Scientific Journal for Damietta Faculty of Science 6 (2) 2016, 106-115 ISSN Print 2314-8594
ISSN Online 2314-8616

Pre-sowing magnetic field- induced changes in water relations and lipid peroxidation in cucumber under salinity stress

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Received: 1 July 2016 / Accepted: 24 Sept. 2016

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Abstract

Overcoming salinity problems through increasing plant tolerance is a substantial strategy to increase crop production. A pot experiment was carried out to investigate the effect of salinity stress, pre-sowing magnetic fields and their combination on cucumber growth, water relations and lipid peroxidation. Seawater salinity (10%) enormously reduced the plant growth, relative water content (RWC), transpiration rate and water use efficiency (WUE), and increased partial osmotic pressure (POP), lipids peroxidation and membrane injury index. Root/shoot ratio was not affected by the salinity stress.
Pre-sowing treatment with 50 mT (for 30 s or 30 min) and 100 mT (30 min) magnetic field enhanced plant growth, root/shoot ratio, RWC, transpiration rate and WUE under control and stress conditions in relation with the un-treated plants. These treatments appeared to reduce lipid peroxidation and membrane injury in cucumber under salinity stress. The effect of these magnetic treatments on POP was not regular. The combination treatment of those magnetic fields and salinity reduced the stress intensity index (SII) by about 25% in relation with salinity alone. Conversely, the application of 200 mT magnetic field for 30 min adversely affected the plant growth and water relations, and increased the SII, lipid peroxidation and membrane injury in cucumber under salinity stress. On many occasions, the effects of 100 mT for 30 min and 200 mT for 30 s were not significant.

Keywords: Dry mass - Lipid peroxidation- RWC-Stress index- transpiration-WUE.

Introduction

Salinity is a major constraint for agricultural crops in many regions, whereas it affects about 7% of total world land (Flowers and Yeo 1995, Shrivastava and Kumar 2015). The problems of salinity are most obvious in arid and semi-arid areas due to insufficient rainfall to move accumulated salts from root zone (Bresler *et al*. 1982). Salinity may be slight when total dissolved salt (TDS) concentrations is 1000 -3000 ppm or moderate as TDS is between 3000 – 10000 ppm or high with TDS > 10000 ppm (Kanga and Jacksona 2016). Salinity stress restricts plant growth and productivity, and consequently contributes for the increased human famine (Abd EL-Kader et al. 2006). The adverse effects of this abiotic stress on crop plants are attributed to the osmotic effect and the specific ions effect (ions toxicity to various physiological process). Furthermore, increased exchangeable Na^+ can lead to soil swelling and dispersion, and root penetration problems (Bresler *et al*. 1982).

Egypt suffers from severe salinity problems due to low precipitation, irrigation with low quality water and high levels of underground water, whereas about of 33% of the agricultural land is already salinized (Hamam and Negim 2014, Wassef and Schüttrumpf 2016). By the end of 20^{th} century, about half of the consumed grains in Egypt was imported (Hinman and Hinman 1992), so alleviating salinity problems is a main target for Egyptian scientists to meet the country's over population. One of the primary strategies to overcome salinity problems is by increasing salt tolerance of plants. This can be achieved through traditional plant breeding or by producing transgenic plants which are salt tolerant. However, the progress to develop such plants is very slow due to the complex nature of salt tolerance (multigenic control) and high cost (Dionisio-Sese and Tobita, 2000, Iqbal and Ashraf, 2013).

An alternative way to increase salt tolerance in crops is by the usage of physical factors such as magnetic field. Application of magnetic field is safe, not expensive and friendly with the environment (Bhardwaj *et al.* 2012, Bilalis *et al.* 2013). On many occasions, the usage of this technology leads to an outstanding biochemical and biophysical changes which enhance seed germination, plant growth and crop productivity in both control and stress conditions (Dhawi 2014, Baghel *et al.* 2016). In this respect, Bilalis *et al*. (2013) found that pre-sowing treatment of cotton seeds with electromagnetic field for 15 and 30 min enhanced plant growth, transpiration rate, stomatal conductance, photosynthetic rate and contents of beneficial ions in relation with control plants. Conversely, the negative impact of magnetic field exposure on some plants was also recognized and was related to the accumulation of free radicals (Jouni *et al*., 2012). Such negative effect appeared to depend on the magnetic intensity and exposure period (Ibrahim 2015).

Cucumber is one of the most common horticultural crops in countries with a Mediterranean climate; however it is a salt sensitive crop (Chartzoulakis 1992). Application of magnetic field at specific intensity and exposure period enhanced seed germination, seedling growth and biochemical aspects in cucumber under control and salinity stress conditions (Bhardwaj *et al*. 2012, Ibrahim 2015). However, no information are available about the interactive effect of seeds magnetization and salinity on water relations and lipids peroxidation in this species, at vegetative stage. So this work was undertaken to characterize the changes in cucumber growth, water relations, lipids peroxidation and cellular membrane injury in response to the pre-sowing magnetic field treatments, salinity stress and their combination.

Materials and Methods

Seeds source:

Cucumber seeds (*Cucumis sativus* L. var. Beit Alpha) were purchased from Al-Qunfudah shop of plant seeds, Al-Qunfudah governorate, Saudi Arabia. This variety is widely used by farmers in this area. Seeds viability was found to be about 90% as evaluated by germination test.

Electromagnetic fields application:

The seeds were sterilized with 5% Clorox solution for 5 min and washed thoroughly with sterile distilled water several times. After that, the seeds were soaked for 8 h in distilled water. Then the seeds were allocated into 4 groups: 0.0, 50 mT, 100 mT and 200 mT magnetic field intensities at 30 s or 30 min exposure period using Dia, Para and Ferromagnetism system at physics Department at Al-Qunfudah College, Umm Al-Qura University, Saudi Arabia. This system has two coils (turns number per coil = 250, coil resistance = 0.6 Ω) and a DC power supply with variable output current used for the electromagnet. A Teslameter model 4060.50 (Frederiksen) was used to monitor the field strength produced between the two poles.

Growing conditions:

The seeds of each group were sown in plastic pots (4 seeds per pot). Each pot (15 cm W × 20 cm L) contained 2.75 kg soil (2 sandy soil:1 peatmos). All pots were transferred to a constructed greenhouse at Al-Qunfudah College, whereas the plant were exposed to natural day/night conditions. Average photoperiod (day/night) and minimum/maximum temperature were 11.5/12.5 h and 20/35 ºC, respectively. All plants were irrigated with normal tap water (EC = 0.2 mS/cm) for three weeks. During this period the plants were thinned to one plant per pot and inorganic fertilizer was added (1 g Ca (NO3)2 and 1 g K2HPO4 per pot). After that, the pots of each group were divided into two subgroups; control and salinity stress (10% Red seawater). The full strength of this seawater is known to has Cl- (22.33%), Na + (11.9%), Mg +2 (1.51%), K+ (0.59%), Ca 2+ (0.49%), pH of 8.1 and EC of 72.5 mS/cm (Al Moubaraki et al. 2015). The total pots number was 112 with 8 replicates for each treatment. The plants in either control or salinity stress conditions were irrigated to field capacity when soil moisture content decreased to 60% of its initial value. The experiment was ended when the control plants started flowering (45 days after seed sowing) and samples were taken for analysis of vegetative growth, water relations, and biochemical aspects.

Evaluated parameters

Determination of plant biomass:

The plants were harvested and separated into shoots and roots which were oven dried at 80° C for 48 h and weighed.

Estimation of stress intensity index:

Stress intensity index was estimated using the formula originally used by Fischer and Murer (1978) with a simple modification. This modification includes substitution of grain yield with total plant biomass as follows:

Stress intensity index (SII) = 1 − (total biomass in stress condition/total biomass in control condition).

Determination of leaf relative water content:

Based on the method described by Yamasaki and Dillenburg (1999), leaf discs from the second fully developed leaf from shoot apex were immediately weighed to have fresh mass (FM). The discs were floated in distilled water for 24 h in closed Petri dishes under dim light at room temperature and reweighed to obtain fully turgid mass (TM). Then the samples were oven dried at 80 for 48 h to obtain dry mass (DM). The relative water content (RWC) was calculated using the formula:

RWC (%) = [(FM - DM)/ (TM - DM)] * 100.

Measurement of osmotic pressure:

Leaf samples (1 g) were heated in deionized water at 90 °C for 1 h. After that, centrifugation take place and supernatant volume was adjusted to 25 cm3. Then the electrical conductivity was assessed by a Mettler-Toledo conductivity meter. The following equation was used to estimate the partial osmotic pressure (POP):

POP (bar) = 0.36 × EC (mmho cm–1) (Bresler et al. 1982)

Determination of transpiration rate:

Transpiration rate was measured by the gravimetric method as described by Xin *et al.* (2008). The pots containing plants were tightly covered with polyethylene sheets at the level of shoot base and weighed (at 7 a.m.). After 12 hours (at 7 p.m.), the pots were re-weighed. The loss in pot weight was used to express the transpiration rate.

Estimation of water use efficiency:

Water use efficiency (WUE) of whole plant was determined using the following formula:

WUE g kg^{-1} = dry weight of final biomass/ total water consumed (Medrano et al. 2015)

Assessment of lipid peroxidation:

Fresh samples were homogenized in ethanol (80%) and centrifuged at 6000g for 10 min. Malondialdehyde (MDA) content as a main product of lipid peroxidation in the supernatant was measured by the thiobarbituric acid (TBA) method of Heath and Packer (1968). In short, 1 cm3 of sample supernatant and an equal volume of TBA solution (0.65 % TBA in 20% trichloroacetic acid) were added to a test tube and heated at 95 °C for 24 min and cooled on ice. The developed colour was read at 532 nm and 600 nm using an UV-Vis spectrophotometer (APEL, PD-303 UV). MDA concentration was calculated by the following equation:

MDA equivalents (nmol.cm-1) = 1000[(Abs 532-Abs 600 nm)/155]

Estimation of membrane injury:

Cell membrane injury was expressed as an index of injury (Id) and estimated as: Id = (Rs - Rc/ 1-Rc) × 100, where Rs and Rc represent electrolyte leakage for stress and control treated tissues, respectively (Flint et al. 1967). The electrolyte leakage was determined by the method of Bajji et al. (2002).

Statistical analysis

A completely random and factorial design was employed during the experimental work. The data were recorded as means from 3 to 8 replicates. Analysis of variance (ANOVA) and least significance difference between means (LSD) were carried out using SPSS version 19 software. Correlation coefficients between the stress intensity index and all evaluated parameters under the stress conditions were also estimated.

Results

Changes in growth parameters:

The results in Table 1 show the effect of seed exposure to different magnetic intensities for 30 s on cucumber vegetative growth. Application of 50 mT magnetic field increased number of leaves number, total plant biomass and shoot length (also root/ shoot ratio) by about 10%, 15% and 20%, respectively compared to the values of non-treated plants. Seed exposure to 100 mT induced non-significant increase in these growth parameters in comparison with the 50 mT treatment. Pre-sowing treatment with 200 mT non significantly affected the growth of cucumber plants in relation with the untreated plants (0 mT treatment).

Salinity stress (10% seawater) reduced shoot length, number of leaves and total plant dry mass by about 25%, 30% and 50% , respectively in comparison with control plants (0 salinity and 0 mT). This clarified that plant dry mass was the most affected growth parameter. However, the root/shoot ratio was insignificantly affected by salinity stress. Pre-sowing treatment with 50 and 100 mT for 30 s obviously enhanced cucumber vegetative growth under salinity stress condition. Results in table 1 showed that these treatments increased shoot length (also number of leaves), plant dry mass and root/shoot ratio by about 15%, 20% and 25%, respectively over the values of salinity stress only. Except for root/shoot ratio which was enhanced by about 15%, almost all the evaluated growth parameters were not significantly affected by the application of 200 mT under salinity stress condition.

Table 1. Effect of pre-sowing treatment with magnetic field for 30 second on growth parameters of cucumber plants grown under salinity stress.

Treatments		Growth parameters			
Salinity	**Magnetic field intensity (mT)**	**Shoot length (cm)**	**Leaves no.**	**Total plant dry mass (g)**	**Root/ Shoot ratio**
0.0	-	23.8c	10a	1.87b	0.23c
	50	28.3ab	11a	2.06a	0.28b
	100	29.5a	11a	2.25a	0.29b
	200	26.5b	10a	1.88b	0.23c
10% SW	-	17.6d	7b	0.91d	0.24c
	50	19.91c	8b	1.12c	0.30b
	100	20.0c	8b	1.2c	0.34a
	200	18.1d	7b	0.93d	0.28b

Values in each column with the same letter(s) are not significantly different at P > 0.05.

Data in Table 2 show the vegetative growth parameters of cucumber in response to seed exposure to different magnetic intensities for 30 min. These results indicated two main differences compared to the results for the seeds that were exposed to magnetic field for 30 s (Table 1). First, the treatment of 50 mT enhanced the growth parameters of cucumber than their counterparts of 100 mT under control and stress conditions. Secondly, pre-sowing treatment with 200 mT for 30 min adversely affected plant growth parameters in comparison to the untreated plants over all conditions.

Changes in stress intensity index (SII):

It can be seen from Figure 1 that seed pre-sowing treatments with 50 mT and 100 mT for 30 s reduced SII by 20% and 35%, respectively.

Table 2. Effect of pre-sowing treatment with magnetic field for 30 minutes on growth parameters of cucumber plants grown under salinity stress.

Treatments		Growth parameters			
Salinity	**Magnetic field intensity**	**Shoot length (cm)**	**Leave s no.**	**Total plant dry mass (g)**	**Root/ Shoot ratio**
0.0	-	22.c	10a	1.87b	0.23cd
	50	30.25a	11a	2.35a	0.30b
	100	28.1a	11a	1.82b	0.25c
	200	25.5b	10a	1.67c	0.22d
10% SW	-	17.6e	7b	0.91e	0.24cd
	50	19.5d	8b	1.2d	0.32a
	100	18.9d	8b	0.96e	0.28b
	200	15.7e	7b	0.64f	0.22d

Values in each column with the same letter(s) are not significantly different at P > 0.05.

The usage of 200 mT for 30 s non significantly affected the SII in relation with the untreated plants. Seeds exposure to 50 mT and 100 mT for 30 min decreased the SII in cucumber by about 30% and 6 % (non significant effect), respectively. On the other hand, pre-sowing treatment with 200 mT for 30 min increased the SII by 30% over the values of the untreated plants (0 mT). These results clarified that seeds magnetization with 50 mT for 30 s or 30 min and 100 mT for 30 s increased the tolerance of cucumber plants to 10% seawater stress, whereas the 200 mT treatment for 30 min decreased this tolerance.

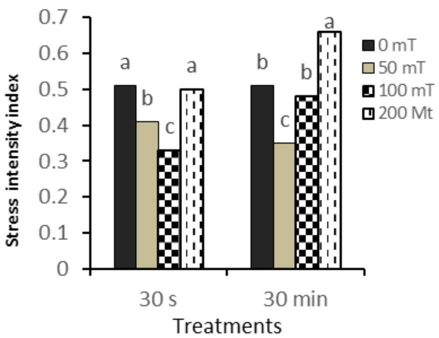

Fig. 1. Effect of electromagnetic fields on the stress intensity index in cucumber plants grown under salinity stress at 45 DAS. Values in a group with the same letter (s) are not significantly different at P ≤0.05. Abbreviation: DAS, days after sowing.

Changes in relative water content and osmotic pressure:

The results for the changes in relative water content (RWC) of the 2nd upper well developed leaf are shown in Figure 2A. In control condition, seed pre-sowing treatments with different magnetic fields for 30 s or 30 min non significantly affected the RWC in cucumber plants in comparison with the untreated plants. Salinity stress lowered the RWC by 30% than the control (0 mT). Under salinity stress conditions, the treatment of 50 mT and 100 mT for 30 s or 30 min enhanced the RWC by about 20% (for each). However, these values did not compensate with control values. Application of 200 mT for 30 s slightly enhanced the RWC under salinity stress in relation with the untreated plants and the vice versa was observed at 30 min exposure.

It can be noted from Figure 2B that all magnetic treatments for 30 s or 30 min, in general, non- significantly affected the estimated partial osmotic pressure (POP) in cucumber in relation with the untreated plants (0 mT).

Discussion

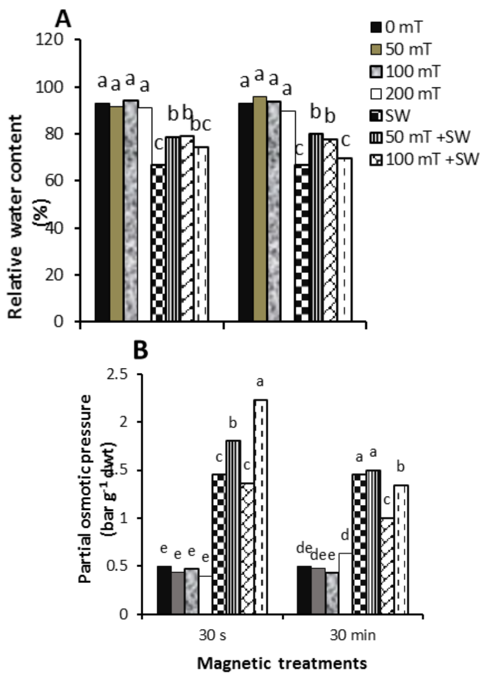

Fig. 2. Effect of pre-sowing treatment with magnetic field for 30 second and 30 minutes on RWC and osmotic pressure in cucumber plants grown under salinity stress at 45 DAS. Values in a group with the same letter (s) are not significantly different at $P \leq 0.05$. Abbreviation: DAS, days after sowing**.**

There was a two-fold increase in the POP of plant leaves in response to salinity stress. Under salinity stress, the effect of magnetic treatments was not regular and on some occasions its value depended on the magnetic intensity and the exposure period. For example the treatment 50 mT significantly increased the POP with 30 s exposure period and had a non-significant effect with 30 min exposure period in relation with the untreated plants

Changes in transpiration rate and water use efficiency:

Figure 3A shows the effect of salinity stress, magnetic fields and their interaction on cucumber transpiration rate. Salinity stress reduced transpiration rate in cucumber by about 60% below control values. Seed pre-sowing treatment with 50 mT and 100 mT for either 30 s or 30 min enhanced the transpiration rate in cucumber under control and salinity stress conditions by about 18%. On many occasions, the application of 200 mT magnetic field had non-significant effect on the transpiration rate in either control or stress conditions.

Seawater stress (10%) reduced WUE in cucumber by 40% in relation with control values (0 mT). Application of 50 mT for 30 s or 30 min, and 100 mT for 30 s mitigated the adverse effect of salinity stress.

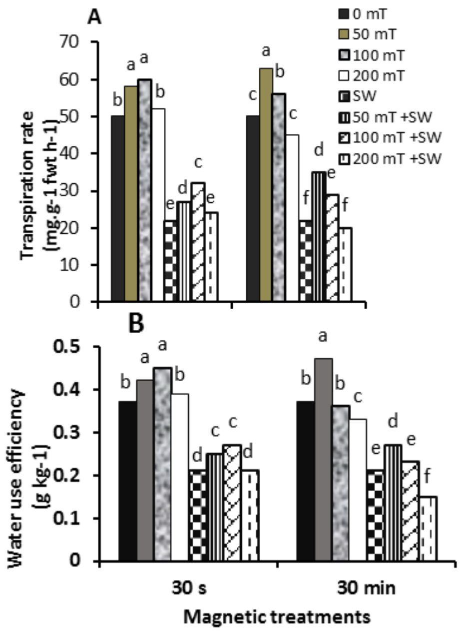

Fig.3. Effect of pre- sowing treatment with magnetic field for 30 second and 30 minutes on transpiration rate and WUE in cucumber plants grown under salinity stress at 45 DAS. Values in a group with the same letter (s) are not significantly different at $P \leq 0.05$. Abbreviation: DAS, days after sowing.

These treatments appeared to enhance the WUE (20% increase) and the effect was more obvious under the stress conditions. On the other hand, the combination treatment of 200 mT for 30 min and salinity stress added more reduction in WUE than the salinity alone (Figure 3B).

Changes in lipid peroxidation and membrane injury index:

The results presented in Figure 4 show the effect of seed magnetization on lipid peroxidation in cucumber under 10% seawater stress. Application of different magnetic fields (50 mT, 100 mT and 200 mT) for 30s did not virtually affect lipid peroxidation in cucumber under control conditions. Salinity stress increased lipid peroxidation by about 150% over the control values. The dual treatments of all magnetic fields for 30 s and salinity stress reduced this physiological aspect by about 25% in relation with salinity treatment alone. Except for 200 mT seed treatment which enhanced lipid peroxidation, the results due to 30 min exposure period were comparable with those of 30 s exposure period.

On many occasions, the combination treatments of magnetic fields and salinity stress lowered the membrane injury index in cucumber than salinity alone (Fig.5). Pre-sowing treatments with 50 mT, 100 mT and 200 mT magnetic field for 30 s decreased the cellular membrane injury index in cucumber by about 15%, 45% and 25%, respectively. The results for 50 mT and 100 mT at 30 min exposure period did not greatly differ from those observed at 30 s exposure period, whereas the application of 200 mT for 30 min non significantly decreased the membrane injury index in relation with salinity stress alone.

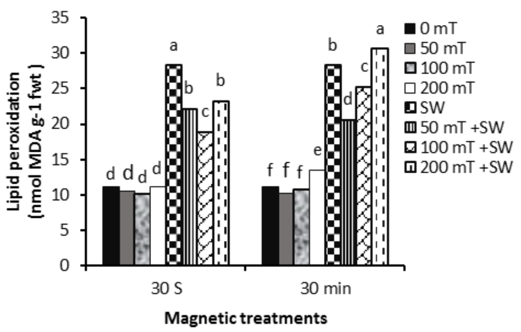

Fig. 4. Effect of pre-sowing treatment with magnetic field for 30 second and 30 minutes on lipid peroxidation in cucumber plants grown under salinity stress at 45 DAS. Values in a group with the same letter (s) are not significantly different at P ≤ 0.05. Abbreviation: DAS, days after sowing.

Under control conditions, the values of this index were also reduced in response to most magnetic treatments.

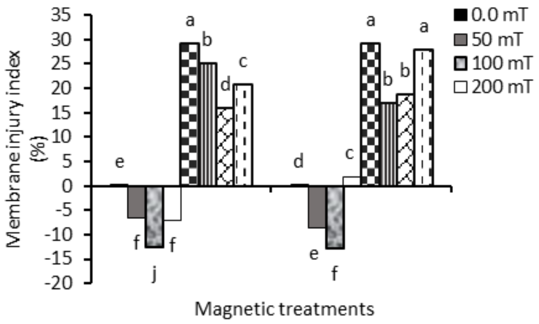

Fig. 5. Effect of pre- sowing treatment with magnetic field for 30 second and 30 minutes on membrane injury index in cucumber plants grown under salinity stress at 45 DAS. Values in a group with the same letter (s) are not significantly different at P≤0.05. Abbreviation: DAS, days after sowing.

Correlation coefficients between SII and the evaluated parameters:

The estimated stress intensity index as an indication of plant susceptibility based on total dry mass, under salinity stress, had a strong negative correlation with shoot length, biomass, root/shoot ratio, transpiration rate and water use efficiency [r = - (0.93 - 0.99); Table 3]. Conversely, a strong positive correlation manifested between the SII and lipid peroxidation (r = 0.91). A modest correlation appeared with RWC (r = - 0.74) and membrane injury index (r = 0.70). The partial osmotic pressure of leaves had non-significant correlation with the SII (Table 3).

Table 3. Correlation coefficients between stress intensity index (SII) and the evaluated parameters in cucumber under salinity stress.

Parameters	Correlation coefficient with SII (r)
Shoot length	- 0.95**
Total dry mass	- 0.99**
Leaves number	- 0.77*
Root/shoot ratio	- 0.93**
Relative water content	- 0.74*
Partial osmotic pressure	0.008
Transpiration rate	- 0.88 **
Water use efficiency	- 0.99 **
Lipid peroxidation	0.91 **
Membrane injury index	0.70*

***, ** indicate significance at p < 0.05 and 0.01, respectively.**

Discussion

During the last decade, a great attention has been offered to the magnetic field application as a possible strategy to improve plant growth and productivity under environmental stress conditions. In this study, the notable reduction in cucumber growth under 10% seawater salinity confirmed that this species is sensitive to salinity stress and this level of salinity is critical (50% total biomass reduction) for its growth. These results are compatible with the findings of Khan *et al*. (2013) that 5 dS m $^{-1}$ salinity stress adversely affected cucumber dry mass, shoot length and number of leaves. The non- significant effect of the used stress on root/shoot ration was also reported by Al-Harbi and Burrage (1993). This indicates that the allocation of dry mass to root system did not enhance under salinity stress, a reason which could contribute to cucumber sensitivity under salinity stress. In contrast to our results, this ratio was found to increase in salinity tolerant cultivars and halophytes under saline conditions (Albacete *et al*. 2010, Ibrahim 2013).

The observed reduction in RWC and transpiration rate in cucumber under salinity stress are expected results and could be related to the decrease of root absorption capacity and clarified that the salinity resulted in cellular dehydration and stomatal closure (Wang *et al*. 2006, Qin *et al.* 2010). This water imbalance led to the reduction in plant water use efficiency in cucumber under stress conditions (Wang *et al*. 2006). The demonstrated increased in lipid peroxidation and membrane injury in response to 10% seawater stress could be attributed to the increment of free radicals which is widely observed under salinity stress (Furtana and Tipirdamaz 2010). It is appeared from the obtained results that the reduction in RWC and transpiration rate as well as the increase in lipid peroxidation and membrane injury resulted in the reduction in plant growth under salinity stress. Others, attributed this reduction to the osmotic effect of salinity and/ or the increase in tissue Na^+ which replaces K^+ ion (Munns and Tester, 2008).

The stimulative effect of pre-sowing magnetic field with the intensity of 50 mT and 100 mT at exposure periods of 30 s or 30 min, on many occasions, on cucumber growth under control and salinity stress was also observed in many other plants (Radhakrishnan and Kumari, 2012 and Azimian and Roshande, 2015). In this regard, Rãcuciu *et al.* (2008) found that the cultivation of *Zea mays* germinated seeds under 50 mT static magnetic field for 14 days greatly enhanced growth parameters and chlorophyll content in relation with non treated plants. This improvement under saline conditions and consequently the reduction in stress intensity index can be related to the amelioration in root/ shoot ratio, RWC and transpiration rate, and to the reduction in lipid peroxidation which enhanced the cellular membrane stability. In support of our result, Bilalis *et al.* (2013) found pre-sowing treatment with magnetic fields for 15 and 30 minutes enhanced plant growth, transpiration rate, stomatal conductance and photosynthetic rate in cotton. It is worth to mention that the actual mechanisms by which magnetic field enhances plant growth are poorly understood. However, growing evidences suggest that magnetic field application increase the physiological availability of small ions such as Ca^{2+} and K^{+1} which regulates many cellular processes, and water mobility due to the decrease in water viscosity and surface tension (Xiao-Fenga and Boa 2008, Pazur and Rassadina 2009).

The observed adverse effect of 200 mT magnetic intensity for 30 min exposure period on cucumber growth under control and stress condition is compatible with the results of Rãcuciu *et al.* (2008) that 150- 200 mT magnetic field negatively affected *Zea mays* growth and chlorophyll content. This reduction was associated with an increase in the stress intensity index and can be attributed to the demonstrated increase in lipid peroxidation and cellular membrane injury, and the decrease in RWC and transpiration rate. Contrary to our results, Baghel *et al* (2016) found the enhancement effect of seed pre-treatment with 200 mT magnetic field on soybean growth and metabolism under both saline (25 and 50 mM NaCl) and non saline conditions. This difference in response indicates the difference in sensitivity to magnetic field between different species.

Conclusion

The application of 10% seawater stress significantly reduced the growth parameters in cucumber plants, except for root/shoot ratio which did not change. This stress imbalance the plant water status and induce lipid peroxidation and membrane injury. Pre-sowing treatment with 50 mT (for 30 s and 30 min) and 100 mT (for 30 s) magnetic fields partially alleviated the adverse effect of salinity stress on plant growth. This beneficial effect was accompanied with an enhancement in RWC, transpiration and WUE, and reduction in lipid peroxidation as well as membrane injury under stress conditions. On the other hand, the dual treatment of 200 mT for 30 min with salinity stress added more adverse effect than salinity alone. So, magnetic field is a promising strategy to overcome salinity problems in cucumber, when it is used at the appropriate intensity and exposure period.

Acknowledgements

Great thanks to Dr. A. M. Abdul-Kader the head of Physics Department (Al-Qunfudah University College, SA) for giving us the chance to use the ferromagnetism apparatus.

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الملخص العربي

عنوان البحث: التغيرات المستحثة بالمجال المغناطيسى قبل البذر فى العلاقات المائية والأكسدة الفوقية للدهون فى الخيار تحت الإجهاد الملحى نباتات

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فى هذه الدراسة تم تعريض بذور نباتات الخيار لمجالات مغناطيسية مختلفة (50 ،100، 200 مللي تسلا) ولمدة 30 ثانية و30 دقيقة . ثم زرعت هذه البذور فى أصص لمدة 45 يوما (بداية عملية الإزهار). وبعد 3 اسابيع من الزراعة قسمت الأصص الى مجموعتين الأولى رويت بماء غير ملحى (كنترول) والأخرى بماء بحر تركيز 10% (إجهاد ملحى). ولقد أدى الإجهاد الملحى الى نقص كبير فى الوزن الحيوى الكلى وطول النبات و كذلك عدد الأوراق ، بينما لم تتأثر نسبة الجذر الى المجموع الخضرى بذلك الإجهاد. ورافق ذلك نقص شديد فى المحتوى المائى النسبى بالأوراق ومعدل النتح وكفاءة إستغلال الماء. كما أدى ذلك الإجهاد الى زيادة كبيرة فى الضغط الإسموزى الجزئى والأكسدة الفوقية للدهون (تركيز ثنائى الداهيد المالون) وتلف الأغشية الخلوية فى نباتات الخيار.

وقد أوضحت الدراسة أن معاملة البذور بمجالات مغناطيسية شدة 50 مللى تسلا (لمدة 30 ثانية أو 30 دقيقة) و100 مللى تسلا (لمدة 30 ثانية فقط) قد أدى الى تحسن ملحوظ فى نمو النباتات فى ظروف الإجهاد الملحى. ورافق ذلك تحسن فى المحتوى المائى النسبى للأوراق ومعدل النتح وكفاءة إستغلال الماء وزيادة نسبة الجذر الى المجموع الخضرى. ولكن لم يكن لتلك المعاملات تأثيراً معنوياً على عدد الأوراق بالنباتات. كما أدت تلك المعاملات الى تقليل الأكسدة الفوقية للدهون وتلف الأغشية الخلوية فى النباتات المجهدة ملحيا. بينما كان تاثير تلك المجالات المغناطيسية على الضغط الإسموزى الجزئى بالأوراق غير ثابت. وعلى العكس كان للمعاملة بالمجال المغناطيسى شدة 200 مللى تسلة لمدة 30 دقيقة تأثيراً سلبياً على نباتات الخيار فى ظروف الإجهاد الملحى. وفى غالبية الأحوال لم يكن للمعاملات 100 مللى تسلا لمدة 30 دقيقة و200 مللى تسلا لمدة 30 ثانية تأثيراً معنوياً على العلاقات المائية وأكسدة الدهون فى نباتات الخيار.