INFLUENCE OF SOWING DATE, VARIETAL DIFFERENCES AND PLANTING DENSITY ON PRODUCTIVITY OF WHEAT CROP (Triticum aestivum L.)

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ABSTRACT: The present study was conducted at field experiment in Mit Ghamer District, Dakahlia Governorate, Egypt, during 2014/2015 and 2015/2016 seasons. The study aimed to find out the effect of sowing dates (November 15th, November 30th and December 15th), cultivars (Giza 171, Sids 12 and Gemmiza 11) and planting densities (300, 400 and 500 grains/m²) on yield and yield attributes of wheat. The early wheat sowing on 15th Nov. appeared to be produced the highest plant height, spike length, number of grains/spike, weight of grains/spike, 1000-grain weight and grain yield/fad. Varietal differences affected significantly on yield and yield attributes where, Gemmiza 11 cultivar appeared to be produced the highest plant height, spike length, grain weight/spike, 1000-grain weight and grain yield per fad. While Giza 171 cultivar tended to produce the highest number of spikes/m². On other hand, dense planting of 500 grains/m² obtained the highest number of spikes per m², as well as, grain yield/fad., as compared with the other two planting densities. While, light density (300 grains/m²) gave the highest grain number/spike and grain weight/spike. Regarding the significant interaction between the studied factors on almost yield and yield attributes, showed that early sowing on 15th Nov. obtained the highest grain yield/fad., with Gemmiza 11 and Sids 12 cultivars when dense planting of 500 grains/m² were applied.

Key words: Wheat, sowing date, planting densities, yield attributes.

INTRODUCTION

Wheat (Triticum aestivum L.) is an important and strategic cereal crop in the world. In Egypt, the total cultivated area of wheat reached 3.39 million faddans and the total production overtake 9.28 million tons (FAOSTAT, 2017). This production, however, does not meet consumption where about 5 million tons are imported. The changes in climate factors are being felt globally in the form of changes in temperature and rainfall pattern. An increase in ambient CO₂ is usually considered beneficial as it results in increased photosynthesis in crops, especially those with C₃ mechanism of photosynthesis as wheat crop. Adaptation options such as growing improved varieties, change in sowing date can reduce the impacts of climate change on wheat crops. Sowing date is one of the most important agricultural factors that determine crop productivity especially wheat crop, which affects the duration of the vegetative and reproductive stages. Randhawa et al. (1977) showed that, delay wheat sowing exposed crop plants to higher temperature during heading, resulting in reduced yield and its attributes. Similar trends were reported by Refay (2011), Costa et al. (2013) and Amal et al. (2016). On other hand, Hozayn and Abd El-Monem (2010) found that the high values of vegetative characters of wheat were occurred when wheat was planted earlier due to exposure plants to high temperature. Also, the highest value of each of yield attributes and grain yield as well as biological yield were occurred when wheat was sown earlier. Moreover, Aftab et al. (2004) reported that biomass accumulation, wheat grain yield and its components were increased with early seeding.
on the beginning of November. On other side, several authors reported significant increase of grain yield and yield attributes due to wheat varietal differences (Abd El-Hameed, 2012; Abd El-Razek and El-Sheshtawy, 2013; Radwan et al., 2014; Fayet et al., 2015; Fadel et al., 2016). Wheat plants are one of dense growing crops which have a high compensatory capacity, so, plant density is a very important agronomic practices that determine the productivity of wheat and are particularly affected by both the varieties and sowing date. Increasing planting density significantly increased plant height, number of spikes/m²; grain, straw and biological yields/fad., but significantly decreased grain weight/spike and 1000 grain weight (Ali et al., 2004). Similar trends were reported by Ghorbani and Basiri (2013), Kenarsari et al. (2014) and Isabelle et al. (2015). While, Stephen et al. (2005) showed that increasing seed rates produced more dense wheat populations and hence, reduced both grain yield and yield components. Therefore, the present study aimed to investigate the effect of sowing dates, cultivars and planting densities on yield and its attributes of wheat.

MATERIALS AND METHODS

The present study was conducted at field experiment in Mit Ghamer District, Dakahlia Governorate, Egypt under Agronomy Department supervision, Faculty of Agriculture, Zagazig University, during 2014/2015 and 2015/2016 seasons. The study aimed to find out the effect of sowing dates, cultivars and planting densities on yield and yield attributes of bread wheat. The experimental site was clay in texture (21.2% sand, 35.7% and 43.1% clay). The soil had an average pH of 8.11 and organic matter of 1.0% as well as available N of 79 ppm, available P of 15 ppm and available K of 270 ppm. A split-split plot of the randomized complete block design with three replications was used, where three sowing dates (November 15th, November 30th and December 15th) were allocated in the main plots. Three cultivars (Giza 171, Sids 12 and Gemmiza 11 cvs.) were allocated in the sub-plots. While, the sub-sub plots were assigned to three planting densities i.e. 300, 400 and 500 grains/m². The sub-sub plot area was 7 m² (3.5 × 2 m) included 10 rows of 3.5 m length and 20 cm apart. Wheat sowing was made after rice (Oryza sativa L.) as a preceding crop in both seasons. Superphosphate (15.5% P₂O₅) was band placed at the time of sowing. Also, N fertilizer at level of 90 kg N/fad., was applied twice before the first and the second irrigations as ammonium nitrate (33.5%). The other culture practices were applied as recommended in the experimental area. At harvest, ten guarded plants were taken at random from each plot to record the following yield and yield attributes: Plant height (cm), spike length (cm), number of grains/spike, grain weight/ spike (g) and 1000-grain weight (g). Number of spikes/ m² was recorded from 1 m² using a wooden square for each experimental plot. Grain yield/ fad., were recorded from 2 m² in each sub-sub plot. Data were statistically analyzed according to Gomez and Gomez (1984) by using MSTAT-C (1991) where statistical program Version 2.1 was used for analysis of variance (ANOVA). A combined analysis was undertaken for the data of the two seasons after testing the homogeneity of the experimental errors by Bartellets test (Steel et al., 1997). Treatment means were compared using least significant differences (LSD) test at 0.05 level of probability (Waller and Duncan, 1969). In interaction Tables, capital and small letters were used to denote significant differences among rows and columns means, respectively.

RESULTS AND DISCUSSION

Plant Height (cm)

Results in Table 1 show the effect of sowing dates, cultivars and planting densities on plant height in the both seasons and their combined. It is evident from Table 1 that plant height was significantly affected by sowing dates in both seasons and their combined. Wheat sowing on mid of November produced longer plants compared with sowing on November 30th and December 15th in both seasons and their combined. These results are in accordance with those reported by Abdel Nour et al. (2011), Alam et al. (2013), Amal et al. (2016) and Fadel et al. (2016). Whereas, Geith et al. (2013) found that sowing wheat on 25th November significantly increased plant height. With respecting to varietal differences, the results revealed that, varietal differences were significantly affected on plant height in both seasons and their combined. It is clear that Sids 12 cv gave the shortest plants compared with
Table 1. Plant height (cm) of wheat plant as affected by sowing dates, wheat cultivars and planting densities and their interactions in the two seasons and their combined

<table>
<thead>
<tr>
<th>Main effects and interactions</th>
<th>Plant height (cm)</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015/2016</td>
<td>2016/2017</td>
</tr>
<tr>
<td>Sowing date (S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S₁-November 15ᵗʰ</td>
<td>113.03 a</td>
<td>109.38 a</td>
</tr>
<tr>
<td>S₂-November 30ᵗʰ</td>
<td>105.85 b</td>
<td>105.25 b</td>
</tr>
<tr>
<td>S₃-December 15ᵗʰ</td>
<td>97.74 c</td>
<td>102.98 c</td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Cultivar (C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C₁-Giza 171</td>
<td>107.10 b</td>
<td>108.55 a</td>
</tr>
<tr>
<td>C₂-Sids 12</td>
<td>97.648 c</td>
<td>101.67 c</td>
</tr>
<tr>
<td>C₃-Gemmiza 11</td>
<td>111.87 a</td>
<td>107.39 b</td>
</tr>
<tr>
<td>F. test</td>
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<tr>
<td>Planting density(D)</td>
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<td></td>
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<tr>
<td>D₁-300 grains/m²</td>
<td>106.45 a</td>
<td>105.60 b</td>
</tr>
<tr>
<td>D₂-400 grains/m²</td>
<td>105.60 a</td>
<td>105.83 ab</td>
</tr>
<tr>
<td>D₃-500 grains/m²</td>
<td>104.56 b</td>
<td>106.17 a</td>
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<tr>
<td>F. test</td>
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<tr>
<td>Interaction</td>
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<td>S × C</td>
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<td>C × D</td>
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</tbody>
</table>

*, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

Giza 171 and Gemmiza 11 cvs in both seasons and their combined. The results are in accordance with those reported by Abdel-Nour et al. (2011) and Fadel et al. (2016). Likely, plant height was significantly decreased with dense planting (500 grains/m²) during the first season. While, in the second season, plant height took reverse direction where light density gave the shortest plants compared with dense planting. However, others got significant increase in plant height due to dense planting (Ali et al., 2004; Yasin and Omar, 2013; Amal et al., 2016). According to the combined analysis, interaction between sowing dates and cultivars, cultivars and planting density, as well as sowing dates and planting densities affected significantly on plant height of wheat. But, no additional information could be obtained other than the main effects. Therefore, interaction tables were not discussed.

**Spike Length (cm)**

The length of spike plays a vital role in wheat towards the grains spike and finally the yield (Shahzad et al., 2007). Thus, the results in Table 2 expose spike length of wheat cultivars as influenced by sowing dates, varietal differences and planting density. Meanwhile, sowing dates revealed highly significant differences during the second season, whereas
### Table 2. Spike length (cm) of wheat as affected by sowing dates, cultivars and planting densities and their interactions in the two seasons and their combined

<table>
<thead>
<tr>
<th>Main effects and interactions</th>
<th>Spike length (cm)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2015/2016</td>
<td>2016/2017</td>
<td>Combined</td>
</tr>
<tr>
<td><strong>Sowing date (S)</strong></td>
<td></td>
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</tr>
<tr>
<td>S₁-November 15ᵗʰ</td>
<td>11.926 b</td>
<td>12.97 a</td>
<td>12.452</td>
</tr>
<tr>
<td>S₂-November 30ᵗʰ</td>
<td>11.937 b</td>
<td>12.79 b</td>
<td>12.367</td>
</tr>
<tr>
<td>S₃-December 15ᵗʰ</td>
<td>12.767 b</td>
<td>12.27 c</td>
<td>12.522</td>
</tr>
<tr>
<td>F. test</td>
<td>N.S</td>
<td>**</td>
<td>N.S</td>
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<tr>
<td><strong>Cultivar (C)</strong></td>
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</tr>
<tr>
<td>C₁-Giza 171</td>
<td>11.707 b</td>
<td>11.64 c</td>
<td>11.678 b</td>
</tr>
<tr>
<td>C₂-Sids 12</td>
<td>11.163 c</td>
<td>12.53 b</td>
<td>11.850 b</td>
</tr>
<tr>
<td>C₃-Gemmiza 11</td>
<td>13.759 a</td>
<td>13.86 a</td>
<td>13.813 a</td>
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<tr>
<td>F. test</td>
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<tr>
<td><strong>Planting density (D)</strong></td>
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<tr>
<td>D₁-300 grains/m²</td>
<td>12.244 a</td>
<td>13.00 a</td>
<td>12.622 a</td>
</tr>
<tr>
<td>D₂-400 grains/m²</td>
<td>12.530 a</td>
<td>12.78 b</td>
<td>12.656 a</td>
</tr>
<tr>
<td>D₃-500 grains/m²</td>
<td>11.856 b</td>
<td>12.27 c</td>
<td>12.063 b</td>
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<td>F. test</td>
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<tr>
<td><strong>Interaction</strong></td>
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<td>S × C</td>
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<tr>
<td>S × D</td>
<td>*</td>
<td>**</td>
<td>NS</td>
</tr>
<tr>
<td>C × D</td>
<td>*</td>
<td>**</td>
<td>NS</td>
</tr>
</tbody>
</table>

Where *, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

### Table 2-a. Spike length of wheat plants as affected by the interaction between sowing dates and cultivars (combined data)

<table>
<thead>
<tr>
<th>Sowing dates</th>
<th>Cultivars</th>
<th>Giza 171</th>
<th>Sids 12</th>
<th>Gemmiza 11</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>November, 15ᵗʰ</strong></td>
<td></td>
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<tr>
<td></td>
<td>B</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.02 a</td>
<td>11.97 a</td>
<td>13.35 b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td><strong>November, 30ᵗʰ</strong></td>
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<tr>
<td></td>
<td>B</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.45a</td>
<td>11.87a</td>
<td>13.78 ab</td>
<td></td>
</tr>
<tr>
<td><strong>December, 15ᵗʰ</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.56a</td>
<td>11.70 a</td>
<td>14.31 a</td>
<td></td>
</tr>
</tbody>
</table>
the early sowing on 15th Nov. gave the longest spike followed by mid- sowing on 30th Nov. while the shortest spike was recorded by the late sowing date. Otherwise, the differences among first season and the combined did not reach the level of significance. Generally the early sowing tended to produce longer spike as compared by the late sowing. This may be due to the heat units and metabolites stored in early sowing caused to vigorous growth and longer spikes. These results are in agreement with those reported by Kandil et al. (2011), Geith et al. (2013), Tomar et al. (2014) and Farooq et al. (2016).

With respect to varietal differences, the results revealed highly significant differences, where Gemmiza 11 cv. appeared to be produced the longest spikes during both growing seasons as well as their combined which followed by Sids 12 and Giza 171 cv. Such differences in spike length almost due to genetical variation and their interaction with environmental condition. These results are in a good accordance with those reported by Abd El-Hameed (2012) and El-Lethy et al. (2013). However, El-Gizawy (2005) indicated that spike length of wheat cultivars did not different significantly. Likely, planting density results indicated highly significant differences throughout the two growing seasons and their combined whereas the light planting density of 300 grains/m² tended to produce the longest spikes which followed by middle density of 400 grains/m², while the shortest spikes were achieved by dense planting of 500 grains/m² through the two growing seasons and the combined. The negative effect of the highest planting density on spike length could be attributes to the increase in population as a result of dense planting and consequently low penetration of light within wheat canopy, hence, high competition between plants for water, minerals and other edaphic factors. In this connection, Ali et al. (2011) and Yasin and Omar (2013). However, Saleh (2000) and Hussain et al. (2003) reported that plant density and/or seeding rate had no significant effect on spike length of wheat. Furthermore, the significant interaction between sowing dates and wheat cultivars (Table 2-a) concerning the combined results, showed that Gemmiza 11 cv. produced the longest spikes under different sowing dates used. Thus, the longest spike (14.31 cm) was achieved by Gemmiza 11 cv. on late sowing of 15th December. On the contrary, the shortest spike (11.45 cm) was recorded by Giza 171 cultivar under middle sowing date of 30th November.

Number of Spikes/m²

Number of spikes/m² results as one of the major yield components are present in Table 3. The influence of sowing date results revealed highly significant differences through both growing seasons and their combined analysis, where late sowing achieved the highest number of spikes/m² during the first season and the combined as compared with other two sowing dates. However, the reverse direction was observed during the second growing season whereas the early sowing on 15th Nov. was obtained the highest number of spikes/m² which followed by late sowing (15th Dec.) then, the lowest number of spikes/m² was recorded by the middle sowing date on 30th Nov. The reverse direction noticed between the two growing seasons may be attributed to effect of climatic factor especially temperature and light through both seasons, which might adversely affect reproductive growth stages. In this connections, several investigators reported significant differences between sowing differences from season to season and from sowing date to another included Gul et al. (2012), El-Nakhlawy et al. (2015) and Farooq et al. (2016). However, Geith et al. (2013) reported that sowing dates had no significant effect on number of spikes/m². Respecting varietal differences results, highly significant differences were observed during both growing seasons and their combined. Mean through, Giza 171 cv. gave the highest number of spikes /m² during the first season and the combined which followed by Sids 12 cv., while in the second season Sids 12 cv. achieved the highest number of spikes/m² (358.81) followed by Giza 171 cv. (352.63). At contrary, Gemmiza 11 cv. recorded the lowest through both growing seasons and their combined. Concerning the combined results Giza 171 cultivar achieved the highest number of spikes /m² (369.00) followed by Sids 12 one (363.51) then, Gemmiza 11 cv. which recorded the lowest number of spikes/m² (324.92). Several investigators showed the varietal differences
Table 3. Number of spikes/m$^2$ of wheat plant as affected by sowing dates, wheat cultivars and planting densities and their interactions in the two seasons as well as the combined

<table>
<thead>
<tr>
<th>Main effects and interactions</th>
<th>Number of spikes /m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015/2016</td>
</tr>
<tr>
<td>Sowing date(S)</td>
<td></td>
</tr>
<tr>
<td>S$_1$-November 15$^{th}$</td>
<td>320.85 c</td>
</tr>
<tr>
<td>S$_2$-November 30$^{th}$</td>
<td>357.44 b</td>
</tr>
<tr>
<td>S$_3$-December 15$^{th}$</td>
<td>413.70 a</td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
</tr>
<tr>
<td>Cultivar (C)</td>
<td></td>
</tr>
<tr>
<td>c$_1$Giza 171</td>
<td>385.37 a</td>
</tr>
<tr>
<td>c$_2$Sids 12</td>
<td>368.22 b</td>
</tr>
<tr>
<td>c$_3$ Gemmiza 11</td>
<td>338.40 c</td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
</tr>
<tr>
<td>Planting density(D)</td>
<td></td>
</tr>
<tr>
<td>D$_1$-300 grains/m$^2$</td>
<td>341.81 c</td>
</tr>
<tr>
<td>D$_2$-400 grains/m$^2$</td>
<td>357.03 b</td>
</tr>
<tr>
<td>D$_3$-500 grains/m$^2$</td>
<td>393.148 a</td>
</tr>
<tr>
<td>F. test</td>
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<tr>
<td>Interaction</td>
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<td>S × C</td>
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<tr>
<td>S × D</td>
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<tr>
<td>C × D</td>
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</tbody>
</table>

Where: *, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

among wheat cultivars regarding number of spikes/m$^2$ included Ali et al. (2004), Abdel-Nour et al. (2011), Abd El-Razek and El-Sheshtawy (2013) and Abd El-Khalek et al. (2015). Likely, planting density results indicated highly significant differences throughout the two growing seasons and their combined. Mean-through, number of spikes/m$^2$ appeared to be significant increase as planting density increased from 300 to 400 and up to 500 grains/m$^2$. Then, the highest number of spikes/m$^2$ (370.46) was obtained by dense planting of 500 grains/m$^2$ which followed by middle density of 400 grains/ m$^2$ (350.81), while the lowest number of spikes/ m$^2$ (336.16) was given by the light density of 300 grain/m$^2$, concerning the combined results. The superiority of dense planting over light and middle densities reached around 9.26 and 5.30%, respectively concerning the combined results. Such increase in number of spikes/m$^2$ achieved by dense planting is mainly due to the increase in number of plants. These results are in agreement with those found by Yasin and Omar (2013), Kenarsari et al. (2014) and Isebelle et al. (2015). Otherwise, Ghorbani and Basiri (2013) reported that number of spikes/m$^2$ reduced by increasing number of grains/m$^2$ (500 /m$^2$) compared to lower number of grains/m$^2$ (250/m$^2$). On the other hand, Ashmawy et al. (2002) showed that either planting density or
seeding rate had no significant effect on number of spikes/m². Regarding the significant interaction between the studied factors (combined results), the interaction between sowing dates and wheat cultivars (Table 3-a) indicated that the highest number of grains/m² (423.27), obtained by Sids 12 cv. under late sowing on 15th Dec., while the lowest number (301.11 spikes/m²) was recorded by the same cultivar (Sids 12) when sown on 15th Nov. Furthermore, the significant interaction between sowing dates and planting densities (Table 3-b) showed that late sowing on 15th Dec. achieved the highest number of spikes/m² when dense planting of 500 grains/m² was applied. At contrary, the lowest number (318.55) was given by early sowing (15th Nov.) with light density of 300 grains/m². Finally, the significant interaction effect between cultivars and planting densities (Table 3-c) indicate that Giza 171 cultivar gave the highest number of spikes/m² (402.00) when dense planting of 500 grain/m² was applied. On the other direction, Gemmiza 11 cultivar recorded the lowest number of spikes/m² (316.00) when light density of 300 grains/m² was used.

**Number of Grains/spike**

Number of grains/spike is an important yield contributing parameter and has direct effect on the final grain yield of wheat. Table 4 shows the influence of sowing dates, varietal differences and planting density on number of grains/spike during both growing seasons and their combined. Concerning the influence of sowing dates on number of grains/spike, the results revealed highly significant differences during the second season and the combined, while it could not reach the level of significant in the first season whereas the early sowing on 15th Nov. produced the highest number of grains/spike which followed by the mid sowing date on 30th Nov., while the lowest number of grains/spike was recorded by the late sowing of 15th Dec. The early sowing resulted in better development of the grains due to longer growing period which produce more assimilates as well as suitable climate factor. These results were strongly supported by those of Tomar et al. (2014), El- Nakhlawy et al. (2015), Farooq et al. (2016). However, Tahir et al. (2009) reported that sowing date had did not significantly affect on number of grains/spike.

Respecting varietal differences influence on number of grains/spike, the results indicated highly significant differences through both growing seasons and their combined, where Sids 12 cv. was the superior in number of grains/spike followed by Gemmiza 11 cv., however Giza 171 cv. gave the lowest number of grains/spike. Differences among cultivars might be attributed to genetic variability. Several investigators stated the significant difference between wheat cultivars regarding number of grains/spike among them Abd El-Iattief (2014) and Ahmed et al. (2017). Regarding the influence of planting density on number of grains/spike, the results revealed significant and highly significant difference during both seasons and their combined, wherein the high density appeared to produce higher number of grains/spike as compared with middle and dense planting. These results almost followed the same patterns of spike length (Table 2). In other words, increasing planting density from 300 to 400 and up to 500 grains/m² tended to decrease number of grains/spike. Such reduction in number of grains/spike resulted from dense planting may be due to the competition between individual plants and struggling for the viable nutrients in surrounding media. In this connection, Ghorbani and Basiri (2013), Yasin and Omar (2013) and Isabelle et al. (2015) stated that number of grains/spike was significantly decreased as planting density or seeding rate was increased. Regarding the significant interaction between the studied factors (combined results), the significant interaction between sowing dates and wheat cultivars (Table 4-a) indicated that Sids 12 cultivar gave the highest number of grains/spike (70.70), when early sown on 15th Nov., was applied, while the lowest one was recorded by Giza 171 cultivar (53.76) under the late sowing on 15th Dec. Furthermore, the significant interaction between sowing dates and planting densities (Table 4-b) showed that the highest number of grains/spike (65.28) was obtained by early sowing on 15th Nov. when middle-planting density of 400 grains/m² was applied. Otherwise, the lowest number of grains/spike (53.73) was given by late sowing (15th Dec.) with middle planting density (400 grains/m²). Finally, the significant interaction between cultivars and planting densities (Table 4-c) revealed that. Sids 12 cultivar achieved the highest number of grains/spike (66.04) when light planting density of 300 grain/m² was used. However, the lowest
Table 3-a. Number of spikes/m$^2$ of wheat plant as affected by the interaction between sowing dates and cultivars (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Cultivar</th>
<th>Giza 171</th>
<th>Sids 12</th>
<th>Gemmiza 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15$^{th}$</td>
<td>A</td>
<td>381.94 a</td>
<td>301.11 c</td>
<td>341.27 a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>334.94 b</td>
<td>366.11 b</td>
<td>312.55 c</td>
</tr>
<tr>
<td>November, 30$^{th}$</td>
<td>A</td>
<td>399.70 a</td>
<td>330.05 c</td>
<td>375.72 b</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>325.72 b</td>
<td>352.05 b</td>
<td>335.88 c</td>
</tr>
<tr>
<td>December, 15$^{th}$</td>
<td>A</td>
<td>402.00 a</td>
<td>370.33 a</td>
<td>399.70 a</td>
</tr>
</tbody>
</table>

Table 3-b. Number of spikes/m$^2$ of wheat plant as affected by the interaction between sowing dates and planting densities (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Planting density 300 grains/m$^2$</th>
<th>400 grains/m$^2$</th>
<th>500 grains/m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15$^{th}$</td>
<td>B</td>
<td>318.55 c</td>
<td>330.05 c</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>November, 30$^{th}$</td>
<td>B</td>
<td>325.72 b</td>
<td>352.05 b</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>December, 15$^{th}$</td>
<td>A</td>
<td>364.22 a</td>
<td>370.33 a</td>
</tr>
</tbody>
</table>

Table 3-c. Number of spikes/m$^2$ of wheat plant as affected by the interaction between cultivars and planting densities (combined data)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Planting density 300 grains/m$^2$</th>
<th>400 grains/m$^2$</th>
<th>500 grains/m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 171</td>
<td>C</td>
<td>340.77 a</td>
<td>364.22 a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>AB</td>
<td>A</td>
</tr>
<tr>
<td>Sids 12</td>
<td>C</td>
<td>351.72 a</td>
<td>364.27 a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>AB</td>
<td>A</td>
</tr>
<tr>
<td>Gemmiza 11</td>
<td>C</td>
<td>316.00 b</td>
<td>323.94 b</td>
</tr>
</tbody>
</table>
Table 4. Number of grains/spike of wheat plants as affected by sowing dates, wheat cultivars and planting densities and their interactions in the two seasons as well as the combined

<table>
<thead>
<tr>
<th>Sowing date(S)</th>
<th>2015/2016</th>
<th>2016/2017</th>
<th>Combined</th>
<th>F. test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$-November 15th</td>
<td>62.411</td>
<td>66.841 a</td>
<td>64.626 a</td>
<td>**</td>
</tr>
<tr>
<td>$S_2$-November 30th</td>
<td>62.157</td>
<td>62.585 b</td>
<td>62.361 b</td>
<td></td>
</tr>
<tr>
<td>$S_3$-December 15th</td>
<td>58.733</td>
<td>53.296 c</td>
<td>56.015 c</td>
<td></td>
</tr>
<tr>
<td>F. test</td>
<td>N.S</td>
<td>**</td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

Cultivar (C)

c1-Giza 171 57.726 c 57.559 b 57.643 c

c2-Sids 12 63.741 a 62.630 a 63.185 a

c3-Gemmiza 11 61.815 b 62.533 a 62.174 b

F. test ** ** **

Table 4-a. Number of grains/spike of wheat plants as affected by the interaction between sowing dates and cultivars (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Cultivar</th>
<th>Giza 171</th>
<th>Sids 12</th>
<th>Gemmiza 11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>November, 15th</td>
<td>58.13b</td>
<td>70.70 a</td>
<td>65.04 a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>AB</td>
<td></td>
</tr>
<tr>
<td>November, 30th</td>
<td>61.03a</td>
<td>63.81 b</td>
<td>62.23 a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>AB</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>December, 15th</td>
<td>53.76c</td>
<td>55.03 c</td>
<td>59.24 b</td>
<td></td>
</tr>
</tbody>
</table>

Where *, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.
Table 4-b. Number of grains/spike as of wheat plants affected by the interaction between sowing dates and planting densities (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15ᵗʰ</td>
<td>A</td>
<td>64.817 a</td>
<td>65.28 a</td>
<td>63.77 a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November, 30ᵗʰ</td>
<td>A</td>
<td>65.07 a</td>
<td>61.85 b</td>
<td>60.16 b</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December, 15ᵗʰ</td>
<td>A</td>
<td>56.89 b</td>
<td>53.73 c</td>
<td>57.32 c</td>
</tr>
</tbody>
</table>

Table 4-c. Number of grains/spike of wheat plants as affected by the interaction between cultivars and planting densities (combined data)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 171</td>
<td>A</td>
<td>56.47 b</td>
<td>58.47 b</td>
<td>57.53 b</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sids 12</td>
<td>A</td>
<td>66.04 a</td>
<td>59.22 b</td>
<td>64.28 a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemmiza 11</td>
<td>A</td>
<td>63.91 a</td>
<td>63.17 a</td>
<td>59.43 b</td>
</tr>
</tbody>
</table>

one (56.47) was recorded by Giza 171 cultivar when light planting density of 300 grain/m² was applied.

Weight of Grains/spike (g)

Results present in Table 5 show the influence of sowing date, varietal differences and planting density on weight of grains/spike during both growing seasons and their combined analysis. Respecting to the influence of sowing dates, the results revealed highly significant differences throughout the two seasons and the combined, where the early sowing on 15ᵗʰ Nov. appeared to produce the highest weight of grains/spike which followed by the mid-sowing on 30ᵗʰ Nov., then the lowest weight of grains/spike was recorded by the late sowing of 15ᵗʰ Dec. In other words, weight of grains/spike tended to be gradually decreased as sowing date delayed from 15ᵗʰ Nov., to 30ᵗʰ Nov. and up to 15ᵗʰ Dec. These results almost followed the same patterns of number of gains/spike (Table 4) the grain weight significantly decreased with each day delay in sowing. This indicate that late sowing shorted the development phases of wheat and adversely affect the grain development and result in low weight of grains/spike. These results are in agreement with those reported by Tomar et al. (2014) and Fadel et al. (2016).

Varietal differences results in Table 5 showed highly significant differences during both growing seasons and their combined analysis, where Gemmiza 11 cv. achieved the highest grains weight/spike which followed by Sids 12 cv., while Giza 171 cv. gave the lowest grains weight/spike. These results almost followed the same patterns of spike length (Table 2). In other words, the superiority of Gemmiza 11 cv. may be attribute to its ability to produce higher dry matter/plant, higher number of spikelets/spike and longer spike which in turn resulted in heaviest grains/spike as compared with the other
Table 5. Weight of grains/spike (g) of wheat as affected by sowing dates, wheat cultivars and planting densities and their interactions in the two seasons as well as the combined

<table>
<thead>
<tr>
<th>Main effects and interactions</th>
<th>Weight of grains/ spike (g)</th>
<th>2015/2016</th>
<th>2016/2017</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing date(S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S₁-November 15ᵗʰ</td>
<td></td>
<td>3.422 a</td>
<td>3.951 a</td>
<td>3.687 a</td>
</tr>
<tr>
<td>S₂-November 30ᵗʰ</td>
<td></td>
<td>3.241 b</td>
<td>2.566 b</td>
<td>2.904 b</td>
</tr>
<tr>
<td>S₃-December 15ᵗʰ</td>
<td></td>
<td>2.542 c</td>
<td>2.103 c</td>
<td>2.326 c</td>
</tr>
<tr>
<td>F. test</td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Cultivar (C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c₁-Giza 171</td>
<td></td>
<td>2.837 c</td>
<td>2.629 c</td>
<td>2.733 c</td>
</tr>
<tr>
<td>c₂-Sids 12</td>
<td></td>
<td>3.048 b</td>
<td>2.911 b</td>
<td>2.980 b</td>
</tr>
<tr>
<td>c₃-Gemmiza 11</td>
<td></td>
<td>3.326 a</td>
<td>3.081 a</td>
<td>3.204 a</td>
</tr>
<tr>
<td>F. test</td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Planting density(D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D₁-300 grains/m²</td>
<td></td>
<td>3.152</td>
<td>2.966 a</td>
<td>3.059 a</td>
</tr>
<tr>
<td>D₂-400 grains/m²</td>
<td></td>
<td>3.085</td>
<td>2.863 b</td>
<td>2.974 b</td>
</tr>
<tr>
<td>D₃-500 grains/m²</td>
<td></td>
<td>2.974</td>
<td>2.792 c</td>
<td>2.883 c</td>
</tr>
<tr>
<td>F. test</td>
<td></td>
<td>N.S</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S×C</td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>S×D</td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>C×D</td>
<td></td>
<td>*</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

Where: *, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

two cultivars. The varietal differences among wheat cultivars concerning the weight of grains/spike were reported by several investigators, from them Wally (2008), Amin (2010), Hafez et al. (2012) and Abd El-Lattief (2014). Planting density results indicated highly significant differences during the second season and the combined when weight of grains/spike appeared to be significant decreased as planting density was increased from 300 to 400 and up to 500 grains/m². In other words, light planting of 300 grains/m² achieved the highest weight of grains/spike followed by middle density of 400 grains/m², while dense planting of 500 grains/m² recorded the lightest grains/spike. However, the differences did not reach the level of significance in the first season. These results almost followed the same patterns of spike length (Table 2) and number of grains/spike (Table 3). In this connection, Raheim et al. (2012), Yasin and Omar (2013), and Isebelle et al. (2015) reported that light planting density or low seeding rate tended to produce heavier grains/spike, However the reverse effect was observed by Amin et al. (2010) and Ali et al. (2011). Concerning the significant interaction between the studied factors regarding the combined results, the interaction between sowing dates and wheat cultivars (Table 5a) indicated that the highest grain weight/spike
Table 5-a. Grains spike weight of wheat plants as affected by the interaction between sowing dates and cultivars (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Cultivar</th>
<th>Giza 171</th>
<th>Sids 12</th>
<th>Gemmiza 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15th</td>
<td>B</td>
<td>3.32 a</td>
<td>3.90 a</td>
<td>3.84 a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>3.09 b</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>November, 30th</td>
<td>B</td>
<td>2.79 b</td>
<td>2.83 b</td>
<td>3.09 b</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2.21 c</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>December, 15th</td>
<td>B</td>
<td>2.09 c</td>
<td>2.21 c</td>
<td>2.68 c</td>
</tr>
</tbody>
</table>

Table 5-b. Grains spike weight of wheat plants as affected by the interaction between sowing dates and planting densities (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15th</td>
<td>A</td>
<td>3.95 a</td>
<td>3.617 a</td>
<td>3.494 a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>3.95 a</td>
<td>3.617 a</td>
<td>3.494 a</td>
</tr>
<tr>
<td>November, 30th</td>
<td>B</td>
<td>2.94 b</td>
<td>3.022 b</td>
<td>2.744 b</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2.94 b</td>
<td>3.022 b</td>
<td>2.744 b</td>
</tr>
<tr>
<td>December, 15th</td>
<td>B</td>
<td>2.28 c</td>
<td>2.28 c</td>
<td>2.44 c</td>
</tr>
</tbody>
</table>

Table 5-c. Grains spike weight of wheat plants as affected by the interaction between planting densities and cultivars (combined data)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 171</td>
<td>A</td>
<td>2.828 c</td>
<td>2.711 b</td>
<td>2.661 b</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>2.828 c</td>
<td>2.711 b</td>
<td>2.661 b</td>
</tr>
<tr>
<td>Sids 12</td>
<td>A</td>
<td>3.022 b</td>
<td>2.922 b</td>
<td>3.060 a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>3.022 b</td>
<td>2.922 b</td>
<td>3.060 a</td>
</tr>
<tr>
<td>Gemmiza 11</td>
<td>A</td>
<td>3.328 a</td>
<td>3.300 a</td>
<td>2.983 a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>3.328 a</td>
<td>3.300 a</td>
<td>2.983 a</td>
</tr>
</tbody>
</table>
(3.9 g) was obtained by Sids 12 cv. under the early sowing date on 15th Nov., while the lowest one (2.089 g) was recorded by Giza 171 cv., when planted late on 15th Dec. Furthermore, the significant interaction effect between sowing dates and planting densities (Table 5-b) showed that the heaviest grains/spike (3.950 g) was achieved by early sowing on 15th Nov. when light planting density of 300 grains/m² was applied. On the other hand, late sowing on 15th Dec. recorded lighter grains/spike compared with light and middle planting densities. Finally, the significant interaction between cultivars and planting densities (Table 5-c) indicated that the heaviest grains/spike (3.328 g) was given by Gemmiza 11 cv. when light planting density of 300 grain/m² was applied. At contrast, the lightest grains/spike (2.661 g) was recorded by Giza 171 cv. when dense planting of 500 grain/m² was used.

**Thousand-Grain Weight (g)**

Table 6 expose the influence of sowing date, varietal differences and planting density on 1000- grain weight during both growing seasons and their combined. Regarding the influence of sowing dates, the results revealed highly significant differences throughout both seasons and the combined, whereas the early sowing on 15th Nov. appeared to obtain the heaviest 1000-grain weight which followed by the middle sowing on 30th Nov. while the lightest 1000-grains was recorded by late sowing on 15th Dec. In other words, 1000-grain weight tended to be gradually decreased as sowing date was delayed from early sowing to middle sowing and late sowing. These results almost followed the same patterns of number of grains/spike (Table 3) and weight of grains /spike (Table 5) while it was taken reverse direction with those of number of spikes/m² (Table 4). It is evident that late sowing of wheat subject the grains to low soil temperature causing poor plant growth (plant height Table 1), and high temperature at the end of the season, which might be adversely affect the reproductive growth stage. The obtained result are in accordance with those reported by Fayed et al. (2015), Fadel et al. (2016) and Farooq et al. (2016). Likely varietal differences revealed highly significant differences during both growing seasons and their combined, where Gemmiza 11 Cv. appeared to produce heaviest 1000-grain which followed by Giza 171 cv., while Sids 12 cv. gave the lightest 1000-grains. Then, Gemmiza 11, Giza 171 and Sids 12 cultivars recorded 46.759, 42.148 and 41.685 g, respectively regarding 1000-grain weight (combined results). These results almost followed the same patterns of plant height, spike length and grains spike weight (Tables 1, 2 and 5 for the same following order). Several investigators reported that wheat cultivars differed significantly in 1000-grain weight included, El-Lethy et al. (2013), Radwan et al. (2014) and Ahmed et al. (2017).

With respect to the influence of planting density on 1000- grain weight “g”, the results showed highly significant difference during both growing seasons and their combined analysis where light and middle planting densities of 300 and 400 grains/m² obtained higher 1000- grain weight as compared with dense planting density of 500 grains/m², regarding the combined results. These results almost followed the same patterns of spike length, number of grains/spike and grains spike weight (Tables 2, 3 and 5, respectively). Others wise, the results showed reverse direction with number of spikes /m² (Table 3). In other words, dense planting tended to produce higher number of spikes /m² and lower grain weight/spike and 1000- grain weight. Such result might be attributed to occurrence of inter and/or intra-competition among dense plants of wheat. These results are in good line with those reported by Ali et al. (2004) Ghorbani and Basiri (2013) and Yasin and Omar (2013). On the contrary, Amin et al. (2010) showed that 1000-grain weight of wheat appeared to be increased as planting density increased from 400 to 500 and up to 600 grains/m². However, Isabelle et al. (2015) reported that planting density from 250 up to 450 grains/m² had no significant effect on 1000-grain weight of wheat. The significant interaction effect between the studied factors regarding the combined results showed that the interaction effect between sowing dates and wheat cultivars (Table 6-a) indicated that the highest 1000- grain weight (56.72 gm) was obtained by Gemmiza 11 cv. under the early sowing date on 15th Nov., while the lowest one (31.88 g) was recorded by Giza 171 cv. when
Table 6. 1000 grain weight (g) of wheat as affected by sowing dates, wheat cultivars and planting densities and their interactions in the two seasons as well as the combined

<table>
<thead>
<tr>
<th>Main effects and interactions</th>
<th>1000- grain weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2015/2016</td>
</tr>
<tr>
<td><strong>Sowing date (S)</strong></td>
<td>**</td>
</tr>
<tr>
<td>S₁-November 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>54.074 a</td>
</tr>
<tr>
<td>S₂-November 30&lt;sup&gt;th&lt;/sup&gt;</td>
<td>49.963 b</td>
</tr>
<tr>
<td>S₃-December 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>34.481 c</td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
</tr>
<tr>
<td><strong>Cultivar (C)</strong></td>
<td>**</td>
</tr>
<tr>
<td>c₁-Giza 171</td>
<td>44.259 b</td>
</tr>
<tr>
<td>c₂-Sids 12</td>
<td>43.481 c</td>
</tr>
<tr>
<td>c₃-Gemmiza 11</td>
<td>50.778 a</td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
</tr>
<tr>
<td><strong>Planting density(D)</strong></td>
<td>**</td>
</tr>
<tr>
<td>D₁-300 grains/m&lt;sup&gt;2&lt;/sup&gt;</td>
<td>47.407 a</td>
</tr>
<tr>
<td>D₂-400 grains/m&lt;sup&gt;2&lt;/sup&gt;</td>
<td>46.037 b</td>
</tr>
<tr>
<td>D₃-500 grains/m&lt;sup&gt;2&lt;/sup&gt;</td>
<td>45.074 c</td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
</tr>
<tr>
<td><strong>Interactions</strong></td>
<td>**</td>
</tr>
<tr>
<td>S×C</td>
<td>**</td>
</tr>
<tr>
<td>S×D</td>
<td>**</td>
</tr>
<tr>
<td>C×D</td>
<td>**</td>
</tr>
</tbody>
</table>

Where; *, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

Table 6-a. Thousand grain weight of wheat plants as affected by the interaction between sowing dates and cultivars (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Cultivar</th>
<th>Giza 171</th>
<th>Sids 12</th>
<th>Gemmiza 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>B</td>
<td>50.00 a</td>
<td>50.83 a</td>
<td>56.72 a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>50.00 a</td>
<td>50.83 a</td>
<td>56.72 a</td>
</tr>
<tr>
<td>November, 30&lt;sup&gt;th&lt;/sup&gt;</td>
<td>C</td>
<td>44.55 b</td>
<td>40.94 b</td>
<td>46.83 b</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>44.55 b</td>
<td>40.94 b</td>
<td>46.83 b</td>
</tr>
<tr>
<td>December, 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>A</td>
<td>31.88 c</td>
<td>33.27 c</td>
<td>36.72 c</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>31.88 c</td>
<td>33.27 c</td>
<td>36.72 c</td>
</tr>
</tbody>
</table>
planted late on 15\textsuperscript{th} Dec. Concerning the significant interaction effect between sowing dates and planting densities (Table 6-b), the results showed that early sowing on 15\textsuperscript{th} Nov., appeared to produce high 1000-grain weight under the different planting densities as compared with the other two sowing dates. On the other hand, the lowest 1000-grain weight (32.00 g) was achieved by late sowing on 15\textsuperscript{th} Dec. when dense planting of 500 grains/m\textsuperscript{2} was applied. In addition, the significant interaction effect between cultivars and planting densities respecting 1000-grain weight (Table 6-c) indicated that the highest 1000- grain weight (49.16 g) was given by Gemmiza 11 cv., when middle planting density of 400 grains/m\textsuperscript{2} was used. However, the lowest 1000- grain weight (40.38 g) was recorded by Sids 12 cv. with middle planting density of 400 grains/m\textsuperscript{2}.

Grain Yield (ton/fad.)

Grain yield of wheat crop is the result of combined effect of various yield contributing components. Results in Table 7 expose the influence of sowing date, varietal differences and planting density on grain yield on wheat during both growing seasons and their combined. Meanwhile, sowing date results revealed highly significant differences throughout both seasons and the combined, whereas the early sowing on 15\textsuperscript{th} Nov. appeared to obtain the highest grain yield/fad., during the two growing seasons and their combined analysis which followed by the middle sowing of 30\textsuperscript{th} Nov. while the lowest grain yield/fad., was recorded by late sowing on 15\textsuperscript{th} Dec. In other words, grain yield/fad., tended to be gradually decreased as sowing date was delayed from early sowing on 15\textsuperscript{th} Nov. to middle sowing on 30\textsuperscript{th} Nov., and late sowing on 15\textsuperscript{th} Dec. The superiority of grain yield/fad., achieved by early sowing relatively to middle and late sowings amount to around 21.31 % and 32.77% for the same following order concerning the combined result. These results almost followed the same patterns of yield components include number of grains/spike (Table 4) weight of grains/spike (Table 5) and 1000- grain weight (Table 6). Such result indicated that delaying of wheat planting led to shorting of vegetative stages as well as the climatic condition were less suitable for growth duration especially temperature degree with the delay in sowing date. So, weather conditions prevailing during wheat growth may be the reason for the detected such variations between sowing dates. These results are in accordance with those reported by Qasim et al. (2008), El-Gizawy (2009), Abbas et al. (2010), Hozayn and Abd El-Monem (2010) who indicated that the reduction in weight grain yield and its attributes with delaying sowing date was a result of expose plants to high temperature, which reduced season length. Also, the obtained results are in agreement with those reported by Gül et al. (2012), Jat et al. (2013), Fayed et al. (2015) and Farooq et al. (2016). Likely, the wheat varietal differences revealed highly significant differences during both growing seasons and their combined analysis, where Gemmiza 11 cv. out-yielded the other two cultivars during both growing seasons and combined which achieved the highest grain yield/fad., through the two seasons and their combined recording 3.781, 3.189 and 3.485 ton/fad., for the same following order. These results almost followed the same patterns of yield attributes included, spike length, grains spike weight and 1000-grain weight (Tables 1, 5 and 6, respectively). The varietal differences among wheat cultivars were reported by several investigator included Radwan et al. (2014) Fayed et al. (2015), Amal et al. (2016) and Ahmed et al. (2017).

Concerning the influence of planting density on grain yield/fad., the results revealed highly significant differences during both growing seasons and their combined analysis where dense planting density of 500 grains/m\textsuperscript{2} appeared to produce the highest grain yield/fad., as compared with the other two planting densities during the second season and the combined, however in the first season the results followed the reverse direction where the light planting density of 300 grains/m\textsuperscript{2} obtained the highest grain yield/fad. Thus, the combined results showed that dense planting of 500 grains /m\textsuperscript{2} gave the highest grain yield/fad., (3.388 ton), then the lowest grain yield/fad., (3.259 ton) was given by middle –density of 400 grains/m\textsuperscript{2}. The superiority of dense planting of 500 grains/m\textsuperscript{2} over lighter density of 300 and 400 grains/m\textsuperscript{2} amounted to about 2.30% and 3.81% for the same following order. These results almost followed the same patterns of number of spikes/m\textsuperscript{2} (Table 3). The obtained results are in accordance with those reported by Costa et al. (2013), Yasin and Omar (2013), Kenarsari et al. (2014) and Eslami et al. (2014). Otherwise,
Table 6-b. Thousand grain weight of wheat plants as affected by the interaction between sowing dates and planting densities (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>A</td>
<td>52.27 a</td>
<td>52.11 a</td>
<td>53.16 a</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>November, 30&lt;sup&gt;th&lt;/sup&gt;</td>
<td>44.44 b</td>
<td>43.88 b</td>
<td>44.00 b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December, 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>34.55 c</td>
<td>35.33 c</td>
<td>32.00 c</td>
<td></td>
</tr>
</tbody>
</table>

Table 6-c. Thousand grain weight of wheat plants as affected by the interaction between cultivars and planting densities (combined data)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giza 171</td>
<td>A</td>
<td>41.88 c</td>
<td>41.77 b</td>
<td>42.77 b</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Sids 12</td>
<td>43.22 b</td>
<td>40.38 c</td>
<td>41.44 c</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Gemmiza 11</td>
<td>46.16 a</td>
<td>49.16 a</td>
<td>44.94 a</td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Grain yield (ton/fad.) of wheat as affected by sowing dates, wheat cultivars and planting densities and their interactions in the two seasons as well as the combined

<table>
<thead>
<tr>
<th>Main effects and interactions</th>
<th>Grain yield (ton/fed.)</th>
<th>2015/2016</th>
<th>2016/2017</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sowing date(S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S₁-November 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S₂-November 30&lt;sup&gt;th&lt;/sup&gt;</td>
<td>3.791 a</td>
<td>4.306 a</td>
<td>4.049 a</td>
<td></td>
</tr>
<tr>
<td>S₃-December 15&lt;sup&gt;th&lt;/sup&gt;</td>
<td>3.799 a</td>
<td>2.574 b</td>
<td>3.186 b</td>
<td></td>
</tr>
<tr>
<td>F. test</td>
<td>3.256 b</td>
<td>2.187 c</td>
<td>2.722 c</td>
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<tr>
<td>Cultivar (C)</td>
<td></td>
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<td>**</td>
<td>**</td>
</tr>
<tr>
<td>c₁-Giza 171</td>
<td>3.494 c</td>
<td>2.996 b</td>
<td>3.245 b</td>
<td></td>
</tr>
<tr>
<td>c₂-Sids 12</td>
<td>3.571 b</td>
<td>2.881 c</td>
<td>3.226 b</td>
<td></td>
</tr>
<tr>
<td>c₃-Gemmiza 11</td>
<td>3.781 a</td>
<td>3.189 a</td>
<td>3.485 a</td>
<td></td>
</tr>
<tr>
<td>F. test</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Planting density(D)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D₁-300 grains/m²</td>
<td>3.687 a</td>
<td>2.933 b</td>
<td>3.310 b</td>
<td></td>
</tr>
<tr>
<td>D₂-400 grains/m²</td>
<td>3.579 b</td>
<td>2.938 b</td>
<td>3.259 c</td>
<td></td>
</tr>
<tr>
<td>D₃-500 grains/m²</td>
<td>3.580 b</td>
<td>3.19 a</td>
<td>3.388 a</td>
<td></td>
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<tr>
<td>F. test</td>
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<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Interactions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S×C</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>S×D</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>C×D</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

Where: *; ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.
Stephen et al. (2005) Ali et al. (2011) and Awoke et al. (2017) reported that the light planting density or low seeding rate gave the highest grain yield/unit area as compared with dense planting and high seeding rate. Respecting the significant interaction effects between the studied factors regarding the combined results, the interaction effect between sowing dates and wheat cultivars (Table 7-a) indicated that Gemmiza 11 and Sids 12 cv. appeared to produce the highest grain yield/fad., (4.201 and 4.115 ton, respectively) when were sown early on 15th Nov., while the lowest grain yield/ fad., (2.559 ton) was recorded by Giza 171 cv. when planted late on 15th Dec. The significant interaction effect between sowing dates and planting densities (Table 7-b), the results showed that early sowing on 15th Nov., was obtained the highest grain yield/fad., (4.125 ton) when dense planting of 500 grains/ m² was applied, while the lowest one (2.648 ton) was recorded by late sowing on 15th Dec., when middle planting density of 400 grains/m² was applied. Finally, the significant interaction effect between wheat cultivars and planting densities (Table 7-c) indicated that Sids 12 and Gemmiza 11 cultivars give the highest grain yield /fad. (3.472 and 3.472 ton, respectively) when dense planting of 500 grain/m² was applied. While Giza 171 cv. obtained higher grain yield/fad., (3.363 ton) when light planting density of 300 grain/m² was applied. On the other direction, Sids 12 cv. recorded lower grain yield/fad., when either light or middle planting densities were used.

Table 7-a. Grain yield (ton/fad.) of wheat plants as affected by the interaction between sowing dates and cultivars (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Cultivar</th>
<th>Giza 171</th>
<th>Sids 12</th>
<th>Gemmiza 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15th</td>
<td>A</td>
<td>3.830 a</td>
<td>4.115 a</td>
<td>4.201 a</td>
</tr>
<tr>
<td>November, 30th</td>
<td>A</td>
<td>3.347 b</td>
<td>2.918 b</td>
<td>3.294 b</td>
</tr>
<tr>
<td>December, 15th</td>
<td>B</td>
<td>2.559 c</td>
<td>2.647 c</td>
<td>2.961 c</td>
</tr>
</tbody>
</table>

Table 7-b. Grain yield (ton/fad.) of wheat plants as affected by the interaction between sowing dates and planting densities (combined data)

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 15th</td>
<td>B</td>
<td>4.003 a</td>
<td>4.018 a</td>
<td>4.125 a</td>
</tr>
<tr>
<td>November, 30th</td>
<td>B</td>
<td>3.158 b</td>
<td>3.110 b</td>
<td>3.292 b</td>
</tr>
<tr>
<td>December, 15th</td>
<td>B</td>
<td>2.769 c</td>
<td>2.648 c</td>
<td>2.748 c</td>
</tr>
</tbody>
</table>
Table 7-bc. Grain yield (ton/fad.) of wheat plants as affected by the interaction between cultivars and planting densities (combined data)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Planting density</th>
<th>300 grains/m²</th>
<th>400 grains/m²</th>
<th>500 grains/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Giza 171</td>
<td>3.363 b</td>
<td>3.152 b</td>
<td>3.222 b</td>
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</tr>
<tr>
<td></td>
<td>B</td>
<td>B</td>
<td>A</td>
<td></td>
</tr>
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<td>Sids 12</td>
<td>3.116 c</td>
<td>3.092 b</td>
<td>3.472 a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Gemmiza 11</td>
<td>3.452 a</td>
<td>3.533 a</td>
<td>3.472 a</td>
<td></td>
</tr>
</tbody>
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REFERENCES


Hozayn, M. and A.A. Abd El-Monem (2010). Alleviation of the potential impact of climate change on wheat productivity using arginine
under irrigated Egyptian agriculture Options Mediterranéennes, A., 95-100.


تأثر ميعاد الزراعة والإختلافات الصفية والكثافة النباتية على إنتاجية محصول القمح

صفاء محمد حسانين عبد الهادي - أحمد عبد الغني علي
عبد الرحمن السيد أحمد عمر - السيد السيد أحمد السيد
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أجريت هذه الدراسة في تربة طينية تابعة لمركز ميت غمر محافظة الدقهلية خلال الموسمين الشتويين 2016/2017، بهدف دراسة تأثير مواعيد الزراعة (15 نوفمبر، 30 نوفمبر و 15 ديسمبر) والأصناف (جذوة 171 وسنسند 12 وجمينة 11) والكثافة النباتية (200 و 300 و 500 حبة/م²) على محصول القمح ومسامته، وتلك تخلص النتائج المتحصل عليها على النحو التالي: أدت الزراعة المبكرة في 15 نوفمبر إلى زيادة معنوية في كل من ارتفاع النبات، طول السنبلة، عدد حبوب السنبلة، وزن حبوب السنبلة، ووزن الألف حبة وكذلك محصول الحبوب للقدان، لوحظ وجود فروق معنوية تأثير الإختلافات الصفية على المحصول ومؤشراتها حيث أدى زراعة الصفن جزية 11 إلى زيادة ارتفاع النباتات، طول السنبلة، وزن حبوب السنبلة، وزن 1000 حبة ومحمول الحبوب/قدان، بينما نفوق الصفن جزية 171 في كل من صفات عد السنبل/م² ومحصول الكلي/قدان، أدت إلى زيادة الكثافة النباتية إلى 500 حبة/م² إلى زيادة معنوية لكل من عد السنبل/م² ومحمول الحبوب/قدان مقابلة بالكثافات الأخرى، حيث حققت الكثافة المنخفضة (300 حبة/م²) أعلى القيم لكل من عدد حبوب السنبلة، وزن حبوب السنبلة، كان هناك تفاعل بين عوامل الدراسة في أغلب الصفات تحت الدراسة، والتي تشير إلى إمكانية ممتازة إنتاجية محصول القمح من خلال التبكر في الزراعة خلال منتصف نوفمبر واستخدام الصفن سنسن 12 أو جزية 11 مع زيادة الكثافة النباتية إلى 500 حبة/م².