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Article

Effect of treatment by nutrient solution (SiliKaSol) and irrigation with magnetically treated water on some physical and chemical properties of tissue-grown short-stem banana plants in greenhouse conditions

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ABSTRACT

This study was conducted at the Agricultural Research and Experiment Station, College of Agriculture, Basra University, from 02.01.2018 to 30.06.2018 on the Indian short-stemmed banana plant *M.caredishii*, multiplied by tissue in the tissue culture laboratory of the Palm and Localized Research Center, at 6 months age. They were grown in a greenhouse equipped with a desert cooling system. The plants were sprayed with 5 concentrations of the nutrient solution SiliKaSol (0, 0.5, 1, 1.5, 2) ml l^{-1} and by 5 sprays between one spray and another 10 days starting from 02.01.2018. These plants were irrigated during the study period by two types of irrigation water: magnetically treated water and normal water. The most important results can be summarized as follows:- Spraying at a concentration of 2 ml l^{-1} of the nutrient solution showed a significant increase in the physical characteristics (increase in plant height and leaf area), reaching 32.33 cm and 312.83 cm^2, respectively, and an increase in chemical properties (content of leaves from proline, total soluble carbohydrates, total chlorophyll and nitrogen percentage in the leaves) reached 16.01 µg g^{-1}, 1.26 mg g^{-1} and 4.31 mg g^{-1}, respectively. The results also showed that the quality of irrigation water had a positive effect on improving most of the physical and chemical properties, as watering with magnetized water achieved an increase in plant height, leaf area, and dry weight of the leaves by 3.07 cm, 290.33 cm, 13.46 g, and 1.56 g, respectively, and caused an increase in the chemical properties of total soluble carbohydrates, total chlorophyll, and the percentage of NPK in leaves, which were 1.32 mg g^{-1}, 4.73 mg g^{-1}, 16.78%, and 1.32% and 20.39%, respectively.

Keywords: Banana, Water Magnatic, SiliKaSol, Nutrient solution.

INTRODUCTION

Banana plant Musa sp. It is a monocotyledonous plant native to India and Southeast Asia, where the wild plants Musa acumiuta and Musa balbisiaua were found. Their fruits contain seeds as it is grown in more than 130 countries in the tropical and subtropical regions of the Southern Hemisphere [1]. It is one of the most famous and cheapest tropical fruits available in most areas with high humidity. Approximately 90 calories, in addition to its richness in antioxidants,

vitamins, and minerals necessary for the human body, contribute to reducing the risk of cancer, high cholesterol levels, joint pain and improving blood flow. [2].

Foliar application is defined as the spraying of nutrient solutions on the vegetative total of the plant with specific concentrations, with no harm to the plant. Its effect does not depend on the growth and development of plants only but extends to the various vital activities that occur in the plant's tissues and affect its yield and components [3].

Many researchers indicated the role of foliar feeding in ensuring that the nutrient element enters the plant and then directly into the metabolism process, which reduces the energy consumption required for the transfer of ions of elements within the plant, as well as saving a lot of time and effort and the ability to mix nutrient solutions with pesticides and growth regulators [4]. The nutrient solution is characterized by containing some nutrients necessary for plant growth in balanced proportions with each other and referring to the role of the nutrient solution (SiliKaSol) in improving plant growth; in a study conducted by [5], spraying seedlings of three varieties of grapes are Al-Halawani, Deiss Al-Anz and Al-Fransi with concentrations (0, 0.4, 0.8, 1, 1.4) ml l^{-1}, the concentration of 1 ml l^{-1} gave the best significant increase in most of the studied traits.

Magnetized water is defined as the water we get after passing it through a specific magnetic field for a time. The factors on which the magnetization of water depends are the quantity of the magnetizing liquid and the magnet's strength used for the duration of the liquid's adhesion to the magnet. The period of the water's retention of properties after its magnetization varies according to the strength of the magnetic field used, the duration of its use, and the distance between the magnetizing source and the location of the cultivated plants [6]. [7] mentioned that magnetized water helps break the hydrogen bonds in salt water, which allows the plant to absorb water and minerals in high salinity soils. Irrigation with magnetically treated water effectively increases the ability of plants to grow and resist diseases, especially sensitive to salinity, such as banana plants. Due to the lack of local studies on the use of the nutrient solution SiliKaSol and the use of magnetized water in the irrigation of short-stemmed and tissue-multiple banana plants, the current study was conducted.

MATERIALS AND METHODS

The study was carried out at the Agricultural Research and Experiment Station of the College of Agriculture, Basra University, from 02.01.2018 to 30.06.2018. Indian short-stemmed banana plants, M.Caredishii, were used, as 30 tissue-accumulated banana plants at the age of 6 months were planted Figure 1. Inside the greenhouse, plants were planted on three lines; the distance between one line and another is 1.5 m, and between one plant and another 2 m by making a hole in the soil of dimensions (60 × 60) cm. The plants were planted in it, and then the pits were filled with soil to cover the root system. The soil around the root system was compacted with care Figure 2, and then it was irrigated with water. Table 1 represents the components of the cultivation soil.

Figure 1: A 6-month-old tissue banana plant

Figure 2: Banana plants are grown in the greenhouse.

Attributive	Value	Unit
EC	4.22	ds m^{-1}
PH	7.40	-
Total N	13.10	mg kg^{-1}
soluble K	10.60	
Ready P	0.77	
$Caco_3$	0.17	g kg^{-1}
Cl^- ions	1.08	mg kg^{-1}
clay	75	%
sand	15th	%
silt	10	%
soil texture	clay soil	

Table 1. Some chemical and physical properties of greenhouse soil during the growing season

Experiment execution plan:

Banana plants were sprayed with 5 concentrations of SiliKaSol nutrient solution (0, 0.5, 1, 1.5, 2) ml l-1 and two types of water. They are magnetized water and normal water (tap water). The electrical conductivity estimated (EC) of tap water and magnetized water in the Biotechnology Laboratory at the Palm Research Center using the Portable Kit EC device model NPC360D. Acidity was also measured using a pH-meter type HACH model HQ 411d, and the amount of two elements was estimated.Na and k are present in water according to the method described [8]. As for Ca, Mg and Cl, which were estimated according to what was described in [9] and HCO 3 according to what was mentioned in [10], and SO4 according to [11] Table 2, the plants were sprayed with the above treatments for 4 months and one spray every ten days, Three replicates were used for each treatment (concentration) (each plant represents one replication). By following up on the experiment, the following characteristics were studied:

1. The rate of increase in plant height is as follows:

Plant height at the end of the experiment - Plant height at the beginning of the experiment

2. The leaf area of the plant was calculated according to the following equation, according to what was mentioned [12].

A = 0.75 * L * W

Where: **A** is leaf area cm2; represents a constant **0.75**; **L** represents the length of a leaf; **W** represents the maximum width of the leaf.

3. Fresh weight and dry weight of leaves

Determination of fresh and dry weight according to [13].

4. Proline content of leaves

Determination of leaf tissue content of proline in laboratories of the College of Agriculture, Basra University, according to the method described by [14].

5. Leaves content of soluble carbohydrates

The total soluble carbohydrate content of leaves was estimated in the laboratories of Agriculture College, Basra University, according to the method described by [15].

6. Total chlorophyll content of leaves in the laboratories of the Palm Research Center according to the method described by [16].

7. Leaf tissue content of ions (%) N, P, K

Measured nitrogen and potassium according to the method described by [8] and estimated phosphorous according to a method by [17].

Item name	Chemical symbol	Before magnetization	After magnetization
		concentrations mg l-1	concentrations mg l-1
chloride	Cl^-	9.50	9.10
Sodium	Na^+	16.60	16.00
sulfate	SO_4^{-2}	5.20	5.30
magnesium	Mg^{+2}	4.90	5.00
Calcium	Ca^{+2}	3.50	3.60
potassium	K^+	0.08	0.13
carbonate	HCO_3^-	4.10	4.19
Ph	8.28		8.46
EC	3.80 **dS.m $^{-1}$**		3.70 **dS.m $^{-1}$**

Table 2: Chemical properties of irrigation water (tap) used in the experiment to irrigate plants

Experimental design

The experiment was carried out as a factorial experiment according to a randomized complete block design (RCBD), with three replicates for each treatment; the significance of the means was tested according to the Least Significant Difference (LSD) test at the 5% probability level [18]. Generate 2007 statistical program was used to analyze the results.

RESULTS

The physical characteristics

The results of Table 1 indicate the effect of spraying with different concentrations of SiliKaSol and watering with magnetically treated water on some physical characteristics of tissue-grown bananas. The most important of these characteristics were:

Increase in plant height

It is clear from the results in Table 3 that spraying with the nutrient solution Sili-KaSol caused a significant increase in plant height. The concentration achieved the highest results between (1.5 and 2 ml l^{-1}) without a significant difference, as recorded (31.50 and 32.33) cm, respectively.

As for the effect of the irrigation water quality, the irrigation treatments with magnetized water significantly outperformed the irrigation treatments with normal water and got the highest increase in plant height, which reached 30.73 cm.

The interaction between spraying with SilikaSol and watering with magnetically treated water was significant. The interaction coefficients (1.5 and 2) ml l^{-1} and magnetized water were superior, and they recorded (40.00 and 41.67) cm, and no significant difference was found between them.

Leaf area

The results of Table 3 indicate a significant increase in the leaf area with an increase in the concentration of spray solution; the concentration of 2 ml l^{-1} achieved the highest increase in leaf area and reached 312.83 cm^2. In comparison, the concentration of 0 ml l^{-1} achieved the lowest increase and reached 201.50 cm^2.

As for the effect on the irrigation water quality, irrigation with magnetized water had a positive impact on increasing leaf area; it scored 29.33 cm^2 with a significant difference from normal water, which recorded 217.73 cm^2. Perhaps irrigation with normal water may lead to the accumulation of salts to a greater extent than irrigation with water itself after its magnetization. The magnetic treatment affects the nature of hydrogen bonds between water molecules.

The interaction between spraying with different concentrations of the nutrient solution SiliKaSol and water quality was positive, as the treatment (2ml l^{-1} SiliKa-Sol and magnetized water) achieved the best results and recorded 330.30 cm^2

Fresh weight of leaf

Table 3 showed that spraying with different concentrations of the nutrient solution SiliKaSol caused a significant decrease in the fresh weight of banana leaves. The 2 ml l^{-1} recorded the lowest fresh weight at 9.99 g, while the concentration of 0 ml l^{-1} gave the highest fresh weight, reaching 14.58 g.

As for the effect on water quality, the results showed that irrigation with magnetized water caused an increase in the fresh weight of the leaf, which amounted to 13.46 g, compared to normal water, which gave 11.44 g.

The interaction between spraying with nutrient solution and water quality was positive, as the interaction treatment (0 ml l^{-1} with magnetized water) had the highest leaf fresh weight, reaching 13.73 g. The interaction treatment (2 ml l^{-1} with non-magnetized water) had the lowest fresh weight at 8.86 g.

SiliKaSol conc.ml l^{-1}	Water quality	Increase in plant height (cm)	leaves are cm^2	Fresh weight (g)	Dry weight (g)
0	normal	11.33	159.00	13.73	**1.84**
	magnetized	17.33	244.00	15.43	**1.68**
0.5	normal	15.33	167.00	12.44	**1.49**
	magnetized	25.00	267.67	14.51	**1.85**
1	normal	18.33	186.00	11.90	**1.20**
	magnetized	29.67	294.33	13.87	**1.61**
1.5	normal	23.00	281.33	10.28	**1.05**
	magnetized	40.00	315.33	12.46	**1.46**
2	normal	23.00	295.33	8.86	**0.977**
	magnetized	41.67	330.33	11.01	**1.070**
LSD (0.05)		2.47	6.541	0.208	**0.034**
The effect of water quality	normal	18.20	217.73	11.44	**1.28**
	magnetized	30.73	290.33	13.46	**1.56**
LSD (0.05)		1.10	4.137	0.131	**0.021**
Interaction effect	0	14.33	201.50	14.58	**1.67**
	0.5	20.17	217.33	11.37	**1.67**
	1	24.00	240.17	13.48	**1.40**
	1.5	31.50	298.33	12.88	**1.25**
	2	32.33	312.83	9.94	**1.02**
LSD (0.05)		1.75	9.251	0.294	**0.048**

Table 3: Effect of spraying with different concentrations of SiliKaSol and watering with magnetically treated water on some physical characteristics of tissue-grown banana plants.

Dry weight of leaves

The results of Table 3 indicate that spraying with different nutrient solution concentrations caused a significant decrease in the dry weight of the short-stem banana leaf. The concentration of 2 ml l^{-1} obtained the lowest dry weight leaf amounted to 1.02 g, while the concentrations (0, 0.5) ml l^{-1} were the highest dry weight of the leaf without significant difference between them it reached 1.67 g for both. This result agrees with the results of Paragraph C, as the decrease in the fresh weight in the above treatments led to a decrease in its dry weight. The effect of water quality that irrigation with magnetized water gave the highest increase in the dry weight of the leaf and amounted to 1.56 g. In comparison, irrigation with ordinary water gave the lowest dry weight and amounted to 1.28 g.

The interaction between the study factors was significant; the interaction treatment (0 ml l^{-1} with magnetized water) had the highest fresh weight of the leaf, 1.68 g, while the interaction treatment (2 ml l^{-1} with non-magnetized water) got the lowest fresh weight of the leaf was 0.077 g.

Chemical properties

The results of Table 5 indicate the effect of spraying with different concentrations of SiliKaSol and irrigation with magnetically treated water on some chemical properties of tissue-grown short-stem banana plants. The most important of these characteristics were:

Proline content of leaves

It is evident from the results of Table 2 that treatment with different concentrations of the nutrient solution SiliKaSol had a positive effect on increasing the leaf content of proline. The treatment with 2 ml l^{-1} SiliKaSol obtained the highest values. It amounted to 16.01 µg g^{-1} fresh weight with an insignificant difference between the two treatments (1, 1.5) ml l^{-1}, while the control treatment had the lowest content of proline in leaves, which was 13.85 µg g^{-1} fresh weight.

Figure 3: The nutrient solution SiliKaSol and the chemicals in its composition

Components	The ratio
Silicon (SiO2)	22.0%
Potassium (K2O) Soluble	11%
Seaweed Extract	2.0%
Amino Acid	2.0%
Fulvic Acid	0.5%
Humic Acid	0.5%

Table 4: Components solution alimentary silikaSol

As for the effect of water quality, the results showed that irrigation with normal water caused the highest accumulation of proline content in the tissues of the leaf, which amounted to 16.68 µg g^{-1} fresh weight as a record with magnetized water,

in which proline reached 13.44 µg g^{-1} fresh weight. The interaction between the concentrations of SiliKaSol and the irrigation water quality was positive. The interaction treatment (2 ml l^{-1} SiliKaSol and normal water) achieved, had the best results and obtained 18.17 µg g^{-1} fresh weight. The interaction treatment (0 ml l^{-1} and magnetized water) had the lowest values, 12.70 µg g^{-1} fresh weight**.**

Total soluble carbohydrates

Results of Table 5 indicate that spraying with different concentrations of SiliKaSol has a positive role in increasing the percentage of total soluble carbohydrates in the leaves of the short-stemmed banana plant ml l^{-1} SiliKaSol at the lowest values and amounted to 0.46 mg g^{-1} fresh weight. Plants irrigated with magnetized water in the proportion of carbohydrates obtained 1.32 mg g^{-1} fresh weight, while the percentage of total soluble carbohydrates in the leaves of plants irrigated with normal water was 0.39 mg g^{-1} fresh weight. This is due to the role of the magnetizing process of water that worked to wash away salts from soil loss and increase the availability of elements by cracking salt crystals, which was positively reflected in increasing the efficiency of the photosynthesis process and the formation of carbohydrates [30,31].

The interaction between the concentrations of the nutrient solution and the water quality was positive, as the interaction treatment (2 ml l^{-1} SiliKaSol with magnetized water) achieved the best results, obtaining 1.93 mg g^{-1} fresh weight. In comparison, the interaction treatment (0.5 ml l^{-1} with normal water) had the lowest value, and it was 0.26 mg g^{-1} fresh weight.

Total chlorophyll

Table 5 results indicate an increase in the total chlorophyll concentration in the banana plant leaves by increasing the concentration from the nutrient solution. The treatment with a 2 ml l^{-1} SiliKaSol obtained 4.31 mg g^{-1} fresh weight, while the treatment with a concentration of 0 ml l^{-1} obtained at least value amounted to 3.62 mg g^{-1} fresh weight.

The irrigation water quality had a positive effect on increasing the concentration of chlorophyll in the leaves. Irrigation with magnetized water increased the chlorophyll concentration in the leaves; it reached 4.73 mg g^{-1} fresh weight compared to normal water, which gave 3.90 mg g^{-1} soft weight.

The interaction between the study factors was positive in this trait, as the interaction treatment of 2 ml l^{-1}, SiliKaSol, and magnetized water had the highest value, reaching 2.73 mg g^{-1}, with an insignificant difference from the treatment of 1.5 ml l^{-1} of SiliKaSol and magnetized water, which obtained the lowest value, which was 3.58 mg g^{-1} fresh weight.

Percentage of nitrogen in the leaves

Table 5 clearly shows that the increase in the nutrient solution concentration caused an increase in the nitrogen concentration in leaves. When treated with 2 ml l^{-1}, it reached 16.01%, while it amounted to 13.84% when treated with 0 ml l^{-1}. The highest value was 16.78%, while the plants watered with normal water had the lowest value, 13.44%. This result can be explained by the fact that one of the properties of the magnetization of water is that it increases or decreases the number of hydrogen bonds between water molecules.

SiliKaSol conc. ml^{-1}	Water quality	Proline content of leaves µ g-1f.w	Total Soluble Carbohydrates mg g^{-1} fw	Total chl. l mg g^{-1}	N%	P%	K%
0	normal	14.88	0.18	3.58	12.70	0.18	**1.63**
	magnetized	12.70	0.75	3.85	14.98	0.75	**3.26**
0.5	normal	16.27	0.26	3.64	13.49	0.41	**2.76**
	magnetized	13.44	0.92	4.26	16.93	1.27	**3.46**
1	normal	16.93	0.41	3.73	13.69	0.51	**2.66**
	magnetized	13.49	1.27	4.46	17.56	1.76	**2.33**
1.5	normal	17.56	0.51	3.87	13.86	0.60	**2.49**
	magnetized	13.69	1.76	4.63	18.17	1.93	**1.97**
2	normal	18.17	0.60	3.90	13.90	0.71	**2.16**
	magnetized	13.86	1.93	4.73	19.08	1.99	**3.06**
LSD (0.05)		0.072	0.045	0.50	0.725	0.45	**0.056**
The effect of water quality	normal	16.78	0.39	3.74	13.44	0.39	**2.77**
	magnetized	13.44	1.32	4.38	16.78	1.32	**2.39**
LSD (0.05)		0.045	0.28	0.032	0.045	0.028	**0.035**
Interaction effect	0	13.85	0.46	3.72	13.84	0.46	**1.89**
	0.5	14.86	0.59	3.95	14.86	0.59	**3.36**
	1	15.21	0.84	4.09	15.21	0.84	**2.49**
	1.5	15063	1.14	4.25	15.63	1..40	**2.23**
	2	16.01	1.26	4.31	16.01	1.26	**2.19**
LSD (0.05)		0.102	0.063	0.071	0.102	0.063	**0.080**

Table 5. Effect of spraying with different concentrations of SiliKaSol and irrigation with magnetically treated water on some chemical properties of tissue-grown banana plants.

The interaction had a significant effect on this characteristic, as the interaction treatment (2 ml l^{-1} SiliKaSol and magnetized water) had the highest value and reached 19.08%, with a significant difference from the rest of the treatments. In comparison, the interaction treatment (0 ml l^{-1} SiliKaSol and ordinary water) had the lowest value and reached 12.70%.

Percentage of phosphorous in leaves

The results shown in Table 5 indicate the positive effect of spraying with the nutrient solution in increasing the phosphorous concentration in the leaves. The treatment 1.5 ml l^{-1} obtained the highest value of 1.40%, while the 0 ml l^{-1} treatment obtained the lowest value and amounted to 0.46%.

Water positively increased the phosphorous concentration in the leaves, as irrigation treatments with magnetized water obtained the highest value and amounted to 1.32%. In comparison, irrigation treatments with non-magnetized water obtained the lowest value and amounted to 0.39%.

Solution SiliKaSol and the irrigation water quality positively increased the percentage of phosphorous in the leaves. The interaction (0 ml l^{-1} and normal water) was at least 0.18%.

The percentage of potassium in the leaves

The results of Table 5 indicate that there are significant differences between the treatments in the percentage of potassium in the leaves, as the treatment obtained 0.5 ml. l^{-1} SiliKaSol had the highest concentration of potassium in its leaves, reaching 3.36%. In comparison, the treatment 0 ml l^{-1} had the lowest value and amounted to 1.89%.

The results show that irrigation treatments with magnetized water were significantly superior to those with non-magnetized (normal water) treatments got 2.39%. In comparison, the treatments of irrigation with non-magnetized water got 2.70%.

The dual interaction had a positive effect on increasing the potassium concentration in the leaves of banana plants. The treatment (0.5 ml l^{-1} SiliKaSol with magnetized water) had the highest potassium concentration in the leaves, which was 3.46%, while the interaction (0 ml l^{-1} SiliKaSol with non-magnetized water) got the lowest value and amounted to 1.63%.

DISCUSSION

Spraying with the nutrient solution, SiliKaSol caused a significant increase in plant height; perhaps the reason for this increase to the role of nutrient solution and its ability to fill the plant's need for the necessary nutrients in balanced quantities to complete the process of photosynthesis and other vital processes affecting the process of cell division and elongation, which was positively reflected on the rate of plant height [19]. However, there was a significant increase in the leaf area with an increase in the concentration of spray solution; the reason for this is due to the richness of the nutrient solution with many compounds, such as humic acid and potassium, in addition to the amino acids Figure 1, which are involved in building protein and the chlorophyll molecule and create the hormone indole acetic acid, which was positively reflected on the leaf area [20]. Irrigation with magnetized water had a positive impact on increasing leaf area. It leads to high absorption of the elements necessary for cell division and elongation, reflected in vegetative growth characteristics, including leaf area [21]. The result showed that accumulation of the contents of nutrient solution in leaves with an increase in its concentration might cause an increase in the mineral elements and carbohydrate content in the leaf and a decrease in its water content [5,22]. Likewise, irrigation with magnetized water caused an increase in the fresh weight of the leaf. The reason may be that magnetized water can penetrate the cell walls and thus fill the cells with water, which leads to an increase in leaf fresh weight [23]. Treatment with different concentrations of the nutrient solution SiliKaSol had a positive effect on increasing the leaf content of proline. The reason for this may be attributed to the fact that the components of the nutrient solution of humic acid amino acids Figure 3 and Table 3 were reduced from the severity of vital tension by increasing the accumulation of the amino acid proline in tissues leaf, which worked to create a state of physiological balance between the juice gap and the cytoplasm [24]. Proline is an osmotic protector of cell membranes and a co-factor in maintaining the vital energy of cells and protecting enzymes through its ability to scavenge free radicals [25,26,27]. The data observed that irrigation with normal water caused the highest accumulation of proline content in the tissues of the leaf. This result can be explained because the

water is Untreated magnetically. The salt content is very high, which pushes the plant with the plant to maintain its physiological balance to form proline acid in large quantities [28]. Moreover, there are high concentrations of the nutrient solution containing its composition of nutrients, humic acid, amino acids, and algae extract Figure 3, which works to increase cell division and elongation and increase Leaf area and leaves the content of total chlorophyll, which was positively reflected on the efficiency of the photosynthesis process and food processing in the leaves [29] and [37]. An increase was observed in the total chlorophyll concentration in the banana plant leaves by increasing the concentration used from the nutrient solution. The reason for this superiority may be due to the effect of the nutrient solution containing algae extract, amino acids, and silicon, as these substances act as inhibitors to the oxidation process and thus prevent the erosion of the chlorophyll molecule as a result of containing obtains compounds, which increased the chlorophyll content in Papers [32]. The interaction between the study factors was positive in the total chlorophyll. Perhaps the reason for this is due to the ability of magnetized water to increase the absorption of exchanged ions and increase the readiness of nutrients, including iron and magnesium, which are included in the composition of the chlorophyll molecule, which was positively reflected in the concentration of chlorophyll in the leaves [33]. Furthermore, an increase in the nutrient solution concentration caused an increase in the concentration of nitrogen in leaves. Perhaps the reason for this is due to the richness of the nutrient solution in amino acids, which is a good source of nitrogen [34], in addition to the presence of other compounds, such as humic acid, which can increase the permeability of the cell membranes, which helps to increase and improve the absorption of nutrients such as nitrogen and increase their movement through the root hairs and thus increase their accumulation in the tissues of the leaf [29]. It also changes the speed of composition and crystal form, as it restricts the bonding of ions in water and thus increases ions' polarization and works to reduce the surface tension of water [23]. The positive effect of spraying with the nutrient solution in increasing the phosphorous concentration in the leaves The reason for this may be attributed to the positive effect of the components of the nutrient solution, which contributed to improving the nutrient growth characteristics and increased the efficiency of the leaf in absorbing nutrients, including phosphorous [35]. Water had a positive effect on increasing the phosphorous concentration in the leaves. This result can be explained by exposing the water to a field. Magnetic energy increases the water absorption capacity of the ions exchanged with it and increases the availability of nutrients in the soil, including phosphorous [36].

CONCLUSION

This study showed that the interaction between spraying with different concentrations of SiliKaSol and irrigation with magnetized water had a positive effect, and the treatment of 2ml l^{-1} SiliKaSol and irrigation with magnetized water was superior in most of the studied traits.

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