The Effect of Magnetically treated Water on the Germination and Growth of a Local variety of millet *Pennisetum glaucum*

Abdulrahman Saeed Al-Hajar and Halimah Omar Al-Khallaf

Department of Biology, Faculty of Sciences, King Abdulaziz University, Jeddah. Kingdom Saudi Arabia
e-mail: halkhallaf@kau.edu.sa

Abstract: The present study aimed to study the effect of magnetically-treated water on the germination and growth of (Pennisetum glaucum), which is rich in nutritional and medical terms in order to produce a good quality and quantity of this plant in the shortest possible time. Additionally, to reduce the use of chemical fertilizers that will be reflected on the human being & environment health in general. The study was carried out using 15 cm high and 48.5 cm diameter plastic bottles filled with soil made of sand and Betemus mixture (2: 1), then millet seeds were planted and placed in a wire mesh under the normal conditions of Jeddah. The experiment was based on 4 harvesters, the first one after two weeks (for shoots), the second after 4 weeks (for vegetative growth), the third after 8 (for flowering) and the fourth after 12 (for fruiting). The parts were then divided into two main groups: the first was treated with magnetically treated water (MTW) and the second was irrigated with normal water (NW) at the field capacity. Some mineral elements, pH and electrical conductivity of the soil extract were estimated before and after planting. It was observed that some of the elements in the soil irrigated with treated water were higher than the normal irrigated ones. The measurements were made for the plant. The total height of the vegetative and it's wet and dry weight and the depth of the root total wet and dry weight and size, measuring the area of the paper and others. The study also included biochemical measurements such as the estimation of chlorophyll A, B and carotenoids in addition to the estimation of some elements and starch estimation. The results showed that the use of magnetically treated water plays an important role in improving the properties of the soil, raising the quality of the plants and increasing the production of the plants.

[Abdulrahman Saeed Al-Hajar and Halimah Omar Al-Khallaf. **The Effect of Magnetically treated Water on the Germination and Growth of a Local variety of millet *Pennisetum glaucum*.** *Life Sci J* 2018;15(5):16-28]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 4. doi:10.7537/marslsj150518.04.

Keywords: magnetically treated water, magnetized water, magnetized water, millet, pearl millet.

1. Introduction

Many research studies conducted in specialized scientific centers have confirmed that many of the problems that humanity suffers today, whether in food, health or water, are closely related to the change in the level of strength of cosmic magnetic fields (Kutbi, 2007). It has been observed that all living organisms ranging from bacteria to mammals undergo significant changes if there is a change in the magnetic field around them (Dandesh, 2004). Magnetism is one of the mysteries of life that God has deposited on the planet. The magnetic field of our planet arranges the molecules and atoms of all the beings on it from solids, liquids and gases (al-Bashir, 2004). Magnetic energy plays a pivotal role in shielding the cosmic rays And X-rays to the Earth's surface by means of a protective magnetic layer called a magnetosphere that surrounds the atmosphere (Suwaidan, 1997). Magnetic fields have a direct impact on biological systems. They play an important role in regulating the vital functions of living organisms. Moreover, it is interesting to know that the land on which all organisms reside is itself a natural magnet (Moon and Chung, 2000) The magnetic field of the Earth and its effects extend to several kilometers around the Earth as it extends to the inside, and the intensity of its effect varies from place to place is strong ratios In the polar region of the Earth and gradually fade as we move towards the equator areas (Dandesh, 2004). It has been scientifically proven that magnetic fields also affect water. For many years, water magnetization technology has been used mainly in some industrialized countries such as Russia, Poland, China and Bulgaria, all of which have demonstrated the effectiveness of magnet use in water treatment for industry, irrigation and domestic use (Hozayn and Abdul Qados, 2010). Water can acquire magnetic energy and hold it for 24-48 hours. The energy gained is strongly related to the magnetic field being exposed, the water flow velocity and the time of exposure (Hilal, 2004). Thus, the magnetically treated water (MTW) (Nora et al., 1996; Tierra, 1997; Noran et al., 1996); and water retention continues for a period of up to 200 hours and this phenomenon is called The effect of memory (Holysz et al., 2007) has been found to have several properties that change in water after passing through the field (Colic and Morse, 1999; Coey and Cass, 1999); and (3) the effects of water vaporization on the surface of the water The values of some of the properties of PMM are also increasing and some are decreasing. For example, surface tension is found to decrease by the frequency of water exposure to magnetic fields (Cai et al., 2009; Mousa and Hmed, 2008; Amiri and Dadkhah, 2006). This allows for rapid melting and transfer of nutrients, and it is observed that viscosity is significantly lower than normal water viscosity (AL-Talib and AL-Sinjary, 2009 Ibrahim, 2006) Water for magnetic fields. It was found that the magnetic treatment of saline water reduces salinity (AL-Qahtani, 1996) where there was a decrease in salt concentration in the samples that were treated magnetically. The magnetic field affects the shape of the water molecules and makes them go in one direction and the contact angles between them (2008 Xiao-Feng and Bo). Thus, this type of arrangement reduces the level of correlation between the molecules on the one hand and leads to a decrease in particle sizes On the other hand and allows to change many of the natural characteristics. Water-based technology has attracted scientists and researchers because of its many advantages. It is safe and hygienic from the environmental point of view and is simple, uncomplicated and low-cost (Tahir and Karim, 2010). In addition, it has important applications in environmental, Different. From the environmental point of view, MTW has increased the germination rate of many plants and has gained resistance against diseases, as well as having an important role in the reclamation of soils, resulting in an increase in production (Saeed, 2007). Irrigation water and found that their use reduces the need for chemical fertilizers and this reflects positively on the environment. The use of this water contributes to a reduction in the amount of industrial detergents, which increases the strength of detergents and solvents to such a degree that it is possible to use one third or one quarter of the amount normally used (Asaf, 2010) and industrial use of this water to remove sediment from industrial boilers (2008 Xiao-Feng and Bo, which increases production on the one hand and reduces the need for frequent maintenance. The use of this type of water also contributes to the reduction of energy consumption required for evaporation in different industrial devices (et al., 2011 Szcześ). This is probably due to the fact that if water is treated magnetically, its evaporation potential increases.

Millet is one of the important summer crops with high productivity, good nutritional value and the common English name of the plant is Millet, a word originally derived from the French word "mille" meaning the thousand because a handful of millet contains thousands of grains. Cereal crops (Chandrasekara, 2013 and Shahidi). Millet is a herbaceous plant belonging to the Poaceae family and has several species, most notably the pearl pennetum Pennisetum glaucum L. The species used for the current study, which can withstand extreme environmental conditions, can grow and thrive despite high temperature, drought and low soil fertility (Andrews and Kumar, 1992; Amer et al., 2012 and Shahidi & Chandrasekara, 2013) found that it can tolerate irrigation for up to 20 days. This is due to the density of its roots and effectiveness, which sometimes reaches a depth of 170 cm. Millet can also grow in saline soils and has been shown to be tolerant of salinity and its ability to follow growth and production well (Hatalani, 1995) and is resistant to diseases and agricultural pests. Millet is grown in several regions of Saudi Arabia, but Makkah, Madinah and Jazan are the most important areas of production, and Jazan is the most productive of all millet at all (Abdali, 2002). As the world is witnessing increased demand for food, especially grain crops, as it is the basis of the food pyramid of humans and is in no way dispensed with. FAO warns in its 2012 report that global food supplies are threatened by falling production and increasing prices during the 10 years In order to link agricultural activity with the urgent need for water, it was necessary for the world to adopt the technologies that support the cultivation of grain crops and help improve their production and improve the quality of water used for irrigation, thus encouraging the application of environmentally friendly technologies. Self-effacement by increasing production and dispensing imported foodstuffs (Al-Balushi, 2006).

2. Materials and Methods

1- Experiment design

A) A well-equipped wire mesh was designed for light and air and suitable for agriculture under the natural conditions of Jeddah city, and plastic seeds were equipped with a suitable number for research. The selected soil was prepared for the cultivation of pearl millet. The experiment was carried out in a suitable period for the cultivation of millet.

B) A sufficient number of millet grains were grown in each pot and the seeds were divided into two main groups. Each group consisted of 15 pots, the first group was fed with normal water, the control group was formed and the second group was treated with magnetically treated water. Each group was divided into four sections. The seed represents 3 replicates and the fifth group is planted as surplus.

Crops were harvested within three months, representing the total period of plant cultivation. Harvest was carried out after 2 weeks, 4 weeks, 8 weeks and 12 weeks.

2 - Method of water treatment magnetically:

The magnetization of water was done using a magnetic device installed on irrigation water pipes from Madaya Industrial Company in the Kingdom of Saudi Arabia

3- Analysis of irrigation water and magnetically treated water:

• pH measurement and electrical conductivity:

The pH of NW and MTW were measured separately using the pH-meter, Mattler MC 235, Toledo. Electrical conductivity was measured in the same water using the EC-meter, Mattler MC 226, Toledo).

• Determination of mineral elements in water:

The mineral elements, micro elements, and MTW were estimated using the Inductively Coupled Plasma Emission Spectrometer (Model variance 735-ES).

4- Analysis of Soil:

• Preparation of soil extract:

Soil Extract was prepared by 5: 1 using electric shaker model (VRN-200, Taiwan).

• pH measurement and soil electrical conductivity:

PH was measured using the pH-meter, Mattler MC 235, Toledo. EC conductivity was measured using EC-meter, Mattler MC 226, Toledo.

5- Morphological Measurements:

• Plant height:

Plant Height was measured by a metric measure from the stem junction region at the root of each treatment in each harvest.

• Root length:

Roots Length was measured by a metrical ruler from the stem junction area at the root to the root end of each treatment in each harvest.

• Root size:

Roots volume was obtained by filling a graduated cylinder with a certain amount of water, then placing the roots inside it, recording the water level, and then calculating the difference between the original size of the water and the new size.

• Leaf area:

The area of the Leaf Area sheets was calculated using the (Larcher, 1995) equation.

Biochemical measurements of the plant Biochemical Measurements:

• Determination of photosynthetic pigments:

The photosynthesis pigments (chlorophyll A, chlorophyll b, carotene) were estimated using (Lichtenthaler, 1987). The amount of dyes extracted using (Spectrophotometer, Model SPECTRONIC 20 GENESYS) at the suitable wavelengths.

• Determination of mineral elements in plants:

Were estimated in the plant after the digestion of plant samples. Both the vegetative and root populations were harvested each time (and millet after the last harvest) separately according to the method (Stewart, 1983). Some mineral elements were then estimated in this extract (magnesium, potassium, iron) using an Inductively Coupled Plasma Emission Spectrometer (Model vararian 735-ES).

• Estimation of Starch:

Starch was estimated in millet grains following the (Nelson, 1944) method. The color density of 650 nm was measured by the Spectrophotometer, Model SPECTRONIC 20 GENESYS. The results were then compared with a standard curve showing the relationship between glucose concentration samples and their light absorption (Naguib, 1964).

6. Statistical Analysis:

The analysis was performed by calculating the mean of the replicates of the results obtained for the two parameters and the standard error was also calculated. Anova analysis was also conducted to find the differences in the probability of less than 0.05 and 0.01 (Gomez and Gomez, 1984) using SPSS version 19.

3. Results

1- Parameters of normal irrigation water NW and magnetically treated MTW:

• pH measurement and electrical conductivity (EC):

Table (1) shows that there is no significant difference between the amount of (EC) in both types of irrigation water, which reached 103 µs / cm in NW and MTW together, and it was noted that the (pH) in NW tends to alkaline at 8.03, 7.59 in MTW which is closer to the equality.

• Estimating the quantity of some metal elements:

Table (2) and Figure (1) show the quantity of some mineral elements that were estimated in NW and MTW. There were no significant differences between the quantities in both types of water except for the difference in the amount of chlorine> **1** compared to 10.1 mg / L in MTW and the slight difference in copper content (3.04 in NW compared to 2.64 mg / L in MTW).

Table (1). Determines the values of pH and electrical conductivity (EC) in (µs / cm) for the water used in irrigation with both normal and magnetic types.

	NW	**MTW**
pH	8.03	7.59
EC	103	103

Table (2). shows the average quantity of some mineral elements (mg / L) in NW and MTW.

Elements	**Ca**	**Mg**	**K**	**N**	**P**	**Na**	**Cl**	**Fe**	**Mn**	**Cu**
NW	17.37	0.9	0.2 >	0.91	0.09>	11.3	**1 >**	0.1 >	0.36	3.04
MTW	17.77	0.9	0.2 >	0.83	0.09>	11.7	10.1	0.1 >	0.31	2.64

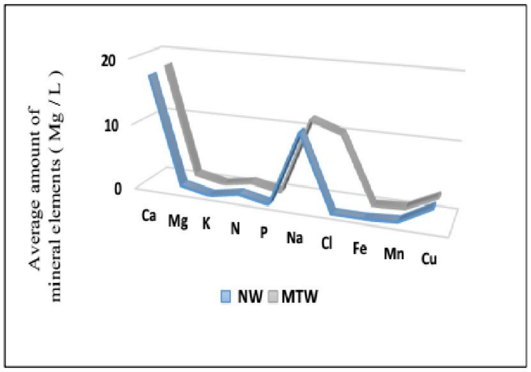

Fig. (1). shows the average amount of mineral elements (mg / L) in NW and MTW.

2- Soil measurements before planting:

• pH measurement, electrical conductivity (EC) of the soil and estimation of the amount of mineral elements in the soil:

Table (3) shows that the pH of soil used prior to planting was 7.14, which is the nearest equivalent and EC 104 µm / cm. There is a moderate increase in the amount of calcium, sodium and potassium by 9.67 mg / L, 8.67 mg / L and 6.33 mg / L, respectively.

Table (3). shows some measurements of the selected soil before planting.

Measurements of selective soil		**Average**
pH		7.14
EC µs/cm		104
Macro elements mg / L	Ca	9.67
	Mg	3
	K	6.33
	P	0.21
Micro elements mg / L	Na	8.67
	Cl	0.01>
	Fe	2

3 - measurements of the virtual form:

• Plant height (total vegetative length):

Table (4) and Figure (2) show the height of the plant for the different stages of the harvest. The natural gradient was observed in the height of the plant with the increase of the harvest period, and no significant difference was found in the first harvest between the two treatments. Morphological differences began to increase from the second harvest until the end of the experiment.

• Root total length:

Table (5) and Figure (3) show the length of the root total of the plant during the different stages of the harvest, showing significant differences between the two treatments from the beginning of the growth until the end of the experiment. The total root length at the fourth harvest was 40.3 cm compared to 35 cm in the control samples.

Table (4). The average height of the plant (total vegetative length (cm)) for plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	13.1 ± 0.5	13.5 ± 1.2	N.S
Second	33.5 ± 1.9	36.9 ± 1.7	*
Third	61.1 ± 2.9	71.9 ± 8.2	*
Fourth	84.1 ± 1.5	92.6 ± 2.7	*

* Significant N.S non significant

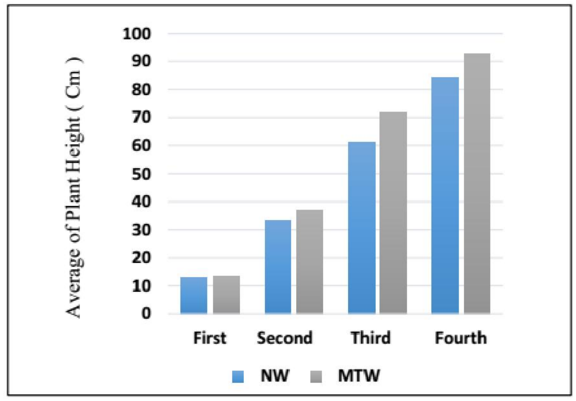

Fig. (2). The average height of the plant (length of total vegetation (cm)) for plants irrigated with NW and MTW during different age stages.

Table (5). The average length of the root total (cm) of plants irrigated with in NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	11.5 ± 0.77	12.4 ± 0.19	**
Second	24.3 ± 3.18	33.4 ± 0.51	**
Third	29.9 ± 2.03	38.5 ± 9.05	*
Fourth	35 ± 1.45	40.3 ± 0.58	**

* Significant ** high Significant

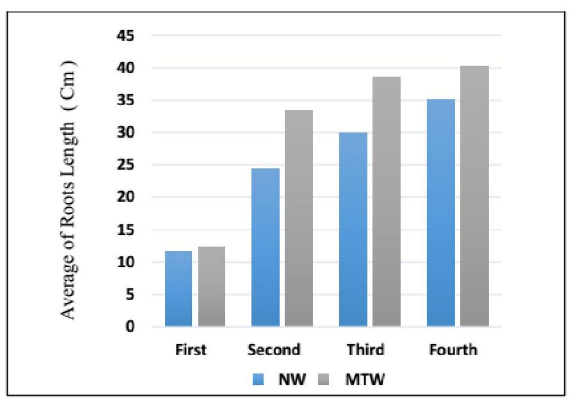

Fig. (3). The average length of the root total (cm) of plants irrigated with NW and MTW during different age stages.

Total root size:

Table (6) and Figure (4) show the size of the root total of the plant during the age stages. The increase in volume is observed from one stage to the other. However, there was no significant difference in the size of the root mass in both treatments at the first harvest (two weeks later). Then, the water-treated plants were magnetically superior to those fed with normal water from the second harvest until the end of the experiment. The final size of the root mass was 6.01 cm^3, B 4.22 cm^3 in plants irrigated with normal water.

• Leaf area:

It was found that the area of pearl millet leaves increases with the transfer of plants from one age stage to another. The results indicated in Table (7) and Figure (5) indicate that the treatment of plants with magnetically treated water has an effective effect in increasing the area of paper.

Table (6). shows the average size of the root total (cm^3) of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	0.33 ± 0.01	0.59 ± 0.09	N.S
Second	0.97 ± 0.08	1.50 ± 0.52	*
Third	1.78 ± 0.19	3.67 ± 0.33	**
Fourth	4.22 ± 0.51	6.01 ± 2.73	**

* Significant ** high Significant N.S non significant

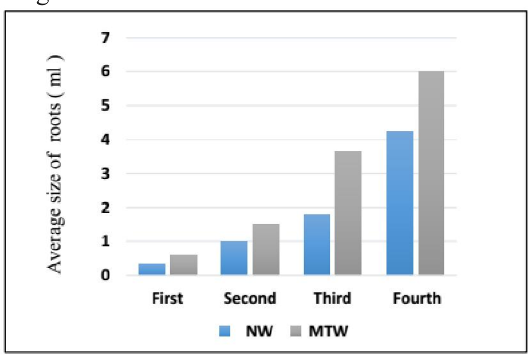

Fig. (4). shows the average size of the root total (cm^3) of plants irrigated with NW and MTW during different age stages.

Table (7). The average area of leaves (cm^2) for plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	9.5 ± 0.66	14.7 ± 0.37	**
Second	18.6 ± 1.8	25.3 ± 1.35	**
Third	33.9 ± 2.9	41.7 ± 3.58	**
Fourth	37.02±4.02	50.2 ± 4.31	**

** high Significant

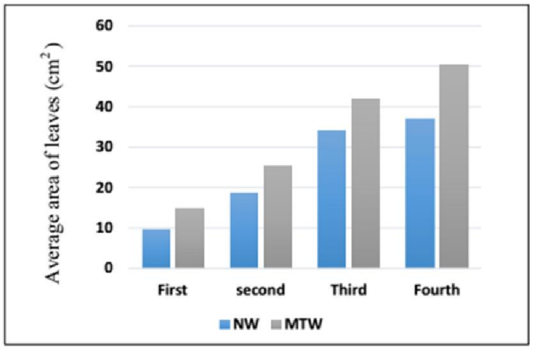

Fig. (5). Average area of leaves (cm^2) for plants irrigated with NW and MTW during different age stages.

4- Biochemical measurements:

• Determination of photosynthesis pigments:

• Chlorophyll (A):

Table (8) and Figure (6) show the amount of chlorophyll (A), which was estimated in the plant extract during the age stages. There is a significant difference between the plants irrigated with normal water and irrigated with magnetically treated water starting from the first harvest and ending with the fourth harvest. Chlorophyll (A) was progressive and there was a slight decrease in the fourth harvest in both treatments.

• Chlorophyll (B):

The results in Table (9) and Figure (7) show no significant differences in the seedling stage (at the first harvest) between the amount of chlorophyll (B) in the plants irrigated with normal water and irrigated with magnetically treated water, then the plant is completed for the vegetative stage and flowering stage There was a significant increase in chlorophyll (B), respectively (0.42 mg / g wet weight in water-treated samples compared to 0.28 mg / g wet weight in samples irrigated with normal water) and 0.64 mg / g wet weight in irrigated samples With treated water compared to 0.40 mg / g wet weight in samples irrigated with normal water.

• Carotenoids:

The amount of carotene in the plant extract was estimated for both treatments and during different stages of growth. The results in Table (10) and Figure (8) show that the highest value of carotene was recorded at the third harvest with 0.54 mg / g wet weight in treated water plants compared to 0.39 mg / g wet weight in plants irrigated with normal water.

• Starch estimation:

Starch was estimated in millet grains in plants irrigated with normal water and magnetically treated water at the fourth harvest. The values recorded in Table (11) and Figure (9) showed a marked increase in the amount of starch in irrigated plants compared with their normal irrigated plants but the difference was not significant between them.

Table (8). shows the average amount of chlorophyll A (mg / g wet weight) in the extract of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	0.72 ± 0.04	0.91 ± 0.04	**
Second	0.87 ± 0.01	1.03 ± 0.01	**
Third	0.90 ± 0.04	1.27 ± 0.09	**
Fourth	0.54 ± 0.01	0.67 ± 0.03	*

* Significant ** high Significant

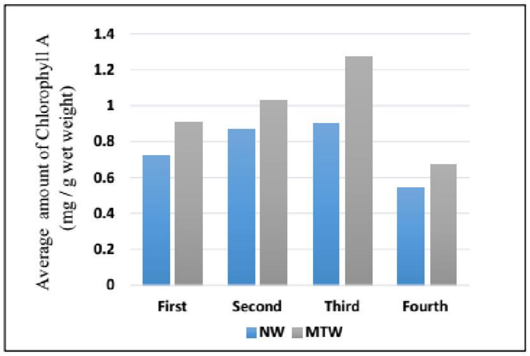

Fig. (6). shows the average amount of chlorophyll A (mg / g wet weight) in the extract of plants irrigated with NW and MTW during different age stages.

Table (9). The average amount of chlorophyll B (mg / g wet weight) in the extract of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	0.30 ± 0.04	0.34 ± 0.06	N.S
Second	0.28 ± 0.10	0.42 ± 0.01	**
Third	0.40 ± 0.03	0.64 ± 0.52	**
Fourth	0.20 ± 0.04	0.25 ± 0.03	*

* Significant ** high Significant N.S non significant

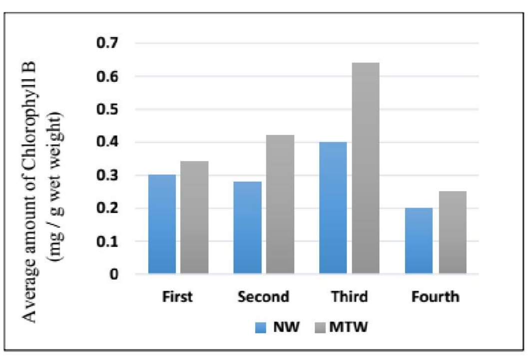

Fig. (7). shows the average amount of chlorophyll B (mg / g wet weight) in the extract of plants irrigated with NW and MTW during different age stages.

Table (10). The average amount of carotene (mg / g wet weight) in the extract of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	0.32 ± 0.02	0.36 ± 0.03	N.S
Second	0.36 ± 0.01	0.43 ± 0.06	**
Third	0.39 ± 0.01	0.54 ± 0.03	**
Fourth	0.20 ± 0.01	0.29 ± 0.01	**

** high Significant N.S non significant

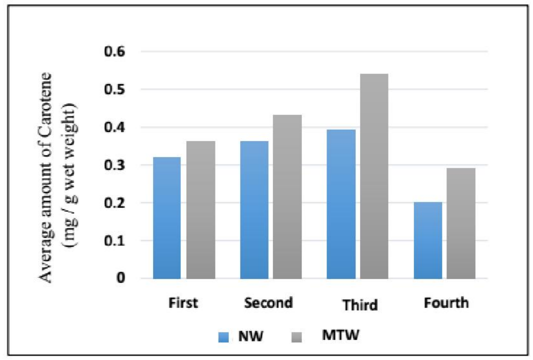

Fig. (8). The average amount of carotene (mg / g wet weight) in the extract of plants irrigated with NW and MTW during different age stages.

Table (11). Average starch quantity (mg / g dry weight) in millet grain for plants irrigated with NW and MTW at the fourth harvest.

Fourth Harvest	NW	MTW	Sig.
Average starch quantity	110.6 ± 3.4	131.2 ± 11.6	N.S

N.S non significant

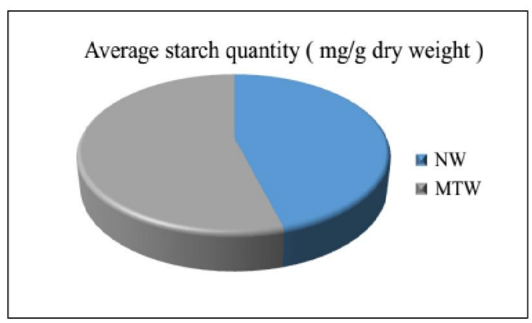

Fig. (9). Average starch quantity (mg / g dry weight) in millet grain for plants irrigated with NW and MTW at the fourth harvest.

5 - Estimating the quantity of some metal elements:

• Determination of the amount of magnesium in the vegetative and plant root:

Tables (12), (13), and Figures (10) and (11) shows an increase in the amount of Magnesium in the vegetative total of the plant in general. Note that the treated plants treated with magnetized water were the highest compared to the control samples. In the first, second and fourth harvest. However, following the path of the element in the root total of both treatments there is a fluctuation in quantity.

Table (12). The average amount of Magnesium Mg (mg / L) in the vegetative part of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	4.11 ± 0.18	6 ± 0.33	**
Second	8.01 ± 0.33	8.44 ± 0.51	*
Third	5.78 ± 0.11	6.77 ± 0.17	N.S
Fourth	4 ± 0.30	4.12 ± 0.50	*

* Significant ** high Significant N.S non significant

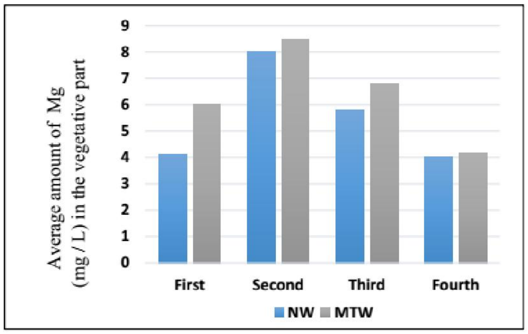

Fig. (10). The average amount of Magnesium Mg (mg / L) in the vegetative part of plants irrigated with NW and MTW during different age stages.

Table (13). shows the average amount of Magnesium Mg (mg / L) in the roots of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	6± 0.34	5.11 ± 0.21	**
Second	9.11 ± 0.17	11.87± 0.18	**
Third	8.33 ± 0.30	7.67 ± 0.88	*
Fourth	3.12 ± 0.51	6.23 ± 0.19	**

* Significant ** high Significant

- **Determination of the amount of potassium in vegetative and plant root:**

Table (14), (15) and Figures (12) and (13) show the average amount of potassium element in the vegetative and root of the plant. There are no significant differences between the two treatments in the total quantity of the vegetative component in all crops. Normal accumulation of potassium in the total vegetative at the first, second and third harvest compared to the irrigated with magnetically treated water, but with the progress of the plant at age and the fourth harvest showed an increase in the amount of potassium in the samples irrigated with treated water compared to control samples but were not significant.

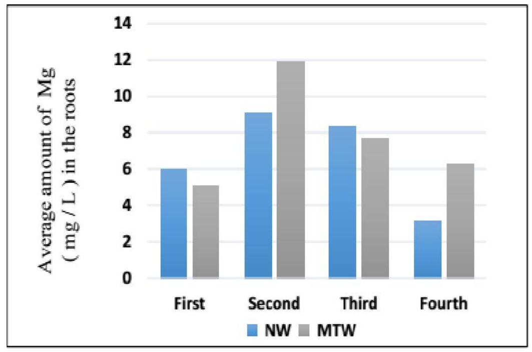

Fig. (11). shows the average amount of Magnesium Mg (mg / L) in the roots of plants irrigated with NW and MTW during different age stages.

Table (14). shows the average amount of potassium K (mg / L) in the vegetative part of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	73 ± 10.81	71 ± 0.59	N.S
Second	88.41 ± 0.38	87.89± 0.51	N.S
Third	66.33 ± 0.33	65 ± 2.60	N.S
Fourth	32.11 ± 5.18	34.11 ± 0.19	N.S

N.S non significant

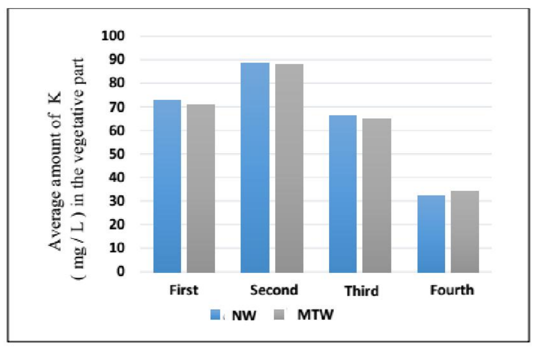

Fig. (12). shows the average amount of potassium K (mg / L) in the vegetative part of plants irrigated with NW and MTW during different age stages.

Table (15). shows the average amount of potassium K (mg / L) in the roots of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	21.78 ± 0.19	30 ± 0.88	*
Second	27.56 ± 0.51	34 ± 0.33	*
Third	15.65 ± 0.01	16.44 ± 0.20	N.S
Fourth	4.89 ± 0.18	9.55 ± 0.18	**

* Significant ** high Significant N.S non significant

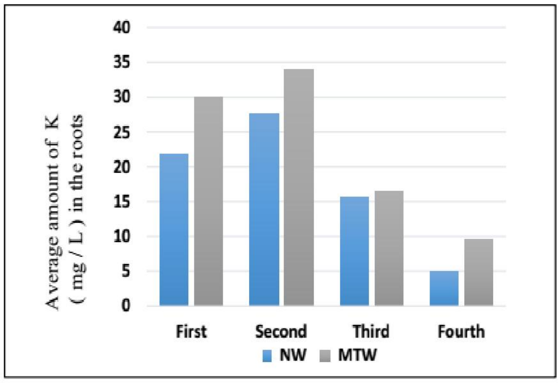

Fig. (13). shows the average amount of potassium K (mg / L) in the roots of plants irrigated with NW and MTW during different age stages.

• Determination of the amount of Iron in vegetative and plant root:

Table (16), (17) and Figures (14) and (15) show the average amount of iron element in the vegetative and root of the plant. There are significant differences between the two treatments from the second harvest until fourth harvest.

• Determination of the amount of some mineral elements in millet grain:

The results in Table (18) and Figure (16) show the values of some mineral elements that were estimated in the millet extract for plants irrigated with NW and MTW at the fourth harvest, namely Ca, Mg, K, P, Na, Cl and Fe.

Table (16). shows the average amount of iron Fe (mg / L) in the vegetative part of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	1 ± 0	1 ± 0	N.S
Second	1.67 ± 1.16	1 ± 0	*
Third	3.46 ± 0.13	1.34 ± 0.58	*
Fourth	2 ± 1.72	1.05 ± 0	*

* Significant N.S non significant

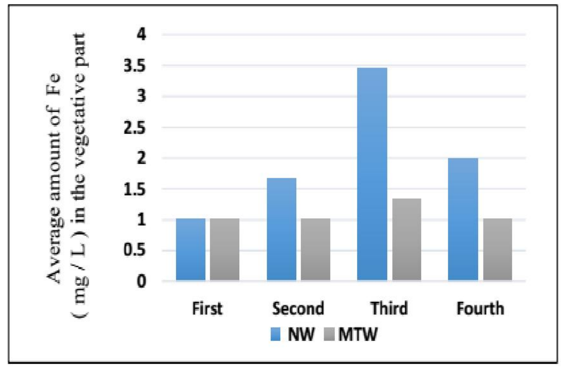

Fig. (14). shows the average amount of iron Fe (mg / L) in the vegetative part of plants irrigated with NW and MTW during different age stages.

Table (17). The mean amount of iron Fe (mg / L) in the roots of plants irrigated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	3.05 ± 0.38	3 ± 0.33	*
Second	7.11 ± 0.19	6.89 ± 0.35	*
Third	7.78 ± 0.69	6.25 ± 0.23	*
Fourth	2.45 ± 0.19	4.90 ± 0.18	*

* Significant

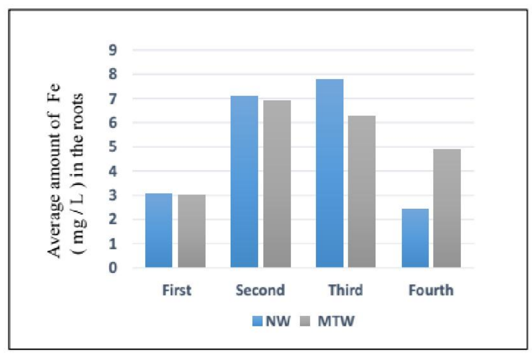

Fig. (15). shows the average amount of iron Fe (mg / L) in the roots of plants irrigated with NW and MTW during different age stages.

Table (18). Average quantity of some mineral elements (mg / L) in millet grain for plants irrigated with NW and MTW at the fourth harvest.

Elements	Ca	Mg	K	P	Na	Cl	Fe
NW	2 ± 0	2 ± 0	7 ± 0.10	1.5 ± 0.1	10.55± 0.19	0.93± 0.04	1.3 ± 1.15
MTW	2 ± 0	2 ± 0	8 ± 0.1	1.83± 0.69	11.01± 0.02	1.10± 0.01	1 ± 0
Sig.	N.S	N.S	*	*	*	N.S	*

* Significant N.S non significant

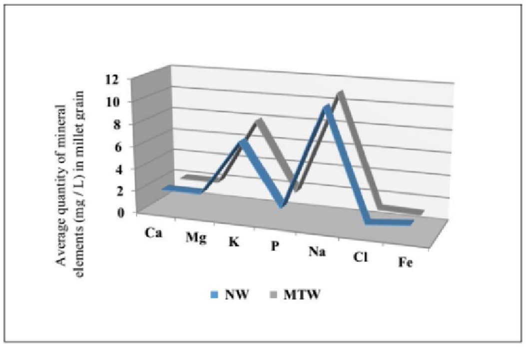

Fig. (16). shows the average quantity of some mineral elements (mg / L) in millet grain for plants irrigated with NW and MTW at the fourth harvest.

6. Soil measurements during the planting period:
pH measurement:

Table (19) and Figure (17) show average pH values in soil extract treated with normal water and magnetically treated water during the period of cultivation. It is noted that the soil treated with ordinary water has recorded absolute superiority over the treated water irrigated. There were significant differences between the treatments in the first, second and third harvest.

Measuring electrical conductivity:

Results of the measurement of the electrical conductivity of soil extract treated with normal water and magnetically treated water. The values recorded in Table (20) and Figure (18) are increased during different stages of plant growth with some fluctuation. And the second and third respectively.

Table (19). Average pH values in soil extract treated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	7.32 ± 0.06	7.25 ± 0.06	N.S
Second	7.75 ± 0.02	7.64 ± 0.07	N.S
Third	7.85 ± 0.05	7.76 ± 0.03	N.S
Fourth	8.17 ± 0.90	6.88 ± 0.54	*

* Significant N.S non significant

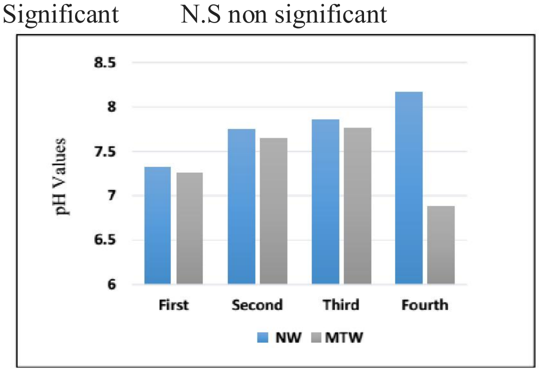

Fig. (17). shows the average pH values in soil extract treated with NW and MTW during different age stages.

Table (20). Average mean of electrical conductivity (EC) (µs / cm) in soil extract treated with NW and MTW during different age stages.

Harvest	NW	MTW	Sig.
First	141 ± 0.02	160 ± 0.03	*
Second	182 ± 0.01	175 ± 0.04	*
Third	212 ± 0.04	265 ± 0.01	*
Fourth	410 ± 0.06	580 ± 0.02	N.S

* Significant N.S non significant

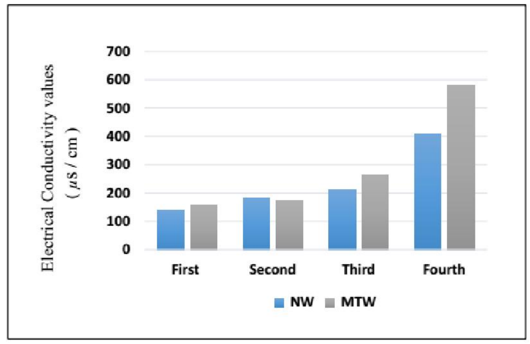

Fig. (18). shows the average mean of electrical conductivity (EC) (µs / cm) in soil extract treated with NW and MTW during different age stages.

4. Discussion

Water is one of the most natural resources consumed especially in the agricultural field in order to provide food requirements that are commensurate with the steady population growth and to achieve food security.

A comprehensive look at the results obtained shows that most of the phenotypic and biochemical properties measured were directly or indirectly affected by the irrigated millet irrigation.

The plant height, which was the first indication of vegetative growth, was a measure of plant status and strength. It was related to plant weight, root length and weight (Abdel Razak) And Maraghi, 1995), as well as the size of the roots and the area of paper in addition to measurements of the crop, such as the number of millet produced, grains and others.

The increase in most vegetative characteristics of a plant can be explained by the treatment of magnetically treated water that the groups of water molecules become small in size compared to their pre-magnetization status. This allows for better and faster transfer through root cells and contributes to increased mineral uptake (Mohammad Amin and Kassem, 2009). Is reflected positively on the plant. Martinez et al. (2002) explained that the magnetic field activates the biological stimulation of the initial growth processes, which results in the supply of plant tissues in large amounts of energy and causes the increase in lengths and weights of plants in general.

Penuelas et al., 2004) states that the response of root growth to magnetic fields is due to the amount of elements with a paramagnetic property (which contains free electrons in their molecules that act as a small magnet and are weakly attracted to the magnetic field) Iron.

An increase in the wet and dry weights of the treated plants was recorded with magnetized water and was clearly visible with age. Male (Mohamed Amin et al., 2011) reported similar results with reddish rose plant, and Reina et al. (2002) Water that turns into a homogeneous liquid after passing through the magnetic field.

It was also observed that the increase in leaf area in treated water treated samples compared to normal water treatment was consistent with the observed Sadeghipour and Aghaei (2013), which showed an increase in the area of treated cowpea leaves in this type of water. Photovoltaic construction and receiving greater amount of lighting, encouraging growth and vegetative expansion.

The results showed that the plants irrigated with magnetically treated water showed a significant increase in the amount of photosynthetic pigments (chlorophyll A, B and carotenoids) compared to samples irrigated with normal water. Mohamed Amin (2009) found similar results, in addition to Taia et al. (2007) in the effect of the magnetic treatment of sweet basil plant.

Some studies also estimated the ratio of chlorophyll A to B and found that it was higher in normal water plants, indicating that these two formulas were not suitable for these plants while the ratio was lower in water plants that were magnetically treated to approximate the amount of these pigments in these plants. Similar results have been reported in Maheshwari and Grewal (2009) and (Assaf, 2010), demonstrating the superiority of magnetically treated water plants in photosynthesis and thus photosynthesis.

The results showed that the vegetative group accumulated more for most of the studied elements compared to the root of the treatments. Similar results were found in the maize and sorghum plant grown in the plant. Al-Jaloud et al., 1995).

The results showed that the large amount of calcium, magnesium, and potassium with the effective structural and functional role was more present in water-treated plants than in conventional water. In addition, the amount of potassium and phosphorus in millet grains compared to normal water plants increased.

Some researchers have explained that this is due to the fact that the magnetization of irrigation water helps to increase the absorption of important elements compared to normal water. This proves its effectiveness in increasing the solubility of solids in the soil and increasing the readiness of nutrients and their speed from soil to roots, (Moon et Chung, 2000). Moon and Chung (2000) reported that water magnetization helps dissolve salts and acids higher than normal water as well as dissolve oxygen and accelerate chemical reactions, as Chang and Weng, 2008) that the rapid movement of ions under the influence of magnetism C is the cause of the breakage of hydrogen bonds of water and the breakup of these links Air oxygen can penetrate the water and thus help microorganisms to increase the concentration of hydrogen, which helps to grow and thus analysis of organic matter useful to the plant.

It is scientifically proven that the increase of mineral elements at the appropriate level stimulates the growth and development of the plant. The effect was observed on increasing the lengths and weights of the plants treated with magnetically treated water. It also contributes to the optimal completion of plant functions. Some studies have indicated the important role of calcium and potassium in The process of closure and opening of holes (Inove and Katoh, 1987) and the regulation of nitrogen in the plant.

The effect of magnetization on the properties of the active substances (antioxidants) obtained for some medicinal plants such as cinnamon, ginger and others was also recorded (et al., 2011) due to its direct impact on magnetization or indirectly due to electrical changes in magnetically treated water.

The iron component was found to have decreased significantly in water-treated plants magnetically and these results were consistent with the results of Asaf, 2010 and Hayati and Al-Thawadi, 2005. The observations revealed that the iron element in the soil is in a non-plant form As it is prone to the formation of non-soluble compounds such as oxides and hydroxides, in addition to the iron has a property of magnetic (non-magnetic field), while the accumulation of some elements of the property of the de-magnetic (anti-magnetic field) because of the attempt to address the magnetic field as mentioned (Dulaimi and Tobia, 1985).

The results of the estimation of the amount of starch in millet grain showed that the content of the treated plants treated with magnetized water was higher than that of the plants treated with normal water. This may be explained by the increase in the plant content of the potassium component, which is one of the major essential elements necessary for its nourishment as it is important in photosynthesis and representation Amino acids, proteins and carbohydrate transfer and helps to increase the plant content of sugar and starch, and it increases the presence of lignin and cellulose in the plant (Taj Eddin et al., 2009).

The results of the pH measurement of the soil extracts showed that the pH was higher in the normal water treated soil extracts compared to the magnetically treated water treated soil extracts. However, the results of the electrical conductivity measurement (EC) (Maheshwari and Grewal, 2009) showed that the value of pH increased with the increase of magnetic force in the plant and decreased in soil. It was also observed that magnetically treated water irrigation Reduces soil pH by hand But increases the value of the electrical conductivity of the other.

A number of researchers have also recorded an increase in the value of electrolysis in mechanically treated soils (Stange et al., 2002). This is due to the effect of magnetic forces on the absorption of saline ions found in soils. also this happens due to the change in salt concentration in the soil to the change occurring to the plant due to the impact of magnetic fields across the cellular membranes with roots.

Melibari (2012) noted that the use of magnetically treated water to irrigate plants can contribute to reducing the use of certain insecticides, especially those used to resist white flies, which indicate a high level of resistance to plants.

Conclusion

The use of water treated magnetically to irrigate the millet plant has improved the qualities of growth and raise the quality of the crop has been shown by increasing the most characteristics of vegetative and radical growth, such as increase the length of the plant and its width and weight wet and dry in addition to increasing the ears of millet and wet and dry weights, and increased pigments The photosynthesis in treated plants, which recorded a significant increase in most of the age of the plant, also contributed significantly to increase the amount of some mineral elements such as calcium, magnesium and potassium, and led to a lack of absorption of some other elements such as iron and led to increase the amount of Sha in millet grain with higher values compared to the values recorded for plants irrigated with ordinary water, which enhances the nutritional benefits of the plant. The use of magnetically treated water also has improved soil properties.

References

1. Abdali, Ali bin Hammad bin Barakat (2002) Effect of Fertilization of Major Elements (NPK) Feed Production of Millet and Sorghum in Hada Al Sham in Makkah Region, Master Thesis, King Abdulaziz University, Jeddah.
2. Abdul Razzaq, Mohammed Saad Al-Din and Al-Maraghi, Abdul Radi Hassan (1995) Fundamentals of Ecology, Doha: Qatar University, 276 - 280.
3. Al- Jaloud, A. A.; Hussain, G.; Adnan, J.; Al-saati, A. J. and Karimulla, S. (1995) Effect of wastewater irrigation on mineral composition of corn and sorghum plant in a pot experiment, *Journal of Plant Nutrition*, Vol.18 (8):1677-1692.
4. Al-Bashir, Munther Babeker (2004) Effect of Magnetized Water on the Malaria parasite, Master Thesis, Sudan University of Science and Technology, Khartoum.
5. Al-Qahtani, H. (1996) Effect of magnetic treatment on Gulf seawater, *Desalination*, Vol.107: 75- 81.
6. AL-Talib, A. A. and AL-Sinjary, Z. A. (2009) Effect of Magnetizing Water on Uniformity of Sprinkle Irrigation, *Al-Rafidain Engineering*, Vol.17: 68- 79.
7. Amer, S.; Hassanat, F.; Berthiaume, R.; Seguin, P. and Mustafa, A. F. (2012) Effects of water soluble carbohydrate content on ensiling characteristics, chemical composition and in vitro gas production of forage millet and forage sorghum silages, *Animal Feed Science and Technology*, Vol.177: 23– 29.
8. Amiri, M. C. and Dadkhah, A. A. (2006) On reduction in the surface tension of water due to magnetic treatment, *Colloids and Surfaces A: Physicochem. Eng. Aspects*, Vol.278: 252–255.
9. Andrews, D. J. and Kumar, K. A. (1992) *Pearl Millet For Food, Feed and Forage*, Nebraska: Academic Press, 100.
10. Assaf, Nabila Mohamed (2010) Environmental impact assessment for the use of magnetized water technology in the cultivation of hothouse, Master Thesis, King Abdul-aziz University Jeddah.
11. Baloushi, Shahina Muhammad Inayat Allah (2006) Agriculture in Wadi Numan Basin, Makkah Region, from 1390 AH to 1426H (1970 AD), Master Thesis, Umm Al-Qura University, Makkah Al-Mukarramah.
12. Cai, R.; Yang, H.; He, J. and Zhu, W. (2009) The effects of magnetic fields on water molecular hydrogen bonds, *Journal of Molecular Structure*, Vol. 938: 15–19.
13. Chang, T. K. and Weng, C. I. (2008) An investigation into the structure of aqueous NaCl electrolyte solutions under magnetic fields, *Computational Materials Science*, Vol.43: 1048-1055.
14. Coey, J. M. and Cass, S. (2000) Magnetic water treatment ، *Journal of Magnetism and Magnetic Materials*, Vol. 209: 71-74.

15. Colic, M. and Morse, D. (1999) The elusive mechanism of magnetic memory of water, *Colloids Surface*, Vol.154: 167-174.
16. Dandash, Nizar (2004) Electromagnetic pollution and human health, Beirut: Dar Al-Mawaraf for Publishing, Printing and Distribution, 95, 97.
17. Dulaimi, Subhi Khamis and Tobia, Sami (1985) Modern Organic Chemistry, Ministry of Higher Education and Scientific Research, Iraq: University of Mosul Press.
18. Gomez, K. A. and Gomez, A. A. (1984) *Statistical Procedures for Agricultural Research*, John Wiley and Sons, Inc., New York, USA.
19. Hatlani, Lulwa Saleh Mohamed (1995) Response of Millet and White Corn for Treatment with Salinity, Master Thesis, King Abdulaziz University, Jeddah.
20. Hayati, Ahmed Al-Mustafa and Al-Thawadi, Ali Mubarak (2005) Fundamentals of Plant Physiology, Dammam: Al-Mutanabbi Library, 223.
21. Hegazi, Ahmed Tawfiq (2003) Encyclopedia of Alternative Medicine - Magnetic Therapy Power after Magnetic Therapy in Touch and in Distance, Amman: Osama House for Publishing and Distribution, 14, 15.
22. Hilal, Mustafa Hassan (2004) Desertification of heavy metals and modern technologies for control, presented at the International Conference on Water Resources and the Dry Environment 2004, held at King Saud University, Riyadh, Saudi Arabia, 5-8 December 2004).
23. Holysz, L.; Szczes, A. and Chibowski, E. (2007) Effects of a static magnetic field on water and electrolyte solutions, *Journal of Colloid and Interface Science*, Vol.316: 996–1002.
24. Hozayn, M. and Abdul Qados, A. M. S. (2010) Irrigation with magnetized water enhances growth, chemical constituent and yield of chickpea (*Cicer arietinum* L.), *Agriculture and Biology Journal of North America*, Vol.1: 671-674.
25. Ibrahim, I. H. (2006) Biophysical properties of magnetized distilled water, *Egypt. J. Sol.*, Vol. 29: 363- 369.
26. Inove, H. and Katoh, Y. (1987) Calcium inhibits iron-Stimulated Stomatal opening in epidermal strips of *Commelina communis* L., *Journal of Experimental Botany*, Vol.38: 142-149.
27. Kutbi, Abeer Mahmoud Ismail (2007) Study of the effect of static magnetic forces on the rate of seed germination and the taxonomic properties of sweet basilicum plant, Ocimum basilicum L, Master Thesis, King Abdulaziz University, Jeddah.
28. Larcher, W. (1995) *Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups*, Springer- Verlage - Berlin Heidelberg- Germany, 20, 25.
29. Lichtenthaler, H. K. (1987) Chlorophylls and carotenoids: Pigments of photosynthetic bio membranes. *Methods of Enzymology*. Vol. 148: 350-382.
30. Maheshwari, B. L. and Grewal, H. S. (2009) Magnetic treatment of irrigation water: Its effects on vegetable crop yield and water productivity, *Agricultural Water Management*, Vol.96: 1229 - 1236.
31. Malibari, Dalia Mohamed Ali (2012), A study on the effect of magnetized water on growth and some physiological characteristics of watercress plants, Master Thesis, King Abdulaziz University, Jeddah.
32. Martinez, E,; Carbonell, M. V. and Florez, M. (2002) Magnetic biostimulation of initial growth stages of wheat (*Triticum aestivum* L.). *Electro- and Magneto Biology*, Vol. 21(1): 43-53.
33. Marwan, S. M.; Al-Nimer, Suad M.; Al-Deen, Zainab W.; Abdul Lateef, I. T. Al-Kayar (2011) Magnetized water induces changes in the antioxidant properties of some medicinal plants extracts, *Journal of Basic and Clinical Pharmacy*, Vol.5(2): 145-148.
34. Mohamed Amin, Sami Kareem and Kassem, Ali Farouk (2009) Effect of salinity of magnetized irrigation water on vegetative growth traits of Gerbera plant Gerbera jamesonii, Damascus University Journal of Agricultural Sciences, No. 25 (1): 63-74.
35. Mohammed Amin, Sami Karim; Aziz, Juvani Korcis and Said, Abdul Karim Abdul Jabbar Muhammad (2011) Response of the Rose damascena Rose water with magnetically treated water and spraying with phosphate fertilizer, Diyala Journal of Agricultural Sciences, No. 3 (2): 544 - 557.
36. Moon, J. D. and Chung, H. S. (2000) Acceleration of germination of tomato seed by applying AC electric and magnetic fields, *Journal of Electrostatics*, Vol. 48: 103 -114.
37. Mousa, A. M. and Hmed, A. S. (2008) The Effect of Magnetic Water on Dissolving Kidney Stones, *Eng. & Tech.*, Vol.26(5): 579- 585.
38. Naguib, M. I. (1964) Effect of sevin on the carbohydrate and nitrogen metabolism during the germination of cotton seed. Ind, *J. Exp. Biol*, Vol. 2: 144 - 152.
39. Nelson, N. (1944) A photometric adaptation of Somogyi method for the determination of glucose, *J. Biol. Chem.* Vol.153: 375-380.

40. Noran, R.; Shani, U. and Lin, I. (1996) The Effect of Irrigation With Magnetically Treated Water on The Translocation of Minerals in The Soil, *Magnetic and Electrical Separation*, Vol.7:109-122.
41. Penuelas, J.; Liusia, J.; Martinez, B. and Fontcuuberta, J. (2004) Diamagnetic Susceptibility and root growth response to magnetic fields in Lens culinaris, Glycine soja and Tritium eastivum, *Electromagnetic Biology and Medicine*, Vol.23 (2): 97-112.
42. Reina, F. G.; Pascaul, L. A. and Fundora, I. A. (2002) Influence of a stationary magnetic field on water relations in lettuce seeds. Part 11: experimental results, *Bioelectromagnetics*, Vol.23 (7): 550-552.
43. Sadeghipour, O. and Aghaei, P. (2013) Improving the growth of cowpea (Vigna unguiculata L. Walp.) by magnetized water, *J. Bio. & Env. Sci.*, Vol.3(1): 37-43.
44. Saeed, S. F. A. (2007) *Effect of magnetizing water and seeds on the production of Cucumber (Cucumis Sativus L.) Under Cooled Plastic Tunnels*, MD. Thesis, University of Khartoum, Al-Khartoum.
45. Shahidi, F. and Chandrasekara, A. (2013) Millet grain phenolics and their role in disease risk reduction and health promotion: A review, *Journal of Functional Foods*, Vol.5: 570 -581.
46. Stange, B. C.; Rowland, R. E.; Rapley, B. J. and Podd, J. V. (2002) Magnetic fields increase amino acid uptake into *Vicia faba* L. roots and alter ion movement across the plasma membrane, *Bioelectromagnetics*, Vol.23(5): 347-354.
47. Stewart, E. A. (1983) *Chemical analysis of ecological materials*, London: Black well Scientific.
48. Su, N. and Wu, C. (2003) Effect of magnetic field treated water on mortar and concrete containing fly ash, *Cement & Concrete Composites*, Vol.25: 681 -688.
49. Suwaidan, Hassan Mohamed (1997) Environmental Pollution Sciences, Riyadh: Al-Khuraiji Publishing House, 15-22.
50. Szcześ, A.; Chibowski, E.; Hołysz, L. and Rafalski, P. (2011) Effects of static magnetic field on water at kinetic condition, *Chemical Engineering and Processing*, Vol.50: 124 - 127.
51. Tahir, N. A. and Karim, H. F. H. (2010) Impact of Magnetic Application on the Parameters Related to Growth of Chickpea (*Cicer arietinum* L.), *Jordan Journal of Biological Sciences*, Vol.3: 175- 184.
52. Taia, W. K.; Al-zahrani, H. S. and Kootbi, A. M. (2007) The effect of static magnetic forces on seed germination and seedling morphological characters of Sweet Basil (*Ocimum basilicum* L.), *Bio-Science Research Bulletin*, Vol.21(2): 119-127.
53. Taj al-Din, Munther Majid; Mohammed, Iman Kassem and Ahmad, Firas Waad Allah (2009) Performance of Yellow Corn at Magnetization of Water with Sulfate and Potassium Chloride, Journal of Iraqi Agricultural Science, No. 40 (5): 37-44.
54. Tierra, M. (1997) *Biomagnetic and Herbal Therapy*, Detroit: Lotus press, 46.
55. Xiao-Feng, P. and Bo, D. (2008) The changes of macroscopic features and microscopic structures of water under influence of magnetic field, *Physica B*, Vol.403: 3571– 3577.

5/13/2018