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Research Article

Studies on the Growth and Forage Production of Some Atriplex Species Under Different Levels of Salinity

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ABSTRACT

This investigation was carried out during the two seasons of 1999/2000 and 2000/2001 to study the growth and forage production of some Atriplex species under different levels of salinity. The most important results could be summarized as follows: Both numbers of leaves as well as branches /plant, Leaf Area Index (LAI), average of both fresh and dry weights per plant (g) was significantly differed due to Atriplex species under study. Salinity concentration evidently affected all vegetative characters of Atriplex plant. It was found that increasing salinity levels caused some losses in the growth and forage production in the two seasons. Relevant results clearly indicated that Atriplex species differed among themselves as crude protein of leaves and stems was concerned since A. nummularia surpassed the other species due to this trait. Salinity levels affected the crude protein content (%) especially that of leaves since higher salinity levels caused lower protein (%) in both leaves and stems. Atriplex nummularia proved to be the most suitable specie among all the species involved in the present study. The growth status of this plant was improved as salinity level was increased up to 0.8% and then began to decrease due to higher salinity levels since the least growth and forage production were recorded due to the higher salinity level of 2.9% NaCl.

Introduction

The pressure of human and livestock population, which is increasing at an alarming pace in developing countries, particularly in Egypt, has borough into focus the emergency of maximizing production from every bit of land including those vast lands either unproductive or under productive. In Egypt, there is shortage of fodder especially during summer season. To fill up this gab, fodder production needs to be stepped up growing suitable shrubs. Saltbush plants (*Atriplex* species, Fam.Chenodiaceae) have been reported to produce adequate good forage on salt lands. However, field trials of *Atriplex* on arid salt lands are lacking. Many investigators stated that Atriplex plant has good nutritive value, and also, it can be used as biological reclamation technique for desalinization of saline soils (EL-Deek *et al.*, 1991 and Abusteit *et al.*, 1991). Zeinab and Sallam (1996) mentioned that the measurement of the biochemical constituents are certainly needed to elucidate the characteristics of adaptation resulted under salinity stress .A correlation between the growth of some *Atriplex spp*. and the increase of salinity stress has been reported by several workers .Edwards and Brown (1998) stated that a plant in a drying, saline soil is exposed to increasing levels of both water stress and osmotic stress , because the matrix potential and the osmotic potential decrease simultaneously with decreasing soil moisture .The response of plants to saline environments is one of the most important features when selecting for plant species to cultivate the desert lands , where water resources , in general , are saline according to the effect of salinity levels in irrigation water on chemical composition. Strogonov *et al* (1970) found that using water containing NaCl, CaCl 2 and NaSo4 in equal cationic concentration caused about 50% reduction in chlorophyll content .Such results was mainly due to the decrease in absorption of minerals needed for chlorophyll biosynthesis i.e. iron and magnesuim .On another hand , Sakvan and petroyan (1964) found that the amount of total and protein nitrogen dropped sharply in grab leaves under soda salinization conditions .They attributed this retardation of protein synthesis to disturbance in cation balance , particularly the abundance of sodium cations .It is well known that salinity affects plant growth on two ways :a) Increase in osmotic pressure of soil solution is associated with decreasments in the physiological availability of water to the plant .b)Effect of accumulation of toxic levels of various ions within the plant .Ashby and Beadle (1957) concluded that *Atriplex nummularia* is defined as an acrinohalophyte i.e. possesses specialized epidermal bladders (vesicular salt hairs) through which salts is actively excreted avoiding progressive accumulation .However , Greenway (1968) and EL-Shorbagy (1969) found that high levels of salinity depressed significantly the growth characters .Gale and Meyer (1970) reported that optimum growth of *Atriplex spp.* was obtained when the osmotic potential of the used culture solution was in the range of 3-5 bar NaCl . Mozafar (1970) found that growth of *Atriplex halimus* was strongly stimulated by low levels of salinity. Also, plant growth was much better on saline media containing equal parts of NaCl and KCl rather than on different concentration of Hogland solution. EL-Shorbagy (1975) reported that salinity depressed the growth and decreased fresh and dry weights but being lowest in *A. nummularia*. Uchiyama (1987) mentioned that *Atriplex* plants is characterized as halophyte since it tolerates a relatively high concentrations of salt due to the presence of vesiculated hairs on the surface of the leaves and stems and its ability for excreting the absorbed salt through leaves surface.

In general, it can be said that salinity causes stunting and depression in the growth which may be due to a destruction of chlorophyll leading to the lowering of photosynthesis rate. However, Mahmoud and Malik (1996) pointed out that *Atriplex* can survive high salinity levels. On the other hand, many workers reported that components of this plant were greatly affected by salinity especially proteins (Sahsah, 1992), amino acids (Khafaga, 1995) and nucleic acids (Gibson *et al*., 1984).

Therefore, the aim of this investigation was to study the effect of salinity levels on growth and forage production and the changes of some nitrogenous constituents, especially crude protein, of selected *Atriplex* species which could be widely cultivated in Egypt

Material and Methods

Four *Atriplex* species i.e. *A. nummularia, A. canescense*, *A. halimus* and *A. leucoclada* were grown in pots in a greenhouse on 15th Oct., 1999 on the basis of such pilot study. The salt used in salinization process was brought directly from the slatterns, where the soluble anions (CO_3^{--}, HCO_3^-, SO_4^{--}, CL^-), and cations (Ca^{++}, Mg^{++}, Na^+, K^+) were measured in meq/100g salts, oven – dry basis by standards procedures as described by Jackson (1967). The potted non –saline soils were artificially salinized by dissolving the salt crust (NaCl is the most dominant salt) in an amount of tap water equivalent to soil field capacity to achieve the studied salinity treatments, *i.e.* 0.2%, 0.5%, 0.8%, 1.1%, 1.4%, 1.7%, 2.0%, 2.3%, 2.6%, 2.9% NaCl. Salinity of the original soil, 0.2 and 0.22 in both seasons , respectively, was taken into consideration when preparing the required degree of salinity. Plastic pots of 40cm diameter and 70cm depth were used .Each pot was filled with 26 kg non-saline clay soil taken from the top surface of soil of the experimental farm and screened through a 2mm sieve .The mechanical and chemical properties of the soil were determined .It contained 46.8% clay and 23.9% silt estimated according to the international pipette method with ammonium hydroxide as a dispersing agent. Water holding capacity was 62% according to the method described by Richards (1954) . Calcium carbonate was 3.4% determined using Collins Calcimeter .Total nitrogen was 187 mg 100g-1 soil determined at wave length of 725 nm in the sodium bicarbonate solution as described by Jackson (1967). Total salts were 0.2g 100-1g soil gravimetrically determined in the 1:4soil :water extract as described by Jackson (1967). An amount of ballast (stones) was put at the bottom of each sack , then forty plants of each of previous species translocated to the sack .A plastic trunk about 25-30 cm tall was put . After that, each one of the plastic sacks was filled with one seedling of 8-month age which was transplanted and irrigation once every two or three weeks through the trunk and another through the top surface of the sack where the salinity levels have been dissolved about 8liters of water: Initially tab water was used for irrigation until the seedlings were 8 months old. Factorial experiment in randomized complete block design with four replicates was achieved and the following characters were studied:

Average plant height (cm), average number of leaves /plant, number of branches /plant, leaf area index (LAI), fresh as well as dry weight /plant (g) and crude protein % of both leaves and stems were estimated. (LAI) was determined according to the formula:

$$\text{LAI} = \frac{\text{Unit leaf area per plant (cm)}^2}{\text{Plant ground area (cm}^{)2}}$$

For crude protein determination, Atriplex samples were oven dried at 70 ^{o}C till constant weight and dry weight was recorded. The plant material was ground to afine powder and sub samples of 0.2(g) were wet digested. Thereafter, nitrogen was colorimetrically at aware length of 420 nm by the Nessleers method as described by Jackson (1967). The colorimetric determination was carried out using Ziess spectrophotometer (spekol).

First cut was taken about 20cm above the soil surface of the sack after 147 days from transplanting. Both of the second and third cuts were taken after three months after the first cut, respectively. The fourth, fifth and sixth cuts were taken after 105 days from the third cut.

Statistical analysis:

Data were subjected to the proper statistical analysis of the randomized complete block design and factorial randomized complete block design as described by Gomez and Gomez (1984) was utilized. Treatments means were compared using LSD. Computation were done using computer software.

Results and Discussion

Relevant data revealed that average number of leaves as well as average number of branches /plant were significantly affected by *Atriplex* species since *A. leucoclada* produced highest numbers of both leaves and branches /plant during the different cuts in the two seasons.

Concerning salinity concentration, it was evident that highest average number of both leaves and branches /plant realized due to lower salinity concentrations of 0.2% and 0.5% NaCl in both seasons (Tables 6 and 7). These results are

Table 1: Chemical composition (meq/100g) of the salt crust used in salinization process.

Anionic and cationic composition. (meq /100 g salt)									
Anions				Sum of anions	Cations				Sum of cations
CO_3^{--}	HCO_3^-	SO_4^{--}	CL^-		Ca^{++}	Mg^{++}	Na^+	K^+	
- -	4.89	18.8	1696.3	1720.0	11.1	8.92	1697.4	2.6	1720.0

Table 2: Physical and chemical analysis of the experimental soil.

Soil texture	Saturation %	P_H	EC ds/m	Particles size distribution mm			Texture	CaCO3 %	O.M %
Clayey	70.00	7.9	2.03	24.00	24.00	50.8	Clayey	2.3	1.9

Table 3: Soluble ions (meq/L) of the experimental soil.

Soil	Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
Clayey	4.10	2.40	5.5	0.06	-	2.4	4.0	5.6

Table 4: Total macro, micronutrients and trace elements (ppm) in the experimental soil.

N	P	K	Fe	Mn	Zn	Cu	Ni	Pb	Cd
580	290	718	2291	120	101	20	20.9	16.4	1.4

Table 5: available macro, micronutrients and trace elements (ppm) in the experimental soil.

N	P	K	Fe	Mn	Zn	Cu	Ni	Pb	Cd
112	10	350	13	11	0.9	0.8	0.7	4.9	0.2

conformed by those of others including Uchiyama (1987), in Japan. On the other hand, these two characters were reduced progressively due to incremental concentrations of NaCl since the least averages were recorded due to the highest concentration of 2.9 % NaCl. Such reduction in leaf as well as branches numbers due to higher salinity levels may be attributed to a destruction of chlorophyll leading to the lowering of photosynthesis rate (Edwards and Brown, 1998). Strogonove *et al.* (1970) stated that chlorophyll was destroyed as a result of high levels of salinity which affect the strength of the forces binding the pigment protien complex to the chlorophyll structure.

As regard to salinity effect on the average plant height (cm) of different *Atriplex* species ,it was clear that this triat ,in general, was improved by increasing NaCl concentration from 0.2% to 0.5% and the maximum plant height was achieved due to concentration of 0.8% NaCl and then plant height began to decrease with excess in salinity level .Since the shortest plants were observed when irrigation water contained the highest salinity level of 2.9% NaCl and this was true , on the whole ,for all *Atriplex* species studied in this investigation (Table 8). Abdullah *et al* (1993) showed that there was a reduction in plant height of Atriplex plant with increasing salinity .Thes results were true at different growth periods. They stated that a large part of reduction in plant height in saline media was the result of the combined suppressing action of salinity and transpiration on plant water potential.

They, also added that salinity was suggested to depress plant height through reduction in cell size or the number of cells per unit area. Since salinity had a dwarfing effect on plant height. Moreover, Khafaga (1991) attributed salinity advers effects on plant growth to the specific toxic effects of ions excessivelly absorbed from saline solution and to the imbalance of nutritive cations in tissues of salts affected plants. Average fresh weight /plant (g) of Atriplex species significantly differed during all cuts in the first and second seasons.The results clearly showed that *A. nummularia* recorded the heighest average of fresh weight /plant (g) during cuts and their total in both seasons.

Average of fresh weight /plant (g) as affected by salinity concentrations significantly differed during different cuts of the two seasons and their totals. The results indicated that the highest average of fresh weight /plant (g) was produced from lower salinity concentration of 0.2%, 0.5% and 0.8% NaCl during different cuts from the first to the sixth cuts as well as the total of fresh weight .Similar trend was detected as the averages of dry weight (g) /plant were concerned (Tables 9 and 10) These results agree with those of Zeinab and Sallam (1996) who stated that increasing salt concentration in irrigation water caused a reduction in dry weight /plant (g) of Atriplex plant. This reduction effect of salinity may be ascribed to the disturbance in metabolic path ways in the plant as a result of the adverse effect of salts on enzymatic activity.

Data collected on the protien content of both leaves and stems of Atriplex plants revealed that Atriplex species significantly differed as this character was concerned. Planting *A. nummularia* evidently produced leaves containing highest protein percentage which averaged 13.7%. While ,the highest protein % in stems was recorded in *A. leucoclada* (1.4%). The results clearly indicated also, that salinity concentration significantly affected protein % in leaves and stems .Highest protein % in leaves realized due to salinity concentrations of 0.2% NaCl which averaged 17.4% in leaves. However ,the lowest protein % in stems were produced due to salinity concentration of 2.9% NaCl which averaged 0.4% only .These results may be conformed by those of other workers including Khafaga (1991) who concluded that crude protein % decreased with higher salinity levels.

Table 6: Average numbers of leaves / plant as affected by *Atriple spp.* and salinity concentration during different cuts, of 1999 / 2000 and 2000 / 2001 seasons.

Treatments	**Cuttings of 1999/2000 season**				**Cuttings of 2000/2001 season**			
	1st	2 nd	3 rd	**Average**	4th	5 th	6 th	**Average**
***Atriplex* species :**								
A.nummularia	263.4	282.2	269.4	271.7	311.1	227.0	234.8	257.6
A.halimus	221.8	226.7	224.4	224.3	293.3	195.9	204.9	231.4
A.leucoclada	305.6	352.2	341.3	333.0	358.6	269.4	361.1	296.4
A.canscense	108.6	130.8	116.6	118.6	155.4	102.5	101.1	119.7
F. test	**	**	**	**	**	**	**	**
LSD 5 %	37.4	39.6	37.7	20.5	38.5	30.0	31.8	31.8
LSD 1 %	49.7	52.6	50.0	27.0	51.1	39.9	42.3	43.0
B: Salinity concentrations :								
0.2% NaCl	324.3	362.1	378.7	355.0	410.2	291.4	269.1	323.5
0.5 % NaCl	356.9	379.9	359.2	365.3	395.6	322.6	302.8	340.3
0.8 % NaCl	356.0	398.2	354.3	369.5	445.6	297.6	293.7	345.6
1.1 % NaCl	271.0	299.2	270.0	280.1	349.4	239.1	253.0	280.5
1.4 % NaCl	231.9	287.7	279.4	266.3	306.7	220.6	235.3	254.2
1.7 % NaCl	214.9	233.6	238.4	229.0	269.9	193.9	214.0	226.0
2.0 % NaCl	161.7	172.8	157.1	163.9	190.9	142.1	147.4	160.1
2.3 % NaCl	152.8	147.1	156.1	152.0	176.8	120.8	123.8	140.4
2.6 % NaCl	99.3	108.4	103.6	103.8	134.1	87.3	94.0	105.1
2.9 % NaCl	79.8	90.7	82.4	84.3	116.8	71.8	71.6	86.7
F- test	**	**	**	**	**	**	**	**
LSD 5 %	59.1	62.6	59.5	23.8	60.9	47.5	50.4	28.6
LSD 1 %	78.6	83.1	79.1	31.4	80.9	63.1	66.9	37.8
Interaction A× B	N.S	N.S	N.S	**	N.S	*	N.S	**

Table 7: Average number of branches/plant as affected by *Atriplex* species and salinity concentrations during different cuts of 1999/2000 and 2000/2001 seasons.

Treatments	**Cuttings of 1999/2000 season**				**Cuttings of 2000/2001 season**			
	1st	2 nd	3 rd	Av.	4 th	5 th	6 th	Av.
A: *Atriplex* species :								
A. nummularia	10.8	12.9	14.1	12.6	14.6	10.2	9.8	11.0
A. halimus	14.1	14.6	14.2	14.3	16.4	12.1	11.0	13.1
A. leucoclada	15.7	17.0	17.0	16.5	18.7	13.6	11.9	14.8
A. canscense	7.0	8.0	7.1	7.4	9.3	6.5	5.8	7.2
F.test	**	**	**	**	**	**	**	**
LSD 5 %	1.5	1.7	1.7	2.1	2.0	1.5	1.3	2.1
LSD 1 %	2.0	2.3	2.3	2.8	2.7	1.9	1.8	2.8
B: Salinity concentrations :								
0.2 % NaCl	14.0	15.6	16.9	15.5	18.6	13.4	10.1	14.0
0.5 % NaCl	16.2	17.9	17.9	17.3	18.7	13.2	10.7	14.2
0.8 % NaCl	17.2	19.3	18.8	18.5	22.0	15.9	13.1	17.0
1.1 % NaCl	13.4	15.1	14.7	14.3	16.7	12.1	12.5	13.8
1.4 % NaCl	13.0	14.3	14.3	13.8	16.0	11.4	11.2	12.9
1.7 % NaCl	11.8	13.5	13.7	13.0	15.1	10.9	10.6	12.2
2.0 % NaCl	9.6	10.1	9.7	9.9	11.3	8.1	7.9	9.1
2. 3% NaCl	9.3	9.8	9.6	9.6	11.0	8.1	7.4	8.8
2.6 % NaCl	7.3	8.1	7.9	7.8	9.8	6.9	6.6	7.8
2.9 %NaCl	7.0	7.3	7.0	7.2	8.1	6.2	6.2	6.8
F. test	**	**	**	**	**	**	**	**
LSD 5 %	2.4	2.8	2.7	1.3	3.2	2.3	2.1	1.3
LSD 1 %	3.2	3.7	3.6	1.8	4.3	3.1	2.8	1.7
Interaction A×B	**	**	N.S	**	**	*	*	**

Table 8: Average plant height (cm) as affected by species and salinity concentrations during cuttings of in first and second seasons.

Treatments	Cuttings of 1999/2000 season				Cuttings of 2000/2001 season			
	1st	2 nd	3 rd	Av.	4 th	5 th	6 th	Av.
A: ***Atripex*** species :								
A. nummularia	52.5	53.1	53.3	52.9	55.3	60.8	58.3	58.1
A. halimus	51.4	48.4	46.4	48.7	46.6	69.2	64.4	60.1
A. leucoclada	40.9	41.3	37.1	39.8	51.1	47.6	45.9	48.2
A. canscense	21.0	20.2	19.9	20.3	29.0	22.6	22.3	24.6
F. test	**	**	**	N . S	**	**	**	**
LSD 5 %	5.7	5.1	5.3	-	4.1	5.8	5.9	4.2
LSD 1 %	7.6	6.8	7.0	-	5.4	7.8	7.8	5.7
B: Salinity concentrations :								
0.2 % NaCl	53.4	50.7	52.0	52.0	57.6	63.0	61.1	60.6
0.5 % NaCl	51.3	50.1	52.2	143.2	57.7	67.7	65.7	63.7
0.8 % NaCl	54.8	54.8	52.1	53.8	62.5	71.9	68.0	67.5
1.1 % NaCl	43.8	45.5	46.4	45.2	52.6	57.6	54.6	55.0
1.4 % NaCl	42.0	43.5	37.2	40.9	48.0	50.9	49.7	49.5
1.7 % NaCl	42.5	41.6	40.2	41.3	47.2	51.6	48.4	49.1
2.0 % NaCl	37.7	33.4	31.6	34.2	35.3	38.6	36.4	36.7
2.3 % NaCl	33.0	32.3	30.4	31.8	34.6	35.9	33.6	34.7
2.6 % NaCl	29.1	29.3	28.0	28.8	31.2	33.9	30.7	31.9
2.9 % NaCl	26.7	26.2	21.7	24.8	28.1	29.6	28.9	28.9
F. test	**	**	**	N.S	**	**	**	**
LSD 5 %	9.0	8.1	8.4	-	6.4	9.2	9.3	4.7
LSD 1 %	12.0	10.7	11.1	-	8.5	12.3	12.4	6.2
A × B	**	*	*	N.S	**	N.S	N .S	**

Table 9: Average fresh weight (g) /plant as affected by Atriplex species and salinity concentration during different cuttings as well as average of forage yield of 1999/2000 and 2000/2001 seasons.

Treatments	Cuttings of 1999/2000 season				Cuttings of 2000/2001 season				Total average
	1st	2 nd	3 rd	Total	4 th	5 th	6 th	Total	
Atriplex **species :**									
A.nummularia	4500.1	4662.8	4984.6	14147.5	4775.4	3203.1	2951.8	10930.3	12538.9
A.halimus	3218.2	3363.8	3233.5	9815.5	3742.1	2531.6	2570.6	8844.3	9329.9
A.leucoclada	3406.9	3573.1	3361.6	10577.6	3616.8	2860.9	2823.4	9301.1	9939.4
A.canscense	1475.7	1568.9	1442.0	4486.6	1717.3	1299.5	1264.3	4281.1	4383.9
F. test	**	**	**	N . S	**	**	**	**	
LSD 5 %	13.8	15.1	14.2	-	14.5	8.9	8.1	10.9	
LSD 1 %	18.3	20.0	18.8	-	19.2	11.8	10.7	14.8	
B: Salinity concentrations									
0.2 % NaCl	1906.3	1864.0	1951.1	5721.4	1982.6	1557.6	1337.9	4878.1	5299.8
0.5 % NaCl	1953.0	1901.0	1808.2	5898.2	1906.4	1504.1	1433.0	4843.5	5370.9
0.8 % NaCl	1911.9	2026.2	2077.3	6015.4	2173.6	1551.2	1499.0	5223.8	5619.6
1.1 % NaCl	1600.3	1694.9	1552.2	4847.4	1757.0	1190.5	1143.7	4091.2	4469.3
1.4 % NaCl	1247.2	1448.3	1420.4	4115.9	1588.1	972.3	962.7	3523.1	3819.5
1.7 % NaCl	1283.3	1352.9	1376.6	4012.8	1370.3	921.8	924.6	3216.7	3614.8
2.0 % NaCl	798.9	918.6	879.5	2597.0	923.4	642.6	691.4	2257.4	2427.2
2.3 % NaCl	713.8	724.9	785.0	2223.7	819.5	591.7	631.1	2042.3	2133.0
2.6 % NaCl	623.5	639.6	645.2	1908.3	683.0	503.4	517.7	1704.1	1806.2
2.9 % NaCl	565.4	598.2	526.2	1689.8	647.7	459.9	469.0	1576.6	1633.2
F. test	**	**	**	**	**	**	**	**	
LSD 5 %	21.8	23.8	22.4	12.5	22.9	14.0	12.8	9.1	
LSD 1 %	28.9	31.6	29.8	16.5	30.4	18.6	17.0	12.0	
A × B	N.S	N.S	N.S	**	N.S	N .S	N .S	*	

Table 10: Average dry weight (g) /plant as affected by *Atriplex* species and salinity concentrations in both seasons.

Treatments	**Cuttings of 1999/2000**				**Cuttings of 2000/2001**				**Total average**
	1st	2 nd	3 rd	Total	4th	5 th	6 th	Total	
***Atriplex* species :**									
A.nummularia	1535.0	1596.9	1693.6	4825.5	1717.2	1304.8	1283.0	4304.9	4565.2
A.halimus	1071.2	1126.1	1080.1	3277.4	1299.2	9.74.8	1047.0	3321.0	3299.2
A.leucoclada	1222.0	1260.4	1232.3	2528.5	1327.1	1084.9	1102.2	3514.3	3021.4
A.canscense	739.9	800.3	766.8	2307.0	823.0	594.7	588.6	2006.4	2156.7
F. test	**	**	**	N.S	**	**	**	**	
LSD 5 %	5.0	4.9	6.1	-	4.7	3.6	3.8	4.4	
LSD 1 %	6.7	6.5	8.1	-	6.2	4.7	5.1	6.0	
B: Salinity concentrations :									
0.2 % NaCl	662.0	645.1	661.5	1968.5	699.2	628.3	576.4	1904.0	1936.3
0.5 % NaCl	703.9	695.0	607.7	2035.4	706.1	624.4	632.3	1962.8	1999.1
0.8 % NaCl	720.7	762.9	876.1	2359.8	820.3	621.8	639.9	2082.0	2220.9
1.1 % NaCl	591.4	600.6	563.1	1755.1	649.3	482.5	503.6	1635.3	1695.2
1.4 % NaCl	444.5	508.2	494.8	1447.6	582.1	375.8	420.8	1378.7	1413.2
1.7 % NaCl	450.8	486.9	461.7	1399.4	513.3	360.2	351.9	1225.3	1312.4
2.0 % NaCl	255.6	322.1	340.9	918.7	355.6	255.9	268.4	879.9	899.3
2.3 % NaCl	266.7	284.5	299.8	851.0	311.3	218.0	233.3	762.6	806.8
2.6 % NaCl	245.5	246.1	252.8	744.4	270.8	197.8	213.5	682.1	713.3
2.9 % NaC	227.0	232.1	214.5	673.6	258.6	194.6	180.7	663.9	653.8
F. test	**	**	**	N.S	**	**	**	**	
LSD 5 %	8.0	7.7	9.7	-	7.4	5.6	6.1	3.3	
LSD 1 %	10.6	10.2	12.8	-	9.8	7.5	8.1	4.3	
Interaction A×B	**	**	*	N.S	*	N.S	N.S	**	

Table 11: Means of protein percentage in leaves and stems as affected by *Atriplex* species and salinity concentration over the sixth cuts.

Treatments	**Protein % in leaves**	**Protein % in stems**	**Treatments**	**Protein % in leaves**	**Protein % in stems**
A: species :			A: species		
A. nummularia	13.7	1.3	***A. leucoclada***	11.1	1.4
A. halimus	12.0	1.2	***A. canescens***	6.7	0.7
F- test	**	**		**	**
LSD 5 %	0.7	0.1		0.7	0.1
LSD 1%	0.9	0.2		0.9	0.2
B: Salinity concentration			B: Salinity concentration		
0.2%NaCl	17.4	1.2	1.7 % NaCl	10.2	1.1
0.5%NaCl	19.0	1.7	2.0 % NaCl	7.7	0.6
0.8%NaCl	14.0	2.1	2.3 % NaCl	6.1	0.8
1.1%NaCl	13.7	1.6	2.6 % NaCl	4.1	0.6
1.4%NaCl	10.9	1.1	2.9 % NaCl	4.6	0.4
F- test	**	**		**	**
LSD 5 %	1.1	0.2		1.1	0.2
LSD 1%	1.5	0.3		1.5	0.3
Interaction A × B	**	NS		**	NS

This physiological decrease of protein content due to higher saliniuty levels may be attributed to the reduction in RNA and DNA content required for protein synthesis. Adverse effect of NaCl salinity on protein content in tissues of salt affected plants was, also, detected by Uchiyama (1987), in Japan. It is generally agreed that the concentration of most metabolic components in plants decreases with active growth due to the contribution in bulding new organs and tissues and diluting with some other un-metabolic components (Staples and Teonniessen, 1984)

Conclusion

According to the relevant results of the present investigation, it could be inferred that *Atriplex nummularia* is the most suitable for cultivation under the local environmental conditions of this trial among the different species studied using bottom stem internode cuttings for asexual reproduction. It was, also, noticed that growth status of the plant was improved as salinity concentration was increased upto 0.8% NaCl. Increasing salinity concentration to the level of 1.1% NaCl caused some decreases however, these decreases did not reach the level of significance in the two seasons. On the contrary, increasing salinity concentration more than 1.1% NaCl caused some tremendous losses in the growth status and forage production of the plant.

References

Abdullah, M.M. Akrame W.A. Khanand Galloway (1993). Selecting halophytic shrubs for the cholistan desert. Proceedings of a workshop held in perth, Western Australia ,10-14 May 1991 pp.45-48(CD Computer System).

Ashby, W.C. and N.C.W. Beadle (1957). Studies on halophytes. II Salinity factors in the growth of Australian salt bush. Ecology ,38:344.

Edward, P. Glenn and J. Jed Brown (1998). Effects of soil salt levels on the growth and water use efficiency of *Atriplex canscense* Chenopodiaceae varieties in drying soil. American J. of Botany 85 (1): 10 - 16.

EL-Deeek, M.H .and E. O. Abusteit (1991). Evaluation of salt bush forage value and chemical composition under some agronomic practies and saline conditions Desert Inst. Bull., Cairo, 41 (2):371-389.

EL-Shorbagy, M.N. (1969). Comparison of the yield and and vegetative characteristics of two strains of *Agropyron elongatum* grown under different salinity levels. M.Sc. Thesis, Fac. Agric. Ain Shams Univ.

EL-Shorbagy, A.A. (1975). Effect of growing season and salinity on growth mineral composition and seed lipid characteristics. Flora, Bd.164:5-51.

Gale, J.R. and A. Mayer (1970). Growth of *Atriplex halimus*, L. in sodium choloride salinited culture solution affected by relative humidity of air. Aust.J.Biol .Sci. 23:973.

Gomez, K.A. and A.A. Gomez (1984). Statistical procedures for Agriculture Research .2nd Ed. John Willey and Sons Inc., New York.

Greenway, H. (1968). Growth stimulation by high chloride concentration in halophytes. Isr. J. Bot. 17: 169.

Jackson, M.L. (1967). Soil chemical analysis. Printice Hall of India, New Delhi.pp. 144-197.

Khafaga, H.S. (1991). Agromanagement studies on the cultivation of salt bush desert forage crop under saline conditions and their effects on weed production. M.Sc. Thesis, Fac. of Agric., Cairo.Univ.

Khafaga, H.S. (1995). Studies on intercropping systems of giant saltbush *(Atriplex nummularia)* and some field crops under saline conditions. Ph.D .Thesis , Fac .of Agric ., Cairo Univ . pp .228 - 250.

Mahmoud, K and K.A. Malik (1996). Seed germination and salinity tolerance in plant species grown in saline west lands. Biologia–Plantarum.38 (2): 309 - 315.

Mozafar, A. (1970). Sodium and potassium interaction in increasing salt tolerance of *Atriplex halimus*, L. Agron. J. 62: 478.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. U.S. Dept. Agric. Handbook.

Sahsah, S.M. (1992). Studies on the adaptive responses of some plants to salinity. Ph.D. Thesis, Fac. of Sci. (for girls), AlAzhar Univ.

Sakvan, R.C. and G.P. Petrouan (1964). The effect of soil salinity on level of nucleic acids and nitrogenous substances in grape leaves. Fisiol. Res .11(4) :681 (C.F. Biol. Abst .1965, 3012).

Staples, R.C. and G.H. Teonniessen (1984). Salinity tolerance in plants: Strategies for crop improvement. Wiley –Interscience Puplication, John Wiley & Sons, New York.

Strogonove, B.P, V.V. Kabanove, N.L. Shevjakova, B.A. Dostanova, and L.S. Prykhodko (1970). Strucure and function of plant cells under salinity. Moscow, Nauka (Cited after EL-Bagoury *et al*, Egypt. J. Argon., 18, No .1-2, pp. 95 – 111, 1993).

Uchiyama, Y. (1987). Salt tolerance of *Atriplex nummularia*. Technical Bulletin. Tropical Agric. Res. Center Japan (22) pp.69 (CD Computer System).

Zeinab, M.A. and H.A.M. Sallam (1996). Chemical changes associated with kinetin and Abscisic acid applications on *Atriplex* plant grown under salinity conditions .1- Changes in growth and nitrogen constituents. Annals Agric. Sci., Ain Shams Univ., 41(1):75-84.