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INFLUENCE OF WATER STRESS AND SALINITY ON GERMINATION AND SEEDLING GROWTH OF THREE MEDICINAL DESRT PLANT SPECIES

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Abstract

The effect of different irrigation intervals and NaCl concentrations on the seed germination and seedling growth of *Asphodelus ramosus, Hyoscyamus muticus,* and *Lavandula pubescens* were investigated under growth chamber and green house conditions. The data indicated that, the percentage of germination in *L .pubescens* was significantly higher than that in *A. ramosus* and *H. muticus* regardless the irrigation intervals or NaCl concentrations. Also, the irrigation interval (8 days), the control and concentration (1000 ppm) of NaCl were significantly higher than the other treatments in germination percentage regardless the species. Both irrigation intervals and NaCl concentrations caused different effects on seedling variables i.e., (height, root length, number of leaves/seedling, fresh weight, dry weight and water content of the shoots) and mortality in all the three studied species. The percentage of seedling mortality of the three studied species were increased significantly after 25 days at most of irrigation intervals under growth chamber conditions, while under green house conditions, increases significantly after 40 days after the plantation. Most seedlings of all studied species did not decline at 1000 ppm NaCl under growth chamber conditions, while under green house conditions, the mortality percentage of *L . pubescens* and *A. ramosus* seedlings reached up to 100% after 30 and 40 days respectively after the plantation at 2000 ppm and 3000 ppm NaCl concentration, however, this percentagewas attained after 60 days for *H. muticus* only at 1000 ppm NaCl cncentration. Data recordede indicated that *H. muticus* significantly considered as less stress-tolerant species to drought and salinity comparing with the other studied species. These results were discussed with regard to distribution of these plants in the Egyptian deserts, also, regard to the use of these species in rehabilitation of desertified lands in Egypt.

Key words: *Asphodelus ramosus, Hyoscyamus muticus, Lavandula pubescens,* irrigation intervals, salinity, germination, seedling, mortality.

Introduction

Seed germination and seedling growth are critical life history stages often subject to high mortality rates. Seeds and seedlings may be less stress tolerant than adults or may be exposed to the more extreme environmental fluctuations at or near the soil surface. In either case, the ability to successfully negotiate this "regeneration niche" can be strong determinant of species distributions in harsh environments. In coastal and inland saline habitats, salinity and water availability (flooding and/or drought) are the abiotic stresses thought to primarily limit species distributions (Waisel, 1972; Unger *et. al*., 1979; Snow & Vince, 1984; Unger, 1991; Penning & Callaway, 1992; Ball & Pidsley, 1995). The variance of species in their responsiveness to abiotic factors (i.e. soil salinity, soil moisture, photoperiod, or temperature) is quantified by the ranges of their proportion germination and speed of germination. The range of the response variables among different treatments of each of the biotic factors is a measure of the relative importance of each abiotic factor in determining germination, and therefore influencing population dynamics, in the field. Some species had small ranges among salinity, moisture or other abiotic factors treatments; others respond with large differences in proportion germination or germination speed among treatments (Noe & Zedler, 2000). The most environmental factors stress affecting plants in the arid and hyperarid conditions of the Egyptian deserts are caused by drought and salinity. Several uncontrolled factors may influence germination percentages in arid natural environments, particularly the presence of salt in soil (Mayer & Poljakoff-Mayber, 1989). For species to become established in saline environments, adaptation of the species to salinity in the germination stage is crucial (Unger, 1995). Therefore, to predict the effects of soil salinization on vegetation in these regions, or to undertake to introduce agronomically important nonhalophytes to salinized locations, informations is important on how salinity affects the seed germination of nonhalophytes distributed in these regions (Tobe, *et.al*., 1999). Desertification is a serious problem in arid and hyper-arid region in Egypt. Drought and salinity is the important process of desertification. There is often a need rehabilitate vegetation in these suffer lands by introducing agronomically important drought and salinity tolerant species. If seed dispersal is the method to be used, information is needed on how the seeds of these species respond to drought and salinity parameters.

Three perennial species will be tested in this study, *Asphodelus ramosus, Hyoscyamus muticus* and *Lavandula pubescens. Asphodelus ramosus* is ephemaroid plant contains some of medicinal substances such as anthraquinons and flavonoid glycoside (Hammouda *et a*l, 1975; Ozdemir, 1987). *Hyoscyamu muticus* is an herbaceous, fleshy, pubescent plant, contains many of alkaloids. *Lavandula pubescens* is a pubescent, viscid plant, distinguishes by strong smiling and contains some of the volatile oils (Batannouny *et al*, 1999). El-Khouly (2006) studied the ecological factors affecting germination and seedling survival of these species in their habitats; he found that soil moisture and salinity play a very important role in germination and seedling survival of the three species studied in their habitats. Therefore, the effect of both factors needs to special and detailed studies.

The goal of the present study was to explain the role of drought and salinity in differences of the establishment of these species in the Egyptian habitats; also use the obtained results of the present study in rehabilitatation of the desertified lands by seed dispersal. To attain this goal, the effect of different irrigation intervals and salinity on germination, seedling growth and mortality were determined; also the magnitude of the effects of both factors on the above-mentioned parameters was compared. Because NaCl is the most abundant salt in salinized lands in Egypt, it was selected for use in this study.

Materials and Methods

The mature fruits of the three studied species were collected randomly during June, 2003 from the growth localities of these species. Individual fruits were allowed to air-dry and stored at room temperature (15-31°C) until September, 2003, when experimental treatments were started. Seeds of each species were separated from the inflorescence, mixed and the sound seeds were selected to run the experiments based on color, size and being uninfected. The weight of 100 seeds was 0.6995±0.0036 gm, 0.0535±0.0083 gm and 0.0473±0.0005 gm for *A. ramosus H. muticus*, and *L. pubescens*, respectively.

Two seperate factorial experiments were conducted to evaluate the most variables affecting seed germination and seedling growth i.e., irrigation intervals and salinity concentrations. The experiments were conducted under growth chamber conditions and green house conditions. Bearing in mind the previous studies which indicated that high percentage of germination for such species was obtained by stratification treatment (El-Khouly, 2006). Therefore, the seeds of the three studied species stratified for one week before germination in both growth chamber and green house.

1. Experiments under Growth Chamber Conditions

The three studied species were germinated and grown in sterilized sandy soil as a seed bed in plastic containers, 20 cm length, 15 cm width, and 5 cm height. In each container, ten seeds were placed at depth 0.5 cm of the soil surface. The containers were placed in growth chamber at incubation temperature 20 ℃, 12 hr light: 12 hr dark, and relative humidity 95%, for one month.

1.1 Effect of irrigation intervals

Five treatments of irrigation intervals were applied as follows: each 6, 8, 10, 12, and 14 days from the begining of the experiment for one month. The containers were arranged in a completely randomized block design with six replicates for each treatment. Each container in each treatment was irrigated by distilled water up to field capacity as the above-mentioned irrigation intervals for one month .

1.2 Effect of salinity

Four treatments of salinity were used as follows: 1000, 2000, 3000 ppm NaCl beside the control (distilled water). Each container was irrigated two times weekly by saline water to the field capacity as the above-mentioned salinity treatments for one month except control that was irrigated by distilled water. The containers were arranged in a completely randomized block design with five replicates for each treatment.

In each treatment, the emergence percentage of seeds was estimated at 5 days intervals for 30 days. At intervals of 15, 20, 25, and 30 days, the percentage of seedling mortality was estimated as: (DS/GS) × 100, where DS= total number of died seedlings & GS= total number of emerged seedlings. At the end of experiment, after one moth, the following estimates were recorded, height of seedling, root length, number of leaves/seedling, fresh and dry weight of the shoots for five individuals of the seedlings for each treatment. The water content (%) of the seedlings was calculated as following formula:

$$\text{Water content} = [(\text{fresh weight-dry weight})/\text{fresh weight}] \times 100$$

The rate of germination of each species was estimated by using a modified Timson´s index of germination velocity as the sum of germination values measured at 5 days intervals for 30 day divided by the total germination period (Khan and Unger, 1997).

2. Experiments under Green House Conditions

The stratified seeds of the three studied species were planted directly into soil. A mixture of 2 mm- sieved sandy soil, vermiculite and peat moss (1: 1: 1) was used as seed bed for germinating the seeds of the studied. Five seeds were placed in each pot, which were transferred out door directly after seeding. Each pot was watered two times weekly by tap water at early morning until the seedlings emerged and been transplanted. After one week, the small similar seedlings of the three studied species were selected and transplanted into a pots have a diameter 15 cm and a height of 20 cm. Each pot had five seedlings. Each pot was filled with sandy soil had EC (1000 µmohs/cm), pH (7.1), organic carbon (1.83 %), Ca (7.0 m eq/L), Mg (4.0 m eq/L), Cl (7.0 m eq/L), So_4 (1.0 m eq/L), and $CaCo_3$ (7.5 %). Pots were placed in a completely random design with ten replicates for each treatment in a green house with mean air temperature of 27 ℃ and relative humidity 60%.

2.1 Effect of irrigation intervals

Five treatments of irrigation intervals were applied as follows: each 6, 8, 10, 12, and 14 days from the begining of the experiment for two month. Tap water was used in the irrigation up to field capacity in each treatment.

2.2 Effect of salinity

Four treatments of salinity were applied as follows: 1000, 2000, and 3000 ppm NaCl and control. Each pot was irrigated two times weekly by saline water up to the field capacity as the above-mentioned salinity treatments for two months except control that was irrigated by tap water.

In each treatment, the following variables were estimated and recorded monthly (at the start of the experiment, 1, 2 months for each treatment), height, root length, number of leaves/plant, fresh and dry weight of the seedling shoots for five seedlings and water content (%) of the seedlings were determined. At intervals of 20, 30, 40, 50, and 60 days, the percentage of seedling mortality was estimated as: (DS/ST) × 100, where DS= total number of died seedlings & TS= total number of transplanted seedlings.

Data Analysis

The obtained data were statistically analyzed according to Snedecor and Cochran, (1973). Also, the least significant differences (LSD) were used to compare the significance of differences between means of the obtained data (Steel and Torrie, 1980).

Results

1. Experiments under Growth Chamber Conditions

1.1 Effect of irrigation intervals

Final percentage of seed germination of *L. pubescens* exceeded 75% at all irrigation intervals were recorded, while the final percentage germination of *A. ramosus* exceeded 40% only at irrigation each 6, 8, 10 days (Fig.1). However it was

(93.3±6.7 and 60±5.8), for *L. pubescens* and *A. ramosus* respectively at 8 days irrigation intervals respectively. The maximum percentage of germination for *H. muticus* was 60±2.9 and obtained at irrigation interval 14 days. Also, the minimum percentages of germination for *A. ramosus* and *H. muticus* (25.0±2.9 and 15±8.7, respectively) were attained at irrigation interval 12 days, while it was 76.7±8.8 for *L. pubescens* at interval 6 days. The most seeds of *H. muticus* took the longest time for germinate after irrigation (more than 15 days after the beginning of the initial irrigation).

The highest rate of germination obtained at 8 days irrigation intervals for *A. ramosus* and *L .pubescens* (7.4±1.0 % and 15.2±1.4%), respectively, while it was(7.0±0.4%) for *H. muticus* at 14 days irrigation intervals (Table.2). On the other hand, the lowest rate of germination obtained at 14 days irrigation intervals for both *A. ramosus* and *L .pubescens*, while at 12 days irrigation intervals the *H. muticus* showed a slower rate of germination.

Data indicated that, generally, the percentage of germination in *L .pubescens* was significantly higher than that in *A. ramosus* and *H. muticus* regardless the treatments. Also, the irrigation interval of 8 days was significantly higher than the other intervas treatments regardless the species (Table.2). The above mentioned results were supported by the interaction effect between species and treatments, where the highest percentage was attained for *L. pubescens* at irrigation interval of 8 days. Generally, the germination percentage can be arranged for *L. pubescens* according irrigation intervals as follows: the germination percentages at 8 > 12 > 10 > 6 > 14 days, however it was 8 > 6 > 10 > 12 > 14 days for *A. ramosus*, while it was 14 > 10 > 8 > 6 > 12 days for *H. muticus*. Data also, showed a significant differences between the species under study in the other seedling variables i.e.,(height, root length, number of leaves/seedling, fresh weight, dry weight and water content of the shoots), where *A. ramosus* had the highest values in these variables except for the highest value of root length recorded in *L. pubescens*. On the other hand, there were significant deference's in a number of leaves/seedling, fresh weight, dry weight and water content of the shoots between the treatments, where the highest values of a number of leaves/seedling, fresh weight were obtained at irrigation each 6 days. Also, the height of seedlings was significantly lower at irrigation interval of 14 days than the other treatments, while the highest value of water content was obtained at this treatment. However, the values of root length and dry weight were significantly higher at irrigation each 10 days than the other treatments. This reflects a significant increase in the of such parameters due to the interaction between plant species and irrigation treatments, where *A. ramosus* had the highest value of height (at 8 days irrigation interval), while the highest values of root length and dry weigth were obtained at 10 days irrigation intervals, however *H. muticus* gained the highest value of fresh weight at 6 days irrigation interval. Also, *L. pubescens* had the highest value of number of leaves/seedling at 8 days irrigation interval.

Figure 2 shows that the mortality percentage of seedlings for all the three studied species increases after 25 days from the begining of the experiment especially at the irrigation interval each 12 and 14 days, while there were no seedling died before this time at most of irrigation intervals for most of species. The highest percentage of mortality for *L .pubescens* and *A. ramosus* was 77.5±2.5% and 11.7±6.7 at irrigation each 12 days respectively, while was 36.6±7.7% for *H. muticus* at irrigation interval 14 days.

The date indicated that there were significant differences in the mortality percentage of seedlings among the studied species regardless to the irrigation intervals, where *L .pubescens* had the highest percentages followed by *A. ramosus* and *H. muticus* (Table.2). Also, there were significant differences in mortality of seedlings between the irrigation intervals, where the irrigation interval of 12 days caused the highest percentage of seedling mortality. On the counterary, irrigation of 6 days interval gave the lowest percentage of mortality.The interaction between species and irrigation intervals showed a highly significant difference in the percentages of mortality, where the highest mortality percentage was attained for *L .pubescens* at irrigation each 12 days.

1.2 Effect of salinity

Figure (3) showed that the final germination percentage after one month exceeded 50% for *L .pubescens* and *A. ramosus* at 1000 ppm NaCl concentration. For *H. muticus,* the percentage of germination was not exceeds 6.7±3.3% at all used NaCl concentrations, where no seeds were germinated at concentration 3000 ppm. Generally, the germination percentage according to salinity for both *L. pubescens* and *A. ramosus* could be arranged in following order: at 1000 ppm > control > 2000 ppm > 3000 ppm, while it was control > 1000 ppm> 2000 ppm > 3000 ppm for *H. muticus*. The majority of seeds of *H. muticus* took the longest time to germinate after irrigation (more than 10 days after the beginning of the initial irrigation).

The highest rate of germination was obtained at 1000 ppm NaCl (9.3±2.1%) for *L .pubescens,* while were 7.2±2.0% and 2.8±1.6% for *A. ramosus* and *H. muticus,* respectively attained at control (Table.2). The lowest rate of germination obtained at 3000 ppm in all studied species.

Analysis of data indicated that the percentage of germination in *H. muticus* was significantly lower than that in *A. ramosus* and *L .pubescens* regardless the treatment type. Also, the control and concentration of 1000 ppm were significantly higher than 2000 and 3000 ppm regardless the species used (Table.3). These results were supported by the interaction effect between species used and treatments, where the highest percentage was attained for *L. pubescens* at 1000 ppm. Data in table (3) showed that, the root length, fresh and dry weight of *H. muticus* were significantly higher than that in the other species regardless of salinity treatments; however, the height of *A. ramosus* was significantly higher than the hights of other species, while *L .pubescens* was significantly higher than the other species in leaves number. On the other hand, there were significance differences between the treatments in root length, fresh and dry weight, and number of leaves regardless species, where 1000 ppm concentration was the best, also the data indicated that the values of seedling height and water content recorded in the control and in1000 ppm salinity treatments were significantly higher than those obtained under 2000 and 3000 ppm salinity treatments. The interaction between plant species and irrigation water salinity treatments indicated that, such parameters, significantly affected by plant species at any of the used salinity levels. For example, *A. ramosus* at 1000 ppm salinity level had the highest values of plant height, root length, fresh and dry weight, while *L .pubescens* at 1000 ppm had the highest value of number of leaves.

Figure (4) shows that in all studied species, all the seedlings were survived at 1000 ppm concentration of NaCl after 30 days, while 100% of seedlings were died at 3000 ppm concentration at the same time. The percentage of mortality could be arranged descendingly for *A. ramosus* due to NaCl concentration as follows: 3000 ppm> 2000 ppm> control > 1000 ppm, however for *L .pubescens* it was 3000 ppm> control>2000 ppm> 1000 ppm, while for *H. muticus* was 2000 ppm> control>1000 ppm. Analysis of data indicated that there were significant differences in the percentage of mortality among the studied species regardless of the treatments type, where *L .pubescens* had the highest percentages followed by *A. ramosus* and *H. muticus* (Table.3). Also, there were highly significant differences in seedling mortality between treatments, where the treatment had the highest percentage of seedling mortality was 3000 ppm, while under 1000 ppm salinity level, lowest percentage of seedling mortality was occured. The interaction between species and treatments show a highly significant difference in the percentages of seedling mortality, where the highest values were attained at 3000 ppm for *A. ramosus and L*

.pubescens, while the respective value for *H. muticus was* obtained under 2000 ppm salinity level.

2. Experiments under Green House Conditions

2.1 Effect of irrigation intervals

Table (4) shows that the correlation between all measured parameters i.e., (height, number of leaves/seedling, fresh weight, dry weight and water content of the shoots) except the root length among the species were significantly affected either by irrigation intervals and / or months, where *L.pubescens* had the highest value of height, fresh weight, and dry weight, while *H.muticus* had the highest value of number of leaves/seedling and water content. Also, there were significant differences in all measured parameters between irrigation intervals regardless species and months (the period after plantation), where the best irrigation intervals in this respect , was irrigating the plants each 6 and 8 days intervals, while the irrigation each 12 days interval had the lowest values of such parameters except in water content, the lowest value was at 10 days irrigation interval excluding in water content, where one month after plantation was the best time. On the other hand, the highest values of all measured parameters were obtained after two months from plantation. The interaction between species, irrigation intervals and months **(**the period after plantation) show a significant difference in all parameters mentioned, where the highest values of root length, fresh weight, and dry weight of the shoots were attained for *L .pubescens* after 2 months from the plantation, when such plants were irrigated at 6 days interval, the highest values of height and number of leaves/seedling were also obtained at 8 days irrigation interval for *L .pubescen* after two months from plantation. Also, the highest values of fresh weight, dry weight, water content, height and number of leaves/seedling, were obtained after two months from plantation of *A.ramosus* which was irrigated every 6 days intervals, while the highest value of root length attained at 14 days irrigation interval after one month from the plantation. For *H.muticus,* the highest values of all measured seedling parameters were obtained after two months from plantation, where the highest fresh weight, dry weight, and water content were obtained at 6 days irrigation interval, the highest values of plant height were obtained at 8 days irrigation treatment, while the highest values of root length, and number of leaves were recorded for the plants irrigated at 10 & 14 days intervals respectevely.

Figure (5) shows clear increase in mortality percentage of the seedlings in all studied species after 40 days at majority of irrigation intervals. Nevertheless more than 90% of *A. ramosus* seedlings were died after 50 days at all used irrigation intervals except at 6 days interval, while in *L .pubescens* all the seedlings died after 30 days at irrigation intervals each 10, 12, and 14 days. For *H. muticus*, over than 75% of seedlings were died after 50 days at irrigation intervals each 10, 12, and 14 days. The data indicated that, the differences in mortality percentages of seedlings between the three studied species were not significant regardless irrigation intervals and months after plantation, the data indicated that irrigation each 10, 12, and 14 days had the highest percentages of seedlings mortality regardless species and months. Also, the second month after plantation had the highest percentage of seedlings mortality. These results were supported by the effect of interaction between species, irrigation intervals and months after plantation, where the highest percentage of mortality (100%) was obtained at the intervals of 8, 10, 12, and 14 days after two months from plantation for *A. ramosus*, at intervals of 10, 12, 14 days after two months, and at 10 days irrigation interval after one month for *L .pubescens*, and approximately for *H. muticus* irrigation each 12 days after two months (Table.4). Consequently, due to the combined treatments of irrigation interval & months passed after plantation, the best irrigation interval during two months from the beginning of plantation, the mortality percentage can be arranged ascending from the lowest percentage of mortality to 100% for *H. muticus* as follows: each 6 days after one month < 10 days after one month< 8 days after one month < 14 days after one month < 8 days after two months< 12 days after one month< 6 days after two months< 14 days after two months< 10 days after two months< 12 days after two months , however for *A. ramosus* it was each 8 days after one month < 14 days after one month < 12 days after one month < 6 days after one month < 6 days after two months< 10 days after one month< 8 days after two months , while it was each 8 days after one month< 8 days after two months < 6 days after one month < 6 days after two months < 14 days after two months for *L .pubescens* .

2.2 Effect of salinity

Table (5) shows that all the seedling parameters vary significantly in relation to species, NaCl concentrations and the period passed after plantation (months). Hyoscyamus muticus had the highest values of root length, number of leaves, and fresh weight, and water content, while L .pubescens had the highest values of height and dry weight regardless of irrigation water salinity and the period passed after plantation. The control treatment had the highest significant values of height, root length, number of leaves, and fresh weight, and water content while under salinity level of 1000 ppm a significant increases in the dry weight was obtained, whereas the 3000 ppm salinity level gave the lowest values of all measured parameters.

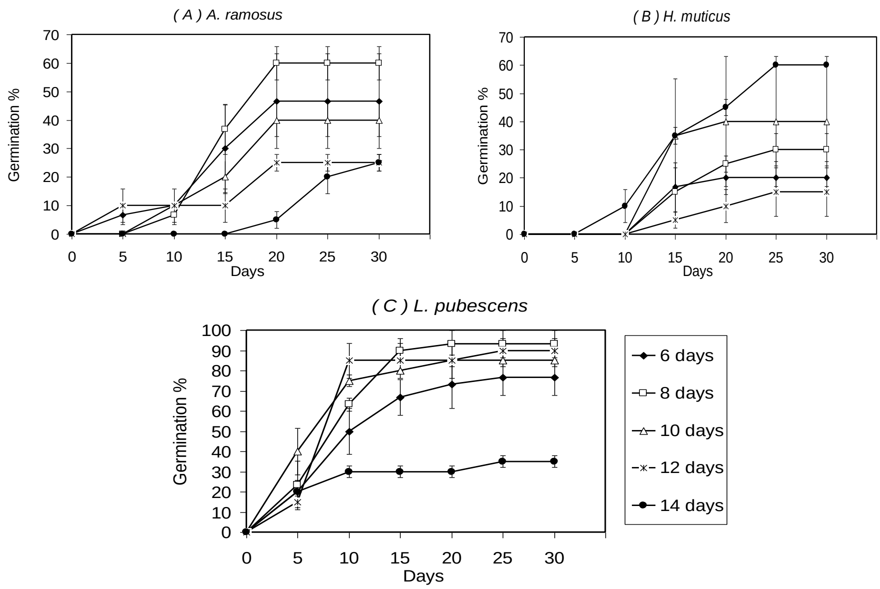

Fig. 1: Effect of different irrigation intervals on cumulative germination percentage (mean ± SE) of the studied species under growth chamber conditions.

Table1. Effect of different irrigation intervals on seed germination and growth characteristics of the studied species under growth chamber conditions after one month (G= Germination).

Species	Treatments	G %	Height (cm)	Root Length (cm)	No. of Leaves	Fresh Weight (gm)	Dry Weight (gm)	Water Content %	Mortality %
A.ramosus	6 days	46.7	6.1	2.7	1.2	0.15	0.03	79.3	8.3
	8 days	60.0	7.2	3.3	1.5	0.18	0.04	80.6	4.9
	10 days	40.0	6.8	4.3	1.1	0.22	0.01	54.5	10.0
	12 days	25.0	7.1	2.8	1.3	0.18	0.04	77.1	11.7
	14 days	25.0	4.3	3.5	1.0	0.16	0.02	87.5	0.0
H.muticus	6 days	20.0	1.6	4.0	3.8	0.25	0.05	80.0	0.0
	8 days	30.0	1.1	3.5	2.5	0.07	0.03	57.1	12.5
	10 days	40.0	1.2	3.8	2.4	0.06	0.02	69.2	12.5
	12 days	15.0	1.1	3.1	2.0	0.05	0.02	60.0	23.3
	14 days	60.0	1.3	2.9	2.8	0.08	0.02	75.0	36.6
L.pubescens	6 days	76.7	2.2	1.8	3.7	0.09	0.03	72.2	0.0
	8 days	93.3	1.7	2.1	4.3	0.16	0.05	67.7	0.0
	10 days	85.0	2.1	3.4	4.0	0.10	0.05	50.0	46.6
	12 days	90.0	1.8	2.5	3.4	0.15	0.05	66.7	77.5
	14 days	35.0	1.5	1.4	2.5	0.10	0.03	75.0	75.0
LSD at p< 0.05 for :									
Species		11.9	0.3	0.4	0.3	5.24E-18	13.5E-19	2.9E-15	8.5
Treatment		15.4	0.3	0.5	0.3	6.76E-18	17.5E-19	3.7E-15	11.0
Species x Treatment		26.6	0.6	0.9	0.6	11.7E-18	6.05E-19	6.4E-15	19.0

Table 2. Index of rate of germination (mean ± SE) under growth chamber conditions.

Treatments		*A.ramosus*	*H.muticus*	*L.pubescens*
Irrigation intervals	**6 days**	6.2±2.0	2.6±0.9	12.1±1.9
	8 days	7.4±1.0	3.3±0.8	15.2±1.4
	10 days	5.0±0.8	5.2±3.0	15.0±0.8
	12 days	3.5±0.9	1.5±0.9	15.0±1.4
	14 days	1.7±0.4	7.0±0.4	6.0±1.0
Salinity concentrations	**Control**	7.2±2.0	2.8±1.6	8.3±2.0
	1000 ppm	6.6±1.3	0.9±0.4	9.3±2.1
	2000 ppm	2.4±0.7	0.4±0.4	4.9±1.3
	3000 ppm	1.3±1.3	0.0	4.0±1.6

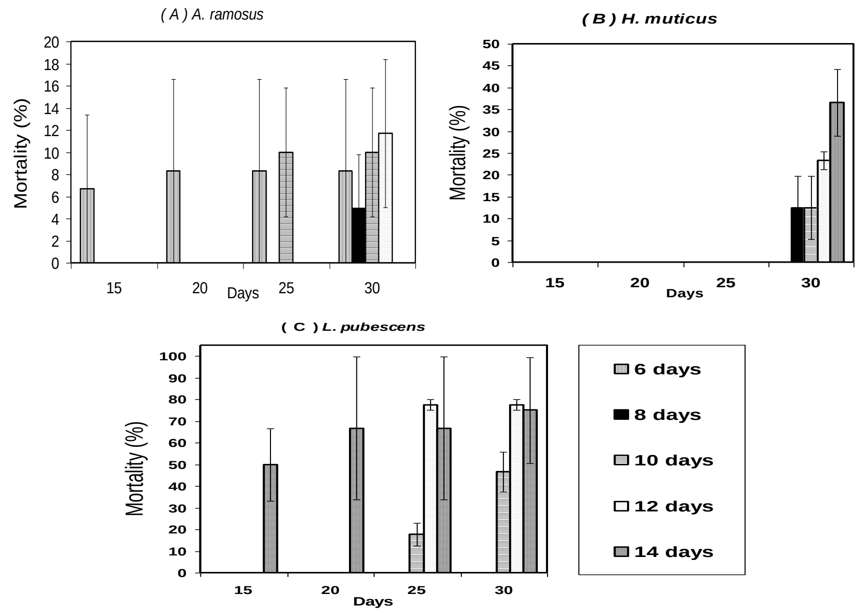

Fig 2 : Changes over 30 days in mortality (mean ± SE) of the studied species at different irrigation intervals under growth chamber conditions.

Also, after two monthes from plantation, highest values of such parameters were recorded regardless of plant species and salinity levels. Such results were supported by the interaction effect between plant species, salinity levels, L .pubescens had the highest values of height, number of leaves, fresh and dry weight at the control treatment after two months from plantation, also H. muticus had the highest values of root length at 2000 ppm salinity levels after two months, whereas A. ramosus had the lowest values of all parameters mentioned at 1000 ppm salinity levels after one month from plantation.

Regarding to the effect of NaCl concentrations on the mortality percentage of the seedlings of the studied species, 100% of seedlings of L .pubescens and A. ramosus were died after 30 and 40 days, respectively at concentration of 2000 and 3000 ppm, while this percentage approximately (99.5±0.5) was attained only after 60 days for H. muticus at 1000 ppm (Fig.6). The data indicated that there were significant differences in the percentage of mortality among the studied species regardless of salinity concentration and months of plantation, where L .pubescens had the highest percentages followed by A. ramosus and H. muticus (Table.5). Also, there were significant differences in seedlings mortality between treatments, where the salinity level of 3000 ppm had the highest percentage of such property, while in control treatment, lowest percentage of seedlings mortality were obtained. Regarding, the effect of months on seedlings mortality, regardless of species and treatments, the second month had the highest percentage of seedlings mortality. Generally, at the second month after plantation, highest percentage of seedlings mortality were recorded for all plant species. Also, the highest percentage of seedlings mortality was attained after two months from plantation for A. ramosus at salinity levels of 1000 ppm, while the lowest percentage was attained after one month.for H. muticus at 2000 ppm salinity level.

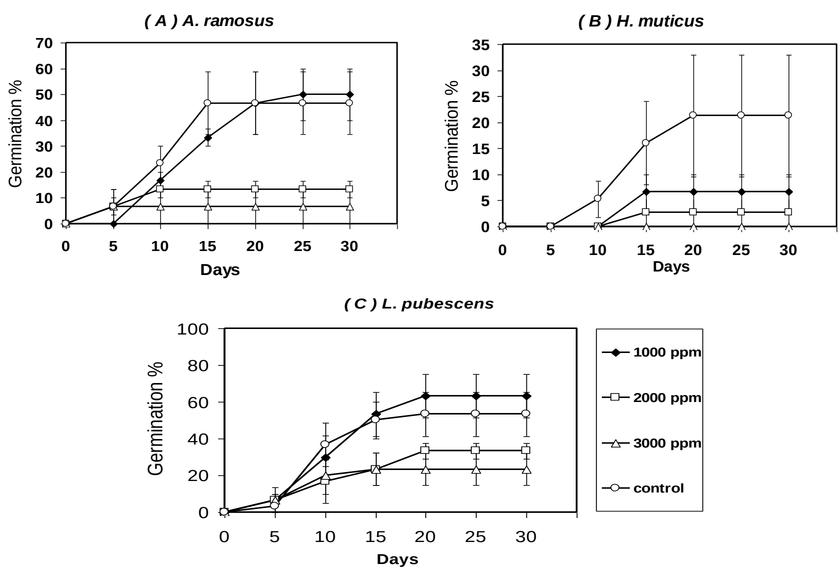

Fig 3 : Effect of different salinity concentrations on cumulative germination percentage (mean ± SE) of the studied species under growth chamber conditions.

Discussion

Deserts are regions of low and irregular rainfall in which potential evapotranspiration exceed precipitation. In certain areas the water table is high and high rate of evaporation causes an accumulation of salts on the surface of the soil. These harsh conditions have led to differential life history strategies in desert plants in order to maximize their fitness (Kigel, 1995). Desert species may differ in their life cycle (annual vs. perennial), life form (shrubs vs. herbaceous), response to drought (tolerance vs. avoidance), time of flowering, reproductive efforts, seed dispersal, and germination behavior (Khan & Ungar, 1996).

Lavandula pubescens had the highest percentage of germination and rate of germination followed by *A. ramosus* and *H. muticus* regardless the treatments. This results indicated that the seeds of *L. pubescens* were germinated faster than the other studied species if they received the first amount and/or small amount of water versus the seeds of *H. muticus*, which took a long time to germinate after irrigation (more than 15 days after beginning of the initial irrigation) , that is in agreement with El-Khouly (2006), this may be due to that water stress can promote the embryo of *L . pubescens* seeds to germinate. Rogers et al. (1995) suggested that fast germination ensure rapid seedling establishment, which can minimize competition that explain the high percentage of survived seedlings of *L . pubescens* (5.56%) in Wadi El-Arousia (middle of Sinai) (El-Khouly, 2006). The longer time of seed germination of *H. muticus* may be due to water absorbed by appendages of seeds persist longer and water was supplied to the seeds even after the sand had dried. The longer imbibitions time of *H. muticus* seeds may therefore be compensated by retention of water by seed appendages (Tobe, et al, 2005). These explanations supported by the results recorded of the best irrigation intervals had the highest percentage of germination for *L . pubescens* and *A. ramosus*, these were at the irrigation interval of 8 days for both, while was at irrigation interval of 14 days for *H. muticus*.

Water stress affects particularly every aspect of plant growth, modifying the anatomy, morphology, physiology, and biochemistry of the plant. Some influnces are related to decrease in turgor, and some to the decrease in water potential(Kramer, 1983). Drought stress is a major source of seedling mortality (Stanton, 1984). The frequencies of irrigation required to cause seedling emergence differed among different species (Tobe et al., 2005). The plant growth decreases with decreasing soil water, but exceptions occur, as will be noted later. It might be useful, if environmental conditions could be characterized in terms of number of days when plant water stress is severe enough to limit growth (Kramer, 1983). The seedlings of the three studied species can be survived up to 25 days without any negative effects at most of irrigation intervals under growth chamber conditions, while under green house conditions, the percentage of seedling mortality increased significantly after 40 days after the plantation. However, *H. muticus* significantly had the lowest percentage of seedlings mortality followed by *A. ramosus* and *L .pubescens* regardless the irrigation intervals whether under growth chamber conditions or green house conditions. This may be due to that, *H. muticus* had the second highest value of water content and root length under growth chamber conditions, while significantly had the highest value of water content, and number of leaves, under green house conditions. These indications were supported by the significantly increases of the height, root length, and number of leaves in the second month after plantation especially when the irrigation intervals increase than 8 days. The plant water content is one of the major measurements to evaluate the plant water stress (Kramer, 1983). The characteristics of *H. muticus* seedling e.g. water content, and number of leaves increase the capability of the plant to use the soil moisture and to make the nutrition through the photosynthesis loss, that is in agreement with similar results obtained by (Kramer, 1983; Azab & Hegazy, 1995). Kramer (1983) suggested that, numbers of distinct traits are possibility involved in the ability of seedlings to withstand summer (e.g., stomatal control, dehydration tolerance, leaf-pubescence level, root system development); also, he stated that, the deep-rooted species often survive droughts than shallow – rooted species. These results explain the survival of *H. muticus* seedlings in the habitat of railway sides of Gefgafa (middle of Sinai) comparing with Siwa road (El-Khouly, 2006), and the distribution of this plant as patches occupying depressions in sandy areas which receive runoff water, sand sheets slightly undulating, inland sand dune, dry salt affected land in most of phytogeographical regions of Egypt (Zahran & Willis, 1992; Batannouny et al, 1999). The seedlings of *A. ramosus* lost their capibability to survival gradually after one month whether under growth chamber conditions or green house conditions, where the plant significantly had the highest value of root length at this period, that was in agreement with the behavior of this plant as ephemroid plant whose gives the vegetative growth above the soil surface in the wet season of Egypt (November-May), and dry or disappears in the other months of the year, on the other hand, explain the domination of this plant in the habitat of the Mediterranean coast of Egypt (Batanouny, 1973; Ayyad & Hilmy, 1974), which receives the highest values of precipitation. The best irrigation interval for *A. ramosus* and *L .pubescens* had the highest values of most of seedling characteristics and the lowest value of mortality under both growth chamber conditions and green house conditions was 8 days and 6 days intervals respectively, while for *H. muticus* was interval 10 days and 8 days, respectively. The plant height, number of leaves, root length, and phytomass decreases as a result of water stress, drought stress and water potential (Hegazy, 1990; Abdel-Kader & Saleh, 2000; Bargali & Tewari, 2004). If root elongation is stopped by soil water stress, roots tend to become suberized to their tips. This sometimes regarded as a protective adaptation, especially in desert plants, because it decreases water loss from roots to drying soil, but it also reduces their capacity to absorb water when the soil is rewetted (Kramer & Boyer, 1995). From all the results discussed above, it could be consider that H. muticus as less stress-tolerant species to drought.

Tobe et al. (2001) found that NaCl seems to have toxic effect on the seeds, but by differing degrees among different species. The highest negative effect of NaCl was detected on the seed germination and rate of germination of *H. muticus*, while the lowest effect was obtained in the seeds of *L . pubescens*. Salts and other solutes in the medium cause osmotic inhibitory effects on the seed's water uptake and retard and/or suppress germination. However, the osmotic effects of solutes in the medium on seeds are mitigated when solutes permeate the seed coat and enter the seeds (Sharma, 1973; Romo & Eddleman, 1985; Tobe et al, 2000). However, salts entering the seeds can cause toxic effects and reduce germinability (Redman, 1974; Ball & Chattopadhyay, 1985; Hardegree & Emmerich, 1990; Tobe et al., 1999). For *L . pubescens*, lower permeation of NaCl through the seed coat would have protected the seeds from salt toxicity pretreatment with NaCl (Tobe *et al*., 1999). In general, the inhibition effect of NaCl on germination detected clearly on the three studied species after concentration of 1000 ppm. These results explain the abundance of *L . pubescens* in the habitats had low salinity value (El-Khouly, 2006).

The studied species differed in seedling characteristics responses to different concentrations of NaCl. Most of these characteristics for all studied species did not decline at 1000 ppm NaCl concentration under growth chamber conditions, while under green house conditions, the mortality percentage of *L . pubescens* and *A. ramosus* seedlings reaches to 100% after 30 and 40 days respectively after the plantation at 2000 ppm and 3000 ppm NaCl, however, this percentage obtained after 60 days after the plantation for *H. muticus* only at 1000 ppm NaCl. Tobe *et.al*.(2000) found that the adverse effects of NaCl were more conspicuous in the older seedling stage due to the increase of Na concentration of the shoots of transpiring plants than in the non-transpiring small seedlings grown at the same external NaCl because transpiration stream causes continuous salt transport to plant tissues. Maintaining a low internal accumulation of salt is an important strategy for plants to survive in saline environments (Clemens *et al.* 1983; Luard & El-Lakany, 1984). Most of seedling characteristics of *A. ramosus* and *H. muticus* were inhibited at 3000 ppm NaCl whether under growth chamber conditions or under green house conditions. At high salinities, growth inhibition might either be caused by reduction the ability to be adjustable osmatically as a result of saturation of the solute uptake system, or because of excessive demand on the energy requirement of such systems (Munns *et al*., 1983; Gale & Zeroni, 1984). Eaton (1942) found that each increase in salt concentration in soil produces a decrease in plant growth. Khan *et al*. (2000) found that, the plant water content is parallel with fresh weight, increasing significantly in low salinity and then declining with increased salinity. Hossain *et al*. (2004) found that, the increase in NaCl concentrations in the cultivars of Chrysanthemum morifolium from 50 to 100 mM progressively decreased root length. The results indicated that *H. muticus* significantly had the lowest percentage of mortality followed by *A. ramosus* and *L .pubescens* regardless NaCl concentrations whether was under growth conditions or green house conditions , this may be due to that, *H. muticus* had the highest value of root length, fresh and dry weight under growth chamber conditions, also, it had the highest value of root length, water content and number of leaves under green house conditions. These results supported by ability of *H. muticus* to continue in their growth at 3000 ppm under green house conditions (mean air temperature 27°C and relative humidity 60%), in addition to the highest values of most seedling characteristics of this plant attained at 2000 ppm NaCl. These results explain the occurrence of *H. muticus* in the salt affected lands such as in the Egyptian oases (El-Khouly & Zahran, 2002), and the dominance of *A. ramosus* in non saline depressions habitat of El-Omyed (Northwest coast of Egypt), which characterized by low soil salinity 0.4 ds/m (El-Khouly, 2006). From all the results discussed above, it could be conculuded that *H. muticus* as less stress-tolerant species to salinity.

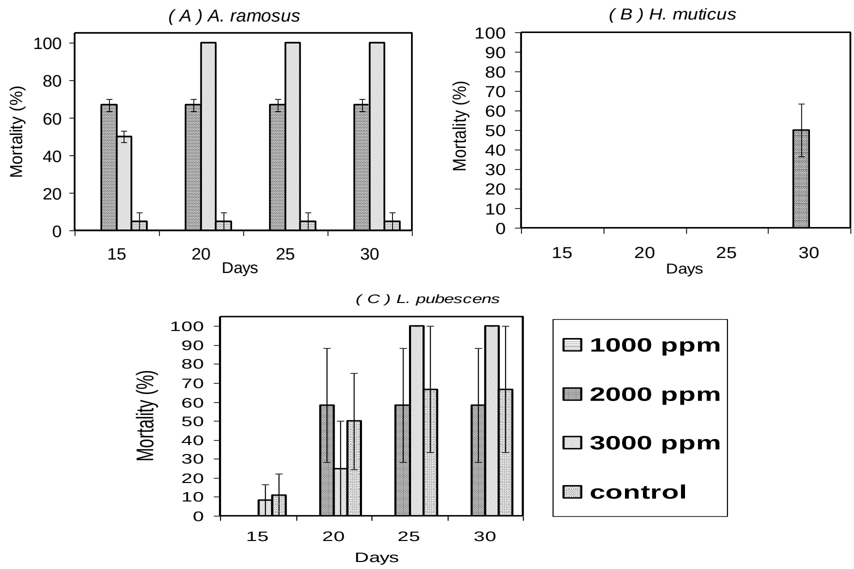

Fig.4 : Changes over 30 days in mortality (mean ± SE) of the studied species at different salinity concentrations under growth chamber conditions.

Conclusion and Recommendations

In conclusion, *Hyoscyamus muticus* consider as less stress-tolerant species to drought and salinity that explain its distribution in majorities of Egyptian ecosystems. *Asphodelus ramosus* had high resistance to drought for 40 days that explain its distribution in habitats distinguishes by high amount of precipitation in the Mediterranean coast of Egypt. *Lavandula pubescens* had the lowest resistance to drought and salinity comparing with the other studied species, that explain the rarity of this plant in the Egyptian deserts and its restricted distribution in the habitats of gravels in the wadi beds, which had high soil moisture content and low salinity. The best irrigation interval for establishment *H. muticus* transplants is irrigation each 10 days continuously for period more than two months in winter, while for establishment *A. ramosus* transplants, the best irrigation interval was 8 days continuously for period 3 months at least in winter.

Salinity adaptability in the older seedling stage of the studied species studied is correlated their geographical distribution with respect to salinity. The three studied species showed a wide variety of adaptation to NaCl in the germination stage and seedling survival. If a habitat of these species salinized, the salt tolerant species (*H. muticus*) will be survive. It seems that some species distributed naturally in nonsaline locations are potentially salt-tolerant and can be candidates to be utilized for the rehabilitation of vegetation in salinized locations. *Hyoscyamus muticus would* be better candidates for dispersal on saline land. Although the seeds of *H. muticus* can not germinate in the high salinity (3000 ppm NaCl), the old seedlings of this plant can be survive and elongate in that concentration, so for establishment this plant in the saline lands, it is prefer to leashing the salts from the soil surface before seed dispersal or using the transplants in the cultivation process. The soil had 2000 ppm NaCl is very favorable to establish the transplants of *H. muticus* especially at low temperature in winter. The transplants of *A. ramosus* can be establishment in soil had salinity not exceeds than 1000 ppm NaCl.

Table 3. Effect of different NaCl concentrations on seed germination and growth characteristics of the studied species under growth chamber conditions after one month (G= Germination).

Species	Treatment	G %	Height (cm)	Root Length (cm)	No. of Leaves	Fresh Weight (gm)	Dry Weight (gm)	Water Content %	Mortality %
A.ramosus	**Control**	46.7	5.1	2.1	1.0	0.05	0.02	55.6	4.8
	1000 ppm	50.0	6.8	3.1	1.6	0.24	0.06	77.1	0.0
	2000 ppm	13.3	1.5	0.4	1.0	0.02	0.01	33.3	66.7
	3000 ppm	6.7	0.3	0.3	1.0	0.02	0.01	33.3	99.5
H.muticus	**Control**	21.3	3.3	3.0	1.7	0.23	0.05	77.8	0.0
	1000 ppm	6.7	1.6	2.8	3.0	0.20	0.05	75.0	0.0
	2000 ppm	2.7	0.7	1.6	1.3	0.04	0.02	47.2	50.0
	3000 ppm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L.pubescens	**Control**	53.3	1.5	1.7	3.2	0.05	0.02	66.5	66.7
	1000 ppm	63.3	1.5	1.8	3.4	0.10	0.03	68.4	0.0
	2000 ppm	33.3	2.2	1.4	2.3	0.08	0.02	75.0	58.3
	3000 ppm	23.3	1.3	0.8	2.0	0.05	0.02	70.0	99.5
LSD at p< 0.05 for :									
Species		16.3	1.3	0.5	0.5	26.3E-03	5.29E-03	6.0	31.4
Treatments		18.8	1.5	0.5	0.5	30.42E-03	6.1E-03	7.0	36.2
Species x Treatment		32.5	2.6	0.9	0.9	0.05	10.6E-03	12.1	62.7

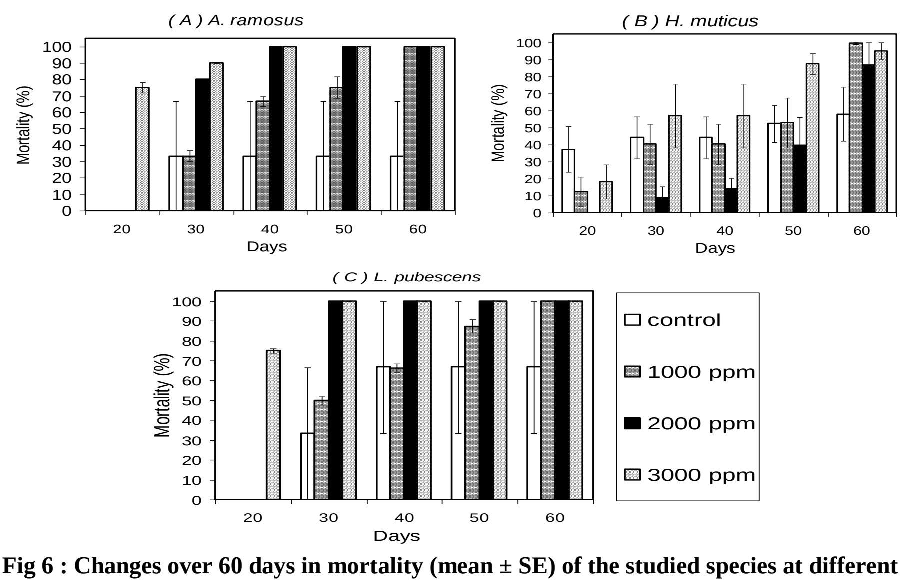

Fig 6 : Changes over 60 days in mortality (mean ± SE) of the studied species at different salinity concentrations under green house conditions.

Table 4. Effect of different irrigation intervals on growth characteristics of the studied species under green house conditions after two months, (S= The period after plantation).

Species	Treatment	Months	Height (cm)	Root Length (cm)	No. of Leaves	Fresh Weight (gm)	Dry Weight (gm)	Water Content %	Mortality %
A.ramosus	S	0	1.9	1.3	1.0	0.12	0.02	88.0	0.0
	6 days	1	6.6	2.9	1.0	0.30	0.04	86.7	33.3
		2	7.5	3.4	3.0	0.26	0.02	92.3	33.3
	8 days	1	5.6	1.9	2.0	0.24	0.02	93.6	0.0
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	10 days	1	3.52	3.0	1.0	0.16	0.02	90.3	90
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	12 days	1	6.1	3.3	2.0	0.28	0.02	92.9	0.0
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	14 days	1	7.1	3.9	2.0	0.30	0.02	93.3	0.0
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
H.muticus	S	0	1.3	1.0	2.5	0.10	0.01	95.0	0.0
	6 days	1	2.6	3.2	8.5	0.39	0.03	95.0	19.7
		2	5.9	3.3	10.0	1.74	0.16	91.1	73.5
	8 days	1	2.4	3.2	7.0	0.59	0.03	94.9	40.6
		2	6.1	3.2	10.0	1.90	0.10	92.2	75.0
	10 days	1	2.3	2.1	6.0	0.51	0.04	91.5	23.2
		2	5.9	3.3	9.0	1.07	0.06	94.8	80.8
	12 days	1	2.3	1.7	4.0	0.19	0.01	94.6	55.0
		2	4.0	3.0	10.0	1.12	0.03	97.8	99.5
	14 days	1	1.9	1.5	5.0	0.26	0.03	90.4	52.8
		2	4.6	2.5	12.0	1.48	0.04	97.6	83.3
L.pubescens	S	0	2.0	1.0	2.0	0.42	0.07	84.5	0.0
	6 days	1	3.9	2.5	11.0	1.25	0.19	84.9	33.3
		2	8.5	5.4	16.0	3.03	0.50	83.5	66.7
	8 days	1	4.5	3.3	12.0	1.33	0.22	83.8	0.0
		2	10.0	4.5	17.0	1.94	0.26	86.8	20.0
	10 days	1	0.0	0.0	0.0	0.0	0.0	0.0	100
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	12 days	1	0.0	0.0	0.0	0.0	0.0	0.0	100
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	14 days	1	0.0	0.0	0.0	0.0	0.0	0.0	100
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
LSD at p< 0.05 for :									
Species			0.7	0.4	0.9	0.12	18.5E-03	0.4	11.1
Treatment			0.8	0.5	1.1	0.16	22.3E-03	0.5	14.3
Months			0.7	0.4	0.9	0.12	18.5E-03	0.4	11.1
Species x Treatment x Months			2.5	1.4	3.4	0.48	0.07	1.4	42.9

Table 5. Effect of different NaCl concentrations on growth characteristics of the studied species under green house conditions after two months, (S= The period after plantation).

Species	Treatment	Months	Height (cm)	Root Length (cm)	No. of Leaves	Fresh Weight (gm)	Dry Weight (gm)	Water Content %	Mortality %
A.ramosus	S	0	1.9	1.3	1.0	0.125	0.02	84.0	0.0
	Control	1	6.6	2.9	1.0	0.30	0.04	86.7	33.3
		2	7.5	3.4	3.0	0.26	0.02	92.3	33.3
	1000 ppm	1	4.6	5.0	2.0	0.28	0.05	83.6	33.3
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	2000 ppm	1	2.4	1.9	1	0.15	0.03	83.3	80.0
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	3000 ppm	1	2.3	2.0	1.0	0.15	0.02	86.7	90.0
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
H.muticus	S	0	1.3	1.0	2.5	0.10	0.05	95.0	0.0
	Control	1	3.8	2.3	6.0	0.16	0.02	88.5	44.2
		2	3.5	5.1	13.0	1.33	0.03	96.4	75.0
	1000 ppm	1	1.6	1.4	7.0	0.43	0.02	95.3	40.3
		2	2.2	2.0	10.0	0.49	0.04	92.9	99.5
	2000 ppm	1	1.7	1.5	7.0	0.28	0.01	96.4	9.0
		2	2.6	5.6	10.5	1.87	0.06	97.2	86.7
	3000 ppm	1	1.8	2.4	6.0	0.41	0.02	96.3	57.0
		2	2.2	2.7	8.0	0.43	0.02	95.3	95.0
L.pubescens	S	0	2.0	1.0	2.0	0.42	0.07	84.5	0.0
	Control	1	3.9	2.5	11.0	1.26	0.19	84.9	33.3
		2	8.5	5.4	16.0	3.03	0.10	83.5	66.7
	1000 ppm	1	3.0	2.0	4.0	0.48	0.10	80.0	50.0
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	2000 ppm	1	0.0	0.0	0.0	0.0	0.0	0.0	100
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
	3000 ppm	1	0.0	0.0	0.0	0.0	0.0	0.0	100
		2	0.0	0.0	0.0	0.0	0.0	0.0	100
LSD at p< 0.05 for :									
Species			0.1	0.1	0.2	0.03	18.6E-04	0.2	11.2
Treatment			0.1	0.1	0.2	0.03	21.5E-04	0.3	12.9
Months			0.1	0.1	0.2	0.03	18.6E-04	0.2	11.2
Species x Treatment x Months			0.4	0.3	0.7	0.09	6.5E-03	0.8	38.7

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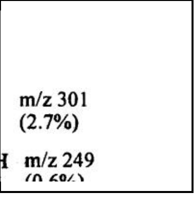

الملخص العربي

تأثير الإجهاد المائى والملوحة على إنبات ونمو بادرات ثلاث أنواع نباتية صحراوية طبية

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مركز بحوث الصحراء – قسم البيئة النباتية والمراعى

تمت دراسة تأثير فترات ري مختلفة وتركيزات مختلفة من كلوريد الصوديوم على إنبات ونمو بادرات نباتات بصل العنصل والسكران والزيتة وذلك تحت ظروف غرفة النمو والصوبة. أوضحت النتائج أن نسبة إنبات الزيتة كانت الأعلى معنوياً مقارنة بالنوعين الآخرين وبغض النظر عن كلاً من فترات الرى أو تركيزات الملوحة. أثبتت النتائج أيضاً أن معاملة فترة الرى كل 8 أيام , وكذلك الكونترول وتركيز 1000جزء فى المليون من كلوريد الصوديوم قد حققت أعلى نسبة إنبات بغض النظر عن أنواع النباتات. تبين أيضاً من الدراسة أن فترات الرى المختلفة , وكذلك التركيزات المختلفة من كلوريد الصوديوم نتج عنها استجابات متباينة فى صفات البادرات للأنواع الثلاثة مثل (ارتفاع البادرة, طول الجذر, عدد الأوراق, الوزن الغض والجاف ومحتوي رطوبة السيقان), وكذلك على نسبة موتها. كما أثبتت الدراسة أن نسبة موت البادرات فى الأنواع الثلاثة قد زادت معنوياً بعد 25 يوم من بداية التجربة فى معظم فترات الرى المستخدمة, وذلك فى ظروف غرفة النمو, بينما إزدادت تلك النسبة بعد 40 يوم من غرس البادرات تحت ظروف الصوبة. كما أوضحت الدراسة عدم موت معظم البادرات تحت تأثير 1000جزء فى المليون من كلوريد الصوديوم, وذلك فى ظروف غرفة النمو, بينما وصلت نسبة موت بادرات الزيتة وبصل العنصل إلى 100% بعد 30, 40 يوم على التوالى فى ظروف الصوبة عند استخدام تركيزي 2000 و 3000 جزء فى المليون كلوريد الصوديوم, إلا أن هذه النسبة لم تتحقق فى بادرات السكران إلا بعد 60 يوم وعند استخدام تركيز 1000 جزء فى المليون فقط. كما أوضحت الدراسة أن نبات السكران يعتبر أقل تأثراً بالإجهاد المائى أو الملحى مقارنة بالنوعين الآخرين. كما تمت مناقشة هذه النتائج فى ضوء انتشار هذه الأنواع فى الصحارى المصرية, وأيضاً فى ضوء إمكانية استخدام هذه الأنواع فى إعادة تأهيل الأراضى المتصحرة فى مصر.