

## Response of Onion to Composted Tomato Residues under Saline Irrigation Water through Drip Irrigation System

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### ABSTRACT

An experiment was conducted during the winter season of 2010/2011 to investigate the response of onion to salinity and compost of tomato residues. Irrigation water treatments included: a normal water (EC, 251 ppm), saline water irrigation (EC, 1600 and 2400 ppm). Compost was also applied at 0, 6 and 12 ton/fed. Results revealed that application of compost to the soil resulted in reduced soil EC, pH and SAR, with a sharp decrease in the concentration of Ca, Mg, Na and Cl by increasing compost application. Data revealed that the highest leaves and bulb of onion obtained from application of 12 ton compost with irrigation water at salinity water 251ppm. The maximum growth reduction in leaves and bulbs yield occurred due salinity water at 2400 ppm were 43.3 and 30.6 % reduction, respectively, compared with normal water at 12 ton compost/acre). Compost application caused yield enhancement at all salinity levels. Salinity diminished N, P and K content of plants to some extent in this study. Under salt-stressed condition, the uptake of N, P and K by plants was generally affected. Increasing compost levels increased N, P and K content of plants.

**Key words:** compost- salinity water – onion plant - Drip Irrigation

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### Introduction

Soil Salinization is a severe worldwide problem and around 20% of the world's cultivated lands are affected (Flowers and Yeo, 1995). In addition, the increasing uses of low quality water and conventional agriculture practice continue on worsening the problem (Darwish *et al.*, 2005).

Excessive amounts of salts have adverse effects on the physical and chemical properties of soil, microbiological processes and on plant growth.

The tissues of plants growing in saline media generally exhibit an accumulation of Na and Cl and/or the inhibited uptake of mineral nutrients, especially Ca, K, N and P (Kaya *et al.*, 2001). The mechanisms of growth inhibition include disturbance of plant water retention, due to the high osmotic potential of the external medium, and adverse effects on gas exchange, photosynthesis and protein synthesis (Romero-Aranda *et al.*, 2001). The adverse effect of soil salinity on plants will depend on the plant tolerance.

In the newly reclaimed sandy and calcareous soils of Egypt, low quality water is used for the agriculture expansion, due to the limited fresh water supply in such areas. However, the uses of saline water in agriculture are of the main sources of soil salinity pollution. An accumulation of salt could be a problem for plant growth. Such problem is considered one of the most important factors that will result in soil degradation in the future. So, the conservation of desert soils irrigated with saline water requires the addition of pollution. In this respect, the use of natural soil conditioners like organic wastes could be practiced for purpose (El-Maghraby, 1995).

The use of chemical amendment as source of Ca, which tend to replace exchangeable Na, as well as soil irrigation with water rich in divalent cations are strategies for soil saline remediation, but in dry soils with basic pH, soil amendment with organic residues could also be a good strategy (Nelson and Oades, 1998; Garcia *et al.*, 2000).

Recently, various organic amendments such as mulch, manures and composts, have been investigated for their effectiveness in soil remediation. It has been demonstrated that the application of organic matter to saline soils can accelerate NaCl leaching, decrease the exchangeable sodium percentage and electrical conductivity and increase water infiltration, water-holding capacity and aggregate stability (El-Shakweer *et al.*, 1998).

An amendment uses have two principal beneficial effects on reclamation of saline soils: 1) improvement of soil structure and permeability thus enhancing salt leaching, reducing surface evaporation, and inhibiting salt accumulation in surface soils and 2) release of carbon dioxide during respiration and decomposition (Raychev *et al.*, 2001).

The present investigation was therefore, undertaken to investigate the effect of saline water and composted tomato residues on properties of sandy soil and the productivity of onion plant.

## Materials and Methods

### 2.1. Location and soil of experimental field plot:

The experiment was conducted at El Khatatba region, Monofia province west of Nile Delta during the winter season of 2010/2011 using drip irrigation system. This area is a desert region and the soil of the experimental site was deep, Well drained sandy composting of 85.6% sand, 9.4% silt and 4.3% clay, with an alkaline pH(1:2.5) 8.2, EC(1:1)3.2 dS/m and  $\text{CaCO}_3$  6.1%.

### 2.2. Preparing of compost:

A compost was prepared from the residues of tomato crop (each one ton was modified by 3.3 kg ammonium sulphate (20.6 %), 1 kg calcium superphosphate (15.5%  $\text{P}_2\text{O}_5$ ) and 3.3 kg lime). After 3 months, the prepared tomato compost having characteristics: pH (1:10) 7.3, EC (1:10) 0.87 dS/m, C 39 %, C: N ratio 18.6:1, N 2.2%, P 0.50 %, K 2.3 % and moisture content 21.4 %.

### 2.2. Raising of seedlings and transplanting:

The onion (cv. Giza 20) seeds were treated with Thiram (2 g kg<sup>-1</sup> of seed) and sown in the raised nursery beds prepared in green house in the third week of November. After sowing, the nursery bed was covered with a thin layer of sand and then covered with straw. The seedbed was then drenched with water. After germination of seeds, straw cover was removed. Two-month-old onion seedlings were transplanted on January, at a plant-to-plant and row-to-row spacing of 10.0 cm × 15.0 cm.

### 2.3. Experimental treatments and field preparation:

Before cultivation, drip tubing (GR, 30 cm dripper spacing, 4l/h discharge rate and 1.5 m apart) was placed directly on surface of the soil beds. Onion seedling were transplanted at a plant-to-plant and row-to-row spacing of 10.0 cm × 15.0 cm, pre-furrowed to receive compost, at 0,6,12 ton/fed, Super-phosphate (15.5 %  $\text{P}_2\text{O}_5$ ) was broadcasted at a rate of 200 kg /fed and potassium sulphate at 50 kg/fed. Prior to planting, as is customary in the region.

Uniform irrigation was applied to the all seedlings through the drip tubing to encourage stand establishment.

The experiment was randomized complete block factorial design consisting of combinations of three compost rates (0 (C0), 6 (C1) and 12 (C3) ton/fed.) and three salinity well levels (251(W1), 1600(W2) and 2400ppm(W3)) and was replicated three times in 4.5 m wide × 10 m long plots. Amounts of irrigation water used after planting was 350 mm for the growing season. Irrigation frequency was running daily from three local well-water having EC 251(W1), 1600(W2) and 2400 ppm(W3), respectively. Properties of the three wells water salinity levels are presented in Table (1).

Nitrogen as  $\text{NH}_4\text{NO}_3$  (300 kg/fed) was applied on weekly basis through drip fertigation in split equal doses and commenced after two weeks of planting. This was done along with phosphorus (150kg P/fed), as phosphoric acid (85%) and potassium (200 kg K/fed) as  $\text{K}_2\text{SO}_4$ , respectively. All N, P and K fertilizers were injected directly into the irrigation water using venture-type injector.

Plants were taken from every plot at 110 days after planting in both investigated seasons. Plant growth expressed as leaves, Neck and bulb weight, as well as the whole fresh and all samples were dried in 70°C<sup>0</sup> oven for 48 h. The dried samples were finely ground and analyzed for N, P and K according the methods described by Black, (1983); Troug and Mayer (1939) and Brown and Lilleland (1946), respectively. Soil samples were collected at depths of 0-20 and 20-40cm arid and analyzed for pH, EC, soluble cations and anions using methods described by Page, *et al.*(1982).

**Table 1:** Composition of well water used at the experimental field site.

Characteristics	Well no.1 (W1)	Well no.2 (W2)	Well no.3 (W3)
EC (well water) (ppm)	251	1600	2400
$\text{Ca}^{++} + \text{Mg}^{++}$ (meq/L)	2.0	11.0	21.2
$\text{Na}^+$ (meq/L)	2.2	11.3	15.0
$\text{CO}_3 + \text{HCO}_3$ (meq/L)	0.1	1.3	1.4
$\text{K}^+$ (meq/L)	0.1	1.4	1.8
$\text{Cl}^-$ (meq/L)	2.6	14.0	23.0
$\text{SO}_4^{--}$ (meq/L)	1.4	8.2	14.0
SAR	2.2	4.8	4.6

## Result and Discussion

### Soil properties:

Compost of plant residues application influenced the distribution of salts, SAR and pH in the soil profile under different saline irrigation water (Table 2). The increase in salinity in irrigation water without compost application increased soil pH. On the other hand, soil pH decreased with increasing compost application. The reduction of soil pH in the compost plots may be due to the organic and inorganic acid formation as a result of organic manure decomposition, besides improving the soil physical conditions, consequently better plant growth. Accordingly more CO<sub>2</sub> was formed with increasing the metabolic activity of the bulb system, the latter plays an important role as H<sup>+</sup> pumping which also contributes to the pH decrement. The highest level of compost treatment maintained soil pH at lower levels compared to other treatments. The pH value was lowest (7.6 at saline water (2400 ppm) and 12 ton compost/fed. and highest (8.3) under non-saline conditions or compost. The soil pH was found to be lower with increasing salinity levels at all compost levels. This may be due to the result of cation – anion imbalance in the plant. The ionic composition of the nutrient-salt solution may affect the balance between the total concentration of cations and anions in plant tissue (Feigin, 1985). According to Mengel and Kirkby (1978), ionic balance was maintained by bulb excretion of H<sup>+</sup> for excess cation uptake by plants. In our study, as Ca, Mg, and Na cations were applied continuously to plants by irrigation water, the pH may decreased to some extent due to excretion of H<sup>+</sup>.

Soil salinity (EC) exerts osmotic effects on plants (Grattan and Grieve, 1999) and often causes physiological drought if the salinity levels are greater than the critical limits of the crop. In this study, changes in EC were monitored at different depths of soil profile (Table 3). At all depths, the EC values increased in the plots that treated with saline water irrigation considerably compared with the initial level. This increase in soil salinity was mainly due to the use of saline water for irrigation. The EC at the soil surface was more affected as compared with the lower depths. The data showed that the use of saline water for irrigation without compost application, soil salinity values were greater than that obtained with the used compost. Especially in the upper layers followed by a gradual decreased with increasing soil depth. However, the soil salinity values were sharply decreased with increasing rate of compost. The rate of decrement below the control reached 21.4 and 28.5 % for C1 (6 ton/fed.) and C2 (12 ton/fed.) compost levels in the surface soil (0-20 cm) when irrigated with saline water (1600 ppm). While it reached 20 and 29.9 % for C1 and C2 compost levels in the same depth when was irrigated with saline water (2400 ppm). Toth *et al.* (2008) and Fathi (2010) found that the biological amelioration methods using living or dead organic matter (crops, stems, straw, green manure, barnyard manure, compost, and sewage sludge) have two principal beneficial effects on reclamation of saline and alkaline soils: 1) improvement of soil structure and permeability thus enhancing salt leaching, reducing surface evaporation, and inhibiting salt accumulation in surface

**Table 2:** Soil chemical properties of the treated soil at harvesting stage of onion plants

Salin. of Irrig. well	Comp. level (ton/fed)	Soil depth(cm)	pH 1:2.5	SAR	EC dS/m (1:1)	Soluble ions (meq/L)					
						Ca+Mg	Na	K	CO <sub>3</sub> +HCO <sub>3</sub>	Cl	SO <sub>4</sub>
W1	C0	0 - 20	8.3	2.24	1.92	10.0	8.0	1.3	1.6	11.0	6.5
		20 - 40	8.3	2.92	3.46	17.0	16.6	1.0	1.0	22.0	11.7
	C1	0 - 20	8.1	2.02	1.62	8.2	7.0	0.5	0.5	9.9	5.2
		20 - 40	8.1	2.81	3.0	15.8	10.9	1.5	1.5	16.0	13.0
	C2	0 - 20	8.1	1.96	1.54	7.7	7.0	0.5	0.5	9.5	5.2
		20 - 40	8.0	2.37	2.08	11.2	8.5	1.3	1.6	13.5	6.5
W2	C0	0 - 20	8.1	2.85	3.23	16.2	10.3	1.8	1.7	17.1	12.9
		20 - 40	8.1	4.32	5.15	37.3	20.2	1.7	1.5	32.4	15.0
	C1	0 - 20	7.9	2.42	2.54	11.7	12.0	1.1	0.7	15.8	8.3
		20 - 40	8.0	3.50	4.54	24.5	19.5	2.2	1.6	28.4	16.0
	C2	0 - 20	7.8	2.38	2.31	11.3	11.0	1.3	1.5	14.0	8.2
		20 - 40	7.8	2.76	3.38	15.2	17.0	1.0	1.0	18.0	13.0
W3	C0	0 - 20	8.0	3.81	3.85	29.0	14.6	1.5	1.4	15.0	11.3
		20 - 40	8.0	3.58	5.77	25.7	28.7	2.0	2.0	39.0	15.8
	C1	0 - 20	7.9	2.79	3.08	15.6	10.8	1.4	1.3	15.6	12.9
		20 - 40	8.0	3.61	5.20	26.0	22.5	2.0	1.6	30.8	16.0
	C2	0 - 20	7.6	2.47	2.7	12.2	12.5	1.5	1.4	16.8	10.2
		20 - 40	7.6	3.55	4.0	25.2	15.0	1.6	1.5	15.5	12.1

soils and 2) release of carbon dioxide during respiration and decomposition. In the latter, large amounts of organic matter should be applied in the long manure, barnyard manure, compost, and sewage sludge) have two principal beneficial effects on reclamation of saline and alkaline soils: 1) improvement of soil structure and permeability thus enhancing salt leaching, reducing surface evaporation, and inhibiting salt accumulation in surface soils and 2) release of carbon dioxide during respiration and decomposition. In the latter, large amounts

of organic matter should be applied in the long term. It seems that by amending a saline soil with a chemically stable organic material, being a permanent source of the organic matter of a high humification degree, the positive amelioration effects mentioned earlier can be reached. Such materials of high CEC can absorb a part of soluble salts, decrease the pH, and promote aggregation. The growth-enhancing effects of the compost may be related to their relative effects on the shoot mineral nutrients.

Data presented in Table (3) show also that, there were accumulation of  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$ ,  $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{HCO}_3^-$  and  $\text{SO}_4^-$  in the soil with saline water irrigation treatments. The highest values were obtained in the lower soil layers. This is in fact due to the irrigation by saline water having high amounts of such ions. Sodium and Cl were the prevailing ions in the soil solution. They were 14.6 and 39.0 meq/L with increasing saline water up to 2400 ppm in the surface soil (0-20 cm) and were 28.7 and 39.0 meq/L in the sub soil (20-40 cm layer), respectively. Concerning the effect of compost application, it has an opposite trends i.e. the concentration of  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$ ,  $\text{Na}^+$  and  $\text{Cl}^-$  were sharply decreased in all soil depths. The favorable effect of organic compost on reducing soluble ions is mainly due to the formation of organic and inorganic acids as a result of organic manure decomposition besides improving soil structure. Consequently, more soluble salt could be leached out by following irrigation. (Nelson and Oades, 1998).

#### Leaves and bulb Yield:

Table (3) shows the effect of salinity-compost interaction on leaves, neck and bulb fresh weight. There was a significant positive response in all three characteristics to increasing compost levels for plants irrigated with the irrigation having salinity. The influence of compost may be varied depending on the salinity levels and this effect should be considered when fertilization programs are developed. Bernstein, *et al.*, (1974) concluded that the effect of salinity and nutrition on plant growth are independent and additive when stresses imposed by nutrient deficiency and salinity are moderate. When either of these factors severely limits growth, the other has little influence on the plant. In saline water irrigation, leaves or bulbs weights slightly decreased with increasing saline water up to 1600 ppm. Moreover, significant increments were noticed when bulb plants were subjected to the high level of salinization (2400 ppm). For instance, the reductions in leaves yield (g/plant) were 10.4 and 32.9 %, respectively in both higher saline water. bulb yield the results were 11.6 and 28.4 % in two higher saline water, respectively. These results are well supported by those published by several authors concerning the effect of salinity on tuber and leaves yields of table beet plants (Kandil, *et al.*, (1999); Mekki and El-Gazzar, (1999) and El-Etreiby, (2000). The depressive effect of salinity on bulb and leaves yield is probably due to osmotic inhibition of water absorption, accumulation of certain ions in high concentration in plant tissues and alteration of the mineral balance of plants (Khafagi and El-Lawandy, 1996), and/or due to the reduction in photosynthetic activity and carbohydrates metabolism (Heuer and Plaut, 1989).

**Table 3:** Onion yield as affected by salinity of irrigation water and different levels of compost (g/plant).

Salin. of Irrig. well	Compost levels				Total
		Leaves	Neck	Bulb	
W1	C0	17.51	10.2	40.7	68.41
	C1	22.12	12.1	49.3	83.52
	C2	26.10	13.5	58.0	97.6
W2	C0	15.30	8.1	35.3	58.7
	C1	19.00	11.0	44.6	74.6
	C2	24.60	11.9	51.0	87.5
W3	C0	11.90	6.3	28.0	46.2
	C1	15.20	9.7	38.0	62.9
	C2	17.00	9.6	40.0	66.6
LSD 0.05		1.38	01.12	3.72	7.23

The decrease in leaves and bulb accumulation is mainly due to increase in  $\text{Na}^+$  and  $\text{Cl}^-$  under high salt stress causing a reduction in the activity of  $\text{CO}_2$  -fixation during photosynthesis and a decrease in the enzymatic activity of the metabolic processes (Ahmed, 1987). Significant increase in leaves and bulb yields of onion plants applied with compost application. Compost application caused growth enhancement at all salinity levels. Possibly due to the beneficial effect of compost on the physicochemical properties affecting plant growth such as soil structure, available water and soil salinity. By supplying nutrients, particularly organic matter can improve the mineral nutrient status and growth of plants in saline soils (Walker and Bernal, 2004). However, this depends upon the salt tolerance of the plant species concerned and the initial salinity and nutrient status of the soil since, when the salinity stress is more severe than any nutrient deficiency, increasing the nutrient supply may not improve growth (Grattan and Grieve, 1992). Leaves yield of onion was responded well to compost application, which increased to 24.1, 60.8 % at irrigation with saline water 1600 ppm and 27.7, 42.9 % at irrigation with saline water 2400 ppm for C1 and C2 compost level, respectively. Also, there are progressive increases in bulb yield with increasing rates of compost application. The highest leaves (30.0 g/plant) and bulb

and neck (71.5 g/plant) weights were obtained under fresh water with 12 ton compost/fed. The reason of maximum yield under compost might be due to the presence of nitrogen, phosphorus and potash in compost. Besides these elements, compost also contains calcium, magnesium, sulfur and trace elements. Chemically, some elements like calcium help to enhance the cation exchange in soil. It can be concluded that compost are helpful in producing better onion yield under application of saline water. Regarding, the interactions between salinity of irrigation water and different levels of compost showed significant effect on bulb and leaves yields. Marked variations were observed with compost application at the different levels of irrigation water salinity. As mentioned above, leaves yield of onion plants behaved similarly as bulb yield with considerable variations among salinity treatments. These results are in agreement with those obtained by El-Etreiby, 2000.

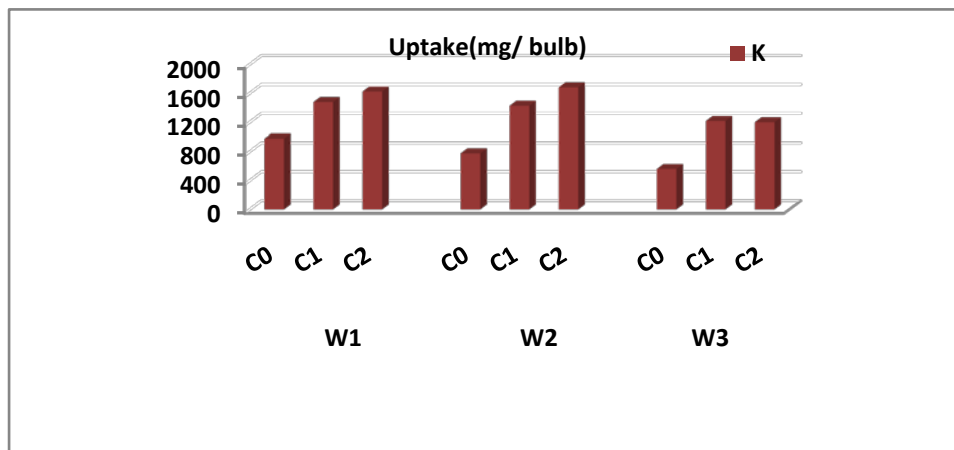
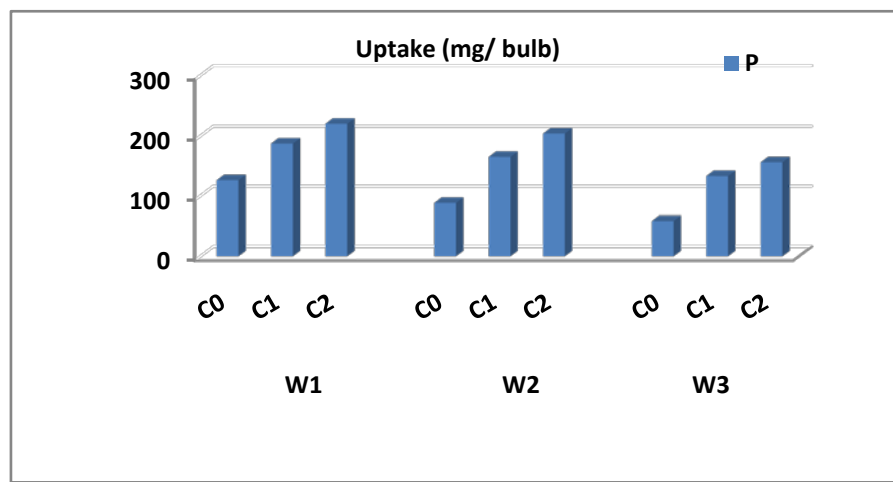
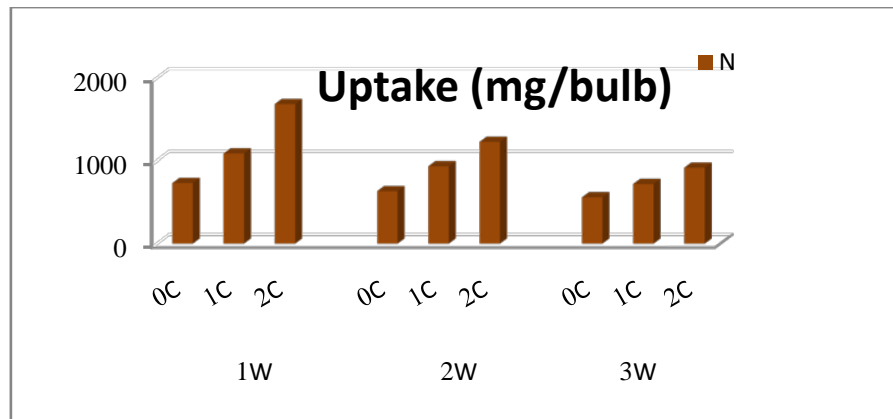
#### *Concentration and uptake of some minerals:*

A significant increase in onion bulb N, P and K concentration and uptake were observed with addition of compost (Table, 4). They differed significantly due to salinity levels irrigation water and compost application. At the lowest salinity (251ppm) there was a significant increased N in the plant associated with increasing compost applied. The relatively high bulb N may be attributed to increases in N availability in the tested soil caused by compost application. Increasing compost levels from 6 to 12 ton compost/fed. In the nutrient solutions was effective in restoring the decrease in the bulb N caused by salinity. Total N uptake by bulb plants was affected by salinity-compost interactions. Since, for plant grown in soil when water saline \ were applied, the growth limiting factor was the salinity rather than compost, the total N uptake at these levels of salinity was significantly lower compared with the N uptake at lowest salinity (251 ppm). The decrease in total N uptake by increasing salinity, apart from the effects of salinity on onion growth, has been partly attributed to a probable substitution of  $\text{Cl}^-$  for  $\text{NO}_3^-$  (Tuil and Van, 1965). Papadopoulos and Rendig, (1983) found that leaf Cl concentration was significantly correlated with the average electrical conductivity of five soil solution samplings during the growing period. Thomas (1980) noted the same effect of increasing salinity on  $\text{Cl}^-$  content of leaves and postulated that the osmotic adjustment of plants may be due to the rapid absorption of  $\text{Cl}^-$ .

**Table 4:** Effect of salinity levels of irrigation water and compost levels on some nutrients concentration and uptake by bulb of onion plant

Saline of Irrig. well	Compost levels	Concentration (%)			Uptake (mg/bulb)		
		N	P	K	N	P	K
W1	C0	1.8	0.31	2.4	732.6	126.17	976.8
	C1	2.2	0.38	2.8	1084.6	187.34	1479.0
	C2	2.9	0.40	3.0	1682.0	220.40	1624.0
W2	C0	2.8	0.25	2.2	635.0	88.25	776.6
	C1	2.1	0.37	3.2	936.6	165.02	1427.2
	C2	2.4	0.40	3.3	1224.0	204.00	1683.0
W3	C0	2.0	0.21	1.8	560.0	58.800	560.0
	C1	1.9	0.35	3.2	722.0	133.00	1216.0
	C2	2.3	0.39	3.0	920.0	156.00	1200.0
LSD 0.05		0.30	0.04	0.4	291.2	30	309

Increasing the salinity level of irrigation water decreased P concentration in bulb of onion plant. The decrease of plant P concentration may be explained on the premise of competition between  $\text{Cl}^-$  and phosphate ions in the blub zone or perhaps due to the restricted blub growth (khalil *et al*, 1967)). At the salinity levels of irrigation water, there was a significant increased P in the plant associated with the increasing compost applied. Phosphorus concentration in leaves tended to increase from 0.31 to 0.38 and 0.40 % as the compost level was raised from control to 6 and 12 ton compost/fed., respectively. The influence of compost on availability of P involve several reactions, but not necessarily exclusive as follows (Stevenson, 1986); i) the action of organic acids and some other organic compounds that are produced during decomposition, resulting in chelating the calcium ions and thus decrease their action on P precipitation, ii) the production of carbonic acid from  $\text{CO}_2$  released during decay encourages the solubilization of insoluble Ca and Mg-phosphate and iii) hamates may form a protective surface over colloidal sesquioxides, with reduction in phosphate adsorption. Increasing compost application to sandy loam soil either irrigated with normal or saline water significantly increased P uptake. The obtained data revealed that increasing the salinity levels of irrigation water decreased K concentration and its uptake by onion plant (Table 4). Potassium concentration tended to decrease from 2.4 to 2.2 and 1.8% as the salinity level was raised from 251 ppm to 1600 and 2400 ppm,



respectively. The reduction of the concentration of k at the highest salinity levels (1600, 2400 ppm), this may be explained by competition between  $\text{Na}^+$  and  $\text{K}^+$  ions, these results confirmed the depression of plant K concentration under the highest levels of salinity. At the salinity levels of irrigation water, there was a significant increased K uptake by leaves and blub of the plant associated with the increasing compost applied.

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