Agrotechniques in Industrial Crops

Journal Homepage: https://atic.razi.ac.ir

Razi University

# Investigation of the Reaction of Potato Plant to Magnetized Saline Water

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**ARTICLE INFO**

***Original paper***

*Article history:*
Received: 26 Sep 2021
Accepted: 25 Nov 2021
Published: 29 Nov 2021

*Keywords:*
Magnetic water
Potato
Salinity
Yield

**ABSTRACT**

Potato is one of the important agricultural products of different regions of Khorasan Razavi province, especially Quchan. The area under potato cultivation in the 2018-2019 crop year in this province was 4979 hectares and its production amount was 163151 tons with an average yield of 32.8 tons per hectare. In order to investigate the reaction of the potato plant to magnetized water, an experiment was conducted in Quchan city, Khorasan Razavi province. This experiment was performed with two types of water, "magnetic water (MW) and Tap water (N-MW)". Fertilization was performed based on the soil test. Row distances (130 cm) and planting distances (20 cm) were in accordance with local customs. The type of drip irrigation was tape and the distance between the drippers was 25 cm. During the growing season, the necessary measurements were performed to determine the important growth factors of potatoes and the effect of magnetized water on them. The EC of saline water was equal to 4.5 ds/m. The results showed that the use of magnetic water compared to the control (N-MW) on the yield of potato tubers was significant at the level of 5% probability. The results of mean comparison showed that the yield of potatoes under the effect of magnetic water treatment (25.4 tons per hectare) was about 30% higher than the control (19.4 tons per hectare). In general, magnetizing saline water significantly increased yield, quality, freshness, germination time, volume and weight of tubers, number of tubers per plant, reduction of weeds and reduction of crop pests.

DOI: 10.22126/ATIC.2022.7145.1025


## 1. Introduction

The application of new technologies is essential in order to make optimal use of limited resources (such as water in agriculture, which is limited in quantity and quality) and to achieve maximum yield in many crops. One of the technologies that have been introduced in recent years to improve water use in various sectors of industry, agriculture and animal husbandry is to magnetize water consumption.

In many countries, water magnetizing devices have been used, some of which are mentioned: Khazah et al. (2018) in a study in the Tel Manin region of Syria entitled "The effect of irrigation with magnetic water on potato germination" concluded that exposing potatoes to magnetic water with fields of 0.03, 0.06 and 09/09 0 Tesla leads to increased germination 73.33%, 86.67% and 93.33% more than the non-magnetic state, respectively. In investigating the effect of using magnetic water on water yield and productivity on chickpea, celery and another type of chickpea (snow pea).

The results showed that the effect of magnetic water on the yield and productivity of water varies depending on the type of water used and the type of plant. Chickpeas showed 12% and 23% increase in yield and 12% and 24% increase in water productivity. For peas, a yield increase of 7.8%, 5.9% and 6% was obtained in the treatment of magnetized milk with milk, recycled water and 1000 ppm salt water. Water productivity also increased by 12%, 7.5% and 13%, respectively (Maheshwari and Grewal, 2009). An experiment on new magnetic systems in irrigation of alfalfa fields in

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Oregon, USA, has shown the results of increasing crop production by about 65% and reducing the need for irrigation and water consumption by up to 42% (Anonymous, 2004). In Northern California (Los Gatos State), lettuce was marketed after only 30 days with a normal 40-day growing period when planted with magnetic water. That is, the growing period was reduced by about 10 days (Anonymous, 2004). In Washington state, apple orchards used magnetic water for only part of the period, as a result of which the apple trees yielded 2 weeks earlier and the fruits produced were sweeter (Anonymous, 2004).

Experiments on the magnetic behavior of pumpkin, tomato and cucumber seeds in Europe have shown that the magnetic field causes 96% of the seeds to germinate in just 3 days. Whereas in ordinary non-magnetic seeds, the germination rate was 73% and the germination duration was about 14 days (3, 16, 20). The use of magnetic water in Colombia to produce roses has resulted in a 41.66 percent increase in the diameter of cultivated flowers (Alleman, 1985).

- The use of magnetic water in the UK has led to an 86% increase in cucumber production in the greenhouse (AlAdjadjiyan and Ylieva, 2003). The use of magnetic water in calcareous and saline soils in Egypt was studied. This research was performed on tomato, pepper, green cucumber and wheat crops which showed the following results (Hilal and Hilal, 2000). Magnetizing the seeds alone doubled the germination power of the pepper while magnetizing the water had less effect on it.
- On the other hand, tomato seeds responded more to magnetic water than to magnetize seeds.
- Green cucumber seeds gave the best response to magnetic water and seed magnetization and about 86% increase in production was observed. In the case of the wheat, 100% germination took place in the seeds and the germination period was 6 days after sowing, while in the case of field with normal seeds, 83% of the seeds germinated and the germination period was 9 days. Also, in all observations, using magnetic water, the formation of hard crust on the soil surface was done more slowly and soil moisture retention increased approximately three times (Hilal and Hilal, 2000).

An experiment was conducted for two seasons on a farm in the Mit Kenana village, Qalyobia, Egypt. The aim was to study the influence of magnetized water technology on the fertilizers during irrigation (fertigation) and its impact on the water, soil as well as the yield and yield components for potatoes. The experiment included: Normal water (NM), magnetic water (MW), adding fertilizer before (FMW) and after magnetism (MWF). The results indicated that irrigation with magnetized water and then adding fertilizer (MWF) had a positive significant effect on the water and soil properties, the tuber engineering parameters improved and the potato productivity increased by 40.5% higher than the NM method (Mostafa, 2020).

Calcium carbonate formation and its deposition in magnetic water were studied. The results showed that as the magnetization of water and the strength of the magnetic field increased, the amount and type of precipitated minerals changed, resulting in a decrease in the amount of calcite ore and an increase in the percentage of mineralization, aragonite and waterite ultimately reducing the sediment in the system. In fact, calcium ions and carbonates, after passing through a magnetic field, become ion pairs that do not precipitate (Khobe *et al.* 2003). In Sabzevar, the effect of water passing through the magnetic field on the growth of broilers and the rate of microbial contamination was investigated, which showed the positive effect of using this water. In Iran, in addition to the above, the effect of magnetic water on the strength of concrete has been studied and its positive results have been reported (Kronenberg, 1993). A study conducted by Mahmoud and Usman (2014) in Lahore, Pakistan under the title "Consequences of Magnetized Water Application on Maize Seed Emergence in Sand Culture". They concluded that in all types of water tested, magnetic water treatment showed faster and heavier growth.

Due to the fact that magnets and electromagnetic devices are widely used in Iran, it is necessary to conduct research projects to fully answer the questions raised.

## 2. Materials and methods

In this experiment, a project with two types of water (magnetic water (MW) and ordinary water (N-MW)) was implemented in the Yousefabad village of Quchan. The farm had four deep wells, all of which were transferred into the water storage pond and after mixing the water from there was pumped into the fields. Ec The water output from the pool was about 4.55 dS/m, which had many restrictions on soil, plants and crops. Therefore, a magnet device and also an electromagnetic

device was installed in series with each other (package) in the path of the water outlet from the pool. In May, potatoes were planted in rows with Agria cultivar. Fertilization was determined based on soil test and the required fertilizer was applied to the soil. Row distances of 130 cm and planting distances of 20 cm were in accordance with the custom of the region. Water and soil characteristics of the study area were investigated by the Soil and Water Research Laboratory. According to the results of the soil test, the amount of fertilizer required was determined based on the recommendation of the Soil and Water Research

Institute. The characteristics of the magnetized water were qualitatively determined. Irrigation was done in the form of drip type with dropper intervals of 25 cm. Irrigation frequency and depth were based on local climate and customs. During the growing season, the necessary measurements were made to determine the important growth factors of potatoes and the effect of magnetized water on them. 186 days after planting potato tuber was harvested and potato yield was analyzed using a t-test by MSTAT-C statistical software. Also, the necessary diagrams were drawn by Excel. Software. The farm had four deep wells, the water of all wells were transferred into the water storage pool and after mixing, the water was pumped into the fields from there. Table 1 shows the results of water decomposition in the pool is brought. The results of the water analysis indicate the salinity of the pool water and the threshold of sodium water and the threshold of bicarbonate water and the presence of salts, especially high chlorine in it.

Also, two soil samples were taken from depths of 0-30 and 30-70 cm from the potato planting site and analyzed in the laboratory of the soil and water research department of Khorasan Razavi Agricultural Research Center, which is shown in Table 2. The result of the soil test shows that the field soil has silty clay loam texture at a depth of 0-30. It has a clay loam texture at a depth of 30-70 cm and is relatively sodium and on the verge of salinization. It is rich in phosphorus and potassium and lacks iron and organic matter.

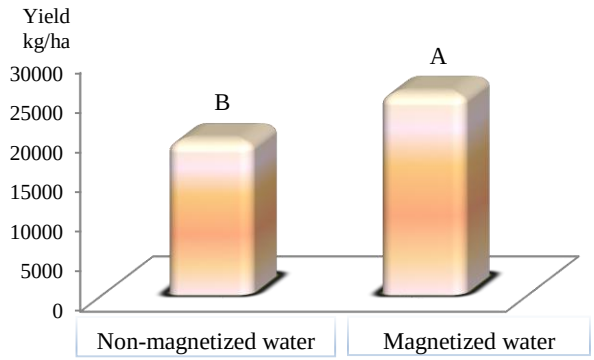


**Figure 1. Comparison of mean potato tuber yield in experimental treatments.**

**Table 1. Chemical characteristics of water in the study area.**

| Specifications | Ec (ds/m) | pH | $(Co3)^{2-}$ (meg/lit) | $HCO3^{-}$ (meg/lit) | Cl (meg/lit) | $(So4)^{2-}$ (meg/lit) | Ca+Mg (meg/lit) | $Ca^{2-}$ (meg/lit) | $Mg^{2+}$ (meg/lit) | $Na^{+}$ (meg/lit) | S.A.R |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pool water | 4.05 | 7.8 | 0.0 | 3.0 | 19.5 | 16.4 | 14.5 | 6.8 | 7.7 | 26.9 | 10.0 |

**Table 2. Physico-chemical characteristics of soil in the study area at two depths of 0-30 and 30-70 cm from the soil surface.**

| Dept cm | pH | EC (ds/m) | T.N.V % | O.C % | Sand % | Silt % | Clay % | P (ppm) | K (ppm) | Fe (ppm) | Mn (ppm) | Zn (ppm) | Cu (ppm) | B (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-30 | 7.8 | 1.96 | 19.5 | 0.70 | 18 | 53 | 29 | 24.3 | 354 | 2.04 | 3.90 | 15.12 | 1.60 | 2.81 |
| 30-70 | 7.8 | 2.36 | 20.8 | 0.4 | 28 | 39 | 33 | 2.5 | 273 | 2.80 | 2.82 | 0.62 | 1.72 | 2.34 |

## 3. Results and discussion

In Table 3 the yield of potato heads in two treatments of magnetic water and Tap water (control) is given in 12 replications.

We used a t-test to compare the means of two statistical populations (a: performance in the case of using magnetized water b: function of the gland in the case of using normal or control water). The results of the t-test are given in Table 4.

The results showed that the test of the assumption of the equality of the two means (Mean l = Mean 2) is invalid and there is a significant difference between the two mean communities. Our results are in agreement with the results of Hachicha et al. (2018). Based on their results, electromagnetic treatment of saline water can reduce the negative effect of salinity on corn

germination and potato crops and increase yield by about 10% in test conditions.

Therefore, the community that shows the highest average yield, is the community of tuber yield in the state of using magnetized water is superior.

Comparison of averages: Table 5 shows a comparison of the average yield of potato tubers in two modes of use in magnetic water and plain water. Comparing the means, we can see a 30% increase in performance in the case of using magnetized water compared to ordinary water (control).

**Table 3. Potato tuber function in two treatments of magnetic water and ordinary water (control).**

| Treatment Rep | Potato tuber yield kg/ha (Magnetized water) | Potato tuber yield (control) kg/ha |
|---|---|---|
| 1 | 28846.15 | 18076.9 |
| 2 | 28846.15 | 19230.8 |
| 3 | 19230.77 | 23076.9 |
| 4 | 25769.20 | 12692.3 |
| 5 | 21392.35 | 20384.6 |
| 6 | 28846.15 | 15386.6 |
| 7 | 26923.10 | 17307.7 |
| 8 | 25769.20 | 15384.6 |
| 9 | 23076.90 | 24861.5 |
| 10 | 23846.10 | 25000.0 |
| 11 | 26153.80 | 20769.2 |
| 12 | 25000.00 | 17307.7 |

**Table 4. T-Test analysis of potato tuber yield in two modes of using non-magnetized water and magnetized water.**

| Sample 1 | Sample 2 |
|---|---|
| 1- Magnetized water (MW) | 2-Non Magnetized water (NMW) |
| Mean: 25352.5 | Mean: 19423.13 |
| Var: 8807245.23 | Var: 14918400.46 |
| SD: 2967.70 | SD: 3862.43 |
| T-Test for hypothesis: variance 1 = variance 2 | |
| The variance of difference between the two mean: 6037682.2237 | |
| Standard deviation (Sd) of deference : 1751.480 | |
| T value:11 | |
| Effective Degrees of freedom:11 | |
| Probability T:0.0045 | |
| Result : significant t Reject the Hypothesis (confidence limits for the difference of the means for $\alpha$=0.05) | |
| So: non- meaning T for acceptation hypothesis mean1=mean 2 | |

**Table 5. Average tuber yield per hectare in both magnetic water and normal water.**

| Treatment | Average yield in plot | Yield kg/ha |
|---|---|---|
| Magnetized water | 79.1 | A 25353 |
| Water without magnet (control) | 60.6 | B 19423 |

**Figure 2 . Farm in two modes of irrigation with magnetized water (right) and non-magnetic water (left).**

**Figure 3. Comparison of the potato plant in two modes of irrigation with magnetized water (right) and non-magnetic water (left).**

The use of magnetized water increased potato tuber yield (about 30%) and reduced and even eliminated salinization of soil and secondly, no clogging of the drippers due to increased salt solubility in the magnetic state (Figs 1, 2 and 3). In addition, the use of magnetized water increased the duration of the greenery of the plant, which means that the duration of growth increased. As the green period of the plant

increases, the tubers have more time to grow and gain more volume and weight. This was evident on the farm, so harvesting was delayed by about a month in comparison to the field irrigated with saline water. Another benefit of magnetized water was the reduction of weeds, significant reduction of pests, which was evident in the visit to the farm. In terms of quality, the field and leaves were fresher and the product was crisp and high quality. Our results showed that the use of magnetized water in agriculture significantly increased yield, tuber quality, the vigor of plants, increased tuber volume and weight, increased the number of tuber per plant, clogging of the drippers decreased due to increased salt solubility and the possibility of reusing the blocked drippers, reducing the hardness of water and in other words increasing the solubility of water and this issue makes the plant more easily absorb water in saline conditions and leads to increased yields. In agreement with our results, Esitken and Turan (2004) and Selim and El-Nady (2011) have shown that there is an increase in the number of flowers, earliness and total fruit yield of strawberry and tomatoes with the application of magnetic fields.

## Acknowledgment

We would like to thank the management of Quchan Agricultural Jihad and the exemplary farmer Mr. Azizullah Sanjari for helping us in this research. Also, We thank Razi University for its financial support. We also would like to thank the valuable guidance of Dr. Danial Kahrizi from Razi University for his help in preparing the article. Thank to the Research and Development of Biseton Shafa Co., Kermanshah, Iran for technical supports.

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**HOW TO CITE THIS ARTICLE**

Rahimian M.H., Zabihi H.R. 2021. Investigation of the Reaction of Potato Plant to Magnetized Saline Water. *Agrotechniques in Industrial Crops* 1(3): 149-153. 10.22126/ATIC.2022.7145.1025