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.
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 is 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 $10^8$, June $1^8$ and June $20^8$) 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.**

<table>
<thead>
<tr>
<th>Season</th>
<th>pH</th>
<th>EC dSm$^{-1}$</th>
<th>OM %</th>
<th>N %</th>
<th>P ppm</th>
<th>Ca$^{2+}$</th>
<th>Mg$^{2+}$</th>
<th>K$^+$</th>
<th>Na$^+$</th>
<th>HCO$_3^-$</th>
<th>Cl$^-$</th>
<th>SO$_4^{2-}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>8.07</td>
<td>2.85</td>
<td>1.58</td>
<td>0.062</td>
<td>12.20</td>
<td>10.04</td>
<td>5.42</td>
<td>1.40</td>
<td>14.10</td>
<td>8.40</td>
<td>18.34</td>
<td>3.22</td>
</tr>
<tr>
<td>2019</td>
<td>8.15</td>
<td>2.60</td>
<td>1.61</td>
<td>0.065</td>
<td>11.8</td>
<td>9.40</td>
<td>4.10</td>
<td>15.0</td>
<td>12.30</td>
<td>7.90</td>
<td>17.10</td>
<td>3.20</td>
</tr>
</tbody>
</table>

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 $10^8$, June $1^8$ and June $20^8$ 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. Seeding 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 15 m$^2$ (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 was 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 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 $1$ t ha$^{-1}$. The straw yield reproducing from 10 m$^2$ was evaluated and converted to $1$ 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).

$$GDD = \sum [(T_{\text{min}} + T_{\text{max}})/2] - \text{Base temperature}$$

Where, $T_{\text{min}}$ = Daily minimum temperature, $T_{\text{max}}$ = Daily maximum 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

$$\text{PTU} (\text{°C day hour}) = \text{GDD} \times \text{DL}$$

Where,

$\text{DL}$ = Day length (Possible sunshine hours from dawn to twilight)

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

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

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.
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.

<table>
<thead>
<tr>
<th>Main effect and interaction</th>
<th>Days to heading (day)</th>
<th>Plant height (cm)</th>
<th>NO. of panicles hill(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing dates (S)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May(^{1})</td>
<td>107.67a</td>
<td>108.67a</td>
<td>114.76a</td>
</tr>
<tr>
<td>June 1(^{1})</td>
<td>96.17b</td>
<td>96.75b</td>
<td>110.32b</td>
</tr>
<tr>
<td>June 20(^{1})</td>
<td>84.58c</td>
<td>85.33c</td>
<td>106.68c</td>
</tr>
<tr>
<td>N levels (kg N ha(^{-1}))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>93.00c</td>
<td>93.11c</td>
<td>100.85d</td>
</tr>
<tr>
<td>55</td>
<td>96.00b</td>
<td>97.00b</td>
<td>107.08c</td>
</tr>
<tr>
<td>110</td>
<td>97.00b</td>
<td>97.78b</td>
<td>113.26b</td>
</tr>
<tr>
<td>165</td>
<td>98.00a</td>
<td>99.78a</td>
<td>121.18a</td>
</tr>
</tbody>
</table>

S x N NS NS NS NS ** **

Table 2. Continued.

<table>
<thead>
<tr>
<th>Main effect and interaction</th>
<th>Panicle weight (g)</th>
<th>Panicle length (cm)</th>
<th>Number of filled grains panicle(^{-1})</th>
<th>Unfilled grains (%)</th>
<th>1000-grain weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing dates (S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May(^{1})</td>
<td>4.93c</td>
<td>4.91b</td>
<td>21.62a</td>
<td>20.77a</td>
<td>162.58b</td>
</tr>
<tr>
<td>June 1(^{1})</td>
<td>5.64a</td>
<td>5.84a</td>
<td>21.88a</td>
<td>21.28a</td>
<td>188.75a</td>
</tr>
<tr>
<td>June 20(^{1})</td>
<td>5.25b</td>
<td>4.91b</td>
<td>19.83b</td>
<td>18.93b</td>
<td>147.47c</td>
</tr>
<tr>
<td>N levels (kg N ha(^{-1}))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>4.66d</td>
<td>4.34d</td>
<td>20.68d</td>
<td>19.15d</td>
<td>137.67d</td>
</tr>
<tr>
<td>55</td>
<td>4.99c</td>
<td>5.02c</td>
<td>20.83c</td>
<td>20.22c</td>
<td>162.89c</td>
</tr>
<tr>
<td>110</td>
<td>5.55b</td>
<td>5.59b</td>
<td>21.32b</td>
<td>20.78b</td>
<td>180.07b</td>
</tr>
<tr>
<td>165</td>
<td>5.90a</td>
<td>5.93a</td>
<td>21.62a</td>
<td>21.17a</td>
<td>184.44a</td>
</tr>
</tbody>
</table>

S x N NS NS 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 May\(^{1}\) during 2018 and 2019 seasons, while the sowing date June 1\(^{1}\) 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 20\(^{1}\) 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 20\(^{1}\) in both seasons. While, the sowing date May\(^{1}\) gave the least panicle weight and 1000-grain weight in both seasons. While, the sowing date June 1\(^{1}\) 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 May 10th 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.

<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>0</th>
<th>55</th>
<th>110</th>
<th>165</th>
<th>0</th>
<th>55</th>
<th>110</th>
<th>165</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10th</td>
<td>17.35d</td>
<td>19.56c</td>
<td>20.92b</td>
<td>21.88b</td>
<td>17.37c</td>
<td>18.60c</td>
<td>21.25b</td>
<td>21.77b</td>
</tr>
<tr>
<td>June 1st</td>
<td>18.93c</td>
<td>22.26b</td>
<td>24.07a</td>
<td>25.04a</td>
<td>17.76c</td>
<td>22.83ab</td>
<td>23.82a</td>
<td>25.12a</td>
</tr>
<tr>
<td>June 20th</td>
<td>15.12e</td>
<td>17.00d</td>
<td>18.55c</td>
<td>20.37b</td>
<td>15.47d</td>
<td>17.98c</td>
<td>19.17bc</td>
<td>21.13b</td>
</tr>
<tr>
<td>May 10th</td>
<td>21.05c</td>
<td>21.38c</td>
<td>21.84bc</td>
<td>22.20a</td>
<td>19.96d</td>
<td>20.55c</td>
<td>21.18bc</td>
<td>21.41a</td>
</tr>
<tr>
<td>June 1st</td>
<td>20.98c</td>
<td>22.01b</td>
<td>22.09a</td>
<td>22.46a</td>
<td>19.74d</td>
<td>21.55b</td>
<td>21.77a</td>
<td>22.08a</td>
</tr>
<tr>
<td>June 20th</td>
<td>19.10e</td>
<td>20.00d</td>
<td>20.02d</td>
<td>20.21d</td>
<td>17.77e</td>
<td>18.56e</td>
<td>19.39d</td>
<td>20.01c</td>
</tr>
<tr>
<td>May 10th</td>
<td>131.33c</td>
<td>164.00c</td>
<td>180.00b</td>
<td>175.00b</td>
<td>134.67f</td>
<td>167.77d</td>
<td>181.83bc</td>
<td>177.33c</td>
</tr>
<tr>
<td>June 1st</td>
<td>155.33cd</td>
<td>199.00c</td>
<td>202.67a</td>
<td>208.00a</td>
<td>155.00e</td>
<td>190.42b</td>
<td>212.110a</td>
<td>222.10a</td>
</tr>
<tr>
<td>June 20th</td>
<td>126.33e</td>
<td>135.07e</td>
<td>157.53d</td>
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<td>127.33f</td>
<td>144.00e</td>
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<td>174.08c</td>
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<tr>
<td>May 1st</td>
<td>5.40b</td>
<td>4.62c</td>
<td>3.96d</td>
<td>3.33d</td>
<td>5.80b</td>
<td>4.64c</td>
<td>4.11c</td>
<td>3.94cd</td>
</tr>
<tr>
<td>June 1st</td>
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<td>4.18b</td>
<td>3.41d</td>
<td>2.04e</td>
<td>5.38b</td>
<td>4.33c</td>
<td>3.22d</td>
<td>2.21e</td>
</tr>
<tr>
<td>July 1st</td>
<td>6.55a</td>
<td>5.73ab</td>
<td>4.34c</td>
<td>4.08c</td>
<td>6.86a</td>
<td>5.63b</td>
<td>4.63c</td>
<td>4.40c</td>
</tr>
</tbody>
</table>

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 translocated 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.

<table>
<thead>
<tr>
<th>Main effect and interaction</th>
<th>Grain yield t ha⁻¹</th>
<th>Straw yield t ha⁻¹</th>
<th>Harvest index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing dates (S)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 10th</td>
<td>9.66b</td>
<td>9.54b</td>
<td>12.71a</td>
</tr>
<tr>
<td>June 1st</td>
<td>10.67a</td>
<td>10.71a</td>
<td>12.74a</td>
</tr>
<tr>
<td>June 20th</td>
<td>8.38c</td>
<td>8.51c</td>
<td>12.27b</td>
</tr>
<tr>
<td>N levels (kg N ha⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8.18c</td>
<td>8.29c</td>
<td>11.58c</td>
</tr>
<tr>
<td>55</td>
<td>9.34b</td>
<td>9.31b</td>
<td>12.30b</td>
</tr>
<tr>
<td>110</td>
<td>10.25a</td>
<td>10.29a</td>
<td>13.01ab</td>
</tr>
<tr>
<td>165</td>
<td>10.58a</td>
<td>10.45a</td>
<td>13.41a</td>
</tr>
<tr>
<td>S x N</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

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 Gewaity 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 May 10th 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.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>55</td>
<td>110</td>
<td>165</td>
<td>0</td>
<td>55</td>
<td>110</td>
<td>165</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Grain yield t ha⁻¹</td>
<td>Straw yield t ha⁻¹</td>
<td>Harvest Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 10th</td>
<td>7.97f</td>
<td>9.19d</td>
<td>10.91bc</td>
<td>10.56f</td>
<td>9.02fl</td>
<td>9.01d</td>
<td>10.79c</td>
<td>10.34c</td>
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</tr>
<tr>
<td>June 1st</td>
<td>8.80d</td>
<td>10.63c</td>
<td>11.23b</td>
<td>12.03a</td>
<td>8.95d</td>
<td>10.60c</td>
<td>11.37b</td>
<td>11.92a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 20th</td>
<td>7.77f</td>
<td>8.19ef</td>
<td>8.62de</td>
<td>8.92d</td>
<td>7.91g</td>
<td>8.31ef</td>
<td>8.71de</td>
<td>9.10d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 10th</td>
<td>11.58ce</td>
<td>12.29bc</td>
<td>13.33a</td>
<td>13.65a</td>
<td>11.89d</td>
<td>12.26ed</td>
<td>13.12b</td>
<td>13.28ab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 1st</td>
<td>11.79ce</td>
<td>12.45bc</td>
<td>12.97b</td>
<td>13.76a</td>
<td>12.08ed</td>
<td>12.41ed</td>
<td>13.08e</td>
<td>14.04a</td>
<td></td>
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<tr>
<td>June 20th</td>
<td>11.38e</td>
<td>12.16c</td>
<td>12.73bc</td>
<td>12.81</td>
<td>11.54ef</td>
<td>12.05ed</td>
<td>12.67e</td>
<td>12.93e</td>
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</tr>
<tr>
<td>Mean</td>
<td>0.408ce</td>
<td>0.428b</td>
<td>0.450a</td>
<td>0.436b</td>
<td>0.403e</td>
<td>0.424ce</td>
<td>0.451ab</td>
<td>0.438b</td>
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</tr>
</tbody>
</table>

Means not sharing the same letter significantly differ using DMRT.

781
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).

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

<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>2018 N levels (kg N ha⁻¹)</th>
<th>2019 Mean</th>
<th>55</th>
<th>110</th>
<th>165</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10th</td>
<td>22.18 26.73 15.70</td>
<td>21.54 18.00 25.18</td>
<td>14.06</td>
<td>19.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 1st</td>
<td>33.27 22.09 19.58</td>
<td>24.98 30.00 22.00</td>
<td>18.00</td>
<td>23.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 20th</td>
<td>7.64 7.73 6.97</td>
<td>7.44 7.27 7.27</td>
<td>7.21 7.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>21.03 18.85 14.08</td>
<td>17.99 18.42 18.15</td>
<td>13.09 16.56</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 indicated 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 °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 resulted in higher 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 May 10th 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.

<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>A</th>
<th>B</th>
<th>Total GDD</th>
<th>A</th>
<th>B</th>
<th>Total PTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10th</td>
<td>2065.80</td>
<td>553.40</td>
<td>2619.20</td>
<td>28027.02</td>
<td>6811.41</td>
<td>34838.43</td>
</tr>
<tr>
<td>June 1st</td>
<td>1885.50</td>
<td>544.50</td>
<td>2430.00</td>
<td>25385.11</td>
<td>6533.48</td>
<td>31918.59</td>
</tr>
<tr>
<td>June 20th</td>
<td>1707.80</td>
<td>538.20</td>
<td>2246.00</td>
<td>22613.08</td>
<td>6297.06</td>
<td>28910.14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>A</th>
<th>B</th>
<th>Total GDD</th>
<th>A</th>
<th>B</th>
<th>Total PTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10th</td>
<td>2242.50</td>
<td>605.30</td>
<td>2847.80</td>
<td>30143.82</td>
<td>7726.90</td>
<td>37870.72</td>
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<tr>
<td>June 1st</td>
<td>2036.40</td>
<td>578.10</td>
<td>2614.50</td>
<td>27419.06</td>
<td>6965.01</td>
<td>34384.07</td>
</tr>
<tr>
<td>June 20th</td>
<td>1848.40</td>
<td>575.00</td>
<td>2423.40</td>
<td>24538.85</td>
<td>6729.19</td>
<td>31268.04</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>2018 HUE (g m⁻² day °C⁻¹)</th>
<th>2019 N levels (kg N ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 10th</td>
<td>0.75 0.82 0.93 0.92 0.85</td>
<td>0.70 0.75 0.84 0.83 0.78</td>
</tr>
<tr>
<td>June 1st</td>
<td>0.85 0.95 1.00 1.06 0.96</td>
<td>0.80 0.88 0.94 0.99 0.90</td>
</tr>
<tr>
<td>June 20th</td>
<td>0.85 0.91 0.95 0.97 0.92</td>
<td>0.80 0.84 0.88 0.91 0.86</td>
</tr>
</tbody>
</table>

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.

REFERENCES


