Enhancing on the Mineral Elements of Exposure to Magnetic Field in Plants Leave

Abdelaziz A.M. El Shokali[1,2], Abdelrazig M. Abdelbagi[1,3,*] and M.D. Abdallah[4]

[1]Physics Department, Science College, Shaqra University Da wadami, P.O. Box 33, Code 11911, Kingdom of Saudi Arabia

[2]Physics Department, Education College, Sennar University, Sennar, Sudan

[3]Omdurman Islamic University Faculty of Science, Box. 832, Omdurman, Sudan

[4]Department of Physics, Sudan University of Science and Technology, Khartoum, Sudan

Abstract: The aim of this work was investigating the accumulation of the element's contents in plant leaves using magnetized and non-magnetized water for irrigation. Sunflower and tomato were irrigated using magnetized water conducted with magnetic field in the range of 250 mT and irrigate with normal water for comparison in an open land. The measurement of elements was performed using atomic absorption spectroscopy to identify the levels of Calcium, Iron, Potassium and Zinc in the leaves of the plants under survey. The results are evaluated using different statistical methods from data obtained to assess the levels of elements enhanced in these leaves. The leaf elements quantity in plants treatment with a magnetic field has a significant impact on plant yield and food quality.

Keywords: Magnetic field, water irrigation, elements, leaves, atomic absorption.

INTRODUCTION

The magnetic field is important a physical factor that originates in the molten core of the earth, which is appearing in electrical current measurement and compasses for system navigation. However, the magnitude is changed due to the depth from the surface of the earth wanders widely over all surfaces. The earth's magnetic field has reversed the direction of the poles periodically and during the 71 million years changed 171 times. The magnetic field of the earth is inclined 11 degrees and varies relative to the rotation axis of the earth and the direction vertically inclined to the north and south poles, whoever is parallel to the equator region [1]. The presence of earth magnetic field (geomagnetic field) is created from earth's interior in the range of 25 to 65 μT that affecting the germination of the plant growth, (Faten Dhawi, 2014). Sun is generated a polar field and that reverse the polarity every 11 years, which are turned out sunspots rose and fell during periodic cycles. The solar wind is affected the geomagnetic field due to the rotation of the planet and that changes with respect to the time. The violent storms cause by the variation of the sun's output is changing the flux density of the geomagnetic field and the magnitude of the magnetic field on the surface of the earth. Solar plasma during sunspots field produced motion of the electric conductor and that is followed simultaneously by creating a magnetic storm disturbed frequency magnetic field during the years. The magnetic field fluctuations are reached the earth's surface and that direct effect on the growth of plants and animals.

The magnetic field strength in the range of 35 to 70 μT magnitudes or twice is affecting the metabolism and plant growth, (Galland & Pazur, 2005; Racuciu, 2011; Shine *et al*., 2011) [2,3]. Two types of magnetic field can be used for water treatment, so that a static magnetic of constant induction and the other an alternating magnetic of oscillating pulse magnetic influences are used for plants treatment and that can create a positive effect on plant growth, (Aguilar *et al*., 2009), (Racuciu, 2011), (Bilalis *et al*., 2011) (Galland & Pazur, 2005) [4].

Influence of magnetic treatment of water and plant is depending on duration, strength of magnetic field and magnetic induction expression [5]. Magnetic field effect on the water is used for several applications in different fields (Kobe *et al.*) [6]. The magnetic field accelerates the crystallization of solubility of carbonates and phosphates. A double ionic layer molecules are induced by a magnetic field and that disturbs the colloidal particles and zeta potential (Parsons *et al.*) [7].

A water molecule is affected with a magnetic frequency and that leads to increase of magnetic susceptibility of water from a negative to positive which to be positive in the range of 0.4 to 1 MHz, [8]. The

*Address correspondence to this author at the Physics Department, Science College, Shaqra University Da Wadami, P.O. Box 33, Code 11911, Kingdom of Saudi Arabia and Omdurman Islamic University Faculty of Science, Box. 832, Omdurman, Sudan; Tel: 00966532801293; E-mail: razig2000@hotmail.com

ISSN: 1814-8085 / E-ISSN: 1927-5129/15

magnetic field boost on water that conducts in a diamagnetic compound and the other content of water are para and ferromagnetic diamagnetic metals and non-metals and the plants metabolism contains 90 to 95%, (Charan, 2009) [9]. However, the magnetic field treatment of water molecules effect on water uptake and photosynthesis of those lead to increase plant metabolism, plants yield and productivity, (Yano *et al*., 2004), (Basant and Harsharn, 2009) [10].

The polarization of atoms of water is arranged with magnetic field displacement which leads to change water properties [11]. Thus, the magnetic field has caused changes in water molecule size due to the extra hydrogen bonds formation and relative to exposure time and that cause increase of viscosity and decrease in surface tension of water, Cai *et al*., Fujimura and Iino [12, 13]. The magnetic force is affecting on water molecule and disturbs dehydration phenomena by changing the orientation of the molecules (Gabrielli *et al.*) [11]. Consequently, magnetic field accelerates the metabolism positively and provides a better growth of the plant. Utilization of magnetic field in irrigation is improving the shoot development and shoot length of maize, which is led to increasing germinating energy and germination of plants (Aladjadjiyan, 2002) [14]. The treatment of water with a magnetic field used for irrigation has a significant effect on plant growth, when compared with normal water (Bogatin) [15].

The magnetic field treatment has an impact on water atoms and that increasing the electric potential, which is increasing the element uptake [14]. Calcium is involved in considerable growth process in plants, so that a magnetic field increases Ca accumulation in the plants by changing ions and major regulation reactions [16, 17]. Therefore, the magnetic field in the range 10-100 mT (50-60 Hz) is capable to modify ion movement and change plasma membrane, [18]. The previous study of using magnetic field of increased membrane permeability and that lead to increasing elements N, K, Ca, Mg, Cu, Fe, Mn, Na and Zn concentration in strawberry leaves (Fragaria xananassa) [19].

The elements are accumulated in plants using magnetic field and that differ significantly in each plant and some different parts of the plant, while affect increase of elements Mg, Fe and Cu in grain and the P, Ca, K and Zn content of straw were noticed [20, 21].

It has been shown that positive effect on magnetic field treatment was increased the germination of fresh and dry onion and rice, (Alliumcepa L, Oryza. sativa L) [22]. Moreover, the presence of the magnetic field has a strong influence on the increasing sunflower length and mass of growing seeds (Helianthusannuus L.) [7], in addition of the positive effect of tomatoes (Pisumsativun) [23]. Investigation and measurement of the experiment show the plant's roots and leaf sizes and thickness were affected by magnetic field exposure times and the increasing magnetic field intensities, (Azita Shabrangi1 and Ahmad Majd, 2009) [24, 25]. Elements Ca, K, Fe and Zn under investigation from the group four in the periodic table from cations, which are positive, charge elements moved in the direction of the magnetic force (Amer *et al.,* 2006), [26].

MATERIALS AND METHODS

In order to evaluate the effects of magnetic field on plants tomato and sunflower irrigation with magnetized water was compared to non-magnetized, where the environment of the area is customarily used for these types of agriculture products. The location of the arid area at the Nile shore is lies in co-ordinates of (E 33.57 longitudes - N 13.568 latitudes) in the Sennar district in central Sudan. The experiment was established for both methods in the same region during the winter season, where the climate a semi-sub-Saharan is moderately cooled.

This experiment was made on research farms in double lands similar in dimension of 24 meters square of each. Subsequently, the soil is clay loam with a sand mixture that adequate for plant germination. The irrigation of the lands was done in an interval of four days of using flood irrigation system techniques according to the plants needed in an open land.

The method of planting was conducted under traditional agriculture technique and texture of the upper surface layer prepared due to a local schedule system. Both lands of magnetized and non-magnetized water were used for irrigation and the plant growth condition without fertilizer application and with no pesticides used. Water irrigation system was circulated in a stationary radial static magnetic field for magnetized water techniques using a nozzle system tube that flow from the same source for all plants. The flow rate of irrigation and the quantity of water was controlled to sustain a suitable amount for irrigation to prevent water wilting and kept soil moisture to an acceptable level relative to the nature of the plant.

Samples of leaves were collected manually from the plants (sunflower, tomato) during cultivation operation period in the session. Leaves samples solution was prepared by using a mixture of nitric acid (HNO_3) with hydrogen peroxide (H_2O_2) (Samanta *et al*., 1999; Chen *et al*., 1999; Puchyr *et al*., 1998). Sample solution of each element was prepared in a different amount and appropriates concentrations, in addition to similar standards from the same elements and series of quantities for concentration adjustment. The element standards solution was prepared using 0.5N HCL and comparable to samples solvent to avoid the physical interference. Measurement of Ca, K, Fe, and Zn determination was performed using atomic absorption spectroscopy.

RESULTS AND DISCUSSION

The experimental analysis of plant elements Ca, K, Fe and Zn contents in leaves were treated with magnetized water compared to the plants in analogous environments irrigated with normal water for a method validation. Figure **1** shows the variation of element K and Ca content in leaves of sunflower and tomato was irrigated with both methods of irrigation. Ca and K concentration in leaves of sunflower and tomato were irrigated with magnetized water is higher compared to content of normal water. Figure **2** is demonstrated the elements Fe and Zn levels in the leaves of sunflower and tomato irrigated with both methods. The result of Fe and Zn concentration higher in leaves of sunflower and tomato was irrigated with magnetized water than normal water. Figure **3** is illustrated the percentage differences in elementary levels increasing of element contents in the leaves of the plants under investigation.

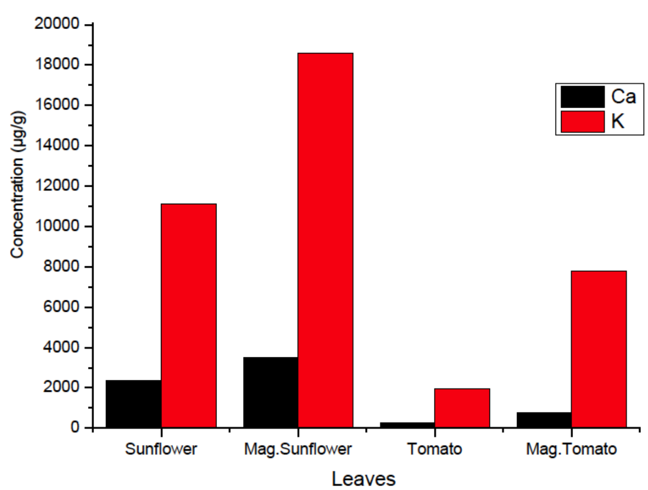

Figure 1: Average Ca and K concentration in plants leaves using magnetized water and normal water.

The data of an element contained in the leaf of the sunflower and tomato irrigated with magnetized water

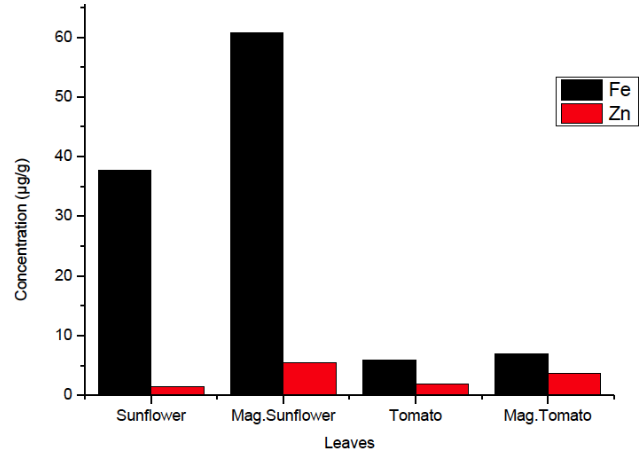

Figure 2: Average Fe and Zn concentration in plants leaves using magnetized water and normal water.

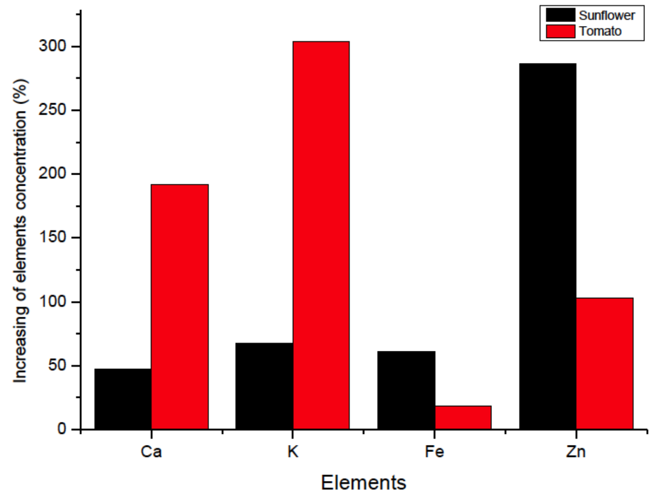

Figure 3: The difference in elements concentration between plants irrigated with magnetized and normal water.

and irrigation with normal water in tables are explained evaluation of a variety of elements using a statistical method. In Table **1** the result illustrates the difference between elements in the leaves of sunflowers and tomato, which shows the changes of communalities extraction. The competent matrix and component rotated matrix extraction of the elements Ca and K are revealed low quantity of leaves irrigated with magnetized water than normal water. Results are specified that these elements of initial Eigenvalues show significant differences between the leaves of sunflower and tomato using both methods of irrigation.

The assessment of the results in a Table **2** presents differently in communalities extractions and low value of the component matrix and rotated component matrix of Fe and for Zn element. The subtle variation of the leaves content is indicated one component in component matrix for Zn, so that no rotation exists. The

Table 1: Calcium and Potassium Statistical Assessment in Plants Leaves

Extraction Method: Principal Component Analysis.		Component Matrix[a]		Rotated Component Matrix[a]		Component	Initial Eigenvalues	
Elements In plants leaves	Communalities Extraction	1	2	1	2		Total	% of Variance
Ca-sunflower	.552	.710	-.218	.577	-.469	1	1.199	29.985
Ca-tomato	.590	.657	.398	.758	.123	2	1.034	25.848
Ca-magnet sunflower	.254	.462	.202	.504	.015	3	.954	23.854
Ca-magnet tomato	.838	-.225	.887	.123	.907	4	.813	20.313
k-sunflower	.721	-.745	-.407	-.844	.092	1	1.523	38.082
K-tomato	.727	-.141	.841	.190	-.831	2	1.220	30.498
K-magnet sunflower	.627	.553	-.567	.295	.735	3	.699	17.467
K-magnet tomato	.668	.801	.161	.802	.157	4	.558	13.953

Table 2: Iron and Zinc Statistical Assessment in Plants Leaves

Extraction Method: Principal Component Analysis.		Component Matrix[a]		Rotated Component Matrix		Component	Initial Eigenvalues	
Elements In plants leaves	Communalities Extraction	1	2	1	2		Total	% of Variance
Fe-sunflower	.731	.824	.228	.854	-.023	1	1.489	37.234
Fe-tomato	.682	-.132	.815	.112	.818	2	1.300	32.511
Fe-magnet Sunflower	.709	.808	.238	.842	-.009	3	.681	17.024
Fe-magnet tomato	.668	-.376	.726	-.147	.804	4	.529	13.231
Zn-Sunflower	.731	.697	*	*	*	1	1.846	46.151
Zn-tomato	.682	-.834	*	*	*	2	.973	24.318
Zn-Mag. sunflower	.709	.757	*	*	*	3	.760	18.996
Zn-magnet tomato	.668	-.303	*	*	*	4	.421	10.534

consequence of initial Eigenvalues shows significant variation of elements in the leaves contents of magnetized water is compared to the normal water irrigation.

CONCLUSION

In conclusion, we observed that high enrichment of elements concentration in the leaves of the plants under a magnetic field influence on both sunflower and tomato indicated substantial impact on plant growth. The assessment of elements Ca, K, Fe and Zn in leaves are showing a significant difference in concentration, which can be assigned a definite indication of an improving quality of the growth of the plants using magnetized water. The result is judged by means of statistical data to confirm the stability of the element uptake in plants and a better growth of plants irrigated *via* a magnetic field. Irrigation with magnetized water can be considered an important technique to enhance the growth of plants and increased the accumulation of elements in the plants which lead to improving the quality of food.

REFERENCES

[1] Dhawi F. Why magnetic fields are used to enhance a plant's growth and Productivity. Annual Research & Review in Biology Sciencedomain International 2014; 4(pt.6): 886-896.

[2] Sadeghipour O, Aghaei P. Improving the growth of cowpea (Vignaunguiculata L. Walp.) by magnetized water. Journal of Biodiversity and Environmental Sciences 2013; 3(pt. 1): 37-43.

[3] El Sayed H, El Sayed A. Impact of magnetic water irrigation for improvethe growth, chemical composition and yieldproduction of broad bean (Viciafaba L.) Plant. American Journal of Experimental Agriculture, Sciencdomain International 2014; 4(pt.4): 476-496.

[4] Nagy I, Georgescu R, Balaceanu L. *et al*. Effects of pulsed variable magnetic fields over plant seeds. Romanian Journal of Biophysics 2005; 15: 133-139.

[5] De Souza A, García D, Sueiro L, Licea L, Porras E.. Pre-sowing magnetic treatment of tomato seeds: effects on the growth and yield of plants cultivated late in the season. Spanish Journal of Agricultural Research 2005; 3(pt.1): 113-122. http://dx.doi.org/10.5424/sjar/2005031-131

[6] Dhawi F, Al-Khayri JM. Magnetic fields induce changes in photosynthetic pigments content indate Palm (Phoenix dactylifera L.) Seedlings. The Open Agriculture Journal 2009; 3: 1-5.

[7] Goodman EM, Greenebaum B, Marron Michael T. Altered protein synthesis in a cell-free system exposed to a sinusoidal magnetic field. Biochimica Biophysica Acta 1993; 12(pt.2): 107-112. http://dx.doi.org/10.1016/0167-4838(93)90070-8

[8] Huang H-H, Wang S-R. The effects of 60Hz magnetic fields on plant growth. Nature and Science 2007; 5(pt.1): 60-68.

[9] Cai R, Yang H, He J, Zhu W. The effects of magnetic fields on water molecular hydrogen bonds. Journal of Molecular Structure 2009; 938: 15-19. http://dx.doi.org/10.1016/j.molstruc.2009.08.037

[10] Rawabdeh H, Shiyab S, Shibli R. The effect of irrigation by magnetically water on chlorophyll and macro-elements uptake of pepper (Capsicum annuum L.) Jordan. Journal of Agricultural Sciences 2014; 10(pt.2): 205-214.

[11] Pang XF, Deng B. The changes of macroscopic features and microscopic structures of water under influence of magnetic field. Physica B 2008; 403: 3571-3577. http://dx.doi.org/10.1016/j.physb.2008.05.032

[12] Fujimura Y, Iino M. Magnetic field increases the surface tension of water. Journal of Physics Conference Series 2009; 156: 12-28. http://dx.doi.org/10.1088/1742-6596/156/1/012028

[13] Ijaz B, Jatoi SA, Ahmad D, Masood MS, Siddiqui S. Changes in germination behavior of wheat seeds exposed to magnetic field and magnetically structured water. African Journal of Biotechnology 2012; 11: 3575-3582.

[14] Aladjadjiyan A. Study of the influence of magnetic field on some biological characters of Zeamais. Journal of Central European Agriculture 2002; 4: 90-94.

[15] Ahmad M, Galland P, Ritz T, Wiltschko R, Wiltschko W. Magnetic intensity affects cryptochrome–dependent responses in Arabidopsis thaliana. Planta 2007; 225-615. http://dx.doi.org/10.1007/s00425-006-0383-0

[16] Belyavskaya NA. Biological effects due to weak magnetic field on plants. Adv Space Res 2004; 34: 1566-1574. http://dx.doi.org/10.1016/j.asr.2004.01.021

[17] Ayrapetyan SN, Grigorian KV, Avanesian AS, Stamboltsian KV. Magnetic fields alter electrical properties of solutions and their physiological effects. Bioelectromagnetics 1994; 15: 133-142. http://dx.doi.org/10.1002/bem.2250150205

[18] Stange BC, Rowland RE, Rapley BI, Podd JV. ELF Magnetic field increase amino acid uptake into Viciafaba L. roots and alter ion movement across the plasma membrane. Bioelectromag 2002; 33: 347-354. http://dx.doi.org/10.1002/bem.10026

[19] Esitken A, Turan M. Alternating magnetic field effects on yield and plant nutrient element composition of strawberry (Fragaria x ananassa cv. Camarosa). Acta Agric Scand Sect B Soil and Plant Sci 2003; 54: 135-139.

[20] Çelik Ö, Atak Ç, Rzakulieva A. Stimulation of raped regeneration by a magnetic field in Paulownia node cultures. Journal of Central European Agriculture 2008; 9(pt.2): 297-304.

[21] Shabrangi A, Majd A. Effect of magnetic fields on growth and antioxidant systems in agricultural plants, PIERS Proceedings, Beijing, China 2009; 1142-1147.

[22] Alexander MP, Doijode SD. Electromagnetic field, a novel tool to increase germination and seedling vigour of conserved onion [Allium cepa L.] and rice (Oryza. sativa L.) seeds with low viability. Plant Genetic Res Newsletter 1995; 104: 1-5.

[23] Bilalis DJ, *et al*. Magnetic field pre-sowing treatment as an organic friendly technique to promote plant growth and chemical elements accumulation in early stages of cotton. Australian Journal of Corp Science 2013; 7(pt.1): 46-50.

[24] Boe AA, Salunkhe DK. Effect of magnetic fields on tomatoes ripening. Nature 1963; 199: 91-92. http://dx.doi.org/10.1038/199091a0

[25] Subber ARH, AbulHail RC, Jabail WA, Hussein HF. Effects of magnetic field on the growth development of Zea mays seeds, Scholars Research Library. J Nat Prod Plant Resources 2012; 2(pt.3): 456-459.

[26] Mahmoud H, Qados AMSA. Magnetic water application for improving wheat (Triticumaestivum L.) crop production. Agriculture and Biology Journal of North America, Science-Huβ 2010; 677-682.

Received on 15-04-2015 Accepted on 15-06-2015 Published on 30-07-2015

http://dx.doi.org/10.6000/1927-5129.2015.11.62