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SALINE WATER ON THE QUALITY OF KOHLRABI PLANTS

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ABSTRACT: A pot experiment was conducted during the two winter seasons of 2004/2005 and 2005/2006 to study the effect of irrigation with saline drainage water on the tuber quality of kohlrabi plants. The hybrid Grand Duke was the genotype used in this study. The used saline water concentration treatments were 1000, 2000, 3000, 4000 ppm and tap water at 260 ppm which considered as a check treatment. The results showed that tuber fresh weight, size and diameter were increased significantly with the increase in saline water levels till 1000 ppm, after which a gradual drop occurred in these characters with the high levels of saline concentration. The tuber firmness was decreased continuously and significantly by the increase of the saline water levels in spite of the difference resulted between the two levels of 2000 and 3000 ppm in the second season which did not attain the level of significance. The contents of T.S.S., titratable acidity, total sugars, sodium and proline were significantly increased with every increase in saline level while ascorbic acid, dry weight, nitrogen, phosphorus and potassium started with an increase up to 2000 ppm then decreased in the higher levels.

INTRODUCTION

Kohlrabi (*Brassica oleracea var. gongylodes, L.*) is a cool season crop belonging to the family cruciferae. It is grown for the swollen stem top, which is the edible portion of this crop. The importance of this vegetable crop is attributed to its nutrition and therapeutic values. In general, brassica vegetables appear to contain flavonoids, phenolic compounds which act as antioxidants and other sulphur compounds containing metabolites doing as anticancer agents have ability to induce detoxification enzymes in mammalian cells and to reduce the rate of tumour development. It is beneficial in the prevention of alzheimers, cataracts, and some of the functional declines associated with ageing

(King and Barker, 2003). Kohlrabi has two of the biggest buzzwords in the world of nutrition which are bioflavonoid and antioxidants. Bioflavonoids are plant pigments that work in conjunction with vitamin C and antioxidants provide some first rate protection against the kind of cell damage that promotes cancer. Kohlrabi is an excellent source of vitamin C and potassium (Junes, 2009). However, the quantity of drainage water which is of reasonable quality reached approximately about 13.5 billion m^3/year, flow unused to the Mediterranian Sea and the coastal lakes which are in direct connection with the sea. Part of this water should be reused for irrigation purposes to overcome water shortage in agricultural area. The use of saline water for irrigation is feasible, however, when water is alternated or combined with good quality water supplies (Abd EL-Sayed et al., 1993).

The previous work revealed that irrigation of Brussels sprouts with saline water ranged from 1000 to 4000 ppm decreased fresh weight, size and diameter but increased T.S.S., titratable acidity, sodium and proline (Mady, 2008). On the other hand, using saline water from 260 to 2000 ppm increased ascorbic acid, dry weight, nitrogen, phosphorus and potassium contents in head cabbage, after which decline took place with the increase in saline levels of 3000 and 4000 ppm (Kamal, 2004). The present work involved studies to have good knowledge and full understand about the physical and chemical changes occurred in kohlrabi tubers affected by using saline water in irrigation.

MATERIAL AND METHODS

A pot experiment was conducted in the experimental farm of the Faculty of Agriculture, AL-Azhar University at Cairo in the two seasons of 2004/2005 and 2005/2006 to study the effect of irrigation with saline drainage water on the physical and chemical compositions of kohlrabi plants hybrid Grand Duke. The used water was brought from Karoun Lake at El-Fayoum Governorate. The concentration of the lake water was about 26000 ppm which was diluted with tap water to the required concentrations of 1000, 2000, 3000 and 4000 ppm. The control pots were irrigated with tap water at the concentration of 260 ppm. The chemical analysis of the diluted saline drainage water was shown in Table (1).

Pots were arranged in three replicates and every replicate consisted of nine pots, where each one contained one seedling. The design of the

experiment was completely randomized blocks. The effect of irrigation with saline water on the grown plants was followed in the transplanted seedlings in pots. The seed sowing in the first and second seasons in the nursery was done on September 20th and 24th in the first and second seasons, respectively. One transplant was planted per pot after 40 days from sowing in both seasons. The used pots (No. 40) were provided with an outlet at the bottom to discharge the excess of water. Each pot was filled with 15 kg dried soil. The used soil type was sand clay loam. The irrigation with saline drainage water started after 10 days from transplanting. The plants were irrigated two to three times per week and each pot received 2.5 liter water to maintain soil continuously moistened in pots. Each pot was fertilized with ammonium sulphate (4.5g), calcium super phosphate (3.75g) and potassium sulphate (1.125g). These amounts of fertilizers were added after 3 weeks from transplanting and 4 weeks later.The obtained data on the tuber were recorded on nine plants from every replicate after harvesting.

Table (1): The chemical analyses of the saline drainage water (meq/L) applied in irrigation.

Concentration	EC (dS/m)	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
260 ppm	0.40	-	2.8	1.3	0.1	1.6	1.3	1.1	0.2
1000 ppm	1.56	-	2.8	9.6	0.2	2.1	3.1	7.1	0.3
2000 ppm	3.12	-	2.8	21.5	0.5	2.5	5.9	15.9	0.5
3000 ppm	4.68	-	2.8	32.1	0.8	3.1	9.3	22.6	0.7
4000 ppm	6.25	-	2.8	45.0	1.1	3.8	13.9	30.3	0.9

Fresh weight, size determined by immersing the tuber in a container filled with water, diameter and firmness measured by Magness and Ballauf pressure tester were recorded.

The chemical characteristics were also estimated following.

Total soluble solids (T.S.S.) were determined as percentage by Abbe refractometer (A.O.A.C., 1990). Titratable acidity was determined by using standard solution of sodium hydroxide (0.01 N) and

phenolphthaline indicator (A.O.A.C., 1990). Total sugars were determined according to Smith et al., (1956). Free proline was determined colorimetrically according to Bates et al., (1973).Ascorbic acid was determined using the dye 2.6 dichlorophenol indophenol method (A.O.A.C., 1990). Dry weight was determined by drying in an oven at 70 °C till constant weight was reached. Total nitrogen was determined according to the micro-Kjeldahl method (A.O.A.C., 1990). Total phosphorus was determined colorimetrically using the hydroquinone and sodium sulphite method (A.O.A.C., 1990). Total potassium and sodium were determined using flamephotometer according to Dewis and Freitas (1970).

The obtained data were statistically analyzed using the analysis of variance method according to Snedecor and Cochran, (1980).

RESULTS AND DISCUSSION

Physical characteristics:

The effect of using different saline water levels on the plant tuber (Table 2) indicated that the fresh weight was increased significantly with the increase of saline water levels till 1000 ppm, after which there were significant decreases in this characteristic which correlated with the increase in the examined saline levels up to the highest level 4000 ppm. The picture caught from the changes in tuber size and diameter in both two seasons showed that using saline water levels up to 1000 ppm gave significant rise in these two characteristics while more salt concentrations till 4000 ppm gradually reduced them.

The firmness of tuber was decreased continuously and significantly by the increase of the saline water levels in spite of the difference between the two levels of 2000 and 3000 ppm in the second season which did not attain the level of significance.

Chemical characteristics:

The general scope from the chemical analyses of plant tuber (Table 3) in both two seasons indicated that the increase in saline water concentrations from 260 to 4000 ppm induced proportional significant increase in the T.S.S., titratable acidity, sugars, sodium and proline contents.

Table (2): Effect of irrigation with various levels of saline water on tuber fresh weight, size, diameter and firmness of Kohlrabi in 2004/2005 and 2005/ 2006 seasons.

Salt level (ppm)	Fresh weight (g).		Size (cm^3).		Diameter (cm).		Firmness (Kg/cm^2).	
	2004/2005 season	2005/2006 season	2004/2005 season	2005/2006 season	2004/2005 season	2005/2006 season	2004/2005 season	2005/2006 season
260 Control	378.20	391.33	355.90	379.07	7.87	8.30	9.00	8.92
1000	388.92	399.05	376.83	389.57	8.70	8.73	8.58	8.67
2000	310.44	333.17	301.28	325.00	7.37	7.67	8.08	8.17
3000	240.43	254.93	230.00	243.67	7.23	7.17	7.83	8.00
4000	199.57	239.10	187.93	218.37	6.47	6.43	7.50	7.58
L. S. D at 5 %	8.61	7.96	15.17	9.29	0.32	0.17	0.18	0.22

Table (3): Effect of irrigation with various levels of saline water on tuber T. S.S, titratable acidity, total sugars, sodium and proline contents of Kohlrabi in 2004-2005 and 2005 – 2006 seasons.

Salt level (ppm)	T. S.S %		Titratable acidity (mg/100g.f.w).		Total sugars (g/100g.d.w.).		Sodium (g/100g.d.w.).		Proline (mg/1g.f.w.).	
	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005 /2006 season	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005 /2006 season
260 Control	6.13	6.43	231.00	206.85	10.63	11.02	0.30	0.28	0.15	0.15
1000	6.33	6.53	244.65	226.80	11.36	11.58	0.37	0.36	0.22	0.24
2000	6.43	6.57	252.00	241.50	12.59	12.71	0.53	0.47	0.30	0.29
3000	6.80	6.87	267.75	257.25	13.32	13.67	0.60	0.54	0.34	0.35
4000	7.07	7.37	288.75	274.05	14.26	14.42	0.65	0.62	0.40	0.39
L. S. D at 5 %	0.17	0.17	7.58	4.59	0.59	0.64	0.06	0.06	0.006	0.008

Table (4): Effect of irrigation with various levels of saline water on tuber ascorbic acid, dry weight, nitrogen, phosphorus and potassium contents of Kohlrabi in 2004-2005 and 2005 – 2006 seasons.

Salt level (ppm)	Ascorbic acid (mg/100g.f.w.).		Dry weight (g/100g.f.w.).		Nitrogen (g/100g.d.w.).		Phosphorus (g/100g.d.w.).		Potassium (g/100g.d.w.).	
	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005/ 2006 season	2004/ 2005 season	2005/ 2006 season
260 Control	58.67	58.77	6.52	6.11	2.57	2.61	0.49	0.51	1.52	1.57
1000	62.03	61.86	7.33	6.68	2.94	3.08	0.53	0.54	1.73	1.71
2000	63.75	63.76	8.07	7.29	3.31	3.41	0.56	0.58	1.95	1.92
3000	60.93	60.52	7.67	7.08	2.42	2.43	0.51	0.50	1.35	1.37
4000	58.73	59.56	6.70	6.27	2.01	2.19	0.46	0.45	1.13	1.20
L. S. D at 5 %	1.59	1.37	0.47	0.27	0.18	0.18	0.005	0.006	0.12	0.08

Ascorbic acid, dry weight, nitrogen, phosphorus and potassium contents were increased by increasing the saline concentrations till 2000 ppm (Table 4), after which a reduction happened in these contents as a result of irrigation with the higher concentrations up to 4000 ppm.

Before the discussion of the foremost picture of the increase in the plant physical characteristics by saline water up to1000 ppm, it advisable to know the idea, a plant can withstand a precise amount of salt adverse effects. However, the term of plant salt tolerance is defined as the inherent ability of the plant to withstand the effect of high salts in the root zone or on the leaves without a significant adverse effect (Shannon and Grive, 1998). Knowing of salt tolerance in vegetable plants is necessary before irrigation with saline water. In truth, the salt tolerance of plant is not exact value as it depends on many factors, conditions and limits such as the specified of the involved salt, the conditions in which the crop is grown and the age and variety of a plant (Kenneth, 1990). Plant adaptation to salinity stress requires some means to adjust the osmotic potential of plant organs to at least matching that of the soil solution in order to maintain turger pressure and a gradient for water uptake. To accomplish this, some plants produce organic solutes as sucrose in carrots, while others take up salts to accomplish the same purpose as beets (Subbarao & Chris, 1994; Raul et al., 1997).

In this experiment the maximum amount of salt concentrations under which kohlrabi grows safety and gives the highest significant yield was the level of 1000 ppm. However, many halophytes have a special and distinguishing feature which enables their growth to be improved by low levels of salts but beyond a certain level growth is reduced (Ruskin et al., 1990). This view that was observed requires some amounts of salts in the growth medium, or in other words need moderate salinity conditions, these salt conditions positively promote plant growth, enhance productivity and improve quality than salts free conditions (Pasternake, 1987; Lo-Casico et al., 1988; Gupta, 1990).

Physiologically speaking, the first picture may be due to that sodium chloride which is the main salt in saline water plays an important role through ionic Na that is absorbed by plant in this form. Sodium was shown recently by Australian workers to be an essential element for a group of plant exhibiting the so called hatch-slack pathway of carbohydrate metabolism. These studies threw light on crop stimulated by

application of sodium (Tisdale and Nelson, 1975).

From another point of view, the gradual depression effect of saline water that started after using the concentration more than 1000 ppm on the physical characteristics may be due to reduction in the osmotic potential of the soil solution which lead to reduction in plant available water, ion imbalance and a specific ion toxicity (Subbarao & Chris, 1994; Dudley, 1994).

Apart from the effect of saline irrigation water on the previous physical characteristics of kohlrabi tuber which is generally the most important part for human food, the chemical characteristics which greatly participate in the product quality under salinity conditions. In this regard, the obtained results showed two main trends. The first trend reflects increases in the contents of T.S.S., titratable acidity, sugars, sodium and proline with the increase in salinity levels. The second one exhibits also an increase in the contents of ascorbic acid, dry weight, nitrogen, phosphorus and potassium up to 2000 ppm, then these contents were decreased with the increase in saline water levels.

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تأثير الرى بالماء المالح على جودة نباتات كرنب أبوركبة

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أجريت هذه الدرسة فى أصص خلال الموسم الشتوى لعامى ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦ لدراسة تأثير الرى بمياه الصرف الزراعى الملحيه على الصفات الطبيعية والكيماوية لنباتات كرنب أبوركبة هجين "جراند دوق" حيث استخدمت تركيزات المياه الملحيه ١٠٠٠ ، ٢٠٠٠ ، ٣٠٠٠ ، ٤٠٠٠ جزء فى المليون فى رى النباتات الى جانب الرى بمياه الصنبور بتركيز ٢٦٠ جزء فى المليون ككنترول، وقد إتضح من النتائج أن الصفات الطبيعية والتى تضمنت الوزن الطازج والحجم والقطر للساق المتضخمة زادت معنوياً مع الرى بالماء المالح حتى ١٠٠٠ جزء فى المليون ثم حدث لها نقص مع زيادة تركيز الملوحة فى ماء الرى حتى ٤٠٠٠ جزء فى المليون.

كما زادت بعض الصفات الكيميائية مع زيادة الملوحة فى ماء الرى حتى ٤٠٠٠ جزء فى المليون والتى تشمل المواد الصلبة الذائبة والحموضة و السكريات الكلية والصوديوم والبرولين.

كذلك ازدادت بعض الصفات الكيميائية مع زيادة الملوحة فى ماء الرى حتى ٢٠٠٠ جزء فى المليون مثل حامض الأسكوربيك والوزن الجاف والنتروجين والفوسفور والبوتاسيوم ثم حدث لها نقص مع زيادة تركيز الملوحة فى ماء الرى حتى ٤٠٠٠ جزء فى المليون.