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Effect of Magnetic treatment in improving Growth, Yield and fruit quality of *Physalis pubescens* plant grown under saline irrigation conditions

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Abstract : Two pot experiments were conducted during 2013/2014 and 2014/2015 seasons at the green house of National Research Centre, Egypt to study the role of magnetic treatments (0, 2 and 4g/L) on growth, productivity, RWC % and fruit quality of *Physalis pubescens* cv. Balady under irrigated with saline water (fresh water, 2000, 4000 and 6000 ppm). Results showed that, low salinity level S1 caused marked increases on vegetative growth, yield, and RWCpercentage of husk tomato plant. Increasing salinity level in irrigation water above this level caused significant reduction on previously mentioned characters means as well as Vit C content, which showed progressive decrease in its content with increasing salinity level as compared with the control. Reveres trend was observed for total soluble solids (TSS)%, acidity%, phenolic compounds and carotenoids content of husk tomato fruit as compared with control plants. The analysis of the collected data during the study proved also that, there were statistically significant increases in plant growth, crop yield, Vitamin C, acidity, and carotenoids contents of husk tomato fruit due to magnetic treatment. Especially under the highest magnetic dose which caused insignificant increase in RWCpercentage and marked reduction in total soluble solids (TSS) percentage and phenolic compounds contents of husk tomato fruit.
Keywords: Salinity, Magnetic treatment, *Physalis pubescens* cv. Balady, Growth characters, Crop yield, Fruit quality.

Introduction

Salinity is the most serious water quality problem in agriculture. Water salinity is an environmental stress factor that inhibits growth and yield of different crops in many regions of the world. The impact of salinity on crops production is becoming increasingly important worldwide problem creating a pressing need for improved salt tolerant plants. Inhibitory effect of salinity on seed germination, plant growth, nutrient uptake and metabolism was mentioned by a number of scientists all over the world **(**Tanji[1]; Flowers and Yeo[2]; Gaballah and Gomaa[3]and Ali *et al.*[4]**)**. Crops vary in their resistance to salinity, this induces the necessity to do investigations to lest the ability of different plants to tolerate salinity and follow the changes that might take place in their physiological activities under saline irrigation.

The genus *Physalis* has high economic importance not only as food supplier, but also for its important chemical compounds. Two major groups of chemical compounds are responsible for the various medicinal properties, the tropane alkaloids (mainly tropine and tigoidine) and the physalins (steroid compounds). Tropanes are responsible for an anti-muscarinic activity; they block the activity of neurotransmitter acetylcholine by binding to muscarinic receptors of the parasympathetic nervous system. These chemical compounds are important in treatment of gastrointestinal and muscular spasms and Parkinson's disease (Choi *et al.*[5]). *Physalins* are under attention because of the anti-tumour and cytotoxic activity (Zaki *et al.*[6], and Chiang *et al.*[7]). *Physali*s has biological activities such as antibacterial, antiseptic, abortifacient, molluscicidal, antiprotozoal, anticancer, cytotoxic and immune modulatory activities (Bastos *et al.*[8] and Vessal and Kooshesh[9]). *Physalis pubescens* cv. Balady is used for their various medicinal properties, the leaf juice is used for worm infection and bowel complaints, and the plant has diuretic properties (Agarwal[10]).

Improving salinity tolerance of crop plants using magnetite (magnetic iron) is one of the most useful factors affecting plant growth; magnetite has a black or brownish-red color, magnetite is a natural row rock that has very high iron content, its hardness of about 6 on the Mohs hardness scale. It is one of two natural row rocks in the world that is naturally magnetic (Mansour[11]).It has been reviewed that the positive effect of magnetic treatment may be attributed to paramagnetic properties of some atoms in plant cells and some pigments such as chloroplasts (Aladjadjiyan[12]). Magnetic properties of molecules determine their ability to attract and then change the energy of a magnetic field in other types of energy and to transfer this energy to other structures in plant cells, thus activating them (Aladjadjiyan[12]). Magnetic field play an important role in cation uptake capacity and have a positive effect on immobile plant nutrient uptake, such as Ca and Mg (Esitken and Turan[13]).Thus, the present study was conducted to evaluate the response of *Physalis pubescens* cv. Balady to magnetic treatments under salt stress.

Materials and Methods

Plant material and growth conditions

Two pot experiments were established at the greenhouse of the National Research Centre, Dokki, Egypt, during the two successive seasons of 2013/2014 and 2014/2015.On the 25th July *Physalis pubescens* cv. Balady seeds were sown in nursery on foam trays and seedlings were transplanted at 1stof September. Seedlings were sown as five plants/plastic pot of 40 cm diameter filled with 10 kg of sandy soil in both seasons. Plants were thinned to one plant/pot. The mechanical and chemical analyses of the soil were determined according to the standard method described by Klute[14]and shown in Table (1). All pots received recommended doses of NPK fertilizers, 2 g calcium superphosphate (15.5% P2O5) which was added before sowing. 1.5g potassium sulphate (48% K2O) which was added immediately after thinning, 2.5 g ammonium nitrate (33.5% N) which was divided into three equal portions the first immediately after sowing, the second after thinning and the third after two weeks from the second, according to the recommendations of Agriculture Ministry.

Table (1): Mechanical and chemical analyses of the soil used during the experiment

Physical properties		Chemical properties	
Sand	89.68%	Organic matter (%)	0.32
Silt	4.22%	pH	8.3
Clay	6.10%	Available N (ppm)	55
Texture	sandy	Available P (ppm)	20
FC	16	Available K (ppm)	88
EC	2.3dsm^{-1}		

Salt and Magnetic Treatments

Seedlings were subjected to three salinity levels of sea salt + control ("fresh water", 2000,4000and 6000 ppm). The irrigation whether with fresh water or saline water must reach the level of 65% of total Water Holding Capacity (WHC) of the soil by weighing each pot daily and the needed amount of water was added. Treatment with saline water started after two weeks from transplanting. The general principal stated by Boutraa and Sanders [15] was used for the water treatment application. Moreover, three magnetic treatments were added to the soil twice during plant's life once after transplanting and the other four weeks later which were (0 "control" 2and 4g/pot). The used magnetite contained 3.72 % SiO_2, 14.90% TiO_2, 1.23% Al_2O_3, 76.56% Fe_2O_3, 0.35% MnO, 1.21% MgO, 0.45% CaO, 0.42% Na_2O, 0.05% K_2O, 0.07% P_2O_5, 0.09% Cl, 0.05% SO_3 and 0.60% L.O.I., as reported by The Egyptian Geological Survey and Mining Authority.

Experimental design

This experiment included 12 treatments which were the combination between three salinity levels plus control(fresh water, 2000,4000 and 6000 ppm)and three magnetic treatments (0 "control", 2 and 4g/pot), treatments were arranged in a randomized complete blocks design with five replicates. The different salinity treatments were assigned at random in the main plots. while sub-plots were devoted to the different magnetite treatments.

Data collection and analysis

A random plant samples of three plants were taken at age of 120 days to estimate plant height (cm), number of branches/plant, number of leaves/plant, root length, leaf area, fresh and dry weights of whole plant. The relative water content percent was measured also on fresh leaves according to Barrs and Weatherly [16].

Mature fruits were continuously harvesting when reaching suitable maturity stages and the following data were recorded: Plant height, number of fruits/plant, fruit diameter, fruit weight and fruits weight/plant.

Total soluble solids (TSS %) was determined by hand Refractometer according to A.O.A.C. [17].

Acidity percentage was analyzed by potentiometric titration with 0.1 M NaOH to pH 8.1 using 15 ml of juice.

Total carotenoids (mg/100 g FW) were determined using spectrophotometer according to A.O.A.C [17].

Vitamin C (mg/100 g FW) was determined by titration with 2,6- dichlorophenolindophenol according to A.O.A.C [17].

Total polyphenolic substances (as tannic acid) (mg/100 g FW) calorimetrically at 640 nm were measured Total phenol content was determined in juice according to **A**.O.A.C. [17].

Statistical analyses

The collected data were subjected to statistical analysis of variance using the normal (F) test and the means were compared using Least Significant Difference (LSD) at 5% level according to Snedecor and Cochran [18].

Results and Discussions

Vegetative growth:

Overall, high salinity level S3 badly affected studied growth characters of *Physalis pubescens* plant during the two growing seasons (Table 2). It was clear also that low salinity levels of S1 markedly increased plant height, no of branches/plant, no of leaves/plant, root length, leaf area as well as fresh and dry weights of whole plant compared with control ones. Stem and root elongation, leaf expansion, total biomass and dry matter accumulation in *Physalis pubescens* plant were significantly decreased with further increase in salinity level, until reached their minimum records under S3 treatment and with significant differences as compared with control. It seems that *Physalis pubescens* plant exhibited a moderate tolerance to salinity, as the plants were able to tolerate up to 2000 ppm of irrigation water. The obtained results were matched with those obtained by Achilea[19]; Agong *et al.*[20] and Zaki *et al.*[6].Furthermore, Naidoo *et al.*[21]recorded that the stimulatory effect of moderate salinity on growth of some plants may be due to improve shoot osmotic status as a result of increasing ions uptake. Similar results were reported by Ashraf and Sharif[22].The reduction in plant growth may be attributed to the reduction in water content and water potential of plant tissues, which resulted in internal water deficit to plants as recorded by (Hishida *et al.*[23]). In addition, Patel *et al.*[24] reported that the reduction in plant growth by NaCl might be attributed to the inhibitory effects of toxic ions mainly Na+ and Cl^-. Furthermore, Díaz-López, *et al.*[25]illustrated that the negative effect of salinity were mainly due to Cl− and/or Na+ toxicity and to a nutritional imbalance caused by an increase in the Na+/K+ ratio. The decrease in leaves number as salinity increased might be due to tolerance of plant to the toxic effects of Cl− and/or Na+, by their

Table 2: Growth parameters and relative water content % of *Physalis pubescens* as affected by salt stress condition and different magnetic doses during the two growing seasons (combined analysis of the two seasons).

Characters / Treatments		Plant height (cm)	No of branches /plant	No of leaves/plant	Root length (cm)	Leaf area Cm^2	FW of whole plant (g)	DW of whole plant (g)	RWC %
Effect of different salinity levels									
S0		93.33	10.00	35.00	29.67	32.02	125.33	47.33	77.33
S1		96.33	12.00	51.33	30.00	33.94	129.67	54.67	78.63
S2		77.00	7.67	25.00	24.00	23.98	85.67	26.00	72.07
S3		54.33	5.33	19.00	21.67	23.11	69.33	26.33	67.15
$LSD_{0.05}$		3.21	1.46	5.22	2.22	3.51	4.75	2.65	3.12
Effect of Magnetic treatment									
M0		62.00	7.00	24.00	24.75	25.04	82.50	34.75	73.35
M1		86.50	9.00	33.50	26.75	29.10	106.75	38.75	74.03
M2		92.25	10.25	40.25	27.50	30.64	118.25	42.25	74.01
$LSD_{0.05}$		4.51	1.04	4.87	1.98	2.87	3.64	3.08	2.13
Effect of interaction between salinity and magnetic treatments									
S0	M0	65	8	20	29	28.16	99	39	79.54
	M1	105	10	40	30	33.68	133	48	76.36
	M2	110	12	45	30	34.21	144	55	76.11
S1	M0	72	10	45	28	29.72	100	47	79.36
	M1	106	12	50	30	34.30	138	57	78.05
	M2	111	14	59	32	37.79	151	60	78.47
S2	M0	60	6	15	22	21.40	79	22	68.36
	M1	80	8	25	25	24.40	84	27	73.95
	M2	91	9	35	25	26.13	94	29	73.91
S3	M0	51	4	16	20	20.86	52	31	66.13
	M1	55	6	19	22	24.01	72	23	67.74
	M2	57	6	22	23	24.45	84	25	67.56
$LSD_{0.05}$		6.24	2.42	7.65	2.94	3.33	6.45	5.64	3.59

S0= fresh water S1=2000ppm S2=4000 ppm S3=6000pm
M0= zero magnetite M1=2g/L M2=4g/L.

accumulation in the older leaves. Then they were avoiding by leaf shedding thereafter (Cuartero and FernaÂndez-Muñóz[28]), as was noticed during the study. Salinity also reduced leaf area /plant by accelerating leaf death as indicated by the development of leaf tip burning symptoms and leaf loss. This is in accordance with Munns [26]who mentioned that salinity frequently accelerates leaf senescence reflected a decrease of fresh and dry mass. Decrease in dry weight seems to be due to reduction in the number of leaves and to a reduction in leaf area under salinity condition (Van Ieperen[27]).

The results of this study revealed also that magnetic treatments positively affected the vegetative growth of *Physalis pubescens* plants. Plants, which were magnetically treated, had significantly higher plant height, no of branches/plant, no of leaves/plant, root length, leaf area as well as fresh and dry weights of whole plant compared with non-magnetically treated plants as shown in Tables 2. Moreover, all previously mentioned characters were progressively and significantly improved with increasing the dose of magnetite, where the maximum significant increases in growth parameters observed under the highest magnetite dose (4 g/pot) M2 treatment as compared to non-magnetically treated plants. Magnetic treatments may affect phyto-hormone production causing increase in plant growth and cell activity (Maheshwari[29]). The present results were conflicted with those obtained by Sudhakar *et al*.[30], Abd El-Al[31], Esitken and Turan[13], Taha *et al*.[32] and Yusuf and Ogunlela[33]. Also to that obtained by De Souza *et al*.[34] who recorded that magnetic treatments led to a remarkable increase in plant root and stem height as well as fresh and dry weights during the nursery period of tomato plant. Magnetic field may play an important role in cation uptake capacity and has a positive effect on immobile nutrient uptake by plant, for example with Ca and Mg (Esitken and Turan[13]).Belyavskaya[35] concluded that magnetic treatment significantly induces cell metabolism and mitosis meristematic cells of lentil, pea and flax. Furthermore, the formation of new protein bands in plants treated with magnetite may be responsible for the stimulation of all growth, and promoters in treated plants. In this respect, Çelik *et al.*[36]mentioned that the increase in the percentage of plant growth was due to the effect of magnetic field on cell division and protein synthesis in paulownia node cultures.

Our results also revealed that the interaction between different salinity levels and different magnetic doses had promoted effect on plant growth and its development, due to the magnetic treatments under different salinity levels. Especially, the S1XM2 treatment which revealed the highest significant means in all studied growth parameters compared with control treatment, and with significant differences. Oppositely, the lowest ones were obtained by the higher salinity level under nonmagnetic treatment (control) in both seasons (S3XM0). The stimulatory effect of magnetic treatment on growth parameters under different salinity levels reported in this study; may be attributed to the improved in capacity for nutrient and water uptake. Providing greater physical support to the developing shoot, better root growth and development in young seedlings might lead to better root systems throughout the lifetime of a plant (Taha *et al*.[32]). Similar findings mentioned by Machado *et al*.[37]and Ibrahim and Kazım[38]and Taha *et al*.[32]

Relative water content (RWC %):

The obtained results pointed out in both growing seasons that under low salinity levels of S1 the relative water content revealed an increase in its percent as compared with control and with the other saline irrigation treatments, followed by progressive decrease in their content with further increase in salinity stress up to 6000 ppm and with significant difference. Where the highest values for relative water content percent was observed in S1 treatment, and the lowest values obtained under the highest salinity level S3. The present results agreed with those obtained by Hajer *et al.*[39], Salter *et al.*[40], Long *et al*.[41], Ekmekçi and Karaman[42]and Khalil *et al.*[43]. The reduction in relative water content because of salinity stress may be due to that increasing salinity in irrigation water reduced the absorption of water leading to a drop in water content of tested plants (Ekmekçi and Karaman[42]).

The application of both magnetic doses revealed insignificant increase in RWC% compared with control treatments. The highest record for RWC% was 74.03 at M1 treatment compared with the control. Followed by M2 treatment where the difference between the two treatments was insignificant. These results were confirmed by Maheshwari and Grewal[44], Al-Khazan *et al*.[45]and Hozayn and Abdul Qados[46] who indicated that treatment with magnetic water had insignificant effect on the water content as compared with the control. Magnetic treatment has been reported to change some of the physical and chemical properties of water, mainly hydrogen bonding, polarity, surface tension, conductivity, pH and solubility of salts, these changes in water properties may be capable of affecting the RWC%(Amiri and Dadkhah[47] and Otsuka and Ozeki [48]).

Examination of the illustrated results in Table 2 pointed out also that using different magnetic doses under salinity stress was proved to be more effective in increasing the RWC% under high salinity levels (S2 and S3), especially under M1treatment.While, using different magnetic doses under fresh water and low salinity levels (S0 and S1) was not so effective in increasing the RWC% in leaves of husk tomato plant, but may cause reduction in RWC% values under these water treatments. The data revealed also that the difference between M1 and M2 was insignificant.

Crop yield

Data in Table 3 showed that there were mostly significant increases in plant height, number of fruit/plant, fruit diameter, fruit weight and fruits weight/plant under low salinity level (S1) while further increase in salinity level up to 6000 ppm (S3) revealed significant reduction in all yield parameters in both growing seasons compared with control plants. Where the highest absolute means in all yield parameters were observed under S1 treatment, the percentages of increments reached to 4.060% for plant height, 16.12% for number of fruits/plant, 17.39 % for fruit weight, 37.78% for fruits weight/plant and 43.3% for fruit diameter compared with control. While, the lowest significant means were obtained under S3 treatment compared with control ones. The percentages of reduction under this treatment reached to29.27% for plant height, 54.84% for number of fruits/plant, 45.41% for fruit weight, 74.27% for fruits weights/plant and by 21.12%for fruit diameter compared with control (Tab. 3). The obtained results were matched with those reported by Maggio *et al.*[49], Al-Harbi *et al*.[50], Al-Omran *et al*.[51] and Al-Harbi *et al* [52].Such stimulatory effect of low salinity levels on yield and its components were mentioned by several authors such as, Babu and Thirumurugan[53]who noted that yield components increased under low salinity level, further increase in salinity decreased yield parameters. Similar findings were recorded by Ozoris and Robishy [54]on wheat and Francois [55]on canola.

Table 3: Yield parameters of *Physalis pubescens* as affected by salt stress condition and different magnetic doses during the two growing seasons (combined analysis of the two seasons).

Characters		Plant height (cm)	No of fruits/plant	Fruit diameter (mm)	Fruit weight (g)	Fruits weight /plant (g)
Effect of Effect of different salinity levels						
S0		115.00	31.00	42.41	2.07	65.03
S1		119.67	36.00	44.25	2.43	89.60
S2		93.67	24.67	40.59	1.70	43.60
S3		81.33	14.33	33.45	1.13	16.73
$LSD_{0.05}$		5.21	3.54	2.31	0.23	5.32
Effect of Magnetic treatments						
M0		96.50	17.75	36.93	1.58	30.40
M1		104.25	29.75	40.45	1.85	59.73
M2		106.50	32.00	43.14	2.08	71.10
$LSD_{0.05}$		3.89	4.22	1.88	0.11	4.21
Effect of interactionbetween salinity and magnetic treatments						
S0	M0	110	20	40.24	1.90	38.0
	M1	116	36	42.33	2.00	72.0
	M2	119	37	44.65	2.30	85.1
S1	M0	113	27	41.21	2.00	54.0
	M1	122	40	44.24	2.50	100.0
	M2	124	41	47.29	2.80	114.8
S2	M0	92	14	34.74	1.40	19.6
	M1	94	28	41.78	1.80	50.4
	M2	95	32	45.26	1.90	60.8
S3	M0	71	10	31.52	1.00	10.0
	M1	85	15	33.45	1.10	16.5
	M2	88	18	35.37	1.30	23.7
$LSD_{0.05}$		6.35	6.21	4.31	0.41	5.32

S0= fresh water S1=2000ppm S2=4000 ppm S3=6000pm
M0= zero magnetite M1=2g/L M2=4g/L.

The increase in yield parameters under S1 treatment may be due to the good growth under this salinity level. The negative effect of high salinity levels on yield losses may be attributed to fact that plants grown under saline environments were directly exposed to osmotic stress resulting from low external water potential induced by high salt concentration in the soil (Khalil [56])**.** She also revealed that the suppressive effect of high salinity was a consequence of several physiological responses including modification of ion balance, water status, stomatal behavior, photosynthetic efficiency, carbon allocation and utilization and yield. Salinity also reduces xylem development; reduction in xylem development would explain the reduction in fruit weight under saline conditions (Cuartero and FernaÂndez-Muñóz[28]). The suppressive effect of salinity on yield was also consequence of marked inhibition in photosynthesis (Taha *et al.*[32]).Salinity mainly affected also leaf elongation which decreases the development of photosynthetic surface area. Moreover, Ehret and Ho [57]also indicated that the reduction of fruit yield by salinity was proportional to the reduction of plant vegetative growth.

As for the effect of magnetic treatments, the data tabulated in Table 3 illustrated that there were significant effect of all magnetic treatments on yield parameters of *Physalis pubescens* plant in both growing seasons. Where, M2 treatment exhibited the maximum significant increases in plant height, number of fruits/plant, fruit diameter, fruit weight and weight of fruits/plant compared with the other magnetic treatment and control one. The percentages of increases reached to 10.36% for plant height, 80.28% for number of fruits/plant, 16.82% for fruit diameter and 31.64% for fruit weight. Similar effect had been recorded by De Souza *et al.*[34,58], Huang and Wang[59], Eskov and Rodionov[60], Grewal and Maheshwari[61]and Ahmed *et al.*[62]. The positive effect of magnetic treatment on yield and its components may be due to the bioenergetics structure excitement. Causing cell pumping and enzymatic stimulation, which affect the regulation of crucial ions mechanisms such as ATP hydrogen pump, and the possibly configuration of pivotal proteins (De Souza *et al.*[58]).

It was also clear from data of interactions that the highest significant records for yield and its components appeared under the effect of dual-interaction of the moderate salinity level S1and the highest magnetic dose (S1XM2) and with significant differences compared with the other treatments in both growing seasons. Several workers recorded similar results such as, Taha *et al*.[32]and Ahmed *et al.*[62]. The promoted effect of magnetic treatments under salinity stress on yield parameters may be due to that magnetic treatment assisting to reduce the Na toxicity at cell level by detoxification of Na, either by restricting the entry of Na at membrane level or by reduced absorption of Na by plant roots (Maheshwari[63]).

Fruit Quality:

Total soluble solids (TSS) and acidity:

There were significant differences in the TSS % and acidity values of husk tomato fruit with different levels of saline irrigation. Increasing saline concentration in the irrigation water from 2000 to 6000 ppm significantly increased the TSS% and acidity of husk tomato fruit, in comparison to irrigation with non-saline water in both growing seasons (Table 4). However, the highest significant increment in TSS% and acidity values were obtained under S3 treatment and with significant difference compared to control treatment. The increased in TSS under salinity stress might be attributed to osmotic adjustment of husk tomato plant to maintain its turgidity and to overcome the increasing resistance of water uptake by the roots (Taha *et al*. [32]). Moreover decreasing water content and turgidity of the plant under saline irrigation increased TSS and acidity of the fruit (Saied *et al*.[64]). Our results also exhibit higher values for TSS and acidity in the juice of fruits from salinized plants, this finding means that the quality of the products is better than control. The increase in TSS of husk tomato under salinity were in line with that recorded by Shakhov[65] who mentioned that salt ions especially the cation of sodium increased the hydrophilous properties of plasma colloids that played a very important role to protect the bio colloids and plasma from the effect of higher salinity. These observations were in agreement with those obtained by Medhat[66]; Fathy *et al*.[67], Khalil[56], and Taha *et al.*[32]. While, the increase in acidity as a result of salinity treatments were reported for other fruits including sweet pepper (Janse,[68]), cucumber (Chartzoulakis,[69]), tomato (Adams,[70];Yungfu and Dashu,[71] Krauss *et al.,*[72] , and Al-Harbi *et al.*[52]).

Pots treated with magnetic treatments showed significant decrease in TSS of husk tomato fruit with increasing magnetite doses as compared to control, in both growing seasons. Moreover, the minimum significant means in TSS were appeared under the highest magnetite dose (M2). While, opposite trend was observed for acidity, which showed gradual increase in their values by increasing the magnetite dose. Where the highest significant values were obtained under M2 treatment compared with the other magnetic treatments. The above statements further suggest that the magnetic treatment probably makes the water more functional within plant system and therefore probably influences cell level (Maheshwari and Grewal[44]).

Regarding the interaction effect between different salinity levels and different magnetite doses on abovementioned parameters of husk tomato fruit, data in Table (4) illustrated that the highest significant values of TSS were obtained under the highest salinity level combined with control treatment (without magnetic treatments) S3XM0.These effect may be due to that magnetic interacts with ionic current induces changes in both ionic concentrations and osmotic pressure on both sides of the membrane (Yaycili and Alikamanoglu[73]). Oppositely, the highest significant means of fruit acidity were observed under the highest salinity level under the highest magnetic dose (S3XM2) in both seasons.

Vitamin C

In current study, our results in Table 4 illustrated that different salinity levels had significant effect on Vitamin C content of husk tomato fruit in both growing seasons. Salinity stress led to gradual significant reduction in vitamin C content of husk tomato fruit compared to control treatment. The maximum records of vitamin C content were observed in control pots (S0 treatment) and with significant difference compared with other three treatments in both seasons. While the minimum significant means were obtained under, the highest salinity level (S3 treatment).Where the percentage of reduction reached to 18.71% compared with control. Similar results were obtained by Smirnoff [74], Zhang *et al*[75], Zan *et al*.[76] and Moghbeli, *et al*.[77]

It can be obviously noticed also from the data in the same Table that both magnetic doses led to marked increases in vitamin C content as compared to control. Where, the maximum significant increment in its content appeared with the greatest dose of magnate (M2 treatment).Positive effect of magnetic treatments on vitamin C were in agreement with those obtained by Huang and Wang[78] on bean, Eskov and Rodionov[60]on tomato and Grewal and Maheshwari[61] on chickpea. The increase in vitamin C due to magnetic treatments may be attributed to the increase in number of harvested fruits /plant and average fruit weight induced by magnetic treatments (Ahmed *et al.*[62]).

Regarding the data of interaction between different salinity levels and different magnetic treatments, the data on hand showed that S0XM2 revealed the highest significant means of vitamin C compared with the other treatments. Followed by S1XM2 treatment where, the difference between the two treatments was insignificant.

Table 4: fruit quality of *Physalis pubescens* as affected by salt stress condition and different magnetic doses during the two growing seasons (combined analysis of the two seasons).

Characters		TSS%	Acidity %	Vit c	Phenols	Carotenoids
Effect of Effect of different salinity levels						
S0		10.00	1.17	20.26	71.50	69.96
S1		11.77	1.44	19.51	73.32	74.80
S2		12.67	1.66	17.94	75.84	78.67
S3		13.83	1.85	16.47	80.01	85.21
$LSD_{0.05}$		0.22	0.08	1.36	2.33	3.01
Effect of Magnetic treatment						
M0		12.38	1.45	17.56	75.74	75.16
M1		12.00	1.51	18.85	75.18	78.32
M2		11.83	1.63	19.24	74.58	78.00
$LSD_{0.05}$		0.14	0.10	1.54	1.88	2.87
Effect of interaction salinity and Magnetic treatments						
S0	M0	10	1.03	19.18	71.00	69.21
	M1	10	1.15	20.62	71.50	70.11
	M2	10	1.32	20.98	71.99	70.56
S1	M0	12	1.41	18.06	74.01	74.21
	M1	12	1.43	20.19	73.21	75.18
	M2	11	1.48	20.29	72.74	75.00
S2	M0	13	1.56	17.00	76.69	77.08
	M1	12.5	1.63	18.14	75.93	79.93
	M2	12.5	1.79	18.69	74.89	79.00
S3	M0	14.5	1.80	16.00	81.26	80.15
	M1	13.5	1.83	16.43	80.07	88.06
	M2	13.5	1.91	16.99	78.69	87.43
$LSD_{0.05}$		0.31	0.21	1.01	3.01	3.77

S0= fresh water S1=2000ppm S2=4000 ppm S3=6000pm
M0= zero magnetite M1=2g/L M2=4g/L

Total phenolic content:

The average total phenolic content found in fruits of husk tomato were presented also in Table 4. The statistical analysis showed that increasing salinity levels revealed progressive significant increase in total phenolic content of husk tomato fruits compared to control. Where the highest salinity level S3 had a significantly higher average total phenolic content compared with the other irrigation treatments and control. Similar findings were reported by Hanan *et al.*[79], Agastain *et al.*[80], Muthukumarasamy *et al.*[81] and Yuan *et al.*[82.] Azimian and Roshandel[83]. The increase in the accumulation of phenolic compounds in fruit of husk tomato under saline conditions may be supporting the theory that, leaf polyphenols protect the plant against the oxidative stress generated by salinity and secondary metabolites play a role in salinity tolerance (Yuan *et al.*[82]). Phenolic compounds act as antioxidants as their extensive conjugated p-electron systems, allow ready donation of electrons or hydrogen atoms from their hydroxyl moieties to free radicals. A highly positive relationship between total phenols and antioxidant activity has been recorded in many researches. Phenolic acids and flavonoids are known as typical phenolics that possess antioxidant activity. Increase in polyphenol concentration under salinity (Azimian and Roshandel[83]).

Treated husk tomato plants with different magnetic doses caused insignificant decrease in total phenolic content of husk tomato fruits as compared to control plants. Where the lowest insignificant means were detected under the highest magnetite dose M2 (4g/pot) as compared to untreated plants.

In addition, there was an increasing trend of reduction in phenolic content due to magnetic treatment under different salinity levels compared to their control; the reduction was more pronounced under the M2 treatments under different salinity level. Radhakrishnan *et al.*[84] reported that pulsed magnetic field treatment of soybean seeds can be effective in alleviating the harmful effect of salinity by improving the suitable level of primary and secondary metabolites under salt stress conditions. Thomas *et al.*[85] reported the activity of total amylase, protease and dehydrogenase increased by magneto-priming under both non-saline and saline conditions. They further showed that magneto-priming of dry seeds of chickpea can ameliorate the harmful effects of salt stress.

Carotenoids content:

Data presented in Table 4 showed that irrigation with saline water significantly influenced carotenoids content of husk tomato fruit. The given data indicated that there was a gradual increase in the concentration of carotenoids content as salt concentration of irrigation water increased up to 6000 ppm as compared to the control. The highest concentration for carotenoids content was 85.21 at 6000 ppm (S3) treatment and the percentage of increase was 21.79% compared with the control, this result was true for both growing seasons. A similar response was recorded also by Petersen *et al.*[86], Khan *et al.*[87], and Khosravinejad and Farboondia[88]who found an increasing effect of salinity levels up to 4 dSm^{-1} in the root zone of tomato plant on total carotenoid and lycopene contents. Petersen *et al.*[86] attributed the enhancing contents of total soluble solids and carotenoids content in husk tomato fruit with increased salinity to concentration effect originating from reduced fruit water content due to the effect of salinity. In addition, Carotenoids were known to act as efficient quenchers of free radical caused by ROS (Khosravinejad and Farboondia[88]).

The obtained results in Table 4 also illustrated that both magnetic treatments caused gradual increase in carotenoids concentration of husk tomato fruit as compared to control treatment. The highest concentration of carotenoids content was detected under the moderate magnetic treatment M1 as compared with control plants, followed by M2 treatment where the difference between the two treatments was insignificant. Furthermore, Karimi *et al.*[89]reported that magnetic field treatment enhances stress tolerance of plant by increasing water absorption, increasing WUE, and inducing proline accumulation and carotenoids content in plants leaves.

For the interaction effect between factors under study on the carotenoids content, results showed that the highest significant values of carotenoids content were obtained under highest salinity level combined with the moderate magnetic dose (S3XM1)compared with the other interactions in both seasons, followed with S3XM2 treatment where the difference between them was insignificant. On the other hand, the lowest ones were recorded when plants were irrigated by the lowest water salinity under nonmagnetic treatment in the two seasons S0XM0.

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