Effect of Saline Irrigation Water on The Landscaping Potentials of *Santolina chamaecyparissus,L*, Plants

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ABSTRACT

The present work was carried out during the years of 2009, 2010 and 2011 at the Flower and Ornamental Plants Research Garden, Faculty of Agriculture, Alexandria University to study the effects of various levels of salinity of irrigation water (control= 0.47, 1, 2, 4, 6, 8, 10 and 12 ds/m) on the parameters that affect the landscaping potentials of *Santolina chamaecyparissus,L.* plants and also surveying the common landscaping uses of it in the green areas of Alexandria city.

The obtained results indicated that increasing the level of irrigation water salinity led to significant decrease of all vegetative growth parameters (plant height, plant diameter, stem diameter and number of main branches/plant) and significant reduction in the aesthetic appearance and landscaping uses of plants (growth shape and plant condition), compared with the control plants which were irrigated only with tap water.

***Santolina chamaecyparissus,L* plants showed tolerance to salinity of irrigation water till 8ds/m, and increasing the salinity level above 8 ds/m led to death of the plants after 6 months from starting the salinity treatments.**

Furthermore, surveying the uses of the plant in the landscaping of green areas showed a wide range of uses i.e. in separate beds, on sloped areas, for edging and shaping beds, drawing and writing on lawns and as herbaceous borders.

It can be generally recommended that *Santolina chamaecyparissus,L* plants can tolerate the salinity of irrigation water up to 8 ds/m and still having high landscaping potentials and a good aesthetic appearance.

INTRODUCTION

For landscape plants, aesthetic appearance is more important than maximum growth. Therefore, evaluation of salinity tolerance of landscape plants should consider the visual appearance along with the plant growth response when irrigated with saline water.

Santolina chamaecyparissus,L (family *compositae*) is native to southern Europe and Mediterranean region and cultivated as herb in garden. It was famously known as an aromatic herb and because of its grey color it is used for writing on lawns or as a border (Osborne, 1972).

The usage of low quality water in irrigation is one of the main sources to save water. Water quality decreases by increasing its salts content, but using saline water such as sea water, waste water and wells water for irrigation is being required, because of water lack, especially in arid and semi-arid regions (Kandeel and Elwan, 1992).

The objectives of the present work were to study the effects of salinity of the irrigation water on the parameters that affect the landscaping potentials of *Santolina chamaecyparissus,L* plants and also to survey the common uses of it in landscaping green areas in Alexandria city.

MATERIALS AND METHODS

The present work was carried out at the Flower and Ornamental Plants Research Gardens, Faculty of Agriculture, Alexandria University, Egypt during the years 2009 and 2010.

Surveying plant uses was carried out on the open green areas of Alexandria city at 2011.

Santolina cuttings were taken on November 2009 from the mother plants in uniform length with an average of 15 cm. and then planted in 30 cm diameter pots, after a month (on December), the rooted cuttings were transplanted into 15 cm pots. After another month (on January 2010) from transplanting, plants were finally transplanted into 30 cm diameter pots (one plant/pot).

The chemical analysis of used soil cleared that it contained 4.49, 9.78, 3.7, 6.9, 16.5 and 4.6 meq/l of potassium, sodium, magnesium, calcium, chloride and bicarbonate; respectively. The electric conductivity (EC) and pH values (1: 2.5 soil: water) were 1.82 dsm^{-1} and 7.73, respectively.

Sodium chloride without purification (contents: NaCl 98.5%, KO_3 30-70% and humidity 0.3%) produced by Egyptian salt and mineral company was used to prepare the stock solution of the salinity (Abbas, 1992).

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Eight concentrations of irrigation water salinity were used namely, control (tap water) of EC 0.47 ds/m, 1, 2, 4, 6, 8, 10 and 12 ds/m.

Tap water was listed as a source of irrigation of the young plants for a month starting from their final transplanting date. After this period, the salinity treatments were commenced two times weekly starting from February to April and three times weekly starting from May to November. A half liter (500 ml) of the salinity of irrigation water was used per plant. The plants were fertilized with a complete fertilizer of 20 N: 10 P: 20 K at a rate of one gram per liter and 500 ml per each pot was added weekly (Blessington, *et al*. 2005).

The experimental design was a randomized complete block design with eight treatments arrayed in replicates and four plants were used for each treatment (plot). The following data was recorded: plant height, plant diameter, cover percentage, stem diameter, number of main branches per plant, growth shape, plant condition and exchange of soil construction.

RESULTS AND DISCUSSIONS

I- Effect of saline irrigation water on the landscaping potentials of *Santolina chamaecyparissus,L* plants:

Data in Tables 1-5 show that increasing the salinity level of the irrigation water treatments significantly decreased all the measured growth parameters i.e. plant height, plant diameter, stem diameter, number of main branches/plant. Furthermore, salinity reduced visual and landscaping characters (Tables 6, 7).

This reduction was gradually increased as salinity level increased.

Plants showed a good growth performance and tolerance to salinity till 5120 ppm. (8ds/m), while increasing the concentration of water salinity more than 8 ds/m caused a damage of the plants leading to death after 6 months from starting of the treatment (in September 2010).

These results were probably due to that high salt concentrations inhibit enzymes by impeding the balance of forces controlling the protein structure besides salinity decrease carbohydrates and some natural growth hormones, thereby inhibiting plant growth as reported by Mazher *et al*. (2007).

Also, saline conditions disrupt several physiological processes in plants such as photosynthesis and carbohydrate accumulation leading to reduction in growth (Burns and Caesar, 1990).

The reduction in plant growth characteristics under salt stress might also be due to slowing down and inhibiting of cell division and meristematic activity of plants as reported by Bolus *et al*.(1972). Also this inhibition cause reduction in cell elongation as mentioned by Ruf *et al*.(1963) and Nieman (1995).

In addition to the accumulation of salt ions especially sodium and chloride ions in the growing media which has an indirect effect on the plant growth. Sodium ions cause a degradation of soil structure which lead to water logging and poor plant growth (Greenway, 1973).

These results are in harmony with those obtained by Nooh and Haikal (1992) and Khalil (1999) on *Pelargnium graveolens* and *Santolina chamaecyparissus,L,* Alshammary *et al*. (2004) on turfs, Niu *et al*. (2007) on herbaceous perennials and groundcovers, Zapryanova and Atanassova (2009) on *Targets patula* and *Agreatum mexicanum* and Abd El Aziz *et al*. (2011) on *Pelargonium zonale*.

II- Survey on the practical applications on the use of Santolina plants:

It was found that the most common uses of Santolina in landscaping open green areas in Alexandria city were planting in separate beds and on sloped areas. Also Santolina plants used for edging and shaping beds, drawing and writing on lawns and as herbaceous borders.

Several researches stated and reported the uses of different perennials as ground cover, in flower beds, edging, in borders, screens, hanging baskets, containers and window boxes beside its aesthetic value by providing color and texture to the landscape garden. Those scientists are; Nooh (1981) , Gilman and Teresa Howe (1999), Bridwell (2003), McNaughton (2004), Schutzki (2005) Mikolajski (2008) and Erler (2011).

III- Soil analysis:

Chemical analysis of soil at the end of the saline water irrigation experiment presented in Table (^) showed that the electric conductivity (EC) of the soil solution was greatly increased as the level of saline water irrigation treatments increased. EC for control was 2.23 ds/m as it slightly increased from the one before adding tap water (1.82 ds/m).

By applying irrigation water with salinity 1, 2, 4, 6, 8, 10 and 12 ds/m the soil EC increased to 4.43, 7.52, 16.85, 21.2, 31.8, 43.6 and 58.3 ds/m ; respectively.

The soil analysis also showed that the soluble cations (Sodium, Potassium, Magnesium and Calcium) were highly increased as the saline water irrigation increased.

Further more, the chloride ions contents showed a high increase with increasing the saline water irrigation treatments.

On the contrary the bicarbonate ions slightly decreased with salinity water treatments.

These results were probably due to the accumulation of salts in the pot soil after a period of 8 months of salinity treatments.

Table 1. Means of plant height (cm) of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	April	May	June	July	August	September	October	November
Control (Tap water)	8.91	9.28	10.87	11.28	11.53	12.37	12.76	13.16
640 (1 ds/m)	8.84	9.31	10.81	11.56	12.75	14.19	14.81	15.00
1280 (2 ds/m)	8.86	8.95	10.66	10.94	10.88	11.75	11.94	12.06
2560(4 ds/m)	8.62	8.94	9.78	10.09	10.62	11.84	12.31	12.37
3840 (6 ds/m)	8.56	8.78	10.09	10.41	10.28	10.74	11.06	11.38
5120 (8 ds/m)	8.44	8.59	9.31	10.22	9.83	10.47	11.44	11.44
6400 (10 ds/m)	8.69	8.84	9.78	9.85	9.72	--	--	--
7680 (12 ds/m)	8.5	8.53	9.59	9.75	9.83	--	--	--
L.s.D at 0.05	N.S.	N.S.	N.S.	0.85	0.85	1.22	1.33	1.29

Table 2. Means of plant diameter (cm) of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	pril	May	June	July	August	September	October	November
Control (Tap water)	4.01	7.54	9.09	10.69	11.34	12.45	13.38	13.72
640 (1 ds/m)	4.01	6.92	8.67	9.65	12.03	13.72	14.72	15.09
1280 (2 ds/m)	4.05	6.73	7.56	8.64	9.78	10.42	11.25	11.78
2560(4 ds/m)	4.05	6.31	7.69	8.58	9.52	11.13	11.78	11.86
3840 (6 ds/m)	4.06	6.67	7.37	7.98	9.03	9.93	11.05	11.23
5120 (8 ds/m)	4.13	5.81	6.53	7.25	8.3	8.56	9.75	9.56
6400 (10 ds/m)	4.00	5.75	5.77	7.54	8.72	--	--	--
7680 (12 ds/m)	3.93	6.04	6.26	7.33	8.14	--	--	--
L.s.D at 0.05	N.S.	0.93	1.04	1.15	1.43	1.90	2.85	2.75

Table 3. Means of cover percentage (%) of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	April	May	June	July	August	September	October	November
Control (Tap water)	0.13	0.45	0.65	0.9	1.02	1.22	1.43	1.50
640 (1 ds/m)	0.13	0.38	0.59	0.73	1.15	1.49	1.76	1.83
1280 (2 ds/m)	0.13	0.36	0.45	0.59	0.75	0.86	1.00	1.09
2560(4 ds/m)	0.13	0.31	0.47	0.58	0.72	0.96	1.10	1.11
3840 (6 ds/m)	0.13	0.35	0.43	0.50	0.64	0.74	0.88	0.89
5120 (8 ds/m)	0.13	0.26	0.34	0.40	0.52	0.51	0.56	0.55
6400 (10 ds/m)	0.12	0.26	0.26	0.30	0.37	--	--	--
7680 (12 ds/m)	0.12	0.29	0.32	0.37	0.33	--	--	--
L.s.D at 0.05	N.S.	0.09	0.11	0.13	0.23	0.36	0.58	0.56

Table 4. Means of stem diameter (mm) of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	April	May	June	July	August	September	October	November
Control (Tap water)	2.56	2.56	3.00	3.69	3.75	5.50	5.50	5.62
640 (1 ds/m)	2.68	2.69	3.31	3.44	3.62	5.81	5.75	5.81
1280 (2 ds/m)	2.50	2.50	2.87	3.25	3.19	4.75	4.75	4.94
2560(4 ds/m)	2.62	2.63	2.81	3.06	3.06	5.12	4.83	4.87
3840 (6 ds/m)	2.69	2.69	3.06	3.25	2.79	4.33	4.33	4.33
5120 (8 ds/m)	2.50	2.50	2.94	2.96	2.78	4.54	3.89	3.89
6400 (10 ds/m)	2.50	2.50	2.75	3.21	2.69	--	--	--
7680 (12 ds/m)	2.18	2.19	2.75	2.38	2.6	--	--	--
L.S.D at 0.05	N.S.	N.S.	0.54	0.35	0.60	0.54	0.47	0.44

Table 5. Means of number of branches per plant of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	April	May	June	July	August	September	October	November
Control (Tap water)	0.77	1.49	2.24	3.12	3.73	3.86	3.93	4.00
640 (1 ds/m)	0.73	1.51	1.94	2.81	3.86	4.14	4.18	4.21
1280 (2 ds/m)	0.43	1.31	1.86	2.66	3.34	3.51	3.57	3.63
2560(4 ds/m)	0.43	1.31	1.81	2.38	3.20	3.39	3.44	3.46
3840 (6 ds/m)	0.60	1.36	1.75	2.27	3.17	3.18	3.20	3.21
5120 (8 ds/m)	0.55	1.36	1.55	2.09	2.86	2.81	2.96	2.86
6400 (10 ds/m)	0.69	1.29	1.51	1.59	2.70	--	--	--
7680 (12 ds/m)	0.77	1.44	1.60	2.07	2.35	--	--	--
L.S.D at 0.05	N.S.	N.S.	0.27	0.35	0.30	0.47	0.31	0.26

Table 6. Means of plant condition of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	April	May	June	July	August	September	October	November
Control (Tap water)	9.00	8.87	8.87	9.00	8.75	9.00	9.00	9.00
640 (1 ds/m)	9.00	9.00	8.87	8.75	8.87	9.00	8.87	8.62
1280 (2 ds/m)	9.00	8.75	8.37	8.12	7.75	8.25	8.87	8.12
2560(4 ds/m)	9.00	8.62	8.25	6.62	6.62	7.50	6.50	6.00
3840 (6 ds/m)	9.00	8.75	8.25	6.25	5.87	5.12	4.20	4.12
5120 (8 ds/m)	9.00	8.25	7.25	4.62	4.37	4.00	3.50	3.00
6400 (10 ds/m)	9.00	7.00	6.00	3.25	2.62	--	--	--
7680 (12 ds/m)	9.00	6.50	5.62	3.83	2.33	--	--	--
L.S.D at 0.05	N.S.	0.91	0.96	1.17	0.94	1.29	1.05	0.85

Table 7: Means of growth shape of *Santolina chamaecyparissus* L. as affected by saline irrigation water treatments

Irrigation water salinity (ppm)	Growing period							
	April	May	June	July	August	September	October	November
Control (Tap water)	0.50	1.25	3.12	6.75	8.87	8.87	9.00	9.00
640 (1 ds/m)	0.44	1.25	2.50	5.25	8.75	8.87	9.00	9.00
1280 (2 ds/m)	0.25	1.00	1.87	4.37	7.62	7.75	8.00	8.50
2560(4 ds/m)	0.25	1.00	1.75	3.25	6.5	7.33	7.83	7.62
3840 (6 ds/m)	0.37	1.00	1.62	3.12	6.25	6.62	6.37	6.79
5120 (8 ds/m)	0.31	1.00	1.00	2.91	5.17	5.08	5.22	5.44
6400 (10 ds/m)	0.44	1.12	1.08	2.58	4.41	--	--	--
7680 (12 ds/m)	0.62	1.12	1.25	3.00	3.56	--	--	--
L.S.D at 0.05	N.S.	N.S.	0.75	1.24	1.22	1.38	1.07	0.73

N.S=Not Significant at 0.05 level of probability.
L.S.D=Least significant difference at 0.05 of probability.

Table 8. Soil analysis of *Pelargonium zonale* L. and *Santolina chamaecyparissus* L. pot plants at the end of the experimentas affected by saline irrigation water treatments.

Irrigation water salinity (ppm)	Soil Characteristics								
	EC	PH	soluble cations meq./1			soluble anions meq./1			SAR
	DS/m		Na^+	K^+	Mg++	Ca^{++}	Ci	HCO^-_3	
Control (Tap water)	2.23	8.52	12.60	0.90	3.20	6.40	17	3.0	5.76
640 (1 ds/m)	4.43	8.60	25.00	0.90	4.00	7.0	23	4.4	10.66
1280 (2 ds/m)	7.52	8.44	47.83	1.31	8.00	9.5	84	4.4	16.17
2560(4 ds/m)	16.85	8.14	139.13	1.90	11.50	17.0	192	3.6	36.86
3840 (6 ds/m)	21.20	8.34	173.91	2.08	11.50	18.0	234	3.6	45.28
5120 (8 ds/m)	31.80	8.10	304.35	2.56	23.00	23.0	320	3.6	63.46
6400 (10 ds/m)	43.60	8.01	358.70	3.33	50.00	32.0	480	3.4	56.02
7680 (12 ds/m)	58.30	7.70	739.13	4.36	58.00	51.0	640	2.6	100.12

REFERENCES

Abbass,R. (1992). Effect of salinity and soil type on the growth of some ornamental plants. PhD. Thesis, Faculty of Agric. Alex. Univ., Egypt.

Abd El-Aziz Nahed G.; Azza A.M.Mazher and Mona H.Mahgoub (2011). Influence of using organic fertilizer on vegetative growth, flowering and chemical constitients of *Matthiola incanna* plant growth under saline water irrigation. Journal of Agriculture Sciences 7(1): 47 – 54.

Alshammary, S.F.; Y.L.Qian and S.J.Wallner (2004). Growth response of four turfgrass species to salinity. Agri.Water Manag. 66: 97 – 111.

Blessington, T.M.; Clement, D.L.; Wadkins, S.L. and Williams, K.G. (2005). Gray Santolina Production and Care. Central Maryland Research and Education Center Ellicott: Maryland Cooperative Extension.

Bolus, S.T.; M.N.El-Shourbagy and N.I.Nissak (1972). Studies on the effect of salinity on the epidermis and mesophyll tissues on some *Ricimus communis* varities. Desert Inst. Bull., 22(2): 421 – 432.

Bidwell, F.M. (2003). Landscape plants "Their Identification, Culture and Use". Text Book 2nd edition Thomson Learning. U.S.A. 29 – 42.

Burns, S. and K. Caesar (1990). Shoot development and tuber yield of several potato cultivars under high salt concentrations at different stages of development. Potato Res., 33(1): 23 – 32.

Erler, C.T. (2011). Landscape for your home. Text Book Creative Homeowner 3rd edition, upper saddle river. New Jersey. 244 – 247.

Gilman, E.F. and Teresa Howe (1999). *Pelargonium x hortorum*, Fact Sheet FPS-458, Institute of Food and Agricultural Sciences, University of Florida. Retrieved from http://edis.ifas.ufl.edu.

Greenway, H.(1973). Salinity plant growth and metabolism. Journal Aust. Inst. Agric. Science, 39: 24 – 34.

Kandeel, A.M. and Elwan, I.M.(1992). Effect of water salinity on the growth and the chemical composition of majoram plants. Agric. Sci. Ain Shams Univ., Cairo, 37(1): 243 – 252.

Khalil, A.M. (1999). Physiological studies on the effect of saline water irrigation and some growth regulators on *Nigella sativia L*. PhD. Thesis, Fac. Agric., Zagazig Univ.

Mazher, A.M.; Azza E.M.; Fatma El-Quesni and M.M.Farahat (2007). Response of ornamental plants and woody trees to salinity. journal of Agric.Sci.3(3): 386 – 395.

McNaughton, V.(2004). Santolina plant named " Sant 101". United States Plant Patent, Patent No.: US PP15,201 P2.

Mikolajski, A. (2008). The Visual Encyclopedia of Garden Plants. Text Book Anness Publishing, 2nd edition, Hermes House Blackfriars road, London. 108 – 109.

Nieman, R.H.(1995). Expansion of bean leaves and its suppression by salinity. Plant Physiology, 40: 156 – 161.

Niu,G.; D.S.Rodriguez and Lizzie Aguiniga (2007). Growth and Landscape Performance of Ten Herbaceous Species in Response to Saline Water Irrigation. J Environ Hortic. 25(4): 204 – 210.

Nooh, A. (1981). Studies on the initial state of some selected woody and annual plants as a base for the suitable using in the shaping of green areas and landscape. PhD. University of Humbolat (Berlin).

Nooh, A. and M.Haikal (1992). Effect of saline water on growth and oil yield of *Pelargonum graveolens*, *Ait* and *Santolina chamaecyparissus,L*. Journal Agric. Sci. Mansoura Univ. 10 (17): 18 – 23.

Osborne, R. (1972). How to grow herbs. Text Book Lane Publishing Co.Menlo park, California. 1st edition : 73.

Ruf, R.H.; R.E.Eckart and O.Richard (1963). Osmotic adjustment of cell sap to increase in root medium osmotic stress. Soil Sci., 96:326 – 330.

Schutzki, R.E. (2005). A Guide for the Selection and Use of Plants in the Landscape. Department of Horticulture, Michigan State University. Retrieved from http://www.emeraldashborer.info

Zapryanova, N. and B. Atanassova (2009). Effect of salt stress on the growth and flowering of ornamental annual species. Biotechnol. & Biotechnol. Special Edition/on-line.

الملخص العربي

تأثير ملوحة مياه الرى على القدرة التنسيقية لنبات الشيح الخراسانى

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أجرى هذا البحث بحدائق أبحاث الزهور ونباتات الزينة بكلية الزراعة جامعة الإسكندرية خلال الأعوام ٢٠٠٩، ٢٠١٠،٢٠١١ بهدف دراسة تأثير عدة تركيزات من ملوحة مياه الرى(كنترول ٠,٤٧)، ١، ٢، ٤، ٦، ٨ ١٠، ١٢ ديسى سمنز/م على المتغيرات المؤثرة على القدرة التنسيقية لنبات الشيح الخراسانى، وأيضا حصر لإستخداماته الشائعة فى تنسيق المساحات الخضراء فى مدينة الإسكندرية.

هذا وقد أظهرت النتائج المتحصل عليها بأن زيادة تركيز ملوحة مياه الرى أدت إلى نقص معنوى فى كل المتغيرات المؤثرة على النمو الخضرى(إرتفاع النبات، قطر النبات، قطر الساق، عدد الفروع الرئيسية/ نبات) وكذلك خفض معنوى فى القدرة الجمالية والتنسيقية لنبات الشيح الخراسانى والمتمثلة فى شكل النمو وحالة النبات بالمقارنة بالنباتات التى تم ريها بماء الصنبور(معاملة الكنترول).

بالإضافة إلى ذلك فقد تبين أن لنبات الشيح الخراسانى القدرة على تحمل ملوحة مياه الرى حتى ٨ ديسى سمنز/م و أن زيادة تركيز ملوحة مياه الرى عن ذلك(١٠ أو ١٢ ديسى سمنز/م) أدت إلى موت للنباتات بعد حوالى ٦ أشهر من بداية المعاملة.

أما بالنسبة لحصر الإستخدامات الشائعة لهذا النبات فقد تبين أن هناك مدى واسع لإستخدامه حيث يزرع فى الأحواض بأنواعها وللرسم والكتابة على المسطحات الخضراء وعلى حوافها.

وبصفة عامة فإنه يمكن التوصية برى نباتات الشيح الخراسانى بماء لا تزيد ملوحته عن ٨ ديسى سمنز/م حيث يمكن للنبات أن ينمو ويحتفظ بقدرة تنسيقية عالية ومظهر جمالى جيد.