Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 3 [10] September 2014: 82-88

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

ORIGINAL ARTICLE

Study of Zeolite and Humic acid impacts on Cadmium absorption by lettuce plant (*Lactuca sativa* L.)

Shervin Borhan Azad[1], Ali Reza Ladan Moghadam[2], Masoud Mashadi Akbar Boujar[3], Farshid Esmaeili[*4]

[1] Department of Horticulture, Science and research Branch, Islamic Azad University, Tehran, Iran
[2] Department of Horticulture, Garmsar Branch, Islamic Azad University, Garmsar, Iran
[3]Department of Biochemistry, Tarbiat Moalem University, Tehran, Iran
[4] Department of Horticulture, Science and research Branch, Islamic Azad University, Tehran, Iran
Corresponding author: E-mail: farshid212@rocketmail.com

ABSTRACT

Nowadays , the potential dangers and risks of toxic heavy metals existing in water, soil and their entrance to the food chain of human beings and animals upon human , plants and animals is well known. In order to study the rate of Cadmium absorption by lettuce plant, a research was executed in the form of a factorial test and based on a completely randomized plan of 6 treatments. The treatments of this test include Zeolite Clinoptilolite in the three levels zero ,2000, 4000 kg per hectare and Humic acid (from trade resource of American Humax) in the three levels zero,20 and 40 liters per hectare. For cadmium contamination in soil, un amount of 3 mg per kilo of pure cadmium from cadmium nitrate source was added to the soil of the treatments under experiment in an equal range. At the end of experiment, the absorption ratio of cadmium, zinc and nitrogen and also dry weight of aerial organ and root were measured. The results showed that the second level of Zeolite and third level of Humic acid had the minimum cadmium absorption in the plant compared to the control. The maximum rate of nitrogen absorption was seen at the third levels of Zeolite and Humic acid. About the ratio of dry weight of aerial organ and root, the maximum amount of root and leaf dry material was seen at the second treatments of Zeolite and Humic acid. The findings of the research illustrated that application of Zeolite and Humic acid can reduce absorption of the heavy metal of cadmium in lettuce plant and insist on further application of these two elements to improve plants'growth.

***Key words**: lettuce, cadmium, zeolite, humic acid*

Received 02.05.2014 Revised 09.07.2014 Accepted 24.08. 2014

INTRODUCTION

Soil pollution by heavy metals is one of the most important environmental problems in many parts of the world [1]. One of the most important environmental pollutants, are heavy metals and among these metals, cadmium has attracted much attention due to several adverse environmental effects and relatively high mobility in soil-plant systems. Accumulation of these elements in soil, in addition to cause harmful effects on plants and fauna of soil, can enter human organism through plant products and consuming food elements and with the biological half-life of 20 years and accumulation in liver and kidney can cause liver and kidney failure, liver or kidney disease, cardiovascular disease, hypertension, inflammation of the lungs and bone diseases [2]. The most important part of heavy metals 'pollution reported in China is related to cadmium element which has been entered to farm lands through phosphate fertilizers and zinc and lead sources [3]. But, there are materials in the nature that can decrease somewhat these harmful effects of heavy metals to plants that among them zeolite and humic materials can be mentioned.

Zeolites are crystalline solids with tiny pores containing pores and channels with dimensions of 3 to 10 Å and It acts like a molecular sieve and in addition to being moderators to the soil , they can have a nutritive and feeding role and permit plant growth in the agricultural lands with the capacity of low cation due to high capacity of cation exchange and existence of some cations like ammonium in their network [4]. It seems that zeolite can store food elements particularly Ammonium and potassium in reservoir form in its structural canals and give them to the plant progressively [5].

Humic materials consist of complicated combinations of humus, having high molecular weight and high complex producer power as well. These materials have the capacity to complex with various cations and can be used as a storage source of polyvalent cations in the soil [6].The benefits and performance of humic materials can be classified into indirect chemical, physical and biological impacts and direct effects upon biochemical and physiological processes of plants [7].
Considering un paralleled and unique characteristics of organic materials in qualitative and quantitative growth of plants and also due to abundance, low price of natural mineral of zeolite in Iran and with regard to importance of soil pollution issue and the need to conserve soil in order to realize the sustainable agriculture ,the necessity of the present study to examine the impact of zeolite and humic acid consumption upon cadmium absorption in lettuce plant ,one of the most consuming vegetables with leaves in the world, is clear and explicit.

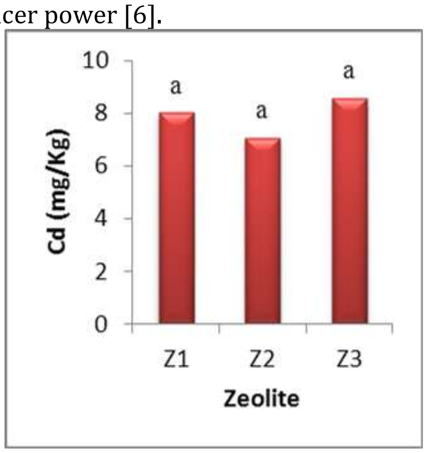
MATERIALS AND METHODS

This empirical plan was performed in a farm located at west of Karaj in the year 2012-2013 and applied from lettuce plant. Zeolite Clinoptilolite was available at 3 levels including 0, 2000 and 4000 kg per hectare and Humic acid at 3 levels including 0, 20 and 40 liters per hectare with 3 repetitions on factorial basis within complete random plan and empirical treatments. Upon disinfection and sterilization of seeds, they wee washed with distilled water and seeds were soaked in water for better germination. In order to culture plant, empirical dividing (agricultural land into patches) was prepared by using monotonous slope and texture of soil and for creation of cadmium pollution as 3ml cadmium in soil, it was applied from cadmium nitrate and empirical treatments. Then the treatments were applied based on dividing (agricultural land into patches) and the ready seeds were grown for culture in soil. Finally the empirical plants were exited from dividing (agricultural land into patches) and the aerial organ of plant was separated from bush. Then the wet and dry weight of serial section of plant and root was written by digital bathroom scale. At next stage, the cadmium, zinc and nitrogen level in root of plant was measured. At the end of experiment, the data analyses were executed using SAS software and Duncan Multi Range Test was used in the probability levels of 1 and 5 % for comparison of the averages.

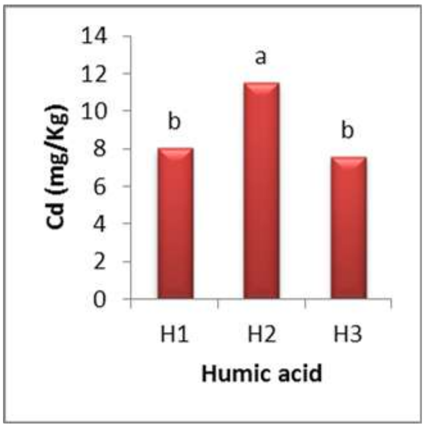
RESULTS AND DISCUSSION

1- Cadmium rate in the plant aerial organ

The graphs 1 and 2 show that the application and use of zeolite in a ratio of 2000 kg per hectare and humic acid in an amount of 40 liters per hectare have caused that the minimum quantity of cadmium absorption in the lettuce plant will be accumulated compared to the control.
Zeolites have tetragonal structures (four atoms of oxygen around a Silicon atom) where there are canals and pores. There is 10 to 20 % of water in these pores . Existence of such structure in zeolites permit them to exchange cations with a capacity between 2/16 to 4/73 meq/g [8] and causes that zeolite is considered as an appropriate absorbent for removing different types of heavy metals. Similarly, Panuccio *et al* [9]also used zeolite for removing cadmium and obtained acceptable results. About humic acid, it may be able to conclude that the higher quantity of this organic material can reduce cadmium accumulation in the plant due to its complex producer power [6].



Graph 1- Effect of zeolite on cadmium absorption by plant aerial organ

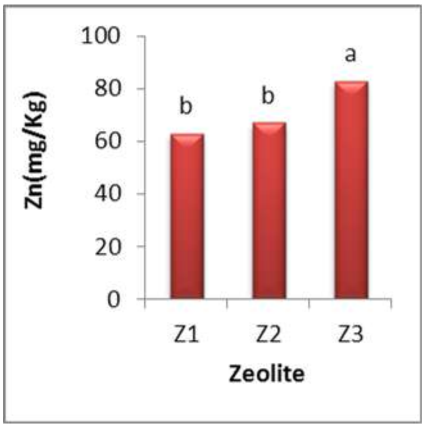


Graph 2- Effect of humic acid on cadmium absorption by plant aerial organ

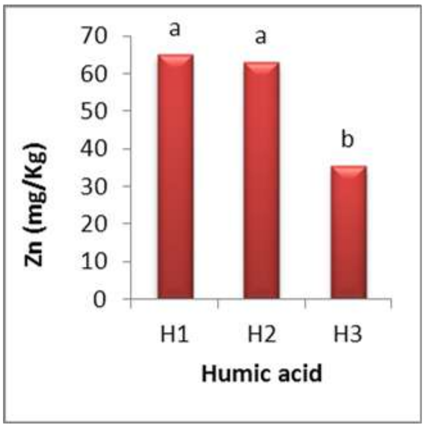
2- The ratio of zinc in the plant aerial organ

The graph No.3 shows that zeolite application caused the increase in zinc density in lettuce aerial organ and more the zeolite consumption increase, more zinc density rises. Of course, this increase was significant on the higher level of zeolite compared to control. This may be due to the high range of this metal in the regional soil.

According to the graph No.4 the minimum ratio of zinc absorption was seen in the treatment of 40 liters per hectare of humic acid. The findings of Asik *et al* [10] has also shown that the use of humic materials in the soil causes the rise in nitrogen absorption as well as the increase of zinc and copper absorption ;in this research higher consumption of this organic material ,the rate of zinc accumulation was reduced in lettuce aerial organ.



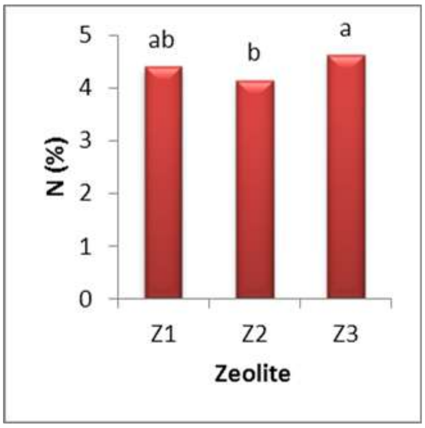
Graph 3- Effect of zeolite on zinc absorption by plant aerial organ



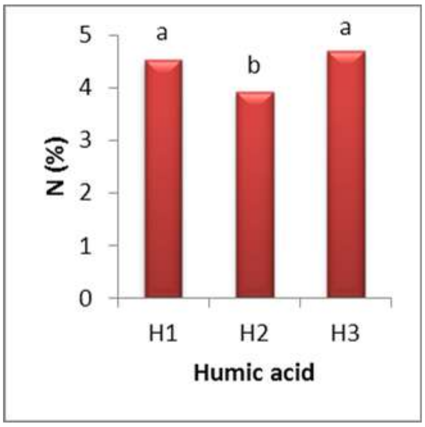
Graph 4- Effect of humic acid on zinc absorption by plant aerial organ

3-The ratio of nitrogen in the plant aerial organ

The graphs nos.5 and 6 shows that the maximum nitrogen absorption is seen in the treated plants with high levels of zeolite and humic acid. It can be stated that zeolites with their crystal structure act like molecular sieve and ammonium ion can enter zeolite pores through appropriate cationic exchange capacity and selected absorption; but the size of such pores and canals are so that prevent nitrifying bacteria to enter zeolite structure .Therefore, the existence of zeolite clinopetilolita in the soil reduce the rate of ammonium conversion to nitrate and as a consequence, nitrogen washing is reduced [11]. On the other part, motivating effects of humic materials have also a direct correlation with the rise of azotes, phosphor and sulfur elements [12]. Researchers like Ayas and Gulser [13] reported that humic acid causes the increase in the growth and height of carrot pant through rise in nitrogen content.



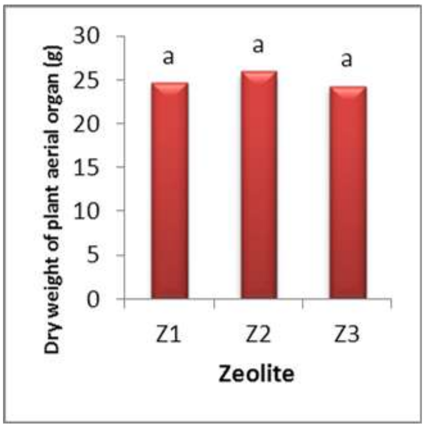
Graph 5- Effect of zeolite on nitrogen absorption by plant aerial organ



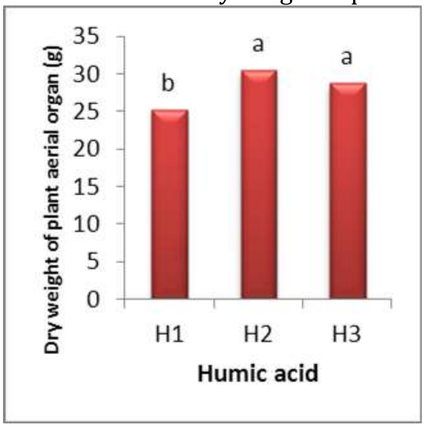
Graph 6- Effect of humic acid on nitrogen absorption by plant aerial organ

4- Dry weight of the plant aerial organ

The graphs nos 7 and 8 show that the second level of zeolite (2000 kg per hectare) and humic acid (20 liters per hectare) have had maximum dry weight of aerial organ compared to control. Gul *et al* [14] studied the impact of different proportions and rates of perlite and zeolite at the lettuce hydroponics cultivation bed and the results showed that weight produced by lettuce at zeolite bed was further than perlite and its weight was increased by rise in zeolite level in cultivation bed. Zeolite can improve water and nutritive elements conserving capacity and product weight and quality due to the high capacity of cationic exchange. Therefore, the result of this experiment illustrates the more and more use of this mineral as a part of cultivation beds. Positive impacts of humic acid on plants growth has been attributed to its direct impact upon plant growth like effects on cellular membrane (leading to treatment of nutritive elements transmission), rise in protein synthesis, hormone-like activity, photosynthesis motivation and effects upon enzyme activity [15]. Accordingly, Vaughan and Linehan proved that low range humic acid consumption had direct and positive impacts upon performance and growth of wheat and also increase of dry and fresh weight of the aerial organs.



Graph 7- Effect of zeolite on dry weight of plant aerial organ

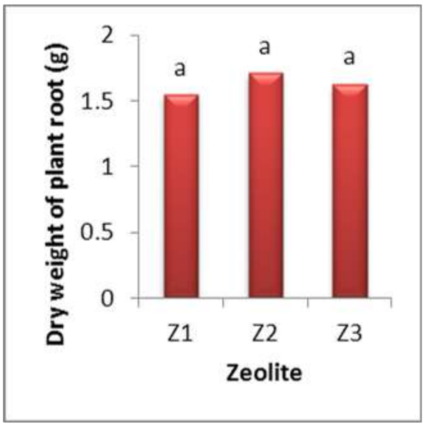


Graph 8- Effect of humic acid on dry weight of plant aerial organ

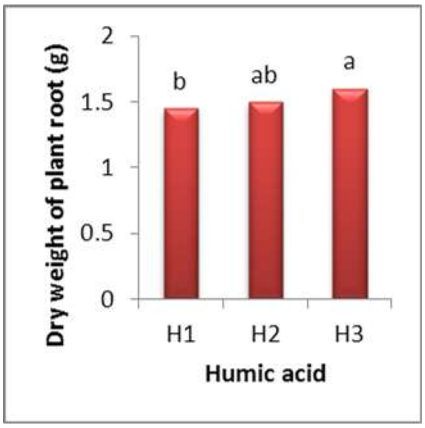
5- Dry weight of the plant root

According to the graphs nos 9 and 10, zeolite and humic acid application has caused that the plants with dry weight have higher root than to control and among these, zeolite second level and humic acid third level show a better situation than double-ionized distilled water.In addition to being moderators to the soil, Zeolite can have a nutritive and feeding role and permit plant growth in the agricultural lands with the capacity of low cation due to high capacity of cation exchange and existence of some cations like ammonium in their network [4]. Therefore, it is not unexpected that we see the dry weight of roots and higher aerial organ in the plants treated with this mineral than double-ionized distilled water. On the other hand, humic acid can also show hormone-like activity and will increase the number of roots and subsequent nutrient uptake and growth [16].

This hormone –like activity leads to an increase in rooting, root biomass and rise in plant growth [17].



Graph 9- Effect of zeolite on dry weight of plant root



Graph 10- Effect of humic acid on dry weight of plant root

CONCLUSION

The results of this research show that zeolite second level and humic acid third level could have minimum ratio of cadmium absorption than double-ionized distilled water. The maximum range of nitrogen absorption was seen in the third levels of zeolite and humic acid. Regarding the rate of aerial organ dry weight and root, the maximum ratio of dry weight of leaves and root,was observed in the second levels of zeolite and humic acid .This results indicate that mineral zeolite and organic materials such as humic acid can play a very effective role in the increase of plants growth and consequently improvement of plants performance. Moreover, these two materials can reduce the absorption of heavy metal cadmium by the plant in the environments polluted by this metal.

REFERENCES

1. Blaster, P., Zimmermann, S., Luster, J. and Shotyk, W. (2000). Critical examination of trace element enrichment and depletion in soils: As, Cr, Cu, Ni, Pb and Zn in Swiss forest soil. Sci. Total. Environ. 249: 257- 280.
2. Mauskar, J. M. (2007). Cadmium –An Environment Toxicant, Central Pollution Control Board,Ministry of Environment & Forests, Govt of India,Parivesh Bhawan,East Arjun Nagar,Delhi-110032
3. Youn-Joo, A. (2004). Soil ecotoxicity assessment using cadmium sensitive plants. Environ. Pollut.127: 21-26.
4. Polat, E., Karaca, M., Demir, H. and Naci Onus, A . 2004. Use of natural zeolita (clinoptilolite) in agriculture. Journal of Fruit Ornam. Plant Research. 12: 183- 189
5. Caballero, R. P., Gil, J., Benitez, C. and Gonzalez, J. L. (2005). The effect of adding zeolite to soils in order to improve the N-K nutrition of olive trees. Preliminary results. American Journal of Agricultural and Biological Sciences. 2: 321-324.
6. Mikkelsen, R. L. (2005). Humic materials for agriculture. Better crops. 89: 45-53.
7. Sangeetha, N., Palani, S. and Ramar, U. (2006). Effect of lignite humic acid and fertilizers on the yield of onion and nutrient availability. 18th word congress of soil science, Philadelphia. Pencilvania, USA.
8. Kocaoba, S., Orhan, Y. and Akyüz, T. (2007). Kinetics and equilibrium studies of heavy metal ions removalby use of natural zeolite. Desalination. 214: 1-10.
9. Panuccio, M. R., Sorgona, A., Rizzo, M. and Cacco, G. (2009). Cadmium absorption on vermiculite, zeolite and pumice: Batch experimental studies. J Environ Manage. 90: 364-374.
10. Asik, B., Turan, B., Celik, M. A. and Katkat, A. V. (2009). Effects of humic substances on plant growth and mineral nutrients uptake of wheat under conditions of salinity. Asian Journal of Crop Science. 4[9]. 20-29
11. Mumpton, F. (1999). La roca magica: Uses of natural zeolite in agriculture and industry. National acad. Sci. 96: 3467-3470.
12. Chien, H. F., Lin, C. C., Wang, J . W., Chen, C. T. and Kao, C. H. (2002). Changes in ammonium ion content and glutamine synthetize activity in rice leaves caused by excess cadmium are a consequence of oxidative damage. Plant Growth Regulation. 36: 41- 47.
13. Ayas, H. and Gulser, F. (2005). The effect of Sulfur and Humic Acid on yield components and macronutrient contents of Carrot. Journal of biological sciences. 5: 801- 804.
14. Gul, A., Erogul, D. and Ongun, A. R. (2005). Comparison of the use of zeolit and perlite as substrate for crisp-head lettuce. Elsevier. Scientia Hort. 106: 464-471.
15. Khaled, H. and Fawy, H. A. (2011). Effect of Different Levels of Humic Acids on the Nutrient Content, Plant Growth, and Soil Properties under Conditions of Salinity,Soil & Water Res. 1: 21–29.
16. Alvarez, R. and Grigera, S. (2005). Analysis of soil fertility and management effects on yields of wheat and corn in the rolling Pampa of Argentina. J. Agron. Crop Sci.191: 321-329.
17. Bachman, G. R. and Metzger, J. D. (2008). Growth of bedding plants in commercial potting substrate amended with vermicompost. Bioresource Technology.99: 3155-3161.

Citation of This Article

Shervin Borhan A, Ali R L M, Masoud M A B, Farshid E. Study of Zeolite and Humic acid impacts on Cadmium absorption by lettuce plant (*Lactuca sativa* L.). Bull. Env. Pharmacol. Life Sci., Vol 3 [10] September 2014: 82-88