



## Impact of Magnetized Freshwater, Saline Water and Treated Wastewater on Plant Growth and Yield Production of Cucumber Crop

Mahmoud Rahil<sup>1\*</sup> and Saif Abo Radi<sup>1</sup>

<sup>1</sup>Department of Environment and Sustainable Agriculture, Palestine Technical University Kadoorie, Tulkarm, Palestine.

### Authors' contributions

This work was carried out in collaboration between both authors. Author MR designed the study, wrote the protocol, managed the literature searches and wrote the first draft of the manuscript. Author SAR managed the analyses of the study and the field work. Both authors read and approved the final manuscript.

### Article Information

DOI: 10.9734/IJPSS/2020/v32i1830391

#### Editor(s):

(1) Dr. Muhammad Shehzad, The University of Poonch Rawalakot AJK, Pakistan.

#### Reviewers:

(1) Ramkrishna Haridas Kadam, Shrikrishna Mahavidyalaya, India.

(2) Soroush Soltani, Universiti Putra Malaysia, Malaysia.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/64421>

Received 25 October 2020

Accepted 30 December 2020

Published 31 December 2020

Original Research Article

### ABSTRACT

**Aims:** The growing scarcity and miss use of the available water resources particularly in arid and semi-arid regions constitute challenges to water demands for various utilities. One possible approach to conserve the scarce resources may be through improving the performance of the existing irrigation water using magnetization technology. The main aim of this study was to investigate the impact of magnetized and non-magnetized different types of water quality: freshwater (FW), magnetic freshwater (MFW), saline water (SW), magnetic saline water (MSW), wastewater (WW), and magnetic wastewater (MWW) on the growth and yield production of cucumber plant cultivated under greenhouse conditions.

**Study Design:** The experiment was designed using a complete randomized design. Six different treatments were used and designed (FW, MFW, SW, MSW, WW, and MWW) with four replicates per each treatment.

**Place and Duration of Study:** The field study was conducted at the experimental farm of Palestine Technical University- Kadoorie on February 2019 for a period of four months.

\*Corresponding author: E-mail: mrahail@ptuk.edu.ps, mrahail@yahoo.com;

**Methodology:** Cucumber seedlings were cultivated in plastic pots (7 liters). Six different types of water quality (FW, MFW, SW, MSW, WW, and MWW) were used for irrigating of cucumber plants. Average plant length, average fruit number per plant, average fruit weight per plant, average total yield, average plant dry matter, and photosynthetic rate were measured during the growing period.

**Results:** Results of this study indicated that the plant irrigated with magnetized freshwater produced the highest plant length and fruit number followed by magnetized treated wastewater compared to the other treatments. Moreover, the plant irrigated with magnetized treated wastewater produced the highest yield, photosynthetic rate and dry matter, followed by magnetized fresh water and magnetized saline water treatments.

**Conclusion:** It is concluded that, magnetized water for irrigation purposes could be a promising technique for agricultural improvements but more investigation is required on different crops.

*Keywords: Magnetization technology; treated wastewater; saline water; plant growth.*

## 1. INTRODUCTION

Magnetized water is water which has been passed through a magnetic field prior to use. Magnetization technology of water was adopted by several countries such as Russia, United States, Britain, Japan, Australia, Germany, Turkey, Poland, China and Portugal were carried out numerous studies used in the field of agriculture, and the researchers found results value in various crops [1].

It was reported that there are some changes occurred in the physical and chemical properties of the water according to magnetic treatment, mainly hydrogen bonding polarity, surface tension, conductivity, pH, and solubility of salts, and these changes in water properties may be capable of affecting the growth of plants [2]. Magnetized water penetrates the soil faster and deeper, allowing roots to penetrate and grow larger. Magnetized water dissolves more nutrients into root zone to become available to stimulate plant growth. These may be the reasons why growth rates are increased. Crop yields are big in a shorter period of time, and with much less water, fertilizers, and pesticides needs. This is the reason why magnetic water be used for irrigation. This result in an increased crop production and good quality of agricultural products coupled with savings in labour and money.

Some studies have shown that magnetized water used for irrigation can improve plant yield and water productivity as well as, enhance water use efficiency [3-6]. Magnetic water treatment is also a technology used worldwide to overcome water salinity problems. In a field experiment, [7] concluded that soil wash of salts by magnetized water increased by 30-33% than those used with normal water. [8] reported that magnetized water

has the ability to remove the effect of the salts accumulated in the soil (50-80%) compared to untreated water (30%). [9] found that, the use of magnetized saline water to produce sunflower has a significant effect in reducing the damage caused by saline water at a level of 5.81 dS/m. [10] showed that irrigation with magnetized saline water increased the production of maize crop by 15% compared to irrigation with the same water without treatment.

An increase in crop yield, size and sugar content of melon grown with magnetized irrigation water in South Africa was shown by Lin and Yotvat [11]. Statistically significant increases in the yield and water productivity of snow peas and celery when irrigated with magnetized water, while, no significant effect on the yield or productivity of peas was reported by Maheshwari and Grewal [5]. Harari and Lin [12] showed that the size of muskmelons, the number of fruits and their sugar content were significantly greater when irrigated with magnetized water. Lentils irrigated with magnetized water showed a significant increase in growth, the stimulation in growth is thought to be attributed to an effect of magnetized water on the induction of cell metabolism and mitosis [1]. Magnetized water has been stated to the triple seedling advent of wheat [13]. Chickpea plants irrigated with magnetized water grew taller and heavier than plants irrigated with tap water [1]. Surendran et al. [14] reached that there was a beneficial effect of using magnetically treated irrigation water on growth and yield of crops, water and soil properties. The magnetic treatment of irrigation water improved the crop growth and yield of cow pea by 25.8% and 17.0%, respectively over the control experiment. Irrigation with magnetized water affected seed germination, root growth, seedling growth, chlorophyll content, and the growth of the meristematic cells [15]. Some

studies have reported the influence of magnetic water on seed germination, vegetative growth, and the yield of pepper [16], snap bean [17], tomato [18], snow pea and chickpea [2,19] concluded that the magnetic treatment accelerated the growth rate of tomato and the stem diameters were bigger comparing with the non-magnetized water. Such an effect may be due to the change in the characteristics of the cell membrane, affected the cell reproduction, and the changes in cell metabolism [20].

The main objective of this research was to investigate the impact of magnetized different types of water quality: freshwater, saline water, and treated wastewater on the growth and yield potential of cucumber crop cultivated inside the greenhouse.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Field Experiment

A field study was conducted at the experimental farm of Palestine Technical University-Kadoorie located at Tulkarm, Palestine on 17 February 2019 for a period of four months. The main aim of this study was to investigate the impact of magnetized and non-magnetized different types of water quality: freshwater (FW), magnetic freshwater (MFW), saline water (SW), magnetic saline water (MSW), wastewater (WW), and magnetic wastewater (MWW) on the growth and yield production of cucumber plant cultivated under greenhouse conditions. Tulkarm area is recognized by its moderate climate, with average yearly precipitation varies between 530-630 mm. Cucumber seedlings were cultivated in plastic pots (7 liters). The experiment was designed using complete randomized design. Six different treatments were designed, with four replicates per each treatment. Compound fertilizers (13:13:13) and (11:8:22) were used during different growth stages based on the nutrient requirements of cucumber as given in Table 1. The different types of water quality (freshwater, saline water, and treated wastewater) were used and magnetized for irrigating of cucumber plants. The six different types of treatments are described in Table 2. Average plant length, average fruit number per plant, average fruit weight per plant, average total yield, average plant dry matter, and photosynthetic rate were measured during the growing period. A portable photosynthesis unit (LCi Photosynthesis System) was used to monitor leaf net photosynthetic rates; using

mature leaves that fully exposed to light. The measurements were taken in the morning between 9:00 and 11:00, when midday heat stress was absent.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth and Yield Parameters of Cucumber

Results of this study indicated that the plant irrigated with magnetized freshwater produced the highest plant length followed by magnetized treated wastewater compared to the other treatments as shown in Fig. 1. The plant irrigated with magnetized treated wastewater produced the highest yield production followed by magnetized freshwater and magnetized saline water. Yield production was increased about 95%, 85%, and 76% under magnetized saline water, magnetized treated wastewater, and magnetized freshwater compared with non-magnetized saline water, treated wastewater and freshwater application respectively, as shown in Fig. 2. The plant irrigated with magnetized freshwater produced the highest fruit numbers followed by magnetized saline water and magnetized treated wastewater compared with the other treatments as shown in Fig. 3. The magnetized water might have resulted in faster activations of enzymes and hormones during the growth process which probably caused an improvement in the mobilization and transportation of nutrients [21]. Adeyolanu et al. [22] found a significant difference in growth of African eggplant irrigated with magnetized domestic treated wastewater in terms of plant heights, stem girths and number of leaves compared with non-magnetized treated wastewater. Al-Janaby et al. [23] found that the highest yield of grain crop of maize amounted to 8.57 tons ha<sup>-1</sup>, while the 4.62 tons ha<sup>-1</sup> when used water without magnetization, and increased by 85.49% when using magnetized water comparing to the water without magnetization. Abdel Kareem [24] found that the yield production of eggplant, tomato and faba beans was 34.05, 77.5, and 6.92 ton ha<sup>-1</sup> for treatments irrigated with magnetized water versus 23.23, 50.76, and 4.25 ton ha<sup>-1</sup> respectively, for treatment irrigated with non-magnetized water. Atak et al. [20] explained the effect of magnetized water was due to the change in the characteristics of the cell membrane, which affected cell reproduction, and the changes in cell metabolism. Furthermore, magnetized water increased nutrient mobility in

soil, and uptake of N, P, K and Fe by plants [25]. Irrigating plants with magnetized water dissolves more nutrients because it lowers the surface tension of water. This lets more minerals be suspended in solution. Also, this improves the pH and causes more minerals and nutrients to pass through the cell walls of the roots. Statistically, treatments with different letters are significantly different. It was indicated that there was a significant difference in the yield production of plants irrigated with magnetized treated wastewater and the other treatments. Also there was no significant difference in fruit number per plant between all treatments.

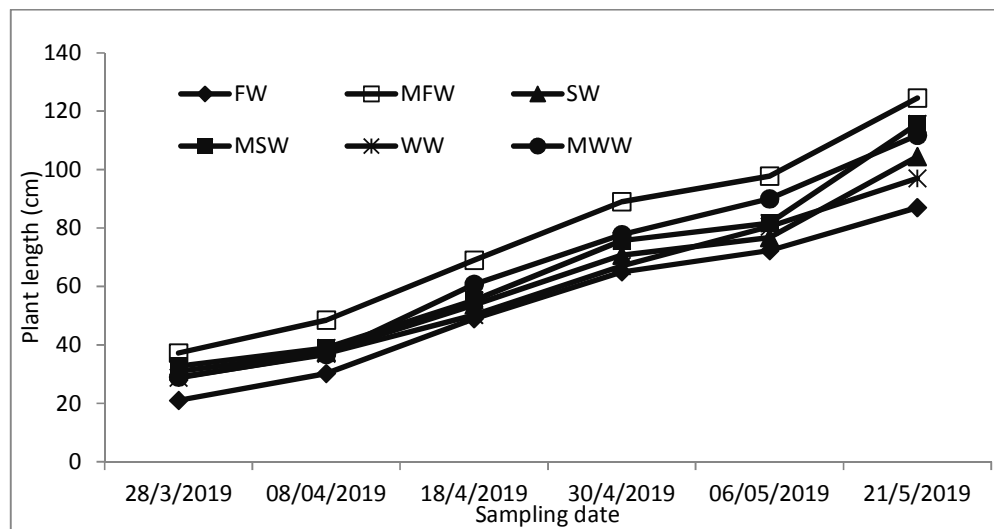
### 3.2 Dry Matter

Results of this study indicated that the plant irrigated with magnetized treated wastewater produced the highest dry matter of plants followed by magnetized freshwater and magnetized saline water as shown in Fig. 4. Moreover, the dry matter was increased about 51%, 48%, and 47% under magnetized treated wastewater, magnetized saline water, and magnetized freshwater irrigation compared with non-magnetized treated wastewater, saline water, and freshwater, respectively. Statistically,

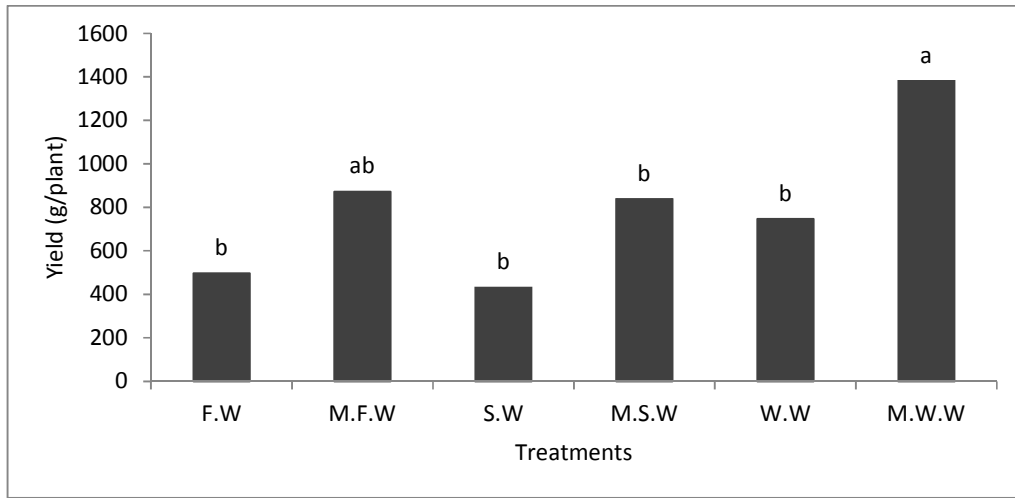
there was no significant difference in dry matter between all treatments. Al-Janaby [23] observed a significant difference in dry matter of maize crop using magnetized water and indicated the highest dry weight of the maize crop amounted to 12.1 tons ha<sup>-1</sup>, while reached only 6.52 tons ha<sup>-1</sup> when using water without magnetization, which increased up to 85.58% when using magnetized water comparing to water without magnetization. Ahmed and Abd El-Kader [26] showed that plant height, leaf area, leaves number, haulm fresh, and dry weights of potato plants were significantly increased by application of magnetized water as compared with non-magnetized water. Selim [27] reported that irrigation with magnetized water has improved plant growth characteristics of tomato and pepper in terms of leaves number, leaf area, and plant height. Also, [28] found that the application of magnetized water improved the growth of pepper plants. Midan and Tantawy [29] and [30] stated that the vegetative growth characteristics of snap beans were improved after irrigation with magnetized water. The positive effect of magnetized water on plant may be attributed to its positive role on nutrients assimilation and absorption, and consequently increasing plant growth characteristics.

**Table 1. Nutrients requirements of cucumber plant during different growth stages**

Growth Stages	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Transplanting -14 Days	150	150	150
14 - 35 Days	250	150	400
35 - End of crop	425	250	670



**Fig. 1. Plant length of cucumber crop irrigated with different types of magnetized and non-magnetized (freshwater, saline water, and treated wastewater)**



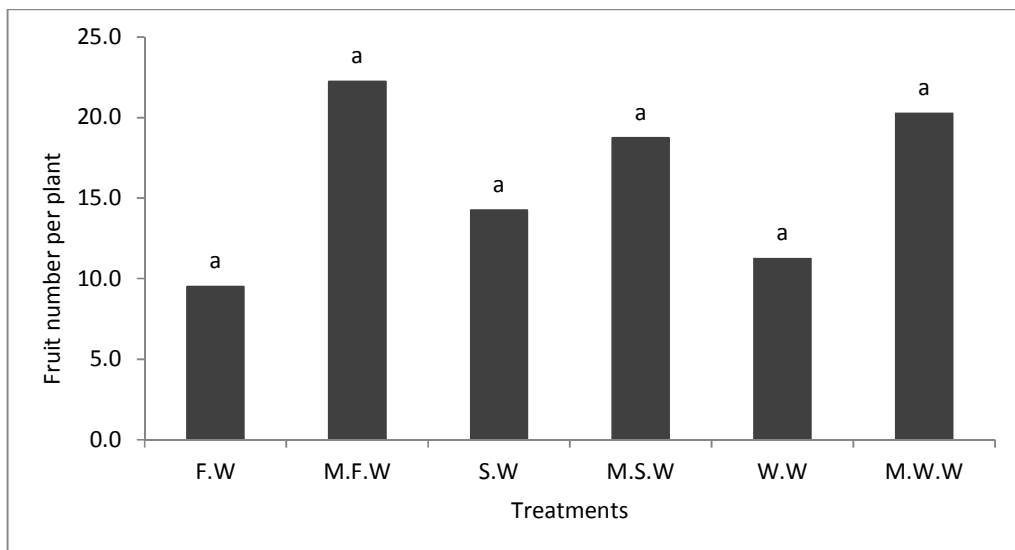
**Fig. 2.** Yield production of cucumber crop irrigated with different types of magnetized and non-magnetized (freshwater, saline water, and treated wastewater)

### 3.3 Chlorophyll Content

Chlorophyll content of the cucumber plants was measured several times during the growing period of the plants using a SPAD meter. It is indicated that the SPAD values seem the same for all treatments during the first two months of the growing period, and at the last growing period the SPAD values of the treatments irrigated with magnetized wastewater were higher than the other treatments as shown in Fig. 5.

### 3.4 Photosynthetic Rate

Results of this study indicated that the highest photosynthetic rate was observed for plant irrigated with magnetized treated wastewater, followed by magnetized freshwater, and magnetized saline water. Moreover, the photosynthetic rate was increased about 33%, 19%, and 5% under magnetized treated wastewater, magnetized freshwater, and magnetized saline water compared with non-magnetized treated wastewater, freshwater, and saline water, respectively as shown in Fig. 6



**Fig. 3.** Fruit number of cucumber crop irrigated with different types of magnetized and non-magnetized (freshwater, saline water and treated wastewater)

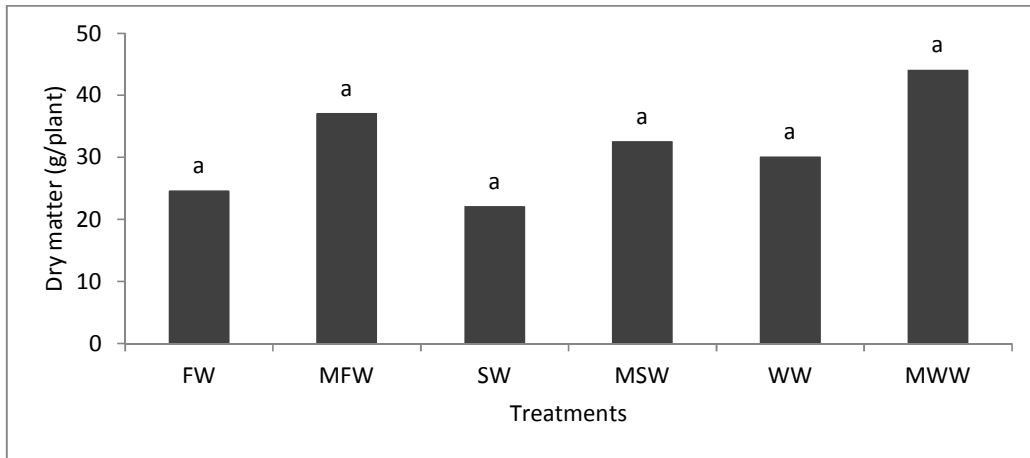


Fig. 4. Dry matter of cucumber crop irrigated with different types of magnetized and non-magnetized (freshwater, saline water and treated wastewater)

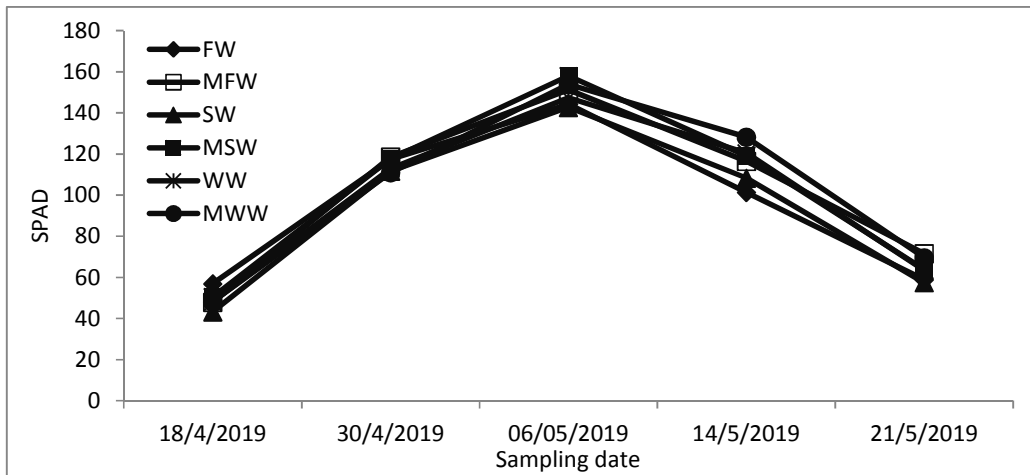


Fig. 5. Chlorophyll content of cucumber crop irrigated with different types of magnetized and non-magnetized (fresh water, saline water, and treated wastewater)

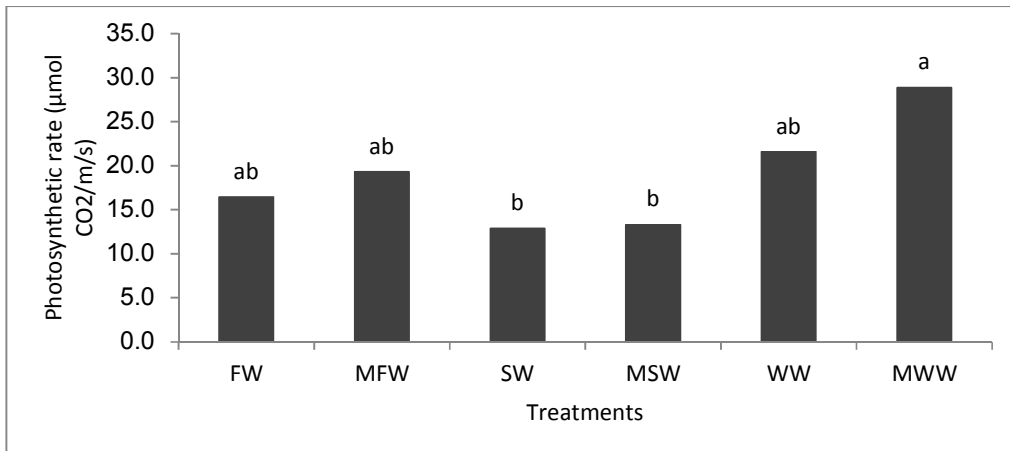


Fig. 6. Photosynthetic rate of cucumber crop irrigated with different types of magnetized and non-magnetized (freshwater, saline water and treated wastewater)

**Table 2. Description of different treatments used in the experiment**

Treatments	Description
FW	Fresh Water
MFW	Magnetized Fresh Water
SW	Saline Water
MSW	Magnetized Saline Water
WW	Waste Water
MWW	Magnetized Waste Water

#### 4. CONCLUSION

It is concluded that the magnetized freshwater, magnetized saline water, and magnetized wastewater played a positive impact in improving the growth parameters of cucumber plant and increased the yield production compared with the plant irrigated with non-magnetized freshwater, saline water, and treated wastewater. The magnetized treated wastewater produced the highest yield production, dry matter and photosynthetic rate compared to the other treatments. Magnetized irrigation water could be a promising technique for agricultural improvements but more investigation is required on different crops.

#### ACKNOWLEDGEMENTS

The authors thank Prof. Dr. Mazen Salman for his assistance in the statistical analysis. Also many thanks for the Palestine Technical University –Kadoorie for the publication's financial support.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

- Hozayn M, Qados A, Saeed A. Magnetic water application for improving wheat (*Triticum aestivum* L.) crop production. *Agr. Biol. J. N. Am.* 2010;1(4).
- Grewal H, Maheshwari B. Magnetic treatment of irrigation water and snow pea and chickpea seeds enhances early growth and nutrient contents of seedlings. *Bioelectromagnetics.* 2011;32:58-65.
- Al-Khazan M, Abdullatif B, Al-Assaf N. Effects of magnetically treated water on water status, chlorophyll pigments and some elements content of Jojoba (*Simmondsia chinensis* L.) at different growth stages. *Afr. J. Environ. Sci. Technol.* 2011;5(9):722-31.
- Khoshravesh M, Mostafazadeh-Fard B, Mousavi S, Kiani A. Effects of magnetized water on the distribution pattern of soil water with respect to time in trickle irrigation. *Soil Use Manage.* 2011;27(4): 515-22.
- Maheshwari B, Grewal H. Magnetic treatment of irrigation water: Its effects on vegetable crop yield and water productivity. *Agric. Water Manage.* 2009; 96(8):1229-36.
- Duarte-Diaz C, Riquenes J, Sotolongo B, Portuondo M, Quintana E, Perez R. Effects of magnetic treatment of irrigation water on the tomato crop. *Horticulture Abstract.* 1997;69:494.
- Zhu Y, Sheng G, Han J, Liu W. Studies on the effectiveness of magnetized water in improving saline soils. *Irrigation and Drainage Abstracts.* 1986;12-16.
- Takachenko P. The application of magnetic technology in agriculture. *Magnetizer.* 1995:9-11.
- Hasan K, Fahad A, Falih A, Rashed T. Magnetic conditioning of saline water characteristics for irrigation: sunflower. *Iraqi J. Agric. Sci.* 2005;36(1): 8-23.
- Fahad A, Hasan K, Falih A, Rashed T. Magnetic conditioning of saline water characteristics for irrigation crops: corn and wheat. *Iraqi J. Agric. Sci.* 2005; 36(1):29-34.
- Lin I, Yotvat J. Exposure of irrigation and drinking water to a magnetic field with controlled power and direction. *J. Magn. Magn. Mater.* 1990;83(1):525-6.
- Harari M, Lin I. Water exposed to magnetic treatment: Muskmelon (cantaloupe) growing. *Magn. Electr. Separ.* 1992;3:93-104.
- Hilal M, Hilal M. Application of magnetic technologies in desert agriculture. I-Seed germination and seedling emergence of

- some crops in a saline calcareous soil. Egypt. J. Soil Sci. 2000;40(3): 413-22.
14. Surendran U, Sandeep O, Joseph J. The Impacts of Magnetic Treatment of Irrigation Water on Plant, Water and Soil Characteristics. Agric. Water Manage. 2016;178:9-21.
  15. Aladjadjyan A. Study of the influence of magnetic field on some biological characteristics of *Zea mays*. J. Cent. Eur. Agric. 2002;3(2):89-94.
  16. Selim D, Gendy A, Maria A, Mousa E. Response of pepper plants to magnetic technologies. 1st Nile Delta Conf. on Export Crops, Faculty of Agriculture, Minufiya University, Egypt. 2009:89-104.
  17. Fatahallah M, Ali F, Gawish R, Hassan D. Effect of water regimes and irrigation with magnetic and non-magnetic water on soil salinity and growth of bean plants. Minufiya J. Agric. Res. 2014;39(5):1643-1654.
  18. De Souza A, Garcia D, Sueiro L, Gilart F, Porras E, Licea L. Pre-sowing magnetic treatment of tomato seeds increase the growth and yield of plants. Bioelectromagnetics. 2005;27(4):247-257.
  19. Kamorudeen Y, Ayodele O. Impact of magnetic treatment of irrigation water on the growth and yield of tomato. Notulae Scientia Biologicae. 2015;7(3):345-8.
  20. Atak C, Emiroglu O, Alikamanglu S, Rzakoulieve A. Stimulation of regeneration by magnetic field in soybean (*Glycine max* L. Merrill) tissue cultures. Cell Mol. Biol. 2003;2:113 -119.
  21. Deia A. Effect of magnetic water and depth of drip irrigation water and yield of cucumber in green houses. Diyala Agricultural Sciences Journal. 2014;6(1): 179-86.
  22. Adeyolanu A, Olanite W, Ariwoola L. Effects of magnetic treated domestic wastewater on the growth of African eggplant (*Solanum macrocarpon*). J. Multidiscip. Eng. Sci. Technol. 2019; 6(5):10131-10135.
  23. Al-JanabyM. Effect of magnetized irrigation water and bio-fertilizer spraying on growth and yields of maize (*Zea mays* L.). J. Genet. Environ. Resour. Conserv. 2014;2(1):10-15.
  24. Abdel Kareem N. Evaluation of magnetizing irrigation water impacts on the enhancement of yield and water productivity for some crops. J. Agr. Sci. Tech. 2018; 8:274-286.
  25. Hajer, AMalibari A, Al-ZahraniH, Almaghrabi O. Responses of three tomato cultivars to sea water salinity1. Effect of salinity on the seedling growth. Afr. J. Biotechnol. 2006;5:855-861.
  26. Ahmed M, Abd El-Kader N. the influence of magnetic water and water regimes on soil salinity, growth, yield and tubers quality of potato plants. Middle East J. Agric. Res. 2016;5(2):132-143.
  27. D Selim. 2008, Response of some economic plants to magnetized water supply. M.Sc. Thesis, Faculty of Agriculture, Minufiya University, Egypt.
  28. Ahmed M, El-Zaawely A, Bayoumi A. Effect of magnetic field on seed germination, growth and yield of sweet pepper plants (*Capsicum annum*). Asian J. Crop Sci. 2013;5(3):286-294.
  29. Midan S, Tantawy M. Effect of magnetized irrigation water on mineral nitrogen fertilization efficiency, nutrients availability and snap bean plants productivity. Minufiya J. Agric. Res. 2013;38(1):423-443.
  30. Fatahallah M, Ali F, Gawish R, Hassan D. Effect of water regimes and irrigation with magnetic and non-magnetic water on soil salinity and growth of bean plants. Minufiya J. Agric. Res. 2014;39(5):1643-1654.

© 2020 Rahil and Radi; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

The peer review history for this paper can be accessed here:  
<http://www.sdiarticle4.com/review-history/64421>