COMPARATIVE STUDIES ON SALT TOLERANCE OF DATE PALM SEEDLINGS

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Abstract

The effect of salinity on survival and mineral composition of seedlings of six date palm cultivars was studied. The seedlings were grown in a nutrient solution salinized with Karoun lake water at final salt concentration of 10000 ppm. There were marked differences among the cultivars tolerance to salinity. Seedlings of the Zagloul cultivar were the least tolerant. However, Hayany seedlings were the most tolerant where about 88 % of the plants survived with the saline treatment for 600 days.

The reduction in seedling growth caused by salinity was closely related to the relative salt tolerance of the cultivars. Seedling growth was 48.8 % of control for the most salt tolerant cultivar (Hayany) vs. 21.5 % of control for the least tolerant cultivar (Zagloul).

Salinity increased Na^+ and Cl^- in the leaves and roots of seedlings for all cultivars. Na^+ content of the cultivar (Hayany) which exhibited a greater degree of salt tolerance was higher in leaves and roots, while the accumulation of Cl^- was high in the leaves.

INTRODUCTION

Date palm is one of the most important fruit trees grown in the Arab countries. Although, the majority of fruit trees are salt sensitive (Bernstein, 1965), date palm is thought to be more tolerant than other species (Mass and Hoffman, 1977). Most of the area in which date palm grown is subjected to salinity. Increasing salinity in Egyptian soils and rising water table levels represent hard problems, which could face fruit production. The ever-increasing demand for agricultural products requires a reassessment of the production potential of low-quality land and water resources (Epstein *et al.*, 1980).

Germination is one of the most critical stages for a crop subjected to salinity. Germination failures on saline soils are often a result of high salt concentrations existed by evaporation from soil surface (Bernstein, 1974) .

Differences in salt tolerance exist not only between species but also among genotypes of certain species (Marschner *et al.*, 1981 and Hassan and Catlin, 1984). Screening for differential salt tolerance has been done for some fruit species (Hassan *et al.*, 1986).

Numerous studies have demonstrated that rate and percentage of seed germination are affected adversely as salinity increases and the osmotic potential of the germination-medium decreases. Temperature also plays a significant role in seed germination, and Temperature x salinity interaction on the germination response of a number of plant species have been noted (Sharma, 1976 and Siraj and Siraj. 2003).

Although fruit species respond similarly to osmotic effects of salt, they differ considerably with regard to specific effects (Bernstein, 1965). Na^+ and Cl^- ions are predominantly those responsible for specific ion toxicity.

The objective of this study is to evaluate the effect of water salinity on date palm seedling cultivars during the early stages of plant development.

MATERIALS AND METHODS

Seeds of date palm (*phoenix dactylifera* L.) cultivars Hayany, Bent-Easha, Sammani, Sewy, Gandela and Zagloul were soaked in distilled water for two hours, and then planted in beds filled with clean sand. The experiment was carried out in a greenhouse at the Central of Laboratory for Date Palm Research and Development, ARC; where 6-month old seedlings of each cultivar were transplanted in polyethylene containers of 50cm in diameter. Eight containers for salt treatment and four for control were used for each cultivar. Salt treatment experiments were carried out for two seasons: the first was initiated in January 2000 until September 2001 and the second was initiated in January 2001 until September 2002. More details for the experimental technique were described elsewhere (Hassan and Catlin, 1984).

The seedlings were irrigated with dilute nutrient solution (Hassan and Hai, 1976). Irrigation was applied by gravity from reservoirs at the base of the containers and solution was allowed to rise to 5 cm above the sand surface. Delivery tubes were then removed and the excess solution was allowed to drain away (Hassan and Catlin, 1984). Salt treatment was started one month after transplanting by the salinization of the basic nutrient solution using Karoun lake water. The composition of the saline solution was Ca^{++}: 118 ppm, Mg^{++}: 269 ppm, Na^+: 2922 ppm, K^+: 135 ppm, CO_3^{-2}: 12 ppm, HCO_3^- : 46 ppm,Cl^- : 2993 ppm and SO_4^{-2}: 3505 ppm. The control received nutrient solution only.

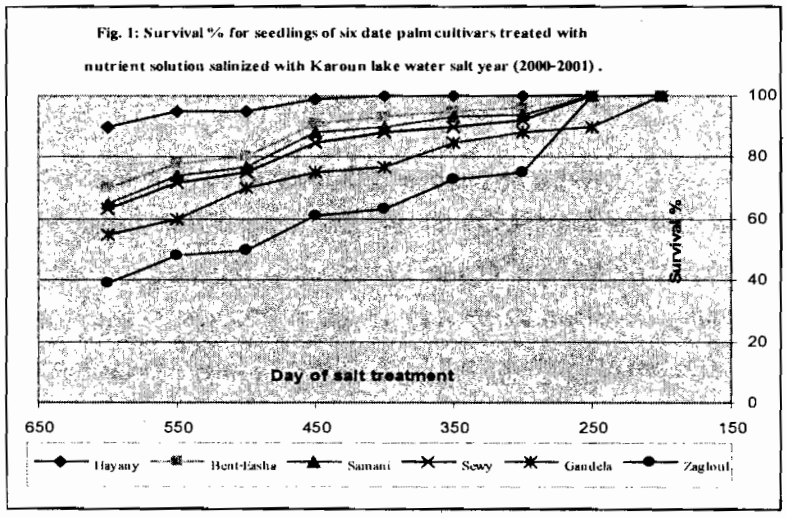
Leaf necrosis was the index of plant damage. The affected plants were removed. Plants which survived and withstood the salt treatment without salinity symptom were considered survivors and were recorded.

Leaf and root samples from seedlings of each cultivar, under salt treatment as well as the control were obtained from 2001/2002 season. The samples were dried at 70 °C, ground and prepared for analysis. Na and K were determined by flame

photometer. Chloride was extracted from the ashed samples with hot water and titrated with standard silver nitrate (A.O.A.C., 1965).

RESULTS AND DISCUSSION

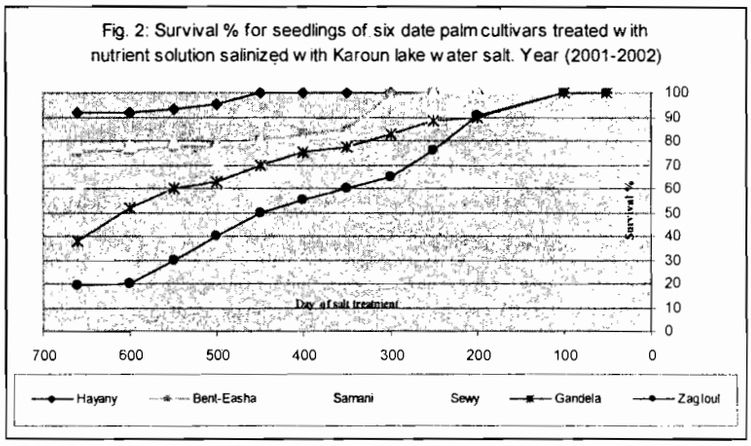
Survival curves obtained from the two seasons with seedlings of six date palm cultivars treated with nutrient solution salinized with Karoun lake water salt are shown in Figures 1 and 2.



The data indicate a great variability among the tested date palm cultivars in their response to salinity. The relative salt tolerance has been found in the following ascending order: Zagloul, Gandela, Sewy, Samani, Ben-Easha and Hayany. Salinity symptoms appeared in the seedlings of the least salt tolerant. Zagloul cultivar after 360 days and 280 days of salt treatment for seasons of 2000/2001 and 2001/2002, respectively (Figures 1 and 2).

The seedlings of the most salt tolerant Hayany cultivar had shown no injury before 440 days and 460 days of salt treatment in the seasons of 2000/2001 and 2001/2002, respectively.

An estimate was made of the day at which 80% survival was reached. These times for Figure 1 were $400^{\pm}25$, $480^{\pm}37$, $520^{\pm}29$, $560^{\pm}40$ and $560^{\pm}38$ and for Figure 2 were: $230^{\pm}37$, $360^{\pm}41$, $420^{\pm}45$, $480^{\pm}46$ and $500^{\pm}41$ for seedlings of Zagloul, Gandela, Sewy, Samani and Bent-Easha, respectively.



The survived seedlings of the least salt tolerant cultivar reached 80 % after 400 days in 2000/2001 season (Figure 1) and 320 days of salt treatment in 2001/2002 season (Figure 2). At the end of the experiments, (600 days of salt treatment) the survived seedlings reached 32 % and 18 % in 2000/2001 and 2001/2002 season respectively. The Hayany cultivar seedlings showed the highest percentage of survival and were the most tolerant to salinity, where seedlings survival reached 80 % and 90% after 600 days of salt treatment for seasons of 2000/2001 and 2001/2002 respectively. Seedlings of the other cultivars showed intermediate values.

Plant growth expressed as dry weight of seedling for salt treated plants and untreated ones is shown in Table 1. Salinity decreased seedling growth for all the studied date palm cultivars compared with the control. The reduction in seedling growth caused by salinity was closely related to the relative salt tolerance of the cultivars. Seedling growth was 48.4, 42.2, 39.1, 38.8, 32.3 and 21.5% relative to the control treatment for Hayany, Bent-Easha, Samani, Sewy, Gandela and Zagloul, respectively.

Determination of Na^+, K^+ and Cl^- was done in the leaves and roots of the seedlings of the six date palm cultivars for the control and salt treated seedlings of 2001/2002 season (Tables 1 and 2).

Salinity increased Na^+ and Cl^- contents in both leaves and roots of seedlings for all the studied cultivars where K^+ decreased. These increases of Na^+ and Cl^- in the seedlings were associated with the relative salt tolerance of the cultivars.

Table 1. Seedlings growth of six date palm cultivars in control and salinized nutrient solution, (600 days of salt treatment).

Cultivar	Control	Salt treatment	% relative to Control
	dry wt / plant (g)		
Hayany	120.2	58.7	48.8
Bent - Easha	116	48.9	42.2
Samani	105.3	41.2	39.1
Sewy	100.7	39.9	38.8
Gandela	102.5	33.1	32.3
Zagloul	108.5	23.3	21.5
LSD 0.05	17.4	8.1	

Table 2. K, Na and Cl contents in dry tissue of leaves of date palm seedlings as a function of the salinization of the nutrient solution (the final salt concentration was 10.000 ppm).

Cultivar	K (%)		Na (%)		Cl (%)	
	Control	Salt treat.	Control	Salt treat.	Control	Salt Treat.
Hayany	1.04	0.82	0.62	2.39	0.47	1.43
Bent - Easha	1.1	0.98	0.56	2.08	0.42	1.24
Samani	1.12	1	0.63	1.98	0.47	1.31
Sewy	1.19	1.05	0.6	1.47	0.5	1.12
Gandela	1.21	1.17	0.58	1.32	0.51	0.95
Zagloul	1.28	1.26	0.63	1.12	0.51	0.91
LSD 0.05	NS	0.09	NS	0.14	NS	0.09

Table 3. K, Na and Cl contents in dry tissue of roots of date palm seedlings as a function of the salinization of the nutrient solution (the final salt concentration was 10.000 ppm).

Cultivar	K (%)		Na (%)		Cl (%)	
	Control	Salt treat.	Control	Salt treat.	Control	Salt treat.
Hayany	0.71	0.81	1.12	2.4	0.66	0.9
Bent - Easha	0.78	0.81	1.18	2.28	0.66	0.9
Samani	0.75	1.83	0.97	2.25	0.65	0.91
Sewy	0.88	1.79	1.03	2.1	0.62	1.12
Gandela	0.87	1.88	1.05	1.9	0.66	1.21
Zagloul	0.91	1.01	1.1	1.98	0.61	1.36
LSD 0.05	0.07	0.08	NS	0.24	NS	0.21

Table 4. K, Na and Cl % in the leaves and roots dry matter of date palm seedlings as a function of the salinization of the nutrient solution.

Cultivar	K (%)		Na (%)		Cl (%)	
	leaves	roots	leaves	roots	leaves	roots
Hayany	0.82	0.81	2.39	2.4	1.43	0.9
Bent - Easha	0.98	0.81	2.08	2.28	1.24	0.9
Samani	1.00	1.83	1.98	2.25	1.31	0.91
Sewy	1.05	1.79	1.47	2.1	1.12	1.12
Gandela	1.17	1.88	1.32	1.9	0.95	1.21
Zagloul	1.26	1.01	1.12	1.98	0.91	1.36
LSD 0.05	0.09	0.08	0.14	0.24	0.09	0.21

The highest Na was found in leaves and roots of seedlings of the most salt tolerant cultivar (Hayany). However, the lowest values were found in case of the least salt tolerant cultivar (Zagloul). Cl was the highest in leaves and the lowest in roots for seedlings of the most salt tolerant cultivars, however, the contrast was found for seedlings of the least salt tolerant cultivar (Zagloul). This reflects the differences in root/shoot ratio of Cl^- in the salt treated plants where the ratios reached 0.6, 0.7, 1.0, 1.3 and 1.5 for seedlings of Hayany, Bent-Easha, Samani, Sewy, Gandela and Zagloul respectively. K^+ increased in roots and decreased in leaves as influenced by salinity in seedlings of all the studied date palm cultivars.

Chloride (Cl) was high in leaves but low in roots in seedlings of the cultivar, which exhibited a greater degree of salt tolerance than the other did. Accordingly, root/shoot ratio of CL- in the salt treated plants was affected and related to the relative salt tolerance of the cultivars. Root/shoot ratio of Cl^- reached 0.6 for the most salt tolerance cultivar (Hayany) vs. 1.5 for the least salt tolerant cultivar (Zagloul). This may indicate that the utilization of Cl^- for osmotic adjustment in vacuoles and that improve the water balance of Cl^-.

The results demonstrated a wide variation in response to salinity among the studied cultivars. The relative salt tolerance was in the following ascending order: Zagloul, Gandela, Sewy, Samani, Bent-Easha and Hayany. Considerable variation in salt tolerance may exist between species of the same genus, between cultivars or indeed within varieties (Van Steveninck *et al.,* 1982; Hassan and Catlin, 1984 Hassan *et al.*, 1986). Although, orchard crops are generally salt sensitive (Mass and Hoffman, 1977), date palm appear to be a relatively salt tolerant crop as evidenced by the survival of 88 % of Hayany seedlings when treated with a saline treatment for 600

days without the appearance of leaf necrosis. Date palm is considered one of the most resistant of all fruit crops (Bernstein, 1965).

Plant growth decreased by salinity. The reduction in seedling growth among the studied cultivars was closely related to their relative salt tolerance. Seedling growth was 48.8 % of control for seedling of the most salt tolerant cultivar (Hayany) vs. 21.5 % of control for the least salt tolerant cultivar (Zagloul).

Moreover, data shown in table (4) indicate that Na % follow the same trend of Cl %. However, K % goes in an opposite trend. Similar responses have been obtained with certain varieties of sugar beet (Marzchner *et al.*, 1981). For many halophytes, uptake of Na^+ and Cl^- serves as useful function by providing osmotic solutes (Shannon, 1984). Plants may accumulate salts in the leaves providing lower osmotic potentials but then may need to exclude salts from the cytoplasm to avoid ionic interactions with enzymatic reactions (Plitman, 1984).

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دراسات مقارنة على قدرة شتلات نخيل البلح على تحمل الملوحة

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يعد نخيل البلح واحدًا من أهم أشجار الفاكهة المنزرعة فى الدول العربية ومع أن معظم أشجار الفاكهة حساسة للملوحة إلا أن نخيل البلح أكثر احتمالا عن الأنواع الأخرى حيث تعتبر معظم المساحات المنزرعة بنخيل البلح متأثرة بالملوحة نسبياً ولاشك أن زيادة الملوحة فى الاراضى المصرية وارتفاع مستوى المياه يمثل مشكلة صعبة تواجه إنتاج الفاكهة .

نفذت الدراسة الحالية باستخدام ستة شتلات من أصناف نخيل البلح لتقدير استجابتها للملوحة وأيضا تتبع تأثير الملوحة على توزيع أيونات الصوديوم والبوتاسيوم والكلور فى هذه الأصناف وقد تم تربية هذه الشتلات بتغذيتها بمحاليل مالحة(تركيز ملوحة عشرة الآلف جزء فى المليون) من بحيرة قارون.

أوضحت النتائج أن هناك اختلافات ملحوظة فى درجة تحمل هذه الشتلات للملوحة حيث وجد أن شتلات البلح الزغلول كانت أقلها تحملاً بينما كانت شتلات الحيانى أكثر تحملاً حيث أن حوالى ٨٨% من النباتات قاومت التعامل بالمياه المالحة لحوالى ٦٠٠ يوم.

كما أظهرت النتائج أن إنخفاض نمو الشتلات لإستخدام المياه المالحة تفاوتت بنسبة تواجد الأملاح فى المياه حيث بلغ نمو الشتلات ٤٨,٨% من عينة المقارنة من البلح الحيانى مقابل ٢١,٥ % لعينة المقارنة فى البلح الزغلول.

وقد تسببت الملوحة فى زيادة أيونات الصوديوم والكلور فى الأوراق وجذور جميع الشتلات ولكن كانت أيونات الصوديوم أعلى فى أوراق وجذور البلح الحيانى - وأن أيونات الكلور تركزت (بنسبة عالية) فى الأوراق.