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Investigation of selenium fertilizer different rates on uptake of selenium in alfalfa plant

Hadi Chamheidar [*,1], Kamran Parvanak [2]

[1]*Department of Soil Science, Shoushtar branch, Islamic Azad University, Shoushtar, Iran*
[2]*Department of Soil Science, Yadegar-e- Imam Khomeini(RAH), Shahre-rey Branch, Islamic Azad University, Tehran, Iran.*

Abstract: One of the crucial elements for livestock and human nutrition is selenium and its deficiency or toxicity can harm human and livestock health. The present study is designed with the aim of studying the effect of different levels of selenium fertilizers (Selcote-Ultra) on the uptake of selenium in alfalfa. For this purpose, a pot experiment with complete randomized block design in the form of a factorial experiment was carried out on a single soil sample with the cultivation of *Medicago sativa* (alfalfa), five levels of selenium fertilizer (0, 5, 10, 20 and 40 g ha^{-1}), and with three replications during the 2012-2013. Plant was harvested at the height of 20 cm in three turns and after preparation the plant samples, their selenium uptake was measured. The result of means comparison showed that the uptake of selenium during three harvests was affected by different levels of selenium fertilizer. With increasing selenium rates, selenium uptake in the plant aerial parts in all three harvests raised significantly ($p<0.05$). Selenium uptake for the cattle in all treatments except for the control treatment in all three harvests was in the optimal range, therefore the treatment of 5 g ha-1 selenium could be used as a suitable treatment for providing cattle and human demands with selenium, because its application is more economical in comparison to treatments of 10, 20, and 40 g ha^{-1}.

Key words: Selenium fertilizer; Uptake; Medicago sativa

1. Introduction

Selenium is among elements which its deficiency or toxicity in diets can lead to many problems for the cattle and consequently for human. Selenium is found in forms of mineral and organic in soils. Thus selenium status in soil and its uptake by the plant, particularly forage, is highly prominent. Although the essentiality of selenium has been known for five decades, the most effective method of selenium delivery to cattle for optimum performance is still being investigated. Several means of administering selenium to deficient ruminants are available (Surai, 2006). Agronomic biofortification is defined as increasing the bioavailable concentrations of essential elements in edible portions of crop plants through the use of fertilizers. The potential for using Selenium-containing fertilizers to increase forage Selenium concentrations and, thus, dietary Selenium intake has been demonstrated in Finland, New Zealand, and Australia where it has proven to be both effective and safe (Whelan *et al.,* 2004; Broadley *et al*., 2006). Soil selenium content varies considerably depending upon geographic location. Low soil pH and high concentrations of sulfur and phosphorus from fertilization decrease selenium availability for plants. Leaching from the topsoil in areas of high rainfall or irrigation also lowers forage selenium content. Plant species also differ in their ability to incorporate selenium from soil. Most forage plants are categorized as non-selenium accumulator plants (Hall, 2013). Selenium content in soils and plants is various due to parent materials origin, climate, and vegetation type. Selenium content in all soils varies from 500 mg kg^{-1} in an organic material-rich soil to less than 0.1 mg kg^{-1} in soils poor in organic material (Wells, 1997). One of the strategies to eliminate difficulties that induced by selenium deficiency is applying selenium fertilizers. Selcote-ultra is a slow release selenium granular fertilizer containing 1% of selenium that was used mainly for compensating selenium deficiency in forage crops. The selenium fertilizer composition included 90% sodium and barium selenate and 10% sodium and barium selenite. Results by Goupta *et al*., (1982) showed that through applying 2.24 kg selenium in each hectare of the soil in the form of selenate, the remaining effect of selenium lasted for 4-5 farming years for thimothy and 2 years for barley, respectively. Utilizing high concentrations of selenium can lead to decrease in different products performance in given regions of the world. For instance, amounts exceeding 2.5 ppm selenium in soil, reduced wheat and sun flower growth in the soil with a pH of 7.9 in Harilna, India (Singh, 2008). *Medicago sativa* (alfalfa) is a forage crop that is utilized for the cattle ration. This plant has different potentials for selenium uptake. Gizel-Nelson, (1991) grew some farming plants and vegetables in order to measure their difference in selenium uptake in a

* Corresponding Author. Assistant Professor, Department of Soil Science, Shoushtar branch, Islamic Azad University, Shoushtar, Iran.

selenium-rich soil. The results revealed that there was up to 10 times difference in selenium uptake. Watingson, et al, (1997) grew three grass types *Brown top*, *Acroptilon repens* and *Trifolium repens* (White Clover) in experimental farm containing selenium. Plants selenium concentration was 35 ppm for the grasses in 6 harvests and 23 ppm for clover in the first harvest, respectively. However in final harvests the differences were hardly observable. In study carried out by Goupta *et al*., (1992) it was shown than applying 1 to 4 kilograms of selenium per hectare in the form of selenium selenite led to selenium concentration rise up to 37 to 142 ppm in *Medicago sativa* and *Egeria densa* and 8 times increase in *Hordeum vulgare* selenium concentration during the first harvest. The current study is designed with the aim of studying the effect of different levels of selenium fertilizers on the uptake of selenium in alfalfa in order to achieve optimum concentration of selenium in this plant.

2. Materials and methods

A pot experiment with complete randomized block design in the form of a factorial experiment was carried out on a single soil sample with the cultivation of *Medicago sativa* (alfalfa), five levels of selenium fertilizer (0, 5, 10, 20 and 40 g ha^{-1}), and with three replications during the 2012-2013. The soil sample was taken from four points of the farm in depth of zero to 30 cm, and the compound sample was provided after mixing the samples. Average selenium concentration in this soil was 0.4 mg kg^{-1} that was classified as selenium deficient soils.

After being air-dried the taken soil samples was passed through a 2 mm- sieve. 360 kg of the soil was divided into two equal parts and half of it was loaded with cattle manure equivalent to 100 tons per hectare and it was thoroughly mixed with soil. The prepared soils were moved to 15 pots with capacity of 6 kilograms. After having pots prepared, selcote-ultra treatments were placed in center and depth of 10 cm of each pot. Afterwards seeds of alfalfa equivalent to 40 kg per hectare was planted in depth of 3 cm and was irrigated immediately. The pots were transferred to the green house. Next irrigations were daily up to appearance of sprouts, then and during the growing phase they were irrigated every 4 days. Urea fertilizer was added to the pots during two steps; 22 mili ppm at the time of germination and 33 ppm when the vegetation was complete. Also 55 ppm of ammonium phosphate was added to all samples. Generally plants were harvested in three turns. The first harvest was when the plant approached the height of approximately 20 cm. Next harvests were done when the plant reached the height of 20 cm. In each harvest, the aerial parts of the plant was taken from 2 cm height from the soil surface. After getting prepared, the plant samples were moved to paper envelopes and they were dried and weighted in a ventilating oven for 72 hours at 65 ºC. The samples were then powdered by Wiley mill and their selenium concentration was measured by Atomic Absorption Spectrometry (Kopsell *et al*., 1997). Data obtained from each treatment were transferred to excel sheets. The diagrams were plotted using this software. Statistical analysis on data was performed using SAS software and Fisher LSD test at level 5%.

3. RESULTS and DISCUSSION

3.1. The effect of selcote-ultra fertilizer on selenium uptake

The mean comparison of selenium uptake under the effect of different selcote-ultra levels in three harvests is shown in Fig. 1.

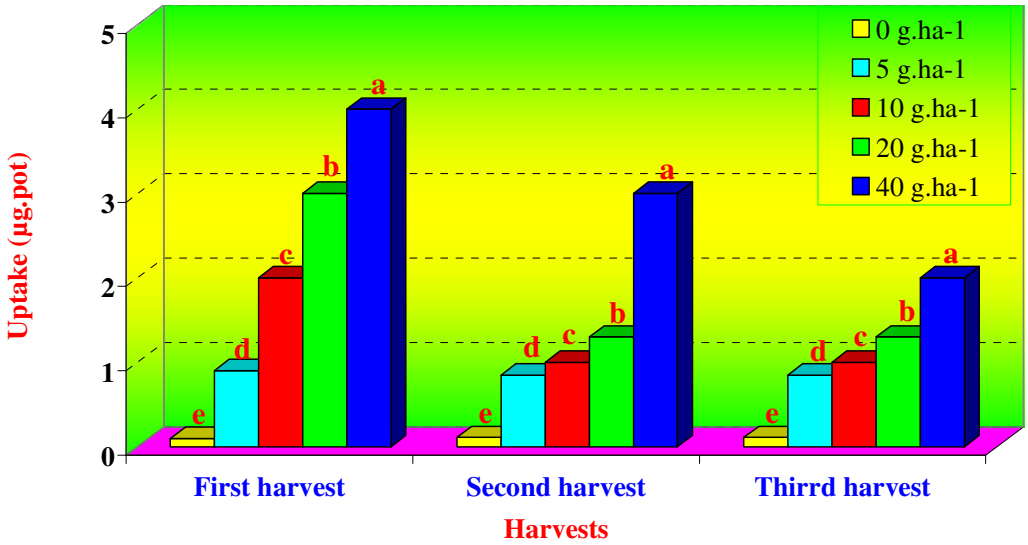

Fig. 1: Mean comparison of the different selenium fertilizer rates on selenium uptake at different harvest turns. (Bars having the same letter are not different at P = 0.05).

As can be observed, with increasing the use of selcote-ultra fertilizer, selenium uptake by alfalfa in three harvests displayed an ascending trend and it was significant (P<0.05). This is also clearly evident in other researcher's works that through planting lettuce in a pot and applying 0.1 and 1 mg selenium per kilogram of soil, selenium uptake of control was 6.24 µg and in 0.1 and 1 mg per kilogram treatment it was 103 and 1150 µg out of each pot, respectively (Hartikainen *et al*., 2000). Through the first harvest to the third, there was a descending trend in plant selenium uptake (Fig. 1). It seems that, the reason for this decrease is due to reduction in fertilizer amount as a result of processes like uptake by the plant, leaching, absorption by microorganisms and their synthetic materials and finally evaporation of its organic forms. However, leaching in this case does not seem that much important since it is a slow releasing fertilizer.

3.2. The effect of selcote-ultra fertilizer on the mean uptake of selenium

The mean comparison of selenium uptake by alfalfa under the effect of selcote-ultra indicated in Table 1. As can be observed, with increasing application of selenium fertilizer, selenium uptake by the plant among control treatment and selenium fertilizer treated samples showed a significant increase (p<0.05). The treatment of applying 40 g selenium per hectare, had the highest uptake and after that were treatments of 20 and 10 g selenium per hectare (Table 1).

Table 1: Effect of selenium fertilizer levels on selenium uptake in alfalfa (µg per pot)

The amount of selcote-ultra (g ha^{-1})	Mean of uptake
0	0.12^{e}
5	0.67^{d}
10	1.50^{c}
20	1.77^{b}
40	2.04^{a}

(Class having the same letter are not different at P = 0.05).

4. CONCLUSION

1. Applying selenium fertilizer led to significantly selenium uptake rise in alfalfa (p<0.05).
2. In next harvests, uptake in the studied plant showed a significant decrease. It seems that the reason for this decrease is decreased amounts of fertilizer as a result of processes like uptake by the plant, leaching, uptake by microorganisms and their synthetic materials and finally evaporation of the fertilizer organic forms.
3. Applying 40 g ha^{-1} selenium in the form of selcote-ultra led to increase selenium uptake in plant, but the obtained uptake did not approach the toxicity threshold for herd of cattle, hence its uptake up to the afore mentioned limit is recommended in this soil.

References

Broadley M.R., White P.J., Bryson R.J., Meacham M.C., Bowen H.C. (2006). Biofortification of UK food crops with selenium. Proc. Nutr. Soc. 65: 169–181.

Gissel-Nielsen G. (1991). Foliar application of selenite to barley plants Low in selenium. Commun. Soil Sci. Plant Anal. 12: 631-642.

Gupta U.C., Kunelius H.T., Winter K.A. (1992). Effect of applied selenium on the selenium content of barley and forages and soil selenium depletion rates. Can. J. Soil Sci. 62: 145-154.

Gupta U.C., Winter K.A., Kunelius H. T. (1993). Effect of treating forage seed with selenium on the selenium concentration of alfalfa and weterwelds ryegrass. Can. J. Soil Sci. 63: 641-643.

Hall J.A., Bobe G., Hunter J.K., Vorachek W.R., Stewart W.C. (2013). Effect of Feeding Selenium-Fertilized Alfalfa Hay on Performance of Weaned Beef Calves. PLoS ONE. 2013; 8:e58188 (a)

Hartikainen H., Xue T., Piironen V. (2000). Selenium as an antioxidant and pro-oxidant in ryegrass. Plant Soil, 225: 193-200.

Kopsell D.A., Williams M., Randle. (1997). Selenate concentration affects selenium and sulfur uptake and accumulation by granex 33 onions. J. Amer. Soc. Hort. Sci. 122(5): 721-726.

Singh M. (2008). Toxicosis in pigs fed selenium-accumulating Astragalus plant species or sodium selenate. Soil Sci. 126: 255-262.

Surai P.F. (2006). Selenium in ruminant nutrition. In: Surai PF, editor. Selenium in nutrition and health. Nottingham: Nottingham University Press, 487–587.

Watkinson J.H., Davies E.B. (1997). Uptake of native and applied selenium by pasture species. I. Uptake of selenium by browntop, ryegrass, cocksfoot, and white clover from Atiamuri sand. N. Z. J. Agric. Res. 10: 116-121.

Wells N. (1997). Selenium in horizons of soil profiles. N. Z. J. Sci. 30: 142-170.

Whelan B.R., Barrow N.J., Peter D.W. (1994). Selenium fertilizers for pastures grazed by sheep. 2. Wool and liveweight responses to selenium. Australian J Agricultural Research, 45: 877–887.