RESPONSE OF SEED GERMINATION AND SEEDLING GROWTH OF TEN LIBYAN DATE PALM VARIETIES TO WATER SALINITY

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Abstract

Response of seed germination and seedling growth of ten Libyan date palm varieties to varying levels of water salinity were studied. Seeds of mature fruits were collected, cleaned, washed and planted in plastic pots full of soil/peat moss mixture at a five seeds/pot rate. Chloride content of the growth media was determined at the start of the study. Saline water consisted of five treatments; 109 (control), 1500, 3000, 4500 and 6000 ppm total soluble salts which were prepared by sea water dilutions. Treatments were replicated four times in a complete randomized block design (CRBD). Pots were irrigated using the same amount of the corresponding water twice a week. Number of germinated seeds was recorded regularly until no more seedlings emerged and the percentage of seed germination was calculated. At the end of the study, seedling heights, fresh and dry weights of their roots and shoots were determined. Concentration of soil and plant chloride was also measured. Results showed that there was a significant reduction in the percentage of seed germination with increasing salinity (88.5%, 59% in control and 6000 ppm respectively) and the reduction varied with the varieties too (40% to 88%). Seedling heights were significantly affected by salinity (30.7 cm in control and 16.3 cm in 6000 ppm treatment) and by the variety also. Similarly, fresh and dry weights of roots and shoots were significantly affected by booth salinity and variety. Leaf and root chloride content clearly indicated that the varieties differ in their ability to exclude chloride and to tolerate salinity.

Key words: Date palm, Chloride, Salinity, Seed germination, Seedling growth.

INTRODUCTION

Date palm (Phoenix *dactylifera* L) has long been one of the most important plants of arid and desert areas of the Arab World. For over 5000 years it provided food because its fruit contain concentrated energy and could be easily stored and carried along on long journeys across the deserts (Furr 1995). Nowadays there is a great attention in Libya from both private and government sectors for the cultivation of date palms. This cultivation is extended over three main areas: Northern (costal), Central and Southern regions. Statistics for the year 1999 indicated that the number of date palms grown in Libya was six million trees, of which four million trees were under production (Ministry

of Agriculture 1999). The underground water is the main source of irrigation in Libya. It usually contains higher amounts of salts than the upper limits which permit growth of most fruit trees. Although date palm is known to be among the most tolerant crops to salinity, many areas in Libya became too saline for date palms to grow. Date palms are propagated by vegetative methods for commercial fruit production, and they can also be propagated by seed. Seeds germinate easily and are available in large numbers and can be stored for years without loosing their viability. Seed propagation is used when palms are to be planted for ornamentals, wind breaks, feed and manufacturing of many traditional commodities such as hand fans, baskets, chairs...etc. Seeds are considered the principle mean for bringing new varieties into existence either for obtaining better fruit quality or for other reasons such as drought and salinity tolerance. Epstien *et al.* (1980) believe that solving the salinity problem should include both the manipulation of the environment to benefit the plant and genetic manipulation of the plant to saline conditions. In the past date palm breeding used to be tedious and to take so many years, but now it can be effectively sped by biotechnology tools of tissue culture and genetic engineering.

The objectives of this study were to determine the effects of salinity on seed germination and seedling growth of ten Libyan date palm varieties and to identify any possible variation between these varieties in salinity tolerance.

MATERIALS AND METHODS

This study was conducted in a green house. Four different levels of salinity were used: 1500, 3000, 4500 and 6000 ppm total soluble salts (TSS), prepared by diluting sea water. The control was a collected rain water containing 109 ppm TSS. Seeds of ten date palm varieties, commercially grown on a large scale in Libya, were also used. The varieties were; Awkly, Tasfert, Adhwi, Bekrari, Talees, Abel, Deglet Noor, Bestian, Khadrai and Tabouni. Seeds were separated from pest free mature fruits, washed and air dried and sorted for size. Seeds of uniform size were planted two cm deep, face down at a rate of five seeds per pot in plastic pots full of volumetric ratio 2:1 steam sterilized soil-peat moss mixture. Pots were heavily irrigated immediately after planting with corresponding treatment water to insure removal of any air packets that may had formed around seeds. Thereafter, pots were irrigated twice a week at a rate of 150 ml per pot. Chloride content of the growth medium was determined at seed planting time, and was found to be 0.01%. Treatments were replicated four times in a factorial experiment using a complete randomized block design (CRBD).

The number of emerging seedlings was recorded daily as they appeared above growth medium until no more seedlings emerged and percentage of seed germination was calculated. At the end of the experiment, seedling heights were measured, leaf and root fresh wt were determined, then dried in an oven at 68 C for 48 hours and

their dry wt was determined too. Chloride percentage in the growth medium, leaves and roots were determined analytically. Data were subjected to statistical analysis (Steel and Torrie 1980).

RESULTS AND DISCUSSION

The percentage of seed germination decreased with the increase in salt concentration in irrigation water. The degree of reduction varied from one variety to another (Table1). The increase in salinity decreased seed germination percentage from 88.5 % in the control to 59 % in the 6000 ppm treatment. Similarly, seed germination percentage was affected by the variety. Tasfert seeds had the highest germination percentage (88 %); Tabouni seeds had the lowest germination percentage (54%). The seed germination of the other varieties ranged between these two values. In the control, seed germination was 90-100% for Awkly Tasfert, Talees, Adhwi and Bekrari, 80-85 in Able, Deglet Noor, Bestian and Khadrai. Tabouni seed germination was the lowest (70%). When salinity was increased to1500 ppm, seed germination was 85-95% for Awkly, Tasfert, Bekrari, and Abel, and 70-80% in the remaining varieties. As salinity was increased to 6000 ppm, seed germination was reduced in all varieties. Reduction was the greatest in Talees and Tabouni (50, 30% respectively), and the least in Tasfert (80%). This showed that Tasfert seeds had higher ability to germinate under salinity conditions as compared to Talees and Tabouni seeds. Hewitt (1966) reported a reduction in Deglet Noor seed germination associated with salt concentration increase relative to seeds of other varieties. Similar results were obtained with Egyptian and Indian date varieties (Brown 1984, Ramoliya and Pandey 2003).

Table 1. Effects of salinity levels and date palm varieties on the percentage seed germination (%).

Treatment / Varieties	control 109 ppm	1500 ppm	3000 ppm	4500 ppm	6000 ppm	Average
Awkly	100	95	80	70	70	83
Tasfert	100	95	85	80	80	88
Adhwi	95	80	80	80	55	78
Talees	100	80	80	60	50	40
Bestian	80	80	65	60	55	68
Abel	85	85	75	70	60	75
Bekrari	90	90	70	60	60	74
Khadrai	80	80	70	60	60	70
Deglet Noor	85	80	80	70	70	77
Tabouni	70	70	55	45	30	54
Average	88.5	83.5	74	65.5	59	74.3

Leaf and root chloride content varied with salinity treatments and varieties (Tables 2, 3). Leaves contained lower chloride percentage than roots. Chloride percentage has increased in the leaves from 0.89% in the control to 2.13% in the 6000 ppm treatment and in the roots from 1.30 % to 3.85% in the same treatments respectively. Awkly and Bekrari had the lowest leaf chloride content (1.27%), while Tasfert had the highest (1.86%). This is in agreement with Djibril *et al.* (2005) who reported that leaf chloride percentage in plants subjected to salinity varied with varieties. On the other hand, both Awkly and Bekrari roots contained high chloride percentage (2.83, 2.82% respectively). As Awkly seedlings produced the highest fresh and dry leaf and root wt (Table 5), it could be concluded that seedlings of this variety had the capability to accumulate chloride in their roots and nullify its effects on plant growth making it a salinity tolerant plant. Kozlownski (1997) reported that many salt tolerant plants have the ability to accumulate salts in their roots to offset or minimize their toxicity effects on plant growth.

Table 2. Effects of salinity levels (ppm) and date palm varieties on the average percentage of seedling leaf chloride (%).

Treatments / Varieties	109 ppm (control)	1500 ppm	3000 ppm	4500 ppm	6000 ppm	Average
Awkly	0.71	1.06	1.24	1.59	1.77	1.27
Tasfert	0.70	1.06	2.13	2.66	2.74	1.86
Adhwi	0.70	1.24	1.43	2.48	2.48	1.67
Talees	0.70	1.24	1.43	1.59	1.59	1.31
Bestian	0.70	1.43	1.59	2.13	2.13	1.60
Abel	0.75	1.77	2.15	2.48	2.48	1.93
Bekrari	0.70	1.06	1.06	1.42	2.13	1.27
Khadrai	1.06	1.43	1.59	1.77	1.77	1.52
Deglet Noor	1.06	1.24	1.43	1.77	1.95	1.49
Tabouni	0.70	1.42	1.42	2.13	2.13	1.56
Average	0.89	1.30	1.55	2.00	2.13	

Table 3. Effects of salinity levels and date palm varieties on the average percentage of seedling root chloride (%).

Treatments / Varieties	109 ppm (control)	1500 ppm	3000 ppm	4500 ppm	6000 ppm	Average
Awkly	1.06	2.13	3.19	3.55	3.90	2.83
Tasfert	1.06	2.13	2.48	3.21	4.50	2.68
Adhwi	0.88	1.59	2.48	3.19	3.55	2.34
Talees	1.24	1.59	2.84	3.01	3.55	2.45
Bestian	1.43	2.13	2.66	2.84	3.90	2.60
Abel	1.08	2.48	2.66	3.37	3.90	2.70
Bekrari	1.43	2.13	2.84	3.55	3.70	2.82
Khadrai	1.24	2.13	2.48	3.55	3.70	2.77
Deglet Noor	1.42	1.95	2.30	3.90	4.60	2.73
Tabouni	1.06	1.77	2.13	2.66	3.19	2.16
Average	1.30	1.80	2.57	3.28	3.85	

Seedling heights were significantly reduced by salinity increase (Table 4). Control seedlings were the tallest (30.73 cm) and seedling heights decreased to their lowest value (16.33 cm) at 6000 ppm treatment. This could be attributed to the physiological and morphological changes which take place in plants exposed to high salinity level. Furr (1995) indicated that young seedling palms showed a linear decline in growth rate when irrigation water contained 3000 ppm salts or more. Kramer (1983) attributed reduction of plant growth by salinity to osmotic effect, toxic effects of ions and imbalance of the uptake of essential nutrient elements.

Increase in salinity had highly significant negative effects on fresh and dry wt of leaves and roots (Table 4). Leaf fresh wt was significantly reduced from 1.61 g in the control to 0.73 g in the 6000 ppm treatment, and leaf dry wt was also significantly reduced from 0.49 g to 0.24 g by the same treatments. This reduction could be related to the reduction in plant growth due to unavailability of water to the seedlings with salinity increase and because of reduction in photosynthesis and an increase in respiration rate (Furr and Ream 1968, Niemen 1962).

Root fresh wt was significantly reduced from 0.77 g in the control to 0.38 g in 6000 ppm treatment and root dry wt was significantly reduced from 0.20 g to 0.08 g in the same treatments. Khudairi (1958) indicated that increase in salt accumulation in date palm roots led to reduction in fresh and dry root wt. due to low growth rate.

Table 4. Salinity level effects on height, leaf and root fresh and dry wt of date palm seedlings.

Salinity level (ppm)	Seedling height (cm)	Leaf fresh wt (g)	Leaf dry wt (g)	Root fresh wt (g)	Root dry wt (g)
109	a30.73	a1.61	0.49 a	0.77 a	0.20 a
1500	b26.67	1.36 b	0.41 b	0.57 b	0.13 b
3000	b23.96	1.12 c	0.36 c	0.48 c	0.11 b
4500	c20.34	c0.95	0.31 c	0.43 c	0.09 b
6000	d16.33	d0.73	0.24 d	0.38 d	0.08 b
LSD1%	3.56	0.21	0.07	0.1	0.05

Averages followed by the same letter in a column are not significantly different.

Varieties too had their effects on seedling heights (Table 5). Awkly produced the tallest plants (28.96 cm); Tabouni produced the shortest ones (15.32 cm) and the remaining varieties varied between these two values.

Varieties significantly affected fresh and dry wt of seedling leaves and roots (Table 5). Awkly seedlings produced the highest leaf fresh wt (1.45 g), leaf dry wt (0.43 g), root fresh wt (0.98 g), and root dry wt (0.23 g). On the other hand, Tabouni seedlings produced the lowest leaf fresh wt (0.87 g), leaf dry wt (0.29 g), root fresh wt (0.36 g) and root dry wt (0.07 g). The remaining varieties varied in between. These differences clearly indicate that the studied varieties differ in their ability to tolerate salinity which was reflected in their seed germination percentage and plant growth. This is in agreement with the results of Rashid *et al.* (2004) who studied salt effects on several tree species and found that there were great differences between tree species and also between trees within the same species in their salt tolerance.

Table 5. Variety effects on height, leaf fresh and dry wt of date palm seedling.

Variety	Seedling height (cm)	Leaf fresh wt (g)	Leaf dry wt (g)	Root fresh wt (g)	Root dry wt (g)
Awkly	28.96 a	1.45 a	0.43 a	0.98 a	0.23 a
Tasfert	27.06 a	1.20 a	0.41 a	0.57 b	0.13 b
Adhwi	26.97 a	1.13 b	0.38 a	0.60 b	0.13 b
Talees	24.05 a	1.12 b	0.32 b	0.54 b	0.13 b
Bestian	22.84 b	1.21 a	0.40 a	0.51 b	0.12 b
Abel	24.00 a	0.95 b	a0.43	0.58 b	0.12 b
Bekrari	24.83 a	1.27 a	0.39 a	0.50 b	0.10 b
Khadrai	18.66 c	0.94 b	0.30 c	0.41 c	0.10 b
D. Noor	23.66 a	1.41 a	0.32 b	0. 56 b	0.10 b
Tabouni	15.32 d	0.87 c	0.29 c	0.36 d	0.07 b
LSD 1%	5.32	0.29	0.09	0.14	0.07

Averages followed by the same letter in a column are not significantly different.

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استجابة إنبات بذور ونمو بادرات عشرة من أصناف نخيل التمر الليبية لملوحة الماء

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تم دراسة مدى استجابة إنبات بذور ونمو بادرات عشرة من أصناف نخيل التمر الليبي لمستويات مختلفة من ملوحة الماء. جمعت البذور من الثمار الناضجة، نظفت، غسلت وزرعت في اكياس بلاستيكية مملوئه بخليط من التربة و البيت موس بمعدل خمسة بذور في الكيس الواحد وقدر تركيز الكلورايد في مخلوط وسط ألإنماء قبل الزراعة. ملوحة الماء تكونت من خمسة معاملات: ١٠٩ (الشاهد)، ١٥٠٠، ٣٠٠٠، ٤٥٠٠، ٦٠٠٠جزء في المليون(*ج ف م*) من الأملاح الكلية الذائبة أعدت بتخفيف مياه البحر. كررت المعاملات اربع مرات وكان نظام التجربة القطع العشوائية الكاملة. رويت البذور بكميات متساوية من المياه ذات التركيز المناسب من الأملاح لكل معاملة مرتين اسبوعيا. سجل عدد البذور التي انبتت بشكل دوري حتى توقف الانبات، ثم حسبت نسبة انبات البذور. عند نهاية التجربة سجلت أطوال البادرات، وقدرت الأوزان الطرية و الجافة لجذورها و أوراقها، كما قدر تركيز الكلورايد في وسط الإنماء، وفي جذور و أوراق البادرات. أظهرت النتائج وجود فروق معنوية في انخفاض نسبة الانبات مع الزيادة في الملوحة (٨٨,٥ % ،٥٩% في معاملات الشاهد و ٦٠٠٠ ج ف م على التوالي) وان هذا الانخفاض اختلف باختلاف الاصناف (٤٠% الى ٨٨%). متوسط طول البادرات تأثر معنويا بزيادة ملوحة مياه الري حيث انخفض من ٣٠,٧ سم في معاملة المقارنة الى ١٦,٣ سم في معاملة ٦٠٠٠ *ج ف م* وتاثر معنويا ايضا بالأصناف. وبالمثل فان الأوزان الطرية و الجافة للجذور و الأوراق تأثرت معنويا بكل من مستوى الملوحة و الاصناف. كما اظهر محتوى البادرات من الكلورايد وجود اختلافات معنوية بين الأصناف في مدى قدرتها على تفادي امتصاص الكلورايد وتحملها لملوحة مياه الري.

الكلمات الدالة: نخيل التمر، الكلورايد، الملوحة، إنبات البذور، نمو البادرات.