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Optimizing Sowing Date and Nitrogen Fertilizer Level for the New Rice Variety Sakha Super 300

Gewaily, E. E.* ; H. Sh. Hamad and E. F. Arafat

Rice Research Department, Field Crops Research Institute, Agricultural Res. Center, Egypt.

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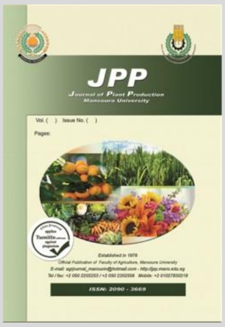

ABSTRACT

A field trial was performed in Randomized Complete Block Design (RCBD) with three replications at the Experimental Farm of Sakha Agricultural Research Station, Kafr ELSheikh, Egypt, during 2018 and 2019 rice growing seasons, to investigate the effect of three sowing dates (May 10th, June 1st and June 20th) and four levels of nitrogen fertilizer (0, 55, 110 and 165 kg N/ha) on the productivity of Sakha Super 300 variety. The results showed that the sowing date June 1st produced the highest grain yield 10.67 and 10.71 t ha^{-1} in both seasons. Nitrogen level of 165 kg N ha^{-1} produced the highest grain yield 10.50 and 10.45 t ha^{-1} without any significant difference with level of 110 kg N ha^{-1} in 2018 and 2019 seasons. The interaction between sowing dates and nitrogen levels was highly significant for number of panicles hill^{-1}, panicle length, number of filled grains panicle^{-1}, unfilled grains percentage and 1000-grain weight, as well as grain and straw yield and harvest index in both seasons. Interaction results showed that, the first sowing date (May 10th) with nitrogen level of 110 kg N ha^{-1} gave the highest grain yield 10.91 and 10.79 t ha^{-1}. On the other hand the second sowing date (June 1st) with nitrogen level of 165 kg N ha^{-1} gave the highest grain yield 12.03 and 11.92 t ha^{-1} in 2018 and 2019 seasons. The highest values of accumulated growing degree days (GDD) and photo thermal units (PTU) were recorded when plants sown on May 10th. On the other hand the maximums heat use efficiency (HUE) was achieved when Sakha Super 300 sown on 1st June with application of 165 Kg N ha^{-1} in both seasons.

Keywords: Sakha Super 300 rice variety, sowing dates and nitrogen levels.

INTRODUCTION

Recently weather changeability is conceived one of the main factors of annually variability of crop growth and productivity in all ecosystems. Temperature and day length also have been affecting on crop growth and progression as well as yield response of different varieties to diverse environments, can be quite different. Modifying sowing dates directly impact on both photo and thermo period, and consequently have great influence on development of the phasic and dry matter partitioning Patel *et al*. (2019).

Since planting date affects the genetic efficiency of rice in environmental resources consumption, the selection of appropriate planting date is a high importance for optimum rice productivity Ali and Rahman (1992). Environmental condition, as a factor affecting yield related properties of rice, varies at different planting dates. The relationship between environmental condition and yield related properties of plant is well documented Rudall (1994).

Planting at the optimal time is necessary for achieving maximum paddy yield. Very early or very late planting result in yield loss due to crop sterility and lower number of effective tillers Nazir (1994). Optimum sowing date guarantees that vegetative growth happens in a period of high rates of solar radiation and satisfactory temperature, and ensures that grain filling happens during the temperatures are more likely, thus superior grain yield and quality were obtained Farrell *et al*. (2003).

Variety is the major factor to achieve superior rice yield depending upon their variations in genotypic background, input requirements and the prevailing ecological conditions throughout the growing season BRRI, (2003). Sowing time for highly rice productivity generally depends on life duration, sensitivity to photoperiod, temperature, rainfall and other environmental items.

Under Egyptian conditions, both day length and average temperature during the different growth stages have considerable effects on rice yield. Thus, planting date plays a significant role in rice productivity in Egypt RRTC, (2002). Delaying planting date reduced the chlorophyll content, leaf area index and dry matter production. Also, delaying planting date by two-four weeks significantly decreased the period from planting to flowering El-Khoby, (2004).

Nitrogen fertilizer is more urgent for security rice production. Apply sufficient nitrogen level is essential not only for getting greatest economic return, but also to lower environmental contamination Fageria and Baligar (2003). Modern high-yielding rice cultivars may have differences in accumulation and using N from the soil and applied. The recovery of fertilizer nitrogen for rice is low and deterrent to get the full potential yield. So it is necessary to identify what the optimal dose needed for each cultivar as well as its influence on yield and its attributes. Shaiful Islam *et al.* (2009) reported that using proper nitrogen level lead to spare money and maintain ours environment sound. Moreover, the abundant application of fertilizer has an influence on the soil

*** Corresponding author.**
E-mail address:Sgewaily@yahoo.com
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and the environment through the fertilizer residual effect. Apply the most suitable dose of nitrogen fertilization is a main interest of economic viability of crop production and the impact of agriculture.

Rice is very much sensitive to photo thermal regimes and the crop growth is influenced largely by the growing environmental conditions. Among them temperature and day length play a significant role in physiological, chemical and biological processes of plants. It are significant environmental factor influencing the growth and progress of crops Malo and Ghosh (2018) and it are simple tools to find out the relationship between plant growth, temperature, and day length.

Sakha super 300 rice variety was commercialized by Rice Research and Training Center, Sakha, Kafr ELSheikh, Egypt in 2017 therefore, it is necessary to generate adequate knowledge concerning planting time and optimum N level to exploit better growth and productivity.

MATERIALS AND METHODS

The experiment was conducted at the Experimental Farm of Sakha Agricultural Research Station, Kafr ElSheikh, Egypt, during 2018 and 2019 seasons to study the effect of three sowing dates (May 10th, June 1st and June 20th) and four levels of nitrogen fertilizer (0, 55, 110 and 165 kg N ha^{-1}) on yield and its attributes of Sakha Super 300. The preceding crop was wheat in the two studied seasons. Soil chemical properties of the experimental sites are presented in Table (1).

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

						Cation and anion meq L^{-1} (soil paste)						
Season	**pH**	**EC dSm^{-1}**	**OM %**	**N %**	**P ppm**	**Ca^{2+}**	**Mg^{2+}**	**K^+**	**Na^+**	**HCO_3^-**	**Cl^-**	**SO_4^{2-}**
2018	8.07	2.85	1.58	0.062	12.20	10.04	5.42	1.40	14.10	8.40	18.34	3.22
2019	8.15	2.60	1.61	0.065	11.8	9.40	4.10	150	12.30	7.90	17.10	3.20

The nitrogen levels 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 three sowing dates in each season for results explanation. According to the sowing dates treatments, on May 10th, June 1st and June 20th in both 2018 and 2019 seasons, seeds rice variety of Sakha Super 300 at the rate of 144 kg ha^{-1} were soaked in fresh water for 24 hr and then incubated for 48 hr to hasten germination and were broadcasted in the nursery. Seedling at 30 days old (3 seedling $hill^{-1}$) were transplanted at 20 x 20 cm distance between hills and rows. The area of experimental plot was $15m^2$ (3mx5m). Nitrogen fertilizer with each level was applied in form of Urea (46.5% N) in two split applications, two third of dose as basal application while the other one third topdressing at 35 days after transplanting. All identical agricultural managements in terms of ploughing, cultivation, P, K and Zn fertilizers, and disease control were done as the recommendation of Rice Research and Training Center RRTC (2012). Days to complete heading was recorded for each treatment. Five hills were randomly identified from each plot to estimate the plant height (cm), and number of panicles $hill^{-1}$. Ten panicles were randomly collected to estimate the panicle weight (g), panicle length (cm), number of filled grains $panicle^{-1}$ and unfilled grains percentage, and1000-grain weight (g). Central 10 m^2 of each plot were harvested at full maturity, dried and threshed, and then the grain and straw yields were recorded. Grain yield was modified to 14% moisture content and transferred into t ha^{-1}.The straw yield reproducing from 10 m^2 was evaluated and converted to t ha^{-1}. Agronomic nitrogen efficiency (ANE) was calculated according to Fageria and Baligar (2003). The growing degree days (GDD) was computed by using the following formula according to Parthasarathi *et al*. (2013).

$$\mathbf{GDD = \Sigma\ [(T_{mix} + T_{min})/2 - Base\ temperature]}$$

Where,

T_{mix} = Daily maximum temperature, T_{min} = Daily minimum temperature. The base temperature (temperature which the plant can not grow lower than it) which is considered 10°C for rice crop according to the Sahu (2003).

Photo thermal unit (PTU) is calculated by multiplying GDD with day length (DL) according to the Patel *et al*. (2013), by using the following formula

$$\mathbf{PTU\ (°C\ day\ hour) = GDD\ X\ DL}$$

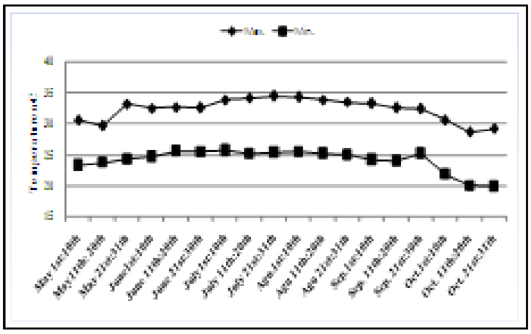
Where,

DL = Day length (Possible sunshine hours from dawn to twilight)

Heat use efficiency (HUE) for total dry matter was evaluated following Patel *et al*. (2013).

$$\mathbf{HUE\ (g\ m^{-2}\ day\ °C^{-1}) = Biomass\ (g\ m^{-2}) / GDD\ (day\ °C)}$$

Data of daily maximum and minimum air temperature as well as day length (hr:min.) has been collected from first of May to end of October 2018 and 2019 for the experimental sites (Latitude: 31 05' 12", Longitude: 30 56' 49"). Figure (1) illustrated the average maximum and minimum temperature °C during growing rice season in 2018 and 2019.



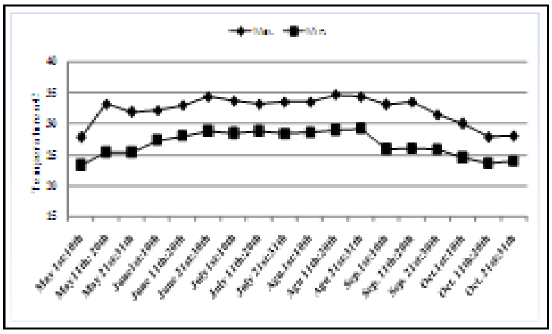


Fig. 1. Average maximum and minimum temperature (oC) during rice growing seasons in 2018 and 2019.

Figure (2) illustrated the average of day length during rice growing season.

Data collected were statistically analyzed according to Gomez and Gomez (1984) using COSTAT Computer Program. The differences amongst treatments were compared via Duncan's Multiple Range Test (DMRT, 1955).

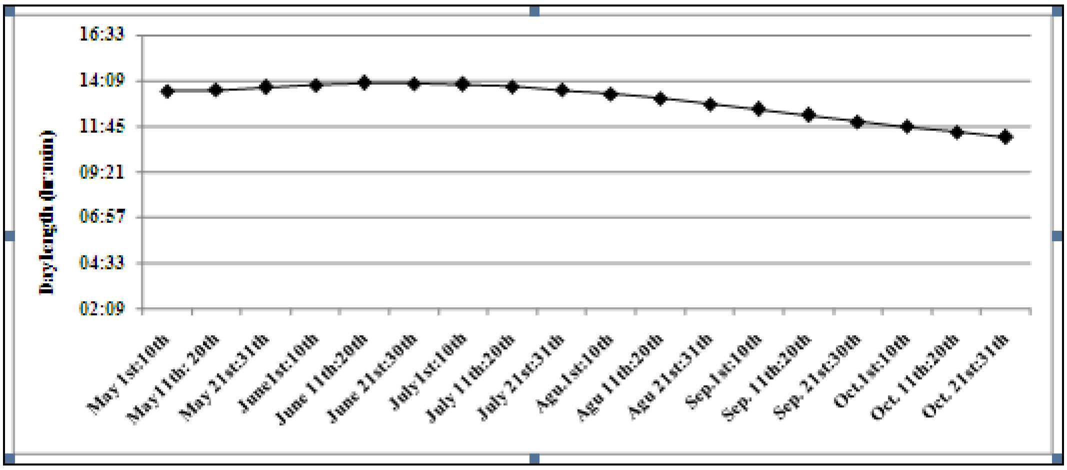


Fig. 2. Average of day length during rice growing season.

RESULTS AND DISCUSSION

The effect of sowing dates, nitrogen levels and their interaction on days to heading, plant height, number of panicles hill^{-1}, panicle weight, panicle length, number of filled grains panicle^{-1}, unfilled grains percentage and 1000-grain weight are given in Table 2.

Table 2. Effect of sowing dates and nitrogen levels as well as their interaction on plant characteristics during 2018 and 2019 seasons.

Main effect and interaction	Days to heading (day) 2018	Days to heading (day) 2019	Plant height (cm) 2018	Plant height (cm) 2019	NO. of panicles hill^{-1} 2018	NO. of panicles hill^{-1} 2019
Sowing dates (S)						
May10th	107.67a	108.67a	114.76a	113.39a	19.93b	19.75b
June 1st	96.17b	96.75b	110.32b	109.26b	22.58a	22.38a
June 20th	84.58c	85.33c	106.68c	104.51c	17.76c	18.43c
N levels (kg N ha^{-1})						
0	93.00c	93.11c	100.85d	100.48d	17.13d	16.87d
55	96.00b	97.00b	107.08c	104.82c	19.60c	19.80c
110	97.00ab	97.78b	113.26b	111.74b	21.18b	21.41b
165	98.00a	99.78a	121.18a	119.18a	22.43a	22.67a
S x N	NS	NS	NS	NS	**	**

Table 2. Continued.

Main effect and interaction	Panicle weight (g) 2018	Panicle weight (g) 2019	Panicle length (cm) 2018	Panicle length (cm) 2019	Number of filled grains panicle^{-1} 2018	Number of filled grains panicle^{-1} 2019	Unfilled grains (%) 2018	Unfilled grains (%) 2019	1000-grain weight (g) 2018	1000-grain weight (g) 2019
Sowing dates (S)										
May10th	4.93c	4.91b	21.62a	20.77a	162.58b	165.40b	4.33b	4.62b	29.01c	28.23b
June 1st	5.64a	5.84a	21.88a	21.28a	188.75a	194.90a	3.74c	3.78c	29.58a	29.59a
June 20th	5.25b	4.91b	19.83b	18.93b	147.47c	153.02c	5.18a	5.39a	29.32b	29.55a
N levels (kg N ha^{-1})										
0	4.66d	4.34d	20.68d	19.15d	137.67d	139.00d	5.76a	6.01a	28.76c	27.72c
55	4.99c	5.02c	20.83c	20.22c	162.89c	167.39c	4.84b	4.87b	29.49a	29.59a
110	5.55b	5.59b	21.32b	20.78b	180.07b	186.87b	3.90c	3.98c	29.44ab	29.53ab
165	5.90a	5.93a	21.62a	21.17a	184.44a	191.17a	3.15d	3.53d	29.51a	29.67a
S x N	NS	NS	**	**	**	**	**	**	**	**

Means not sharing the same letter significantly differ using DMRT.
*** = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.**

The highest values for days to heading and plant height were obtained with the first sowing date May10st during 2018 and 2019 seasons, while the sowing date June 1st gave the highest values for number of panicles hill^{-1}, panicle weight, panicle length, number of filled grains panicle^{-1} and 1000-grain weight in both seasons. On the other hand, the sowing date June 20th gave the highest unfilled grains percentage during the two seasons. Moreover, the lowest values of days to heading, plant height, number of panicles hill^{-1}, panicle length and number of filled grains panicle^{-1} were obtained with sowing date June 20th in both seasons. While, the sowing date May10st gave the least panicle weight and 1000-grain weight in both seasons. While, the sowing date June 1st gave the least unfilled grains percentage in both seasons. The results are in harmony with those obtained by Farrell *et al*., (2003) who reported that mildly photoperiod-sensitive cultivars had a reduced likelihood of encountering low temperature compared with photoperiod-insensitive cultivars. The benefits of photoperiod sensitivity include wider sowing flexibility and growth duration is shortened when sowing is delayed. Abo Youssef *et al*. (2005) stated that the duration from seedling to heading depended on the date of sowing, the duration was longer in earlier sowing than in later sowing. Abdel-Hafez *et al.* (2005) showed that early sowing dates increased plant height.

Otherwise, there were highly significantly differences among nitrogen levels on days to heading, plant height, number of panicles hill^{-1}, panicle weight, panicle length, number of filled grains panicle^{-1}, unfilled grains percentage and 1000-grain weight. The highest values of days to heading, plant height, number of panicles hill^{-1}, panicle weight, panicle length, number of filled grains panicle^{-1} and 1000-grain weight were obtained with application of 165 kg N ha^{-1} in both seasons. While, the highest values of unfilled grains percentage were obtained with 0 nitrogen levels (without N application) in both seasons. On the other hand, the lowest values for days to heading, plant height, number of panicle hill^{-1}, panicle weight, panicle length, numbers of filled grains panicle^{-1} and 1000-grain weight were obtained from control treatment (without N application) in both seasons. While, the nitrogen application at the level of 165 kg N ha^{-1} gave the least unfilled grains percentage in both seasons. Haque *et al* .(2006) who reported that irrespective of cultivars, the days requested to heading and maturity significantly increased with the increasing the level of nitrogen application. Accelerated vegetative growth could be a reason for delaying heading and crop maturity with the enhancing in the doses of nitrogen fertilizer. Also, Peng-fei *et al.* (2013) reported that delayed heading with higher nitrogen dose may be due to more vegetative growth, which resulted in enhanced plant height, which delayed maturity. The improved in yield attributes with increasing N levels mostly due to the function of nitrogen on improving rice growth, photosynthesis, internodes elongation and metabolism as well as assimilation of production, led to extra panicle formation during the productive stage, produce maximum spikelets per panicle as well as grain filling accordingly, the weight of grain was high. The promoting impacts of nitrogen on yield attributes were stated by Sorour *et al*. (2016) and Gewaily *et al*. (2018).

The interaction between sowing dates and nitrogen levels was highly significant for number of panicles hill^{-1}, panicle length, number of filled grains panicle^{-1}, unfilled grains percentage and 1000-grain weight in both seasons. While, its not significant for days to heading, plant height and panicle weight in both seasons.

The results in Table (3) showed that the combination between sowing date June 1st with nitrogen level at 165 kg N ha^{-1} produced significantly highest values of number of panicles hill^{-1}, panicle length, number of filled grains panicle^{-1} and 1000-grain weight in both seasons. While, the sowing date on June 20th without nitrogen application (0 kg N /ha^{-1}) produced significantly highest values for unfilled grains percentage in 2018 and 2019 seasons. However, the sowing date on June 20th without nitrogen application (0 kg N ha^{-1}) produced the lowest values for number of panicles hill^{-1}, panicle length and number of filled grains panicle^{-1} in both seasons. While, the sowing date on May10th without nitrogen application (0 kg N ha^{-1}) produced the least 1000-grain weight (g) in the both seasons. Also, the sowing date on June 1st with nitrogen level of 165 kg N ha^{-1} produced lowest unfilled grains percentage in both seasons.

Table 3. Number of panicles hill^{-1}, panicle length (cm), number of filled grains panicle^{-1}, unfilled grains percentage and 1000-grain weight (g) as affected by the interaction between sowing dates and nitrogen levels during 2018 and 2019 seasons.

Sowing dates	2018				2019			
	N levels (kg N ha^{-1})							
	0	55	110	165	0	55	110	165
	Number of panicles hill-1							
May10th	17.35d	19.56c	20.92b	21.88b	17.37c	18.60c	21.25b	21.77b
June 1st	18.93c	22.26b	24.07a	25.04a	17.76c	22.83ab	23.82a	25.12a
June 20th	15.12e	17.00d	18.55c	20.37b	15.47d	17.98c	19.17bc	21.13b
	Panicle length (cm)							
May10th	21.05c	21.38c	21.84bc	22.20a	19.96d	20.55c	21.18bc	21.41a
June 1st	20.98c	22.01b	22.09a	22.46a	19.74d	21.55b	21.77a	22.08a
June 20th	19.10e	20.00d	20.02d	20.21d	17.77e	18.56e	19.39d	20.01c
	Number of filled grains panicle^{-1}							
May10th	131.33e	164.00c	180.00b	175.00bc	134.67ef	167.77d	181.83bc	177.33c
June 1st	155.33cd	189.00b	202.67a	208.00a	155.00e	190.42b	212.10a	222.10a
June 20th	126.33e	135.67e	157.53cd	170.33c	127.33f	144.00e	166.67d	174.08c
	Unfilled grain %							
May1st	5.40b	4.62c	3.96d	3.33d	5.80b	4.64c	4.11c	3.94cd
June 1st	5.34b	4.18c	3.41d	2.04e	5.38b	4.33c	3.22d	2.21e
July 1st	6.55a	5.73ab	4.34c	4.08c	6.86a	5.63b	4.63c	4.40c
	1000-grain weigh (g)							
May10th	28.37de	29.10c	29.33b	29.23b	28.47d	29.60b	29.60b	29.10c
June 1st	29.20c	29.70a	29.83a	30.10a	29.43c	29.67b	29.70b	30.17a
June 20th	28.70d	29.67ab	29.37b	29.00	29.27c	29.30c	29.30c	29.73b

Means not sharing the same letter significantly differ using DMRT.

The effect of sowing dates, nitrogen levels and their interaction on grain and straw yield (t ha^{-1}) as well as harvest index are given in Table (4). Results showed that the highest values for grain and straw yield (t ha^{-1}) as well as harvest index were obtained from the second sowing date June 1st, which was significantly superior to each of 10th May and 20th of June in both seasons. On the other hand, sowing date June 20th produced the lowest grain and straw yield t ha^{-1} as well as harvest index (%) in both seasons. If photosensitive varieties are transplanted a little early, their vegetative growth extended which resulted more plant height and leafy growth. Due to increased plant height, such variety sensitive to lodging when transplanted early time. As a result, the grain yield from such a crop is reduced drastically. On the other hand, when planting was later beyond optimal period, the grain progress is very meager which causes more amount of under developed grains and eventually severe drop in grain yield Sarkar and Reddy (2006). Also delaying the sowing date beyond the first of June will shorten rice vegetative phase. A shorter vegetative period means less carbohydrates and mineral accumulation in the different plant organs which, in turn, will be translocted to the panicle. Consequently, low yields will be expected. Similar conclusion was previously drawn by Nahar *et al*. (2009).

Table 4. Effect of sowing dates and nitrogen levels, as well as, their interaction on grain, straw yield and harvest index during 2018 and 2019 seasons.

Main effect and interaction	Grain yield t ha^{-1} 2018	Grain yield t ha^{-1} 2019	Straw yield t ha^{-1} 2018	Straw yield t ha^{-1} 2019	Harvest index 2018	Harvest index 2019
Sowing dates (S)						
May10th	9.66b	9.54b	12.71a	12.64ab	0.430b	0.429b
June 1st	10.67a	10.71a	12.74a	12.90a	0.455a	0.453a
June 20th	8.38c	8.51c	12.27b	12.30bc	0.406c	0.409c
N levels (kg N ha^{-1})						
0	8.18c	8.29c	11.58c	11.84c	0.414c	0.412c
55	9.34b	9.31b	12.30b	12.24b	0.430b	0.431b
110	10.25a	10.29a	13.01ab	12.96ab	0.439a	0.441a
165	10.50a	10.45a	13.41a	13.42a	0.438a	0.437a
S x N	**	**	**	**	**	**

Means not sharing the same letter significantly differ using DMRT.
*** = Significant at 0.05 level, ** = Significant at 0.01 level and NS= Not significant.**

Otherwise, there were highly significantly differences among nitrogen levels for grain yield (t ha^{-1}), straw yield (t ha^{-1}) and harvest index. The highest values for grain and straw yield (t ha^{-1}) were obtained with nitrogen level 165 kg N ha^{-1} and it was statistically the same of 110 kg N ha^{-1} treatment in both seasons. However, the highest harvest index was obtained with application of 110 kg N ha^{-1} but, was statistically at par with application of 165 kg N ha^{-1} in both seasons. On the other hand, the lowest values of grain and straw yield (t ha^{-1}) as well as harvest index were obtained when nitrogen fertilizer no added in both seasons. The grain yield enhancement could be due to the role of nitrogen in increasing grain yield attributes i.e., panicles per hill, panicle length, number of filled grains per panicle and panicle weight. These results are similar to those obtained by Gharib *et al*. (2011) and Gewaily *et al*. (2018).

The results in Table (5) showed that the sowing date on June 1st with nitrogen application level of 165 kg N ha^{-1} produced significantly highest values for grain and straw yields (t ha^{-1}) in both seasons. However, the sowing date on June 20th without any nitrogen application (0 kg N ha^{-1}) produced the lowest values of grain and straw yields in both seasons. It should note that plants were sown on May10th achieved the highest grain yield when treated with 110 kg N ha^{-1} in both seasons. The highest harvest index were achieved when plants were sown on June 1st and treated with 165 kg N ha^{-1} and 110 kg N ha^{-1} in first and second seasons, respectively. While, the lowest harvest index were obtained when plants were sown on June 20th and treated with 55 kg N ha^{-1} in the first season, and when plants were sown on May 10th without nitrogen fertilizer application in the second season.

Table 5. Effect of interaction between sowing dates and nitrogen levels on yield and yield attributes during 2018 and 2019 seasons.

Sowing dates	2018				2019			
	N levels (kg N ha^{-1})							
	0	55	110	165	0	55	110	165
	Grain yield t ha-1							
May10th	7.97f	9.19d	10.91bc	10.56c	8.02fg	9.01d	10.79c	10.34c
June 1st	8.80d	10.63c	11.23b	12.03a	8.95d	10.60c	11.37b	11.92a
June 20th	7.77f	8.19ef	8.62de	8.92d	7.91g	8.31ef	8.71de	9.10d
	Straw yield t ha^{-1}							
May10th	11.58ce	12.29bc	13.33a	13.65a	11.89d	12.26ed	13.12b	13.28ab
June 1st	11.79ce	12.45bc	12.97b	13.76a	12.08ed	12.41ed	13.08be	14.04a
June 20th	11.38e	12.16c	12.73bc	12.81	11.54ef	12.05ed	12.67e	12.93e
	Harvest Index							
May10th	0.408ce	0.428b	0.450a	0.436b	0.403e	0.424ce	0.451ab	0.438b
June 1st	0.427bc	0.461a	0.464a	0.466a	0.426c	0.461a	0.465a	0.459a
June 20th	0.406e	0.402e	0.404e	0.410ce	0.407e	0.408e	0.407e	0.413e

Means not sharing the same letter significantly differ using DMRT.

Agronomic Nitrogen Use Efficiency

Agronomic nitrogen efficiency (ANE) (grain yield (kg) produced per nitrogen applied (kg)) as affected by sowing dates and nitrogen levels are presented in Table (6). Results showed that the highest ANE was achieved when Sakha super 300 rice variety was sown on June 1st followed by sowing on May10th in both seasons.

Table 6. Agronomic nitrogen efficiency as affected by sowing date and N levels during 2018 and 2019 seasons.

Sowing dates	2018				2019			
	N levels (kg N ha^{-1})							
	55	110	165	Mean	55	110	165	Mean
May10th	22.18	26.73	15.70	21.54	18.00	25.18	14.06	19.08
June 1st	33.27	22.09	19.58	24.98	30.00	22.00	18.00	23.33
June 20th	7.64	7.73	6.97	7.44	7.27	7.27	7.21	7.25
Mean	21.03	18.85	14.08	17.99	18.42	18.15	13.09	16.56

Among N levels, the highest (ANE) was obtained with application of 55 kg N ha^{-1}. Whereas the decline in ANE has been observed by supplementary N application up to 110 and 165 kg N ha^{-1}. These results are confirmed by the findings of Saleque *et al*. (2004) and Gewaily *et al*. (2018) who informed that ANE is ordinarily higher at low level of N fertilizer application. Also results indicted that the maximum ANE was produced when plants was sown on June 1st with application of 55 kg N ha^{-1}. While the minimum ANE was produced when plants was sown on June 20th with application of 165 kg N ha^{-1}.

Agro-meteorological indices

The data on growing degree days (GDD) and photo thermal units (PTU) accumulated by Sakha Super 300 under various growing environment from sowing up to harvesting are presented in Table (7). The highest value of accumulated GDD and PTU were recorded when plants sown on May 10th followed by June 1st while, the June 20th had the least GDD. These results are in general agreement with the findings of Sreenivas *et al*.(2010) and Patel *et al*. (2013) who reported that the accumulated GDD and PTU values decreased with delayed sowing due to early maturity of crops under delayed sowing condition. Sridevi and Chellamuthu (2015) indicated that high temperature enhance the rice plant to produced more buds and there by increases number of tillers per plant and plant height.

Heat use efficiency (HUE) as affected by different sowing date and N levels varied considerably (Table 8). The results indicated that the maximums HUE (0.96 and 0.90 g m^{-2} day $^{o}C^{-1}$ in respective 2018 and 2019 seasons) were achieved when Sakha Super 300 sown on 1st June followed by 20th June. On the other hand the highest values of HUE were produced with application of 165 Kg N ha^{-1} in both seasons. While the lowest values of HUE were obtained when no N was added. This is due to the fact that higher application of nitrogen had increased the number of calendar days and thermal time of the crop which in turn increased GDD and HTU (Davood *et al*., 2009). These findings are in confirmatory with the results of Abhat *et al*. (2015) who stated that the synchronized and higher application of nitrogen resulted in higher grain and biological yield which accounted for higher heat use efficiency.

The results in Table (8) also showed that the sowing date on June 1st with nitrogen application at the level of 165 kg N ha^{-1} achieved the highest values for HUE in both seasons due to higher dry matter accumulation. However, the sowing date on May10th without any nitrogen application (0 kg N ha^{-1}) give the lowest values of HUE in both seasons. The same deduction was formerly drawn by Malo and Ghosh (2018) who stated that HUE i.e. efficiency of utilization of heat in terms of grain yield or dry matter accumulation depends on crop type, genetic background and time of sowing as well as has significant practical application.

Table 7. Accumulated growing degree days (GDD) and Photo Thermal Units (PTU) by Sakha Super 300 as influenced by different sowing dates during 2018 and 2019 seasons.

	2018					
	GDD (day °C)			PTU (day °C hr)		
Sowing dates	A	B	Total GDD	A	B	Total PTU
May10th	2065.80	553.40	2619.2	28027.02	6811.41	34838.43
June 1st	1885.50	544.50	2430.0	25385.11	6533.48	31918.59
June 20th	1707.80	538.20	2246.0	22613.08	6297.06	28910.14
	2019					
May10th	2242.50	605.30	2847.80	30143.82	7726.90	37870.72
June 1st	2036.40	578.10	2614.50	27419.06	6965.01	34384.07
June 20th	1848.40	575.00	2423.40	24538.85	6729.19	31268.04

A= form sowing date up to heading **B= from heading up to harvest**

Table 8. Heat use efficiency (HUE) as affected by sowing dates and N levels during 2018 and 2019 seasons.

Sowing dates	HUE (g m^{-2} day $^{o}C^{-1}$)									
	2018					2019				
	N levels (kg N ha^{-1})									
	0	55	110	165	Mean	0	55	110	165	Mean
May10th	0.75	0.82	0.93	0.92	0.85	0.70	0.75	0.84	0.83	0.78
June 1st	0.85	0.95	1.00	1.06	0.96	0.80	0.88	0.94	0.99	0.90
June 20th	0.85	0.91	0.95	0.97	0.92	0.80	0.84	0.88	0.91	0.86
Mean	0.82	0.89	0.96	0.98	0.91	0.77	0.82	0.89	0.91	0.83

CONCLUSION

Sowing on June 1st produced the highest grain yield in both seasons. Nitrogen application at the level of 165 kg N ha^{-1} produced the highest grain yield without any significant difference with the level of 110 kg N ha^{-1} in both seasons. Results of interaction between sowing dates and nitrogen levels showed that, the combination between the first date (May 10th) and nitrogen level of 110 kg N ha^{-1} gave the highest grain yield. On the other hand the combination between second date (June 1st) and nitrogen level of 165 kg N ha^{-1} gave the highest grain yield in both seasons. The highest values of GDD and PTU were recorded when rice plants were sown on May 10th. The maximums HUE was achieved when Sakha Super 300 was sown on 1st June with application of 165 Kg N ha^{-1} in both seasons. These results lead to conclusion that Sakha Super 300 optimum sowing date is first June with nitrogen level 165 kg N ha^{-1}.

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تحديد أمثل ميعاد للزراعة ومستوى التسميد الأزوتي لصنف الأرز الجديد سخا سوبر 300

السيد السيد جويلي ، حسن شحاته حمد و السيد فاروق عرفات

قسم بحوث الأرز بسخا- معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - مصر

أجريت تجربة حلقية في قطاعات كاملة العشوائية فى ثلاث مكررات بموسمي الزراعة 2018 و 2019 بالمزرعة البحثية لمحطة البحوث الزراعية بسخا كفر الشيخ- مصر لدراسة انسب ميعاد للزراعة و أفضل مستوي للسماد الأزوتي للصنف سخا سوبر 300 و كانت مواعيد الزراعة هي 10 مايو, 1 يونيو و 20 يونيو بينما مستويات السماد الأزوتي هي صفر (بدون إضافة), 55, 110 و 165 كجم أزوت للهكتار. أظهرت النتائج المتحصل عليها أن زراعة الصنف سخا سوبر 300 في الأول من يونيو أنتج اعلي محصول للحبوب (10.67 و 10.71 طن للهكتار). و أن إضافة السماد الأزوتي بمعدل 165 كجم أزوت للهكتار قد أعطي اعلي محصول للحبوب (10.50 و 10.45 طن للهكتار) دون وجود أي اختلاف معنوى مع إضافة 110 كجم أزوت للهكتار و ذلك فى موسمى الزراعة و كان هناك تأثير معنويا للتفاعل بين مواعيد الزراعة و مستويات السماد الأزوتي علي كل من عدد السنابل لكل جورة, طول السنبلة, عدد الحبوب الممتلئة لكل سنبلة, نسبة الحبوب الفارغة ووزن ال1000 حبة و كذلك محصول الحبوب و القش و دليل الحصاد. أظهرت نتائج التفاعل أيضا بين مواعيد الزراعة و مستويات السماد الأزوتي أن ميعاد الزراعة المبكر (10 مايو) أعطي اعلي محصول للحبوب (10.91 و10.79 طن للهكتار) مع إضافة 110 كجم أزوت للهكتار, بينما أعطي ميعاد الزراعة في الأول من يونيو اعلي محصول للحبوب (12.03 و11.92 طن للهكتار) مع إضافة 165 كجم أزوت للهكتار. كما وجد أن أعلى درجة حرارة متجمعة و كذلك أعلى وحدات ضوء حرارية قد سجلت عند الزراعة في العاشر من مايو بينما سجلت أعلي كفاءة لاستخدام الحرارة عند الزراعة في الأول من يونيو مع إضافة 165 كجم أزوت للهكتار و ذلك في كلا موسمي الزراعة. و لذا من خلال النتائج المتحصل عليها فان الزراعة فى الأول من يونيو مع إضافة 165 كجم أزوت للهكتار هى الأنسب للصنف سخا سوبر300