

Impact of Foliar Selenium Feeding on Grain Selenium Content and Grain Yield of Wheat (*Triticum aestivum*)

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Abstract

Selenium (Se) is an essential micronutrient for living cell to be highly rich antioxidants, anti aging, anti cancer and many diseases. Also having an important effect on plant growth as a nutrient. Wheat is an important dietary source of organic selenium. Experiment in north Baghdad included six levels of Selenium Sulphate solution applied as a foliage feeding on wheat plant to increase grain Se content (Biofortification) and to improve grain yield. Results showed that grain selenium concentration increased to 4.5 mg per kg at the upper level (5mgm/L). Grain yield (ton/ha) showed a positive response, the yield was increased by 123% attributed to increasing of spikes per m², 1000 grain weight and grain no. per spike. Biomass yield also showed a positive response to increased (se) solution concentration by doubled at the upper limit. Over all, these results encourage us to increase the upper limit of (Se) solution concentration to obtain the climax point.

Keywords: Wheat; Selenium; Biofortification; Antioxidan

التدعيم الحيوي لنبات الحنطة بعنصر السيلينيوم على محتوى الحبوب من العنصر

الخلاصة

عنصر السيلينيوم من العناصر الغذائية الصغرى الاساسية للانسان والحيوان ويجعلها غنية بمضادات الاكسدة ويفيد لمنع مرض السرطان والتقدم العمري وامراض عديدة اخرى، بالاضافة ال تأثيره الايجابي على نمو النبات. تعتبر الحنطة مصدر غذائي مهم للسيلينيوم العضوي، اجريت تجربة حقلية شمال بغداد اشتملت على (6) ستة مستويات من محلول كبريتات السيلينيوم للتغذية الورقية كتدعيم حيوي لنبات الحنطة بعنصر السيلينيوم ولزيادة غلة الحبوب. اظهرت النتائج زيادة محتوى العنصر بالحبوب حيث ارتفع الى معدل (5-4mg/kg) عند اعلى مستوى في محلول التغذية (5mgm/L) وازداد حاصل الحبوب بمقدار 123% وذلك لزيادة عدد السنابل للمتر المربع الواحد، وزن 1000 حبة وعدد الحبوب للسنبلة. تضاعف حاصل الكتلة الحيوية عند اعلى مستوى للتغذية الورقية. هذه النتائج تشجع على استخدام مستويات اعلى من العنصر في المحلول المغذي.

الكلمات المرشدة: الحنطة، السيلينيوم، التدعيم الحيوي، مضادات الأكسدة

INTRODUCTION

Although Se is not considered as essential element for plant growth but it is essential micronutrient for human and animal health. Generally, cell health depends largely on balancing between free radicals, which are formed during cell respiration. Increased Free radicals are particularly cause damaging to cell components. The cell's defense mechanisms against free radicals are done by antioxidants. When the amount of antioxidants within cells are insufficient to balance with free radicals, thus very reactive molecules easily react with vital molecules such as DNA causing mutations in the sequences of genetic material. Accumulation hurt changes would be thought causing aging development and degenerative diseases [1]. Supplementation of antioxidant like Vitamin A and E, minerals like Selenium and nutritional antioxidant as cofactors like lipoid acid have an essential roll in protecting the cells from impact of free radicals by neutralizing free radical impact. In human cell. Selenium is a trace element nutrient, which functions as cofactor for glutathione peroxidase enzyme to make equilibrium between reduced and oxidized forms of glutathione. Certain forms of thioreductase, enzymes found in animal and some plant cells need (Se) as cofactor. Generally, in the human diet he main sources of Se are entire grain, meat and fish [2], as selenomethionine were absorbed better than inorganic form [3,4]. Thus, cereals are a significant source of Se intake in many countries. Se content of crops reflect its availability in the soil, which is affected by background levels of Se. Soil properties also effect Se availability, with higher availability occurring on high pH soil. Se availability also tends to be high with low soil moisture content [5]. Also applications of fertilizers (N,P,K) tend to dilute lowering the plant levels of other essential nutrient like selenium. This situation has been remedied by addition of carefully controlled levels of selenium salt either as soil fertilizer or by foliar fertilizer more environmentally friendly and target oriented than soil fertilizer to plants Foliage feeding have been watched more efficiently than traditional methods [6]. Plant's function is conversion of inorganic selenium, which applied to organic selenium form this operation called biofortification. Biofortified wheat with selenium have good antioxidant activity ability to scavenge damaging free radicles and protection against lipid peroxidation [7]. Bio-fort wheat is likely to be one of the actual selenium forms to protect against cancer and incidence of colon cancer precursors [8]. Wheat enriched with selenium by foliar application was found to be extremely effective in raising plasma selenium 53% increase after 6 weeks of 25 mg/d selenium from wheat) glutathione peroxidase activity in blood increased and anti-oxidative stress parameters decreased [9]. In Iraq [5] results showed that grain yield and biomass yield of wheat increased progressively with Selenium fertilization. The aim of this study was to determine the potential for grain (Se) concentration, grain yield and biomass yield for wheat crop.

Materials and Methods

Experiment was conducted on 2011 in Baghdad. Soil samples were taken randomly from the soil surface to assess physical and chemical properties [10] as presented below.

Soil Se was not determined because of moderate content in Iraqi soil [5]. The experimental design was completely randomized block with three replications, Plot size was 2m by 3m Wheat (*Triticum aestivum*) Abu-Ghuraib variety was sown at 20 cm row spaces with seeding rate 160 kg ha⁻¹, all plots were fertilized with 100 kg N ha⁻¹ as urea and 150 kg P ha⁻¹ as a triple super phosphate, at tillering stage foliage

feeding with six levels of selenium sulphate solution (0,1,2,3,4,5) gm/liter were done for one time, Biomass yield at heading(ton/ha) was measured by harvesting three 1 - meter length of rows from each plot and dried at 60 c then weighted. Ten mature plants were selected randomly from each plot to determine 1000 grain wt.(gm), grain no. per spike and grain se concentration. GRAIN Se concentration measured by digestion wheat grain powder (whole grain) using mixture of HCl & HNO₃, then measured with atomic absorption (Schimatzu 6800), one square meter randomly selected from each plot to measure grain wheat yield(kg/ha) and spike no. per m² collected data were statistically analyzed by steel and Torrie method [11].

Table (1). Soil experiment field properties

Physical properties			Chemical properties	
Clay (%)	silt (%)	sand (%)	PH	EC (mmoh/cm)
36.52	20.12	0.0	7.9	5.1

Results and Discussion

Grain Selenium concentration

Grain selenium concentration varied considerably from the lower to the upper Selenium concentration of foliage feeding, ranging from 2.2 mg.kg⁻¹ in control treatment to 4.5 mg.kg⁻¹ at the upper se concentration (5 gm.liter⁻¹) in feeding solution, as shown in Fig.1 it means a positive response had happened [12] and we have to test higher concentrations than applied. The important thing that toxic symptoms did not appear. Se absorption depends on cuticle and stomata of leaf tissue [13]. Therefore, absorption Se ability may improve via breeding program [14]. Generally, there was important effect of Se treatment on grain yield and some components, grain yield increased by 22%, which attributed to the positive effect of selenium foliage feeding on 1000-grain wt. and grain no. per spike and spike no per m². Selenium feeding increased 1000 grain wt. by 20%, grain no. per spike 30% and spike no. per m² 11%. These trends may attribute to improve root system absorption ability [5], then encourage cell division which increased tillers per plant and spike no. per m². It is known that selenium improve viability of germ cell which increased fertilization probability, then increased grain no. per spike also available se in plant tissues improve absorption of minerals and accumulation later in grain [15].

Table (2). Grain wheat yield and its components at different se concentration foliage feeding

Se conc.	Grain yield(kg/ha)	1000 grain wt.gm	Grain no.per spike	Spike no. per m ²
Control	3358.0 _a	36.1 _a	48.4 _a	402 _a
1gm liter ⁻¹	3506.0 _a	38.3 _a	47.5 _a	401 _a
2 gm liter ⁻¹	3722.0 _b	40.8 _b	53.20 _a	412 _b
3 gm liter ⁻¹	3881. 0 _b	40.5 _b	52.9 _a	425 _b
4 gm liter ⁻¹	4083. 0 _b	43.2 _b	59.1 _b	438 _c
5 gm liter ⁻¹	4121. 0 _b	43.5 _b	63.2 _b	446 _c

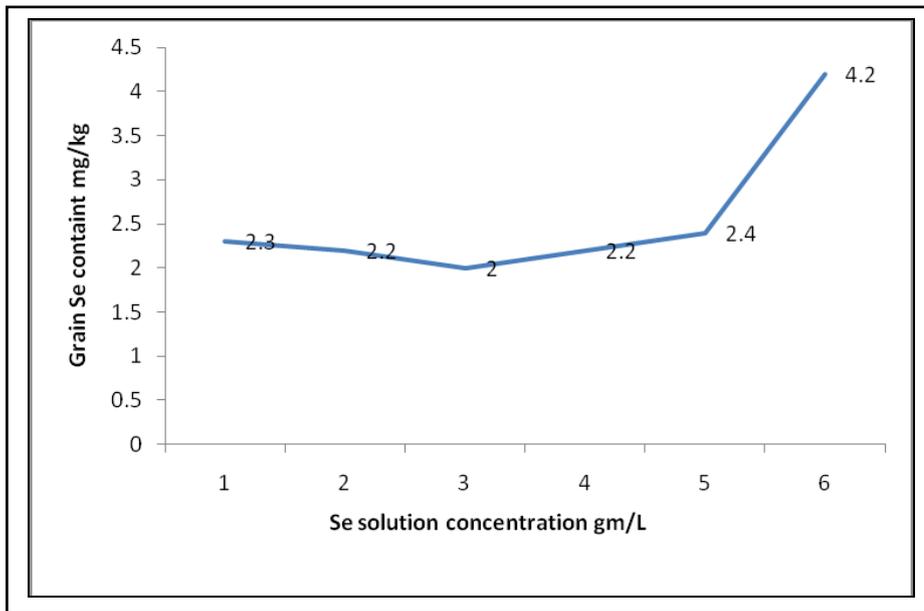


Figure (1). Grain se contain different level of selenium solution

Biomass yield

Biomass yield have been increased but not significantly affected by selenium foliage feeding Figure 2. It is worth mentioning did not show negative impact due to toxicity and a little bit increasing may be caused by improving physiology status [16,17,18]. Moreover, positive impact of Se on changes in the activity and permeability of the cellular membrane has been found to improve cell growth [19]. Root system minerals absorption increased by Se fertilization resulted growth vegetation got better [5] Figure 2.

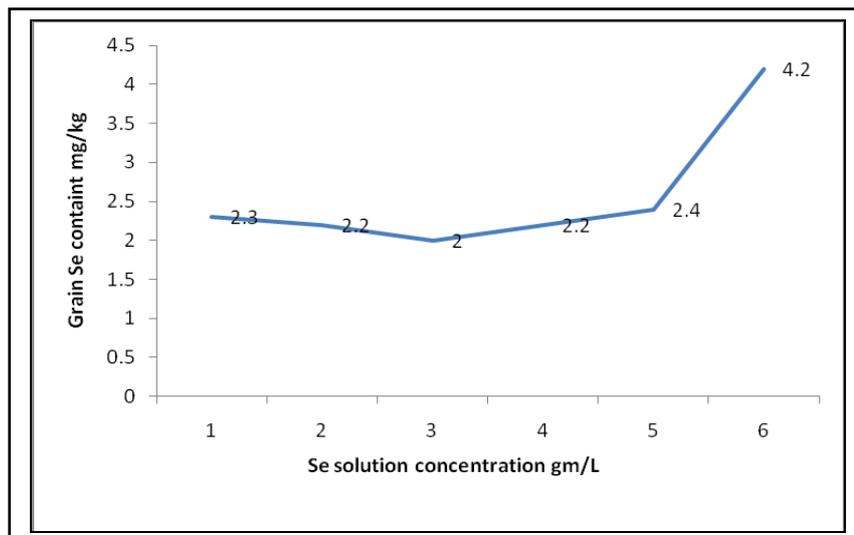


Figure (2). Effect of Se concentration on biomass yield

Conclusions

The concentration of selenium in wheat grain was increased by foliage feeding selenium concentration rate. Increased selenium feeding did not increase biomass yield significantly while grain yield increased significantly. which due to increase in spike no. per m², grain no. per spike and 1000 grain wt. therefor Se foliage feeding can be used to increase the concentration of Se of wheat grain and grain yield with in applied levels in addition to biofortification which have done by foliage feeding, Plants breeders may use genetic variations within wheat varieties for Se accumulation ability to improve Se grain content.

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