J. Plant Production, Mansoura Univ., Vol. 4 (10): 1429 - 1436, 2013

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 Na_2SeO_3 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:

1. Control (Without Selenium).
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 m^2 (*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 19^{th} and 24^{th} 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 (cm^2) 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

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 antioxidant 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.

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.

Characters / Selenium treatments:	Plant height (cm)		Flag leaf area (cm^2)		Stem diameter (cm)		Number of tillers/plant		Spike length (cm)	
	Man-soura	Kala-bsho	Man-soura	Kala-bsho	Man-soura	Kala-bsho	Man-soura	Kala-bsho	Man-soura	Kala-bsho
Without selenium (control)	88.03	58.40	23.74	10.69	0.267	0.245	2.27	1.00	14.57	14.32
Spraying with 2.5 g selenium/fed after 50 DFS	90.62	61.50	27.58	11.83	0.285	0.250	2.40	1.35	15.52	14.73
Spraying with 5.0 g selenium/fed after 50 DFS	96.15	64.90	33.01	14.23	0.318	0.308	2.95	1.85	16.55	15.50
Spraying with 7.5 g selenium/fed after 50 DFS	**100.42**	68.55	38.08	18.26	0.343	0.328	3.80	2.22	17.07	16.25
Spraying with 2.5 g selenium/fed after 70 DFS	92.50	62.95	29.06	12.72	0.293	0.265	2.62	1.47	15.82	15.02
Spraying with 5.0 g selenium/fed after 70 DFS	97.67	65.95	35.65	16.46	0.322	0.308	3.35	1.85	16.62	15.89
Spraying with 7.5 g selenium/fed after 70 DFS	**100.90**	69.55	39.40	20.47	0.348	0.340	4.20	2.52	17.52	16.35
Spraying with 2.5 g selenium/fed after 50 and 70 DFS	94.72	63.81	29.28	13.27	0.315	0.282	2.82	1.77	16.27	15.37
Spraying with 5.0 g Selenium/fed after 50 and 70 DFS	99.37	67.50	36.55	18.31	0.335	0.325	3.42	1.95	16.97	16.01
Spraying with 7.5 g selenium/fed after 50 and 70 DFS	**104.22**	72.63	47.33	20.73	0.365	0.362	4.72	3.05	17.90	17.39
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 0.05 %	2.78	1.45	3.82	2.83	0.023	0.024	0.57	0.28	0.90	0.40

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.

Characters / Selenium treatments:	Number of spikelets/ spike		Number grains/spike		Grains weight/spike (g)		100-grain weight (g)		Grain yield (ardab/fed)	
	Man-soura	Kala-bsho	Man-soura	Kala-bsho	Man-soura	Kala-bsho	Man-soura	Kala-bsho	Man-soura	Kala-bsho
Without selenium (control)	16.52	15.35	41.75	28.45	1.77	0.72	3.41	2.66	17.90	8.53
Spraying with 2.5 g selenium/fed after 50 DFS	17.20	15.85	46.05	31.15	2.05	0.78	4.00	2.92	18.79	9.64
Spraying with 5.0 g selenium/fed after 50 DFS	18.57	16.30	50.67	35.57	2.25	1.05	4.38	3.02	19.81	10.52
Spraying with 7.5 g selenium/fed after 50 DFS	19.75	17.22	56.92	40.22	2.37	1.19	4.56	3.40	19.82	11.65
Spraying with 2.5 g selenium/fed after 70 DFS	17.60	16.02	47.62	32.15	2.12	0.91	4.26	2.93	19.82	10.08
Spraying with 5.0 g selenium/fed after 70 DFS	19.07	16.42	52.27	38.60	2.24	1.16	4.50	3.09	19.83	11.21
Spraying with 7.5 g selenium/fed after 70 DFS	20.07	17.82	58.87	42.25	2.88	1.32	4.65	3.45	20.32	11.76
Spraying with 2.5 g selenium/fed after 50 and 70 DFS	17.85	16.15	48.77	34.20	2.20	0.98	4.45	2.94	19.87	10.73
Spraying with 5.0 g Selenium/fed after 50 and 70 DFS	19.15	16.75	53.77	38.90	2.41	1.18	4.52	3.24	20.13	11.25
Spraying with 7.5 g selenium/fed after 50 and 70 DFS	20.35	17.95	63.47	47.20	3.04	1.57	4.94	3.46	21.21	12.19
F. test	*	*	*	*	*	*	*	*	*	*
LSD at0.0 5 %	0.68	0.45	3.59	3.03	0.26	0.24	0.68	0.26	0.37	0.41

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/fed. 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

Cao, Z.H. ; X.C. Wang ; D.H. Yao ; X.L. Zhang and M.H. Wong (2001). Selenium geochemistry of paddy soils in Yangtze River Delta. Environ. Inst., 26: 335–339.

Ducsay, L. and O. Ložek (2006). Effect of selenium foliar application on its content in winter wheat grain. Plant Soil Environ., 52(2): 78–82.

Ducsay, L. ; O. Ložek ; L. Varga and T. Lošák (2007). Effects of winter wheat supplementation with selenium. Eco. Chem. and Eng., 14(3–4): 289-294.

Eurola, M. ; V. Hietaniemi ; M. Kontturi ; H. Tuuri ; A. Kangas ; M. Niskanen and M. Saastamoinen (2004). Selenium content of Finnish oats in 1997–1999: effect of cultivars and cultivation techniques. Agric. and Food Sci., 13: 46–53.

Fargašová, A. ; J. Pastierová and K. Svetková (2006). Effect of Se-metal pair combinations (Cd, Zn, Cu, Pb) on photosynthetic pigments production and metal accumulation in *Sinapis alba* L. seedlings. Plant Soil Environ., 52: 9–16.

Germ, M. ; V. Stibilj and I. Kreft (2007). Metabolic importance of selenium for plants. The European J. of Plant Sci. and Biotech., 1(1): 91-97.

Gomez, K.N. and A.A. Gomez (1984). Statistical procedures for agricultural research. John Wiley and Sons, New York, 2nd Ed., 68 P.

Hartikainen, H. (2005). Biogeochemistry of selenium and its impact on food chain quality and human health. J. of Trace Elements in Medicine and Biology, 18: 309-318.

Hasanuzzaman, M. ; M.A. Hossain and M. Fujita (2010). Selenium in higher plants: Physiological role, antioxidant metabolism and abiotic stress tolerance. J. of Plant Sci., 5 (4): 345-375.

Lyons, G.H. ; Y. Genc ; J.C.R. Stangoulis ; L.T. Palmer and R.D. Graham (2005). Selenium distribution in wheat grain, and the effect of postharvest processing on wheat selenium content. Biol. Trace Element Res., 103: 155-168.

Pennanen, A. ; T. Xue and H. Hartikainen (2002). Protective role of selenium in plant subjected to severe UV irradiation stress. J. of Applied Botany, 76: 66-76.

Rayman, M.P. (2000). The importance of selenium in human health. Lancet, 356: 233–241.

Snedecor, G.W. and W.G. Cochran (1980). "Statistical Methods" 7th Ed. The Iowa State Univ. Press, Iowa, USA.

Thomson, C.D. (2004). Assessment of requirements for selenium and adequacy of selenium status: a review. European J. of Clinical Nutrition, 58: 390–402.

Xue, T. H. Hartikainen abd V. Piironen (2001). Antioxidative and growth-promoting effect of selenium in senescing lettuce. Plant and Soil, 237: 55-61.

تأثير معاملات الرش الورقى بالسيلينيوم على نمو وإنتاجية محصول القمح

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أجريت تجربتان حقليتان بمحطة التجارب والبحوث الزراعية بمنطقتى المنصورة وقلابشو وزيان – كلية الزراعة – جامعة المنصورة خلال الموسم الشتوى٢٠١٠/٢٠١١ لتحديد تأثير معاملات الرش الورقى بالسيلينيوم (معدلات وميعاد إضافة) على النمو ومحصول الحبوب ومكوناته للقمح صنف سخا ٩٣. أجريت كلا من التجربتين في تصميم القطاعات العشوائية الكاملة ذو أربعة مكررات فى كل من موقعى المنصورة وقلابشو. أظهرت النتائج المتحصل عليها وجود فروق معنوية فى جميع الصفات المدروسة إستجابة لمعاملات الرش الورقى بالسيلينيوم بمختلف المعدلات وأوقات التطبيق في كلا الموقعين. نتجت أعلى القيم لصفات النمو ومحصول الحبوب ومكوناته عند رش نباتات القمح مرتين بـ ٧.٥ جم سيلينيوم/فدان بعد ٥٠ و ٧٠ يوما من الزراعة. تلى هذه المعاملة الرش الورقى بعد ٧٠ يوما فقط من الزراعة بنفس معدل السيلينيوم، ثم الرش الورقى بعد ٥٠ يوما فقط من الزراعة بنفس المعدل أيضا من السيلينيوم في كلا الموقعين. فى حين أن معاملة المقارنة (بدون استخدام سيلينيوم) أنتجت أدنى القيم لجميع الصفات المدروسة في كلا الموقعين.

من النتائج المتحصل عليها فى هذه الدراسة فإنه يمكن التوصية بالرش الورقى لنباتات القمح مرتين بـ ٧.٥ جم سيلينيوم/ فدان بعد ٥٠ و ٧٠ يوما من الزراعة لزيادة النمو والإنتاجية تحت الظروف البيئية لمنطقتى المنصورة وقلابشو ، محافظة الدقهلية.

قام بتحكيم البحث

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