EFFECT OF SELENIUM FOLIAR APPLICATION TREATMENTS ON GROWTH AND YIELD OF WHEAT
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ABSTRACT
The aim of this study was to determine the effect of selenium treatments (rates and time of application) as foliar spraying on growth and grain yield of wheat Sakha 93 cultivar. Two field experiments were selected for the study (Station Farm at Mansoura and Kalabsho & Zayian region, Faculty of Agriculture, Mansoura University during the winter season of 2010/2011. A randomized complete block design with four replications was used. Selenium foliar spraying significantly increased (p<0.05) the growth and yield of wheat. The highest values of growth, grain yield and its components were associated with spraying wheat plants twice with 7.5 g selenium/fed after 50 and 70 days from sowing. This treatment followed by foliar spraying after 70 days from sowing only with the same levels of selenium, then foliar spraying after 50 days from sowing only with also the same levels of selenium with significant differences (p<0.05) in both locations.

In conclusion, foliar spraying wheat plants twice with selenium at the rate of 7.5 g/fed after 50 and 70 days from sowing to maximize growth and productivity under the environmental conditions at both locations.

Keywords: Wheat, selenium, rates, times, growth, yield.

INTRODUCTION
Wheat (Triticum aestivum L.) is the most strategic cereal crops in the world as well as in Egypt. The properties of its grain make it the main leading cereal for human food. Selenium is an important microelement, exists in small amounts in microorganisms, plants, animals and human (Lyons et al., 2005 and Germ et al., 2007). Although the importance of selenium as an essential trace nutrient for humans and most other animals as an antioxidant, toxicity occurs at high concentrations due to replacement of sulphur with selenium in amino acids resulting in incorrect folding of the protein and consequently nonfunctional proteins and enzymes (Hasanuzzaman et al., 2010). Thus, plant selenium uptake and metabolism can be exploited for the purposes of developing high- selenium crop cultivars and for plant-mediated removal of excess selenium from soil or water.

Selenium enters the food chain through the plants which take it up from soil. Low selenium status in human organism may increase the risk of cardiovascular, cancer and other diseases, which are caused by free radicals (Rayman 2000). Foliar application of selenium in the form of Na2SeO3 under various crops is stated by Cao et al. (2001). Differences between essential and toxic rates of selenium are very narrow (Fargašová et al. 2006).

The aim of this study was to determine the effect of foliar spraying of wheat plants with selenium (rates and time of application) on growth, grain yield under the environmental conditions of clayey soils in Mansoura and sandy soils in Kalabsho districts.
MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Station Farm in Mansoura and the Experimental Station Farm in Kalabsho and Zayian region, Faculty of Agriculture, Mansoura University during the winter season of 2010/2011 to determine the effect of selenium treatments (rates and time of application) as foliar spraying on growth, grain yield and its components of wheat Sakha 93 cultivar.

Each experiment in Mansoura and Kalabsho location was practiced in Randomized Complete Block Design (RCBD) of ten treatments with four replicates as follows:
2. Spraying with 2.5 g Selenium/fed after 50 days from sowing (DFS).
3. Spraying with 5.0 g Selenium/fed after 50 days from sowing (DFS).
4. Spraying with 7.5 g Selenium/fed after 50 days from sowing (DFS).
5. Spraying with 2.5 g Selenium/fed after 70 days from sowing (DFS).
6. Spraying with 5.0 g Selenium/fed after 70 days from sowing (DFS).
7. Spraying with 7.5 g Selenium/fed after 70 days from sowing (DFS).
8. Spraying with 2.5 g Selenium/fed after 50 and 70 days from sowing (DFS).
9. Spraying with 5.0 g Selenium/fed after 50 and 70 days from sowing (DFS).
10. Spraying with 7.5 g Selenium/fed after 50 and 70 days from sowing (DFS).

Selenium as sodium selenate was obtained from El-Gomhouria Company for Trading Pharmaceutical Chemical & Medical. The foliar solution was completed to 200 L/fed and spraying was conducted by hand sprayer until saturation point.

The soil was clayey texture with an electrical conductivity (EC) of 1.71 dS/m and a pH of 7.80 in Mansoura location, while in Kalabsho location the soil was sandy texture and little fertility with an electrical conductivity (EC) of 8.62 dS/m and a pH of 8.43. The experimental unit area in each location was 3 X 3.5 m occupying an area of 10.5 m² (i.e. 1/400 fed). The preceding summer crop in Mansoura location was maize (Zea mays L), while in Kalabsho location the soil in the summer season was uncultivated.

The experimental field was well prepared through two ploughings, compaction and then divided into the experimental units with dimensions as previously mentioned. The cultivation took place on November 19th and 24th in Mansoura and Kalabsho locations, respectively. Wheat grains at the rate of 75 and 90 kg/fed were sown by using broadcasting Afir method in Mansoura and Kalabsho locations, respectively. The common agricultural practices such as irrigation, fertilization (NPK), weed and pest control for growing wheat in clayey and sandy soils according to the recommendations of Ministry of Agriculture and Land Reclamation were followed, except the factors under study.
Studied Characters:
A- Growth characters:
   After 120 days from sowing (After heading stage), one square meter was randomly choice from each plot to estimate the following characters:
   1- Plant height (cm) was measured from the soil surface to the top of the main stem spike as average of ten plants.
   2- Flag leaf area (cm²) was calculated by the following formula according Gardner et al. (1985):
      \[ a = L \times W \times 0.75 \]
      Where; \( a = \) Flag Leaf Area, \( L = \) Length of flag leaf and \( W = \) Maximum width of flag leaf.
   3- Stem diameter (cm) was measured in cm by using a varnier caliper on the third internode of the stem above the soil surface.
   4- Number of tillers/plant was measured by counting number of tillers (effective and non – effective) per plant.

B- Grain yield and its components:
   At harvesting, one square meter was randomly selected from each plot to estimate the following characters:
   5- Spike length (cm) was determined as the distance from the base of main spike to the top as average of ten spikes.
   6- Number of spikelets/spike was estimated by counting number of spikelets per spike as average of ten spikes.
   7- Number of grains/spike was determined by counting number of grains per spike as average of ten spikes.
   8- Grains weight/spike (g) was determined by weighting whole extracted grains of spike as average of ten spikes.
   9- 100 – grain weight (g) was determined by weighting 100 grains of each sample.
   10- Grain yield (ardab/fed) was calculated by harvesting whole plants in each plot and air dried, then threshed and the grains at 13 % moisture were weighted in kg and converted to ardab per feddan (one ardab = 150 kg).

Statistical analysis
   All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for randomized complete block design as published by Gomez and Gomez (1984), using MSTAT statistical package (MSTAT-C with MGRAPH version 2.10, Crop and Soil Sciences Department, Michigan State University, USA). Least Significant Difference (LSD) method was used to test the differences between treatment means at 0.05 % level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of selenium treatments on growth characters:
   From obtained results foliar spraying wheat plants with various rates and times of application of selenium showed significant effect on all studied growth characters (plant height, flag leaf area, stem diameter and number of
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tillers/plant) in both locations (Tables 1). It can be noticed that wheat plants sprayed with 7.5 g selenium/fed after 50 and 70 DFS were among those having the highest values of growth characters. Foliar spraying plants with selenium at the rate of 7.5 g/fed after 70 DFS ranked after previously mentioned treatment, followed by spraying with selenium at the rate of 7.5 g/fed after 50 DFS in both locations. Wheat plants did not foliar sprayed with selenium (control treatment) resulted in the lowest values of growth characters in Mansoura and Kalabsho locations. In general view of obtained data, increasing selenium rates from 2.5 to 5.0 and 7.5 g/fed and delaying in time of application from 50 to 70 and 50 & 70 DFS associated with gradual increases in growth characters in Mansoura and Kalabsho locations. This increase in growth characters by foliar spraying wheat plants with various rates and times of application of selenium may be due to the role of selenium in enhancement growth of plants and improve antioxidative capacity of plants either by acting as antioxidant directly or by increasing the activities of antioxidative enzymes getting easier reflecting increases in growth and plant height. These results are in good agreement with those obtained by Xue et al. (2001), Pennanen et al. (2002), Thomson (2004), Germ et al. (2007) and Hasanuzzaman et al. (2010).

**Effect of selenium treatments on grain yield and its components:**

Referring the effect of foliar spraying treatments with selenium (combinations treatments of three rates and three times of application) on grain yield and its components (spike length, number of spikelets/spike, number grains/spike, grains weight/spike 100-grain weight and grain yield/fed), it was significant in the two locations of this study as presented in Tables 1 and 2. Foliar spraying wheat plants twice after 50 and 70 days from sowing with the highest rate of selenium (7.5 g selenium/fed) surpassed other studied selenium foliar spraying treatments and resulted in the highest means of grain yield and its components in Mansoura and Kalabsho locations, respectively. This treatment followed by spraying with the highest rate also of selenium but after 70 days from sowing only, then foliar spraying with the highest rate too of selenium but after 50 days from sowing only in both locations. On the contrary, the lowest means of grain yield and its components were produced from control treatment (without selenium application) in Mansoura and Kalabsho locations, respectively. It worth mentioning that the arrangement of other selenium treatments could be like this; spraying with 5.0 g selenium/fed after 50 and 70 DFS, spraying with 5.0 g selenium/fed after 70 DFS, spraying with 5.0 g selenium/fed after 50 DFS, spraying with 2.5 g selenium/fed after 50 and 70 DFS, spraying with 2.5 g selenium/fed after 70 DFS and spraying with 2.5 g selenium/fed after 50 DFS in both locations. It means that increasing rates and delay times of selenium application as well as frequently more than one time let to gradual increases grain yield/fed in both studied locations.
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The increases in wheat grain yield and its components because of foliar spraying treatments with selenium can be easily ascribed to its role in improvement early growth, more dry matter accumulation and stimulation the building of metabolic products, consequently enhancement yield components (number of grains/panicle, grains weight/spike and 100-grain weight) and thus increasing grain yield/feet. These results are in compatible with those found by Eurola et al. (2004), Hartikainen (2005) and Hasanuzzaman et al. (2010). On the other hand, Ducsay and Ložek (2006) and Ducsay et al. (2007) reported that applied treatments of selenium fertilization did not influence wheat grain yield.

REFERENCES


تأثير معاملات الرش الورقى بالسيليسيوم على نمو ونتاج محصول القمح
صالح السيد سعده*، مسعد عبد العزيز أبو ريه**، مي مدحت محمد الدناصورى
"قسم المحاصيل - كلية الزراعة، جامعة المنصورة - مصر.
"قسم الصناعات الغذائية - كلية الزراعة، جامعة المنصورة - مصر.

أجريت تجربتان حقلية بمحطة التجارب والبحوث الزراعية بمنطقة المنصورة وقلايشو وزيران - كلية الزراعة – جامعة المنصورة خلال الموسم الشتوي 2011/2012 لتحديد تأثير معاملات الرش الورقى بالسيليسيوم (معدلات وحيدات إضافية) على النمو ومحصول الحبوب ومكوناته القمح صنف سخا 32. أجريت كلاً من التجربتين في تصميم القطاعات العشوائية الكاملة ذو أربعة مكررات في كل من موقع المنصورة وقلايشو. أظهرت النتائج المتاحل عليها وجود فروق معنوية في جميع الصفات المدرجة استجابةً لمعاملات الرش الورقى بالسيليسيوم بختلف المعاللات وأوقات التطبيق في كل الموقعين. تنبت أعلى الفئات الفلاحية والمحصول الحبوب ومكوناته عند رش نباتات القمح مرتين بـ 7.5 جم سيليسيوم/قدن بعد 30 و70 يوما من الزراعة. تلي هذه المعاملة الرش الورقى بعد 70 يوما فقط من الزراعة بنفس معدل السيليسيوم، ثم الرش الورقى بعد 50 يوما فقط من الزراعة بنفس النموي أيضاً من السيليسيوم في كلا الموقعين. في حين أن معالمة المقارنة (بدون استخدام السيليسيوم) أنجحت ذي الفئات لجميع الصفات المدرجة في كلا الموقعين من النتائج المتاحل عليها في هذه الدراسة فإنه يمكن التوصية بالرش الورقى لنباتات القمح مرتين بـ 7.5 جم سيليسيوم/قدن بعد 30 و70 يوما من الزراعة لزيادة النمو والاحترافية تحت الظروف البيئية لمنطقة المنصورة وقلايشو ، محافظة الدقهلية.

قام بتحكيم البحث

كلية الزراعة – جامعة المنصورة

مركز البحوث الزراعية

أ.د / محسن عبد العزيز بدوى
أ.د / إبراهيم فتحى عبد الرحمن مرسال
Table 1: Plant height, flag leaf area, stem diameter, number of tillers/plant and spike length of wheat as affected by selenium treatments in Mansoura and Kalabsho locations.

<table>
<thead>
<tr>
<th>Selenium treatments:</th>
<th>Characters</th>
<th>Plant height (cm)</th>
<th>Flag leaf area (cm²)</th>
<th>Stem diameter (cm)</th>
<th>Number of tillers/plant</th>
<th>Spike length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Man-soura</td>
<td>Kala-bsho</td>
<td>Man-soura</td>
<td>Kala-bsho</td>
<td>Man-soura</td>
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<tr>
<td>Without selenium (control)</td>
<td></td>
<td>88.03</td>
<td>58.40</td>
<td>23.74</td>
<td>10.69</td>
<td>0.267</td>
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<tr>
<td>Spraying with 2.5 g selenium/fed after 50 DFS</td>
<td></td>
<td>90.62</td>
<td>61.50</td>
<td>27.58</td>
<td>11.83</td>
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<td>96.15</td>
<td>64.90</td>
<td>33.01</td>
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<tr>
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<td>100.42</td>
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<td>92.50</td>
<td>62.95</td>
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<td>12.72</td>
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<td>29.28</td>
<td>13.27</td>
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<td>67.50</td>
<td>36.55</td>
<td>18.31</td>
<td>0.335</td>
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<td>104.22</td>
<td>72.63</td>
<td>47.33</td>
<td>20.73</td>
<td>0.365</td>
</tr>
<tr>
<td>F. test</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
</tr>
<tr>
<td>LSD at 0.05 %</td>
<td></td>
<td>2.78</td>
<td>1.45</td>
<td>3.82</td>
<td>2.83</td>
<td>0.023</td>
</tr>
</tbody>
</table>
Table 2: Number of spikelets/spike, number grains/spike, grains weight/spike 100-grain weight and grain yield/fed of wheat as affected by selenium treatments in Mansoura and Kalabsho locations.

<table>
<thead>
<tr>
<th>Characters</th>
<th>Number of spikelets/spike</th>
<th>Number grains/spike</th>
<th>Grains weight/spike (g)</th>
<th>100-grain weight (g)</th>
<th>Grain yield (ardab/fed)</th>
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</thead>
<tbody>
<tr>
<td>Selenium treatments:</td>
<td>Man-soura</td>
<td>Kala-bsho</td>
<td>Man-soura</td>
<td>Kala-bsho</td>
<td>Man-soura</td>
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<td>Without selenium (control)</td>
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<td>31.15</td>
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<td>56.92</td>
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<td>17.95</td>
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<td>F. test</td>
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<td>*</td>
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</tr>
<tr>
<td>LSD at 0.05 %</td>
<td>0.68</td>
<td>0.45</td>
<td>3.59</td>
<td>3.03</td>
<td>0.26</td>
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</table>