American-Eurasian J. Agric. & Environ. Sci., 1 (3): 215-224, 2006
ISSN 1818-6769

Response of *Dalbergia sissoo* to Sulphur Application under Saline Condition

[1]Azza A.M. Mazher, [2]Sahar M. Zaghloul and [2]A.A. Yassen

[1]Ornamental Plants and Woody Trees Department, [2]Plant Nutrition Department,
National Research Centre, Dokki, Cairo, Egypt

Abstract: A pot experiment was conducted during 2004 and 2005 seasons at National Research Centre, Dokki, Cairo, Egypt, to study the effect of sulphur application (0, 5 and 10 g/pot) rates on the growth and chemical composition of *Dalbergia sissoo* seedlings grown on calcareous soil irrigated with four concentrations of saline water (1000, 2000, 3000 and 4000 ppm). Results indicated that saline water application alone led to a significant decrease in all growth parameters, while those parameters were significantly increased with increasing sulphur application rates under irrigation with normal or saline water up to 4000 ppm. The use of saline irrigation water decreased the content of chlorophyll a, b and carotenoids, soluble, non soluble and total sugar as well as N, P, K and S concentration. While a pronounced increase was noticed for phenols and indoles contents, as well as Na, Cl and Ca concentration. On the other hand, all of those above mentioned gave the opposite results with sulphur application. The interactive effects between sulphur and salinity levels showed a markedly decrease in phenol and indole content, Na, Cl and Ca concentration, while chlorophyll a, b and carotenoids, soluble, non soluble and total sugar as well as N, P, K and S concentration increased. Almost similar trend was obtained for the uptake of concerned nutrients as previously mentioned for their concentration. It can be concluded that sulfur application had decreased the hazard effect of salinity, also, it had a favourable effect on growth and availability of chemical composition to *Dalbergia sissoo* seedlings grown on calcareous soils.

Key words: *Dalbergia sissoo* · growth · salinity · sulphur · calcareous soil

INTRODUCTION

Dalbergia sissoo is among the main timber trees cultivated as a source of woods, shade and forage in different kinds of soils. Worldwide, there is insufficient fresh water to develop all potential arable land. Several researchers have investigated the effect of salinity on growth of different woody trees species and they reported that, salinity stress at different concentrations usually reduces growth characters. Ahmed [1] on *Robinia pseudoacacia*, El Settawy and El-Gamal [2] on *Casuarina glauca*, Roussos and Pontikis [3] on *Simmondsia chiensis*, Azza *et al*. [4] on *Sesbania aegyptiaca* reported that salinity application decreased growth patterns. Abd El-Fattah [5] on *Adhatoda vasica*, *Hibiscus rosa sinensis* and *Phyllanthus embmlica*, Eid and Azza [6] on *Casuarina glauca*, Soad [7] on *Simmondsia chinensis* and Azza *et al*. [4] on *Sesbania aegyptiaca* found that saline water at different levels decreased various biochemical and chemical constituents such as chlorophyll a and b, soluble and non soluble sugar and N, P and K percentage but increased Ca and Na content. El-Baha *et al*. [8] on *Acacia saligna*, *Casuarina cunninghamiana* and *Eucalptus camaldulensis* and Soad [7] on *Simmondsia chinensis* found that increasing salinity levels significantly decreased N, P and K content in the leaves. Bondok *et al.* [9] working on peach mentioned that proline content tended to increase as a result of increasing salinity.

The sulfur metabolism of plants provides several mechanisms by which plants are able to deal with abiotic and biotic stress. The intensity of the mechanisms is supposed to be closely related to the sulfur nutritional status of plant and may be enhanced by applying sulfur fertilizers to the plant. Burke *et al.* [10] studying wheat found that leaf area reduced by sulfur deficiency in plants. Also, El-Magharby *et al.* [11] and El-Magharby [12] working on wheat stated that the application of sulfur

Corresponding Author: Dr. Azza A.M. Mazher, Ornamental Plants and Woody Trees Department, National Research Centre, Dokki, Cairo, Egypt

led to increases in yield. Burke *et al*. [10] and Dietz [13] mentioned that a drastic decrease in chlorophyll content of leaves is a feature of sulfur deficiency and total sugar content decreased by decreasing sulfur levels. On the other hand El-Magharby *et al.* [11] found that the total uptake of N, P and K were significantly increased when soil was treated by sulfur. In this respect, El Gala *et al.* [14] studying barley stated that dry matter yield was significantly increased with increasing sulfur application rates under irrigation with normal or saline water. Also, the interactive effect between sulfur rates and salinity levels showed a markedly decreases in Na concentration, while K, P and SO_4 increased.

The main objective of this work is to determine the influence of different rates of sulfur and saline water on the growth and chemical composition of *Dalbergia sissoo* trees grown in calcareous soil.

MATERIALS AND METHODS

The experiment was carried at the greenhouse of the National Research Centre during two successive seasons of 2004 and 2005 to investigate the response of *Dalbergia sissoo* seedlings grown under saline conditions, in addition to sulfur treatment in calcareous soil. The soil of the experimental site was calcareous in texture of the following characteristics 37.43% coarse sand, 39% fine sand, 8.75 silt, 14.82 clay, pH 7.3, EC 9.4 dS m^{-1}, $CaCO_3$ 50.48% OM 0.15%, Ca 37.11, Mg 13.53, Na 21.3, K 1.56, Cl 42.30, HCO_3 3.25 and SO_4 24.31 meq l^{-1}. Seeds of *Dalbergia sissoo* Family Memosaceae, were sown on the 15^{th} of March. Each pot received 3-5 seeds/pot. The soil samples were uniformly packed in pots of 30 cm diameter and 30 cm height at a rate of 10 kg calcareous soil. The seedlings were thinned twice at the age of 3 and 4 weeks leaving one seedling/pot. Elemental sulfur was mixed with the soil at three rates S_1, S_2 and S_3 (0, 0.5 and 1.0 ton/fed.) before cultivation. All plants received Kristalon (NPK 19:19:19) through this experimental work were used at a rate of 5.0 g/pot in four doses. The plants were fertilized after 4, 8, 16 and 20 weeks from sowing date. Seedlings were irrigated during the four weeks with tap water. Then, four salinity levels were prepared (1000, 2000, 3000 and 4000 ppm) by adding a mixture of sodium chloride and calcium chloride at a ratio (1:1) by weight for irrigating seedlings. Tap water was used for control; 250 ml of water was added to each pot twice a week through the course of this study (6 months).

The experimental design included 15 treatments which were the combinations of 4 salinity levels (1000, 2000, 3000 and 4000 ppm) viz control (Tap water) and three levels of sulfur (0, 5 and 10 g S/pot) of the air dried soil. A Completely Randomized in factorial experiment as a statistical Design was used, each treatment was replicated three times. Stem length (cm), stem diameter (mm), root length (cm), leaves number/plant, leaf area, fresh and dry weight of all plant organs (g) were estimated. The obtained results were subjected to statistical analysis of variance according to the method described by Snedecor and Cochran [15] and the combined analysis of the two seasons was calculated according to the method of Steel and Torrie [16]. The following chemical analysis was determined in soluble, non soluble and total sugar percentages were determined according to the method followed by Dubios *et al.* [17]. Chlorophyll (a, b and carotenoids content) were determined according to Saric *et al.* [18]. Total phenols were determined by using A.O.A.C. [19] procedures. Total indoles were determined according to the method followed by Selim *et al.* [20]. The proline concentration was determined using fresh material according to Bates *et al.* [21].

Nitrogen, phosphorus, potassium, sodium and calcium were determined according to the method described by Cottenie *et al.* [22]. Chloride percentage was determined according to the method described by Higinbothan *et al.* [23]. Sulfur percentage was determined according to the method described by Dewis and Freitas [24]. The physical and chemical properties of the soil were determined according to Chapman and Pratt [25].

RESULTS AND DISCUSSION

Growth characters: Data in Tables 1-3 revealed that all growth characters, stem length, stem diameter, root length, leaves number/plant, leaf area, fresh and dry weight of all plant organs decreased with increasing salt concentration. Ruf *et al.* [26] and Bolus *et al.* [27] stated that, the reduction in stem length might be due to the salinity as it decreased each of cell division, cell elongation and meristemic activity. Also, the reduction in leaves number/plant under salinity condition might be caused a disturbance in natural hormones in leading to unbalanced growth of the plant. In this respect, Bernstein *et al.* [28] reported that the effect of high salt concentration in the rooting media on growth may be due

Table 1: Effect of sulfur amendment on vegetative growth of *Dalbergia sissoo* Under different levels of salinity (average value of 2004 and 2005 seasons)

	Sulfur (g)							
Characters	Stem length (cm)				Stem diameter (mm)			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean
Control	35.31	39.74	41.54	38.86	5.10	5.70	6.30	5.70
1000	31.53	32.61	35.11	33.08	4.60	4.90	5.20	4.90
2000	25.71	26.11	30.34	27.39	4.20	4.30	4.60	4.37
3000	20.73	24.31	26.76	23.93	3.40	3.70	3.90	3.67
4000	17.11	20.51	23.11	20.24	2.30	3.00	3.20	2.83
Mean	26.08	28.66	31.37		3.90	4.30	5.80	
L.S.D. 0.05%								
A				2.52				0.56
B				1.78				0.39
A x B				3.56				0.79

	Sulfur (g)							
Characters	Root length (cm)				Leaves number/plant			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean
Control	24.51	25.96	29.37	26.61	13.35	14.51	16.11	14.66
1000	22.63	23.76	25.51	23.97	11.71	12.67	13.85	12.74
2000	17.64	19.64	23.44	20.24	10.07	12.11	12.71	11.63
3000	14.11	15.35	19.11	16.19	8.51	10.00	10.75	9.75
4000	12.63	14.61	16.73	14.66	6.11	7.05	8.13	7.10
Mean	18.30	19.86	22.83		9.95	11.27	12.31	
L.S.D. 0.05%								
A				2.18				0.81
B				1.54				0.57
A x B				3.09				1.14

	Sulfur (g)			
Characters	Leaf area			
Salinity (ppm)	0	5	10	Mean
control	4.19	4.53	5.24	4.65
1000	3.53	3.88	4.56	3.99
2000	3.11	3.47	3.89	3.49
3000	2.46	2.78	3.25	2.83
4000	2.15	2.60	2.81	2.52
Mean	12.31	3.09	3.45	3.95
L.S.D. 0.05%				
A				0.36
B				0.26
A x B				0.73

A: salinity B: sulfur

Table 2: Effect of sulfur amendment on fresh weight of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

	Sulfur (g)											
Characters	Stem				Leaves				Root			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Control	5.31	5.83	6.26	5.80	6.74	6.89	7.16	6.93	3.17	3.36	3.55	3.36
1000	4.63	4.95	5.11	4.90	5.15	5.45	6.17	5.59	3.00	3.12	3.31	3.14
2000	3.81	4.37	4.79	4.32	4.76	4.91	5.34	5.00	2.46	2.71	2.95	2.71
3000	3.06	3.34	3.68	3.36	3.55	3.87	4.11	3.84	2.05	2.19	2.34	2.19
4000	2.47	2.79	3.14	2.80	9.11	3.43	3.71	3.43	1.73	2.00	2.17	1.97
Mean	3.86	4.26	4.59		4.66	4.91	5.30		2.48	2.68	2.86	
L.S.D. 0.05%												
A				1.13				0.47				0.35
B				0.80				0.33				0.25
A x B				1.60				0.67				0.50

Table 3: Effect of sulfur amendment on dry weight of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

	Sulfur (g)											
Characters	Stem				Leaves				Root			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Control	3.01	3.22	3.49	3.24	3.15	3.37	3.77	3.43	2.02	2.09	2.17	2.09
1000	2.16	2.21	2.67	2.35	2.71	2.83	3.35	2.96	1.41	1.51	1.65	1.52
2000	1.77	1.96	2.16	1.96	2.14	2.37	2.76	2.42	1.05	1.20	1.24	1.16
3000	1.25	1.44	1.71	1.47	1.76	1.96	1.12	1.95	0.76	0.82	0.94	0.84
4000	0.87	1.12	1.29	1.09	1.12	1.27	1.56	1.32	0.61	0.66	0.78	0.68
Mean	1.81	1.99	2.26		2.18	2.38	2.71		1.17	1.26	1.36	
L.S.D. 0.05%												
A				0.25				0.63				0.12
B				0.18				0.44				0.08
A x B				0.37				0.86				0.17

A: salinity B: sulfur

to the osmotic inhibition of water absorption, by specific ions concentration in the saline media or a combination of both. The decrease in fresh weight of leaves might be due to salinity that increased osmotic pressure which caused a drop in plant water content as found by Sanchezconde and Azura [29]. High salinity levels caused a depression in photosynthetic activities resulting in low CO_2 fixation. The decrease in leave dry weight due to salinity treatments might be attributed to that salinity reduced the synthesis of organic matter in leaves of the plant as mentioned by Kabanov *et al.* [30] on pea. The decrease in stem weight may be due to the inhibition of water absorption and this greatly affected the metabolic processes. However, the decrease in root fresh and dry weights due to salinity might be due to the reduction in water and minerals absorption and/or the reduction in upper ground growth. These result are in harmony with those found by El Settawy and El-Gamal [2] Roussos and Pontikis [3] Azza *et al.* [4] and Eid and Azza [6].

All previous growth characters were greatly stimulated by using at different concentration levels of S. The stimulation was gradual and parallel to the increase in the level with up 10 g. Scott [31] and El-Shall *et al.* [32]

Table 4: Effect of sulfur amendment on Chlorophyll a, b and carotenoids (mg g^{-1} F.W.) of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

	Sulfur (g)											
Characters	Chlorophyll (a)				Chlorophyll (b)				Carotenoids			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Control	2.17	2.23	2.33	2.24	0.65	0.71	0.79	0.72	0.92	0.97	1.15	1.01
1000	1.93	2.01	2.17	2.04	0.56	0.66	0.73	0.65	0.87	0.93	0.98	0.93
2000	1.81	1.85	2.03	1.90	0.53	0.62	0.65	0.60	0.82	0.91	0.93	0.89
3000	1.62	1.68	1.76	1.75	0.48	0.55	0.61	0.55	0.63	0.69	0.81	0.71
4000	1.30	1.34	1.58	1.41	0.43	0.48	0.53	0.48	0.55	0.59	0.76	0.63
Mean	1.77	1.83	1.97		0.53	0.60	0.66		0.76	0.82	0.93	

found that the favorable effect of sulfur was referred to its influence on reducing soil pH, improving soil structure and increasing the availability of certain plant nutrients. Marschner [33] stated that, sulfur requirement for optimal growth varies between 0.1 and 0.5% of the dry weight of plants. Also, under sulfur deficiency shoot growth is more depressed than root growth, leading, for example in tomato, to a decrease in shoot-root dry weight ratio from 4.4 in sulfur sufficient to 2.0 in sulfur deficient plants [34]. Interruption of a sulfur supply within a few days decreases root hydraulic conductivity, stomatal aperture and net photosynthesis [35]. The reduced leaf area in sulfur-deficient in plants is the result of both smaller size and particularly number of leaf cells [10]. The number of chloroplasts per mesophyll cell might or might not be affected, for example, in wheat [10] or distinctly decreased, for example in spinach [13].

Concerning the effect of interaction, sulfur treatments were also effective on the growth characters of salinized water irrigated plant, the growth characters were greatly induced, these trends point out the ability of inoculation to overcome the restricting effect of this type of irrigation water. This could be due to the influence of produced sulphate ions on decreasing the hazard effect created by both Na and Cl ions. Such results were in good agreement with those reported by Gohk *et al.* [36].

Chemical composition:

***Pigments content*:** Data in Table 4 show that, increasing salinity level generally decreased the content of photosynthetic pigments (chlorophyll a, b and carotenoids). These results are in agreement with those obtained by Patil *et al.* [37] and Batanouny *et al.* [38] who found that the lowered photosynthetic ability under salt stress conditions was due to stomata closure, inhibition of chlorophyll synthesis, a decrease of carboxylase and due to high chlorophyllase activity.

Regarding the effect of sulfur, all photosynthetic pigments increased by increasing sulfur rates. The former results were in agreement with those obtained by Dietz [13] who reported that, this is to be expected as in leaves a high proportion of the protein is located in the chloroplasts where the chlorophyll molecules comprise prosthetic groups of the chromoproteid complex. Accordingly, under sulfur deficiency, shortage of the sulfur-containing amino acids cysteine and methionine not only inhibits protein synthesis but also decreases the chlorophyll content in leaves in a similar manner.

Dealing with salt stress and sulfur interaction, the data indicated that the combination of both factors on chlorophyll a, b and carotenoids was more effective than the effect of each factor when tested alone.

***Sugar percentage*:** It was clear from Table 5 that soluble, non soluble and total sugar percentage showed the same trend as photosynthetic pigment in regard to the influence of salinity treatments. soluble, non soluble and total sugars were gradually augmented as the salinity concentration was sloping down. In this concern, Kabanov *et al.* [30], mentioned that high salinity levels caused a depression of photosynthetic activates, resulting in low CO_2 fixation. The absorption of mineral could be retarded leading to low plant metabolism.

As for the effect of sulfur on sugar percentage, sulfur at both used rates caused an increase in soluble, non soluble and total sugar percentage as compared with the untreated seedlings. Increase in sugar percentage being

Table 5: Effect of sulfur amendment on soluble, non soluble and total sugar percentage of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

Characters	Sulfur (g)											
	Soluble sugar (%)				Non soluble sugar (%)				Total sugar (%)			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Control	4.26	4.61	4.78	4.55	16.76	17.09	17.74	17.20	21.02	21.70	22.52	21.75
1000	3.57	4.33	4.51	4.14	15.14	15.64	16.07	15.60	18.71	19.97	20.58	19.75
2000	3.21	4.11	4.37	3.90	14.21	14.64	15.11	14.65	17.42	18.75	19.48	18.55
3000	3.13	3.78	3.91	3.61	13.76	13.97	14.36	14.03	16.93	17.75	18.27	17.65
4000	2.67	2.89	3.16	2.91	12.11	13.54	13.86	13.17	14.78	16.43	17.02	16.08
Mean	3.37	3.94	4.15		14.40	14.98	15.43		17.77	18.92	19.57	

Table 6: Effect of sulfur amendment on proline, Phenols and Indoles contents of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

Characters	Sulfur (g)											
	Proline (μm g^{-1})				Phenols (mg g^{-1} F.W.)				Indoles (mg g^{-1} F.W.)			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Control	3.9	3.50	2.90	3.43	13.37	12.07	10.71	12.05	1.83	1.67	1.58	1.69
1000	4.7	4.10	3.50	4.10	15.16	13.31	11.00	13.16	1.91	1.84	1.70	1.82
2000	5.5	4.80	4.10	4.80	16.74	15.12	13.07	14.98	1.99	1.88	1.74	1.87
3000	6.7	5.60	5.00	5.77	19.11	17.41	15.13	17.22	2.07	1.95	1.83	1.95
4000	8.2	7.20	5.80	7.07	21.43	18.34	16.36	18.71	2.14	2.01	1.94	2.03
Mean	5.8	5.04	4.23		17.16	15.25	13.25		1.99	1.87	1.76	

gradual and parallel to increase the applied level of S up to 10 g. The positive effect of sulfur on enhancing the sugar percentage may be due to starch may accumulate as consequence either of impaired carbohydrate metabolism at the sites of production (the source) or of low demand at the sink sites (growth inhibition) [33]. The interaction between two factors (salinity x sulfur) showed an increased in sugar percentage compared with using each alone.

***Proline content*:** Data in Table 6 indicated that, salinity increased proline concentration as its concentration increased up to that 4000 ppm. Levitt [39] mentioned that, salt stress inhibits growth and protein synthesis preventing the utilization of proline and thus leading to its accumulation. There is also, evidence that proline accumulation is a sign of injury rather than of resistance.

On the other hand, proline concentration decreased by increasing sulfur rates. Considering the interaction effect, lowest proline values were generally found when using sulfur at a rate of 10 g combined with tap water salinity then with 1000 ppm salinity.

***Phenols and Indoles content*:** Similarly phenols and indoles contents showed the same trend obtained previously on proline content. They were increased as the salinity concentration increased. Sweidan *et al.* [40] stated that accumulation of phenolic compounds in plants tissues may be considered as one of the indirect factors causing toxicity of salt treated plants and consequently reduce its growth. Indeed, this may be attributed to the fact that phenolics may have indirect effect on physiological processes, through more non specific effects on intermediary metabolism. Concerning

Table 7: Effect of sulfur amendment on N, P and K percentage of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

Characters	Sulfur (g)											
	N %				P %				K %			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
Control	2.47	2.59	2.71	2.59	2.55	2.61	2.75	2.64	2.31	2.39	2.51	2.40
1000	2.15	2.19	2.37	2.24	2.23	2.37	2.51	2.37	2.00	2.11	2.15	2.09
2000	1.56	1.76	1.90	1.74	1.9	2.05	2.16	2.04	1.65	1.71	1.76	1.71
3000	1.12	1.31	1.45	1.29	1.67	1.72	1.84	1.74	1.31	1.35	1.39	1.35
4000	0.78	0.97	1.07	0.94	1.23	1.60	1.67	1.50	0.99	1.12	1.18	1.10
Mean	1.62	1.76	1.90		1.92	2.07	2.19		1.65	1.74	1.80	

Table 8: Effect of sulfur amendment on N, P and K uptake / plant leaves of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

Characters	Sulfur (g)											
	N				P				K			
Salinity (ppm)	0	5	10	Mean	0	5	10	Mean	0	5	10	Mean
control	77.81	87.28	102.17	88.84	80.33	87.96	103.68	90.55	72.77	80.54	94.63	82.30
1000	58.27	61.98	79.40	66.30	60.43	67.07	84.09	70.15	54.20	59.71	72.03	61.86
2000	33.38	41.71	52.44	42.12	40.66	48.59	59.62	49.37	35.31	40.53	48.58	41.38
3000	19.71	25.68	30.74	25.16	29.39	33.71	39.01	33.93	23.06	26.46	29.47	26.33
4000	8.74	12.32	16.69	12.41	13.78	20.32	26.05	19.80	11.09	14.22	18.41	14.52
Mean	29.32	32.05	42.94		41.86	49.27	59.53		35.97	41.41	48.78	

Table 9: Effect of sulfur amendment on Na, Ca percentage and uptake/plant leaves of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

Caharcters	Sulfur (g)															
	Na %				Na uptake				Ca %				Ca uptake			
Salinty (ppm)	0	200	400	Mean	0	200	400	Mean	0	200	400	Mean	0	200	400	Mean
Control	3.15	2.86	2.41	2.79	99.23	94.36	90.86	94.82	2.13	1.85	1.45	1.81	67.1	62.35	54.67	61.37
1000	3.41	3.01	2.53	2.98	92.41	85.18	84.76	87.45	2.17	1.91	1.58	1.89	58.81	54.05	52.93	55.26
2000	3.52	3.13	2.65	3.10	75.33	74.18	73.14	74.22	2.30	1.99	1.67	1.99	49.22	47.16	46.09	47.49
3000	3.81	3.26	2.74	3.27	67.06	63.90	58.09	63.02	2.38	2.08	1.75	2.07	41.89	40.77	37.10	39.92
4000	4.11	3.49	2.79	3.46	46.03	44.32	43.52	44.62	2.68	2.30	1.80	2.26	30.02	29.21	28.08	29.10
Mean	3.60	3.14	2.62		76.01	72.39	70.07		2.33	2.03	1.65		49.41	46.71	43.77	

Table 10: Effect of sulfur amendment on S, Cl percentage and uptake/ plant leaves of *Dalbergia sissoo* under different levels of salinity (average value of 2004 and 2005 seasons)

Caharcters	Sulfur (g)															
	S %				S uptake				CL %				CL uptake			
Salinty (ppm)	0	200	400	Mean	0	200	400	Mean	0	200	400	Mean	0	200	400	Mean
Control	0.20	0.24	0.28	0.24	6.30	8.10	10.60	8.33	0.45	0.37	0.28	0.37	15.44	12.47	10.56	12.82
1000	0.17	0.21	0.24	0.21	4.60	5.94	8.04	6.19	0.55	0.41	0.31	0.42	14.91	11.6	10.39	12.30
2000	0.15	0.18	0.21	0.18	3.21	4.27	5.80	4.43	0.64	0.48	0.37	0.50	13.7	11.38	10.21	11.76
3000	0.12	0.16	0.19	0.16	2.11	3.14	4.03	3.09	0.73	0.56	0.44	0.58	12.85	10.98	9.33	11.05
4000	0.09	0.12	0.15	0.12	1.01	1.52	2.34	1.62	0.91	0.74	0.57		10.19	9.4	8.89	9.49
Mean	0.15	0.18	0.21		3.45	4.59	6.16		0.66	0.51	0.39		13.42	11.17	9.88	

sulfur, phenols and indoles contents were decreased with increasing sulfur rates.

As for the interaction effect between water salinity and sulfur, the lower values were provided when adding 10 g sulfur combined with tap water salinity than with 1000 ppm salinity.

***Mineral content*:** Data presented in Tables 7-10 revealed that the use of saline water decreased the percentage and uptake of N, P, K and S in leaves. Saline conditions were claimed to inhibit growth through the osmotic limitation of water absorption and or specific ion effects of the constituent's ion the saline medium [41]. The effect operated on both components of the plant production system i.e. by inducing disturbances in plant nutrition. Such disturbances was clearly shown in the obtained results, for instance, the decrease in N, P and K content with an increase in proline content which might indicate disturbance in protein metabolism. Similarly Na, Ca and Cl uptake presented the same trend obtained previously on the percentage and uptake of N, P, K and S. They were decreased as the salinity concentration was increased. On the other hand, Na, Ca and Cl percentages showed an opposite trend, they increased by increasing salinity concentration. The obtained reduction in K uptake might refer to the existence of some antagonistic effects between Na and K that might be responsible for the diminished (K) concentration under saline condition [42]. Generally, the decrease in the contents of some nutrients determined under salinity condition might be attributed to the depressive effects of salinity on the absorption, uptake and or translocation of these elements.

On the contrary, the percentage and uptake of N, P, K and S were clearly increased in leaves while the percentage and uptake of Na, Ca and Cl tended to decrease as a result of S application. Similar results were obtained by El Gala *et al*. [14].

The favorable effects of sulfur may be referred to its influence on increasing the availability of such nutrients as previously mentioned.

The interaction effect between different salinity levels and sulfur application rates showed that the highest values percentage and uptake of N, P, K and S illustrated in the seedling treated with sulfur at level of 10 g and combined with saline water irrigation at level 1000 ppm mixed salts. Meanwhile, the interaction showed that sulfur treatments decreased Na, Ca and Cl concentration in plants grown on calcareous soil, but their values still higher than those found for the control treatment. These could be due to the influence of produced sulphate ion on decreasing the hazard effect created by both Na and Cl ions. Such results were in good agreement with those reported by Gohk ***et al.*** [36].

From the above mentioned results, it can be concluded that, sulfur application had decreased the hazard effect of salinity of irrigation water, in addition had favorable effect on growth and availability of chemical compositions to *Dalbergia sissoo* seedlings grown on calcareous soils.

REFERENCES

1. Ahmed, E.T., 1998. Effect of soil salinity and GA_3 on growth and chemical composition of *Robinia pseudoacacia* L. seedlings. Proc. Sec. Conf. of Ornam. Hort., Ismailia, Egypt.
2. El Settawy, A.A. and A.A. El-Gamal, 2003. Effect of salinity stress on the growth of *Casuarina glauca* Sieber Ex Spreny and nodulation by endpoint frankia. Alex. J. Agric. Res., 48: 149-156.
3. Roussos, P.A. and C.A. Pontikis, 2003. Long term effect of sodium chloride salinity on growing *in vitro* proline and phenolic compound content of jojoba explant. European J. of Hort. Sci., 68: 38-44.
4. Azza, A.M. Mazher, Rawya, A. Eid and Nahed, G. Abd El-Aziz, 2006. Effect of Microbien under salt stress on nodulation, growth and chemical constituents of *Sesbania aegyptiac* in sandy soil, Bull. NRC., Egypt, 31: 247-268.
5. Abd El-Fattah, G.H., 2001. Physiological studies on some shrubs. Ph. D. Thesis, Fac. of Agric., Zagazig Univ.
6. Eid A. Rawya and Azza A.M. Mazher, 2004. Effect of gibberellins spray on growth and some chemical constituents of *Casuarina glauca* seedlings grown under diluted sea water conditions. J. Agric. Sci. Mansoura Univ., Egypt.
7. Soad M.M. Ibrahim, 2005. Responses of vegetative growth and chemical composition of jojoba seedlings to some agricultural treatments. Ph.D. Thesis, Fac. of Agric. Minia Univ. Egypt.
8. El-Baha, A.M., A.A. EL-Settawy, E.E. Kandeel and N.H. Mohamed, 2003. Effect of irrigation with different levels of sea water and fertilization on growth and mineral content of some timber tree seedlings. Effect on plants. Alex. J. Agric. Res., 48: 183-197.
9. Bondok, A., H. Tawfic, A. Shaltout and N. Abdel-Hamid, 1995. Effect of salt stress growth and chemical constituents of three peach rootstocks. Assiut J. of Agric. Sci., 26: 173-194.

10. Burke, J.J., Holloway and M.J. Dalling, 1986. The effect of sulfur deficiency on the organization and photosynthetic capability of wheat leaves. J. Plant Physiol., 125: 371-375.
11. El-Magharby, S.E., F.A. Hashem and M.M. Wassif, 1996. The use of sulfur and organic manure for controlling soil salinity pollution under high saline water irrigation. Egypt. J. Soil Sci., 36: 269-288.
12. El-Magharby, S.E., 1997. Impact of natural conditioners and saline irrigation water frequency of calcareous soil productivity. Egypt. J. Soil Sci., 37: 267-281.
13. Dietz, K.J., 1989. Recovery of spinach leaves from sulfate and phosphate deficiency. J. Plant Physiol., 134: 551-557.
14. El Gala, A.M., M.A. Mostafa and S.E. El-Magharby, 1889. Influence of sulphur and saline irrigation water on growth and elemental status of barley plant grown on calcareous soil. Egypt. J. Soil Sci., S: 443-455.
15. Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods, 7th ed. Iowa Stat Univ., Press Amer, Iowa, USA.
16. Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics. Mcgrow-hill book Co., Inc., Newyork, Toronto, London.
17. Dubios, M., A, Giolles, Hamelton P.A. Robers and P.A. Smith, 1959. A clorimetric for determination of sugar and related substances. Anal Chin., 28: 350-356.
18. Saric, M.R. Kostrori, T. Cupina and I. Geric, 1967. Chlorophyll determination Univ. U. Noven Sadu Prakitikum is kiziologize Bilijaka Beogard, Haucna, Anjiga.
19. A.O.A.C., 1965. Officinal Methods of Analysis, 9th ed. Benjamin Frankl in Washington.
20. Selim, H., M.A. Fayek and M.A. Sweidan, 1978. Reproduction of Bircher apple cultivar by layering. Ann. Agric. Sci., Moshtohor, Egypt, 9: 127.
21. Bates, L.S., R.P. Waldren and I.D. Teare, 1973. Rapid determination of proline for water stress studies. Plant and Soil, 39: 205-207.
22. Cottenie, A., M. Verloo, L. Kiekens, G. Velghe and R. Camerlynck, 1982. Chemical Analysis of Plant and Soil. Laboratory of Analytical and Agrochemistry, State Univ. Ghent. Belgium, pp: 100-129.
23. Higinboyhandan, N., B. Ethero and R.J. Fosyer, 1967. Nineration contents and cell transmembran electropotential of pea and oat seedlings tissue, Plant Physiol., 42: 37-46.
24. Dewis, J. and Freitas, 1970. Physical and chemical methods of soil and water analysis. Food and Agric. Organization of the United Nation, Soil Bulletin No. 10: 233-238.
25. Chapman, H.D. and P.F. Pratt, 1961. Methods of Analysis for Soils, plant and water. Div. of Agric. Sci. Univ. of Calif, pp: 309.
26. Ruf, R.H. Jr., R.E. Eckart Jr. and O. Richard, 1963. Osmotic adjustment of cell sap to increase in root medium osmotic stress. Soil Sci., 96: 326-330.
27. Bolus, S.T., M.N. El-Shourbary and N.L. Missak, 1972. Studies on the effect of salinity on the epidermis and the mesophll tissnes of some *Ricinus communis* L. Varieties. Desert Inst. Bull., 22: 421-432.
28. Bernstein, L., L.E. Francois and R.A. Clark, 1972. Salt tolerance of ornamental shrubs and ground covers. J Amer. Soc. Hort. Sci., 97: 550-556.
29. Sanchezconde, M.P. and P. Azura, 1979. Effect of balanced solution with different osmotic pressure tomato plant. J. Plant Nutr., 3: 295-307.
30. Kabanov, V.V., E.I. Tsenov and B.P. Strogonov, 1973. Effect of NaCl on the content and synthesis of nucleic acids in pea leaves Fisiolgiva. Rastenii, 20: 466-472.
31. Scott, N.M., 1985. Sulphur in soils and crop in the North of Scotland. Soils and Fert., 48: 10045.
32. El-Shall, A.M., M. Wassif Hilal and I. El Bagouri, 1986. Response of barley to sulphur application in calcareous soil under saline irrigation water. Desert Inst. Bull., A.R.E., 37: 11-17.
33. Marschner, H., 1995. Mineral nutrition of higher plant. Academic Press, Orlando F.L.
34. Edelbauer, A., 1980. Auswirkuny van abgestuften Schwefelmangel auf Wachstum, Substanzbildung und Minerals to ffgehalt von tomate (*Lycopersicon esculentum* Mill in Nahrlosungskultur. Die Bodenkultur, 31: 329-241.
35. Karmoker, J.L., D.L. Clarkson, L.R. Saker, J.M. Rooney and T.V. Purves, 1991. Sulphate deprivation depresses the transport of nitrogen to the xylem and the hydraulic conductivity of barley (*Hortdeum vulgare* L.). Roots Planta, 185: 269-278.
36. Gohk, M., R.J. Hanyanes and K. Keet, 1980. Ionic plants and composition of perennial ryegrass. Soil and Fert., 34: 1414.
37. Patil, T.M., P.B. Mirojkar, B.A. Hedge and G. Joshi, 1983. Influence of salinity on morphology, rate of CO_2 assimilation photosynthesis products and enzyme activities in sorghum hybrid CSH-S. Indian J. of Plant Physiol., 26: 153-162.

38. Batanouny, K.H., M.M. Hussein and M.S. Abo El-Kheir, 1988. Response of *Zea mays* to temporal variation of irrigation and salinity under farm conditions in the Nile Delta Egypt, International conference on plant growth, Drought and salinity in the Arab region, Cairo Univ. Egypt, December 3-7.
39. Levitt, J., 1980. Responses of plant to Environmental stress. Academic Press, New York.
40. Sweidan, A.M., A.T. Salem and G.R. Stino, 1982. Growth and mineral content of apricot seedlings as influenced by various levels of sodium chloride. Res. Bull., Zagazig, Univ., Fac., Agric., 9: 544-557.
41. Russel, E.W. and E.J. Russel, 1961. Soil conditions and plant growth, 9^{th} ed. 2.30 Grratlaugmans Rut Ltd. Calcutta.
42. Ayers, A.D. and D.L. Eberhard, 1960. Response of edible broad bean to several levels of salinity. Agron. J., 52: 110-111.