Effect of Spraying Liquorices Root Extract on Vegetative Growth, Chemical Characters and Photosynthetic Pigments of *Chrysanthemum morifolium* L.) Grown under Salt Stress

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Abstract: This experiment was conducted in Horticulture Department, School of Plant Production, Faculty of Agriculture and Forestry, University of Duhok, Iraq in 2010 on *Chrysanthemum* plants, in order to mitigate the adverse influence of salinity by the use of liquorice root extract and study its effect on vegetative growth, chlorophyll content in leaves from chlorophyll and assistant pigment, carbohydrate and starch. Subsequently, the trail consisted of three levels of salinity (0, 4 and 8 ds m⁻¹) and three concentrations of the liquorice root extract 0, 2.5 and 5 g L⁻¹. Results showed that salinity (4 ds m⁻¹) rate caused significant increases in certain vegetative characteristics (branches number, plant height, leaves number and leaf area), photosynthetic pigments (Chl a, Chl b, total chlorophyll, α -carotene, β -carotene, zeaxanthin, astaxanthin), fresh shoot weight, fresh root weight, shoot dry weight, root dry weight, shoot: root ratio, carbohydrate dry weight percentage and starch percentage as compared to untreated check. However, increasing salinity rate to 8 ds m⁻¹ resulted in substantial reductions in all above mentioned traits. Treatment with liquorices root extract, in particular, 5 g L⁻¹ manifested a potent capability in ameliorating the salinity negative effects in terms of vegetative and photosynthetic pigments aspects.

Key words: *Chrysanthemum morifolium*, liquorice root extract, salinity.

1. Introduction

Chrysanthemum morifolium is one of common ornamental plants, belonging to composite family. It is a perennial herb, weak stand, lateral branching, and herbaceous angular and present woolly. It is important not only for its outstanding aesthetic beauty and a long lasting capability but also for its good potentials for marketing as cut flowers and potted plants to many countries; *Chrysanthemum morifolium* Ramet, commonly called as guldaudi or autumn queen, is propagated vegetatively either through root suckers or terminal cuttings [1]. Salinity adversely affects the plant by inducing injury, inhibiting growth, altering

plants morphology and anatomy, often being a prelude to tree mortality [2]. All plant parts, including leaves, stems, and roots, revealed signs and symptoms displayed as leaf necrosis (death), marginal leaf needle burn, leaf shedding and eventual plant death. Buds may fail to burst or grow and branches may die [3]. Salt induced slowing of plant growth is accomplished by a variety of metabolic dysfunctions in non-halophytes, including inhibition of enzymatic activity, photosynthesis, absorption of minerals, protein and nucleic metabolism and respiration. Salinity also affects synthesis of carbohydrates as well as transport of photosynthetic products and their utilization in production of new tissues. Most investigations were conducted to study the effects of soil salinity on growth and mineral nutrients in many

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species. Graifenberg et al. [4] treated *Catharanthus roseus* plants by different concentrations of NaCl (25, 50, 75 and 100 mM) on 30, 45, 60 and 75 days after sowing noted that salinity affected all the morphological parameters and decreased the growth. Steven and Miyasaka [5] found that the reduction in plant growth and accumulation of inorganic ions (Na^+ and Cl^-) when vegetative propagates were grown under different levels of NaCl. Kiarostami et al. [6] studied the effects of salinity on some agro-physiological parameters in rosemary. They found that plant growth parameters were not affected by low concentrations of NaCl, but they were reduced with higher concentrations. The content of photosynthetic pigments was decreased at all salinity levels. There is strong evidence that in many crop plants natural accumulation of osmoprotectant and other organic compounds are very low and this deficiency can be overcome by their exogenous application [7, 8]. Exogenous applications of osmoprotectant, plant growth regulators, fertilizers, and antioxidants have been reported to successfully mitigate the adverse effects of salinity on plants. Of these, exogenous application of antioxidants has recently gained a ground as a very promising means of mitigating the adverse effects of salt on plant growth and metabolism [9-11]. Investigators reported that exogenous application of liquorice root extract reduced the toxicity of salinity and sometimes enhanced the growth [12]. The root of the plant is known to contain about 4% glycyrrhizin, the potassium or calcium salt of glycyrrhizinic acid, where this potassium salt aquired tolerance for plant to salinity stress by increasing turgidity and reducing tissue succulence [13]. Extractions from any of the many strains of this plant will yield a complex mixture containing more than 100 compounds besides sugars [14]. The root extract had profound concentration of glucose, sucrose and amino acid like histidine, phenylalanine, methionine glycine and proline, which is believed to protect plant tissues against stress by

acting as nitrogen-storage compound osmosolute and hydrophobic protectant for enzyme and cellular structures, also sugars and amino acids and other [15]. Organic solutes are believed to improve salt tolerance by contributing to osmotic balance and preserving enzyme activity [16]. Subsequently, the objective of this study was to investigate the possibility of liquorice root extract in mitigating the adverse effects of varying salt rates.

2. Materials and Methods

The current investigation was applied a greenhouse at Horticulture Department, School of plant production, Faculty of Agriculture and Forestry, University of Duhok, Iraq in 2010 to find out the role of exogenously application of liquorice root extract on *Chrysanthemum morifolium* grown under varying salt rates in order to alleviate the adverse effects of salt rates on growth parameters. Seedlings of *Chrysanthemum morifolium* were collected from the faculty garden and then thoroughly washed with deionized water then, seedlings were planted in plastic pots 25 cm diameter filled with 5 kg of sand, two seedlings were planted per pot and the pots were watered to the field capacity with deionized water for 20 days and grown hydroponically in the sand culture. The seedlings were pre-soaked in 250 mL of deionized water (control) and 250 mL of nutrient solutions which contain NaCl (E_c 4 and 6 ds m^{-1}) for each pot weekly. The liquorice root extract was weekly sprayed on plants at rates of 0, 2.5 and 5 g L^{-1} . The experimental design was a randomized complete block design (RCBD). Where the salt rates represented factor A and extracts represented factor B. Therefore, eight treatments were included, each was replicated three times and each replicate consisted of nine pots of two plants. Leaves number, branches numbers were counted, whereas plant height was measured by ruler. Vegetative fresh parts and fresh root were weighed by three decimal electrical balances. Fresh weights were oven-dried at 70 °C for

72 h then reweighed to calculate the dry matter percentage. Chlorophyll a, b, total and a/b ratio beside α -carotene, β -carotene, zeaxanthin, astaxanthin and total Ch/Car were determined by uv-visible spectrophotometer type [17]. Carbohydrates and starch percentage were measured as recommended by Joslen [18]. Finally, data were statistically analyzed by SAS comuterized program and Duncan test at 0.05% level was adopted for significance variations [19].

3. Results

3.1 Vegetative Growth Characteristics

Applying nutrient solution containing 4 ds m⁻¹ of NaCl gave the highest values in all detected vegetative characteristics as compared with the other rates (Table 1). Liquorices' root extract 5 g L⁻¹ was the most effective rate, since it gave the highest plant height, number of leaves, branches number, and leaf area (75.922 cm, 68.278, 2.967, 18.967 cm²), respectively as compared to other treatments. Applying nutrient solution containing 4 ds m⁻¹ of NaCl and 5 g L⁻¹

liquorice root extract dual treatment significantly mitigated the adverse effects of salinity, as it manifested the highest plant height (79.9 cm), leaves per plant (77.2 leaves per plant 3.1), and leaf area (21.100 cm²).

Applying nutrient solution containing 4 ds m⁻¹ of NaCl gave the highest values in fresh and dry weight and fresh and dry weight of roots as compared with the other rates (Table 2). Spraying liquorice root extract 5 g L⁻¹ produced higher rates for all characteristics and was significantly superior upon the most other concentrations. Applying nutrient solution containing 0 ds m⁻¹ of NaCl and 5 g L⁻¹ liquorice root extract dual treatment gave the highest value of the fresh vegetative weight and fresh root weight (68.667 g and 69.333 g), respectively. The nutrient solution with 8 ds m⁻¹ of NaCl and 2.5 g L⁻¹ liquorice root extract gave the highest values of vegetative and root dry weight 14.467 g, 17.700 g, respectively.

3.2 Photosynthetic Pigments Characteristics

Applying nutrient solution with 4 ds m⁻¹ of NaCl

Table 1 Effect of spraying liquorice root extract on some vegetative growth characteristics of *Chrysanthemum morifolium* L. under salt stress.

NaCl Ec (ds m ⁻¹)	Parameters			
	Plant height (cm)	Number of leaf/plant	Number of branches/plant	Leaf area (cm ²)
0	62.000 b	53.567 b	2.378 b	14.844 a
4	71.411 a	70.156 a	2.978 a	16.733 a
8	64.533 b	64.167 ab	2.967 a	16.589 a
Liquorice root extract (g L ⁻¹)				
0	57.544 c	54.178 b	2.489 a	13.656 b
2.5	64.478 b	65.433 ab	2.867 a	15.544 b
5	75.922 a	68.278 a	2.967 a	18.967 a
NaCl + liquorice root				
0 + 0	44.033 e	40.000 b	1.300 b	10.700 d
0 + 2.5	62.067 cd	56.167 ab	2.967 a	15.500 bc
0 + 5	78.333 a	64.533 a	2.867 a	18.333 ab
4 + 0	56.967 d	57.400 ab	2.867 a	13.867 cd
4 + 2.5	58.300 d	72.000 a	2.967 a	14.800 bc
4 + 5	79.900 a	77.200 a	3.100 a	21.100 a
8 + 0	71.633 ab	65.133 a	3.067 a	16.400 bc
8 + 2.5	73.067 ab	68.133 a	2.967 a	16.333 bc
8 + 5	69.533 bc	63.100 a	2.867 a	17.467 bc

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table 2 Effect of spraying liquorice root extract on vegetative and root fresh and dry weight of *Chrysanthemum morifolium* L. under salt stress.

NaCl <i>Ec</i> (ds m ⁻¹)	Parameters			
	Vegetative fresh weight/plant (g)	Root fresh weight (g)	Vegetative dry weight/plant (g)	Root dry weight (g)
0	45.222 a	45.000 a	10.378 b	13.433 a
4	52.111 a	53.333 a	14.178 a	13.967 a
8	49.556 a	52.889 a	12.178 ab	13.389 a
Liquorice root extract (g L ⁻¹)				
0	40.111 b	42.444 b	10.500 b	13.222 a
2.5	50.111 a	49.667 ab	12.033 ab	13.311 a
5	56.667 a	59.111 a	14.200 a	14.256 a
NaCl + liquorice root				
0 + 0	21.667 d	20.667 c	6.800 b	8.700 b
0 + 2.5	45.333 bc	45.000 b	10.333 ab	15.567 ab
0 + 5	68.667 a	69.333 a	14.000 a	16.033 ab
4 + 0	40.000 c	53.667 ab	10.867 ab	13.267 ab
4 + 2.5	53.667 b	48.667 ab	11.300 ab	14.267 ab
4 + 5	55.000 b	56.333 ab	14.367 a	14.367 ab
8 + 0	58.667 ab	53.000 ab	13.833 a	10.100 ab
8 + 2.5	51.333 bc	55.333 ab	14.467 a	17.700 a
8 + 5	46.333 bc	51.667 ab	14.233 a	12.367 ab

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

gave the highest rate whereas applying nutrient solution with 8 ds m⁻¹ of NaCl gave the lowest rate as compared with the other rates in all photosynthetic pigments characteristics (Table 3). A high concentration of liquorice root extract at 5 g L⁻¹ tended to increase chlorophyll content in plant (Chl a, Chl b, total Chlorophyll) (14.621%, 10.621% and 25.242%), respectively. Whereas, the chlorophyll a/b was the highest at 0 liquorice root extract treatment (1.536%). Applying nutrient solution with 4 ds m⁻¹ of NaCl and 5 g L⁻¹ liquorice root extract combination treatment significantly mitigated the adverse effects of salinity, since it gave the highest values (photosynthetic pigments) of all chlorophylls. While, the highest chlorophyll a/b was confined to the control treatment, as it exceeded other concentrations by 1.683%.

3.3 Assistants Photosynthetic Pigments

Applying nutrient solution containing 4 ds m⁻¹ of NaCl gave the highest value of assistant

photosynthetic pigments such as (α -carotene 6.311%, β -carotene 5.293%, zeaxanthin 5.538%, astaxanthin 4.315% and chlorophyll/carotene 1.858%), which was significantly superior upon other concentrations (Table 4). Whereas, the effect of liquorice root extract did not differ significantly from the other treatments concerning α -carotene, β -carotene, zeaxanthin and astaxanthin. While, the high concentration of liquorice root extract 5 g L⁻¹ gave a higher rate of about 1.783% concerning the characteristics of chlorophyll/carotene. Applying nutrient solution containing 8 ds m⁻¹ of NaCl and 2.5 g L⁻¹ liquorice root extract gave the highest value of the α -carotene (6.819%). While, concerning the β -carotene and astaxanthin and chlorophyll/carotene, the treatment of nutrient solution containing 4 ds m⁻¹ of NaCl and 5 g L⁻¹ liquorice root extract gave the highest values (5.909%, 4.843% and 2.452%) respectively. Whereas, applying nutrient solution containing 0 ds m⁻¹ of NaCl and 2.5 g L⁻¹ liquorice root extract gave the highest rate of zeaxanthin (6.304%) as compared with control.

Table 3 Effect of spraying liquorice root extract on some photosynthetic pigments of *Chrysanthemum morifolium* L. under salt stress.

NaCl <i>Ec</i> (ds m ⁻¹)	Parameters			
	Chlorophyll a (mg/g FW)	Chlorophyll b (mg/g FW)	Total chlorophyll	Chlorophyll a/b
0	11.535 b	7.535 b	19.070 b	1.553 a
4	15.521 a	11.521 a	27.043 a	1.353 c
8	12.859 b	8.859 b	21.718 b	1.470 b
Liquorice root extract (g L ⁻¹)				
0	12.167 b	8.167 b	20.334 b	1.536 a
2.5	13.128 b	9.128 b	22.255 b	1.454 b
5	14.621 a	10.621 a	25.242 a	1.386 c
NaCl + liquorice root				
0 + 0	9.865 f	5.865 f	15.731 f	1.683 a
0 + 2.5	11.477 ef	7.477 ef	18.955 ef	1.539 b
0 + 5	13.262 be	9.262 be	22.525 be	1.436 bd
4 + 0	11.738 df	7.738 df	19.476 df	1.549 b
4 + 2.5	12.637 ce	8.637 ce	21.273 ce	1.464 bc
4 + 5	16.398 a	12.398 a	28.796 a	1.326 d
8 + 0	14.897 ac	10.897 ac	25.795 ac	1.374 cd
8 + 2.5	15.269 ab	11.269 ab	26.538 ab	1.359 cd
8 + 5	14.203 ad	10.203 ad	24.405 ad	1.397 cd

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

Table 4 Effect of spraying liquorice root extract on assistant photosynthetic pigments in leave of *Chrysanthemum morifolium* L. under salt stress.

NaCl <i>Ec</i> (ds m ⁻¹)	Parameters				
	α -carotene (mg/g FW)	β -carotene (mg/g FW)	Zeaxanthin (mg/g FW)	Astaxanthin (mg/g FW)	Chlorophyll/ Carotene
0	4.898 b	4.528 a	5.002 a	3.191 b	1.258 b
4	6.311 a	5.293 a	5.538 a	4.315 a	1.856 a
8	5.730 ab	5.172 a	5.493 a	3.783 ab	1.165 b
Liquorice root extract (g L ⁻¹)					
0	4.624 b	4.557 a	5.046 a	3.468 a	1.197 b
2.5	6.041 a	4.634 a	5.786 a	3.915 a	1.299 b
5	6.274 a	5.802 a	5.201 a	3.906 a	1.783 a
NaCl + liquorice root					
0 + 0	3.856 c	2.968 b	3.112 b	3.051 b	1.077 b
0 + 2.5	5.173 ac	4.833 ab	6.304 a	3.509 ab	1.023 b
0 + 5	5.664 ac	5.781 a	5.589 a	3.013 b	1.675 ab
4 + 0	4.613 bc	5.357 ab	6.160 a	3.245 ab	1.019 b
4 + 2.5	6.131 ab	4.445 ab	4.899 a	4.243 ab	1.254 b
4 + 5	6.712 a	5.909 a	4.592 ab	4.843 a	2.453 a
8 + 0	5.403 ac	5.347 ab	5.867 a	4.109 ab	1.494 b
8 + 2.5	6.819 a	4.622 ab	6.155 a	3.992 ab	1.620 b
8 + 5	6.445 ab	5.715 a	5.420 a	3.861 ab	1.222 b

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

3.4 Carbohydrate, Shoot: Root Ratio, Dry Weight Percentage and Starch Percentage Characteristics

Applying nutrient solution containing 4 ds m⁻¹ of NaCl gave the highest percentage of carbohydrate, shoot:root ratio, dry weight percentage and starch percentage (2.441 mg/g, 1.154 shoot:root, 27.967% and 440.525%) respectively as compared to the other concentrations (Table 5). Spraying liquorice root extract at 5 g L⁻¹ was the most effective rate, since it gave the highest value of carbohydrates, shoot: root ratio, dry weight percentage and starch percentage (2.531 mg/g, 1.060 shoot: root, 28.667% and 441.650%), respectively. Applying nutrient solution containing 8 ds m⁻¹ of NaCl and 5 g L⁻¹ liquorice root extract gave the highest response of shoot: root ratio (1.229). While, the highest carbohydrates and dry weight percentages of plant was accompanied with the treatment of nutrient solution containing 4 ds m⁻¹ of NaCl and 5 g L⁻¹ liquorice root extract (3.058 mg/g and 34.733%, respectively). The treatment 5 g L⁻¹ liquorice root extract gave the highest starch

percentage (442.013%) as compared to the other treatments.

4. Discussion

The obtained results were in accordance with those reported by Faiaz and AL-Zobaidy [20, 21]. *Chrysanthemum* plants subjected to salinity revealed substantial inhibition in terms of plant height, branches number per plant, leaf area and total leaf number per plant. These reductions were gradually apparent with salinity increases, particularly at 8 ds m⁻¹. These adverse effects can be attributed to the imbalance in the hormonal and metabolic besides the influence of osmosity which resulted in water scarcity which finally negatively affected cell divisions and expansions. Salinity is usually accompanied by osmotic alteration and thus plant required energy for re-conditioning their cells on the expanse of organic developments [22]. It is appeared that higher levels of salt inhibited each of longitudinal and width growth and these results are in harmony with those of

Table 5 Effect of spraying liquorice root extract on some carbohydrate and shoot: root ratio and dry weight percentage and starch percentage of *Chrysanthemum morifolium* L. under salt stress.

NaCl Ec (ds m ⁻¹)	Parameters			
	Carbohydrate (mg/g FW)	Shoot: root ratio	Dry weight percentage (%)	Starch percentage (%)
0	1.554 b	0.809 b	18.644 b	441.498 a
4	2.441 a	1.154 a	27.967 a	440.525 a
8	2.167 a	1.040 ab	26.978 a	440.084 a
Liquorice root extract (g L ⁻¹)				
0	1.601 b	0.927 a	21.944 b	439.865 b
2.5	2.031 b	1.016 a	22.978 b	440.593 ab
5	2.531 a	1.060 a	28.667 a	441.650 a
NaCl + liquorice root				
0 + 0	1.433 c	0.833 a	17.033 c	440.525 ab
0 + 2.5	1.636 bc	0.717 a	17.933 c	441.957 a
0 + 5	1.594 c	0.876 a	20.967 bc	442.013 a
4 + 0	1.661 bc	0.835 a	23.867 bc	440.863 a
4 + 2.5	1.900 bc	1.210 a	25.300 ac	441.238 a
4 + 5	3.058 a	1.074 a	34.733 a	439.474 ab
8 + 0	1.708 bc	1.112 a	24.933 ac	438.208 b
8 + 2.5	2.556 ab	1.122 a	25.700 ac	441.754 a
8 + 5	2.941 a	1.229 a	30.300 ab	440.291 ab

Means within a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple range test at the probability of 0.05 levels.

AL-Sahaf [23]. The low levels of salinity 4 ds m⁻¹ motivated increasing the leaves area. Similar results have been found by Badawi [24]. Reductions observed in leaf area of *Chrysanthemum* plants as a result of salinity in this study is alike with those mentioned by Van-Lepren [25]. The spraying of liquorice root extract led to obtain a significant increase in leaf area of the plant and may be due to increasing leaf area that liquorice root extract has a behavior similar to giberellin and working to increase the elongation and division of cells of leaves, leading to increase the area of a leaf and then increase the leaf area of the plant. These results agree with Alphones [26]. Regarding the interaction between treatments, it was significant because spraying of liquorice root extract minimized the effect of salinity an inhibiting the leaf area. The results in the same Table 1 clearly show that 4 ds m⁻¹ at salinity significantly increased the total number of leaves, while increasing of salinity levels 8 ds m⁻¹ significantly reduced the number of leaves. These results are in agreement with those stated by Ahmed [27]. The effects of liquorice root extract on promoting vegetative growth can be explained as it contains many compounds especially reducing and non-reducing sugars, amino acids and some of minerals such as potassium, calcium, phosphorous, and other minerals that caused increasing in nutrient compounds in photosynthesis process which positively reflect on vegetative growth characters [28]. The results manifested that increasing of salinity levels showed reducing efficacies in total vegetative fresh weight, significantly. This may be due to the inhibited plant height, low lateral branches and leaf area because of high levels of salinity which facilitates reduction in the amount of absorbed water by plant and also absorbing of essential nutrients for growth, further than effecting on plant bioactivities. The results of this investigation are in agreement with those of Cruz et al. [29], who mentioned that high level of salinity decreased the fresh weight of vegetative system. The treatment of liquorice root

extract (Table 2) significantly increased the total vegetative fresh weight due to their effects on promoting vegetative growth traits. The interaction between treatments was significant adding liquorice root extract reduced the effect of salinity on inhibiting fresh weight of root system. A significant down was found warding in dry weight for vegetative growth with the increasing of salinity levels of this is accompanied with the decreasing in photosynthesis rate because of increasing of salinity levels in addition of short aging of nutrient absorptions and salt deficiency on various anabolism process. This result agreed with those [25, 30]. Treating plants with liquorice root extract significantly led to increasing the dry weight of vegetative system of level 5 g L⁻¹. Regarding the interaction between salinity and liquorice root extract, their effect on vegetative dry weight was non significant. The results in Table 3 clearly show that increasing salinity levels 8 d Sm⁻¹ led to a significant decrease in chlorophyll a and b levels. This might due to that the salinity causes to chlorophyll destroy. This was in agreement with what has been published [31, 32]. They found that salinity caused chlorophyll destruction and the speed of destroy is slow in salinity tolerant plants. Also in the same table, the results shows a significant decrease in total chlorophyll (a and b). This result might be due to higher accumulation of NaCl in soil and this led to decreasing the chlorophyll structure. This result was in agreement with Khattab [33]. They declared that the significant decreasing in total chlorophyll by using NaCl is due to the decrease of enzymes activities, those specific in building green pigments. Concerning the rate of chlorophyll (a and b) in the same table, the decrease of the a/b chlorophyll rate level. The reason might be due to decrease of concentration of both chlorophylls (a and b), because of the accumulation of NaCl in soil solution. The effect of liquorice root extract (Table 3) led to a superior significant in chlorophyll a and b and total chlorophyll (a and b) because the liquorice root extract decreased the effect

of negative salinity. The interaction between treatments shows significant differences between them and the addition of liquorice root extract led to decrease the harmful effect of salinity and increase the chlorophyll level. Table 5 showed that there were lower significant differences in carbohydrates by increasing the salinity level. This might be due to the effect of salinity has a role in the process of carbohydrates structures building up through the inhibition of photosynthesis process, because of the low absorption of CO₂ due to close of stomata to decrease the water loss through transpiration or the effect on green plastids structure or chlorophyll synthesis [34]. Transmission speed influenced by products of photosynthesis under conditions of saline tensile inversely and in general, which affects the growth and production [34]. These results agree with the researchers [31, 32]. They found that saline potential led to lower accumulation of carbohydrates in plant, and that the decline in carbohydrate content of plants grown under saline conditions due to the reduction made in the activity of photosynthesis [35]. These results agree with Kotb and EL-Gamal [36] for *Nigella sativa* L.. This significant decrease of carbohydrates increased levels of salinity. Liquorice root extract in the same, Table 5 led to increase the rate of carbohydrates. These results agree with Khafagi [37] obtaining an increase in the accumulation of carbohydrates in a number of plants tested. The interaction between the treatments was of significant effect, where the addition of extract of liquorice root extract led to minimize the negative effects of salinity and led to increase the proportion of carbohydrates. Liquorice root extract may lead to increase in the rate of photosynthesis or may reduce the rate of respiration, as the both cases that lead to increased production of dry matter. At the same Table 5, it can be noted that the increase in salinity levels has led to a significant decrease in the ratio of shoot to root which might be due to the decline in each of the weight of dry matter of vegetative and root groups

(Table 2), and minimizing of (S/R) ratio is the positive indicators that show the increase the salinity resistant of *Chrysanthemum* plant, as confirmed by Shamsi [38] that the low rate of (S/R) refers to increase plant resistance to the lack of nutrients in the growth medium causes increase the growth and root density aggregates and spread through the larger mass of soil and then leads to increased absorption of nutrients, despite the lack of readiness of the nutrients in the soil. Concerning the dry weight percentage in Table 5, it also can be noted that the decrease in the dry weight percentage increased salinity that this decline may be due to the lower area of the leaf (Table 1), as confirmed by Hu [39] that the area of leaves is one of the directories that can be adopted to study the effects of salinity on the growth of leaves. As well as for the decline in the leaves growth may be due to the accumulation of sodium chloride in leaves. These results are in agreement with those reached by Munns [40] that for the decline in growth was due to collected salts are toxic to the turbulent inside the plant.

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