J. Plant Production, Mansoura Univ., Vol. 3 (11):2883 - 2902, 2012

IMPACT OF SALINITY AND BIOLOGICAL AND ORGANIC TREATMENTS ON GROWTH, YIELD AND FRUIT QUALITY OF SWEET PEPPER

Mostafa, Doaa M. and K. A. M. Nour
Veg. Res. Dept., Hort. Res. Inst., Agric. Rec. Center

ABSTRACT

Two pots experiments were carried out during summer seasons of 2011 and 2012, in order to study the effect of irrigation with sea water mixed with fresh water at different levels of NaCl (0.0, 1000, 2000 and 3000 ppm) and application of humic acid at 2cm^3/l, halex-2 at 2gm /l and the combination between them as well as control (without) and their interactions on vegetative growth characters, leaf pigments, yield and its components, fruit quality and leaf chemical constituents of sweet pepper plants (*Capsicum annuum* L.). cv. Spanish pepper.

Vegetative growth characters,i.e plant height, number of branches, leaf number, dry weight / plant, leaf area/plant, fruit yield and its components parameters and TSS in fruit juice were significantly decreased by increasing NaCl level in the irrigation water from control up to 3000 ppm while, irrigation with 2000 ppm gave the highest values of K percentage on fruit. On the other hand, 3000 ppm NaCl resulted in the highest values of titratable acidity and proline contents in the leaves.

Treating sweet pepper plants with the combination between halex-2 at 2 gm/ l and humic acid at 2cm^3 / l recorded the highest values of all studied growth characters, average fruit weight, early yield, total yield TSS and nitrogen percentage followed by humic acid at 2cm^3 / l with non significant differences between both treatments while, treating plants with halex-2 at 2gm/l recorded the highest values of phosphorus percentage.

Zero Nacl in combination with humic acid at 2cm^3 / l singly or with halex-2 at 2 gm/ l caused a stimulatory effect on most of the studied characters of sweet pepper plants. Meanwhile, the same treatments recorded the lowest values of TSS in pepper. On the other side, the interaction between NaCl at a rate of 3000 ppm in the irrigation water without adding halex-2 or humic acid (control) recorded the lowest values of all studied growth characters, yield and its components and fruit quality.
Keywords: Sweet pepper, salinity, halex-2, humic acid, growth, yields.

INTRODUCTION

In the Mediterranean region, pepper *(Capsicum annuum* L.) is one of the main crops cultivation and high-quality yield is an essential prerequisite for its economical success. However, the excess of salts in the soil solution and in the irrigation water causes severe problems like the reduction of fruit size (Navarro *et al.,* 2002). In Egypt, salinity of water and soil became a more pronounced problem in both newly and ancient lands or in North Coast areas. It adversely affects vegetative growth and biomass yield of most horticultural crops. Most of the saline soils are located in the northern middle of Nile Delta as well as its eastern and western sides. This problem is usually counteracting the expansion in land reclamation (Gehad, 2003).

Salt stress in plants influence some basic plant metabolic process such as, photosynthesis, energy and lipid metabolism and protein synthesis

(Parida and Das, 2005). Salt stress conditions are an osmotic which is apparently similar to that brought by water deficit (Almogaera *et al*., 1995). Injurious ions such as Na^+ and Cl^- negatively affect nutrient uptake and balance (Sauram and Tyagi, 2004 and Hussein *et al*, 2007).

Application of higher salt concentration (120mM NaCl) led to more significant decrease in all studied growth characters, yield and its components as well as seed quality of pea (El-Ghinbihi, 2007).

The lowest values of plant growth, total pods yield, N, P and K uptake and K/Na and Ca/Na ratio. Also, N, P, K, protein and carbohydrate contents in cowpea seeds tissues were observed by the highest salinity level of 5500 ppm (El-Hefny, 2010). Increasing NaCl levels in the nutrient solution from 0 to 100 mM decreased significantly vegetative growth, leaf area, dry matter / plant, fruit yield parameters, calcium content of fruits as well as K and Ca content in the leaves of tomato plants(Nour *et al.,* 2010).

The low level (50 mM NaCl) of salinity treatment had no deleterious effects on vegetative growth parameters of pepper plants, while at higher concentration of NaCl (100 and 200 mM), growth parameters were drastically reduced. Salinity treatments caused a reduction in chlorophyll content, accumulation of proline and enhancement of CAT activity in shoot and root of pepper plants (Chookhampaeng, 2011).

Humus is final residue obtained from microbial decomposition of organic matter (Rizal *et al.,* 2010). Humic substances are component of humus and widely distributed over earth surface (Yigit and Dikilitas, 2008). Humic substances could be classified into three categories, i.e, humic acid, fulvic acid and humin (Solange and Rezende, 2008). Applications of humic acid affected significantly pepper seedling growth. 1000 and 2000 mg / kg-1 humic acid applications increased fresh and dry leaf weights, fresh and dry root weights, stem diameter, root length and shoot length. The highest rates of humic acid (4000 mg kg-1) decreased these criteria of pepper seedling under the saline soil condition (Gulser *et al.,* 2010).

Foliar application of humic acid for faba bean (Giza-461) at concentration of $20cm^3/l$ enhanced the number and weight of pods and straw as well as seeds, biological yield and nutrient uptake more than control (Afifi *et al.,* 2010). Increasing the rates of humic acid (1, 2 and 3 ml L^{-1}) fertilization increased pepper yield (quality and quantity) as compared with untreated (Abd El-Rheem *et al.,* 2012).

Application of halex-2 increased all growth characters of pepper plants. Moreover, the results indicated that chlorophyll pigments and total soluble sugars (T.S) as well as mineral concentrations were significantly reduced in pepper leaves; however proline concentration was increased under water stress compared to control. Meanwhile, in plants treated with biofertilizer, minerals concentration (N, P, K) were enhanced as compared with the untreated plants. Also, number of flowers, yield and fruit quality as represented by No. of fruits, fruit weight, fruit length and width, pericarp thickness and vitamin C were increased in response to all fertilization treatments when compared with control plants. Moreover, T.S.S. of fruit was increased slightly; meanwhile fruit vitamin C recorded a high significant increase. (Hammad and El-Gamal, 2004).

Inoculation of pea plants with halex-2 increased significantly all studied growth characters, chemical components and depressed markedly proline accumulation in pea leaves as well as increased pea yield and seed quality (El-Ghinbihi, 2007). Marjoram transplant treated with halex-2 biofertilizers gave the highest values of herb fresh and dry yield, N, P and K contents and its uptake by herb in the early cut, volatile oil percentage, as well as oil yield/ plant and per hectare **(**Al-Fraihat *et al.,* 2011).

MATERIALS AND METHODS

Two pot experiments were carried out at the Experimental Farm , Sabahia Horticultural Research Station, Alexandria Governorate, during summer seasons of 2011 and 2012 in order to study the effect of irrigation with fresh water mixed with sea water at different levels of NaCl ,(i.e., 0., 1000, 2000 and 3000 ppm) application of humic acid at 2cm^3/l, halex-2 at 2cm^3/l and the combination between humic acid and halex-2 on vegetative growth, leaf pigments, yield and its components, fruit quality and leaf chemical constituents of sweet pepper plants *(Capsicum annuum* L.). Sweet pepper transplants cv. Spanish pepper were transplanted after forty days from seed sowing in a plastic containers (40 cm in depth and 50cm in diameter) on 8th May in the two seasons. Each pot had a hole in its bottom which was partially closed with glass wool.

The trials were carried out on virgin soil collected from the southern region of Tahrir Province (Beheira Governorate). The physical and chemical properties of the experimental soil are presented in Table 1.

Table 1 . The physical and chemical properties of the used soil (average of the two seasons)

Physical properties		Chemical properties		Soluble Cations (meq/l)		Soluble Anions (meq/l)	
Sand (%)	36.2	PH	7.64	Ca^{++}	48	CO_3^{-2}	3.0
Silt (%)	24.2	E.C (dsm^{-1})	1.10	Mg^{++}	1.9	HCO_3^{-3}	1.8
Clay (%)	39.6			K^+	18	Cl^-	5.3
Soil texture	clay loam			Na^+	6.1	SO_4^{-2}	3.3
				Total N (%) 0.18		Available P (ppm) 31.15	

***The Chemical analyses of Mediterranean water is shown in table 2**

Table 2. Chemical properties of Mediterranean water Some .

EC dsm^{-1}	Cl^-	Na^+	Mg^{+2}	So_2^{-4}	Ca^{+2}	K^+	Br^-	Sr^{+2}	F^-
	Mol/kg								
35	0.546	0.469	0.0528	0.0282	0.0103	0.0102	0.00085	0.00009	0.00007

***u.s. office of Naval Research Ocean Water temperature**

All plants received NPK (19-19-19) commercial fertilizer, 2gm for each one, each month during the whole season, irrigated with tap water during the first four weeks. After that, they were irrigated twice weekly with salinized water during the whole season. Irrigation with salinized water was initially amounted to 0.5 l/ plant, step wisely increased with time to 2 l / plant / day. Plants were frequently received irrigation water of zero (control), 1000, 2000 and 3000 ppm NaCl concentrations. Salinized water was prepared by mixing sea water with fresh water and its concentration was measured by EC meter.

The experiment included 16 treatments which were the combinations between four salinity levels (zero (control), 1000, 2000 and 3000 ppm NaCl) and four biological and organic treatments (humic acid at 2cm^3/l, halex-2 at 2cm^3/ l and the combination between humic acid and halex-2 as well as control). The treatments were arranged in a split plot design with four replications. The saline levels were assigned at random in the main plots, while the biological and organic treatments were arranged randomly in sub-plots. The sub-plot contained eight containers. 50 cm border space was left between each foliar application treatments to avoid overlapping of humic foliar application solution.

Halex-2 is a biofertilizer containing a mixture of growth promoting N-fixing bacteria of genera Azospirillum, Azotobacter and Klebsiella, which was kindly supplied by Biofertilizer Unit, Plant Pathology Dept., Alex. Univ., was used in this study and was added in irrigation water at a rate of 2gm /l after four weeks from transplanting, and then sprayed every 10 days throughout the growing season. Humic acid was obtained from microbiology department, Soil Water and Environment Research Institute, Agric. Res. Center, Giza, Egypt, and was added as a foliar application at a rate of 2cm^3 / l after four weeks from transplanting, and then sprayed every 10 days throughout the growing season.

After 70 days from transplanting, samples of three plants from each treatment were taken for recording vegetative growth parameters, i.e., plant height, number of leaves and branches, leaf area and leaves dry weight. Leaves were dried at 70^{0}C till constant weight, grounded and analyzed for total N, P and K using the methods described by Chapman and Parti (1961). Proline was determined spectrophotometrically following the ninhydrin method described by Bates et al. (1973).Chlorophyll was determined by the methods described by Yadava (1986) The fruits were harvested weekly and the overall yields were calculated at the end of harvesting.

Samples of five fruits were taken from each plot at full-ripe maturity stage from the second picking to determine total soluble solids (T.S.S) by Carl Zeis refractometer, while titratable acidity and vitamin C were determined according to A.O.A.C. (1984). Also dry matter percentage was also estimated in pepper fruits. Obtained data were subjected to the analysis of variance according to Snedecor and Cochran (1980). Duncan`s multiple range test was used for the comparison among treatments means (Duncan, 1955).

RESULTS AND DISCUSSION

Vegetative Growth

Effect of salinity

Data presented in Table 3 show the effect of saline water on vegetative growth characters of pepper plants as plant height, number of leaves and branches, leaf area and leaves dry weight. It is clear from the data that all growth characters were markedly reduced by increasing saline water level in irrigation water. Such results may be due to that biomass production of plants was inhibited by salinity as suggested by Bernstein (1963) and Cusido *et al.,* (1987) who mentioned that suppression of plant growth under saline conditions may be due to osmotic reduction in water availability or to excessive accumulation of Na and Cl in plant tissues.

Nevertheless, similar findings coincided with the harmful effects of salinity on the plant growth performance that previously reported by El-Ghinbihi, (2007) on pea, El-Hefny 2010 on cowpea, Nour *et al.,* (2010) on tomato and Chookhampaeny(2011) on pepper, ,

Effect of organic and biofertilizer compounds

Data presented in Table 3 show the effect of halex-2 at $2cm^3$ / l, humic acid at $2cm^3$ / l and their combination as well as control (without) on vegetative growth characters of pepper plants. It is clear from the data that the combination between halex-2 and humic acid was the superior treatment which recorded the highest values of growth characters as compared with other treatments followed by halex-2 alone, while, the control treatment gave the lowest values of growth characters.

The increment in vegetative growth due to biofertilizers application might be due to the vital role of bacteria present in the applied biofertilizer and capable of contributing some hormone substances, i.e, gibberellins, auxins and cytokinins (Cacciari *et al.,* 1989). These phytohormones may stimulate the cell elongation and development and hence plant growth (Paleg, 1985). The obtained results are in harmony with those reported by Hammad and El-Gamal (2004) on pepper, El-Ghinbihi, (2007) on pea and Al-Fraihat *et al.,* (2011) on Marjoram.

Effect of interaction between salinity and organic and biofertilizer compounds

Presented data in Table 4 indicate that the interaction between saline water levels and application of halex-2 and / or humic acid had a significant effect on all vegetative growth characters. Meantime, the interaction between zero NaCl and humic acid recorded the highest values of number of branches / plant in the two seasons of study, the interaction between zero NaCl and the combination between halex-2 and humic acid gave the highest values of number of leaves / plant, while the interaction between NaCl at 1000 ppm and the combination between halex-2 and humic acid recorded the best values of plant height. On the other hand the interaction between zero NaCl and untreated plants recorded the highest values of leaf area per plant in first season and the interaction between 1000 ppm NaCl and untreated plants gave the highest values of leaf area per plant in the second season.

3

4

Thus, it could be concluded that the superior treatments were the interaction between zero NaCl and the combination between halex-2 and humic acid followed by the interaction between 1000 ppm NaCl and the combination between halex-2 and humic acid. On the other side the interaction treatments between halex-2 and / or humic acid and higher levels of saline water (2000 or 3000 ppm NaCl) inhibited the biomass production of pepper plants.

Leaf Chemical Constituents

Effect of salinity

Obtained results in Table 5 reveal that irrigation of pepper plants with saline water at 1000 ppm NaCl increased significantly phosphorus percentages while, irrigation pepper plants with any level of saline water significantly increased potassium percentage with non significant differences between them as compared with control, but it did not reflected any significant effect on nitrogen percentage, these results are true in the two growing seasons. As for the effect of salinity on total chlorophyll, the same results in Table 5 show also that irrigation with different levels of saline water did not reflected any significant effect on total chlorophyll in first season, but irrigation with 1000 ppm NaCl significantly increased total chlorophyll in the second season with non significant differences between the other levels. On the other hand irrigation with 3000 ppm NaCl increased significantly proline content in pepper leaves as compared with other treatments.

The negative effects of salinity on leaf chemical constituents are well-known and are often related to a low uptake of calcium, decreasing translocation of this element through xylem or an unfavorable partitioning of cations in plant tissues (Sonneveld, 1988). The obtained results are in harmony with those reported by El-Hefny (2010) on cowpea, Nour *et al.,* (2010) on tomato and Chookhampaeny (2011) on pepper.

Effect of organic and biofertilizer compounds

The effect of organic and biofertilizer compounds on leaf chemical constituents are presented in Table 5. It can be seen from such data that treating pepper plants with halex-2 significantly increased phosphorus percentage as compared with other treatments, while treating plants with humic acid at $2cm^3/l$ recorded the highest values of nitrogen percentage. On the other hand, the highest values of potassium content were recorded from untreated plants, while the lowest values of phosphorus and nitrogen percentage were recorded by control treatment. As for the effect of organic and biofertilizer compounds on proline content and total chlorophyll , the same results in Table 5 show also that treating pepper plants with halex-2 + humic acid gave the lowest values of proline content while, the control recorded the highest values, while treating pepper plants with organic and biofertilizer compounds did not reflected any significant effect on total chlorophyll .these results are true in the two growing seasons.

5

The stimulative effect of humic acid on chemical constituents may be due to that humic acid is one of the most active fractions of organic matter, it improves the absorption of nutrients by plants and soil microorganisms, have a positive effect on the dynamic of N and P in soil, stimulate plant respiration and the photosynthesis process, and favor the formation of soil aggregates, etc. (Brunetti *et al.,* 2007). Similar findings were previously observed by Afifi *et al.,* (2010) on faba bean and Abd El-Rheem *et al.,* (2012) on pepper.

Effect of interaction between salinity and organic and biofertilizer compounds

Presented data in Table 6 indicate that the interaction between saline water levels and application with halex-2 and / or humic acid had significant effect on leaf chemical constituents, meantime, the interaction between NaCl at 3000 ppm and humic acid at 2cm^3/l recorded the highest values of nitrogen percentage, while the interaction between NaCl at 1000 ppm and halex-2 at 2gm/l gave the best values of phosphorus percentage and total chlorophyll. In the other words, the interaction between zero NaCl and halex-2 at 2gm/l caused significant stimulative effect on potassium percentage. As for the effect of interaction between salinity and organic and biofertilizer compounds on proline content, the same results in Table 6 show also that the interaction between NaCl at 3000 ppm and untreated plants significantly increased proline content in pepper leaves.

Yield and its Components

Effect of salinity

It is obvious from the data in Table 7 that number of fruits per plant, average fruit weight, early yield per plant and total yield per plant were significantly decreased by increasing the level of NaCl in the irrigation water from zero ppm to 3000 ppm, the highest values of yield and its components were recorded from the plants which irrigated with zero ppm NaCl in irrigation water, while, the lowest values were recorded from the plants irrigated with 3000 ppm NaCl in irrigation water.

Such results may be due to that biomass production of plants was inhibited by salinity as shown in Table 3. These results compatible with those reported by El-Ghinbihi, (2007) on pea, El-Hefny (2010) on cowpea, Nour *et al.,* (2010) on tomato and Chookhampaeny (2011) on pepper.

Effect of organic and biofertilizer compounds

Data presented in Table 7 show the effect of applying halex-2 at 2gm / l, humic acid at 2cm^3 / l and their combination as well as control on yield and its components of pepper plants. It is clear from the data that, the combination between halex-2 and humic acid was the superior treatment which recorded the highest values of fruits number per plant, average fruit weight, early yield per plant and total yield per plant followed by humic acid at 2cm^3/l with non significant differences between them as compared with other treatments While, the lowest values of yield and its components were recorded by control.

The increase in yield may by due to that humic acids enhance the absorbance capacity of nutrients of the roots by having carboxyllic and phenolic groups and increasing H+-ATPase activity in the root cells (Canellas *et al.*, 2002) .

6

7

Chen and Aviad (1990) pointed out that humic acid was important for plant growth hormones. Dorneanu *et al.,* (2008) reported that humic acid enhances the penetration of nutritive ions in leaves, stimulates the formation of some physiological active metabolite compounds and enlarge the capacity of plants for root absorption of elements from soil. These results compatible with those reported by Afifi *et al.,* (2010) on faba bean and Abd El-Rheem *et al.,* (2012) on pepper.

Effect of interaction between salinity and organic and biofertilizer compounds

Presented data in Table 8 indicate that the interaction between saline water levels and application of halex-2 and / or humic acid had a significant effect on all yield and its components characters. Meantime, the interaction between zero NaCl and the combination between halex-2 and humic acid was the superior treatment regarding number of fruits per plant, average fruit weight, early yield and total yield per plant, followed by the interaction between 1000 ppm NaCl and the combination between halex-2 and humic acid. As it has been mentioned above, the higher levels of saline water (2000 or 3000ppm NaCl) inhibited the yield and its components of pepper plants.

Fruit Quality

Effect of salinity

Results listed in Table 9 demonstrate that all fruit quality parameters were significantly affected by increasing saline water level in irrigation water except nitrogen percentage. Irrigation of pepper plants with saline water at zero ppm NaCl significantly increased dry matter percentage, while irrigation with 1000 ppm NaCl significantly increased TSS and phosphorus percentage. Furthermore, irrigation with2000 ppm NaCl significantly increased vitamin C. on the other side, irrigation of pepper plants with 3000 ppm NaCl significantly enhanced titratable acidity. Injurious ions such as Na^+ and Cl^- negatively affect nutrient uptake and balance (Sauram and Tyagi, 2004 and Hussein *et al.,* 2007). Similar findings coincided with the harmful effects of salinity on the fruit quality performance that previously reported by El-Ghinbihi, (2007) on pea, El-Hefny (2010) on cowpea, Nour *et al.,* (2010) on tomato and Chookhampaeny (2011) on pepper.

Effect of organic and biofertilizer compounds

The effect of organic and biofertilizer compounds on fruit quality of pepper are presented in Table 9. It can be seen from the data that, application of halex-2 and /or humic acid did not reflected any significant effect on vitamin C, phosphorus and potassium percentage, while application of humic acid at $2cm^3/l$ recorded the highest values of dry matter and titratable acidity. Furthermore, application of the combination between halex-2 and humic acid to pepper plants was the superior treatments which gave the highest values of Tss and nitrogen content. These results compatible with those reported by Afifi *et al.,* (2010) on faba bean and Abd El-Rheem *et al.,* (2012) on pepper.

Effect of interaction between salinity and organic and biofertilizer compounds

Presented data in Table 10 indicate that the interaction between saline water levels and application of halex-2 and / or humic acid had significant effect on fruit quality of pepper plants.

8

9

10

Meantime, the interaction between zero NaCl and humic acid was the best treatment regarding dry matter, nitrogen and phosphorus percentage, while the interaction between zero NaCl and the combination between halex-2 and humic acid was the superior treatment regarding vitamin C and TSS. On the other side, the interaction between NaCl at 3000 ppm and control gave the lowest values of fruit quality.

RECOMMENDATION

From the previous mentioned results, it could be concoluded that application of humic acid at $2cm^3$ / l or the combination between halex-2 at 2 gm/ l and humic acid at $2cm^3$ / l to sweet pepper plants grown under saline condition were the superior treatments for enhancing growth, fruit yield and quality as compared with the other treatments.

REFERENCES

A.O.A.C. 1984. Association of official Agricultural chemists. 10th ed. Washington, D.C., U.S.A

Abd El-Rheem, Kh. M., A. A. Afifi and R. A. Youssef. 2012. Effect of humic Acid Isolated by IHSS-N_2 / Mn Method and P Fertilization on Yield of Pepper Plants. Life Science J. 9(2): 356-362.

Afifi, M.H.M., M. F. Mohamed and S.H.A. Shaaban. 2010. Yield and nutrient uptake of some faba bean varieties grown in newly cultivated soil as affected by foliar application of humic acid. J. Plant Production 1(1): 77-85.

Al-Fraihat H. H., S. Y. A. Al-dalain, Z. B. Al-Rawashdeh, M. S. Abu-Darwish and J. A. Al-Tabbal. 2011. Effect of organic and biofertilizers on growth, herb yield and volatile oil of marjoram plant grown in Ajloun region, Jordan. J. of Medicinal Plants Res. 5(13): 2822-2833.

Almogaera, C., M.A. Coca, and I. Jouanin. 1995. Differential accumulation of sunflower le Tran liquation RNA, during zygotic embryogenesis and developmental regulation of their heat shock response. Plant Physiol., 107(3): 765-773.

Bates, L.S., A. P. Waldren, and I. D. Teare .(1973). Rapid determination of free proline for water-stress studies. Plant and Soil 39:205-207

Bernstein, L. 1963. Osmotic adjustment of plants to saline media. (II) Dynamic phase. Am. J. Botany. 48:909-918.

Brunetti, G., C. Plaza, C. E. Clapp and N. Senesi. 2007. Compositional and functional features of humic acids from organic amendments and amended soils in Minnesota, USA. Soil Biol. Biochem. 39 : 1355-1365.

Cacciari D.L., T. Pietrosanti, W. Pietrosanti 1989. Phytohormones – like substances produced by single and mixed diazotrophic cultures of *Azospirillum* and *Arthrobacter*. Plant and Soil 115: 151-153.

Canellas, L.P., F.L. Olivares, A.L. Facanha-Okorokova, and A.R. Facanha (2002). Humic acids isolated from earthworm compost enhance root elongation, lateral root emergence, and plasma membrane H+-ATPase activity in maize roorts, Plant Physiology. 30: 1951–1957.

Chapman, H. D. and P. E. Parti. 1961. Method of analysis for soils, plants and waters. Univ. Calif. Div. Agric. Sci., p 309.

Chen, Y. and T. Aviad 1990. Effects of humic substances on plant growth, p.161-186 in P. MacCarthy, C. E. Clapp, R. L. Malcolm and P. R. Bloom (Eds.). Humic substances in soil and crop science, selected readings. Am Soc. Agron. and Soil Sci. Soc. Of Am, Madison, WI.

Chookhampaeng, S., 2011 . The effect of salt stress on growth, chlorophyll content proline content and antioxidative enzymes of pepper (*Capsicum annuum* L.) seedling . European J. of Scientific Res. 49 (1): 103-109.

Cusido, R. M., j. Palazon, T. Altabella and, C. Morales. 1987. Effect of salinity on soluble prolein, free amino acids and nicotine contents in *Nicotiana rustica* L. Plant and Soil 102:55-60.

Dorneanu, A.D., M. E. Dorneanu, C. Preda, L. Anton and L. Oprica. 2008. Fertilization with liquid humic fertilizers, procedure of high efficiency in improving plant nutrition along the growing season. Proc. 17^{th} Intern. Symp. Of CIEC, 24-27 Nov. Micronutrient Project, Cairo,Egypt, pp. 259-264.

Duncan, B. D. 1955. Multiple range and multiple F-test Biometrics. 11:1-42.

El- Ghinbihi, F. H. 2007. Physiological response of pea plants to salt stress treatments in relation to biofertilizer (halex-2) or mineral fertilizer (Zinc). Zagazig J. Agric. Res. 34 (3) : 463-499.

El-Hefny, E. M., 2010. Effect of saline irrigation water and humic acid application on growth and productivity of two cultivars of cowpea (*Vigna unguiculata* L. Walp). Aust. J. Basic Appl. Sci. 4(12): 6154-6168.

Gehad, A. 2003. Deteriorated Soils in Egypt: Management and Rehabilitation executive authority for land improvement projects (EALIP), Ministry of Agriculture, Egypt.

Gulser, F., F. Sonmez and S. Boysan. 2010. Effects of calcium nitrate and humic acid on pepper seedling growth under saline condition. J. Environ. Biol. 31(5): 873-876.

Hammad, S. AR. and S. M. El-Gamal. 2004. Response of pepper plants grown under water stress condition to biofertilizer (halex-2) and mineral nitrogen. Minufiya J. Agric. Res. 29(1): 1-27.

Hussein, M.M., A.A. Abdel-Kadier, M.S. Abou El-Khair, and O.M. Kassab. 2007. Effect of diluted sea water and benzul adenine on macro and micronutrient content of barley shoots. Egypt. J. Agron., 28(2): 97-107.

Navarro, J.M., C. Garrido, M. Carvajal, and V. Martinez. 2002. Yield and fruit quality of pepper plants under sulphate and chloride salinity. J. Horti. Sci. Biotechnol. 77: 52-57.

Nour. K. A. M., E. A. Radwan, and M. M. Ramadan. 2010. Effect of salinity and calcium foliar application on growth, yield and fruit quality of tomato.Minufiya J. Agric. Res. 35(3):993-1012.

Paleg LG, (1985). Physiological effects of gibberellins. Ann. Rev. Plant Physiol., 16: 291-322.

Parida, A.K. and A.B. Das. 2005. Salt tolerance and salinity effects on plants review. Ecotoxicol. Environ. Safety 60: 324-329.

Rizal, M. Y., Y. Marlida and I P. Kompiang. 2010. The role of humic acid in palm kernel cake fermented by *Aspergillus niger* for poultry region. Pakhistan J. of Nutrition 9(2):182-135.

Sauram, R.K. and A. Tyagi. 2004. Physiology and molecular biology of salinity stress tolerance in plants. Curr. Sci., 86(3): 407-421.

Snedecor, G. W. and W. G. Cochran 1980. Statistical Methods. 7th ed. The Iowa State Univ., Press, Amer., Iowa, USA.

Solange, L. M. and M. O. Rezende. 2008. A powerful tool to characterize humic acid (HA), J.Brazil Chemical Society. 19:24-28.

Sonneveld, C. 1988. The salt tolerance of greenhouse crops. Netherlands J. Sci., 36: 63-73.

Yadava, U.L. 1986. A rapid and non-destructive method to determine chlorophyll in intact leaves. Hort. Sci., 21:1449-1450

Yigit, F. and M. Dikilitas. 2008. Effect of humic acid application on the root rot disease caused by *Fusarium* sp. on tomato plants. J. Plant Pathol. 7(2):179-182.

تأثير الملوحة و بعض المعاملات البيولوجية والعضوية على النمو والمحصول وجودة الثمار فى الفلفل الحلو

دعاء محمد مصطفى و خالد عطية محمود نور
أقسام بحوث الخضر- معهد بحوث البساتين – مركز البحوث الزراعية

أجريت تجربتى أصص بمزرعة التجارب البحثية بمحطة بحوث البساتين بالصبحية ، محافظة الأسكندرية خلال الموسم الصيفى لعامى 2011 و 2012 وذلك لدراسة تأثير الرى بتركيزات مختلفة من مياه البحر المخلوطة بالماء العذب وهى صفر ، 1000، 2000 ، 3000 جزء فى المليون كلوريد صوديوم والمعاملة بمركب هالكس 2 بمعدل 2جم /لتر وحمض الهيومك بمعدل 2سم^{3} / لتر كل على حده والجمع بينهما بالإضافة إلى معاملة الكنترول (بدون) والتفاعل بينهم على صفات النمو الخضرى والصبغات النباتية والمحصول الكلى ومكوناته و جودة الثمار وكذلك المحتوى الكيماوى لأوراق نباتات الفلفل الحلو الصنف الأسبانى.

أدت الزيادة فى مستوى كلوريد الصوديوم فى ماء الرى من صفر إلى 3000 جزء فى المليون إلى حدوث إنخفاضا معنويا فى صفات النمو الخضرى (ارتفاع النبات و عدد الافرع و عدد الاوراق والوزن الجاف / نبات و المساحة الورقية/نبات) والمحصول الثمرى ومكوناته و المواد الصلبة الكلية الذائبة فى الثماربينما رى نباتات الفلفل بتركيز 2000 جزء فى المليون أدى إلى زيادة محتوى الثمار من البوتاسيوم وعلى الجانب الآخر أدى رى نباتات الفلفل بتركيز 3000 جزء فى المليون من كلوريد الصوديوم فى ماء الرى إلى زيادة الحموضة الكلية فى الثمار وكذلك محتوى الأوراق من البرولين.

سجلت معاملة حمض الهيومك بتركيز 2سم^{3} / لتر بمفرده و الجمع بينه وبين مركب الهالكس 2 بتركيز 2جم / لتر زيادة معنوية بالنسبة لكل القياسات الخضرية و محتوى الأوراق من

النيتروجين و الكلوروفيل الكلى و المحصول ومكوناته و المواد الصلبة الكلية الذائبة فى الثمار وكذلك المادة الجافة فى الثمار.

أوضحت النتائج أن معاملة التفاعل بين مستوى كلوريد الصوديوم بمعدل صفر جزء فى المليون وإضافة حمض الهيوميك بتركيز 2سم ^{3} / لتربمفرده أو مع مركب الهالكس 2 بتركيز 2جم / لتر سجلت تأثيرا معنويا منشطا على معظم الصفات التى تمت دراستها ، فى حين أنها سجلت أقل القيم من المواد الصلبة الكلية الذائبة فى الثمار. ومن ناحية أخرى سجلت معاملة التفاعل بين الكنترول و الرى بكلوريد الصوديوم بتركيز 3000 جزء فى المليون فى ماء الرى اقل القيم بالنسبة لصفات النمو الخضرى والمحصول ومكوناته وكذلك جودة الثمار.

قام بتحكيم البحث

أ.د / كوثر كامل ضوه — **كلية الزراعة – جامعة المنصورة**

أ.د / المتولى عبد السميع الغمرينى — **كلية الزراعة – جامعة الزقازيق**

Table 3.Effect of salinity levels and biological and organic applications on vegetative growth characters of pepper plant after 70 days from transplanting during 2011and 2012 seasons

Treatments	Growth characters / plant									
	Season 2011					Season 2012				
	Plant height (cm)	No. of leaves	No. of branches	Leaf area cm^2/ plant	Leaves D.w.(g)	Plant height (cm)	No. of leaves	No. of branches	Leaf area cm^2 /plant	Leaves D.w.(g)
Irrigation water salinity (ppm)										
control	86.1a	47.1a	5.83a	2518a	27.8a	82.6a	50.4a	5.33a	2564a	24.7a
1000	84.2a	41.8b	5.33ab	2199a	21.1b	81.3a	44.2b	5.00ab	2369a	20.2ab
2000	80.9b	33.9c	4.83bc	1966ab	18.4c	79.3a	38.8c	4.83ab	1749b	19.4b
3000	76.2c	29.2d	4.33c	1481b	17.4c	74.2b	28.2d	4.50b	1460c	17.1b
Biological and organic treatments										
Control	80.8b	33.3b	4.67a	1866ab	17.1c	78.7b	36.1b	4.33b	1824b	17.7b
Halex -2 (2gm /l)	81.4b	39.3ab	5.17a	1982ab	19.7b	77.8b	39.2b	4.50b	2142a	19.4b
Humic acid (2cm^3 /l)	79.0b	36.4b	5.33a	1722b	18.6b	76.6b	40.6b	5.33a	2018ab	18.8b
Halex-2 + humic acid	86.1a	43.1a	5.16a	2194a	29.4a	84.3a	45.6a	5.5a	2158a	25.5a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 4. Effect of interaction between salinity levels and biological and organic applications on vegetative growth chracters of pepper plant after 70 days from transplanting during 2011and 2012 seasons

Treatments		Growth characters / plant									
		Season 2011					Season 2012				
Irrigation water salinity (ppm)	Biological and organic treatments	Plant height (cm)	No. of leaves	No. of branches	Leaf area (cm^2/plant)	Leaves D.w.(g)	Plant height (cm)	No. of leaves	No. of branches	Leaf area (cm^2/plant)	Leaves D.w.(g)
control	Control	87.7ab	40.5c-e	5.33a-c	2883a	17.5b-e	90.0b	45.5bc	6.00a	2808a	17.8e-g
	Halex -2 (2gm /l)	81.0de	47.8b	5.67ab	2269b-d	15.7de	84.7c-e	47.9b	6.00a	2382ab	15.0h
	Humic acid (2cm^3 /l)	81.3de	45.9bc	6.00a	2144cd	16.7c-e	81.0d-f	46.9b	6.00a	2323ab	16.6h
	Halex-2 + humic acid	87.3bc	54.4a	5.33a-c	2867a	19.1b-e	88.7bc	61.1a	5.33ab	2741a	20.3b-e
1000	Control	79.2def	39.3d-f	4.67cd	2277b-d	22.3a	79.3f	41.3cd	4.67ab	2307ab	23.3b
	Halex -2 (2gm /l)	82.7cd	43.7b-d	5.00bc	2582ab	18.7b-e	84.7c-e	43.9bc	5.33ab	2734a	18.9d-g
	Humic acid (2cm^3 /l)	76.ef	37.2e-g	5.67ab	1716ef	20.8ab	77.3fg	45.2bc	6.00a	1869bc	21.9bc
	Halex-2 + humic acid	92.5a	47.1b	5.33a-c	2562a-c	20.8ab	95.3a	46.3b	5.33ab	2566a	21.4b-d
2000	Control	80.8de	26.8i	4.00d	1567ef	15.6de	81.3d-f	32.1e	4.00b	1510cd	26.4a
	Halex -2 (2gm /l)	83.8cd	36.9e-g	4.67cd	1865de	17.1c-e	85.3b-d	37.7d	5.33ab	1948bc	14.9h
	Humic acid (2cm^3 /l)	7.7fg	33.7f-h	5.67ab	2304bc	18.9b-e	77.7fc	41.3cd	5.33ab	2691a	17.7fg
	Halex-2 + humic acid	80.2def	38.7d-g	5.00bc	1623ef	18.4b-e	79.3f	44.0bc	4.67ab	1715cd	18.6e-g
3000	Control	71.3g	26.7i	4.00d	1553ef	17.2c-e	72.7gh	25.7g	4.00b	1540cd	17.3f-h
	Halex -2 (2gm /l)	71.0g	28.7hi	4.00d	1531ef	20.2b-d	71.0h	27.2fg	4.00b	1503cd	19.5c-f
	Humic acid (2cm^3 /l)	77.7ef	29.0hi	4.00d	1317f	19.5b-e	80.0ef	28.8e-g	4.00b	1188de	18.2e-g
	Halex-2 + humic acid	80.7ed	32.3g-i	5.67ab	1651ef	18.8b-e	81.0d-f	31.1ef	5.33ab	1611cd	18.7e-g

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 5. Effect of salinity levels and biological and organic treatments application on leaf chemical constituents of pepper plants during 2011and 2012 seasons

Treatments	leaf chemical constituents									
	Season 2011					Season 2012				
	N%	P%	K%	Proline (mg/100g D.W.)	Total chlorophyll (mg/g D.W.)	N%	P%	K%	Proline (mg/100g D.W.)	Total chlorophyll (mg/g D.W.)
Irrigation water salinity (ppm)										
control	3.08a	0.721b	3.90b	159d	43.9a	3.04a	0.685b	3.02c	148d	44.5b
1000	3.13a	0.781a	6.14a	205c	49.4a	2.86a	0.761a	5.70ab	195c	49.9a
2000	3.21a	0.718b	6.16a	246b	47.7a	2.92a	0.747a	6.35a	234b	48.1ab
3000	3.16a	0.749ab	5.90a	281a	46.8a	2.98a	0.697b	5.33b	270a	46.9ab
Biological and organic treatments										
Control	2.99b	0.611c	6.15a	257a	44.0a	2.82b	0.583c	5.92a	234a	43.1a
Halex -2 (2gm /l)	3.17ab	0.837a	5.71ab	218b	47.2a	3.01ab	0.828a	5.01b	218ab	49.0a
Humic acid (2cm^3 /l)	3.26a	0.763b	5.51b	217b	48.9a	3.12a	0.732b	4.91b	206bc	48.9a
Halex-2 + humic acid	3.17ab	0.757b	5.14b	198c	47.6a	2.83ab	0.747b	4.81b	190c	48.5a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple

Table 6. Effect of interaction between salinity levels and biological and organic treatments application on leaf chemical constituents of pepper plants during 2011and 2012 seasons

Treatments		leaf chemical constituents									
		Season 2011					Season 2012				
Irrigation water salinity (ppm)	Biological and organic treatments	**N%**	**P%**	**K%**	**Proline (mg/100g D.W.)**	**Total chlorophyll (mg/g D.W.)**	**N%**	**P%**	**K%**	**Proline (mg/100 g D.W.)**	**Total chlorophyll (mg/g D.W.)**
control	Control	2.87c-f	0.643gh	3.08g	171i	41.9ef	2.88bc	0.633de	2.77fg	162f	41.7b
	Halex -2 (2gm /l)	3.36ab	0.833b	4.93de	160ij	42.9ef	3.36ab	0.833ab	5.01c-e	156fg	41.4b
	Humic acid (2cm^3 /l)	2.85d-f	0.660g	4.02f	157ij	41.5f	2.77bc	0.623de	2.71fg	144fg	41.5b
	Halex-2 + humic acid	3.15a-e	0.677fg	3.83f	150j	50.6a-d	3.13a-c	0.650de	2.61fg	132g	50.8ab
1000	Control	3.04b-f	0.592hi	7.80a	224ef	43.0c-f	2.97a-c	0.580ef	7.52a	206e	43.2ab
	Halex -2 (2gm /l)	2.80ef	0.908a	5.63cd	199gh	55.2a	2.70c	0.893a	5.45c-e	195e	55.0a
	Humic acid (2cm^3 /l)	3.22a-d	0.805b-d	6.00bc	204gh	55.1a	3.17a-c	0.813a	5.6b-e	192e	55.2a
	Halex-2 + humic acid	2.92c-f	0.780cd	4.25ef	195h	45.3b-f	2.60c	0.760bc	4.21ef	189e	44.1ab
2000	Control	3.01b-f	0.555i	6.85b	296b	42.9d-f	2.88bc	0.523f	7.08ab	253c	43.3ab
	Halex -2 (2gm /l)	3.08a-f	0.733cd	5.10de	225ef	49.3a-e	2.97a-c	0.790b	4.93c-e	241c	48.3ab
	Humic acid (2cm^3 /l)	3.25a-c	0.713ef	6.86b	248cd	48.3a-f	3.07a-c	0.700cd	7.19a	236c	48.4ab
	Halex-2 + humic acid	2.92c-f	0.787b-d	6.22bc	216fg	51.1ab	2.77bc	0.773bc	6.21a-c	209de	50.8ab
3000	Control	2.71f	0.598hi	6.43bc	340a	46.6b-f	2.58c	0.593ef	6.32a-c	315a	47.8ab
	Halex -2 (2gm /l)	3.10a-e	0.817bc	5.79cd	291b	45.1b-f	3.00a-c	0.797b	4.67de	280b	44.0ab
	Humic acid (2cm^3 /l)	3.45a	0.813b-d	3.98f	260c	50.6a-c	2.50a	0.793b	4.12ef	253c	50.5ab
	Halex-2 + humic acid	3.02b-f	0.763de	6.27bc	234de	45.2b-f	2.83bc	0.803b	6.22a-c	232cd	44.7ab

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 7. Effect of salinity levels and biological and organic treatments application on yield and its components of pepper plants during 2011and 2012 seasons

Treatments	Yield and its components							
	Season 2011				Season 2012			
	No. of fruits/ plant	Average fruit wt. (g)	Early yield (g/plant)	Total yield (g/plant)	No. of fruits/ plant	Average fruit wt. (g)	Early yield (g/plant)	Total yield (g/plant)
Irrigation water salinity (ppm)								
control	16.1a	28.9a	155.2a	466.2a	16.8a	30.9a	174.3a	519.9a
1000	14.2b	25.6a	119.1b	367.9b	13.8b	26.1b	122.9b	363.9b
2000	11.6c	20.6b	80.9c	241.9c	10.4c	20.6c	75.3c	220.1c
3000	7.2d	15.4c	39.4d	110.7d	7.3d	15.1d	38.6d	110.9d
Biological and organic treatments								
Control	10.5b	21.5b	79.4c	237.1b	10.3c	21.9b	82.1c	248.7c
Ialex -2 (2gm /l)	12.1ab	17.3c	75.2c	229.7b	11.9b	17.5c	79.9c	234.5c
Iumic acid (2cm^3/l)	12.9a	24.9a	112.5b	340.1a	12.6ab	25.9a	119.1b	345.1b
Ialex-2 + humic acid	13.6a	26.6a	127.6a	379.8a	13.4a	27.3a	130.2a	386.6a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 8.Effect of interaction between salinity levels and biological and organic treatments application on yield and its components of pepper plants during 2011and 2012 seasons

Treatments		Yield and its components							
		Season 2011				Season 2012			
Irrigation water salinity (ppm)	Biological and organic treatments	No. of fruits/ plant	Average fruit wt. (g)	Early yield (g/plant)	Total yield (g/plant)	No. of fruits/ plant	Average fruit wt. (g)	Early yield (g/plant)	Total yield (g/plant)
control	Control	15.0cd	24.8c	123.3e	370.4c	16.0bc	28.2cd	144.3e	450.8c
	Halex -2 (2gm /l)	15.7a-c	29.7ab	155.5c	467.1b	16.7ab	31.0b	172.9c	517.1b
	Humic acid (2cm^3/l)	16.7ab	29.0b	162.2bc	484.2b	16.1ab	30.3bc	181.7b	517.9b
	Halex-2 + humic acid	17.0a	31.9a	179.8a	543.2a	17.4a	34.1a	198.4a	593.9a
1000	Control	12.3ef	26.2c	103.1fg	322.3cd	12.0de	26.8de	107.5f	321.9d
	Halex -2 (2gm /l)	13.4de	15.9de	63.9h	213.0e	13.3d	15.9gh	74.3h	211.8f
	Humic acid (2cm^3/l)	15.3bc	29.2b	143.1d	447.3b	14.7c	30.5b	149.5e	447.7c
	Halex-2 + humic acid	15.7a-c	31.2ab	166.2b	488.7ab	15.3c	31.0b	160.6d	474.6c
2000	Control	9.3g	17.6d	58.8hi	163.2ef	8.7gh	16.9fg	49.3ij	146.8g
	Halex -2 (2gm /l)	11.7f	14.6e	56.9h-j	170.6ef	10.0fg	13.8h	46.8j	137.7g
	Humic acid (2cm^3/l)	12.0ef	24.7c	95.7g	296.8d	10.7ef	25.8e	96.7g	276.4e
	Halex-2 + humic acid	13.3ef	25.3c	111.7f	337.1cd	12.3d	25.9e	108.6f	319.3d
3000	Control	5.3i	17.4d	32.4k	92.4gh	4.8i	15.7gh	27.1k	75.4h
	Halex -2 (2gm /l)	7.6h	9.0f	24.5k	68.1h	7.7h	9.27i	25.7k	71.5h
	Humic acid (2cm^3/l)	7.8gh	16.9de	48.3j	132.1fg	8.0h	17.2fg	48.4ij	138.2g
	Halex-2 + humic acid	8.3gh	18.1d	52.6ij	150.2f	8.7gh	18.2f	53.2i	158.4g

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table9. Effect of salinity levels and biological and organic treatments application on fruit quality characteristics during 2011and 2012 seasons

Treatments	Fruit quality													
	Season 2011							Season 2012						
	T.S.S %	Dry matter%	Vit.C m.g/ 100ml juice	Titrat-able acidity %	N%	P%	K%	T.S.S %	Dry matter %	Vit.C m.g/ 100ml juice	Titrat-able acidity %	N%	P%	K%
Irrigation water salinity (ppm)														
control	4.93bc	7.54a	65.5ab	0.348b	3.24a	0.600b	3.89b	4.89b	7.59a	65.4b	0.341b	3.14a	0.621b	4.05b
1000	5.38a	5.70b	63.9c	0.334c	3.14a	0.690a	3.74bc	5.32a	6.03b	63.4c	0.332d	3.24a	0.680a	4.08b
2000	5.10b	5.55b	66.7a	0.335c	3.30a	0.638ab	4.81a	4.97b	5.96b	66.9a	0.337c	3.16a	0.637ab	4.72a
3000	4.67c	6.21ab	64.8bc	0.358a	3.19a	0.664a	3.39c	4.75b	6.74ab	65.3b	0.359a	3.21a	0.667ab	3.41c
Biological and organic treatments														
Control	5.08a	6.78a	65.7a	0.348b	3.16ab	0.643a	4.14a	4.89b	6.99ab	65.1a	0.341b	3.08ab	0.648a	4.15ab
Halex -2 (2gm /l)	5.16a	5.12b	65.5a	0.325d	3.12b	0.658a	3.90a	5.26a	5.79c	65.8a	0.325c	3.00b	0.642a	4.10ab
Humic acid (2cm^3/l)	4.60b	6.73a	65.3a	0.367a	3.19ab	0.668a	3.79a	4.52c	7.27a	65.2a	0.367a	3.33a	0.680a	3.83b
Halex-2 + humic acid	5.23a	6.35a	64.6a	0.335c	3.41a	0.623a	4.02a	5.25a	6.27bc	64.9a	0.338b	3.34a	0.635a	4.19a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test

Table10.Effect of interaction between salinity levels and biological and organic treatments application on fruit quality characteristics of pepper plants during 2011and 2012 seasons

Treatments		Fruit quality													
		Season 2011							Season 2012						
Irrigation water salinity (ppm)	Biological and organic treatments	T.S.S (%)	Dry matter (%)	Vit.C mg/ 100ml juice	Titrat-able acidity (%)	N%	P%	K%	T.S.S (%)	Dry matter (%)	Vit.C mg/ 100ml juice	Titrat-able acidity (%)	N%	P%	K%
control	Control	5.05cf	7.31bc	69.9a	0.348e	3.05ae	0.520g	4.27b	5.27ad	7.81ac	70.1a	0.360cd	3.09ac	0.530ef	4.20bc
	Halex -2 (2gm /l)	4.80fh	7.46b	60.3f	0.300h	2.92e	0.667cd	3.78bd	4.73de	6.91bd	59.8f	0.300g	2.97be	0.633be	3.67ce
	Humic acid (2cm^3 /l)	4.60gh	9.64a	62.3e	0.390b	3.42a	0.690ad	3.84bd	4.47e	9.57a	63.0cd	0.390ab	3.45ac	0.663bd	3.70ce
	Halex-2 + humic acid	5.20de	6.01cf	69.4ab	0.340ef	3.40ab	0.565fg	4.00bd	5.27ad	5.84cf	69.2ab	0.340ef	3.48ab	0.573df	4.01cd
1000	Control	4.80fh	6.01cf	68.0bc	0.328g	3.11ae	0.648ce	4.03bc	4.87ce	6.00cf	68.3ab	0.333ef	3.23ae	0.623ce	3.86ce
	Halex -2 (2gm /l)	5.76a	5.50eg	64.1d	0.300h	2.93de	0.650c-e	3.75ce	5.80a	5.18df	64.5c	0.300g	2.86e	0.667bd	3.63ce
	Humic acid (2cm^3 /l)	5.27bd	5.46eg	62.6de	0.377c	3.34ac	0.752ab	3.84bd	5.33ac	5.28df	62.7ce	0.377bc	3.19ae	0.793a	3.81ce
	Halex-2 + humic acid	5.57ab	6.50be	61.1f	0.328g	3.38ab	0.690ad	4.05bc	5.53ab	6.35ce	60.4ef	0.327f	3.25ae	0.677ad	3.69ce
2000	Control	5.17ce	5.14fg	61.6ef	0.335fg	2.97ce	0.705ac	4.99a	5.27ad	4.72df	62.0df	0.333ef	2.93ce	0.707ac	5.06a
	Halex -2 (2gm /l)	5.40bc	4.43g	69.4ab	0.300h	3.32ad	0.667cd	4.93a	5.27ad	4.36ef	69.5a	0.300g	3.53a	0.700ac	4.93ab
	Humic acid (2cm^3 /l)	4.50h	6.53be	68.9ac	0.360d	3.28ae	0.680bd	3.86bd	4.80ce	6.19ce	68.3ab	0.360cd	3.26ae	0.653be	3.97cd
	Halex-2 + humic acid	5.07cf	6.91bd	67.4c	0.348e	3.36ab	0.498g	5.31a	5.07bd	6.91bd	67.0b	0.347de	3.48ab	0.493f	5.31a
3000	Control	4.93dg	9.26a	62.0e	0.365d	3.37ab	0.708ac	3.29ef	4.93ce	8.59ab	62.2cf	0.363cd	3.37ae	0.713ac	3.42ce
	Halex -2 (2gm /l)	4.90eg	4.45g	68.8ac	0.400a	3.07ae	0.617df	3.53d-f	4.87ce	4.07f	68.0ab	0.400a	3.10ae	0.633be	3.37de
	Humic acid (2cm^3 /l)	3.87i	6.37bf	67.2c	0.340ef	3.02be	0.573eg	3.70ce	3.80f	5.89cf	67.1a	0.340ef	2.88de	0.560df	3.67ce
	Halex-2 + humic acid	5.13cf	5.84df	62.1e	0.328g	3.36ab	0.763a	3.09f	5.07bd	6.32c-e	61.9df	0.327f	3.42ad	0.750ab	3.11e

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.