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Effect of Anti-salinity Agents on Growth and Fruiting of Different Date Palm Cultivars

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ABSTRACT

The study was undertaken to assess the effect of salinity and the anti-salinity agents on alleviating the adverse effects of salinity on growth and fruiting of Sewy, Zaghloul and Hayany date palm cultivars during 2010-2011 under Qena conditions. Ten years old, thirty palm trees of each cultivars, were evaluated to their tolerance to soil salinity and also to anti-salinity. The nine anti-salinity agents were sulphur, salicylic and citric acids, Effective Microorganism (EM), humic acid, compost enriched with actinomyces, filter mud, Uni-Sal and Cal-Mor. Moreover, the effect of these anti-salinity on leaf area, yield and fruit quality were also studied. Results revealed that date palm cultivars Sewy, Zaghloul and Hayany were tolerance to soil salinity, in descending order. However, Hayany date palm was highly sensitive to salinity than the other two cultivars and the Sewy cultivar was the most tolerant to soil salinity. Application of all anti-salinity agents was very effective in alleviating the adverse effect of salinity on the leaf area, yield and fruit quality as compared to the check treatment. The more effective five anti salinity agents were arranged in descending order as follows, Cal-Mor, Uni-Sal, citric acid, filter mud and compost enriched with actinomyces. Treated date palm with Cal-Mor at 150 mL/palm, Uni-Sal at 50 mL/palm or citric acid at 500 ppm twice considered to be preferable for avoiding the adverse effects of soil salinity on fruiting. Using of Cal-Mor on Sewy dates gave the highest value for vegetative growth and fruiting characters.

Key words: Date palm, salinity, anti-salinity, sulphur, salicylic acid, citric acid, humic acid, compost, actinomyces, filter mud

INTRODUCTION

Salinity of soil or irrigation water is a major factor limiting the growth of fruit trees. The horizontal expansion in agricultural land depends partially at least on the availability and quality of irrigation water and the level of soil salinity (Nijjar, 1985). Newly reclaimed sandy soil may also be affected at various degrees by some sorts of salinity. In order to achieve salt-tolerance, the foremost task is either to prevent or alleviate the damage, or to re-establish homeostatic conditions in the new stressful conditions in the new stressful environment (Parida and Das, 2005).

The majority of the new lands in Egypt are sandy and calcareous soils. The main problems of these soils are their poor structure, low availability of water and nutrients, low fertility and higher salinity and calcium carbonate and the possibility of forming a surface crust and indurate layers at shallow depths. The reclamation of these soils was mainly depended upon the addition of many natural amendments such as sulphur, calcium with some material, organic and biofertilization, sulphur and compounds containing organic, antioxidants especially salicylic and citric acids, microorganism. These compounds shown to be very effective in alleviating the adverse effects of salinity on growth, nutritional status and fruiting of fruit crops (Abada *et al*., 2010; Kassem, 2012).

Sulphur, can improving growth and alleviate the adverse effects of salinity through, reducing soil pH , increasing the activity of soil microorganism and it has becomes one of the most strongly limiting nutrients in agricultural Production in calcareous soil (Abbey *et al*., 2002; Eriksen *et al*., 2004; Abada *et al*., 2010; Kassem, 2012). As well as, calcium can be adversely affected by salinity induced by exchangeable sodium content or remove it (Gaines and Shennanb, 1999). On the other hand, Sodium ions may compete with Ca ions in membrane-binding sites. Therefore, high Ca concentration plays an important role in protecting the cell membrane against salinity stress (Busch, 1995). Moreover, low sodium concentration increasing Ca and K uptake resulting to enhance plant growth and reduced harmful salinity condition on plant (Cramer *et al*., 1986; Rengel, 1992).

The organic matter is crucial for maintaining soil fertility, which have positive impact on biological, chemical and physical properties of soils. Also, Humic substance and Fulvic acid are essential in soil organic matter In addition, the nature stability of these substances affects carbon and nitrogen cycles and carbon sequestration. Moreover, it can ameliorate the negative effect of salt that would inhabit the plant gross and the uptake of nutrient elements (Demir *et al*., 1999; Casierra-Posada *et al*., 2009).

Many soils in semiarid tropical regions are characterized by low C concentration and this has negative consequences for crop yield (Jones *et al*., 2005; Khan and Joergensen, 2006). Therefore, salinity is a major threat to agriculture in combination with very low levels of soil organic matter (Rasul, 2007). Currently sugarcane filter cake, has a considerable quantity of organic matter, macro and micronutrients and soil amendment characteristics, due to sulfur it contains (Rasul *et al*., 2008).

To adverse effects of osmotic stress Polyethylene glycol (PEG) playing an important role in plant responses to salt and water stress which increases the osmotic pressure in root cell lead to diminution of water flow through root (Pandey and Agarwal, 1998; Slama *et al*., 2007). On the other hand, growth my be inhibited due to either a toxicity or nutrient deficiency. Then it is necessary to decreased their during the positive action of antioxidant (citric acid and salicylic acid) as non enzymatic antioxidant in chelating these free radicals and protecting plant from injury could result in prolonging the shelf life of plant cells and improving growth characters (Elad, 1992; Zhang and Klessig, 1997; Rao *et al*., 2000).

Recently, the use of biological methods as practical way to alleviate saline soil stresses on plant growth has received increased attention (Miransari *et al*., 2008). The effect is always more pronounced in the rhizosphere during the increase in water absorption by the plants due to transpiration (Jiang *et al*., 2007), microorganism (EM), actinomyces and mycorrhiza can alleviate the stress of salinity on plant growth as well inhibiting high uptake of Na and Cl and their transfer to the plant shoots (Al-Karaki, 2006). It have been considered as bio-ameliorators of saline soils (Azcon-Aguilar and Barea, 1997).

The date palm growth and production in the arid regions is adversely affected by salinity. There are differences in salt tolerance between date palm cultivars, which appear to be related to the salt exclusion mechanisms by the root parts, resulting in reduced Na^+ translocation to the shoots (Greenway and Munns, 1980; Karim and Dakheel, 2006). Khnaizi, Lulu, Nabtut Safi and Razez date palm cultivars showed greatest growth parameters and Na:K ratios than other cultivars (Al-Hammadi, 2006). Bartamuda date was the best cultivar in growth vigor than Sewy and Samani cultivars under height salinity condition, also Khalas was the most salt tolerant than Barhee and Majdool date palm cultivars (El-Sharabasy *et al*., 2008; Al-Abdoulhadi *et al*., 2011).

Although most date palm cultivars are tolerant to salinity problems, they grew well and gave more yields under non-salinization conditions. Any fruit crop especially those withstand saline conditions gave unsatisfactory yield comparing with growing under non-salinization case. Nowadays, using antioxidants especially salicylic and citric acids (Hegab, 2000; Morsy and El-Bana, 2000; Ahmed *et al*., 2003; Ragab, 2004) organic and biofertilization, (Dahama, 1999) sulphur and compounds containing organic (Zachariakis *et al*., 1999) sulphur and calcium were shown to be very effective in alleviating the adverse effects of salinity, on growth, nutritional status and fruiting of fruit crops (Gowda, 2002; Kannaiyan, 2002; Mohamed, 2005; Djibril *et al*., 2005).

Therefore the experiment was undertaken to evaluate the effect of anti-salinity agents on growth and fruiting behavior and also the sensitivity to salinity of different date palm cultivars (Sewy, Zaghloul Hayany) grown under saline soil conditions.

MATERIALS AND METHODS

The experiment was carried out in Horticultural Research Farm, Qena Faculty of Agriculture, Qena Governorate, Egypt during 2010 and 2011 seasons on ninety uniform in vigour ten years old Sewy, Zaghloul and Hayany date palms (on the basis of 30 palms per each). The texture of soil was sandy characterized with higher salinity (1088 ppm soil salinity). Analysis of the tested soil was done according to the procedure of Chapman and Pratt (1965) (Table 1).

The selected palms are planted at 8×8 m apart. Surface irrigations system was followed. All the selected date palms received the same and common horticultural practices that were usually applied in the orchard except for anti-salinity agents application.

Experimental treatments and design: The experiment was laid out in Completely Randomized Block Design (CRBD) in split plot arrangement where the three date palm cultivars and the ten anti-salinity treatments occupied the main and subplots, respectively. Factor (A) consisted from three date palm cultivars namely Sewy, Zaghloul and Hayany and factor (B) comprised with the following ten treatments from anti-salinity treatments:

b_1: Control (salinization conditions)
b_2: Soil application of elemental sulphur at 100 g/palm/year
b_3: Spraying salicylic acid at 100 ppm
b_4: Soil addition of Effective microorganisms (EM) at 50 mL/tree/year
b_5: Soil addition of humic acid at 50 mL/palm/year
b_6: Soil addition of compost enriched with actinomyces at 5 kg/palm/year
b_7: Soil addition of filter mud at 5 kg/palm/year
b_8: Spraying citric acid at 500 ppm

Table 1: Analysis of the tested soil

Constituents	Values	Constituents	Values ($meqL^{-1}$)
Sand (%)	80.0	Ca	35.00
Silt (%)	10.0	Mg	1.40
Clay (%)	10.0	Na	3.25
Texture	Sandy	K	23.00
pH (1:2.5 extract)	7.90	CO_3^-	0.00
EC (1:2.5 extract mm hos/1 cm/25°C)	1088	Cl^-	3.50
Total $CaCO_3$ (%)	9.0	SO_4^-	3.90

b_9: Soil addition of Uni-Sal compound at 50 mL/palm/year
b_{10}: Soil addition of Cal-Mor (solving problem compound) at 150 mL/palm/year

Each treatment was replaced three times, one palm per each. The two organic amendments namely filter mud (contained the following element and nutrient concentrations g-1C, 34 mg, total N, 12.3 mg, total S, 11.7 mg, K, 3.9 mg and (23.4) mg Ca and compost enriched with actinomyces (2% N) each at 5 kg/palm/year were added once at the middle of January. Both humic acid (contains 8% active humic acid, 1% active folic acid and 72.3% organic matter) and EM (contains lactic acid bacteria, yeasts, photosynthetic bacteria and other types of microorganisms) were added twice at growth start (1st week of March) and two months later (1st week of May) on the basis of 25 mL/palm/year for each addition. The two solving salinity compounds namely Uni-Sal (contains 9% PEG, 7.5% calcium, 7% glutaric acid, 5% nitrogen and 1% citric acid) at 50 mL/palm/year. Whereas Cal-Mor (contains 9% calcium, 7% glutaric acid, 19.5% nitrogen and 2% citric acid) at 150 mL/palm/year were added twice as previously mentioned of the application of humic acid and EM (each at the half amount/addition). Sulphur was also added twice (at growth start at two months later). Both the two antioxidants namely salicylic acid at 100 ppm soluble in Ethyl alcohol and citric acid at 500 ppm were sprayed twice at the same previous two dates.

Leaf area (m^2) was determined according to Ahmed and Morsy (1999) in the four pinnae taken from the middle parts of each leaf, following the equation:

$$\text{Leaf area} = \frac{0.37\ (\text{Length} \times \text{width}) + 10.29 \times \text{No. of pinnae}}{1000}$$

All bunches were harvested (1st week of August for Zaghloul and Hayany date palms and the mid of Sept. for Sewy date palm cultivar) for measuring number of bunches/palm, bunch weight (kg.) and yield per palm. Physical and chemical characteristics of the fruits namely weight of fruit (g.) as well as percentages of pulp, total soluble solids %, total and reducing sugars %, crude fibre % (AOAC, 1995) and total soluble tannins % according to Winton and Winton (1985) by using Indigo carmine indicator after titration was carried out using 0.1 N potassium permanganate solution. Tannins content was calculated as grams tannins/100 gram fresh weight of the flesh according to the following equation:

$$1\ \text{mL oxalic acid (0.1 N)} = 0.00416\ \text{g tannins}$$

The data were analyzed statistically according to Mead *et al.* (1993) using new LSD test at 5%.

RESULTS AND DISCUSSION

Leaf area: It is clear from the data in Table 2 that varying date palm cultivars had announced significant differences on the leaf area. The maximum leaf area was presented in date palm cultivars Sewy, (3.12, 3.32 m^2), meanwhile Hayany cultivars, recorded the lowest values in this respect, (2.80, 2.95 m^2) on the same time the intermediate values noticed in Zaghloul (2.95, 3.01 m^2) during 2010 and 2011 seasons, respectively. This means that Sewy date palms grown under saline soil had the greatest tolerance to salinity followed by Zaghloul date palm while Hayany date palm considered the most sensitive date palm cultivar to salinity. It's clear from the data Sewy date

Table 2: Effect of some anti-salinity agents on the leaf area (m)^{2}and the number of bunches per palm of Zaghloul, Hayany and Sewy date palms during 2010 and 2011 seasons

	Leaf area (m^2)								No. of bunches palm^{-1}							
	2010				2011				2010				2011			
Antisalinity	A1	A2	A3		A1	A2	A3		A1	A2	A3		A1	A2	A3	
treatments (b)	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean
b1	2.24	2.11	2.36	2.24	2.33	2.20	2.45	2.32	9.0	8.0	10.0	9.0	10.0	9.0	11.0	10.0
b2	2.39	2.26	2.51	2.39	2.48	2.36	2.61	2.48	10.0	9.0	11.0	10.0	11.0	10.0	11.0	10.7
b3	2.55	2.42	2.65	2.54	2.63	2.52	2.81	2.65	10.0	9.0	12.0	10.3	11.0	10.0	12.0	11.0
b4	2.71	2.58	2.80	2.70	2.79	2.68	2.97	2.81	11.0	10.0	12.0	11.0	11.0	11.0	12.0	11.3
b5	2.90	2.73	2.95	2.86	2.94	2.84	3.15	2.98	11.0	10.0	12.0	11.0	11.0	11.0	12.0	11.3
b6	3.04	2.88	3.20	3.04	3.10	3.03	3.51	3.21	11.0	10.0	12.0	11.0	12.0	11.0	12.0	11.7
b7	3.18	3.03	3.40	3.20	3.25	3.20	3.69	3.38	11.0	10.0	12.0	11.0	12.0	11.0	12.0	11.7
b8	3.33	3.18	3.61	3.37	3.36	3.38	3.84	3.53	11.0	11.0	12.0	11.3	12.0	11.0	12.0	11.7
b9	3.50	3.32	3.81	3.54	3.52	3.55	4.00	3.69	12.0	11.0	12.0	11.7	12.0	11.0	12.0	11.7
b10	3.64	3.47	3.95	3.69	3.68	3.73	4.16	3.86	12.0	11.0	12.0	11.7	12.0	11.0	12.0	11.7
Mean	2.95	2.80	3.12		3.01	2.95	3.32		10.8	9.9	11.7		11.4	10.6	11.8	
	Leaf area (m^2)								No. of bunches palm^{-1}							
	2010				2011				2010				2011			
	A	b	Ab		A	b	Ab		A	b	Ab		A	b	Ab	
LSD 5%	0.11	0.14	0.24		0.14	0.14	0.24			1.0	1.0		1.7	1.0	1.0	17

b_1: Control, b_2: Sulphur 100 g/palm, b_3: Salicylic acid at 100 ppm, b_4: Effective microorganis at 50 mL/palm, b_5: Humic acid at 50 mL/palm, b_6: Compost with actinomyces 5 kg/palm, b_7: Filter mud at 5 kg/palm, b_8: Citric acid at 500 ppm, b_9: Uni-Sal at 50 mL/palm, b_{10}: Cal-Mor at 150 mL/palm

palm was the most salt tolerant than Zaghloul and Hayany in this respect. This may be due to the differences between cultivar in salt tolerance which appear to be related to the salt exclusion mechanisms by the root parts resulting in reduced Na^+ translocation to the shoots (Greenway and Munns, 1980). These results are in agreement with those obtained by Al-Hammadi (2006), El-Sharabasy *et al.* (2008) and Al-Abdoulhadi *et al.* (2011).

Also, data in Table 2 indicate that anti-salinity treatments were significantly increased the leaf area compared to untreated one. The using Cal-Mor at 150 mL/palm (b10) gave the highest values of leaf area (3.69 and 3.86 m^2) in the first and second seasons, respectively. Soil application with Uni-Sal (b_9) was significantly enhanced the leaf area comparing with using citric acid, (b_8), Filter mud (b_7) and compost enriched with actinomyces, (b_6) in descending order in both seasons. These finding may be due to the basic mechanism of PEG it's a primary factor contributing a decrease of water flow through roots and control water potentials (Pandey and Agarwal, 1998; Slama *et al.*, 2007; Mehanna *et al.*, 2010). The lowest values in leaf area of all cultivars were obtained from b_1 (control) (2.24 and 2.32 m^2) and b_2 treatment (Sa^+ 100 g/palm) (2.39 and 2.48 m^2) in the first and second seasons, respectively.

These results may be attributed that the positive role of Calcium against salinity-induced inhibition in growth, as well as improve physicochemical properties. These results were in agreement with Busch (1995), Jha (2006) and Abada *et al.* (2010).

Using citric acid (b_8) has highly significant effective in enhancing the leaf area comparing with using salicylic acid (b_5). This indicated that citric acid is more effective than salicylic acid on protect cell from senescence and activity photosynthesis resulting improve growth characters. These finding were in agreement with Elad (1992), Zhang and Klessing (1997) and Rao *et al.* (2000).

Moreover, data in Table 2 show that the interaction between cultivar and anti-salinity treatment had a significant effect on leaf area. The maximum values were recorded on Sewy date palm that treated with Cal-Mor at 150 mL/palm/year (3.95 and 4.16 m^2) in the first and second seasons, respectively. On the other hand, untreated Hayany date palm gave the lowest values of leaf area (2.11 and 2.20 m^2) in both seasons. In general, the inhibiting effect of salinity on the leaf area might be attributed to its negative effects on the biosynthesis of organic foods especially carbohydrates, cell division and the uptake of water and different nutrients (Nijjar, 1985).

The positive action of salinity agents on alleviating the adverse effects of salinity on growth might be attributed to their beneficial effect on lowering soil pH and enhancing organic matter and the uptake of water and nutrients (Cooke, 1982; Gulser, 2005). These results are in agreement with obtained by Morsy and El-Bana (2000), Ahmed *et al.* (2003) and Kassem (2012).

Yield component: Data in Table 2 and 3 clearly show that yield expressed in number of bunches and bunch weight as well as yield (kg.) per palm was significantly varied among the three date palm cultivars grown under saline soil. The data in Table 3 showed that the highest values in yield and bunch weight in Sewy date palm (128.9 and 130.9 kg/tree and 11 and 11.1 kg^{-1}) followed by Zaghloul (113.7 and 120.6 kg/tree and 10.4 and 10.5 kg^{-1}) meanwhile Hayany cultivar was the lowest values (97.1 and 117.5 kg/tree and 9.7 and 9.7 kg^{-1}) during the first and second year, respectively. The same trend was observed in number of bunches/tree in Table 2. The sensitivity of soil salinity was appeared in date palm cultivar Hayany while Sewy date palm was considered most tolerance to soil salinity. This reduction in number of bunches and bunch weight might be attributed to the inhibition in growth which can notice under soil salinity. It is well known that growth, fruit production and quality parameters are seriously limited by soil salinity, reduce plant

Table 3: Effect of some anti-salinity agents on the average bunch weight (kg) and the yield per palm (kg) of Zaghloul, Hayany and Sewy date palms grown under sandy salinized soil during 2010 and 2011 seasons

	Bunch weight (kg.)								Yield /palm (kg.)							
	2010				2011				2010				2011			
	A1	A2	A3		A1	A2	A3		A1	A2	A3		A1	A2	A3	
Antisalinity treatments (b)	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean
b1	7.66	7.11	8.20	7.70	7.73	7.18	8.30	7.70	68.4	56.9	82.0	69.1	77.3	64.6	91.3	77.7
b2	8.30	7.66	8.81	8.30	8.38	7.73	8.90	8.30	83.0	68.9	96.9	82.9	92.3	87.3	97.9	89.2
b3	9.00	8.30	9.51	8.90	9.10	8.37	9.61	9.00	90.0	74.7	114.1	92.9	100.1	83.7	115.3	99.7
b4	9.56	8.90	10.10	9.50	9.63	8.97	10.20	9.60	105.2	89.0	121.2	105.1	105.9	98.7	122.4	109.0
b5	10.22	9.45	10.79	10.20	10.29	9.52	10.90	10.20	112.4	94.5	129.5	112.1	113.2	104.7	130.8	116.2
b6	10.78	9.99	11.30	10.70	10.86	10.10	11.40	10.80	118.6	99.9	135.6	118.0	130.3	111.1	136.8	126.1
b7	11.30	10.50	11.82	11.20	11.37	10.60	11.92	11.30	124.3	105.0	141.8	123.7	136.4	116.6	143.0	132.0
b8	11.85	11.00	12.41	11.80	11.92	11.10	12.50	11.80	130.4	121.0	148.9	133.4	143.0	122.1	150.0	138.4
b9	12.42	11.56	13.00	12.30	12.50	11.63	13.10	12.40	149.0	127.2	156.0	144.0	150.0	127.9	157.2	145.0
b10	13.00	12.20	13.60	12.90	13.10	12.27	13.71	13.00	156.0	134.2	163.2	115.1	157.2	134.0	164.5	151.9
Means	10.40	9.70	11.00		10.50	9.70	11.10		113.7	97.1	128.9		120.6	117.5	130.9	
	Bunch weight (kg.)						Yield /palm (kg.)									
	2010			2011			2010			2011						
	A	b	Ab	A	b	Ab	A	b	Ab	A	b	Ab				
LSD 5%	0.50	0.55	0.95	0.56	0.60	1.04	2.1	2.5	4.3	2.0	2.5	4.3				

b_1: Control, b_2: Sulphur 100 g/palm, b_3: Salicylic acid at 100 ppm, b_4: Effective microorganis at 50 mL/palm, b_5: Humic acid at 50 mL/palm, b_6: Compost with actinomyces 5 kg/palm, b_7: Filter mud at 5 kg/palm, b_8: Citric acid at 500 ppm, b_9: Uni-Sal at 50 mL/palm, b_{10}: Cal-Mor at 150 mL/palm

through osmotic effects, toxicity of ions, nutrient uptake imbalance, or a combination of these factors. Form this study, it can be noticed that date palm cultivars differences in salt tolerance. These findings are in agreement with those obtained by Greenway and Munns (1980), Al-Hammadi (2006), El-Sharabasy *et al.* (2008) and Al-Abdoulhadi *et al.* (2011).

Data in Table 3 indicate that anti-salinity treatments significantly increased the yield and bunch weigh/kg compared untreated one. Using Cal-Mor at 150 mL/palm(b10) gave the highest values (115.1 and 151.9 kg/palm and 12, 9 and 13, 0/kg) in the first and second seasons, respectively. Followed by Uni-Sal (b_9) was significantly increased the bunch weigh comparing with using citric acid, (b_8), Filter mud (b_7) and compost enriched with actinomyces, (b_6) in descending order in both seasons. This results due to the important role of PEG in contributing a decrease of water flow through roots and control water potentials (Pandey and Agarwal, 1998; Slama *et al.*, 2007; Mehanna *et al.*, 2010). Meanwhile the lowest values in yield and bunch weigh of all cultivars were obtained from b_1 (control) (69.1 and 77.7 kg/tree and 7.7 and 7.7/kg) and b_2 treatment (Sa^+ 100 g/palm) (82.9 and 89.2 kg/tree and 8.3 and 8.3/kg) in the first and second seasons, respectively. From the presented data in Table 2 it can observed that the number of bunches/tree took place the same direction look like yield and bunch weigh under the same treatments.

The increase of bunch weight, number of bunch/date, may be attributed that the increase of Ca concentration of the soil solution decreases the osmotic potential of the soil creating severe water stress deraiing the uptake process (Parida and Das, 2005). These results were in agreement with Busch (1995), Jha (2006) and Abada *et al.* (2010). On the other hand, using sulphur occupied the last position in this respect may be due to 100 g/tree was insufficient to adverse effects of salinity. (Abbey *et al.*, 2002; Eriksen *et al.*, 2004).

As interaction effects, Table 2 and 3 show that the highest yield and bunch weight was observed on Sewy date palms that treated with Cal-Mor (163.2 and 164.5 kg/tree; 13.6 and 13.7 kg) during first and second seasons, respectively. Untreated Hayany date palms gave the minimum values (68.9 and 87.3 kg/palm; 7.66 and 7.73 kg) during first and second seasons, respectively. The same trend was noticed in number of bunches/tree in Table 2. From the results it can be concluded that promoting effect of anti-salinity on growth, soil fertility and nutritional status of the trees surely reflected on improving the yield. These results are in agreement with those obtained by Mohamed (2005), Abada *et al.* (2010) and Kassem (2012).

Fruit quality

Physical characteristics of the fruits: It is clear from the data in Table 4 that physical characteristics average fruit weight (g.) and pulp percentage of the fruits were significantly varied among the three date palm cultivars. Fruit quality was greatly improved in date palm cultivars Sewy, Zaghloul and Hayany, in descending order. The highest values recorded in Sewy dates (9.52 and 9.54 (g) and 87.7 and 88.7%) during the first and second seasons, respectively. In the same time Hayany dates came in the last position in this respect recorded (8.8 and 8.54 (g) and 81.0 and 74.1%) in the first and second seasons, respectively. Intermediate values were recorded in Zaghloul dates.

Also, data in Table 4 concerning the effect of anti-salinity agents on fruit quality of different date palm cultivars, reveal that application of all the previous anti-salinity agents was significantly enhanced fruit quality in terms of increasing fruit weight and percentage of pulp. Sewy date palm cultivar treated with Cal-Mor at 150 mL/palm gave the highest values (14.02 and 14.23(g) and 88.1 and 88.8%) in the first and second seasons, respectively. Uni-Sal compound at 50 mL/palm was the

Table 4: Effect of some anti-salinity agents on the average fruit weight (g) and the pulp percentage of Zaghloul, Hayany and Sewy date palms grown under sandy salinized soil during 2010 and 2011 seasons

	Fruit weight (g)								Pulp (%)							
	2010				2011				2010				2011			
Antisalinity	A1	A2	A3		A1	A2	A3		A1	A2	A3		A1	A2	A3	
treatments (b)	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean
b1	18.00	8.10	8.70	11.60	17.80	7.00	8.55	11.12	81.0	78.0	83.0	80.7	81.4	78.5	84.0	81.3
b2	18.30	8.17	8.88	11.78	18.32	7.16	8.71	11.40	81.7	78.7	83.6	81.3	82.1	79.2	84.6	82.0
b3	19.00	8.35	9.06	12.14	19.05	7.40	8.91	11.79	82.3	79.5	84.0	81.9	82.7	79.9	85.0	82.5
b4	19.39	8.52	9.25	12.39	19.40	8.57	9.12	12.36	83.0	80.1	85.0	82.7	83.5	80.6	86.0	83.4
b5	19.80	8.70	9.41	12.64	19.85	8.75	9.30	12.63	83.6	80.7	86.2	83.5	84.0	81.2	87.3	84.2
b6	19.99	8.86	9.61	12.82	20.05	8.91	9.50	12.82	83.9	81.4	87.2	84.2	84.4	82.0	88.3	84.9
b7	20.50	8.99	9.82	13.10	20.50	9.16	9.80	13.15	84.2	82.0	88.9	85.0	85.0	82.6	89.9	85.8
b8	21.00	9.20	10.0	13.40	21.25	9.25	10.19	13.56	84.3	82.6	91.2	86.0	85.0	83.1	92.3	86.8
b9	21.70	9.36	10.16	13.74	21.80	9.41	10.50	13.90	85.0	83.3	93.3	87.2	85.5	84.0	94.3	87.9
b10	22.00	9.71	10.35	14.02	22.10	9.79	10.80	14.23	86.0	84.1	94.1	88.1	86.5	85.0	94.9	88.8
Mean	19.97	8.80	9.52		20.01	8.54	9.54		83.5	81.0	87.7		84.0	74.1	88.7	
	Fruit weight (g)								Pulp percentage							
	2010				2011				2010				2011			
	A	b		Ab	A	b		Ab	A	b		Ab	A	b		Ab
LSD 5%	0.16	0.16		0.28	0.14	0.15		0.26	0.5	0.6		1.0	0.6	0.7		1.2

b_1: Control, b_2: Sulphur 100 g/palm, b_3: Salicylic acid at 100 ppm, b_4: Effective microorganis at 50 mL/palm, b_5: Humic acid at 50 mL/palm, b_6: Compost with actinomyces 5 kg/palm, b_7: Filter mud at 5 kg/palm, b_8: Citric acid at 500 ppm, b_9: Uni-Sal at 50 mL/palm, b_{10}: Cal-Mor at 150 mL/palm

second effective and significantly in this respect. Application of citric acid (b_8) came in the third position in this respect, followed by Filter mud (b_7) and compost enriched with actinomyces, (b_6) in descending order. Sulphur application was the last value between treatments of anti-salinity. This results may be due to the promoting effect of anti-salinity agents on quality of the fruits was mainly attributed to their positive action on counteracting the adverse effects of salinity on the biosynthesis and translocation of carbohydrates and the uptake of water and different nutrients (Nijjar, 1985; Gulser, 2005).

In addition, data in Table 4 reveals that fruit weight and pulp % respond significantly to interaction between cultivar and anti-salinity treatment. The maximum value in fruit weight obtained on Sewy date palm that treated with Cal-Mor at 150 mL/palm/year (10.35 and 10.8 (g) and 94.1 and 94.9%) in the first and second seasons, respectively). On the other hand, Hayany date palm treated with the sulphur at 100 g/palm/year anti-salinity gave the lowest values of physical characteristics (8.17 and 7.16 (g) and 78.7 and 79.2%) in the two tested seasons, respectively. the increment of fruit weight and pulp % due to using anti-salinity treatment especially Ca^{++} with Sewy cultivar which was the greatest tolerance to salinity followed by Zaghloul cultivar while Hayany cultivar was the lowest value in this respect. These results are in harmony with those obtained by Ragab (2004), Mohamed (2005), Abada *et al.* (2010) and Mehanna *et al.* (2010).

Chemical characteristics of the fruit: It is clear from the data in Table 5 to 7 that chemical characteristics (total soluble solids %, total and reducing sugars %, total soluble tannins % and crude fiber %) of the fruits were significantly varied among the three date palm cultivars. Chemical characteristics were greatly improved in date palm cultivars Sewy, Zaghloul and Hayany, in descending order on almost chemical characteristics. Sewy cultivar recorded the highest values in (total soluble solids %, total and reducing sugars %) giving (76.3 and 76.5%, 75.3 and 75.8%; 76.9 and 68.0%) during the first and second seasons, respectively. In the same time Sewy cultivar gradually decreased to be the lowest in (total soluble tannins % and crude fiber %) recorded (0.46 and 0.43%; 0.5 and 0.47 %) in the first and second seasons, respectively. The lowest values in (total soluble solids %, total and reducing sugars %) were recorded in Hayany cultivar giving (24.9 and 25.3%, 18.4 and 18.9%; 12.0 and 12.3%) during the first and second study seasons, respectively. On the other side the same cultivar had the highest values of total soluble tannins % (0.36 and 0.56) in the first and second seasons, respectively. Meanwhile crude fiber percentage in Zaghloul fruits was the highest values (0.65 and 0.64) from any other cultivars Sewy and Hayany.

It could be concluded that the superiority of fruit quality in Sewy dates due to the increment of accumulation of total soluble solids %, total and reducing sugars than Hayany dates in this respect. This means Sewy date palm cultivar was the greatest tolerance of salinity stress than Zaghloul and Hayany cultivars. The differences between cultivar in salt tolerance which appear to be related to the salt exclusion mechanisms by the root parts (Greenway and Munns, 1980). In general salinity stress inhibited growth and development, also decreased in translocation of photosynthetic products and nutrients uptake then the accumulation of total soluble solids %, total and reducing sugars form declined (Nijjar, 1985; Gulser, 2005). These results agreed with those obtained by (Al-Hammadi, 2006; El-Sharabasy *et al.*, 2008; Al-Abdoulhadi *et al.*, 2011).

Concerning the application of all the previous anti-salinity agents, Table 5-7 cleared that fruit chemical characteristics were significantly effected in enhancing in terms of increasing the

Table 5: Effect of some anti-salinity agents on the percentage of total soluble solids (T.S.S) and total sugars in the fruits of Zaghloul, Hayany and Sewy date palms during 2010 and 2011 seasons

	TSS (%)								Total sugars (%)							
	2010				2011				2010				2011			
Antisalinity	A1	A2	A3		A1	A2	A3		A1	A2	A3		A1	A2	A3	
treatments (b)	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean
b1	23.0	22.0	72.0	39.0	22.7	21.8	71.0	38.5	18.0	16.0	72.0	35.3	17.7	16.0	71.0	34.9
b2	23.6	22.6	72.7	39.6	24.0	23.0	73.0	40.0	18.4	16.5	72.7	35.9	18.2	16.9	73.0	36.0
b3	24.3	23.3	73.9	40.5	24.7	23.7	74.2	40.9	19.0	17.0	73.4	36.5	18.9	17.5	73.9	36.8
b4	25.0	24.0	75.0	41.3	25.2	24.5	75.4	41.7	19.5	17.5	74.0	37.0	19.5	18.3	74.5	37.4
b5	25.6	24.7	75.9	42.1	26.0	25.1	76.4	42.5	19.9	18.1	75.0	37.7	20.1	19.0	75.6	38.2
b6	26.3	25.4	77.0	42.9	27.0	25.9	77.3	43.4	20.5	18.6	75.8	38.3	20.7	19.5	76.5	38.9
b7	27.0	26.0	77.5	43.5	27.5	26.5	78.0	44.0	21.0	19.2	76.6	38.9	21.5	19.7	77.2	39.5
b8	27.5	26.6	78.4	44.2	28.0	27.0	78.9	44.6	21.6	19.7	77.3	39.5	22.0	20.2	78.0	40.1
b9	28.0	27.0	79.5	44.8	28.5	27.5	80.0	45.3	22.3	20.3	78.0	40.2	22.7	20.8	78.9	40.8
b10	28.9	27.6	80.6	45.7	29.5	28.2	81.2	46.3	22.8	20.8	78.5	40.7	23.2	21.2	79.5	41.3
Means	25.9	24.9	76.3		26.3	25.3	76.5		20.3	18.4	75.3		20.5	18.9	75.8	
	TSS (%)								Total sugars (%)							
	2010				2011				2010				2011			
	A	b	Ab		A	b	Ab		A	b	Ab		A	b	Ab	
LSD 5%	0.5	0.6	0.0		0.5	0.6	1.0		0.4	0.5	0.9		0.4	0.5	0.9	

b_1: Control, b_2: Sulphur 100 g/palm, b_3: Salicylic acid at 100 ppm, b_4: Effective microorganis at 50 mL/palm, b_5: Humic acid at 50 mL/palm, b_6: Compost with actinomyces 5 kg/palm, b_7: Filter mud at 5 kg/palm, b_8: Citric acid at 500 ppm, b_9: Uni-Sal at 50 mL/palm, b_{10}: Cal-Mor at 150 mL/palm

Table 6: Effect of some anti-salinity agents on the percentage of reducing sugars and total soluble tannins in the fruits of Zaghloul, Hayany and Sewy date palms grown under sandy salinized soil during 2010 and 2011 seasons

	Reduciug sugars								Total soluble tannins							
	2010				2011				2010				2011			
Antisalinity	A1	A2	A3		A1	A2	A3		A1	A2	A3		A1	A2	A3	
treatments (b)	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean	Zaghloul	Hayany	Sewy	Mean
b1	13.0	10.0	63.0	28.7	13.3	10.5	62.3	28.7	0.79	0.82	0.66	0.76	0.77	0.79	0.64	0.73
b2	13.5	10.4	63.9	29.3	13.8	10.4	64.0	29.4	0.76	0.79	0.63	0.73	0.73	0.74	0.60	0.69
b3	14.0	10.8	65.9	30.2	14.3	11.0	66.0	30.4	0.73	0.76	0.60	0.70	0.69	0.69	0.57	0.65
b4	14.5	11.2	66.4	30.7	14.8	11.5	66.5	30.9	0.70	0.73	0.51	0.65	0.66	0.64	0.47	0.59
b5	15.0	11.7	68.0	31.6	15.3	12.0	68.2	37.8	0.66	0.69	0.48	0.61	0.60	0.60	0.45	0.55
b6	15.3	12.3	69.0	32.2	15.9	12.6	69.3	32.6	0.65	0.60	0.45	0.57	0.55	0.55	0.40	0.50
b7	15.9	12.7	69.7	32.8	16.5	13.0	70.0	33.2	0.63	0.57	0.40	0.53	0.51	0.50	0.36	0.46
b8	16.4	13.0	70.0	33.1	17.0	13.9	70.5	33.8	0.57	0.50	0.36	0.48	0.47	0.42	0.32	0.40
b9	16.8	13.3	70.9	33.7	17.5	14.0	71.0	34.2	0.40	0.44	0.30	0.38	0.44	0.39	0.27	0.37
b10	17.2	14.1	71.8	34.4	17.9	14.4	71.9	34.7	0.36	0.40	0.25	0.34	0.40	0.36	0.21	0.32
Means	15.2	12.0	67.9		15.6	12.3	68.0		0.63	0.63	0.46		0.58	0.56	0.43	
	Reduciug sugars								Total soluble tannins							
	2010				2011				2010				2011			
	A		b	Ab	A		b	Ab	A		b	Ab	A		b	Ab
LSD 5%	0.3		0.4	0.69	0.3		0.4	0.69	0.02		0.03	0.05	0.02		0.03	0.05

b_1: Control, b_2: Sulphur 100 g/palm, b_3: Salicylic acid at 100 ppm, b_4: Effective microorganis at 50 mL/palm, b_5: Humic acid at 50 mL/palm, b_6: Compost with actinomyces 5 kg/palm, b_7: Filter mud at 5 kg/palm, b_8: Citric acid at 500 ppm, b_9: Uni-Sal at 50 mL/palm, b_{10}: Cal-Mor at 150 mL/palm

Table 7: Effect of some anti-salinity agents on the percentage of crude fiber in the fruits of Zaghloul, Hayany and Sewy date palms during 2010 and 2011 seasons

	Crude fiber							
	2010				2011			
	A1	A2	A3		A1	A2	A3	
Anti-salinity treatments (b)	Zaghloul	Hayany	Sewy	Mean b	Zaghloul	Hayany	Sewy	Mean b
b1	0.82	0.85	0.71	0.79	0.85	0.88	0.74	0.82
b2	0.79	0.83	0.68	0.77	0.77	0.80	0.64	0.74
b3	0.77	0.81	0.62	0.73	0.75	0.79	0.58	0.71
b4	0.74	0.78	0.57	0.70	0.72	0.75	0.53	0.67
b5	0.71	0.74	0.50	0.65	0.69	0.70	0.46	0.62
b6	0.68	0.71	0.46	0.62	0.66	0.68	0.42	0.59
b7	0.60	0.63	0.42	0.55	0.57	0.60	0.39	0.52
b8	0.55	0.58	0.38	0.50	0.53	0.55	0.35	0.48
b9	0.47	0.50	0.35	0.44	0.45	0.46	0.31	0.41
b10	0.40	0.43	0.31	0.38	0.38	0.39	0.27	0.35
Means	0.65	0.69	0.50		0.64	0.66	0.47	
	Crude fiber							
	2010				2011			
	A	b		Ab	A	b		Ab
LSD 5%	0.02	0.03		0.05	0.02	0.03		0.05

b_1: Control, b_2: Sulphur 100 g/palm, b_3: Salicylic acid at 100 ppm, b_4: Effective microorganisms at 50 mL/palm, b_5: Humic acid at 50 mL/palm, b_6: Compost with actinomyces 5 kg/palm, b_7: Filter mud at 5 kg/palm, b_8: Citric acid at 500 ppm, b_9: Uni-Sal at 50 mL/palm, b_{10}: Cal-Mor at 150 mL/palm

(total soluble solids %, total and reducing sugars % and decreasing, total soluble tannins % and crude fiber % comparing with leaving the soil without soil addition of these agents. The best agent in this respect was Cal-Mor at 150 mL/palm followed by Uni-Sal compound at 50 mL/palm. Application of citric acid came in the third position in this respect.

The highest values in total soluble solids %, total and reducing sugars % were observed in Sewy date palm cultivar treated with Cal-Mor at 150 mL/palm (45.7 and 46.3%, 40.7 and 41.3% and 34.4 and 34.7%) in the first and second seasons, respectively. But the total soluble tannins % and crude fiber % were decreased to be the lowest in Sewy cultivar in this respect recorded (0.34 and 0.32%; 0.38 and 0.35%). Uni-Sal compound at 50 mL/palm was the second effective and significantly in this respect. Application of citric acid (b_8) came in the third position in this respect. Followed by Filter mud (b_7) and compost enriched with actinomyces, (b_6) in descending order. Sulphur application was the last value between treatments of anti-salinity in total soluble solids %, total and reducing sugars % recorded (39.6 and 40.0%, 35.9 and 36.0% and 29.3 and 29.4%) in the same time recorded the highest values in total soluble tannins % and crude fiber % (0.73 and 0.69%; 0.77 and 0.74%) in the first and second seasons, respectively. This results may be due to the promoting effect of anti-salinity agents especially Ca on quality of the fruits was mainly attributed to their positive action on counteracting the adverse effects of salinity on the biosynthesis and translocation of carbohydrates, cell division, growth substances and the uptake of water and different nutrients (Nijjar, 1985; Gulser, 2005).

As the interaction between cultivar and anti-salinity treatment, data in Table 5 to 7 showed that a significant effect was observed on chemical characteristics. Total soluble solids %, total and reducing sugars % were increased while total soluble tannins % and crude fiber % decreased it. The maximum value of fruit quality obtained on Sewy date palm cultivar grown under saline soil and treated with Cal-Mor at 150 mL/palm/year (80.6 and 81.2%, 78.5 and 79.5 total sugars % and 71.8 and 71.9%) in the first and second seasons, respectively). On the other hand, untreated Hayany date palm gave the lowest values of TSS (22.0 and 21.8%), total sugars (16.0 and 16.0%) and reducing sugars (10.0 and 10.5%) in the two studied seasons, respectively. These results are in agreement with those obtained by Ragab (2004), Mohamed (2005), Abada *et al.* (2010) and Mehanna *et al.* (2010).

CONCLUSION

From the present study, it is concluded that Sewy date palm cultivar is more tolerance to soil salinity followed by Zaghloul. Whereas, Hayany came in the last position in this regards. For increasing the withstand of every date palm cultivar to soil salinity, it is advised to use compounds solving salinity problem such as Cal-Mor at 150 mL/palm/year, Uni-Sal at 50 mL/palm/year or citric acid at 500 ppm in twice. Citric acid is considered a promising antioxidant used for alleviating the inferior effects of soil salinity on cropping of date palm growing under Salinization conditions.

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