Technical paper

Effects of salinity and indole acetic acid on growth and mineral content of date palm seedlings

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Abstract — Introduction. Salinity in irrigation water is a serious problem for agriculture in the Arabian Gulf States. Irrigation with saline water depresses the plant growth and productivity of date palm trees. Nevertheless, irrigation of date palm seedlings with GA_3 in combination with salts allowed the shoot and root Na and Cl concentrations to be reduced. **Materials and methods**. An experiment was conducted at the United Arab Emirates University, in Al-Ain, to study the effect of saline water on growth properties and mineral contents of date palm (*Phoenix dactylifera* L., cv. Lulu) seedlings. Effects of salt alone (16 or 26 $g \cdot L^{-1}$) or in combination with indole acetic acid (IAA), and IAA alone (150 or 200 $mg \cdot L^{-1}$) added to the irrigation water were studied. After the treatment application, growth characteristics and leaf, stem and root mineral concentrations were measured. **Results and discussion**. The salinity in the irrigation water reduced the leaf number per seedling, increased the leaf and stem dry matter percentage, and the Na concentration in leaves, stems and roots of Lulu seedlings. There was no consistent effect of salts or IAA added to the irrigation water on N, P, K, Mn, Zn and Fe concentrations of leaves, stems and roots. The Na concentration gradually decreased from roots to leaves for most treatments. **Conclusion**. Compared to saline water used alone, the irrigation of date palm seedlings with indole acetic acid in combination with salts added to the water reduced the adverse effect of salt by reducing the Na accumulation in leaves and stems of Lulu seedlings. © Éditions scientifiques et médicales Elsevier SAS

Gulf States (Qatar) / *Phoenix dactylifera* / irrigation / salt water / IAA / seedlings / leaves / stems / roots / mineral content / growth

Effets de la salinité et de l'acide indolacétique sur la croissance et la teneur en éléments minéraux de plantules du palmier dattier.

Résumé — Introduction. La salinité de l'eau d'irrigation est un sérieux problème pour l'agriculture des États du Golfe arabe. L'irrigation avec de l'eau salée ralentit la croissance de plantes et la productivité du palmier dattier. Cependant, l'irrigation de jeunes palmiers dattiers avec de l'acide gibbérellique (GA_3) combiné à des sels a permis de réduire les concentrations en sodium (Na) et en chlore (Cl) des tiges et des racines. **Matériel et méthodes**. Une expérimentation a été entreprise à l'université des Émirats arabes unis, à Al-Ain, pour étudier les effets de l'eau salée sur la croissance et la teneur en éléments minéraux de plantules de palmier dattier (*Phoenix dactylifera* L., cv. Lulu). Les effets de l'addition, dans l'eau d'irrigation, de sels seuls (16 ou 26 $g \cdot L^{-1}$), de sels combinés avec de l'acide indole acétique (AIA), ou d'AIA seul (150 ou 200 $mg \cdot L^{-1}$) ont été étudiés. Après traitements, certaines caractéristiques de croissance ont été mesurées, ainsi que les concentrations minérales des feuilles, tiges et racines. **Résultats et discussion**. La salinité de l'eau d'irrigation a réduit le nombre de feuilles par plantule, a augmenté le pourcentage de matière sèche de la feuille et de la tige et la concentration en Na dans les feuilles, tiges et racines des plantules de Lulu. Il n'y pas eu d'effet sensible dû à la présence de sels ou d'AIA dans l'eau d'irrigation sur les concentrations en N, P, K, Mg, Zn et Fe des feuilles, tiges et racines. La concentration en Na a progressivement diminué des racines aux feuilles pour la plupart des traitements. **Conclusion**. Par rapport à l'utilisation d'une eau salée seule, l'irrigation des plantules de palmier dattier avec de l'AIA ajouté aux sels a permis de réduire l'effet nocif de la salinité des eaux d'irrigation en freinant l'accumulation de Na dans les feuilles et les tiges des plantules du cv. Lulu. © Éditions scientifiques et médicales Elsevier SAS

États du Golfe (Qatar) / *Phoenix dactylifera* / irrigation / eau salée / AIA / plantule / feuille / tige / racine / teneur en éléments minéraux / croissance

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1. introduction

In many countries of the world, including the Arabian Gulf State, salinity in irrigation water is a serious problem for agriculture. In particular, irrigation with saline water depressed date palm plant growth and productivity [1–4].

Salinity has also been found to reduce shoot and root dry weight of sour orange, Volkamer lemon and Balady lime seedlings [5, 6], and peach trees [7]; leaf and root fresh weight, leaf number and growth rate of date palm, Volkamer lemon, Balady lime and sweet orange are also affected. Nevertheless, saline water had no significant effect on *Citrus macrophylla* and Rough lemon seedling growth rate [8–14] and the dry matter percentage of date palm seedlings [2], and it was found that the irrigation of date palm seedlings with saline water alone or in combination with gibberellic acid (GA_3) increased the shoot dry matter percentage [15].

Salinity leads to the high accumulation of chlorine (Cl), sodium (Na) and potassium (K) in date palm leaves [4]. Similarly, the addition of sodium chloride (NaCl) to the irrigation water increased Cl, K, Na, nitrogen (N) and phosphorus (P) concentrations, but reduced calcium (Ca) and magnesium (Mg) in the shoots of most citrus rootstocks [16]. Several researchers found that the application of saline water to citrus plants decreased, K, N, P, Ca, Mg, iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) concentrations in leaves and roots [17–19]. However, others [15, 20] found that salinity had no effect on K, N and P concentrations, but led to large Cl and Na accumulation in *Citrus aurantium* leaves. The high accumulation of Cl and Na in date palm leaves may provide beneficial physiological activity through the osmotic adjustment [4]. The accumulation of ions in date palm roots and leaves gradually increased with increasing salt concentration in the irrigation water up to 12 000 ppm, and that further increase had no significant effect [12]. Irrigation of date palm seedlings with GA_3 in combination with salt reduced the shoot and root Cl and Na concentrations [21].

The aim of our work was to investigate the possible improvement in growth and the increase of some mineral contents of Lulu date palm seedlings under salt stress conditions due to the application of indole acetic acid (IAA).

2. materials and methods

The experiment was conducted in the nursery of the Experimental Station of Agricultural Science College at Al-Oha region, in the United Arab Emirates.

Three-year-old and uniform-size date palm (*Phoenix dactylifera* L.) seedlings of Lulu cultivar were transplanted in 40 cm in diameter and 30 cm deep plastic pots filled with yellow sand. All plants were irrigated with water three times a week; in addition, every week they received 1.5 L of Hoagland's solution [22] per seedling. Plants were arranged in completely a randomized block design, equally split among three levels of saline irrigation water of 0, 16 and 26 $g \cdot L^{-1}$ NaCl, plus $CaCl_2$ in mixture of 1:1 by weight. Salinity treatments were imposed by irrigating each plant once a week with 1.5 L of different salt concentrations besides 1.5 L of various IAA solutions (150 $mg \cdot L^{-1}$ and 200 $mg \cdot L^{-1}$) added monthly. The experiment consisted of nine treatments, replicated four times, with five seedlings as the experimental unit.

Seedling shoot lengths were measured 20, 40 and 80 d after the treatment application. Other plant growth characteristics (leaf, stem and root dry matter percentages, leaf number per seedling, and root lengths) were recorded at the harvest date (80 d after the first treatment) following the procedure described previously [23].

The nitrogen content was determined by the micro-Kjeldahl method. Measurement of Ca, Fe, K, M, Mg, Na and Zn concentrations was conducted after wet digestion with a mixture (4:1) of nitric/perchloric acid. Phosphorus concentration was determined by autoanalyser (Model CSA 100). Chlorine concentration was not measured because of technical problems.

The data were subjected to an analysis of variance and Duncan's multiple range test was used for mean comparison with $p < 0.05$.

3. results and discussion

3.1. salinity effects on plant growth characteristics

When irrigated for 80 d with 16 or 26 $g \cdot L^{-1}$ salts, either alone or in combination with IAA, the leaf number per plant significantly reduced. Nevertheless, the irrigation of cv. Lulu seedlings with water containing 150 or 200 $mg \cdot L^{-1}$ IAA did not affect the leaf number per seedling compared with the non-treated control (*table I*). These results agree with those of Aljuburi [2], which showed that the salinity in irrigation water reduced the date palm seedling leaf number, or with those of other works [7] on peach rooted cuttings, which demonstrated that salinity in irrigation water increased the abscised leaf number per plant; the same applies for Banuls' works [14], which showed that NaCl or potassium chloride (KCl) addition in irrigation water increased leaf defoliation percentage of sweet orange seedlings.

Cultivar Lulu seedling irrigation for 20, 40 or 80 d with saline water, alone or in combination with IAA, did not affect the shoot length as compared with the control seedlings, except for the high IAA level which showed significant effects (*table I*).

Seedling root length did not respond to application of salt solutions or IAA alone as compared with the control seedlings, whereas using the combination of 16 $g \cdot L^{-1}$ salts with 150 or 200 $mg \cdot L^{-1}$ IAA reduced root lengths as compared with application of IAA alone.

Leaf dry matter percentages increased with application of 26 $g \cdot L^{-1}$ salts alone or in combination with 150 $mg \cdot g \cdot L^{-1}$ IAA, as compared with control (*table I*). The combination of high salinity and high IAA concentration in irrigation water reduced leaf dry matter percentages as compared with application of 26 $g \cdot L^{-1}$ salt concentration alone. Similar results have already been obtained which showed that shoot dry matter percentages of date palm seedlings increased

Table I.
Effect of salinity and IAA on number of leaves/seedling, shoot length (cm), at 0, 20, 40 and 80 d after first treatment, root length (cm), leaves, stem and root dry matter (%) of Lulu cultivar date palm seedlings at 80 d after first treatment. Values are mean of analysis of 20 seedlings: four replications each with five seedlings.

Treatment	Number of leaves/ seedling	Shoot length measured (cm) after the first treatment				Root length (cm)	Dry matter (%)		
		0 d	20 d	40 d	80 d		Leaves	Stem	Root
Control	4.85 a	63.17 ab	64.63 ab	61.53 b	73.00 ab	77.10 abc	34.00 c	38.25 bc	30.75 ab
150 $mg \cdot L^{-1}$ IAA	4.75 ab	61.67 ab	63.63 ab	65.28 ab	71.35 ab	92.20 a	34.75 bc	36.25 c	29.50 b
200 $mg \cdot L^{-1}$ IAA	4.65 abc	76.40 ab	70.57 a	71.63 a	79.90 a	86.55 a	33.25 c	36.00 c	29.50 b
16 $g \cdot L^{-1}$ salt									
Alone	4.40 bcd	67.95 a	68.13 ab	67.40 ab	75.55 ab	81.20 abc	38.25 bc	41.00 ab	31.50 ab
+ 150 $mg \cdot L^{-1}$ IAA	4.45 bcd	67.45 ab	65.72 ab	66.03 ab	71.90 ab	67.80 c	39.75 bc	39.25 abc	33.00 a
+ 200 $mg \cdot L^{-1}$ IAA	4.30 cd	62.78 ab	63.70 ab	63.25 b	70.00 b	69.45 bc	38.50 bc	42.25 a	31.00 ab
26 $g \cdot L^{-1}$ salt									
Alone	4.30 cd	67.30 ab	67.63 ab	67.13 ab	74.65 ab	80.80 abc	48.50 a	42.25 a	32.50 a
+ 150 $mg \cdot L^{-1}$ IAA	4.30 cd	61.17 b	61.72 b	60.88 b	67.18 b	80.40 ab	41.75 ab	42.25 a	32.50 a
+ 200 $mg \cdot L^{-1}$ IAA	4.10 d	62.90 ab	63.63 ab	62.67 b	70.06 b	77.14 abc	39.75 bc	41.75 a	31.50 ab

For each element, means within a same column followed by the same letter do not differ significantly ($p = 0.05$), using Duncan's multiple range test.

with application of saline water alone or in combination with GA_3 [15].

Irrigation of Lulu seedlings with low saline water, alone or in combination with low IAA, or with IAA alone, did not affect stem dry matter percentage (*table I*). Addition to irrigation water of high salt concentration with IAA, high salt concentration alone, or the combination of low salt with high IAA concentration significantly increased stem dry matter percentages. The same applies for other works [15] which showed that dry matter percentages of Lulu and Khalas seedlings increased with application of saline water alone or in combination with GA_3, or for previous studies of Aljuburi [2] which demonstrated that shoot dry matter percentages of date palm seedlings increased with addition of salinity in irrigation water.

High salt concentrations alone in irrigation water or salts in combination with low IAA concentrations significantly increased root dry matter percentages of Lulu seedlings as compared with application of IAA alone (*table I*). The addition to irrigation water of salinity in combination with high IAA concentrations had no effect on root dry matter percentage of Lulu seedlings as compared with the control. These results agree with other findings [16].

3.2. salinity and IAA effects on leaf mineral concentrations

Irrigation with saline water, IAA alone or a combination of salt with IAA did not affect leaf N concentration as compared with control (*table II*), except for the high salt level combined with the low IAA concentration, which significantly reduced leaf N concentration. Similarly, other works showed that salinity had no effect on N, P and K concentrations, but led to large Na and Cl accumulations in *Citrus aurantium*, Volkamer lemon and *Citrus macrophylla* leaves [13, 21]; moreover, according to other results [17–19], the application of saline water to citrus plants decreased N, P, K, Ca, Mg, Fe, Mn, Zn and Cu concentrations in leaves and roots.

Date palm seedling irrigation with water containing salts or IAA alone did not affect leaf P concentration (*table II*). Saline water in combination with IAA increased leaf P concentration over the control. Previous studies showed also that Khalas seedling irrigation with saline water did not affect

Table II.
Effect of salinity and IAA on leaf mineral concentration of Lulu cultivar date palm seedlings (values are mean of analysis of 20 seedlings: four replications each with five seedlings).

Treatment	N	P	K	Na	Mn	Zn	Fe
	Leaf dry weight (%)				(ppm)		
Control	1.36 a	0.083 c	0.938 abc	0.37 c	13.25 c	30.50 abc	162.3 c
150 mg·L^{-1} IAA	1.30 ab	0.088 c	1.018 abc	0.32 c	15.75 abc	31.75 ab	172.5 c
200 mg·L^{-1} IAA	1.40 a	0.075 c	0.633 c	0.74 b	17.75 abc	16.75 e	425.8 a
16 g·L^{-1} salt							
Alone	1.41 a	0.098 bc	1.003 abc	1.13 a	17.75 abc	30.00 abc	187.3 c
+ 150 mg·L^{-1} IAA	1.55 a	0.14 ab	0.607 c	0.70 b	14.25 abc	30.50 abc	211.5 bc
+ 200 mg·L^{-1} IAA	1.30 ab	0.17 a	0.893 bc	0.77 b	18.00 abc	32.75 a	307.3 b
26 g·L^{-1} salt							
Alone	1.60 a	0.11 bc	1.125 ab	0.86 ab	20.75 a	28.00 bcd	184.3 b
+ 150 mg·L^{-1} IAA	1.00 b	0.14 ab	1.043 abc	0.76 b	14.50 bc	25.00 d	221.3 bc
+ 200 mg·L^{-1} IAA	1.56 a	0.18 a	1.400 a	0.86 ab	19.50 ab	26.25 cd	244.0 bc

For each element, means within a same column followed by the same letter do not differ significantly (p = 0.05), using Duncan's multiple range test.

shoot P concentration, but low concentration of saline water in combination with low concentration of GA_3 increased shoot P concentration over the control [21].

Irrigation with water containing salts, IAA or both did not significantly change leaf K concentrations of treated seedlings as compared with results obtained with control seedlings. The combination of high saline water with high IAA concentrations increased leaf K concentration as compared with application of 200 $mg \cdot L^{-1}$ IAA alone, or low salt concentration in combination with IAA (*table II*). Aljuburi and Al-Masry [13] found that salinity in irrigation water had no significant effect on leaf N, P and K concentrations of Volkamer lemon and *Citrus macrophylla*.

Leaf Na concentrations of Lulu seedlings were increased when irrigated with salt application alone or in combination with IAA, while it was not affected by low concentration of IAA over the control (*table II*). These results are in agreement with others [4, 16, 20] which demonstrated that the salinity in irrigation water increased leaf Na and Cl concentrations in date palm and citrus seedlings. Other workers [21, 24] showed also that the application of plant growth regulators on some plants alleviated the effects of salt stress.

Irrigation of Lulu seedlings with 26 $g \cdot L^{-1}$ salts alone or in combination with high concentration of IAA increased leaf Mn concentration over the control. Irrigation with high salt in combination with low IAA concentrations decreased seedling leaf Mn concentrations as compared with application of 26 $g \cdot L^{-1}$ saline water alone (*table II*). Indole acetic acid, low salinity, alone or in combination, or high salinity in irrigation water in combination with low IAA concentration had no effect on Lulu leaf Mn concentration as compared with the control. These results agree with previous work [21] which showed that date palm seedling irrigation with salt alone or in combination with GA_3 increased shoot Mn concentration in the Khalas cultivar as compared with the control.

Application of high concentrations of IAA alone or high salinity in combination with low IAA concentrations reduced the seedling leaf Zn concentrations as compared with the control. Irrigation of Lulu seedlings with low IAA, low salt concentration alone or in combination, or high salinity in combination with high IAA concentration had no effect on leaf Zn concentration (*table II*). Similar results have already been obtained [21] with Lulu and Khalas seedlings.

When irrigated with high concentration of IAA solution alone or in combination with low salt concentration, seedling leaf Fe concentration was higher than that of the control. Irrigation of Lulu seedlings with low IAA, low salt concentration alone or in combination had no significant effect on leaf Fe concentration relative to the control. High salinity in combination with IAA in irrigation water had no effect on leaf Fe concentration of Lulu cultivar seedlings as compared with the control (*table II*). Similar results have already been obtained in previous studies [21].

3.3. salinity and IAA effects on stem mineral concentration

Irrigation of Lulu seedlings with water containing salts, IAA or both did not affect stem N level as compared with the control (*table III*).

Application of low IAA or low salt concentration alone or in combination, or high salt concentration in combination with IAA had no significant effect on P level of Lulu seedling stems. Addition to irrigation water of high IAA concentrations with or without low salt, or high salt concentrations increased stem P concentration of Lulu seedlings over the control (*table III*).

Date palm seedling irrigation with saline water or IAA, alone or in combination, did not affect stem K concentrations as compared to the control, except the low IAA concentrations which increased the stem K concentration over the control. Addition to irrigation water of 150 $mg \cdot L^{-1}$ IAA in combination with 26 $g \cdot L^{-1}$ salts significantly decreased stem K concentrations of Lulu seedlings as compared with application of high salinity concentrations alone.

Table III.
Effect of salinity and IAA on stem mineral concentration of Lulu cultivar date palm seedlings (values are mean of analysis of 20 seedlings: four replications each with five seedlings).

Treatment	N	P	K	Na	Mn	Zn	Fe
	Stem dry weight (%)				(ppm)		
Control	1.13	0.073 c	0.355 abc	0.44 d	12.25 c	27.25 b	307.0 c
150 mg·L^{-1} IAA	1.11	0.105 bc	0.548 a	0.42 d	18.00 abc	43.75 a	307.3 c
200 mg·L^{-1} IAA	1.05	0.168 ab	0.384 abcd	0.47 d	22.00 abc	49.25 a	539.3 a
16 g·L^{-1} salt							
Alone	1.14	0.105 bc	0.310 cd	2.14 c	19.75 abc	37.25 ab	414.3 abc
+ 150 mg·L^{-1} IAA	1.18	0.138 abc	0.480 abc	2.40 bc	26.50 a	42.50 ab	599.8 ab
+ 200 mg·L^{-1} IAA	0.94	0.185 a	0.390 abcd	2.15 c	15.50 bc	46.75 a	385.0 bc
26 g·L^{-1} salt							
Alone	1.16	0.178 ab	0.505 ab	3.05 a	25.75 a	40.25 ab	480.5 abc
+ 150 mg·L^{-1} IAA	1.19	0.110 abc	0.285 d	2.44 bc	24.00 ab	45.75 a	403.8 abc
+ 200 mg·L^{-1} IAA	1.14	0.143 abc	0.383 abcd	2.76 ab	21.75 abc	42.00 ab	444.8 abc
Significance	ns	**	**	**	**	**	**

For each element, means within a same column followed by the same letter do not differ significantly (p = 0.05), using Duncan's multiple range test.
ns: not significant; ** significant at $p < 0.05$.

As compared with control seedlings, stem Na concentrations of Lulu seedlings significantly increased when irrigated with salts alone or in combination with IAA (*table III*). The combination of high saline water with low IAA concentrations decreased stem Na concentrations of Lulu seedlings, compared with application of high saline water alone. These findings are in agreement with other works [4, 16, 20, 21] which showed that the salinity increased Na concentration in date palm and citrus leaves.

Irrigation of Lulu seedling with saline water in combination with low IAA concentrations or with high salt concentrations significantly increased stem Mn concentrations as compared with the control. Indole acetic acid, low salt alone or low and high salts in combination with high IAA concentrations had no effect on Lulu stem Mn concentrations relative to non-treated control. Other works demonstrated that the combination of low salt with high GA_3 and high salt with GA_3 increased shoot Mn concentrations of Lulu seedlings [21].

Application of IAA, high concentrations of saline water in combination with low IAA, or the combination of high IAA with low salt concentrations increased Lulu stem Zn concentration over the control. Irrigation of Lulu seedlings with low salt concentrations alone or in combination with low IAA, or high salt concentration alone or in combination with high IAA had no effect on stem Zn concentrations as compared with the control (*table III*).

Irrigation of Lulu seedlings with saline water, or IAA alone or IAA in combination with saline water had no effect on stem Fe concentrations as compared with the control (*table III*), except for high IAA concentrations alone or low salinity in combination with low IAA concentrations.

Most of these results agree with those previously obtained with the use of GA_3 [21].

3.4. salinity and IAA effects on root mineral concentration

Irrigation of Lulu seedlings with saline water, IAA alone or in combination had no effect on root N concentrations as compared with the control (*table IV*). Applica-

tion of high concentrations of IAA in combination with low saline water reduced root N concentrations as compared with application of low concentrations of salt alone or in combination with low IAA, or with application of high salinity alone or in combination with high concentrations of IAA in irrigation water.

Irrigation of Lulu seedlings with saline water alone significantly reduced root K concentrations as compared with the control. Application of high concentrations of IAA alone increased root K concentrations as compared with non-treated seedlings. The results of root K concentrations of Lulu seedlings agree with those of Nawar and Ibrahim [17], Atalla [18] and Banuls et al. [19]. Aljuburi [21] showed that the salinity in irrigation water decreased root K concentrations of citrus and date palm seedlings.

Root Na concentrations in Lulu seedlings increased with application of salinity in irrigation water alone or in combination with IAA over the control. However, IAA application alone had no effect on root Na concentrations (*table IV*). Other works [4, 16, 21] demonstrated that the salinity led to accumulation of Na, Cl and K in date palm and citrus seedlings, and Aljuburi [21] showed that the GA_3 application to irrigation water had no effect on date palm root Na concentrations.

Irrigation of Lulu date palm seedlings with saline water alone or in combination, or with low IAA alone, increased the root Mn concentrations as compared with the non-treated control; only the high IAA concentrations alone had no effect on the root Mn concentrations (*table IV*).

Irrigation with low IAA concentrations alone or with salts alone or in combination with IAA had no effect on root Zn and Fe concentrations. Only the high IAA concentrations alone, added in the irrigation water, increased the Zn concentrations and decreased the Fe concentrations in root, as compared with the control (*table IV*).

4. conclusion

The irrigation of date palm seedlings with indole acetic acid in combination with salts reduced the adverse effect of salt by reducing the accumulation of Na in leaves and stems of Lulu seedlings over using salts alone.

Table IV.
Effect of salinity and IAA on root mineral concentration of Lulu cultivar date palm seedlings (values are mean of analysis of 20 seedlings: four replications each with five seedlings).

Treatment	N	P	K	Na	Mn	Zn	Fe
	Leaf dry weight (%)				(ppm)		
Control	1.04 abc	0.048 d	0.565 bc	1.04 b	16.75 bc	18.75 bc	382.3 abc
150 mg·L^{-1} IAA	0.93 abc	0.063 bcd	0.750 ab	0.97 b	24.00 a	22.00 b	379.3 abc
200 mg·L^{-1} IAA	0.88 bc	0.120 a	0.907 a	0.34 b	11.5 c	31.50 a	161.5 d
16 g·L^{-1} salt							
Alone	1.09 ab	0.056 cd	0.473 cd	2.50 a	21.00 ab	19.50 bc	396.5 ab
+ 150 mg·L^{-1} IAA	1.13 a	0.105 ab	0.503 cd	2.99 a	19.00 ab	19.25 bc	440.3 a
+ 200 mg·L^{-1} IAA	0.84 c	0.118 a	0.610 bc	3.37 a	19.75 ab	20.00 bc	425.8 a
26 g·L^{-1} salt							
Alone	1.11 a	0.058 cd	0.348 d	3.39 a	23.25 ab	18.75 bc	440.8 a
+ 150 mg·L^{-1} IAA	0.98 abc	0.088 abcd	0.525 cd	2.96 a	22.25 ab	20.50 bc	249.0 cd
+ 200 mg·L^{-1} IAA	1.09 ab	0.095 abc	0.590 bc	3.12 a	24.75 a	16.75 c	279.0 bcd

For each element, means within a same column followed by the same letter do not differ significantly ($p = 0.05$), using Duncan's multiple range test.

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Efectos de la salinidad y del ácido indolacético sobre el crecimiento y el contenido mineral de las plantas de semillero de la palma datilera.

Resumen — Introducción. La salinidad en agua de riego es un problema serio para la agricultura en los estados árabes del golfo. El riego con agua salina limita el crecimiento vegetal y la productividad de los árboles de la palma datilera. Sin embargo, el riego de las plantas de semillero de la palma datilera con ácido giberélico (AG_3) conjuntamente con las sales permitió reducir las concentraciones del sodio (Na) y del cloro (Cl) de los tallos y de las raíces. **Material y métodos**. Un experimento fue conducido en la universidad de los Emiratos Arabes Unidas, en Al-Ain, para estudiar el efecto del agua salina sobre el crecimiento y los contenidos minerales de las plantas de semillero de la palma datilera (*Phoenix dactylifera* L., cv. Lulu). Los efectos de la sal solamente (16 o 26 $g \cdot L^{-1}$) o conjuntamente con el ácido indolacético (IAA), e IAA solamente (150 o 200 $mg \cdot L^{-1}$) agregados al agua de riego fueron estudiados. Después de la aplicación del tratamiento, las características del crecimiento y las concentraciones minerales de la hoja, del tallo y de la raíz fueron medidas. **Resultados y discusión**. La salinidad en el agua del riego redujo el número de hojas por planta de semillero, aumento el porcentaje de la materia seca de la hoja y del tallo y la concentración del Na en las hojas, tallos y raíces de las plantas de semillero de Lulu. No había efecto constante de sales o IAA agregado al agua de la irrigación en concentraciones de N, P, K, Mg, Zn y Fe de las hojas, tallos y las raíces. La concentración del Na disminuyó gradualmente de las raíces a las hojas para la mayoría de los tratamientos. **Conclusión**. En relación con el uso del agua salina solamente, el riego de plantas de semillero de la palma datilera con el ácido indolacético conjuntamente con las sales agregadas al agua redujo el efecto nocivo de la sal reduciendo la acumulación del Na en hojas y tallos de las plantas de semillero de Lulu.

Estados del Golfo (Qatar) / *Phoenix dactylifera* / riego / agua salada / AIA / plántulas / hojas / tallo / raíces / contenido mineral / crecimiento