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REDUCING SALINITY INJURIES ON GROWTH AND QUALITY OF *MURRAYA EXOTICA* (L.) JACK PLANT USING SOME SOIL ADDITIVES

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ABSTRACT: A pot experiment was conducted in the open field at the nursery of Hort. Res. Institute, Giza, Egypt during 2022 and 2023 seasons to study the role of either gypsum ($CaSO_4.2H_2O$) or magnetic iron (Fe_3O_4) at 2.0 g/plant for each in reducing the harmful effects of saline irrigation water at 0, 2000, 4000, 6000, 8000 and 10000 ppm concentrations on orange jasmine (*Murraya exotica* (L.) Jack) transplants. The interaction effect between the previous two factors was also studied. Results of this experiment showed that the mean values of survival % were progressively declined with increasing salinity level to be less than 50% by 6000 and 8000 ppm levels. However, transplants watered with 10000 ppm level, even in the presence of either $CaSO_4$ or Fe_3O_4 died, while in their absence, transplants stayed alive only up to 4000 ppm level. Hence, survival % was improved by application of either $CaSO_4$ to be higher than 70% for plants irrigated with 8000 ppm level in the two seasons or Fe_3O_4 to be higher than 59% in the 1st season and 67% in the 2nd one by 8000 ppm salinity treatment. Similarly, were the results of the vegetative and root growth parameters and flowering characteristics, with few exceptions in both seasons. In general, concentrations of pigments, N, P, K and total carbohydrates were gradually decreased with the progressive increment in salinity level, while the application of either $CaSO_4$ or Fe_3O_4 significantly improved their concentrations as compared to their concentrations in the absence of their additives under the same level of salinity, with few exceptions in the two seasons. The opposite was the right concerning concentrations of proline, Cl, Na and Ca in most cases of both seasons. However, application of $CaSO_4$ (2 g/plant) gave generally better results as compared to 2 g Fe_3O_4/plant treatment under the same salinity level. According to the previous results, it can be recommended to amend orange jasmine (*Murraya exotica* (L.) Jack) transplants with calcium sulphate ($CaSO_4.2H_2O$) at a rate of 2 g/plant, 4 times with 2 months intervals during the active growing season under irrigation with saline water (up to 8000 ppm level) to obtain better growth performance, floriferous and high aesthetic value pot plants.

Keywords: calcium sulphate, salinity, orange jasmine, transplants, vegetative and root growth, flowering, pigments

INTRODUCTION

Owing to the scarcity of high-quality water resources, the use of brackish and saline water for landscape irrigation becomes obligatory. However, many investigators demonstrated that using of such waters usually causes several damages for ornamentals, such as those recorded by El-Khateeb (1994), Farieri *et al*. (2016), Fascella *et al*. (2017) and Fascella *et al*. (2020) on *Murraya exotica* (*M. paniculata*) and those obtained on other ornamentals by Niul and Rodriguez (2010) on some bedding plants (*Angelonia angustifolia*, *Capsicum annuum* cvs. Calcio and Black Pearl, *Helenium amarum*, *Helichrysum petulatum*, *Catharanthus roseus* and *Plumbago auriculata*), Abdel-Fattah (2014) on *Jacaranda actuifolia*, Ahmed *et al*. (2016) on *Acalypha wilkesiana*, Yasemin *et al*. (2017) on *Chrysanthemum paludosum*, Amarin *et al*. (2020) on *Dianthus caryophyllus* vars. Bizet Sagr and Grand Slam Hygr, El-Nashar and Hassan (2020) on two cultivars of *Zinnia elegans* (Short Stuff and Profusion), Paraskevopoulou *et al*. (2020) on four lavander species (*Lavandula angustifolia*, *L. dentata* var. dentata, *L. dentata* var. candicans and *L. stoechas*), Toscano *et al*. (2020) on Convolvulus, Ceratonia and Ligustrum, Mrudhula *et al*. (2021) on chrysanthemum, marigold and tulip, Alvarez *et al*. (2022) on *Hibiscus rosa-sinensis*, Banon *et al*. (2022) on *Euphorbia* “Acost Rainbow”, Yasemin and Koksal (2023) on two zinnia species (*Zinnia elegans* “Zinnita Scarlet” and *Z. marylandica* “Double Zahara Fire Improved”) and Abdou *et al*. (2024) on rosemary.

In order to reduce the damages occurred by salt stress to ornamental plants, the scientists innovated many ways to acquire this goal, such as those detected by Abdel-Aziz *et al*. (2006) on *Khaya senegalensis*, El-Mahrouk *et al*. (2010) on *Conocarpus erectus*, El-Shawa and El-Zohiry (2018) on *Rosa hybrida* cv. Centrix, El-Hindi *et al*. (2020) on *Calendula officinalis*, El-Shawa *et al*. (2020) on *Calendula officinalis*, Ashour *et al*. (2023) on *Calliandra haematacephala*, Hamidian *et al*. (2023) on saffron (*Crocus sativus*) and Ahmed and Shahin (2023) on *Euphorbia pulcherrima*.

Among ornamental shrubs, which may be moderately sensitive to salinity and needs to enhancing its tolerance to this abiotic stress is Orange Jasmine (*Murraya exotica* (L.) Jack, formerly *M. paniculata*), which belongs to Rutaceae family. It is a slow-growing evergreen shrub or small tree, up to 2-3 m in height, (Parrotta, 2001). Alternate leaves usually 3-9 leaflets are produced on this shrub. The leaflets are 3-5 cm^3 in size, dark green, glossy and cuneate or rounded at the base. Flowers are white and fragrant, and produced in a small cluster at the terminal of branches, appear in spring and summer. It is a popular as a solitary specimen and for hedges in the tropics and subtropics, and is commonly grown in gardens and as potted plant for its glossy, dark green foliage and clusters of fragrant flowers (Huxley *et al*., 1992). It is considered a medicinal plant, as it contains especially bark on several chemical compounds, mainly alkaloids, coumarins, carotenoids and flavones, which have long been used in pharmacology (Vasca-Zamfir *et al*., 2019).

Thus, the current work was set out to evaluate the effect of either calcium sulphate or magnetic iron on mitigating the deleterious impact of saline water on growth and quality of orange jasmine when used for irrigating such ornamental shrub.

MATERIALS AND METHODS

A pot experiment was carried out at the nursery of Hort. Res. Inst., ARC., Egypt throughout 2022 and 2023 growing seasons to find out the response of *Murraya exotica* (L.) Jack transplants to irrigation with saline water at different concentrations in the presence and absence of either calcium sulphate or magnetic iron.

Thus, one-year-old homogenous seedlings of orange jasmine (*Murraya exotica* (L.) Jack) at the initial length of about 25±1.0 cm, carrying about 18.0±1.5 leaves were transplanted on March, 15th for every season in 20-cm-diameter plastic pots filled with about 3.5 kg/pot of sandy clay soil (Table, a).

Directly after transplanting, the seedlings were irrigated with 350 ml fresh water/pot until April, 1st, as they received the following treatments:

Table a. Some physical and chemical properties of the sandy clay soil used in 2022 and 2023 seasons.

Particle size distribution (%)				Soil texture	Cations (meq/l)				Anions (meq/l)			E.C. (dS/m)	pH	S.P.
Coarse sand	Fine sand	Silt	Clay		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}			
13.09	44.02	19.62	23.27	Sandy clay	9.79	5.91	21.16	0.58	3.84	7.36	26.24	1.90	8.17	31.78

a. Additives treatments:

Where the pots were drenched with 0.00 and 2.0 g of either calcium sulphate ($CaSO_4$) or magnetic iron (22.5% Fe_3O_4/pot), four times with 2-month intervals throughout the growing season.

b. Saline water treatments:

Where pure salts of both NaCl and $CaCl_2$ were mixed well together (1:1, w/w), saline irrigation water was then prepared from this salt mixture at concentrations of 0, 2000, 4000, 6000, 8000, and 10000 ppm. The plants were irrigated three times a week with only 300 ml of saline water at the different concentrations mentioned previously until the end of the experiment on 1st November for every season

c. Interaction treatments:

Each treatment of additives was factorially combined with each concentration of saline water to create 18 interaction treatments.

A factorial experiment in a complete randomized design with 3 replicates was accomplished in the two seasons (Mead *et al*., 1993), and the different agricultural practices required for such plantation were conducted in time as the gardener did.

At the end of each season, the following data were recorded: survival (%), plant height (cm), stem diameter (mm), number of branches and leaves/plant, root length (cm) and aerial parts and roots fresh and dry weights (g). During flowering, number of flowers/cluster and flower fresh and dry weights (g) were measured. In fresh leaf samples: concentrations of photosynthetic pigments (mg/g f.w.) were determined according to the method of Sumanta *et al*. (2014), while in dry ones, the percentages of nitrogen, phosphorus and potassium (Chapman and Pratt, 1982), total carbohydrates (Herbert *et al*., 1971), proline as ppm (Bates *et al*., 1973), chloride as ppm and the percentages of sodium and calcium (Jackson, 1973) were measured.

Data were then tabulated and subjected to analysis of variance using the Assistant Software Program suggested by Silva and Azevedo (2016), followed by Duncan`s new Multiple Range T-test (Steel and Torrie, 1980) to compare means of treatments.

RESULTS

Effect of saline water treatments, additives and their interactions on:

Survival percentage:

It is evident from data presented in Table (1) that survival % means were progressively decreased with increasing salinity levels to be less than 50% (47.81 and 44.03%) in the 1st season by 6000 and 8000 ppm salinity ones, respectively. The same trend occurred in the 2nd season, but the percentage of survival declined to less than 50% (45.97%) with only 8000 ppm treatment. In the two seasons however, the plants died by 10000 ppm salinity level.

On the other hand, means of such trait were improved by application of either calcium sulphate ($CaSO_4$) or magnetic iron (Fe_3O_4) at a rate of 2 g/plant for each, as they significantly increased survival % in the 1st season from 37.35% to 71.73 and 62.56%, and in the 2nd one from 36.82% to 70.24 and 69.91%, successively, with the dominance of 2 g $CaSO_4$ treatment over 2 g Fe_3O_4 one in both seasons.

Interaction treatments also, showed a remarkable effect on the mean values of this trait, where combining salinity treatments and 0.00 g of either additive led to the death of the

Table 1. Effect of salinity levels, additives and their interactions on survival, plant height and stem diameter of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	Additives treatments											
	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	Survival (%)				Plant height (cm)				Stem diameter (mm)			
	First season: 2022											
0 ppm	100.00a	100.00a	100.00a	100.00A	51.33b	56.00a	53.30ab	53.54A	5.29b	6.21a	5.30b	5.60A
2000 ppm	65.33f	92.03b	78.81d	78.72B	31.47fg	51.53b	42.03de	41.74B	3.01fg	5.47b	4.60c	4.36B
4000 ppm	58.76g	85.72c	73.65e	72.71C	29.03g	48.00c	39.27e	38.77C	2.60g	5.19b	4.09c-e	3.96C
6000 ppm	0.00h	79.65d	63.79f	47.81D	0.00h	44.60d	34.00f	26.20D	0.00h	4.47cd	3.85e	2.77D
8000 ppm	0.00h	73.00e	59.10g	44.03E	0.00h	42.03de	33.43f	25.16D	0.00h	3.90de	3.53ef	2.48D
10000 ppm	0.00h	0.00h	0.00h	0.00F	0.00h	0.00h	0.00h	0.00E	0.00h	0.00h	0.00h	0.00E
Mean	37.35C	71.73A	62.56B		18.64C	40.39A	33.67B		1.82C	4.21A	3.56B	
	Second season: 2023											
0 ppm	100.00a	100.00a	100.00a	100.00A	54.27bc	59.33a	56.33ab	56.64A	5.14ab	5.51a	5.48a	5.38A
2000 ppm	63.78h	91.33b	92.31b	82.47B	34.57h	54.15bc	52.04cd	46.92B	3.63f	5.29ab	4.94bc	4.62B
4000 ppm	57.11i	83.96c	81.25c	74.11C	30.98i	50.31d	45.77e	42.36C	3.15g	4.96bc	4.63cd	4.25C
6000 ppm	0.00j	75.71e	78.46d	51.39D	0.00j	44.80ef	44.22ef	29.68D	0.00h	4.43d	4.28de	2.90D
8000 ppm	0.00j	70.45f	67.45g	45.97E	0.00j	41.80f	38.07g	26.62E	0.00h	4.24de	3.90ef	2.71D
10000 ppm	0.00j	0.00j	0.00j	0.00E	0.00j	0.00j	0.00j	0.00F	0.00h	0.00h	0.00h	0.00E
Mean	36.2B	70.24A	69.91A		19.97C	41.43A	39.41B		1.99C	4.07A	3.87B	

No significance among means having the same letters

plants irrigated with saline water at a level higher than 4000 ppm, giving 0.00 survival % by 6000, 8000 and 10000 ppm treatments in the two seasons. Besides, 2000 and 4000 ppm salinity levels caused a highly significant decrement in the means of this character compared to control ones in both seasons. On the other side, interacting between salinity treatments and applying any of the additives enhanced the plants to stay alive under salinity levels up to 8000 ppm with survival % higher than 70% in the two seasons by applying 2 g $CaSO_4$ (73.00 and 70.45%) and higher than 59.00 and 67.00% in both seasons by applying 2 g Fe_3O_4/plant. However, the application of either $CaSO_4$ or Fe_3O_4 failed to keep the plants irrigated with 10000 ppm salinity alive in the two seasons.

Vegetative and root growth parameters:

From data averaged in Tables (1, 2, 3 and 4), it can be concluded that mean values of the different growth attributes were significantly decreased, in a consequence order as salinity of irrigation water was increased to reach minimum by both 6000 and 8000 ppm levels with non-significancy in between. The plants irrigated with 10000 ppm salinity level died, as mentioned before.

On the other hand, gypsum ($CaSO_4$) and magnetite (Fe_3O_4) application, significantly raised the mean values of the aforenamed growth characters with the superiority of 2 g $CaSO_4$/plant treatment, which raised means of various growth parameters to maximal values, and followed by 2 g Fe_3O_4/plant one in the two seasons. Hence, the positive effect of such additives on growth traits can be scaled in the following descending order: $CaSO_4$ > Fe_3O_4 > control (without additives) in the two seasons.

A great variable with various significance levels occurred concerning the effects of interaction treatments on growth traits in the two seasons. However, the best records were obtained by the interaction between irrigation with fresh water (control) and application of 2 g $CaSO_4$, and sometimes between freshwater irrigation and 2 g Fe_3O_4 application, followed by the interactions of freshwater + zero additives and 2000 ppm saline water + 2 g $CaSO_4$/plant, and then a combination of 2000 ppm saline water + 2 g Fe_3O_4/plant, with the prevalence of freshwater + 2 g $CaSO_4$/plant interaction treatment, which acquired the utmost high means in all growth traits. On the contrary, the worst effect of interactions was attained by irrigation with either 2000 or 4000 ppm saline water in the absence of both additives, with the inferiority of 4000 ppm saline water + zero g additive interaction.

Flowering characteristics:

As shown in Table (5), a similar trend to that of growth traits, was achieved, as well with respect to flowering characteristics, where the mean values of the number of flowers/cluster and flower fresh and dry weights (g) were linearly decreased as a result of the progressive increase in saline water concentration to be minimum by 8000 ppm level compared to control ones in the two seasons, while application of either $CaSO_4$ or Fe_3O_4 to the soil significantly boosted means of the previous flowering characters, with the excellence of 2 g $CaSO_4$/plant treatment which gave higher records relative to 2 g Fe_3O_4/plant one.

Likewise, were the results of interaction treatments, which also exhibited a great variable in their effects on flowering traits with different significance levels in between, but the upper hand was for the interaction of freshwater irrigation + 2 g $CaSO_4$/plant application, that maximized means of flowering traits to maximal values in the two seasons.

Chemical composition of the leaves:

From data averaged in Tables (6, 7 and 8), it is clear that concentrations of chlorophyll a, b and carotenoids (mg/g f.w.) and the percentages of N, P, K and total carbohydrates in the leaves of plants irrigated with saline water were gradually decreased with significant differences in response to the gradual increment in salinity level to be minimum by 8000 ppm treatment in the two

Table 2. Effect of salinity levels, additives and their interactions on No. branches/plant, No. leaves/plant and root length of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	Additives treatments											
	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	No. branches/plant				No. leaves/plant				Root length (cm)			
	First season: 2022											
0 ppm	2.00c	4.00a	3.00b	3.00A	70.67c	84.33a	75.00b	76.67A	30.73cd	36.60a	33.17bc	33.50A
2000 ppm	1.00e	3.77a	2.67b	2.48B	39.33h	68.67c	64.33d	57.44B	25.33hi	32.93bc	33.33bc	30.20B
4000 ppm	1.00e	3.00b	2.00c	2.00C	33.67i	61.00de	55.33d	50.00C	23.23i	29.47de	28.23ef	26.98C
6000 ppm	0.00f	2.00c	2.00c	1.33D	0.00j	59.33e	53.33f	37.56D	0.00j	27.90e-g	26.47f-h	18.12D
8000 ppm	0.00f	1.33de	1.67cd	1.00E	0.00j	47.67g	41.67h	29.78E	0.00j	26.30f-h	25.80gh	17.37D
10000 ppm	0.00f	0.00f	0.00f	0.00F	0.00j	0.00j	0.00h	0.00F	0.00j	0.00j	0.00j	0.00E
Mean	0.67C	2.35A	1.89B		23.94C	53.50A	48.28B		13.22C	25.53A	24.33B	
	Second season: 2023											
0 ppm	2.33d	4.67a	3.30c	3.43A	69.60cd	86.33a	72.20c	76.04A	34.70bc	39.83a	35.37b	36.63A
2000 ppm	1.33e	4.00b	3.00c	2.78B	40.50h	76.30b	67.00d	61.27B	27.20fg	34.70bc	3.37d	30.76B
4000 ppm	1.00e	3.10c	2.43d	2.18C	36.67i	62.77e	60.90e	53.44C	25.63g	32.70c	29.87de	29.40C
6000 ppm	0.00f	2.20d	2.20d	1.47D	0.00j	59.33e	55.40f	38.24D	0.00h	30.27d	28.17ef	19.48D
8000 ppm	0.00f	2.00d	2.07d	1.36D	0.00j	51.93e	49.40g	33.78E	0.00h	25.53fg	27.30fg	18.28E
10000 ppm	0.00f	0.00f	0.00f	0.00E	0.00j	0.00j	0.00j	0.00F	0.00h	0.00h	0.00h	0.00F
Mean	0.78C	2.66A	2.17B		24.46C	56.11A	50.82B		14.59C	27.51A	25.18B	

No significance among means having the same letters

Table 3. Effect of salinity levels, additives and their interactions on aerial parts fresh and dry weights of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	Additives treatments							
	Aerial parts fresh weight (g)				Aerial parts dry weight (g)			
	First season: 2022							
0 ppm	20.17c	24.54a	21.82b	22.18A	6.91c	9.86a	7.62b	8.13A
2000 ppm	11.73g	19.97c	16.05d	15.92B	3.55h	6.83c	5.48e	5.29B
4000 ppm	8.06h	15.94d	14.52e	12.84C	2.77i	5.94d	4.73f	4.48C
6000 ppm	0.00i	14.66e	13.67ef	9.44D	0.00j	4.98f	4.66f	3.21D
8000 ppm	0.00i	13.83e	12.67fg	8.83E	0.00j	4.10g	4.06g	2.72E
10000 ppm	0.00i	0.00i	0.00i	0.00F	0.00j	0.00j	0.00j	0.00F
Mean	6.66C	14.82A	13.12B		2.21C	5.29A	4.42B	
	Second season: 2023							
0 ppm	22.48c	26.22a	24.31b	24.34A	7.90c	10.34a	8.41b	8.88A
2000 ppm	13.26h	22.22c	20.11d	18.53B	4.24i	7.39d	6.43e	6.02B
4000 ppm	9.35j	18.30e	15.09f	14.25C	3.61j	6.29e	5.39f	5.10C
6000 ppm	0.00k	14.75fg	13.47h	9.41D	0.00k	5.47f	4.68gh	3.38D
8000 ppm	0.00k	13.99gh	12.28i	8.76E	0.00k	4.92g	4.30hi	3.08E
10000 ppm	0.00k	0.00k	0.00k	0.00F	0.00k	0.00k	0.00k	0.00F
Mean	7.51C	15.92A	14.21B		2.63C	5.74A	4.87B	

No significance among means having the same letters

Table 4. Effect of salinity levels, additives and their interactions on roots fresh and dry weights of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	Additives treatments							
	Roots fresh weight (g)				Roots dry weight (g)			
	First season: 2022							
0 ppm	16.26b	17.81a	16.72b	16.93A	5.29c	6.44a	5.63bc	5.78A
2000 ppm	10.49g	16.57ab	14.87c	13.98B	2.56h	5.83b	4.58d	4.33B
4000 ppm	7.61h	14.95c	13.41d	11.99C	2.41h	4.12e	3.94ef	3.49C
6000 ppm	0.00i	12.64e	12.30ef	8.31D	0.00i	3.67f	3.63f	2.44D
8000 ppm	0.00i	11.91f	10.45g	7.46E	0.00i	3.55f	2.99g	2.18E
10000 ppm	0.00i	0.00i	0.00i	0.00F	0.00i	0.00i	0.00i	0.00F
Mean	5.73C	12.31A	11.29B		1.71C	3.94A	3.46B	
	Second season: 2023							
0 ppm	17.75bc	18.31a	18.04ab	18.03A	6.49c	7.16a	6.75b	6.80A
2000 ppm	12.19h	17.62bc	17.29c	15.70B	3.61i	5.77d	4.65e	4.68B
4000 ppm	8.48i	16.72d	15.79e	13.67C	2.51k	4.45ef	4.25fg	3.74C
6000 ppm	0.00j	15.45e	14.43f	9.96D	0.00l	4.20fg	4.01gh	2.74D
8000 ppm	0.00j	14.62f	13.61g	9.41E	0.00l	3.91h	3.28j	2.40E
10000 ppm	0.00j	0.00j	0.00j	0.00F	0.00l	0.00l	0.00l	0.00F
Mean	6.40C	13.79A	13.20B		2.10C	4.25A	3.82B	

No significance among means having the same letters

Table 5. Effect of salinity levels, additives and their interactions on No. flowers/cluster, flower fresh and dry weights of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	No. flowers/cluster				**Flower fresh weight (g)**				**Flower dry weight (g)**			
	First season: 2022											
0 ppm	24.27f	35.30a	27.63c	29.07A	0.737e	2.480a	2.010b	1.742A	0.310d	0.740a	0.687a	0.579A
2000 ppm	13.93j	29.67b	26.53d	23.38B	0.340gh	1.983b	1.923bc	1.416B	0.120fg	0.553b	0.487b	0.387B
4000 ppm	11.30k	25.30e	22.48g	19.69C	0.213h	1.833c	0.490f	0.846C	0.103g	0.390c	0.160fg	0.318C
6000 ppm	0.00l	21.93h	18.93h	13.62D	0.000i	0.983d	0.413fg	0.466D	0.000h	0.260de	0.180fg	0.147D
8000 ppm	0.00l	19.33h	16.60i	11.98F	0.000i	0.670e	0.370fg	0.347E	0.000h	0.197ef	0.120fg	0.106D
10000 ppm	0.00l	0.00l	0.00l	0.00F	0.000i	0.000i	0.000i	0.000F	0.000h	0.000h	0.000h	0.00E
Mean	8.25C	21.92A	18.69B		0.215C	1.325A	0.868B		0.089C	0.357A	0.272B	
	Second season: 2023											
0 ppm	28.63d	39.67a	30.67c	32.99A	2.143c	3.397a	2.293b	2.611A	0.647c	0.950a	0.883b	0.827A
2000 ppm	15.43i	32.27b	25.67f	24.46B	1.277f	2.203bc	1.927g	1.802B	0.280f	0.680c	0.463d	0.474B
4000 ppm	13.53j	29.10d	25.00fg	22.54C	0.447j	1.973d	0.977g	1.132C	0.180g	0.453d	0.340e	0.324C
6000 ppm	0.00k	27.10e	21.10h	16.07D	0.000k	1.443e	0.687i	0.710D	0.000h	0.377e	0.223fg	0.200D
8000 ppm	0.00k	24.53g	20.43h	14.99E	0.000k	0.867i	0.500j	0.456E	0.000h	0.263f	0.180g	0.148E
10000 ppm	0.00k	0.00k	0.00k	0.00F	0.000k	0.000k	0.000k	0.000F	0.000h	0.000h	0.000h	0.000F
Mean	9.60C	25.44A	20.48B		0.644C	1.647A	1.064B		0.184C	0.454A	0.348B	

No significance among means having the same letters

Table 6. Effect of salinity levels, additives and their interactions on chlorophyll a, b and carotenoids concentrations of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	Additives treatments											
	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	Chlorophyll a (mg/g f.w.)				Chlorophyll b (mg/g f.w.)				Carotenoids (mg/g f.w.)			
	First season: 2022											
0 ppm	1.368de	1.892a	1.851a	1.704A	0.628b	0.691a	0.629b	0.649A	0.388b-d	0.466ab	0.402a-c	0.419A
2000 ppm	1.234fg	1.635b	1.511c	1.460B	0.507d	0.572c	0.650ab	0.576B	0.281d-f	0.513a	0.336c-e	0.376A
4000 ppm	1.144g	1.375de	1.398d	1.305C	0.313g	0.479de	0.428e	0.407C	0.192f	0.275d-f	0.265ef	0.244B
6000 ppm	0.000h	1.337de	1.278ef	0.872D	0.000i	0.369f	0.309g	0.226D	0.000g	0.200f	0.192f	0.131C
8000 ppm	0.000h	1.214fg	1.177g	0.797E	0.000i	0.232h	0.188h	0.140E	0.000g	0.187f	0.163f	0.117C
10000 ppm	0.000h	0.000h	0.000h	0.000F	0.000i	0.000i	0.000i	0.00F	0.000g	0.000g	0.000g	0.000D
Mean	0.624C	1.242A	1.202B		0.241C	0.391A	0.367B		0.143C	0.273A	0.226B	
	Second season: 2023											
0 ppm	1.389b	1.691a	1.387b	1.489A	0.332de	0.540a	0.446b	0.439A	0.587c	0.781a	0.554c	0.641A
2000 ppm	1.296c	1.289c	1.092e	1.226B	0.219gh	0.384c	0.352cd	0.318B	0.371e	0.692b	0.465d	0.510B
4000 ppm	1.168d	1.125de	0.959f	1.084C	0.159ij	0.311ef	0.285f	0.252C	0.197h	0.467d	0.371e	0.345C
6000 ppm	0.000j	0.992f	0.719h	0.570D	0.000k	0.234g	0.189hi	0.141D	0.000i	0.335ef	0.292e-g	0.209D
8000 ppm	0.000j	0.893g	0.521i	0.471E	0.000k	0.186h-j	0.148j	0.111E	0.000i	0.265f-h	0.220gh	0.162E
10000 ppm	0.000j	0.000j	0.000h	0.000F	0.000k	0.000k	0.000k	0.000F	0.000i	0.000i	0.000i	0.000F
Mean	0.642C	0.998A	0.780B		0.118C	0.276A	0.237B		0.193C	0.423A	0.317B	

No significance among means having the same letters

Table 7. Effect of salinity levels, additives and their interactions on nitrogen, phosphorus and potassium concentrations of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	Additives treatments											
	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	N (%)				P (%)				K (%)			
	First season: 2022											
0 ppm	2.56c	3.10a	2.86b	2.84A	0.960c	1.087a	1.000b	1.016A	2.82f	2.85e	2.85e	2.84A
2000 ppm	1.69j	2.53d	2.27f	2.16B	0.583i	0.887d	0.803e	0.758B	1.99k	3.62a	2.79g	2.80B
4000 ppm	1.68j	2.30e	2.11g	2.03C	0.460j	0.793ef	0.730g	0.661C	1.85l	3.42b	2.76h	2.67C
6000 ppm	0.00k	1.99h	1.99h	1.33D	0.000k	0.773f	0.590i	0.454D	0.00m	3.18c	2.67i	1.95D
8000 ppm	0.00k	1.72i	1.70j	1.14E	0.000k	0.620h	0.563i	0.394E	0.00m	2.93d	2.26j	1.73E
10000 ppm	0.00k	0.00k	0.00k	0.00F	0.000k	0.000k	0.000k	0.000F	0.00m	0.00m	0.00m	0.00F
Mean	0.99C	1.94A	1.82B		0.334C	0.693A	0.614B		1.11C	2.67A	2.22B	
	Second season: 2023											
0 ppm	2.70c	3.56a	3.02b	3.09A	1.000b	1.087s	0.963bc	1.017A	2.76h	3.04e	3.00f	2.93A
2000 ppm	1.76i	2.23ef	2.61cd	2.20B	0.623g	0.930cd	0.893d	0.816B	2.12k	3.79a	2.91g	2.94A
4000 ppm	1.58j	2.49d	2.30e	2.13C	0.547h	0.883d	0.807e	0.746C	1.88l	3.61b	2.73h	2.74B
6000 ppm	0.00k	2.15fg	2.03e	1.39D	0.000i	0.737f	0.730f	0.489D	0.00m	3.38c	2.62i	2.00C
8000 ppm	0.00k	1.98h	1.84i	1.27E	0.000i	0.620g	0.620g	0.413E	0.00m	3.12d	2.33j	1.82D
10000 ppm	0.00k	0.00k	0.00k	0.00F	0.000i	0.000i	0.000i	0.000F	0.00m	0.00m	0.00m	0.00E
Mean	1.01C	2.07A	1.97B		0.362C	0.709A	0.669B		1.13C	2.82A	2.27B	

No significance among means having the same letters

Table 8. Effect of salinity levels, additives and their interactions on total carbohydrates and proline concentrations of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	Additives treatments							
	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	Total carbohydrates (%)				Proline (ppm)			
	First season: 2022							
0 ppm	38.82cd	44.36a	41.58b	41.59A	1344.8g	536.5l	1178.8j	1020.0C
2000 ppm	19.86i	40.10bc	35.73e	31.90B	1633.5b	1010.4k	1258.2i	1300.7B
4000 ppm	16.22j	37.45de	30.34f	28.00C	1859.7a	1255.8i	1308.7h	1474.7A
6000 ppm	0.00k	35.89e	28.46g	21.45D	0.00m	1424.6e	1402.6f	942.4E
8000 ppm	0.00k	29.12fg	25.14h	18.08E	0.00m	1565.1c	1468.6d	1011.2D
10000 ppm	0.00k	0.00k	0.00k	0.00F	0.00m	0.00m	0.00m	
Mean	12.48C	31.15A	26.87B		806.3C	965.4B	1102.8A	
	Second season: 2023							
0 ppm	37.57cd	45.52a	42.17b	41.76A	1345.7g	610.2l	1180.1j	1045.3C
2000 ppm	30.78fg	44.19a	38.98c	37.99B	1637.6b	1011.5k	1263.1i	1304.1B
4000 ppm	21.09i	36.70de	35.45e	37.99B	1863.5a	1259.6i	1311.4h	1478.2A
6000 ppm	0.00j	32.38f	31.61f	21.33D	0.00m	1426.8e	1410.3f	945.7E
8000 ppm	0.00j	29.86gh	28.88h	19.58E	0.00m	1569.9c	1471.6d	1013.8D
10000 ppm	0.00j	0.00j	0.00j	0.00F	0.00m	0.00m	0.00m	0.00F
Mean	14.91C	31.44A	29.52B		807.8C	979.7B	1106.1A	

No significance among means having the same letters

seasons, except for 2000 ppm salinity treatment which gave concentration of carotenoids in the 1st season and K (%) in the 2nd one nearly close to those of untreated ones. On the other hand, concentrations of these constituents were significantly increased compared to control by the two additives used in the study, with the prevalence of 2 g $CaSO_4$/plant treatment that fulfilled over 2 g Fe_3O_4/plant one.

Accordingly, combining between 2 g $CaSO_4$/plant dose and any level of salinity attained better concentrations of the previous components than combining between 2 g Fe_3O_4/plant dose and the same level of salinity in most cases of the two seasons, with the dominance of 2 g $CaSO_4$/plant addition + freshwater irrigation (no salinity) combined treatment, which enhanced concentrations of pigments, N, P, K and total carbohydrates to maximum values.

Contrast to the above results, were those results of proline (ppm), Cl (ppm) and the percentages of Na and Ca (Tables, 8 and 9), which fluctuated in response to salinity treatments, except for 4000 ppm levels that raised concentrations of such chemicals to the highest values, followed by 2000 ppm one. Furthermore, 2 g Fe_3O_4/plant treatment gave the highest concentrations of proline, Cl and Na in both seasons, whereas 2 g $CaSO_4$/plant one acquired the maximum concentration of Ca, accompanied by the least concentration of Cl.

In addition, a great variable was attained in respect of proline, Cl, Na and Ca concentrations, as the highest concentrations of proline were achieved in the two seasons by the interaction between 4000 ppm salinity treatment and 0.00 g additive/plant (1859.7 ppm), followed by 2000 ppm saline water + no additive interaction (1633.5 ppm), and then by 8000 ppm salinity treatment + 2 g $CaSO_4$/plant one (1565.1 ppm), while the lowest concentrations of both Cl and Na elements were obtained by the interacting between freshwater irrigation (no salinity)

Table 9. Effect of salinity levels, additives and their interactions on chloride, sodium and calcium concentrations of *Murraya exotica* (L.) Jack plant during 2022 and 2023 seasons.

Salinity treatments	Additives treatments											
	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean	0.00 g /plant	2.0 g $CaSO_4$ /plant	2.0 g Fe_3O_4 /plant	Mean
	Cl (ppm)				Na (%)				Ca (%)			
	First season: 2022											
0 ppm	4.73h	1.24j	2.96i	2.98E	0.12ef	0.10f	0.16d-f	0.13C	0.54ef	0.72de	0.62e	0.63C
2000 ppm	11.77b	5.71g	5.90f	7.79B	0.24b-d	0.18d-f	0.22c-e	0.21B	0.40fg	1.15a	1.08ab	0.88A
4000 ppm	13.83a	5.89f	7.38e	9.03A	0.36a	0.21c-e	0.24b-d	0.27A	0.33g	1.00ab	0.92bc	0.75B
6000 ppm	0.00k	7.36e	8.81d	5.39D	0.00g	0.23b-d	0.31a-c	0.18B	0.00h	0.80cd	0.64de	0.48D
8000 ppm	0.00k	8.70d	9.40c	6.03C	0.00g	0.33ab	0.34a	0.22AB	0.00h	0.53ef	0.61e	0.38E
10000 ppm	0.00k	0.00k	0.00k	0.00F	0.00g	0.00g	0.00g	0.00D	0.00h	0.00h	0.00h	0.00F
Mean	5.06B	4.82C	5.74A		0.12B	0.18A	0.21A		0.21B	0.70A	0.65A	
	Second season: 2023											
0 ppm	3.83k	1.44m	3.06l	2.78E	0.14ef	0.13f	0.18d-f	0.15D	0.57fg	0.76de	0.67e-g	0.66C
2000 ppm	12.42b	5.95j	6.26i	8.21B	0.26cd	0.21c-e	0.23cd	0.23BC	0.51gh	1.24a	1.21a	0.99A
4000 ppm	15.26a	6.62h	8.33f	10.07A	0.39a	0.24cd	0.27bc	0.30A	0.37h	1.13ab	0.98bc	0.83B
6000 ppm	0.00n	7.98g	9.35d	5.78D	0.00g	0.25cd	0.35ab	0.20C	0.00i	0.89cd	0.68ef	0.53D
8000 ppm	0.00n	9.15e	10.79c	6.65C	0.00g	0.34ab	0.41a	0.25B	0.00i	0.57fg	0.65e-g	0.41E
10000 ppm	0.00n	0.00n	0.00n	0.00F	0.00g	0.00g	0.00g	0.00E	0.00i	0.00i	0.00i	0.00F
Mean	5.25B	5.19C	6.30A		0.13C	0.20B	0.24A		0.24C	0.77A	0.70B	

No significance among means having the same letters

and 2 g $CaSO_4$/plant application in the two seasons. In general, $CaSO_4$ addition minimized both Cl and Na concentrations more than applying Fe_3O_4 under the different salinity levels in the 1st and 2nd seasons. As for the greatest Ca concentration, it was attained in the two seasons by both 2000 ppm salinity treatment + either 2 g $CaSO_4$/plant (1.15 and 1.24%) or 2 g Fe_3O_4/plant (1.08 and 1.21%) and 4000 ppm salinity level + 2 g $CaSO_4$/plant dose (1.00 and 1.13%, respectively) combinations, followed by 4000 ppm salinity level + 2 g Fe_3O_4/plant combination, which gave 0.92 and 0.98% in the two seasons, successively.

From the foregoing, it proposes to add 2 g gypsum ($CaSO_4$) to every plant of *Murraya exotica*, 4 times with 2-month intervals throughout active growth to mitigate the harmful impact of saline water (up to 8000 ppm level) to a minimum.

DISCUSSION

Results of this work exhibited that using saline water for irrigating orange jasmine (*Murraya exotica*) transplants caused gradual decreases in survival (%) means, vegetative and root growth parameters, flower characters and most constituents of the leaves to reach a minimum by 4000 ppm salinity level, whereas transplants irrigated with higher levels (up to 10000 ppm) died. This may be attributed to that, such plant species are moderately sensitive to salinity (Parrota, 2001). In this regard, El-Khateeb (1994) found that saline water of 1500 or 3000 ppm had no significant effects on survival % and vegetative growth of *Murraya exotica* seedlings, but higher salinity concentrations significantly decreased them. Among fifteen ornamental shrubs diffused in the Mediterranean environment, Farieri *et al*. (2016) categorized *Murraya paniculata* as an intermediate species for seawater solution. Likewise, Fascella *et al*. (2017) reported that *Murraya paniculata* exhibited medium tolerance to the salinity of irrigation water (4.0 and 6.0 dS m^{-1}). Moreover, Fascella *et al*. (2020) noticed that *M. paniculata* showed moderate tolerance to NaCl treatments up to 40 mM concentration, while 80 mM one greatly reduced growth.

Besides, plants under salinity stress failed to uptake enough water necessary for vital processes activating due to either the low potential of soil water or certain ion toxicity (Na^+ and Cl^-) or both. Uptaking of Na^+ and Cl^- can result in a nutritional imbalance because of the antagonism between nutrients and saline ions with possible effects on the foliage. Salinity can negatively affect water relations in plants and reduce photosynthetic capacity through stomatal limitations and the direct effect of salt on the photosynthetic apparatus (Garcia-Caparros and Lao, 2018).

Also, salinity may result in depressing cell division at a constant cell number leading to a decrease in the cell volume. High salinity causes leaf abscission and prevents ATPase from participating in the endoplasmic reticulum-Golgi mediated, protein sorting machinery for both housekeeping function and compartmentalization of excess Na^+ (Amarin *et al*., 2020). Furthermore, reactive oxygen species (ROS) and the activity of antioxidant enzymes are affected, as well by salinity (Toscano *et al*., 2020).

Parallel results to those of the current work were gained on *Murraya exotica* (*Murraya paniculata*) by El-Khateeb (1994) who declared that a mixture of NaCl and $CaCl_2$ salts at concentrations higher than 3000 ppm (up to 7500 ppm) significantly decreased most vegetative growth traits and pigments (chlorophyll a, b and carotenoids) concentration, while N, K, Na, Ca, Cl and proline concentrations were, generally increased with increasing salinity level. Farieri *et al*. (2016) found that *M. paniculata* plants exposed to seawater solution showed a decrease in their fresh and dry weights of shoots and roots, leaf area and number and leaf damage increased with increasing the exposure period to seawater solution. Fascella *et al*. (2017) observed that high EC values of nutrient solution (up to 6.0 dS m^{-1}) reduced the growth of *M. paniculata* plants with leaf chlorosis and abscission. As well, Fascella *et al*. (2020) mentioned that growth, leaf chlorophyll content and net photosynthetic of Murraya plants were lower under 80 mM NaCl treatment than 40 mM NaCl one.

Moreover, results of our study are in accordance with those postulated by El-Nashar and Hassan (2020) on *Zinnia elegans* cvs. Short Stuff and Profusion, Paraskevopoulou *et al*. (2020) on four lavender species, Toscano *et al*. (2020) on *Convolvulus*, *Ceratonia* and *Ligustrum*, Mrudhula *et al*. (2021) on chrysanthemum, marigold and tulip, Alvarez *et al*. (2022) on *Hibiscus rosa-sinensis* and Banon *et al*. (2022) who indicated that growth of *Euphorbia* "Acost Rainbow" plant was reduced when irrigated with 3.3 dS m^{-1} saline water, while growth was ceased by 4.9 dS m^{-1} treatment. On *Rosmarinus officinalis* plant irrigated with saline water at 0, 1.4, 2.8 and 4.2 dS m^{-1} levels, Abdou *et al*. (2024) found that plant height, No. branches/plant and herb fresh and dry weights were decreased by increasing salinity levels (2.8 and 4.2 dS m^{-1}) in both cuts during both seasons. The essential oil % and yield were significantly decreased by 4.2 dS m^{-1} saline water treatment in both cuts of the two seasons. Concentrations of pigments, N, P and K took a similar trend of the vegetative growth parameters, while Na and proline concentrations were increased with increasing salinity levels in the 2^{nd} cut in both seasons.

Although ornamental plants resort to some mechanisms to avoid the harmful effects of salinity, these mechanisms alone are not enough to protect sensitive or moderately sensitive ornamentals from avoiding such damages. Thus,innovating some of integrative practices, including exogenous application of either gypsum or magnetite, may serve well in improving the ability of such plants to tolerate, even the moderate concentrations of salinity.

In this study using either gypsum ($CaSO_4.2H_2O$) or magnetic iron (Fe_3O_4) at a rate of 2 g/plant for each significantly improved survival (%), vegetative and root growth, flowering and chemical composition of Murraya plants under various salinity levels, except for 10000 ppm one, which led to death of the plants. However, the upper hand was for $CaSO_4$ which caused better improvement than Fe_3O_4 in most characters. This may be ascribed to that $CaSO_4$ regulates the exchange of sodium (Na^+) for calcium (Ca^{2+}) on the clay surfaces, thereby increasing the Ca^{2+}/Na^+ ratio in the soil solution. Intracellularly, Ca^{2+} also promotes a higher K^+/Na^+ ratio. Simultaneously, $CaSO_4$ supplies plants with sulphur (S) for enhancing growth and improving yield and quality through increasing the production of phytohormones, amino acids, glutathione and osmoprotectants, which are considered vital elicitors in plant`s responses to salinity stress (Bello *et al*., 2021). Moreover, Ca^{2+} of gypsum supports cell walls of plants and serves as a secondary internal messenger when plants are physically or biochemically stressed. Calcium, in the form of $CaSO_4$ promotes aggregation (binding soil particles). So, improving porosity. The Ca^{2+} component of $CaSO_4$ replaces Na^+ in salt soil or soil irrigated with saline water. Subsequently, Na^+ is removed from the rooting zone with either natural rainfall or irrigation (Chaganti and Culman, 2017).

As regards the positive effects of either magnetic iron or magnetized water on growth and aesthetic value of garden plants suffered from salt stress may be referred to its role in promoting the uptake of N, P, K and Fe which activate plant growth against the toxicity of Na^+ and Cl^- ions, to induces cell metabolism and mitosis of meristematic cells, to improve the movement of nutrients to the plant roots, to increase water absorption from the soil with increasing fertilizer efficacy. Magnetite declines the hydration of salt ions and colloids, increasing salt solubility, consequently leaching such salts from the soil. It is found in the form of granules very accurate with high magnetic effect, and when contact with water produces an electromagnetic field that helps the passage of macro-and micro-elements to the plant roots, it shocks the nematodes and microbes found on the roots and has high ability to make water of 10000 ppm salinity proper for irrigation

(El-Hindi *et al*., 2020; Sharavdorj *et al*., 2022).

Supporting gains to those of our study were also revealed on some ornamental and wood plants by Abdel-Aziz *et al*. (2006) on *Khaya senegalensis*, El-Mahrouk *et al*. (2010) on *Conocarpus erectus*, Abdel-Fattah (2014) on *Jacaranda actuifolia*, Ahmed *et al*. (2016) on *Acalypha wilkesiana*, El-Shawa and El-zohiry (2018) on *Rosa hybrida* cv. Centrix, and El-Hinidi *et al*. (2020) who found that irrigating *Calendula officinalis* plants with magnetized water (MW) showed significant improvement in all vegetative and flowering growth traits compared to control ones. Also, mineral concentrations and survival of plants irrigated with MW were higher than those of control plants. Irrigation with MW significantly reduced levels of Na^+ and Cl^- ions in the leaves showing the role of MW in reducing hazards of salinity.

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خفض أضرار الملوحة على نمو وجودة شتلات الموريا (*Murraya exotica* (L.) Jack) بإستخدام بعض الإضافات للتربة

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أجريت تجربة أصص بالحقل المفتوح بمشتل معهد بحوث البساتين، الجيزة، مصر، خلال موسمي ٢٠٢٢، ٢٠٢٣ لدراسة دور الجبس الزراعي (سلفات الكالسيوم) أو الحديد الممغنط (أكسيد الحديديك) بمعدل ٢ جم/نبات لكل منهما على حدة في خفض التأثيرات الضارة لمياه الري المالحة بتركيزات: صفر، ٢٠٠٠، ٤٠٠٠، ٦٠٠٠، ٨٠٠٠ و ١٠٠٠٠ جزء في مليون على نمو وجودة شتلات الموريا (*Murraya exotica* (L.) Jack). تم أيضاً دراسة تأثير التفاعلات المشتركة بين تركيزات الملوحة والمواد المضافة في تجربة عاملية تامة العشوائية، ثلاثية التكررات. أظهرت نتائج هذه التجربة أن القيم المتوسطة للنسبة المئوية للبقاء على قيد الحياه قد إنخفضت تدريجياً بزيادة مستوى الملوحة لتصبح أقل من ٥٠٪ بمستويات الملوحة ٦٠٠٠، ٨٠٠٠ جزء في مليون. إلا أن الشتلات التي رويت بمستوى ملوحة ١٠٠٠٠ جزء في مليون، حتى في وجود سلفات الكالسيوم أو الحديد الممغنط قد ماتت، بينما عند غياب هاتين الإضافتين بقيت شتلات الموريا حية حتى تركيز

ملوحة ٤٠٠٠ جزء في مليون فقط. وعليه، فقد تحسنت النسبة المئوية للبقاء إما بإضافة سلفات الكالسيوم لتكون أعلى من ٧٠٪ للنباتات المروية بماء مالح تركيزه ٨٠٠٠ جزء في مليون في كلا الموسمين أو بإضافة الحديد الممغنط لتكون أعلى من ٥٩٪ في الموسم الأول و ٦٧٪ في الموسم الثاني بمعاملة الملوحة ٨٠٠٠ جزء في مليون. وبالمثل، كانت نتائج قياسات النمو الخضري والجذري والزهري، مع بعض الإستثناءات القليلة في كلا الموسمين. وبصفة عامة، إنخفضت تركيزات الصبغات (كلوروفيللي أ، ب والكاروتينويدات)، النيتروجين، الفوسفور، البوتاسيوم والكربوهيدرات الكلية تدريجياً بالزيادة التدريجية في تركيز ملوحة مياه الري، بينما أدت إضافة سلفات الكالسيوم أو الحديد الممغنط إلى زيادة معنوية في تركيزات هذه المكونات الحيوية عند مقارنتها بتركيزاتها حال غياب هذه الإضافات عند نفس المستوى من الملوحة، مع بعض الإستثناءات القليلة بكلا الموسمين. ولقد كان العكس صحيحاً فيما يتعلق بتركيزات البرولين، الكلوريد، الصوديوم والكالسيوم في معظم الحالات بكلا الموسمين. إلا أن إضافة الجبس الزراعي (٢ جم/نبات) أعطت، بصفة عامة نتائج أفضل من النتائج التي حققتها إضافة الحديد الممغنط بنفس المعدل (٢جم/نبات) عند نفس المستوى من الملوحة. طبقاً للنتائج السابقة ؛ يمكن التوصية بإضافة الجبس الزراعى (سلفات الكالسيوم) بمعدل ٢ جم/نبات،أربع مرات بفاصل شهرين خلال فترة النمو النشط لشتلات الموراي (*Murraya exotica* (L.) Jack) عند الري بالماء المالح (حتى ٨٠٠٠ جزء في المليون) للحصول على نباتات أصص جيدة النمو، جيدة الإزهار، عالية القيمة الجمالية.