Response of Two Transplanting Wheat Cultivars to Foliar Spray with Micronutrients Mixture

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ABSTRACT

The present investigation was carried out in the green house of Rice Department at Giza Experimental Research Station in 2012/2013 and 2013/2014 growing seasons. The main objective was to study the effect of chelating micronutrients mixture (Fe, Zn and Mn) at the rate of 300 ppm for each element which sprayed at 2 weeks after transplanting (WAT), 7 WAT or twice (at the two times) on leaf chlorophyll fluorescence, morphological characters and productivity of Gemmeiza 9 and Gemmeiza 10 wheat cultivars which cultivated by hand transplanting method. The most important results were as follows:
- Leaf chlorophyll fluorescence, flag leaf area, plant height, spike length, number of grains/spike, 1000 grain weight and straw yield of Gemmeiza 9 were significantly surpassed those of Gemmeiza 10.
- Any of the three assigned treatments of micronutrients application increased significantly all investigated morphological characters, leaf chlorophyll fluorescence and productivity of the two wheat cultivars under study compared to the control treatment.
- The interaction between cultivars and micronutrients had significant effect on all characters. The highest values were obtained from Gemmeiza 9 sprayed twice with micronutrients mixture.

Key words: Wheat, transplanting, micronutrients, chlorophyll fluorescence, productivity

Introduction

Wheat is the most important cereal crop in Egypt because the production is not reached the level of our-sufficiency, the development of agriculture technique is very necessary. Egyptian clover competitive wheat in the Egyptian crop rotation. Transplanting wheat after clover is a new trend for increase its area in Egypt. Farmers can cultivate clover to having 2-3 cuts for animals and then transplant wheat.

Wheat transplanting technology has been studied since 1950’s in India and since 1990’s in Egypt. Malik (1983), in India, indicated that under late sown-conditions of wheat plants, the crop grown from transplanted seedling gave higher grain yield than direct sown crops. El-Menoufi et al. (1993), in Egypt, observed that under late sowing condition, transplanting wheat was significantly superior to direct sowing. In Bangladesh, Hossain and Moniruzzaman (1993) indicated that transplanting of wheat might be available alternative to direct sowing under late planting situations. El-Habbal and Noreldin (1994), in Egypt, found that the highest grain, straw, protein and carbohydrate yields were obtained by transplanting of wheat seedlings at 21-day old in comparison to other seedling ages (28, 35 and 42-day) as well as direct seeding. Abo El-Naga et al., (2006), in Egypt, studied the effect of different transplanting methods on barley crop productivity. They found that under late sowing date, manual transplanting gave the highest grain yield, while the lowest grain yield was obtained by manual broadcasting at the same time of transplanting operation. Madkour (2007) in Egypt, reported that mechanical transplanting of wheat after clover (3 cuts) increased grain yield of wheat. The high yield which obtained by mechanical transplanting may be due to raising strong healthy seedlings and optimum population with better plant distribution (El-Keredy and Abdel-Hafez 1986). Some investigators in Egypt suggested transplanting of other crops as a new planting method to overcome the delay in optimum sowing date, improving productivity and to save irrigation water (Sorour et al., 1992, on cotton and El-Kholi, 2014, on sugarcane).

It is well known that, micronutrients are essential elements for plant life, they play important role in the production or function of several enzyme systems in plants. In Egypt, Hassan et al. (1992) showed that micronutrients mixture (Fe + Zn + Mn) increased grain yield of wheat. Samira (1995) reported that, under desert soil conditions of Egypt, foliar application with micronutrients Fe, Zn and Mn (40+80 days after sowing) significantly increased plant height, flag leaf area, spike length, number of spikes/m², number of grains/spike, 1000-grain weight, grain and straw yields/fed. In Iran, Ziaeeian and Malakouti (2001) found that Fe, Mn, Zn and Cu fertilization increased grain yield, straw yield, 1000-grain weight and number of grains per spike of wheat. Pahlavan – Red and Pessarakli (2009), recorded significant interactive effects between Zn and Mn on number of grains/spike and between Zn and Fe on 1000 grain weight in wheat.

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The aim of this investigation was to study the effect of foliar spraying with chelating micronutrients Fe, Zn and Mn on physiological and morphological characters, yield and its components of transplanted wheat.

**Materials and Methods**

The present study was carried out in the green house of Rice Department at Giza Experimental Research Station, (Latitude 30° 03 N, Longitude 31° 13E and Altitude 18.6 m above sea level) during the winter successive seasons of 2012/2013 and 2013/2014. The main objective was to study the effect of foliar spraying with chelating micronutrients mixture (Fe, Zn and Mn) at the rate of 300 ppm for each element on Gemmeiza 9 and Gemmeiza 10 wheat cultivars.

Randomized complete block design with four replications was used. The treatments of micronutrients mixture were:

1. Control.
2. Foliar application of micronutrients mixture at two weeks after transplanting (WAT).
3. Foliar application of micronutrients mixture at 7 WAT.
4. Foliar application of micronutrients mixture at 2 + 7 WAT.

In the nursery, wheat grains at the rate of 250 grams/seedling box (58×28×3cm) were sowing on 9 and 8 December in the first and second season, respectively.

After three weeks, seedlings were hand transplanted in the irrigated permanent field on rows (15 cm a part), 3-4 seedlings per hill (13 cm apart), in cementing basins, 10 m long and 2 m width, (Fig. 1). 100 kg/fed. of calcium superphosphate (15.5% P$_{2}$O$_{5}$) was added before transplanting. Nitrogen at the rate of 75 kg/fed. was splitted into 3 equal portions which were applied before transplanting, at tillering and booting stages in the form of urea (46% N).

**The studied characters:**

1. Heading date (number of days from sowing to 50% of spikes were fully emerged).
2. Flag leaf area (cm$^2$) at 50% heading was estimated by the following formula:
   \[
   \text{Leaf area} = \text{leaf length} \times \text{leaf width} \times 0.75
   \]
   According to Palamiswamy and Gomez (1974).
3. Leaf chlorophyll fluorescence was determined at 67 days after transplanting to calculate the maximum quantum yield of photo-system II (PSII) using chlorophyll fluorometer (OS-30, Opti-Sciences, Inc. USA) by the formula of Maxwell and Johnson (2000) as follow:
   \[
   F_v / F_m = (F_m - F_o) / F_m
   \]
   where:
   - $F_v / F_m$ is the maximal quantum efficiency of PSII (MQE), $F_m$ is the maximal chlorophyll fluorescence and $F_o$ minimum chlorophyll fluorescence (in the dark).
4. Plant height at harvest (cm).
5. Number of spikes/m$^2$.
6. Spike length (cm).
7. Number of grains/spike.
8. 1000-grain weight (g).
9. Grain yield (g/m$^2$).
10. Straw yield (kg/m$^2$).

Data of the two seasons and combined were statistically analyzed according to Steel and Torrie (1980), using MSTAT-C method. Means were compared using least significant difference (LSD) test at 0.05 level of probability.

**Soil chemical analysis of the experimental site in the two growing seasons are shown in the following table.**

<table>
<thead>
<tr>
<th>The exp. Season</th>
<th>Available (ppm)</th>
<th>Organic matter %</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>P</td>
<td>K</td>
</tr>
<tr>
<td>2012/2013</td>
<td>36.00</td>
<td>15.00</td>
<td>525</td>
</tr>
<tr>
<td>2013/2014</td>
<td>37.50</td>
<td>13.00</td>
<td>520</td>
</tr>
</tbody>
</table>
Sowing 9/12/2012

Transplanting 30/12/2012

Harvest time 30/4/2013

Fig.1. Photographs illustrating wheat sowing, transplanting and harvest time of the growing season 2012/2013. WAS = Weeks after sowing. DAT = Days after transplanting.
The meteorological data which obtained from Giza station during 2012/2013 and 2013/2014 seasons are recorded in the following table:

<table>
<thead>
<tr>
<th>Month</th>
<th>2012 / 2013</th>
<th>2013 / 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temp. (°C)</td>
<td>Rainfall (mm)</td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>November</td>
<td>27.4</td>
<td>16.1</td>
</tr>
<tr>
<td>December</td>
<td>22.8</td>
<td>10.2</td>
</tr>
<tr>
<td>January</td>
<td>21.4</td>
<td>8.2</td>
</tr>
<tr>
<td>February</td>
<td>23.5</td>
<td>9.7</td>
</tr>
<tr>
<td>March</td>
<td>28.1</td>
<td>13.8</td>
</tr>
<tr>
<td>April</td>
<td>29.4</td>
<td>15.1</td>
</tr>
<tr>
<td>May</td>
<td>35.1</td>
<td>19.7</td>
</tr>
</tbody>
</table>

### Results and Discussion

1. **Heading date:***

The results in Table (1) clearly indicated that foliar application with micronutrients had significant effects on heading date of Gemmeiza 9 and Gemmeiza 10 wheat cultivars. Spraying micronutrients mixture gave a significant difference concerning both cultivars, Gemmeiza 9 showed longer time up to heading date than Gemmeiza 10. Application of micronutrients prolonged heading date by 3.77, 6.04 and 8.15% over the control; respectively.

The interaction effect between wheat cultivars and micronutrients treatments on heading date was significant. The highest value was obtained from Gemmeiza 9 treated with micronutrients at the two times (27 WAT). While the lowest value was obtained from Gemmeiza 10 under control.

2. **Flag leaf area:**

Flag leaf area of Gemmeiza 9 was larger than Gemmeiza 10 by 13.02% (Table 1). Applying micronutrients had significant effect on wheat flag leaf area. The lowest flag leaf area was obtained from control treatment. While, foliar application of micronutrients at the two times gave the highest flag leaf area, followed by application of micronutrients at 7 WAT and at 2 WAT. The increase in flag leaf area which obtained from the above treatments were 37.30, 27.09 and 17.41% over the control, respectively.

The interaction effect between cultivars and micronutrients on flag leaf area was significant. The highest value was obtained from Gemmeiza 9 treated with micronutrients at the two times (27 WAT). While, the lowest value was obtained from Gemmeiza 10 under control.

### Table 1. Heading date, leaf chlorophyll fluorescence and certain morphological characters of the two transplanting wheat cultivars as affected by micronutrients mixture in 2012/2013 and 2013/2014 growing seasons.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Chlorophyll fluorescence (Fv/Fm)</th>
<th>Plant height (cm)</th>
<th>Spike length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gemmeiza 9</td>
<td>0.91</td>
<td>0.93</td>
<td>0.76</td>
</tr>
<tr>
<td>Gemmeiza 10</td>
<td>0.99</td>
<td>0.66</td>
<td>0.79</td>
</tr>
<tr>
<td>Mic. 1 (Mic.)</td>
<td>0.96</td>
<td>0.83</td>
<td>0.86</td>
</tr>
<tr>
<td>Mic. 2 (Mic.)</td>
<td>0.93</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>Mic. 3 (Mic.)</td>
<td>0.91</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>G = Mic. 0</td>
<td>0.92</td>
<td>0.84</td>
<td>0.83</td>
</tr>
<tr>
<td>G = Mic. 1</td>
<td>0.96</td>
<td>0.84</td>
<td>0.83</td>
</tr>
<tr>
<td>G = Mic. 2</td>
<td>0.93</td>
<td>0.84</td>
<td>0.82</td>
</tr>
<tr>
<td>G = Mic. 3</td>
<td>0.91</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>G = Mic. 0</td>
<td>0.94</td>
<td>0.85</td>
<td>0.83</td>
</tr>
<tr>
<td>G = Mic. 1</td>
<td>0.98</td>
<td>0.85</td>
<td>0.84</td>
</tr>
<tr>
<td>G = Mic. 2</td>
<td>0.91</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>G = Mic. 3</td>
<td>0.90</td>
<td>0.82</td>
<td>0.81</td>
</tr>
<tr>
<td>G = Mic. 0</td>
<td>0.96</td>
<td>0.84</td>
<td>0.83</td>
</tr>
<tr>
<td>G = Mic. 1</td>
<td>0.95</td>
<td>0.83</td>
<td>0.82</td>
</tr>
<tr>
<td>G = Mic. 2</td>
<td>0.91</td>
<td>0.83</td>
<td>0.81</td>
</tr>
<tr>
<td>G = Mic. 3</td>
<td>0.90</td>
<td>0.82</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Mic. = Foliar spraying with micronutrients mixture (Fe + Zn + Mn). WAT = Weeks after transplanting. DAT = Days after transplanting.

* = Significant.

3. Chlorophyll fluorescence:

Chlorophyll fluorescence analysis is a good index for rapidly measuring of the change in photosynthetic metabolism of plants under environmental stress conditions (Conroy et al., 1986).

From data recorded in Table (1), Gemmeiza 9 was assess of Gemmeiza 10 in chlorophyll fluorescence value, with an increase of 19.46%.
Concerning the effect of micronutrients application, data indicated that chlorophyll fluorescence value was significantly increased in treated plants. The relative increase over the control treatment was 30.66, 41.08 and 47.90% when micronutrients applied at 2 WAT, 7 WAT and at the two times; respectively.

The interaction between cultivars and micronutrients application was found to be significant in leaf chlorophyll fluorescence. The maximum value of such trait was obtained from Gemmeiza 9 sprayed with micronutrients mixture at the two times (2+7 WAT). The lowest value was obtained from Gemmeiza 10 under control treatment.

4. Plant height:
   The results in Table (1) indicated that Gemmeiza 9 had taller plants than Gemmeiza 10. The increase was 11.72%.
   Spraying micronutrients mixture showed significant increase in plant height over control treatment with about 4.01, 7.12 and 13.90% for plants treated at 2 WAT, 7 WAT and at the two times; respectively.
   The interaction between cultivars and micronutrients on plant height was significant. The maximum value was obtained from Gemmeiza 9 with micronutrients application at the two times. Similar results were reported by Samira (1995).

5. Spike length:
   Spike length of Gemmeiza 9 was significantly higher than that of Gemmeiza 10 by 12.68% (Table 1).
   Spike length was increased as a result of foliar application with micronutrients at every time under study. These increases were 9.48, 17.61 and 25.42% due to spraying at 2 WAT, 7 WAT and at the two times; respectively compared to the untreated plants.
   The effect of interaction between cultivars and different treatments on spike length was significant. The highest value was obtained from Gemmeiza 9 treated with micronutrients at 2 or 7 WAT. While, the lowest value was obtained from Gemmeiza 10 under control. These results are in general agreement with those obtained by Samira (1995).

6. Number of spikes/m²:
   Number of spikes/m² of Gemmeiza 10 seemed to be larger than Gemmeiza 9. However the difference did not reach the level of significance (Table 2).
   Number of spikes/m² showed a positive response to micronutrients application. These increases were about 21.54, 17.09 and 26.33% for spraying at 2 WAT, 7 WAT and at the two times; respectively compared to control.
   The interaction between cultivars and micronutrients for this trait showed that the highest value was obtained from Gemmeiza 10 treated with micronutrients at the two times. Samira (1995) found that number of spikes/m² was significantly affected by micronutrients application.

7. Number of grains/spike:
   Number of wheat grains/spike was significantly differed between cultivars. Gemmeiza 9 was surpassed Gemmeiza 10 in this trait, with an increase of 13.47% (Table 2).
   The different micronutrients application treatments showed significant increases in number of grains/spike. The relative increases were 13.64, 22.15 and 31.97% for the micronutrients application at 2 WAT, 7 WAT and at the two times, respectively compared to the control treatment.
   The effect of interaction between wheat cultivars and different micronutrients treatments was significant on this character. Gemmeiza 9 sprayed with micronutrients mixture at the two times gave the highest value. These results are in accordance with those reported by Ziaeian and Malakouti (2001) and Pahlavan-Rad and Pessarakli (2009).

8. Thousand grain weight:
   The results in Table (2) clearly indicated that Gemmeiza 9 wheat cultivar has heavier grains than Gemmeiza 10, with 9.77%.
   Micronutrients treatments showed significant increases in this trait by 9.67, 18.30 and 23.87% for the plants sprayed at 2 WAT, 7 WAT and at the two times; respectively over the control treatment.
   The interaction between cultivars and micronutrients had significant effect on 1000-grain weight. Gemmeiza 9 sprayed with micronutrients at the two times gave the highest value of this character. While, the untreated plants of Gemmeiza 10 gave the lowest value. In this connection, Samira (1995), reported that applying micronutrients (Fe, Zn and Mn) as foliar spray at tillering and at heading stages significantly increased 1000-grain weight.
9. Grain yield (g/m²):

Grain yield of Gemmeiza 9 seemed to be higher than Gemmeiza 10, however the difference was not significant (Table 2).

Concerning the effect of micronutrients application, grain yield was significantly increased by 20.82, 31.22 and 43.71% with spraying micronutrients at 2 WAT, 7 WAT and at the two times; respectively compared to the control. The effect of interaction between wheat cultivars and different micronutrients treatments on grain yield was significant. Gemmeiza 9 treated with micronutrients at the two times gave the highest value. While, Gemmeiza 10 under the control treatment gave the lowest value. Hassan et al. (1992), Samira (1995), Ziaeian and Malakouti (2001) and Pahlavan-Rad and Pessarakli (2009) showed that micronutrients Fe, Zn and Mn increased grain yield of wheat, being in agreement with the present findings.

Table 2. Grain yield, its components and straw yield of the two transplanting wheat cultivars as affected by micronutrients mixture in 2012/2013 and 2013/2014 growing seasons.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No. of spikes / m²</th>
<th>No. of grains / spike</th>
<th>1000 - grain weight (g)</th>
<th>Grain yield (g/m²)</th>
<th>Straw yield (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gemmeiza 9</td>
<td>367.31</td>
<td>397.75</td>
<td>382.53</td>
<td>53.86</td>
<td>52.78</td>
</tr>
<tr>
<td>Gemmeiza 10</td>
<td>394.69</td>
<td>400.75</td>
<td>397.72</td>
<td>47.38</td>
<td>46.59</td>
</tr>
</tbody>
</table>

10. Straw yield Kg/m²:

The results in Table (2) showed that straw yield of Gemmeiza 9 was significantly higher by 14.29% over Gemmeiza 10. Micronutrients mixture (Fe + Zn + Mn) treatments showed significant increase in straw yield/m² 8.93, 8.31 and 31.46% for the time of application at 2 WAT, 7 WAT and at the two times; respectively compared to untreated plants.

The effect of interaction between cultivars and micronutrients straw yield was significant. Gemmeiza 9 with micronutrients application at the two times gave the highest value. Similar trends were reported by Hassan et al. (1992), Samira (1995) and Ziaeian and Malakouti, (2001).

Conclusion

Application of micronutrients chelating mixture (Fe + Zn + Mn) at the rate of 300 ppm for each element to transplanted wheat plants increased leaf chlorophyll fluorescence, growth and yield components associated with high grain yield. The maximum grain yield was obtained from Gemmeiza 9 treated twice with micronutrients.

Acknowledgement

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References


