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Irrigation with Magnetically Treated Water, Foliar Application of Ascorbic Acid and Cobalt for Improving Onion Growth, Yield and Quality

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ABSTRACT

Two field experiments were performed aiming to assess the impact of irrigation with different types of water (Non-treated irrigation water and magnetically treated irrigation water) as main plots and exogenous application of some stimulants as sub plots at different rates ,*i.e.*, 0.0,100,150 and 200 mg ascorbic acid L^{-1} and cobalt sulphate at rates of 20,40 and 60 mg Co L^{-1} on the performance of onion plants during two successive seasons. The results indicated that onion plants irrigated with magnetically treated water possessed growth, yield and quality parameters better than that irrigated with non-treated water. Regarding foliar application, the control treatment gave the lowest performance compared to the other six treatments of both ascorbic acid and cobalt. On the other hand, the values of growth, yield and quality parameter under ascorbic acid treatments were better than that under cobalt treatments, where the performance significantly increased as the rate of ascorbic acid increased, while the performance under cobalt treatments significantly increased with increasing added cobalt from 0.0 mg L^{-1} to 20 and 40 mg Co L^{-1} and then significantly decreased at 60 mg Co L^{-1}, where the toxicity of cobalt might appear on the plants grown at this rate. Also, the interaction between irrigation with magnetically treated water and foliar sprayed with ascorbic acid at rate of 200 mg L-1 gave highest significant values of plant growth parameters, yield and quality parameters (Vit .C , TSS, dry matter , total sugar, fiber, Anthocyanin, pyruvic acid , carbohydrates and protein).

***Keywords**: Irrigation water, magnetically treated water, stimulants, ascorbic acid, cobalt and onion plants.*

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family of Amaryllidaceae. It is considered an important vegetable crop in Egypt. It contains antioxidants and compounds that fight inflammation, decrease triglycerides and reduce cholesterol levels all of which may lower heart disease risk. Their potent anti-inflammatory properties may also help reduce high blood pressure and protect against blood clots (Golubkina and Caruso, 2020).

Currently, magnification of irrigation efficiency is becoming necessary due to the water shortage in all countries of the world, including Egypt, thus we must work on improving the properties of irrigation water. Recently researches indicate many positive effects of using magnetically treated water techniques for irrigation purposes.

Magnetically treated water technology is a promising approach to address the requirement of optimization of irrigation efficiency. This technology has widely investigated and adopted in the agriculture sector in many countries. Many studies proved that magnetically treated water helps plants easily absorb nutrients from the soil, where the magnetization of low-quality water *e.g.,* agricultural drainage water, reduces its hazard salinity influences on plants and soil due to its ability to washing of different anions from the soil, thus leaching away salts. In other words, subjecting low-quality water to a magnetic field leads to modification of its traits, as it becomes more energetic, therefore abler to flow. Also, subjecting the water to a magnetic field prevents the absorption of heavy metals and increases absorption of essential nutrients *e.g.,* P and K by plant roots, where this treated water dissolves more essential and beneficial nutrients into the root zone to become available and subsequently stimulating plant growth (Faiyad and Hozayn, 2020).

Plants which irrigated with magnetized water had many benefits as well as; raising rate of germination, growth of roots and shoots system, development of inflorescence and fruiting, fruits number, yield and quality as well as decrease the amounts of irrigation water, the solubility of salts and pH (Grewal and Maheshwari, 2011). Magnetized water treatment might potentially diminish the application of fungicides, insecticides, herbicides, which are expensive costs and often harmful human health and environment (Aliverdi *et al.*, 2015).

Doklega (2017) cleared that irrigation potato plants with magnetically treated water produced the highest significant values of plant growth, chlorophylls, yield, chemical composition and quality parameters except nitrate (NO_3) and nitrite (NO_2) contents compared to normal water treatments.

One of the protective ways from environmental stress is treating the plants with antioxidants *e.g.,* ascorbic acid as an foliar application, where it plays a beneficial role in scavenging reactive oxygen species (ROS) resulting from oxidate stress in addition to its essential role in cell division and expansion (Fouda, 2021). Majeed *et al.* (2019) investigated the effects of foliar application of ascorbic acid at rates of 0.0, 250 and 500 ppm on growth and

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productivity of potato. The results showed that the treatment of 250 ppm was superior in plant yield and tuber weight as well as leaf chlorophyll, P and K content. Beside, Khazaei and Estaji (2020) reported that external application of ascorbic acid enhanced the growth performance and antioxidants of sweet pepper plants under drought stress.

Cobalt is classified as an essential element in plant nutrition according to the Official Journal of the European Union, REGULATION (EU) 2019/ 1009. Many studies confirmed the vital role of the cobalt element in improving the plants performance. Gad and Kandil (2010) evaluated the effect of cobalt and different sources of phosphorus fertilizers on the performance and yield quantity of tomato, where their results showed that cobalt addition increased all parameters of tomato growth and yield with all sources of P fertilizers. Beside, Gad (2012) found that cobalt had a appositive role in improving growth performance and yield of cowpea plants.

The current study was performed to evaluate the effect of magnetically treated irrigation water on the performance of onion plants and some foliar applications ,*i.e*, ascorbic acid and cobalt element.

MATERIALS AND METHODS

1. Experimental Site and Climate Conditions.

The present investigation was performed in a private farm located in Mansoura city, Egypt.

2.Experimental Setup.

Two experiments were done during two successive winter seasons 2019/2020 and 2020/2021 at the Experimental Station Mansoura Univ., Egypt to evaluate the effect of irrigation with magnetically treated water, foliar application of ascorbic acid and cobalt on vegetative growth, chemical composition, yield, and quality parameters of onion plants.

The experiment layout was split-plot system in a randomized complete block design with 3 replicates. The main plots were for irrigation water treatments (magnetized and non- magnetized) while foliar application treatments (ascorbic acid and cobalt) were distributed in the sub plots.

The experimental sub plot area was 15.75 m^2 (4.5 m × 3.5 m with a separator of 2.5 m between both main irrigation plots with 8 ridges of 0.75 m wide and 3.0 m long in each sub plot). Onion seedlings (**Cv. Giza Red**, **60 days old**) were transplanted on 25th October.

The magnetized water was obtained by passing through a magnetically treated water unit (2.0 inch diameter, 0.60 mT and supplied.

Both ascorbic acid (0.0,100,150 and 200 mg/L) and cobalt sulphate (20,40 and 60 mg Co L-1) were obtained from El-Gamhoria Company, Egypt and its foliar application was repeated three times with three weeks intervals starting the 3rd irrigation event for both, where these materials were applied with a solution volume of 500 L fed^{-1} for both. Generally, both fertilization processes and all traditional agricultural practices for onion production were done according to Ministry of Agri. and Land Rec. in Egypt.

3.Soil and irrigation water Analyses.

The characteristics of planting soil (at depth of 0-30 cm) of the experimental site as well as irrigation water before and after the subjecting to magnetization analysis are presented in Tables 1 and 2, where the analyses were according to Dane and Topp (2020) and Sparks *et al.* (2020).

Table 1. Characteristics of the planting soil.

Physical properties	Value
Mechanical analysis	
Sand,%	17.32
Silt ,%	33.18
Clay,%	50.50
Texture class is clay	
Chemical properties	
CEC, cmol kg^{-1}	49.0
Organic matter,%	1.75
$CaCO_3$, %	1.75
EC_w, dS m^{-1}	2.65
pH (1:2.5 soil suspension)	8.10
Available nutrients, mg kg^{-1}	
Nitrogen	51.5
Phosphorus	8.22
Potassium	220

Table 2. Chemical analysis of the irrigation water before and after the subjecting to magnetization.

Parameter	Non-treated water	Magnetically treated water
pH	7.300	7.100
EC (dSm^{-1})	2.05	1.85
**SAR, meq l^{-1}	9.39	9.60
***RSC, meq l^{-1}	-2.1	-1.19
Soluble cations, meq L^{-1}		
Ca^{+2}	2.465	1.650
Mg^{+2}	2.800	2.695
Na^+	15.24	14.15
K^+	0.005	0.005
Soluble anions, meq L^{-1}		
CO_3^{-2}	--	--
HCO_3^-	3.16	3.15
Cl^-	15.5	13.6
SO_4^{-2}	1.85	1.75

**** Sodium adsorption ratio (SAR)=Na/SQRT (Ca^{+2} + Mg^{+2})/2**
*****Residues sodium carbonate (RSC) = (CO_3^{-2} + HCO_3^-)- (Ca^{+2} + Mg^{+2})**

4.Measurement traits.

After 95 days from transplanting, some growth and chemical traits of onion plants were determined as follows;

- Foliage fresh and dry weights were measured.
- Total chlorophyll and carotene contents were determined according to Şükran *et al.* (1998).
- Nutrients ,*i.e.*, Nitrogen, phosphorus and potassium were determined according to Tandon (2005).

When bulbs reached to the proper maturing stage, harvesting was done, where some physical and quality characteristics of bulbs were determined as follows;

- **Physical characteristics of bulbs and total yield:** Average bulb weight, total bulb yield and marketable bulb yield.
- **Quality characteristics of bulbs**: Vitamin C and total soluble solid (TSS) were determined according to AOAC (2000). To calculation of dry matter (DM), onion samples were oven-dried at 70 C° until constant weight. Total sugar and fiber were determined according to AOAC (2000). Anthocyanin pigment was determined as described by Crecente-Campo *et al.* (2012). Pyruvic acid was determined according to Anthon and Barrett (2003). Carbohydrates and crude protein were determined according to AOAC (2000).

5.Statistical Analysis.

Data was statistically analyzed according to Gomez and Gomez (1984) and the treatment means were compared according to Duncan (1955)

RESULTS AND DISCUSSION

Magnetically treated water effect:

Data of Tables 3, 4, 5, 6 and 7 show that onion plants irrigated with magnetically treated water possess the highest values of vegetative growth parameters, chemical constituents and quality parameters compared to plants irrigated with non-treated water and the differences were significant. Also, it can be noticed that improvement of growth criteria as a result of irrigation with magnetically treated water positively reflected bulbs yield and characteristics. The superiority of magnetically treated water may be attributed to changes in its properties ,*i.e.*, viscosity, hydrogen bonding, polarity, conductivity and solubility of salts, pH and surface tension and these changes improved onion plant performance. Many studies proved that these changes in water characters capable to affect the plant's performance (Ali *et al.*, 2017; Hozayn *et al.*, 2020 and Sarraf *et al.*, 2020).

Foliar application effect:

Data illustrate that control treatment recorded the lowest values of vegetative growth criteria and chemical constituents as well as bulbs yield and characteristics compared to the other six treatments of both ascorbic acid and cobalt. On the other hand, the values of all aforementioned traits under ascorbic acid treatments were better than that under cobalt treatments, where the performance significantly increased as the rate of ascorbic acid increased, while the performance under cobalt treatments significantly increased with increasing added cobalt from 0.0 mg L^{-1} to 20 and 40 mg Co L^{-1} and then significantly decreased at 60 mg Co L^{-1}, where the toxicity of cobalt might appear on the plants grown at this rate.

The superiority of ascorbic acid may be attributed to its vital role in cell wall expansion and cells division in addition to its key role in the ascorbate-glutathione pathway. Similar results were obtained by Farooq *et al.* (2020).

The positive effect of cobalt at concentrations of 20 and 40 mg Co L^{-1}) may be due to its role in reducing the rate of transpiration, where cobalt element may be caused an increase in the leaf water potential relative, therefore improvement of the photosynthesis process which positively reflected on bulbs yield and quality parameters. Our findings are in accordance with those of Akeel and Jahan (2020).

Interaction effect:

Data elucidate that onion plants irrigated with magnetically treated water and sprayed with ascorbic acid at rate of 200 mg L^{-1} have the best performance compared to other combined treatments in all measurements and the differences were significant.

The obtained results took the same direction for all vegetative and chemical measurements, yield and its components and the influence of treatment with magnetically treated water and both ascorbic acid and cobalt treatments, where these treatments play important roles in influencing the growth of plants, which is reflected positively on all measurements mentioned in the tables.

The effect of magnetically treated water on the differences between normal and magnetically treated water is clear as shown in the same tables, and this in turn is the reason for the superiority of magnetically treated water as previously mentioned.

Table 3. Impact of investigated treatments on growth parameters and photosynthetic pigments of onion plants after 95 days from transplanting during seasons of 2019/2020 and 2020/2021.

Treatments		Plant fresh weight		Plant dry weight		T. chlorophyll		Carotene	
		g/ plant				mg/ g F.W			
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Irrigation water treatments									
Non-treated water		64.38b	65.91b	7.58b	7.73b	1.061b	1.086b	0.426b	0.434b
Magnetically treated water		68.88a	70.31a	8.17a	8.37a	1.174a	1.201a	0.511a	0.523a
Foliar applications									
Cont.		64.66g	65.92e	7.60d	7.83d	1.068e	1.094d	0.438f	0.450f
100 mg L^{-1} Ascorbic acid		67.28c	68.71bc	7.98abc	8.09b	1.136b	1.160b	0.481c	0.491c
150 mg L^{-1} Ascorbic acid		67.94b	69.47ab	8.07ab	8.23a	1.147ab	1.181a	0.492b	0.502b
200 mg L^{-1} Ascorbic acid		68.55a	70.11a	8.16a	8.30a	1.165a	1.187a	0.503a	0.515a
20 Cobalt mg L^{-1}		65.97e	67.27d	7.81cd	7.98bc	1.104cd	1.125c	0.455e	0.463e
40 Cobalt mg L^{-1}		66.64d	68.00cd	7.89bc	8.05b	1.115c	1.146b	0.467d	0.479d
60 Cobalt mg L^{-1}		65.39f	67.29d	7.60d	7.89cd	1.088d	1.112cd	0.444f	0.453f
Interaction									
Non-treated water	Cont.	62.38n	63.65h	7.28i	7.50h	1.008l	1.033j	0.406j	0.415i
	100 mg L^{-1} Ascorbic acid	65.03j	67.01ef	7.66e-h	7.80efg	1.078hi	1.102fg	0.435h	0.444g
	150 mg L^{-1} Ascorbic acid	65.67i	67.21ef	7.75efg	7.91ef	1.092gh	1.125f	0.447g	0.455fg
	200 mg L^{-1} Ascorbic acid	66.30h	67.81e	7.84def	7.97e	1.109fg	1.130ef	0.458g	0.467f
	20 Cobalt mg L^{-1}	63.78l	64.68gh	7.51ghi	7.62gh	1.049jk	1.068hi	0.412ij	0.419hi
	40 Cobalt mg L^{-1}	64.39k	66.01fg	7.58f-i	7.75fg	1.060ij	1.088gh	0.422i	0.430h
	60 Cobalt mg L^{-1}	63.13m	64.97gh	7.41hi	7.56h	1.031kl	1.053ij	0.403j	0.411i
Magnetically treated water	Cont.	66.93g	68.18de	7.92cde	8.15d	1.127ef	1.156de	0.471f	0.485e
	100 mg L^{-1} Ascorbic acid	69.53c	70.41bc	8.30ab	8.38bc	1.193bc	1.218ab	0.527b	0.537bc
	150 mg L^{-1} Ascorbic acid	70.20b	71.73ab	8.38ab	8.54ab	1.202ab	1.238a	0.536b	0.549b
	200 mg L^{-1} Ascorbic acid	70.79a	72.40a	8.48a	8.63a	1.220a	1.243a	0.549a	0.562a
	20 Cobalt mg L^{-1}	68.16e	69.85c	8.11bcd	8.34c	1.160d	1.181cd	0.498d	0.507d
	40 Cobalt mg L^{-1}	68.89d	70.00c	8.19abc	8.35c	1.171cd	1.203bc	0.513c	0.527c
	60 Cobalt mg L^{-1}	67.64f	69.61cd	7.78efg	8.21cd	1.145de	1.170d	0.486e	0.496de

The treatment means were compared according to Duncan (1955)

Table 4. Impact of investigated treatments on N,P and K content in onion plants after 95 days from transplanting during seasons of 2019/2020 and 2020/2021.

Treatments		N%		P %		K%	
		1st	2nd	1st	2nd	1st	2nd
Irrigation water treatments							
Non-treated water		2.95b	3.07b	0.269b	0.274b	2.47b	2.52b
Magnetically treated water		3.57a	3.68a	0.324a	0.332a	2.94a	3.00a
Foliar applications							
Cont.		2.99g	3.09d	0.273g	0.279g	2.50g	2.55g
100 mg L^{-1} Ascorbic acid		3.35c	3.47bc	0.304c	0.310c	2.75c	2.82c
150 mg L^{-1} Ascorbic acid		3.44b	3.58ab	0.312b	0.317b	2.84b	2.90b
200 mg L^{-1} Ascorbic acid		3.52a	3.67a	0.320a	0.328a	2.92a	2.98a
20 Cobalt mg L^{-1}		3.18e	3.20d	0.289e	0.298e	2.64e	2.69e
40 Cobalt mg L^{-1}		3.26d	3.38c	0.296d	0.303d	2.70d	2.75d
60 Cobalt mg L^{-1}		3.10f	3.21d	0.281f	0.287f	2.58f	2.64f
Interaction							
Non-treated water	Cont.	2.65l	2.75j	0.245k	0.249j	2.22l	2.27k
	100 mg L^{-1} Ascorbic acid	3.04i	3.16gh	0.275h	0.280fg	2.53i	2.59h
	150 mg L^{-1} Ascorbic acid	3.13h	3.27fg	0.284g	0.287f	2.62h	2.69g
	200 mg L^{-1} Ascorbic acid	3.21g	3.34f	0.294f	0.301e	2.71g	2.76f
	20 Cobalt mg L^{-1}	2.89j	3.00hi	0.261ij	0.268h	2.40j	2.45i
	40 Cobalt mg L^{-1}	2.96j	3.08h	0.268hi	0.273gh	2.48i	2.53h
	60 Cobalt mg L^{-1}	2.78k	2.88ij	0.254j	0.261i	2.33k	2.38j
Magnetically treated water	Cont.	3.32f	3.43ef	0.302e	0.308d	2.77f	2.84e
	100 mg L^{-1} Ascorbic acid	3.67c	3.79bc	0.333b	0.340b	2.98c	3.06b
	150 mg L^{-1} Ascorbic acid	3.75b	3.90ab	0.339ab	0.347b	3.07b	3.12b
	200 mg L^{-1} Ascorbic acid	3.84a	4.00a	0.346a	0.354a	3.14a	3.20a
	20 Cobalt mg L^{-1}	3.48e	3.40ef	0.317d	0.327c	2.88de	2.93cd
	40 Cobalt mg L^{-1}	3.57d	3.68cd	0.325c	0.332c	2.92cd	2.96c
	60 Cobalt mg L^{-1}	3.41e	3.54de	0.309e	0.313d	2.83ef	2.89de

The treatment means were compared according to Duncan (1955)

Table 5. Impact of investigated treatments on average weight of bulbs and total yield at harvest stage during seasons of 2019/2020 and 2020/2021.

Treatments		Average bulb weight g F.W		Total bulb yield Ton h^{-1}		Marketable bulb yield Ton h^{-1}	
		1st	2nd	1st	2nd	1st	2nd
Non-treated water		92.90b	94.66b	34.19b	34.84b	32.32b	33.07b
Magnetically treated water		109.08a	110.93a	40.14a	40.82a	38.26a	39.02a
Cont.		93.89g	95.51g	34.55g	35.15g	32.74g	33.38g
100 mg L^{-1} Ascorbic acid		103.26c	105.41c	38.00c	38.79c	36.16c	36.86c
150 mg L^{-1} Ascorbic acid		105.73b	107.58b	38.91b	39.59b	36.98b	37.85b
200 mg L^{-1} Ascorbic acid		107.98a	109.76a	39.74a	40.39a	37.81a	38.64a
20 Cobalt mg L^{-1}		98.70e	100.51e	36.32e	36.99e	34.48e	35.12e
40 Cobalt mg L^{-1}		101.13d	103.16d	37.22d	37.97d	35.25d	35.96d
60 Cobalt mg L^{-1}		96.24f	97.64f	35.41f	35.93f	33.59f	34.54f
Non-treated water	Cont.	85.82n	87.60n	31.58n	32.24n	29.85i	30.45n
	100 mg L^{-1} Ascorbic acid	95.24j	97.47j	35.05j	35.87j	33.17g	34.13j
	150 mg L^{-1} Ascorbic acid	97.56i	99.54i	35.90i	36.63i	33.98fg	34.84i
	200 mg L^{-1} Ascorbic acid	99.76h	101.68h	36.71h	37.42h	34.79ef	35.61h
	20 Cobalt mg L^{-1}	90.64l	92.03l	33.36l	33.87l	31.53h	31.90l
	40 Cobalt mg L^{-1}	93.02k	94.71k	34.23k	34.85k	32.28h	33.05k
	60 Cobalt mg L^{-1}	88.26m	89.59m	32.48m	32.97m	30.63i	31.53m
Magne tically treated water	Cont.	101.96g	103.42g	37.52g	38.06g	35.63e	36.31g
	100 mg L^{-1} Ascorbic acid	111.27c	113.35c	40.95c	41.71c	39.15b	39.59c
	150 mg L^{-1} Ascorbic acid	113.90b	115.61b	41.92b	42.54b	39.98ab	40.86b
	200 mg L^{-1} Ascorbic acid	116.21a	117.83a	42.77a	43.36a	40.83a	41.66a
	20 Cobalt mg L^{-1}	106.75e	109.00e	39.28e	40.11e	37.42c	38.33e
	40 Cobalt mg L^{-1}	109.24d	111.61d	40.20d	41.08d	38.22c	38.87d
	60 Cobalt mg L^{-1}	104.21f	105.69f	38.35f	38.89f	36.55d	37.54f

The treatment means were compared according to Duncan (1955)

Table 6. Impact of investigated treatments on quality characteristics of bulbs at harvest stage during seasons of 2019/2020 and 2020/2021.

Treatments		Vitamin C mg $100g^{-1}$		TDS %		Dry matter %		Total sugar %		Fiber %	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Irrigation water treatments											
Non-treated water		11.38b	11.62b	10.77b	11.45b	10.58b	10.83b	7.37b	7.55b	2.92b	2.97b
Magnetically treated water		13.13a	13.39a	12.07a	14.19a	12.20a	12.44a	8.11a	8.27a	3.83a	3.91a
Foliar applications											
Cont.		11.43g	11.76g	10.85e	11.63g	10.67g	10.87f	7.39f	7.53e	2.96g	3.03g
100 mg L^{-1} Ascorbic acid		12.54c	12.67c	11.59b	13.19c	11.66c	11.89c	7.86bc	8.05b	3.51c	3.59c
150 mg L^{-1} Ascorbic acid		12.77b	13.10b	11.79a	13.58b	11.86b	12.14b	7.96ab	8.12ab	3.62b	3.69b
200 mg L^{-1} Ascorbic acid		13.04a	13.30a	11.99a	14.00a	12.12a	12.38a	8.06a	8.25a	3.75a	3.83a
20 Cobalt mg L^{-1}		12.01e	12.23e	11.25c	12.46e	11.13e	11.34e	7.64de	7.81cd	3.27e	3.33e
40 Cobalt mg L^{-1}		12.28d	12.52d	11.42bc	12.80d	11.38d	11.62d	7.74cd	7.90c	3.39d	3.46d
60 Cobalt mg L^{-1}		11.71f	11.96f	11.05d	12.06f	10.92f	11.24e	7.55e	7.70d	3.10f	3.17f
Interaction											
Non-treated water	Cont.	10.48n	10.77n	10.16m	10.26n	9.87j	10.06j	6.99l	7.12k	2.49n	2.54m
	100 mg L^{-1} Ascorbic acid	11.66j	11.78j	10.94ij	11.79j	10.83g	11.16g	7.49hi	7.71gh	3.05j	3.10j
	150 mg L^{-1} Ascorbic acid	11.90i	12.15i	11.16hi	12.20i	11.05g	11.33fg	7.60gh	7.78fg	3.16i	3.21i
	200 mg L^{-1} Ascorbic acid	12.16h	12.40h	11.36gh	12.61h	11.31f	11.57ef	7.68fg	7.88efg	3.28h	3.35h
	20 Cobalt mg L^{-1}	11.17l	11.48l	10.60kl	11.13l	10.33hi	10.46i	7.29jk	7.48ij	2.83l	2.88k
	40 Cobalt mg L^{-1}	11.45k	11.68k	10.76jk	11.43k	10.57h	10.84h	7.38ij	7.54hi	2.96k	3.02j
	60 Cobalt mg L^{-1}	10.83m	11.05m	10.41lm	10.72m	10.12ij	10.42i	7.16kl	7.31jk	2.65m	2.70l
Magnetically treated water	Cont.	12.38g	12.75g	11.54fg	13.01g	11.47ef	11.69e	7.80ef	7.94def	3.43g	3.52g
	100 mg L^{-1} Ascorbic acid	13.42c	13.56c	12.24bc	14.59c	12.48b	12.61b	8.23bc	8.38b	3.98c	4.07c
	150 mg L^{-1} Ascorbic acid	13.63b	14.04b	12.42ab	14.96b	12.68ab	12.96a	8.32ab	8.45ab	4.09b	4.18b
	200 mg L^{-1} Ascorbic acid	13.91a	14.19a	12.61a	15.40a	12.93a	13.18a	8.43a	8.61a	4.22a	4.31a
	20 Cobalt mg L^{-1}	12.85e	12.99e	11.91de	13.79e	11.93cd	12.21cd	7.99d	8.14cd	3.71e	3.78e
	40 Cobalt mg L^{-1}	13.12d	13.36d	12.08cd	14.17d	12.18c	12.39bc	8.09cd	8.27bc	3.83d	3.90d
	60 Cobalt mg L^{-1}	12.60f	12.86f	11.69ef	13.40f	11.73de	12.05d	7.94de	8.08cde	3.55f	3.63f

The treatment means were compared according to Duncan (1955)

Table 7. Impact of investigated treatments on anthocyanin pigment, pyruvic acid , carbohydrates and protein of bulbs at harvest stage during seasons of 2019/2020 and 2020/2021

Treatments		Anthocyanin mg $100g^{-1}$		Pyruvic acid µmol $.g^{-1}$		Carbohydrates %		Protein %	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Irrigation water treatments									
Non-treated water		26.82b	27.34b	5.12b	5.22b	16.10b	16.49b	7.59b	7.77b
Magnetically treated water		28.55a	29.04a	6.77a	6.89a	17.68a	18.01a	8.54a	8.71a
Foliar applications									
Cont.		26.95e	27.44f	5.32g	5.42g	16.21g	16.52f	7.63g	7.78d
100 mg L^{-1} Ascorbic acid		27.84bc	28.43c	6.15c	6.26c	17.10c	17.50bc	8.22c	8.38b
150 mg L^{-1} Ascorbic acid		28.13ab	28.64b	6.35b	6.45b	17.31b	17.66b	8.33b	8.52a
200 mg L^{-1} Ascorbic acid		28.41a	28.89a	6.61a	6.75a	17.56a	17.97a	8.47a	8.65a
20 Cobalt mg L^{-1}		27.49cd	27.98d	5.73e	5.84e	16.66e	17.04de	7.94e	8.08c
40 Cobalt mg L^{-1}		27.74bc	28.32c	5.95d	6.04d	16.96d	17.31cd	8.09d	8.26b
60 Cobalt mg L^{-1}		27.22de	27.63e	5.53f	5.64f	16.43f	16.75ef	7.79f	8.01c
Interaction									
Non-treated water	Cont.	26.13k	26.70j	4.57l	4.69n	15.39m	15.70k	7.13k	7.27l
	100 mg L^{-1} Ascorbic acid	26.84hij	27.48h	5.26j	5.34j	16.30i	16.79gh	7.75h	7.97hi
	150 mg L^{-1} Ascorbic acid	27.20ghi	27.74g	5.47i	5.57i	16.55h	16.92fg	7.86gh	8.06gh
	200 mg L^{-1} Ascorbic acid	27.45fgh	28.00f	5.78h	5.93h	16.80g	17.24ef	8.00fg	8.19fg
	20 Cobalt mg L^{-1}	26.71ijk	27.12i	4.91k	4.99l	15.90k	16.32ij	7.48i	7.58jk
	40 Cobalt mg L^{-1}	26.94hij	27.45h	5.11j	5.20k	16.13j	16.46hi	7.59i	7.77ij
	60 Cobalt mg L^{-1}	26.47jk	26.89j	4.76k	4.84m	15.65l	15.99jk	7.32j	7.53k
Magnetically treated water	Cont.	27.77efg	28.19ef	6.06g	6.14g	17.03f	17.34ef	8.13ef	8.29ef
	100 mg L^{-1} Ascorbic acid	28.84abc	29.37bc	7.03c	7.17c	17.90c	18.22b	8.68c	8.78bc
	150 mg L^{-1} Ascorbic acid	29.06ab	29.54b	7.23b	7.34b	18.07b	18.39ab	8.80ab	8.98ab
	200 mg L^{-1} Ascorbic acid	29.37a	29.77a	7.43a	7.56a	18.31a	18.70a	8.93a	9.11a
	20 Cobalt mg L^{-1}	28.27cde	28.85d	6.56e	6.68e	17.42d	17.76cd	8.40d	8.59cd
	40 Cobalt mg L^{-1}	28.54bcd	29.19c	6.79d	6.88d	17.79c	18.17bc	8.58c	8.74c
	60 Cobalt mg L^{-1}	27.97def	28.37e	6.29f	6.43f	17.21e	17.51de	8.25e	8.48de

The treatment means were compared according to Duncan (1955)

CONCLUSION

This study increases our knowledge regarding the efficacy of the subjecting of water to magnetization before its usage for irrigation purposes, where magnetically treated water had a positive role in improving onion performance.

Also, results obtained confirmed that both ascorbic acid and cobalt possess a vital role in improving onion performance.

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الري بالماء المعامل مغناطيسيا والرش الورقي بحمض الاسكوربيك والكوبالت لتحسين نمو ومحصول وجودة البصل

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تم إجراء تجربتين حقليتين تهدفان إلى تقييم تأثير الري بأنواع مختلفة من المياه (مياه الري غير المعامله ومياه الري المعاملة مغناطيسيًا) في القطع الرئيسية والرش الورقي لبعض المنشطات في القطع المنشقة بمعدلات مختلفة (٠ – ١٠٠ – ١٥٠ -٢٠٠ مجم/لتر) من حمض الاسكوربيك وكبريتات الكوبالت بمعدلات (٢٠ - ٤٠ - ٦٠ مجم /لتر) على نمو نباتات البصل خلال موسمين متتاليين. اوضحت النتائج أن نباتات البصل التي تم ريها بالمياه المعاملة مغناطيسيا اعطت أفضل صفات للنمو والمحصول والجودة مقارنة بتلك التي تم ريها بالمياه غير المعاملة. فيما يتعلق الرش الورقي ، أعطت معاملة الكنترول أقل القيم مقارنة مع المعاملات الستة الأخرى لكل من حامض الأسكوربيك والكوبالت. من ناحية أخرى ، اعطي الرش بحمض الأسكوربيك اعلي قيم النمو والمحصول وصفات الجودة مقارنة بتلك التي تم معاملتها بالكوبالت ، كانت هناك زيادة معنوية مع زيادة معدل حمض الأسكوربيك ، بينما كانت هناك زيادة معنوية مع زيادة الإضافة بالكوبالت من ٠,٠ إلى ٢٠ و ٤٠ مجم /لتر ثم ينخفض بشكل ملحوظ عند ٦٠ مجم /لتر بسبب سمية الكوبالت على النباتات المزروعة بهذا المعدل. كذلك أعطي التفاعل بين الري بالماء المعامل مغناطيسيا مع الرش الورقي بحمض الاسكوربيك بمعدل ٢٠٠ ملجم /لتر أعلي قيم معنوية لقياسات النمو و المحصول و صفات الجوده (فيتامين C و المواد الصلبة الكلية و المادة الجافة والسكريات الكلية و الالياف والانثوسيانين وحمض البيروفيك و الكربوهيدرات والبروتين).