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Response of *Schefflera Arboricola* L. To Gypsum and Sulphur Application Irrigated with Different Levels of Saline Water

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Abstract: A pot experiment was conducted during 2009 and 2010 seasons at National Research Centre, Dokki, Cairo, Egypt,to study the effect of adding gypsum(20gm) and sulphur(20gm) on growth and chemical composition of *Schefflera arboricola* seedlings grown on sandy soil irrigated with three concentrations of saline water (0, 2000 and 4000ppm).Results indicated that saline water application alone led to a significant decrease in all parameters, while those parameters were significantly increased with gypsum or sulphur application under irrigation with normal or saline water up to 4000ppm.The use of saline irrigation water decreased the content of chlorophyll a, b and carotenoids and total carbohydrates as well as N,P,K and S concentration. While, a pronounced increase was noticed for Na, Ca concentration and proline content. On the other hand, all of those above mentioned gave the opposite results with gypsum and sulphur application. The interactive effects between gypsum or sulphur plus salinity levels showed a markedly decrease in Na, Ca concentration and proline content, while chlorophyll a, b and carotenoids and total carbohydrates as well as N,P,K and S concentration increased compared with saline water treatments. It can be concluded that gypsum or sulphur application had decreased the hazard effect of salinity, also, they had a favourable effect on growth and availability of chemical composition to *Schefflera arboricola* seedlings grown on sandy soil

Key words: Indoor plants- *Schefflera arboricola*-Salt stress-Soil amendments

INTRODUCTION

Brassaia (Schefflera) spp. Queensland, star leaf umbrella plant, belongs to family Araliaceae .The genus of Brassaia includes 150 species, which has its name in honor of 19th centry German botanist Jacob Schefflera (Uphof 1959). *Schefflera arboricola* L. is an evergreen shrub, 200 cm. or more height with large decorative leaves. These plants are good choice for interior conditions, as pot plants and good specimens in the gardens. The species Schefflera is used as an antipyretic, antiflammetory, analgesic and tomic and to treat liver diseases (Baily, 1978).

Gypsum is calcium sulfate dihydrate ($CaSO_4\,2H_2O$), and is a mineral from the evaporite family Zumberge, (1976). Gypsum and other evaporates are typically formed from the evaporation of seawater after the climate has changed to more arid conditions. The functions of gypsum is agriculture are crop nutrition (Ca and S),ameliorate subsoil acidity by increasing crop rooting depth and increasing water and nutrient uptake at depth, improve water infiltration and drainage, reduce soil crusting for better seedlings emergence and ameliorate sodium-affected soils.(Pavan *et al*.,1984;Sumner *et al*., 1986;Farina&Channon, 1988 and Raij *et al*.,1998).

Sulphur is increasingly used as component of fertilizers. The most important from of sulphur for fertilizer is the mineral calcium sulfate. Sulphur also improves the use efficiency of other essential plant nutrients, particularly nitrogen and phosphorus. Ceccotti,(1996). Plant requirements for sulphur are equal to or exceed those for phosphorus. It is one of major nutrients essential for plant growth, root nodule formation of legumes and plant protection mechanisms. Sulphur deficiency has become widespread in many countries, because atmospheric inputs of sulphur will continue to decrease, the deficit in the sulphur input/output is likely to increase, unless sulphur fertilizers are used (Zhao, 1999 and Blake-Kalff, 2000).

Salinity is considered a significant factor affecting ornamental plants and woody trees production and agricultural sustainability in many regions of the world as it reduces the value and productivity of the affected land.

Salinity adversely affects plant by inducing injury, inhibiting growth, altering in plants morphology and anatomy, often being a prelude to tree mortality(Kozlowski and Pallardy,1997).Maynard *et al*.(1997) on *Picea glauca* and El-Settawy and El-Gamal(2003) on *Casuarina glauca* seedlings found that plant height, steam diameter, total dry matter were decreased by increasing salinity stress. Morphological symptoms are the results of interaction of all injuries effects of salinity, salt stress may inhibit cell division and/or cell elongation in the growing tissues of roots, stems and leaves Zidan *et al*., (1990) which lead to reduce plant height, dry weight of the plant parts and number of leaves of gerbera plant Jimenez *et al*., (1997).Thus, the main objective of this

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work is to determine the influence of different soil amendments (gypsum or sulphur) and saline water on growth and chemical composition of *Schefflera arboricola* seedlings grown in sandy soil .

MATERIALS AND METHODS

A pot experiments were carried out at the greenhouse of the National Research Centre, Dokki, Giza, Egypt during 2009 and 2010 seasons to evaluate the effect of gypsum and sulphur on growth and chemical constituents of *Schefflera arboricola* L. irrigated with saline water. The investigated soil characterized by coarse sand 80.5%, fine sand 9.4%, silt 4.5% and 5.6% clay with pH 7.8, EC 1.4dsm^{-1},$CaCo_3$2.46%, K^+0.3, Na^+2.3, Ca^{++}1.0, Mg^{++}0.6, $HCO^-_3$2.3, Cl^-1.8, $SO^=$0.1meqL^{-1}. The seedlings were obtained from the Research and Production Station, Nubaria, the seedlings were planted at the first week of March during the two successive seasons, as seedling/pot 30cm in diameter filled with 10kg soil, the average height of seedlings was 18-20cm. After planting, seedlings were irrigated using tap water for 21days. Gypsum ($CaSo_42H_2O$) and Sulphur (S) were mixed with the soil before cultivation. Saline water irrigation was prepared by mixing salts of sodium chloride (NaCl) and calcium chloride ($CaCl_2$) .One letre of water was added to each pot twice a week throughout the course of the study(6 months), starting from March until the ending of the experiment. Gypsum and sulphur were mixed with the soil at the rate (20g/pot) before cultivation. All plants were received with kristalon (NPK19:19:19) through the growth season at the rate of 15.0g/pot divided in three doses, after 4,8,16 weeks from planting. Other agricultural processes were performed according to normal practice. At harvest time 20th September 2009 and 2010 seasons, the growth characters, i.e. plant height (cm), stem diameter (mm), number of leaves/plant, root length(cm), leaf area (cm^2) and fresh and dry weights of leaves, stems and roots (gm) were recorded.

The statistical analysis of the experiment was Completely Randomized Design with 9 treatments as following:- [two salinity levels (2000 and 4000ppm), gypsum (20g) and sulphur (20g) either alone or with combination with different salinity levels, additionto untreated plants]. Each treatment included three replicates (3pots). The following chemical analysis was determined as follows: Chlorophyll a,b and carotenoids contents were determined in leaves according to Saric *et al.*,(1967). Total carbohydrates percentage in leaves, stems and roots was determined according to Dubois *et al* ., (1956). Total proline content was determined using fresh material in all plant organs according to Bates *et al*.,(1973). Nitrogen, phosphorus, potassium, calcium and sodium were determined in all plant organs according to the method described by Cottenie *et al*., (1982). Sulphur percentage was determined according to the method described by Dewis and Freitas (1970).The physical and chemical properties of the soil were determined according to Chapman and Partt (1961). All previous data were subjected to statistical analysis according to procedure outlined by Snedecor and Cochran(1980) and the combined analysis of the two seasons was calculated according to the method of Steel and Torrie (1980).

RESULTS AND DISCUSSION

Growth Characters:

Data presented in Tables (1 and2) show the effect of different levels of salinity water on vegetative growth, it is clear that increasing salinity levels significantly decreased all growth parameters, plant height, stem diameter, leaves number/plant, root length, leaf area and fresh and dry weights of all plant organs. The depressive effect on plant height by salinity might be mainly attributed to reduction in cell division and enlargement, water stress induced by salinity, also causes of stomata which reduced the supply of carbon dioxide for photosynthesis (Lewis *et al*.,1980).In this context, the inhibition in stem diameter according to salinity treatment may be attributed to excessive ion accumulation in plant tissue and/or changed the endogenous growth hormones balance (Aldesuquy,1991). Additionally, natural hormones might be affected due to the saline conditions leading to unbalanced growth of the plant, consequently ,the decrease in number of leaves/plant.

In this respect, Dunlap and Binzel (1996) showed that increasing concentrations of Na Cl can reduce the endogenous level of IAA in roots, this auxin is known to promote cell elongation. Therefore, it can be suggested that IAA concentrations under saline conditions may be insufficient to induce root elongation. The obtained data also cleared that, stem, leaves and root fresh and dry weight were significantly decreased gradually by increasing salinity levels. This effect was pronounced in plants grown under higher salinity level. The depressive effects of salinity on fresh weight of stem and leaves might be attributed to the inhibitory effects induced by salinity on many metabolic processes including enzyme activities, protein and nucleic acid synthesis and the activities of mitochondria and chloroplast(Sanchezconde and Azura1979).In addition, suppression of dry weight of stem and leaves under saline condition may either be due to osmotic reduction in water availability, which was supported by stomatal resistance value of the plants, or to excessive ions, Na and Cl accumulation in plants tissue (Gunies *et al*.1996).

Table 1: Effect of gypsum and sulphur application on plant height (cm), stem diameter (mm),leaves number/plant, root length(cm) and leaf area (cm^2)*Schefflera arboricola* seedlings irrigated with different levels of saline water (Average of two season 2009 and 2010).

Characters	Plant height(cm)	Stem diameter(mm)	Leaves number/plant	Root length(cm)	Leaf area (cm)
Control	62.00	8.9	16.66	32.00	3.18
Salinity(2000ppm)	58.11	8.6	15.07	31.66	2.41
Salinity(4000ppm)	54.00	8.5	14.63	28.66	2.11
Gypsum(20gm)	79.00	11.4	23.00	42.33	6.13
Sulphur(20gm)	75.31	9.9	20.65	39.33	5.68
Salinity(2000ppm)+Gypsum(20gm)	71.41	9.3	19.00	38.00	4.45
Salinity(4000ppm)+Gypsum(20gm)	66.12	9.1	18.00	36.33	3.90
Salinity(2000ppm)+Sulphur(20gm)	68.60	9.2	17.35	37.00	4.00
Salinity(4000ppm)+Sulphur(20gm)	65.31	9.0	17.00	33.66	3.44
L.S.D at 5%	2.02	0.1	0.31	1.01	0.02

Table 2: Effect of gypsum and sulphur application on fresh and dry weight in leaves, stem and roots(gm) of *Scheflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2009 and 2010).

Characters	Fresh weight(g)			Dry weight(g)		
Treatments	Leaves	Stems	Roots	Leaves	Stems	Roots
Control	46.83	23.61	25.11	11.47	6.37	7.71
Salinity(2000ppm)	43.86	20.01	23.31	10.05	5.61	7.02
Salinity(4000ppm)	40.55	17.51	21.31	9.32	4.13	6.33
Gypsum(20gm)	63.44	31.37	40.41	17.13	9.25	13.34
Sulphur(20gm)	60.48	28.00	38.42	16.29	8.20	12.52
Salinity(2000ppm)+Gypsum(20gm)	57.91	26.33	37.36	14.33	7.87	11.99
Saslinity(4000ppm)+Gypsum(20gm)	52.00	22.75	28.74	12.98	7.01	9.02
Salinty(2000ppm)+Sulphur(20gm)	55.50	24.11	31.85	13.55	7.40	10.12
Salinity(4000ppm)+Sulphur(20gm)	50.25	21.00	27.77	12.06	6.82	8.00
L.S.D at 5%	2.31	1.21	1.02	0.55	0.45	0.65

However, the decrease in fresh and dry weights of roots due to salinity might be due to the reduction in water and minerals absorption and/or the reduction in upper ground growth (Azza *et al.*2006).These result are in harmony with those found by Yadav *et al* (2005) on *Albizia lebbeck* and *Melia azedarach*, Romoliya *et al*., (2006) on *Prosopis cineraria* and Nahed *et al.(*2011) on *Matthiola incana*.

All previous growth characters were greatly stimulated by using different amendments (sulphur and gypsum) . Data observed that application of sulphur and gypsum significantly increases all growth parameters. Application of gypsum at a rate of 20g/pot increased the plant height, stem diameter, leaves number/plant, root length and leaf area by about(27.41, 28.09, 38.06, 32.28 and 92.77%) compared with untreated plants, respectively thus, these increase may be due to calcium, its an essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant (Marschner, 1995).Also, calcium is essential for many plant functions, some of them are preper cell division and elongation, enzyme activity and starch metabolism.

Results also noticed that application of sulphur at 20g/pot was significantly increase the all growth parameters (plant height, stem diameter, leaves number/plant, root length and leaf area),the average of increase were (21.5,11.24,23.95,22.91 and 78.62%) as compared with control respectively. Scott (1985) and El-Shall *et al*.(1986).found that the favorable effect of sulphur was referred to its influence on reducing soil pH, improving soil structure and increasing the availability of certain plant nutrients.

Data also observed that, application of sulphur or gypsum increase the fresh and dry weight of all plant organs as compared with control and other treatments. Generally application of gypsum was more effective than sulphur on all growth characters. These finding by gypsum and sulphur might be due to increasing the availability of nutrients in soil [Diab *et al*.,1995.and El-Aaser *et al*., 1996] stated that soil amendments have the capability to improve the physical and chemical properties of soil and in turn its nutrients supplying power. The moderate effect of interaction on growth parameters were obtained when plants treated with salinity at 2000ppm combined with gypsum at 20gm.

Chemical Composition:

Pigments Content:

Data in Table (3) 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* (1983) and Batanouny *et al* (1988) who found that 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.

Table 3: Effect of gypsum and sulphur application on chlorophyll a, b and carotenoids(mg/g F.W.) of *Schfflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2009and 2010).

Characters / Treatments	Chlorophyll (a)	Chlorophyll (b)	Total Carotenoids
Control	2.19	0.65	0.96
Salinity(2000ppm)	1.93	0.56	0.87
Salinity(4000ppm)	1.81	0.53	0.82
Gypsum(20gm)	2.33	0.80	1.01
Sulphur(20gm)	2.23	0.78	1.16
Salinity(2000ppm)+Gypsum(20gm)	2.17	0.63	0.95
Salinity(4000ppm)+Gypsum(20gm)	2.04	0.60	0.91
Salinity(2000ppm)+Sulphur(20gm)	2.03	0.61	0.92
Salinity(4000ppm)+Sulphur(20gm)	2.00	0.58	0.89

The three photosynthetic pigments took similar trend in response to gypsum and sulphur. The two treatments used caused an increase in the contents of chlorophyll a, b and carotenoids in regard to those of untreated seedlings. In harmony with these results were those revealed by Kreimer *et al*., 1988 demonstrated that, the important regulatory function of the calcium transport from the cytosol into the chloroplasts illumination.

Also, calcium is transported along the electrochemical potential gradient from the cytosol into the stoma of the chloroplasts. Dietz (1989) reported that, this is 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 sulphur deficiency, shortage of the sulphur-containing amino acids cysteine and methionine not only inhibits protein synthesis but also decreases the chlorophyll content in the leaves in a similar manner.

Dealing with salt stress and gypsum or sulphur interaction, the data indicated that the combination of salinity at 2000ppm with gypsum at 20gm gave the highest values of chl a,b and carotenoides contents.

Total Carbohydrates Percentage:

It was clear from Table (4) that total carbohydrates percentage in leaves, stems and roots showed the same trend as photosynthetic pigment in regard to the influence of salinity treatments. Total carbohydrates were gradually augmented as the salinity concentration was sloping down. In this concern, Kabanov *et al.,* (1973) 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 gypsum and sulphur on total carbohydrates percentage, gypsum and sulphur at used rates an increase in total carbohydrates percentage in leaves stems and roots as compared with the untreated seedlings. The positive effect of sulphur on enhancing the total carbohydrates 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) [Marschner, 1995].The interaction between two factors (salinity x gypsum) or (salinity x sulphur) showed an increased in total carbohydrates percentage compared with salinity and untreated plants treatments.

Table 4: Effect of gypsum and sulphur application on total carbohydrates percentage and proline content (µmq-1) of *Schefflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2009 and 2010).

Characters	Total carbohydrates %			Proline (µmq-1)		
Treatments	Leaves	Stems	Roots	Leaves	Stems	Roots
Control	31.11	25.16	20.51	4.1	3.6	3.3
Salinity(2000ppm)	27.01	22.35	19.09	5.9	6.7	5.8
Salinity(4000ppm)	24.31	20.00	15.73	6.9	7.6	7.3
Gypsum(20gm)	38.78	32.63	29.96	3.5	3.2	3.0
Sulphur(20gm)	37.42	32.42	27.74	3.4	3.3	2.7
Salinity(2000ppm)+Gypsum(20gm)	29.63	28.00	27.08	5.4	6.2	5.2
Salinity(4000ppm)+Gypsum(20gm)	29.00	28.31	24.35	6.1	6.8	6.2
Salinity(2000ppm)+Sulphur(20gm)	28.09	27.11	25.67	5.5	6.3	5.0
Salinity(4000ppm)+Sulphur(20gm)	27.00	25.67	22.45	6.3	7.2	6.4

Proline Content:

Data in Table (4) indicated that, salinity increased proline content in leaves, stems and roots as its levels increased up to that 4000 ppm. Levitt (1980) stated 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 that of resistance. On the other hand, proline content decreased by using gypsum or sulphur in the leaves, stem and roots. Considering the interaction effect, lowest proline values were generally found when using gypsum or sulphur combined with tap water then with 2000ppm salinity,while the heighest values of proline were generally found when plants treated with salinity at 4000 ppm combined with sulphur or gypsum at 20gm.

Mineral Content:

Data presented in Fig (1-6) revealed that the use of saline water decreased the percentage of N, P, K and S in leaves, stem and roots. Saline conditions were claimed to inhibit growth through the osmotic limitation of water absorption and or specific ion effects of the constituents ion the saline medium (Russel and Russel, 1961).

The effect operated on both components of the plant production system i, e. by inducing disturbances in plant nutrition. On the other hand, Na and Ca percentages showed an opposite trend, they increased by increasing salinity concentration. The obtained reduction in K percentage might refer to the existence of some antagonistic effect between Na and K that might be responsible for the diminished (K) concentration under saline condition (Ayers and Eberhard, 1960).Generally, the decrease in the percentage of some nutrients determined under salinity condition might be attributed to the depressive effects of salinity on the absorption and or translocation of these elements.

The same results were obtained by Azza *et al* (2008) on *Taxodium disticum*. On the contrary, the percentage of N,P,K and S were clearly increased in all plant organs while the percentage of Na and Ca tended to decrease as a result of gypsum or sulphur .Similar results were obtained by Azza *et al*.,(2006) on *Dallberia sissoo.*

From the above mentioned results, it can be concluded that application of gypsum was more pronounced effects on the nutrients percentage in all plant organs than sulphur treatments. This effect seemed to be dependant on soil properties that determine the buffering capacity and native nutrient content. Also the favorable effect of soil amendments were referred to their influence on reducing soil PH, improving soil structure and increasing the availability of the studied nutrients in soil.

The interaction effect between different salinity levels plus gypsum or sulphur application showed that the highest values percentage of N, P, K and S illustrated in the seedlings treated with gypsum combined with saline water irrigation at level 2000ppm in all plant organs, the interaction between gypsum or sulphur with the levels of salinity (2000 and 4000ppm) showed that decreased Na and Ca percentage compared with salinity treatments alone .Those could be due to the influence of produced calcium or 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*., (1980). From the above mentioned results, it can concluded that, gypsum or sulphur application had decreased the hazard the effect of salinity of irrigation water, in addition had favorable effect on growth and availability of chemical composition to *Schefflera arboricola* seedlings grown on sandy soils.

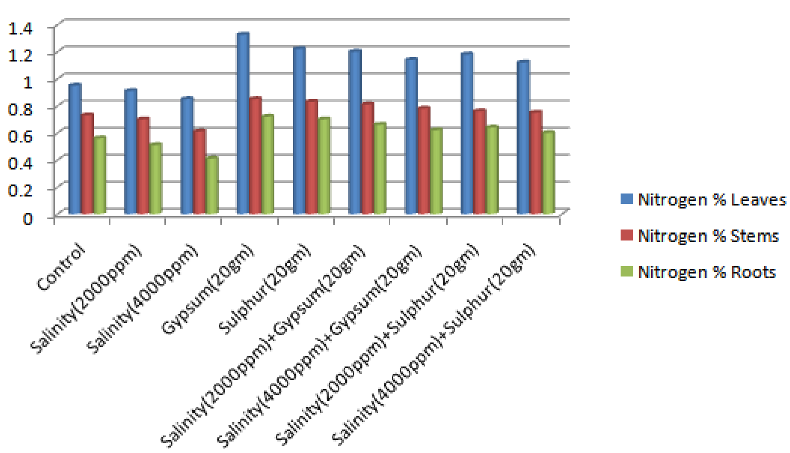

Fig. 1: Effect of gypsum and sulphur application on nitrogen percentage of *Schefflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2008 and 2009).

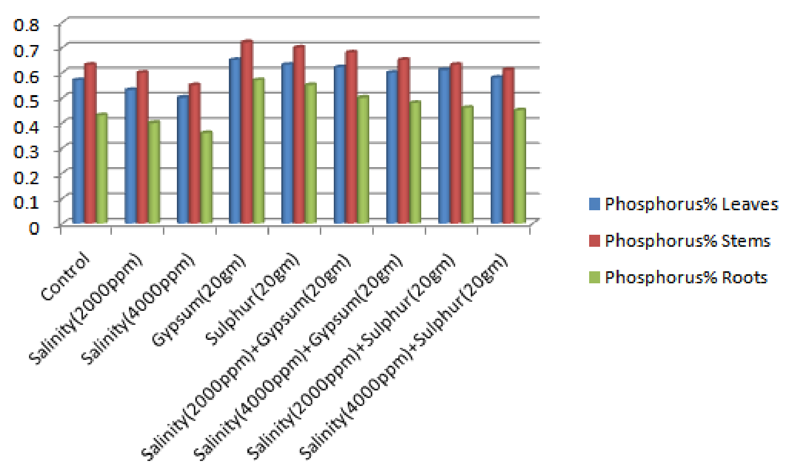

Fig. 2: Effect of gypsum and sulphur application on phosphorus percentage of *Schefflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2008 and 2009).

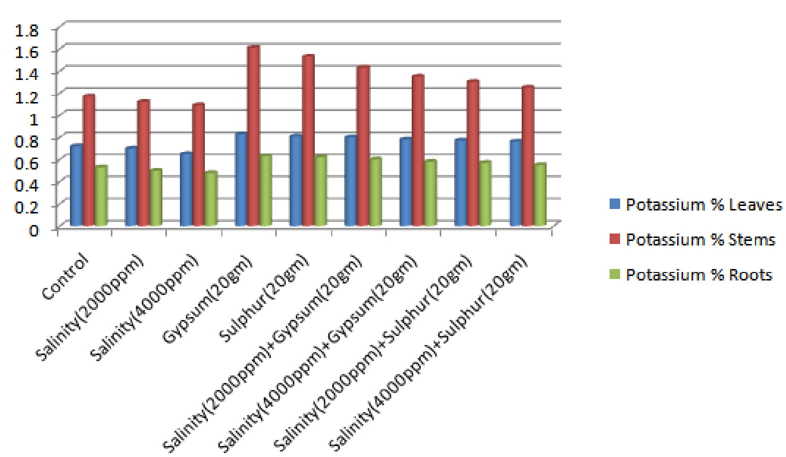

Fig. 3: Effect of gypsum and sulphur application on potassium percentage of *Schefflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2008 and 2009).

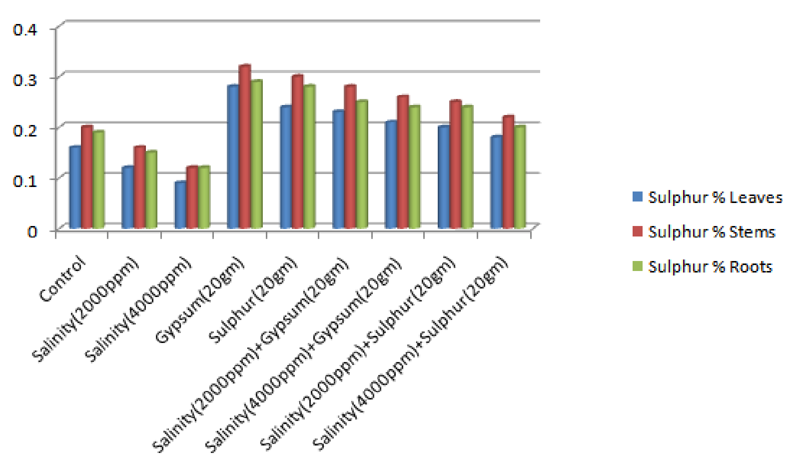

Fig. 4: Effect of gypsum and sulphur application on sulphur percentage of *Scheflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2008 and 2009).

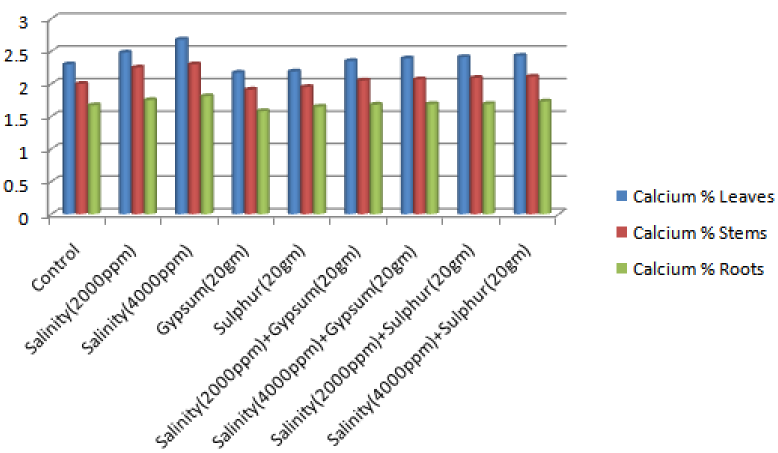

Fig. 5: Effect of gypsum and sulphur application on calcium percentage of *Scheflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2008 and 2009).

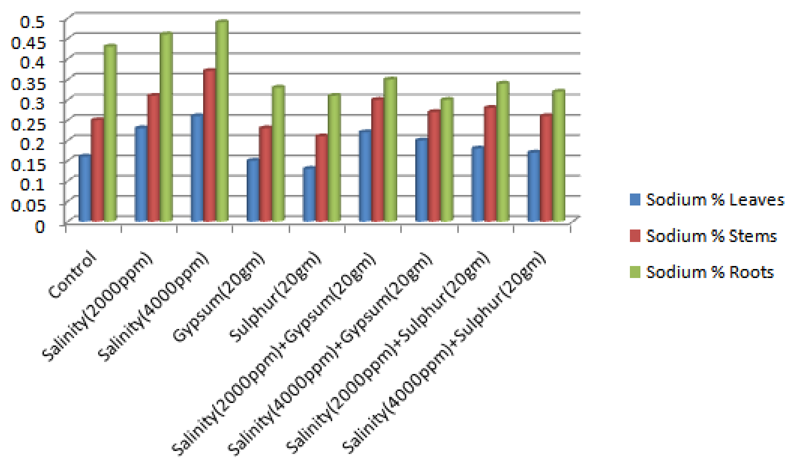

Fig. 6: Effect of gypsum and sulphur application on sodium percentage of *Scheflera arboricola* seedlings irrigated with different levels of saline water (Average of two seasons 2008 and 2009).

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