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GROWTH PERFORMANCE AND PRODUCTIVITY OF SOME EXOGENOUS ACACIA SPECIES UNDER SALINITY CONDITIONS AT RAS SUDR AT SOUTH SINAI

BY

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ABSTRACT

The effect of two salinity levels of irrigation water (4000 and 8000 ppm) on some growth parameters, forage yield and chemical composition of different Acacia species (*Acacia sclerosprma* Benth, *Acacia cuthbertsonii* Benth, *Acacia viectoria* Benth-Bramblea and *Acacia tetragenophylla* F. Muell) was studied at Ras Sudr Experimental Station, Desert Research Center (DRC), during the period extended from autumn 2001 (dry season) to spring 2003 (wet season). The obtained results could be summarized as follows:

- Growth parameters, forage yield and chemical composition were negatively affected by increasing the salinity level of irrigation water during wet and dry seasons in two years.
- *Acacia sclerosprma* significantly surpassed the other three species in most of the studied growth parameters, forage yield and chemical composition which was followed by *Acacia viectoria* .
- The interaction between salinity levels and Acacia species had a significant effect on some parameters during autumn 2002, where *Acacia sclerosprma* surpassed the other species when irrigated with 4000 ppm salinity.

Key words: *Acacia sclerosprma, Acacia cuthbertsonii, Acacia viectoria* and *Acacia tetragenophylla*, salinity, growth parameters, chemical composition and forage yield.

INTRODUCTION

In Egypt, there is a real need for perennial forage species that furnish reasonable quality fodder for livestock during dry seasons. However, most of the cultivated fodder species in South Sinai at Wadi Sudr region have been developed and released based on specific characteristics of best fit to their establishment and production under drought and salinity conditions rather than concentrating on nutritive value.

Drought and salinity are the most important environmental stresses restricting plant growth and development. Salinity seems to be one of the most important problems in many parts of the world which affects plant growth and

yield, especially in arid and semi- arid regions (Hillel, 2000) Effect of salinity can be expressed in two ways. Firstly, by increasing osmotic pressure of the substrate solution of the soil which in turn, causes in availability of water and nutrients for plants; secondly by the toxic effect of some ions on the different functions of plant life (Annie and DuBois 2003). It is important to cultivate fodder species that could sustain the a biotic and edaphic stresses. Wadi Sudr region is located at South of Sinai where rain- fall or the existing sweet water is limited. It is one of the area that can be cultivated by forage plants. Recently, there is strong interest of cultivating shrubs that have salinity tolerance in such region. There are a number of species that though to be promising for saline tolerance, as Acacia species.

Acacia is one of the most successful leguminous species that are cultivated in arid and saline environments for producing supplementary source of fodder that plays an important role in compensate the lack of fodder in the desert dry conditions. This may due to its rapid growth and its drought and salinity tolerance (Abou- Deya *et al.*, 1990, Topps 1992 and Tag El- Din and Al – Sheikh 2002). Some Acacia species tolerate high levels of ground water salinity, as *Acacia stenophylla, Acacia redolens, Acacia ampliceps* and *Acacia translucens,* where all grow in high saline areas. The *Acacia viectoria* and *Acacia salicina* grow in saline soils and appears to have high nutritive quality species (Turnbull, 1986 and Tag El- Din and Al- Sheikh, 2002). Furthermore, Zoghet *et al.*, (1993) reported that *Acacia sclerosprma* and *Acacia viectoria* are trees of an excellent growth, they tolerate all desert hazards and are used as livestock forage during drought season.

The target of this research was to study growth parameters, forage productivity and chemical content of some Acacia species to salinity levels under Wadi Sudr Experimental Station conditions.

MATERIAL AND METHODS

The present investigation was conducted during the period extended from autumn 2001 (dry season) to spring 2003 (wet season) in Ras Sudr Research Station, Desert Research Center at South Sinai Governorate to study the effect of salinity levels (4000 and 8000 ppm) on growth parameters, forage yield and chemical content of four exogenous Acacia species (*Acacia sclerosprma, Acacia cuthbertsonii, Acacia viectoria* and *Acacia tetragenophylla*) .

The mechanical and chemical analysis of the experimental soil were shown in Table (1 & 2).

Seeds of four Acacia species were sown in polyethylene bags filled with sand and clay soil (1: 1) in September 1999 in Desert Research Center greenhouse under controlled conditions. Six months later (March, 2000), uniform healthy seedlings were transplanted in the permanent site at Ras Sudr Exp. Station, after applying 30m^3/fed. of sheep manure, which was mixed to soil a month before

cultivation. Seedlings were planted at a distance of 2 x 2 meter (1050 shrubs/ fed) and were irrigated weekly with underground saline water (4000 and 8000 ppm from two different wells).

The analysis of such water, was presented in (Table 3) .

Table (1): Mechanical analysis of the experimental soil :

$CaCO_3$ %	Particle size distribution					
49.75	Coarse sand	Moderate sand	Fine sand	Very fine sand	Silt	Clay
	(%)					
	46.60	28.80	11.30	4.20	6.00	3.10

Table (2) : Chemical analysis of the experimental soil :

Ec mmhos / cm	pH	Soluble cations				Soluble anions		
25.61	7.85	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	$SO_4^=$
		(meq / L)						
		75.95	50.10	97.67	8.51	9.15	121.53	100.65

Table (3): Analysis of irrigation water

Wells	T.S.S. (ppm)	pH	Cations				Anions		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	$SO_4^=$
			(meq/ L)						
1st	4000	7.60	26.50	23.50	21.50	0.28	3.50	49.25	19.03
2nd	8000	7.63	44.50	13.00	63.00	0.40	4.00	109.50	7.00

The new growing shoots were browsed after two years of shrubs-establishment during autumn (25 October 2001 and 2002) and spring (15 April 2002 and 2003) years.

The experiment included 8 treatments which were arranged in split plot design for three replications. They are the combinations of two concentrations of salt irrigation water (4000, 8000 ppm) were layed out in the main plots and four species of *Acacia* (*Acacia sclerosprma, Acacia cuthbertsonii, Acacia viectoria* and *Acacia tetragenophylla*) were randomly devoted to the sub plots.

The studied growth parameters of five shrubs were measured in autumn and spring seasons. These were shrub height (cm): from ground surface up to the tallest branch tip.

Canopy cover or crown cover (m^2) and crown volume (m^3) were determined by using crown diameter method, two diameter measurements on crown spread of individual shrubs are used (Thalen 1979). The first measurement gives the maximum value of the diameter (D_1). The second is taken perpendicular

to the first giving the maximum value in this direction (D_2). Then crown cover (m^2) and crown volume (m^3) are calculated using the following formula:

Crown cover = $\frac{1}{4} \pi \times D_1 \times D_2$

Crown volume = $\frac{1}{6} \pi \times D_1 \times D_2 \times H$

where $\pi = 3.14$, D_1 and D_2 = the two diameters of the shrub and H= shrub height.

Fresh fodder yield (Ton/ fed.) was determined by weight the browsed shoots for each shrubs (kg/ shrub) using a simple balance (capacity to 10 kg, read to 1 g precise) in the field immediately. Then fresh fodder yield was calculated by multiplying the average tender biomass of the shrub by the number of shrubs / fed.

Dry fodder yield (Ton/ fed.) was determined by taking fresh samples from every shrub, then dried in an air force drying oven at 105°C till constant weight to determine the dry matter percentage and dry fodder yield.

Samples of fresh matter (about 100 g) were taken from each treatment of three replications and were placed in a labeled kraft paper bags in air forced drying oven (70°C) and kept till constant weight. Dry samples were milled to fine powder and used for the following chemical analysis:-

- Crude protein: total nitrogen was determined by modified micro kjeldahl according to Peach and Tracy (1956) and multiplied by 6.25 (Tripathi *et al.*, 1971).
- Crude fiber and total ash content were determined as outlined A.O.A.C. (1970).
- Sodium and potassium were estimated using a flam photometer according to Brown and Lilleland (1946).

All data were statistically analysed using COSTAT computer program according to Snedecor and Cochran, 1980. The differences between means were tested according to LSD method at 5% level (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

The effect of irrigation with saline water (4000 and 8000 ppm) on growth parameters, forage productivity and chemical composition of some Acacia species, during the period extended from autumn 2001 to spring 2003 are presented in Table (4).

I. Growth parameters:

Increasing salinity levels of water irrigation from 4000 to 8000 ppm caused insignificant decrease in all of the studied growth parameters during autumn and spring in the two years except for shrub height in autumn 2001 and 2002. These results are in harmony with those obtained by Shenouda (1996) on Acacia shrubs species, Omran *et al.* (1996) on *Acacia saligna, Casurina glauca* and *Eucalyptus camaldulensis* and Tag El- Din and El- Sheikh (2002) on *Acacia saligna*, who found that increasing salinity of irrigation water decreased some growth parameters.

The harmful effect of salinity of irrigation water on growth parameters may be attributed to the increase the osmotic pressure of soil, solution which alters water relations of the plant and restrict the regular water and nutrients function on plant growth and development.

This in turn would cause negative response for appropriate physiological functions in soil- water- plant relations.

This may lead to a reduction in the rate of development of new roots, leaves and lateral shoots (Annie and DuBois, 2003).

Acacia species differed significantly in their response to salinity levels (Table 4). The *Acacia sclerosprma* was superior than the other species in most of the studied growth parameters in the two years, meanwhile *Acacia viectoria* seems to be the second in the descending ranking order. This may be due to their relatively rapid growth and could tolerate prevailing harsh desert environmental conditions which will lead to an accepted successful growth in saline soil (Turnbull, 1986).

Table (4): Forage growth, yield and chemical content of Acacia species as affected by salinity of irrigated water (during the period from autumn 2001 to spring 2003 seasons).

Treatments	Salinity levels (ppm)			Acacia species (A)				
Traits Autumn 2001	4000	8000	LSD	A_1	A_2	A_3	A_4	LSD
Shrub height (cm)	91.13	96.00	NS	130.00	36.75	172.50	35.00	42.46
Crown cover (m^2)	2.047	1.846	NS	3.662	0.035	3.339	0.233	0.95
Crown volume (m^3)	1.914	1.535	NS	2.917	0.012	3.887	0.082	0.86
F. yield /shrub (kg)	2.866	2.504	NS	6.500	0.113	4.025	0.103	1.78
D. yield /shrub (kg)	1.021	0.822	NS	1.857	0.043	1.739	0.048	0.51
F. forage yield (Ton/fed.)	3.010	2.629	NS	6.825	0.118	4.226	0.108	1.87
D. forage yield (Ton/fed.)	1.072	0.863	NS	1.949	0.045	1.826	0.050	0.54
Crude protein (%)	5.426	4.753	NS	5.035	5.755	5.699	3.878	NS
Crude fiber (%)	27.518	26.514	NS	21.258	21.663	30.705	34.438	8.57
Total ash (%)	9.169	11.348	NS	18.320	13.420	5.255	4.043	5.02
N^+ (%)	0.800	0.678	NS	0.885	0.695	0.700	0.593	NS
K^+ (%)	0.321	0.281	NS	0.350	0.244	0.338	0.275	NS
Spring 2002								
Shrub height (cm)	81.75	81.50	NS	120.25	35.75	122.25	48.25	34.90
Crown cover (m^2)	1.361	2.102	NS	3.809	0.061	2.867	0.204	0.93
Crown volume (m^3)	1.090	1.560	NS	2.823	0.017	2.393	0.009	1.26
F. yield /shrub (kg)	3.575	2.481	NS	9.425	0.225	2.125	0.338	3.88
D. yield /shrub (kg)	1.435	1.149	NS	1.382	0.116	1.382	0.207	1.07
F. forage yield (Ton/fed.)	3.754	2.605	NS	9.896	0.237	2.231	0.355	4.07
D. forage yield (Ton/fed.)	1.508	1.206	NS	3.639	0.121	1.452	0.218	1.13
Crude protein (%)	6.049	4.056	NS	6.598	4.783	4.908	3.923	NS
Crude fiber (%)	23.790	23.365	NS	16.893	19.275	24.535	33.608	7.98
Total ash (%)	8.898	8.410	NS	17.498	4.565	6.595	5.958	3.88
N^+ (%)	0.243	0.223	NS	0.285	0.243	0.190	0.213	0.06
K^+ (%)	0.333	0.326	NS	0.465	0.296	0.303	0.254	0.09

Table (4): Cont.

Treatments	Salinity levels (ppm)			Acacia species (A)				
Traits / Autumn 2002	4000	8000	LSD	A_1	A_2	A_3	A_4	LSD
Shrub height (cm)	83.25	84.94	NS	122.81	38.69	126.44	48.44	8.73
Crown cover (m^2)	2.169	1.828	NS	4.915	0.054	2.778	0.248	0.44
Crown volume (m^3)	1.818	1.609	NS	4.322	0.016	2.430	0.086	0.58
F. yield /shrub (kg)	3.485	2.742	NS	9.719	0.244	2.131	0.360	0.97
D. yield /shrub (kg)	1.400	1.243	NS	3.509	0.125	1.440	0.214	0.26
F. forage yield (Ton/fed.)	3.659	2.880	NS	10.205	0.256	2.238	0.378	1.02
D. forage yield (Ton/fed.)	1.466	1.283	NS	3.662	0.132	1.467	0.218	0.31
Crude protein (%)	5.881	4.146	NS	6.757	4.697	4.728	3.872	0.50
Crude fiber (%)	24.093	23.252	NS	16.518	19.408	24.706	34.056	1.99
Total ash (%)	8.272	8.879	NS	17.596	4.563	6.374	5.768	0.97
N^+ (%)	0.241	0.224	NS	0.290	0.243	0.189	0.207	0.02
K^+ (%)	0.330	0.328	NS	0.475	0.290	0.301	0.252	0.02
Spring 2003								
Shrub height (cm)	122.25	110.63	NS	152.50	45.75	199.00	68.50	36.89
Crown cover (m^2)	2.024	2.005	NS	3.881	0.114	3.387	0.676	1.33
Crown volume (m^3)	2.106	2.132	NS	3.693	0.037	4.575	0.211	1.38
F. yield /shrub (kg)	6.163	4.014	NS	10.250	0.600	8.752	0.750	3.52
D. yield /shrub (kg)	2.835	1.642	NS	3.844	0.463	4.250	0.396	1.89
F. forage yield (Ton/fed.)	6.471	4.213	NS	10.761	0.630	9.189	0.788	3.69
D. forage yield (Ton/fed.)	2.976	1.724	NS	4.036	0.486	4.463	0.416	1.99
Crude protein (%)	7.713	7.230	NS	7.545	6.653	8.173	7.515	NS
Crude fiber (%)	25.809	27.091	NS	18.789	22.086	33.161	31.764	4.03
Total ash (%)	10.480	9.641	NS	19.393	9.550	6.120	5.180	5.33
N^+ (%)	0.801	0.713	NS	0.861	0.759	0.710	0.699	0.10
K^+ (%)	0.326	0.291	NS	0.357	0.253	0.338	0.286	0.02

A_1: *Acacia sclerosprma* A_2: *Acacia cuthbertsonii*
A_3: *Acacia viectoria* A_4: *Acacia tetragenophylla*

The interaction effect between the two factor under study on grow parameters was not significant during wet and dry seasons during each of the two years except shrub height in autumn 2002. (Table 5).

The highest value of shrub height was obtained when *Acacia viectoria* was irrigated with water contain 4000 ppm .

II. Forage productivity

It is apparent from results presented in (Table 4) that both fresh and dry weight per shrub (kg) as well as their fresh and dry forage yields (Ton/ fed.) of different Acacia species were insignificantly affected by increasing salinity levels in irrigation water from 4000 to 8000 ppm during both seasons in the two years.

The obtained insignificant response of forage productivity to the applied water salinity levels may due to the great difference between the electrical conductivity of experimental soil site (Table 2) and irrigation water salinity (Table 3).

Table (5): Interaction effect of Acacia species to water salinity levels respect to some of studied parameters during autumn 2002.

Acacia species (A) / Salinity levels (ppm)	A1	A2	A3	A4
Shrub height (cm)				
4000	118.00	40.25	133.00	41.75
8000	127.63	37.13	119.88	55.13
LSD		8.90		
Fresh yield /shrub (kg)				
4000	11.313	0.182	2.188	0.257
8000	8.125	0.307	2.075	0.263
LSD		0.98		
Dry yield /shrub (kg)				
4000	4.057	0.090	1.331	0.125
8000	2.961	0.160	1.549	0.303
LSD		0.26		
Fresh forage yield (Ton/fed)				
4000	11.879	0.191	2.297	0.270
8000	8.532	0.322	2.179	0.486
LSD		1.02		
Dry forage yield (Ton/fed)				
4000	4.256	0.094	1.398	0.118
8000	3.109	0.170	1.537	0.318
LSD		0.31		
Crude protein (%)				
4000	7.724	5.938	5.832	4.032
8000	5.790	3.457	3.625	3.713
LSD		0.10		
Total ash (%)				
4000	15.209	4.389	6.157	7.332
8000	19.983	4.737	6.592	4.205
LSD		0.97		
Na^+ (%)				
4000	0.277	0.252	0.205	0.230
8000	0.304	0.235	0.173	0.184
LSD		0.01		

A_1: *Acacia sclerosprma* A_2: *Acacia cuthbertsonii*
A_3: *Acacia viectoria* A_4: *Acacia tetragenophylla*

With respect to the different Acacia species, data in Table (4) indicate that *Acacia sclerosprma* produced significantly higher fresh and dry weight of forage / shrub (kg) and their fresh and dry forage yields (Ton/ fed.) as well during both seasons in the two years except in the spring of the second year. However, *Acacia viectoria* surpassed the other Acacia species in forage dry weight / shrub (kg) and dry forage yield (Ton/fed.) during this season.

The interaction effect between the two main factors (salinity levels and Acacia species) was significant on fresh and dry forage weight/ shrub (kg) and for their fresh and dry yields (Ton/fed.) in autumn of the second year, (Table 5). The highest values were obtained for *Acacia sclerosprma* when irrigated with water contain 4000 ppm.

III. Chemical content:

Percentage of chemical composition of different forage material of Acacia species in wet and dry seasons of 2001/2002 and 2002/ 2003 under irrigation water salinity levels of 4000 and 8000 ppm are presented in (Table 4). Results show that there was gradual and slight insignificant effects on percentage of crude protein, crude fiber, total ash and mineral content by increasing salinity level of irrigation water from 4000 to 8000 ppm in both seasons. Meanwhile, it could be concluded that such increase in salinity levels from 4000 to 8000 ppm decreased crude protein percentage of the obtained forage of Acacia species. These results are in harmony with those found by Shenouda (1996) on Acacia species and Mohamed (2003) on *Ochradenus baccatus* and *Colutea istria*. This trend was true for other chemical contents except for the total ash percent in autumn (2001 and 2002) and crude fiber in spring (2003).

Concerning the different Acacia species, chemical content percentage of their forage responded significantly during both seasons of the two years except for crude protein in autumn 2001 as well as in spring 2002 and 2003; and for Na^+ and K^+ in autumn 2001. Maximum values of crude protein, total ash and minerals were obtained for *Acacia sclerosprma*. However *Acacia tetragenophylla* showed the maximum value of crude fiber.

The interaction effect between salinity levels and Acacia species on the chemical content of their forage was not significant during both seasons in two years except for crude protein (%), total ash (%) and Na^+ (%) in autumn 2002 (Table 5).

CONCLUSION

This study clearly showed that, under Ras Sudr Experimental Station conditions, some exogenous Acacia species shrubs (*Acacia sclerosprma* Benth, *Acacia cuthbertsonii* Benth, *Acacia viectoria* Benth-Bramblea and *Acacia tetragenophylla* F. Muell) can be planted and irrigated with brackish saline water containing 4000 and / or 8000 ppm.

Acacia sclerosprma Benth significantly surpassed the other three species in most growth parameters, forage productivity and chemical composition, mean while, *Acacia victoria* Benth – Bramblea came the following descending ranking order in this respect. Moreover they are of the most promising performance and can often grow in sites unsuited for sensitive forage crops production under salinity conditions.

Further research is need to complete the overall view of nutritional value for the successful Acacia species under salinity conditions.

Browsing simulation and feeding studies should be in also in consideration for future investigations.

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نمو وإنتاجية بعض أنواع الأكاسيا المدخلة تحت ظروف الملوحة براس سدر جنوب سيناء

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أجرى هذه البحث خلال الفترة من خريف ٢٠٠١ حتى ربيع ٢٠٠٢ وذلك لدراسة تأثير مستويان لملوحة مياه الرى (٤٠٠٠ و ٨٠٠٠ جزء فى المليون) على إنتاجية ونوعية أربع أنواع من شجيرات الاكاسيا. *(Acacia scle rosprma, Acacia cuthbertsonii, Acacia viectoria* and *Acacia tetragenophylla)* وذلك تحت ظروف محطة بحوث راس سدر- محافظة جنوب سيناء .

تضمنت الدراسة تقييم صفات النمو والمحصول العلفى الغض والجاف ومكوناتها الكيميائية (البروتين الخام - الألياف الخام - الرماد - الصوديوم- البوتاسيوم) خلال موسمى الخريف والربيع. وذلك للأنواع المختلفة من شجيرات الاكاسيا العلفية تحت ظروف الملوحة. وكانت أهم النتائج:

- استجابة صفات النمو (ارتفاع الشجيرة- الغطاء التاجى- الحجم التاجى) والمحصول الغض والجاف والتركيب الكيماوى سلبيا عند رفع مستوى ملوحة مياه الرى من ٤٠٠٠ إلى ٨٠٠٠ جزء / مليون. إلا أن الخلاف لم يكن معنويا.
- تفوقت *Acacia sclerosprma* على الثلاث أنواع الأخرى معنويا فى معظم صفات النمو والمحصول الغض والجاف والتركيب الكيماوى عدا ارتفع الشجيرة حيث تفوقت *Acacia viectoria*.
- تم الحصول على أعلى قيم لمحصول الشجيرة (كج) غض وجاف وكذلك الإنتاجية الغض والجافة (ط/ ف) عند رى *Acacia sclerosprma* بتركيز (٤٠٠٠ جزء / مليون)، بينما زادت بها النسبة المئوية للرماد والصوديوم عند ريها بتركيز (٨٠٠٠ جزء / مليون) خلال موسم الخريف ٢٠٠٢.