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Nitrogen Forms Effects on the Growth and Chemical Constituents of *Taxodium Disticum* Grown under Salt Conditions

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Abstract: A pot experiment was conducted during 2006 and 2007 seasons in the greenhouse of National Research Centre, Dokki, Cairo, Egypt. The aim of this work is to study the effect of two nitrogen forms (urea and ammonium nitrate) and untreated one, as control plant under three levels of salinity (1000, 2000 and 3000 ppm) and tap water served as control and their interactions on growth and chemical constituents. Salinity treatments have a depressing effect on various growth parameters; i.e. stem length, stem diameter, root length, number of branches / plant, fresh and dry weight of shoots, fresh weight of shoot / fresh weight of root ratio and dry weight of shoot / dry weight of root ratio. The same tendency was observed regarding chlorophyll a, b, and carotenoids content as well as the percentage of N, P, and K at shoots.Such depressive effect was increased prominent with increasing salinity level. While, the percentage of Na increased by increasing salinity level. On the contrary, all a formentioned growth parameters and chemical constituents, expect the percentage of Na tended to increase by urea and ammonium nitrate applications compared to the untreated one. It could be recommended to fertilized plants grown in regions irrigated with saline water with urea and ammonium nitrate to overcome the hazard destructive effects of salinity.

Key words: *Taxodium distium*-salinity-urea-ammonium nitrate

INTRODUCTION

Taxodium disticum L (Fam. Taxodiaceae), it has been widly cultivated as an ornamental tree for its source of woods.Its length reached 40 m. It occurs naturally in swaps, flood plants and along the edges of lakes and rivers it likes an acidic soil and will develop yellowing of the leaves if grown in neutral or calcareous soils.

Salinity is the major constraint affecting plant growth and productivity around the world. It is estimated that 10% of the world's current croplands are affected by salinity; about 1500 million ha. of non irrigated areas where cropping relies on limited rainfall is affected by salt. Naynard *et al* (1997) studied the growth of spruce (*Picea glauced*) under saline water (EC 0, 0.5, 1.0, 1.7 and 3.1 dS / m) conditions, results indicated that the growth decreased to reach 50% in the 0.5 dS/ m treatment compared with the control. El. Settawy and El Gamal (2003) studied the effect of salinity at 0, 1, 5, and10 mg Na Cl /g soil on *Casuarina glauca* seedling they found that plant height ,stem diameter, total dry matter were decreased by increasing salinity application. Eid and Mazher (2004) on *Casuarina glauca*, Nahed *et al* (2006) on *Khaya senegalensis* and Mazher *et al* (2006) on *Dalbergin sissoo,* they found that salinity treatments have a depressing effect on various growth parameters (i.e. stem length, stem diameter, root length, fresh and dry weight of all plants organs. Abd El Fattah (2001) on *Adhatoda*, *hibiscus* and Phyallanthus shrubs, Azza *et al* (2006) on *Sasbania aegyptiaca* and Nahed *et al* (2006) on *Khaya seneglensis* declared that saline water decreased the various chemical constituents such as chlorophyll a, b, and carotenoides content as well as the percentage of N, P, and K but increased Na percentage.

Nitrogen, one of many elements required by all plants, it used by plants in relatively large quantities. Although N is slowly available to plants from natural sources, the majority of N used by plants comes from inorganic fertilizer. Most inorganic fertilizer contain N in three basic forms: urea, ammonium (NH_4) and nitrate (NO_3). Fertilizers can be formulated to contain varying proportions of each of these forms by choosing different ingredients. Many investigators had studied the effect of N forms application on growth and chemical composition on plants. Steinkamp *et al* (1992) pointed out that increasing NH_4 or urea decreasing the used

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of NH_3 in fertilizer improved growth or quality of (Silver queen) aglaonema, peacock plant (*Calathea makoyana*) and philodendron (*Philoden dron selloum*) Nidia and Gilberto (2002) on the two *Catasetum fimbriatum* genotypes, reported that the nitrogen sources [organic (urea and glutamine) or inorganic nitrogen forms (nitrate and ammonium)] supplied affected dry matter accumulation in shoots and roots of both genotypes. Takato (2004) found that fertilizers containing the NH_4 –N form are essential for optimum growth of 'Tifblue'rabbiteye blueberry. Ahamed *et al* (2006) on *Catharanthus roseus* indicated that plants fed with nitrate plus ammonium showed the greatest increase in shoot dry matter whereas ; the lowest shoots dry matter and total dry matter were exhibited in nitrate treatment. Peck *et al* (1989) on sweet corn mentioned that seedling P content was higher when N applied as ammonium nitrate than urea treatment. Whereas, El –Fadaly and Mishriky (1990) indicated that urea enhanced the accumulation of N and P in spinach as compared with ammonium nitrate fertilizer. Total nitrogen content in plant tissues increased by N fertilizers. El –Khateeb (1993) on *Eucalyptus torquata* and *E. angulosa* and Hussain *et al* (1990) on *Dalbergia sissoo*. They found that the source of nitrogen can play an important role to increase plant tolerance to salinity, Bar *et al* (2003) found that good growth of avocado was obtained at 16 meq / L. Cl in the presence of 16 meq /L NO_3 application. In this connection, Al- Mutawa and El- Katony (2001) studied the response of two wheat cultivars (Giza 157 and Sakha8) grown hydroponically under greenhouse to different levels of salinity (0.75 and 150 mM NaCl) in the nutrient solution containing either NH_4 or NO_3 as sole nitrogen source at concentration of 12 mM. They found that nitrate application increased growth of both cultivars particularly, Sakha 8 , than ammonium nutrition. Ammonium –fed plants were poorly developed with distinctly lower root / shoot ratio and thick, shoot and highly branched roots compared with nitrate fed plants.

Therefore the aim of this investigation is to study the influence of two nitrogen forms fertilization on growth and chemical constituents of *Taxodium disticum* seedling irrigated with saline water

MATERIALS AND METHODS

The experimental trials were carried out during 2006 and 2007 seasons in the greenhouse of National Research Centre. It was intended to find the individual and combined effect of two nitrogen forms of nitrogen fertilization under different salinity levels on growth and chemical constituents of *Taxodium disticum* .The investigated soil characterized by sand 55.93% , silt 4.35 , clay 39.72 with pH 7.81, EC 0.76 dSm^{-1}, $CaCO_3$ 2.3 %, OM 1.58%, Ca 2.8, Mg 0.1, Na 2.2, K 1.3, Cl^- 2.5, SO_4 2.8 meq/L^{-1}.

Plant material and procedure: One year old seedlings of *Taxodium disticum* were obtained from the nursery of Forestry Department Horticulture Research Institute , Agricultural Research Centre, the seedling were planted at the third week of March during the two seasons , as one seedling / pot 30 cm in diameter filled with ten kg soil, the average height of the seedling was (20-25 cm), each season as one seedling / pot 30. Three salinity levels were prepared (1000, 2000 and3000ppm) by adding sodium chloride plus calcium chloride (1:1) by weight for irrigation seedlings with previously prepared salinized. The untreated plants (control) were irrigated with tap water ; every pot received 250ml of the formationed salinity levels and water was added twice a week throughout the course of the study (6 months). Starting from March until one month before ending the experiment, the seedling received nitrogen was applied at two forms as follows: urea and ammonium nitrate recommended rate and untreated plant as control. Basal doses of phosphorus and potassium were added as superphosphate (50 mg kg^{-1} P_2O_5) and potassium sulphat (40 mg kg^{-1}soil K_2O) in four doses. The statistical layout of the experiment was a completely randomized in factorial experiments design each treatment included 6 replicates. The following data were recorded: Stem length (cm), stem diameter (mm), root length (cm), root number/ plant, number of branches/ plant, fresh and dry weight of all plant organs (g). Shoot fresh weight /root fresh weight and shoot dry weight /root dry weight. All previous data were subjected to statistical analysis of variance according to the method described by Snedecor and Cochran (1980) Treatment means compared by L.S.D. test and the combined analysis of the two seasons was calculated according to the method of Steel and Torrie (1980). Chlorophyll a, b, and carotenoids content were determined according to Saric *et al* (1967) Nitrogen, phosphorus, potassium, and sodium were determined according to the method described by Cottenie *et al* (1982)The physical and chemical properties of the soil were determined according to Chapman and Pratt (1961).

RESULTS AND DISCUSSION

Growth Characters:

The growth parameters as affected by saline water irrigation treatments are showed in table (1). However, all growth parameters, stem length, stem diameter, root length, root number/ plant, number of branches/ plant, fresh and dry weight of roots and shoot were reduced by irrigation with different levels of saline water

Table 1: Effect of nitrogen forms on vegetative growth of *Taxodium disticum* under different levels of salinity (average values of 2006 and 2007 seasons).

(a)

characters	Stem length (cm)				Stem diameter (cm)				Number of branches			
Treatment	N source				N source				N source			
salt	0	U	N	Mean	0	U	N	Mean	0	U	N	Mean
Tap water	40.48	41.90	45.70	42.69	6.40	6.60	7.40	6.8	8.56	8.99	9.37	8.97
1000	36.40	37.04	40.77	38.07	4.90	5.10	5.80	5.3	6.24	6.71	7.87	5.71
2000	30.80	31.12	35.12	32.35	4.20	4.40	4.80	4.5	4.45	5.05	5.56	5.02
3000	25.02	30.04	32.56	29.21	3.10	3.20	3.70	3.3	2.85	3.15	3.67	3.22
Mean	33.18	35.03	38.54		4.70	4.80	5.40		5.53	5.98	6.62	
L.S.D. 0.5												
Salt (A)		5.64				0.28				1.30		
N source (B)		4.89				0.24				1.13		
(A) x (B)		9.77				0.48				2.26		

U: urea N: ammonium nitrate

(b)

characters	Root number				root length (cm)			
Treatment	N source				N source			
salt	0	U	N	Mean	0	U	N	Mean
Tap water	9.57	10.33	11.84	10.58	23.59	24.31	25.37	24.42
1000	7.24	7.84	8.70	7.93	20.25	21.78	23.89	21.97
2000	5.38	5.84	6.44	5.89	16.55	18.00	19.12	17.89
3000	3.36	3.70	4.50	3.85	12.96	13.71	15.12	13.93
Mean	6.39	6.92	7.87		18.34	19.45	20.88	
L.S.D. 0.5								
Salt (A)			1.57				2.91	
N source (B)			1.36				2.52	
(A) x (B)			2.71				5.04	

(c)

characters	Shoot fresh weigh (g)				Root fresh weigh (g)				Shoot / Root Ratio			
Treatment	N source				N source				N source			
salt	0	U	N	Mean	0	U	N	Mean	0	U	N	Mean
Tap water	91.11	92.30	95.04	92.82	32.57	34.50	38.89	35.32	2.80	2.68	2.44	2.64
1000	76.50	79.07	83.77	79.78	27.79	29.70	34.94	30.81	2.75	2.66	2.40	2.60
2000	62.10	66.77	71.59	66.82	22.89	26.72	29.99	26.53	2.71	2.50	2.39	2.53
3000	43.44	47.67	51.90	47.67	16.90	19.98	24.92	20.60	2.57	2.39	2.08	2.35
Mean	68.29	71.45	75.58		25.04	27.73	32.19		2.71	2.56	2.33	
L.S.D. 0.5												
Salt (A)		6.01				2.99					-	
N source (B)		5.22				2.59					-	
(A) x (B)		10.43				5.17					-	

(d)

characters	Shoot dry weigh (g)				Root dry weigh (g)				Shoot / Root ratio			
Treatment	N source				N source				N source			
salt	0	U	N	Mean	0	U	N	Mean	0	U	N	Mean
Tap water	48.44	50.04	58.64	52.37	16.70	17.82	22.02	18.85	2.90	2.81	2.66	2.79
1000	40.59	45.87	52.22	46.23	14.17	16.53	19.90	16.87	2.86	2.77	2.62	2.75
2000	30.24	33.92	37.41	33.86	11.28	12.86	14.90	13.01	2.68	2.64	2.51	2.61
3000	25.17	28.43	31.35	28.32	9.43	10.99	12.62	11.01	2.67	2.59	2.48	2.58
Mean	36.11	39.57	44.91		12.90	14.55	17.36		2.78	2.70	2.57	
L.S.D. 0.5												
Salt (A)		3.91				1.81					-	
N source (B)		3.39				1.57					-	
(A) x (B)		6.77				3.13					-	

as compared with the control plants. The reduction in Stem length might be due to salinity which decreased each of cell division, cell elongation and meristemic activity (Ruf *et al* 1973 and Bolus *et al* 1972).Also, under salinity conditions, reduction of leaves number /plant might cause a disturbance in natural hormones leading to unbalanced growth of the plant. Bernstien *et al* (1973) found that, the decrease in root length due to salinity treatments might be attributed to the inhibition in cell division and /or cell enlargement caused by salinity. Also, the effect of high salt concentration in rooting media on growth might be due to an osmotic inhibition of water absorption, specific ion concentration in the saline media, or a combination of both. Moreover, the decrease in fresh and dry weight of all plant organs due to the Cl or Na accumulation in leaves might cause injury by interfering with normal stomatal closure causing excessive water loss and leaf injury symptoms like those of drought and CO_2 fixation might be reduced under high level of salinity which led to lower metabolism. In this respect, such decrease in fresh and dry weight of stem might be due to the inhibition of water absorption and /or distribution of mineral balance and /or absorption and utilization under salinity condition. In the same time, the decrease in fresh and dry weight of roots might be due to the reduction in water and mineral absorption and / or the reduction in upper ground growth under salinity conditions. Similar results were obtained by Roussos and Pontikis (2003), Azza *et al* (2006) and Nahed *et al (*2006).

Concerning the effect of nitrogen forms in growth parameters, data in table (1) revealed that using different nitrogen forms had a significant favorable effect on all growth parameters of *Taxodium disticum* seedling during the two growing seasons. However, ammonium nitrate treatment was more effective than urea on all growth parameters. This may be attributed to the intensive use of urea which had an adverse effect (Miwa and Ozaki 1976). It also, may be due to high mobility of NO_3- N and it can easily leach out. Thus, it more available in the soil for the plant to take up again (Sarakadi *et al* 1986 and Bogdanovic 1986). Nitrate is often a preferential source for plant growth. Plant mainly takes up NO_3 even when NH_4 fertilizers are applied, due to of the microbial oxidation of the NH_4 in the soil. Moreover, nitrate is the only inorganic form that can and does accumulate in the plant without injurious effects. Generally increase fresh and dry weight of shoots may be explained on the assumption that, with increasing nitrogen supply, the proportion of the carbohydrate used in the aerial portion increase.

With regard to the interaction between salt concentrations and different nitrogen froms, data presented in table (1) revealed that fertilizer with different nitrogen forms under salinity stress significantly increased growth parameters. This may be due to salt stress inactivated nitrate reductive activity due to decreased NO3 uptake, moreover, Al bassam (2001) found that high nitrate in irrigation solution is necessary to decrease salt concentration and convert inactive reductase to the active form.

Chemical Composition:

Photosynthetic Pigments:

It is clear from table (2) that, increase of salt concentration in the irrigation water gradually decreased the content of photosynthetic pigments (chlorophyll a, b, and carotenoids). These results are in agreement with those obtained by Patil and Potil (1982) and Batanouny *et al* (1988) they mentioned that the lowered photosynthetic ability under salt stress condition was due to stomata closure, inhibition of chlorophyll synthesis, a decrease of carboxylase and due to high chlorophyallase activity.

As for as effect of nitrogen forms on all photosynthetic pigments, N at both used forms caused an increase in the chlorophyll a, b, and carotenoids content as compared with the untreated seedlings. This may be due to that N is a component of chlorophyll pigments. The interaction between the two factors (salinity and nitrogen) were increased all Photosynthetic pigments content compared with using salinity alone.

Nutrients:

The content of nutrients (N,P,K and Na) in all plant organs as affected by different salinity levels and various nitrogen application treatments in both seasons through experimental period are presented in tables (3, 4, 5 and 6). It is clear from data that increasing salinity levels reduced the percentage of N, P, and K and the uptake in the two growing seasons. These results are in agreement with those obtained by (Azza *et al* 2006) on ***Sesbania aegyptiaca*.** In this connection, Hanafy Ahmed *et al* (1996) pointed out that salinization impaired N accumulation and incorporation into protein and raised total free amino acid accumulation in saline plant .Also, it can be suggested that amino acids can act as components of salt tolerance mechanism and build up a favorable osmotic potential inside the cell in order to combat the effects of which replaced nitrate in the vacuoles. Further more, the reduction in P uptake under saline conditions could be explained on the fact that Na salt raised the pH of the soil, which in turn reduced the availability of to the

Table 2: Effect of nitrogen forms on Chlorophyll a, b and carotenoids (mg/g-1F.W) of *Taxodium disticum* under different levels of salinity (average values of 2006 and 2007 seasons).

Characters	Chlorophyll (a)				Chlorophyll (b)				carotenoids			
Treatment	N source				N source				N source			
salt	0	U	N	Mean	0	U	N	Mean	0	U	N	Mean
Tap water	1.71	1.73	1.79	1.74	0.67	0.73	0.81	0.74	0.73	0.76	0.85	0.78
1000	1.62	1.67	1.73	1.67	0.60	0.68	0.75	0.68	0.64	0.70	0.78	0.71
2000	1.53	1.59	1.64	1.59	0.49	0.56	0.67	0.57	0.53	0.63	0.71	0.62
3000	1.38	1.42	1.48	1.43	0.36	0.46	0.54	0.45	0.45	0.52	0.53	0.52
Mean	1.56	1.60	1.66		0.53	0.61	0.69		0.59	0.65	0.73	

Table 3: Effect of nitrogen forms on nitrogen content (%) on shoot and root of *Taxodium disticum* under different levels of salinity (average values of 2006 and 2007 seasons).

Characters	Shoot				Root			
Treatment	N source				N source			
Salt	0	U	N	Mean	0	U	N	Mean
Tap water	2.79	2.87	2.94	2.87	1.85	1.92	2.48	2.08
1000	2.03	2.19	2.31	2.18	1.79	1.87	2.38	2.01
2000	1.91	2.00	2.24	2.05	1.42	1.69	2.06	1.72
3000	1.58	1.89	2.12	1.86	1.36	1.58	1.87	1.60
Mean	2.08	2.24	2.40		1.61	1.77	2.20	

Table 4: Effect of nitrogen forms on phosphorus content (%) on shoot and root of *Taxodium disticum* under different levels of salinity (average values of 2006 and 2007 seasons).

Characters	Shoot				Root			
Treatment	N source				N source			
Salt	0	U	N	Mean	0	U	N	Mean
Tap water	073	0.91	1.04	0.89	0.22	0.26	0.34	0.27
1000	0.64	0.81	0.93	0.79	0.19	0.21	0.28	0.23
2000	0.57	0.74	0.81	0.71	0.13	0.17	0.23	0.18
3000	0.49	0.64	0.72	0.62	0.09	0.12	0.16	0.12
Mean	0.61	0.78	0.88		0.16	0.19	0.41	

plants (Sonneveld and Voogt 1983). In this context, Gemea *et al* (1996) found an increase in Na concentration and a decrease in K concentration in leaves with salinity, this result may be due to a possible antagonism between K and Na. This antagonism could be due to the direct competition between K and Na at the sit of ion uptake at plasmalemma. Data in tables (3,4,5 and 6) indicated that there was a gradual increase in Na percentage in the shoots with increasing salt concentration irrigation water. Accordingly, the increase in Na concentration in plant with salinity may be a result of the ability of plants to use Na to maintain an adequate osmotic potential gradient between the plant tissues and the external solution (Glenn 1987). In this respect, Flowers *et al* (1977) noted that osmotic adjustments are essential for a plant to survive in saline environments.

Data presented in tables (5 and 6) indicated that increasing salinity levels in irrigation water generally increased Na / K ratio in plants. These results are in harmony with those obtained by Ashour *et al* (2004). In this respect, Yang *et al* (1990) reported that the greatest tolerance observed in plant under saline condition was obtained with higher levels of Na /K and greater capacity for osmotic adjustment.

Regarding to the effect of different N sources application on N, P and K concentration, it is noticed from the results that, the percentage of N, P and K increased by two nitrogen forms compared with the untreated plant. This might be attributed to the increase in the root surface per unit of soil volume and nutrient uptake,

Table 5: Effect of nitrogen forms on Na, K and Na / K ratio on shoot of *Taxodium disticum* under different levels of salinity (average values of 2006 and 2007 seasons).

characters	Na				K				Na / K ratio			
Treatment	N source				N source				N source			
salt	0	U	N	Mean	0	U	N	Mean	0	U	N	Mean
Tap water	0.15	0.10	0.04	0.10	1.98	2.06	2.20	2.08	0.076	0.049	0.018	0.048
1000	0.19	0.11	0.06	0.12	1.89	2.01	2.04	1.98	0.101	0.055	0.029	0.062
2000	0.21	0.15	0.07	0.14	1.81	1.89	1.93	1.88	0.116	0.079	0.036	0.077
3000	0.26	0.20	0.12	0.19	1.51	1.68	1.79	1.66	0.172	0.119	0.067	0. 119
Mean	0.20	0.14	0.07		1.80	1.91	1.99		0.116	0.076	0.038	

Table 6: Effect of nitrogen forms on Na, K and Na / K ratio on root of *Taxodium disticum* under different levels of salinity (average values of 2006 and 2007 seasons).

characters	Na				K				Na / K ratio			
Treatment	N source				N source				N source			
salt	0	U	N	Mean	0	U	N	Mean	0	U	N	Mean
Tap water	0.37	0.28	0.24	0.30	0.86	0.97	1.01	0.95	0.43	0.29	0.24	0.32
1000	0.49	0.37	0.33	0.40	0.71	0.83	0.91	0.82	0.69	0.45	0.36	0.50
2000	0.57	0.38	0.35	0.43	0.49	0.55	0.76	0.60	1.16	0.69	0.46	0.77
3000	0.61	0.55	0.39	0.51	0.36	0.43	0.57	0.45	1.69	1.28	0.51	1.16
Mean	0.51	0.33	0.32		0.61	0.70	0.81		0.99	0.68	0.39	

or might be due to the high capacity of plant supplied with N fertilizer in building metabolites which might contribute much to the increase dry matter content and nutrients uptake by plant.

Furthermore, the combination between salinity levels and two N forms were almost positive for the percentage of N, P and K .therefore, it can be postulated that N forms treatments might increase the rate of incorporation of free amino acid into protein. Also, the protection of plant against salt stress by an exogenous supply of N is believed to be caused indirectly as a result of its effect of K uptake which plays an essential role in many metabolic processes such as photosynthesis process and hence the formation of starch. On the other hand, the interaction between salinity levels and N forms application rates decreased Na percentage in different plant organs compared with untreated plants. Hence, it could be recommended to fertilizer plants, grown in regions irrigated with saline water, with nitrogen forms to overcome destructive effect of salinity.

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