sowing dates May 20th with the seedling ages of 40 days and one direction of male parent produced the lowest values of panicle weight (1.36 and 1.30 g), seed set (25.39 and 26.05 %), number of filled grains panicle^{-1} (32.26 and 30.29), harvest index (13.43 and 14.09 %) and seed yield (1.225 and 1.218 t ha^{-1}) during 2018 and 2019 seasons, respectively. These results are in agreement with those reported by Huang *et al.* (1998) and El-Mowafi *et al.* (2016).

Table 10. Effect of interaction among sowing dates, seedling ages and male rows direction on panicle characteristics and yield during 2018 and 2019 seasons.

Sowing dates	Seedling ages	Male direction	Panicle weight (g)		Seed set (%)		Filled grains panicle^{-1}		Harvest index (%)		Seed yield (t ha^{-1})	
			2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
April 20th	20 days	One direction	2.82e	2.89cd	33.26f	34.16e	47.32e	49.02f	17.81de	21.04b	2.230d	2.600d
		Two directions	3.14a	3.85a	37.60a	38.24a	58.60a	63.34a	21.81a	23.23a	2.664a	2.790a
	30 days	One direction	2.61f	2.65e	32.51g	32.84i	45.69g	47.23i	17.59def	18.02i	1.807f	2.275g
		Two directions	3.04b	3.41b	36.21b	37.15b	50.41b	52.24b	20.17b	20.26c	2.640a	2.700b
	40 days	One direction	2.03i	2.21fgh	32.30h	33.07h	45.62g	47.16ij	17.52def	18.02i	1.730fg	2.063h
		Two directions	2.98c	2.97c	35.9c	35.9c	49.48c	51.27c	20.06b	20.18d	2.550b	2.655c
May 5th	20 days	One direction	2.60f	2.26fg	32.19i	32.35j	45.52g	47.01j	17.25efg	18.28h	1.655g	1.854i
		Two directions	2.97c	2.92cd	34.34d	35.16d	48.07d	50.24d	19.08c	19.15e	2.220d	2.510e
	30 days	One direction	2.18h	2.31f	31.76j	31.87k	44.24	46.14k	16.99fgh	17.74k	1.550h	1.755j
		Two directions	2.93d	2.81cd	34.14e	35.21d	47.40d	49.35e	18.01d	18.71f	2.401c	2.496e
	40 days	One direction	2.04i	2.10ghi	29.55m	30.04n	40.27i	42.14m	16.77gh	17.16n	1.485hi	1.687
		Two directions	2.84e	2.75de	33.17f	33.26g	45.78g	47.39h	17.78de	18.34gh	2.043e	2.310f
May 20th	20 days	One direction	2i	2.06hi	30.13l	30.65m	39.34j	41.12n	16.51h	17.64l	1.375ij	1.520l
		Two directions	2.82e	2.91cd	33.27f	33.53f	46.77f	47.84g	17.05fgh	18.39g	1.459hi	1.411m
	30 days	One direction	1.83j	1.74j	28.87n	29.27o	38.16k	40.04o	16.95fgh	17.32m	1.288jk	1.408m
		Two directions	2.54g	2.26fg	31.16k	31.76l	44.13h	45.84l	17.70de	17.81j	1.325jk	1.281o
	40 days	One direction	1.36l	1.30k	25.39p	26.05q	32.26l	30.29q	13.43j	14.09p	1.225l	1.218p
		Two directions	1.67k	2.02i	27.55o	28.8p	29.22m	34.37p	14.45i	15.06o	1.275kl	1.318n

CONCLUSION

From going discussion, early sowing date at April 20th combined with young rice seedling of 20 days along two mal rows direction is recommended to get high yield of hybrid rice seed production under Egyptian conditions

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تأثير مواعيد الزراعة وأعمار البادرات و إتجاه شتل الأب على إنتاجية تقاوى الأرز الهجين

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أجريت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا - كفر الشيخ - مصر خلال موسمى 2018 و2019 وكان الهدف من التجربة هو دراسة تأثير ثلاثة مواعيد زراعة (20 أبريل و 5 مايو و 20 مايو) وثلاثة أعمار للشتل (عمر 20 و 30 و 40 يوم) وإتجاه شتل الأب المعيد للخصوبة (فى إتجاه واحد وفى إتجاهين) علي إنتاجية تقاوى الأرز الهجين للسلاله العقيمة ذكريا سيتوبلازميا (IR69625A) والملقحة بالأب المعيد للخصوبة جيزه 178 . كان التصميم المستخدم فى هذه التجربة هو القطع المنشقة مرتين في ثلاث مكررات حيث تم وضع مواعيد الزراعة فى القطع الرئيسية وأعمار الشتل فى القطع المنشقة و إتجاه شتل الأب المعيد للخصوبة في القطع المنشقة مرة ثانية. أوضحت النتائج أن عدد أيام التزهير حتى 50% وإرتفاع النبات وطول الدالية ومعدل بزوغ الدالية من غمد ورقة العلم تأثروا تأثرا عالى المعنوية بمواعيد الزراعة وأعمار الشتلات ولكن هذة الصفات لم تتأثرتأثيرا معنويا مع إتجاه شتل الأب المعيد للخصوبة سواء فى اتجاه واحد أو فى اتجاهين ، وعلى الجانب الاخر تأثر كلا من وزن الدالية ونسبة العقد و عدد الحبوب الممتلئة فى الدالية ودليل الحصاد ومحصول التقاوي تأثرا عالى المعنوية بمواعيد الزراعة وأعمار الشتلات وإتجاه شتل ألأب المعيد للخصوبة فى كلا موسمى الزراعة, حيث سجلت أعلى القيم من هذه الصفات عند ميعاد الزراعة المبكر فى 20 إبريل والشتل عند 20 يوم مع شتل الأب المعيد للخصوبة فى إتجاهين. ويتضح من نتائج هذه التجربة أن الزراعة المبكرة فى 20 أبريل وشتل البادرات عند عمر 20 يوم مع شتل الأب المعيد للخصوبة فى اتجاهين يعطى محصول عالى من تقاوى الأرز الهجين تحت ظروف هذه التجربة