EFFECT OF WATER SALINITY AND SOME NUTRITIONAL COMPOUNDS ON THE GROWTH AND PRODUCTION OF SWEET MARJORAM PLANTS (*MAJORANA HORTENSIS* L.)

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Abstract

Aiming to study the marjoram (*Majorana hortensis* L.) potential to survive under salinity condition and to find out the effect of some bio-fertilizers on this potential, two experiments were conducted in Baramoon Experimental Station, Dakahlia Governorate, Egypt, during two successive seasons of 2003-2004 and 2004-2005. The present investigation were planed to test (4) levels of saline water as well as foliar nutrition by some bio-compounds i.e., Askobein, Novitrein, Citrein and Anciabein mixtures effects and their interactions on plant growth, essential oil, quantity and quality. Marjoram seedlings were grown in plastic bags.

Plants irrigated with saline water displayed deleterious effects on all growth characters, and these effects were proportional to salinity concentrations. Marjoram plants showed a quite tolerance to salinity at 2000 ppm, whereas the excess concentration (4000 and 6000 ppm) caused a severe damage to the irrigated plants, a remarked reduction in survival percentage and significantly reductions of leaves essential oil percentage. Oil analysis by gas liquid chromatography showed that saline water slightly decreased percentages of main components at levels of 2000 and 4000 ppm, whereas 6000 ppm caused vanishing of some constituents and caused severe harmful to oil principals.

All bio-compound i. e., Novitrein, Citrein, Askobein or Anciabein, slightly caused significant increments on the studied plant growth characters and displayed the best estimates in the two seasons. Application of these compounds raised the plant potential to tolerate salinity and simultaneous increased the survival percentage. In addition utilizing these compounds slightly increased oil active principals and could be overcome the harmful effect of saline irrigation water.

INTRODUCTION

Sweet marjoram (*Majorana hortensis* L.), Labiatae (Lamiaceae) is an important aromatic and medicinal plant. In Egypt, it is considered as an important economic agricultural export crop. It is used for seasoning soups dressing, poultry and sausage. It is used as carminative and stimulant and is greatly used for confectionery, tooth pastes and whooping cough.

Several investigators studied the effect of different levels of salinity on the growth, essential oil percentage and constituents of several medicinal and aromatic plants.

In Egypt, it grows well and widely particularly in Upper Egypt and Sinai. So, it can be successfully extended to the newly reclaimed soils in the south El-Wady region. Most of promising lands in Egypt are situated either near the Mediterranean Sea or in the Western desert. In the former region, saline water is generally used for irrigation, whereas, in the later, it is mostly saline soils. Thereupon, under deficiency of water, irrigation with saline water is the mainly available source in many parts of newly reclaimed areas (El-Queseni and El-Gayar, 1993). In the same time, under the arid climatic conditions prevailing in Egypt and the perennial irrigation practices, association with imperfect drainage system, continuously cause an increase of water table levels and the relatively high salinity levels of water sources particularly in the new reclaimed desert land. This salinity of soils is rapidly going to be an acute problem.

Soil salinity disrupts several physiological processes in plant lead to reduction in growth. Therefore, the need for protecting such plants is in demand. This can achieved throughout selecting superior species, which its plant has a high survival capability against soil and water salinity. The useful usages of plant foliar spray with certain trace elements such as iron, manganese and zinc have recently overcome the low tolerance to salinity and minimize salinity injuries (Hasegawa *et al.,* 1986).

Hussein (1999) studied the effect of salinity levels on some varieties of *Ocimum basilicum.* They found that the level of salinity (1500 ppm) caused an increase in plant height, number of leaves/plant, fresh and dry weight of leaves as well as oil percentage and content in *Ocimum basilicum* var purpurascens.

The use of microelements to improve the yield and the active ingredients of medicinal and aromatic plants is considered as one of the most important and interested research subjects.

As for micro-elements, it was found that, growth characters in terms of plant height, branches number and dry weight as well as the yield of flower significantly increased by using foliar spray of Zn, Mn and Fe singly or in combinations (Makarim and Bishr 1988) on chamomile.

Omar *et al.* (1983) on anise plants indicated that the high doses of Zn and Mn 3 gm/liter had expressed the highest significant effect on fruit yield per plant, the essential oil and/or fixed oil yield per plant.

Harridy (1986) found that, Zn at (100 ppm) increased significantly the dry matter of periwinkle plants.

The present research was carried out to study the effect of different levels of salinity on growth and oil yield of marjoram and how to overcome the harmful of high level of salinity by using some nutritional compounds.

MATERIALS AND METHODS

This investigation was carried out during the two successive seasons (2003 and 2004) at the experimental Farm in Baramoon, Dakahlya Governorate.

Cuttings of *Majorana hortensis* L. (Marjoram) were taken from symmetry mother plants grown in the Medicinal and Aromatic Plants Farm in the Fac. of Agric. Mansoura Univ. and planted in the nursery under shaded conditions for rooting on Oct. 15th 2003 and 2004 seasons. After three months, on Jan. 15th, the rooted cuttings were individually transplanted in plastic bags of 25 x 35 cm, each bag was filled with 4.5 kg of air dried soil of physical and chemical properties shown in Table A. Each bag had one plant (about 10 cm in height). Plants were held under natural conditions and irrigated with tap water until the irrigation with saline water treatments and foliar spray. Plants were fertilized with 2.5 g ammonium sulphate (33.5 %), 3.5 g calcium super phosphate (15.5 %) and 1.25 g potassium sulphate (48 %) per bag after 3 weeks from transplanting date.

Table A. The physical and chemical properties of the experiment soil.

Sand (%)	15.32	Total nitrogen (%)	0.50
Silt (%)	34.96	Water soluble phosphorus (%)	0.05
Clay (%)	45.12	Available potassium (meq/l)	0.06
Organic matter (%)	1.68	Available iron (ppm)	17.5
EC mmhos/cm	1.41	Available manganese (ppm)	3.50
pH	7.75	Available zinc (ppm)	5.10

Physical and chemical contents according to the standard described by Jackson (1967).

I. Saline irrigation water treatments:

A month later after transplanting, on February 15th for the two seasons, plants were arranged to receive different treatments in (20 groups of bags) every group contained (5 bags) and treatments were as following:

-Treatment (1): plants irrigated with tap water of 304 ppm as control plants.

-Treatment (2): plants sprayed with Askobein solely at rate of (1g / ¾ l).

-Treatment (3): plants sprayed with Novitrein solely at rate of (3 cm^3/ l).

-Treatment (4): plants sprayed with Citrein solely at rate of (6 cm^3/ l).

-Treatment (5): plants dressed with Anciabein solely at rate of (1g to every bag before transplanting).

-Treatment (6): plants received saline water at level (2000 ppm).

-Treatment (7): plants received saline water at level (2000 ppm) and sprayed with Askobein at rate of (1g / ¾ l).

-Treatment (8): plants received saline water at level (2000 ppm) and sprayed with Novitrein at rate of (3 cm^3/ l).

-Treatment (9): plants received saline water at level (2000 ppm) and sprayed with Citrein at rate of (6 cm^3/ l).

-Treatment (10): plants received saline water at level (2000 ppm) and dressed with - Anciabein at rate of (1g to every bag before transplanting).

-Treatment (11): plants received saline water at level (4000 ppm).

-Treatment (12): plants received saline water at level (4000 ppm) and sprayed with Askobein at rate of (1g / ¾ l).

-Treatment (13): plants received saline water at level (4000 ppm) and sprayed with Novitrein at rate of (3 cm^3/ l).

-Treatment (14): plants received saline water at level (4000 ppm) and sprayed with Citrein at rate of (6 cm^3/ l).

-Treatment (15): plants received saline water at level (4000 ppm) and dressed with - Anciabein at rate of (1g to every bag before transplanting).

-Treatment (16): plants received saline water at level (6000 ppm).

-Treatment (17): plants received saline water at level (6000 ppm) and sprayed with Askobein at rate of (1g / ¾ l).

-Treatment (18): plants received saline water at level (6000 ppm) and sprayed with Novitrein at rate of (3 cm^3/ l).

-Treatment (19): plants received saline water at level (6000 ppm) and sprayed with Citrein at rate of (6 cm^3/ l).

-Treatment (20): plants received saline water at level (6000 ppm) and dressed with Anciabein at rate of (1g to every bag before transplanting).

Saline solution was prepared from a mixture of 2:1 sodium and calcium both in chloride form respectively. The bags were irrigated with tape water for four weeks before irrigation with the saline water. Irrigation water was applied to raise the soil moisture content up to the field capacity with 15% excess as leaking fraction to avoid salt accumulation in the bags until the end of the experiment in the two seasons.

II. Askobein, Novitrein, Citrein and Anciabein:

(a) Askobein:

Natural growth activator as a product of Agricultural Ministry contains nutritional organic substances (nearly 62%) for acceleration of plant growth. The active substances of Askobein are Ascorbic acid + citric acid nearly 38%.

(b) Novitrein:

Foliar spray fertilization on vegetative growth and it contains macro- and microelements such as nitrogen 5%, P_2O_5 5%, K_2O 5%, iron EDTA (Fe 15%) manganese EDTA (Mn 10%), zinc EDTA (zinc 15%), boron (B 0.05%) and molybdenum (Mo 0.02%).

(c) Citrein:

Activator foliar plant organic nutritional, empty of hormones, contains iron EDTA (Fe 6%) manganese EDTA (Mn 6%), zinc EDTA (zinc 6%), beside citric acid (15%) and carbohydrate substances (3%).

(d) Anciabein:

Slow soluble nitrogen fertilizer contains 40% nitrogen and it can be utilized at long run of age for plant.

Experimental design:

The experimental design factorial experiment is complete randomized blocks design with three replicates, each replicate contain 20 bags. All the plants received normal agricultural practices whenever they needed. The following data were recorded at harvest date June 15th in both seasons:

1. Vegetative growth characters,

They were recorded in the samples taken after 90 days from transplanting as follows:

- Plant height (cm): It was measured from the surface of the ground to the tallest part of each plant.
- Number of branches.
- Fresh weight of whole herb per plant (g).
- Dry weight of whole herb per plant (g).

2. Survival percentage:

It was recorded before two weeks from harvest date (after all the fertilization treatments were applied) as:

$$\text{Survival \%} = \frac{\text{Number of survival plants/treatment}}{\text{Number of survival plants/control}} \times 100$$

3. Essential oil percentage:

The estimation of volatile oil was carried out on samples (100 g.) just at cutting time of fresh herb according to the method described by Guenther (1961).

GLC analysis technique was used to separate and identify the component of essential oil of marjoram herb.

The GLC analysis was carried out in the Central Laboratory of Fac. Agric. Cairo Univ. (Varian VISTA series 6000, FID detector). The constituents of the essential oil

were identified by matching their retention time (RT) with those of authentic samples under the same conditions, according to Guenther and Joseph (1978).

Statistical analysis:

Data of the present study was statistically analysis and the differences between the means of the treatments were considered significant when they were more than least significant differences (LSD) at the levels of 5% or 1% according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Effect of saline irrigation water, some nutritional compounds (Askobein, Novtrein, Citrein, Anciabein) and their interactions on vegetative growth of marjoram plants:

1.1. Plant height:

It is evident from the data in Table (1) that saline water treatments, significantly decreased marjoram plant height compared without control plants (tap water). This reducing was increased as raising salinity level up to 6000 ppm. This result is supported with results obtained by Kandeel and Elwan (1991).

Table 1. Plant height (cm) of *Majorana hortensis* L. as affected by saline irrigation water, some nutritional compounds and their interactions during 2003 and 2004 seasons.

Salinity (S) ppm	First season 2003						Second season 2004					
	Nutritional compounds						Nutritional compounds					
	0	Novitrein	Citrein	Askobein	Anciabein	S mean	0	Novitrein	Citrein	Askobein	Anciabein	S mean
Cont.*	30.7	43.9	41.8	39.2	36.6	38.4	32.6	44.8	41.3	39.1	35.2	38.6
2000	28.3	38.6	37.2	36.0	34.3	34.9	29.9	39.7	37.8	36.3	34.5	35.6
4000	25.6	36.7	35.0	33.9	32.7	32.8	26.7	36.2	35.2	34.8	33.6	33.3
6000	22.8	34.7	33.5	32.3	31.0	30.9	23.6	30.0	33.9	32.9	31.5	31.2
MT means	26.9	38.5	36.9	35.6	33.7	--	28.2	38.7	37.1	35.8	33.7	--
LSD at 5%	S= 0.54		MT= 0.60		S x MT= 1.21		S= 0.58		MT= 0.65		S x MT= 1.30	

•Control (tap water).

The same table revealed that spraying plants with Novitrein solely, Cetrein solely, Askorbein solely and dressing Anciabein solely, respectively proved more enhancing of plant height compared with control plants. Novitrein established the over all improvement of plant height may be attributed to its content of major Macro and Microelements which are necessary for most biosynthesis reactions in the plant. Also, Citrein after Novitrein enhanced remarkable increment in plant height compared with control plants during the two seasons owing to its content of mixtures to iron, manganese and zinc EDTA, beside its content of Citric acid which is an organic substance for stimulation growth. On the other hand, Askobein followed by Anciabein realized improvement in plant height than control ones but more less than Novitrein

and Citrein, respectively. The recorded results were significant in both seasons. These findings are in complete agreement with those obtained by Morsy (1999) on *Thymus vulgaris* plants who found a significant effect for trace elements on growth characters measured including plant height.

From data recorded in Table (1) decreasing effect of salt stress and promoting one of macro, trace elements and some organic acids in both of Novitrein, Citrein, Askobein and Anciabein tested on plant height can be explained in the former effect as the accumulation of salt ions in the growing media increased osmotic pressure and depressed water adsorption which in turn negatively affected on the activity of meristematic cell division and elongation (Greenway, 1973). On the other hand, the positive effect based on the active role of Fe and Zn ions in chlorophyll and IAA synthesis, respectively in plant tissues as well as Mn ion in biosynthesis of proteins (Khamara, 1984). Accordingly, the addition of such trace-elements in the proper mixture greatly promotes cell division and /or elongation of stem stress leading to increasing in plant height.

From Table (1), it was cleared a significant increasing effect of interactions between saline irrigation water and trace-elements mixture with other organic components on plant height comparing with control plants in all cases of the two seasons. Under all salinity levels, the highest results realized at treatments combination with Novitrein, Citrein, Askabein and Anciabein, respectively in plant height compared to control and those of salinity treatments alone. Otherwise, increasing salinity level up to 6000 ppm under each level of trace-element mixtures with other components decreased plant height compared to Novitrein, Citrein Askobein and Anciabein solely. Also, it was cleared that using trace-elements mixture with other components reduced the harmful effect of saline water treatments. Similar results were found by Ramadan (1996) on guar, who reported that under high salinity levels in irrigation water spraying plants with trace-elements (Fe, Man and Zn) solely or in combinations at certain levels greatly overcome the harmful effect of salinity on plant height.

1.2. Number of branches per plant:

Data in Table (2) that have been performed in term of number of branches per plant emphasized that saline water irrigation on one side and both of Novitrein, Citrin, Askobein and Anciabein on other side and their interactions behaved in the same manner favorable altering of the plant height.

Data presented in Table (2) illustrated that increasing in salinity levels up to 6000 ppm caused gradual decreasing in number of branches per plant, whenever components of both Novitrein, Citrein, Askobein and Anciabein, every of all solely

enhanced the most increasing in results, respectively and the differences between results of treatments and control were significant in both seasons.

On the other hand, interaction treatments proved the over-all improvement in term of the number of branches per plant when compared with control plants or plants which dressed with different saline irrigation water levels, alone. Ingredients of both Novitrein, Citrein, Askobein and Anciabein can over-come the harmful effect of saline irrigation water and using of it in spite of salinity caused improvement in significant recorded results in both seasons.

Table 2. Number of branches/plant of *Majorana hortensis* L. as affected by saline irrigation water, some nutritional compounds and their interactions during 2003 and 2004 seasons.

Salinity (S)	First season 2003						Second season 2004					
	Nutritional compounds						Nutritional compounds					
ppm	0	Novitrein	Citrein	Askobein	Anciabein	S mean	0	Novitrein	Citrein	Askobein	Anciabein	S mean
Cont.*	26.34	34.66	32.65	30.87	28.98	30.72	25.86	35.27	33.69	31.81	28.33	30.99
2000	25.11	33.41	31.21	30.00	28.63	29.67	24.35	33.45	31.23	29.99	28.00	29.40
4000	22.76	31.61	29.87	28.71	28.00	28.19	21.69	31.67	29.76	28.73	27.89	27.95
6000	18.91	28.73	27.06	26.81	27.56	25.81	18.73	28.71	27.11	26.72	27.46	25.75
MT means	23.28	32.10	30.20	29.12	28.29	--	22.66	32.28	30.45	29.31	27.92	--
LSD at 5%	S= 0.45 MT= 0.51 S x MT= 1.01						S= 0.46 MT= 0.52 S x MT= 1.03					

* Control (tap water).

1.3. Fresh and dry weight per plant:

The results in Table (3) demonstrated that the lower level of saline water did not affect herb fresh weight/plant, while raising salinity in irrigation water up to 4000 or 6000 ppm caused highly significant decrease in herb fresh weight comparing with control in both seasons.

Table 3. Herb fresh weight/plant (g) of Majorana hortensis L. as affected by saline irrigation water, some nutritional compounds and their interactions during 2003 and 2004 seasons.

Salinity (S)	First season 2003						Second season 2004					
	Nutritional compounds						Nutritional compounds					
ppm	0	Novitrein	Citrein	Askobein	Anciabein	S mean	0	Novitrein	Citrein	Askobein	Anciabein	S mean
Cont.*	47.47	107.23	98.56	85.74	73.53	82.51	48.33	117.21	102.63	87.63	74.63	86.09
2000	41.36	100.56	89.86	76.36	63.46	74.32	42.76	103.65	92.54	74.91	63.66	75.50
4000	35.29	88.11	71.34	65.12	52.86	62.54	36.38	91.87	80.63	67.11	54.32	66.06
6000	28.32	69.23	61.35	50.32	48.91	51.63	28.65	73.31	65.72	63.44	48.93	54.01
MT means	38.11	91.28	80.28	68.39	59.69	--	39.03	96.51	85.38	70.77	60.39	--
LSD at 5%	S= 4.56 MT= 5.09 S x MT= 10.20						S= 3.74 MT= 4.18 S x MT= 8.36					

•Control (tap water).

The same was true increase of herb dry weight/plant, it was significantly reduced across all salinity concentrations comparing with unsalinized control plants as shown in Table (4). Similar reduction in herb fresh weight/plant was observed by Kandeel and Elwan (1991) on *Majorana hortensis* plants. The reduction in the herb characters might attributed to that salinity reduced the synthesis of organic matter in plant tissues. And it increase osmatic pressure of irrigation water which led to a reduction in water absorption by plants consequently reduced plant photosynthesis (Mandour *et al.*, 1979).

As for the effect of trace-elements and other components in both of Novitrein, Citein, Askobein and Anciabein it is obvious from Tables 3 and 4 that mentioned treatments previously significantly increased both herb fresh and dry weights/plant. Novitrein recorded the highest values followed by Citrein, Askobein and Anciabein, respectively if compared with control plants. This increasing could be attributed to important functions (of trace-elements mixture with organic acids and other components), consequently plant growth as indicated before.

The effect of saline irrigation water and both of Novitrein, Citrein, Askobein and Anciabein interactions indicated in Tables 3 and 4. Data showed that the lower or moderate concentration of salinity (2000 or 4000 ppm) and all the used of different structures caused an increase in fresh and dry weight of marjoram plants comparing with generally control or salinity treatments solely. While increasing salinity concentration in irrigation water up to 6000 ppm combined with any of previous structures decreased both herb fresh and dry weights per plant and per plot compared with control plants in the two seasons.

Table 4. Herb dry weight/plant (g) of Majorana hortensis L. as affected by saline irrigation water, some nutritional compounds and their interactions during 2003 and 2004 seasons.

Salinity (S)	First season 2003						Second season 2004					
	Nutritional compounds						Nutritional compounds					
ppm	0	Novitrein	Citrein	Askobein	Anciabein	S mean	0	Novitrein	Citrein	Askobein	Anciabein	S mean
Cont.*	11.72	26.94	24.33	22.04	18.66	20.14	11.93	28.94	22.03	22.02	19.03	21.39
2000	10.29	25.39	22.58	19.53	16.15	18.79	10.66	25.78	22.85	18.50	16.04	18.77
4000	8.82	21.97	17.97	16.28	13.05	15.62	8.98	22.68	20.26	16.69	13.41	16.40
6000	7.26	17.31	15.69	11.81	12.17	12.85	6.82	18.56	16.31	13.29	12.36	13.47
MT means	9.52	22.94	20.14	17.41	15.01	--	9.60	23.99	21.11	17.63	15.21	--
LSD at 5%	S= 0.49		MT= 0.55		S x MT= 1.10		S= 0.59		MT= 0.65		S x MT= 1.31	

•Control (tap water).

The enhancing effect of interaction treatments between the used structures and the low or moderate saline water level (2000 or 4000 ppm) on fresh and dry weights of

herb marjoram might attributed some extent, to some trace elements, i.e. Fe, Mn and Zn besides some organic acids which reduced the harmful effect of salt stress due to their enhancing effect on the metabolic process (anabolism) causing stimulation of vegetative growth, consequently more herb weight. On the other hand, the highest level of salinity (up to 6000 ppm) might inhibit the most physiological processes, in addition to the toxic effect of certain ions which may be absorbed by plant roots causing adverse effect on herb growth.

2. Effect of saline irrigation water, Askobein, Novtrein, Citrein, Anciabein and their interactions on survival percentage of marjoram plants:

The concerned results in Table (5) indicated a gradual decrease on survival percentage as the level of water salinity increased, since at 6000 ppm level most plants were died. Otherwise, under 2000 ppm the treated plants showed a good tolerance and gave a slight decrease in the two seasons. These results agreed with those obtained by El-Sayed (1997) on guar. He reported that salinity results in a considerable decrease in survival percentage. The reduction in survival percentages under salinity stress might be attributed to osmotic inhibition of water absorption, toxicity of one or more specific ions or the combination of the two factors. These in turn could disrupt survival physiological processes in plants causing reduction in growth and its ability of salinity tolerance consequently more reduction in survival percentage.

With respect to structures of both Askobein, Novtrein, Citrein and Anciabein, the same table proved that previous structures resulted in an increment in survival percentage and such increment was the best value at application of Novtrein, Citrein, Askobein and Anciabein, respectively in both seasons, comparing with control. Such results are in complete agreement with those obtained by Ramadan (1986) on guar.

The interaction effect in this respect was also revealed in Table (5). Data showed that level 6000 ppm of salinity water caused the lowest survival percentage during the two seasons in spite of its combination with activator mentioned structures. At the moderate salinity level 4000 ppm, structures enhanced salinity tolerance. They raised survival percentage in both seasons. These results are in harmony with those of Ramadan (1996) on guar, who raised survival percentage of salinity plants by using mixtures of trace-elements.

Table 5. Survival percentage of Majorana hortensis L. as affected by saline irrigation water, some nutritional compounds and their interactions during 2003 and 2004 seasons.

Salinity (S) ppm	First season 2003						Second season 2004					
	Nutritional compounds						Nutritional compounds					
	0	Novitrein	Citrein	Askobein	Anciabein	S mean	0	Novitrein	Citrein	Askobein	Anciabein	S mean
Cont.*	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2000	100.0	100.0	98.7	97.3	94.6	98.12	98.6	100.0	98.2	97.1	95.3	97.84
4000	57.3	85.6	69.8	59.3	52.4	64.88	48.7	85.6	68.9	59.2	51.4	62.76
6000	8.2	13.8	11.8	11.5	10.9	11.24	9.1	14.2	12.5	11.8	10.3	11.58
MT means	66.4	74.9	70.1	67.0	64.5	--	64.1	74.9	69.9	67.0	64.3	--
LSD at 5%	S=1.03 MT= 1.15 S x MT= 2.30						S= 1.11 MT= 1.25 S x MT= 2.50					

* Control (tap water).

3. Effect of saline irrigation water, some nutrional compounds and their interactions on leaves essential oil quantity and quality of marjoram plants:

3.1. Leaves essential oil content (%):

The data in Table (6) indicated that plants irrigated with the lower level of saline water proved slightly increment of essential oil percentage in dry leaves. On the other hand, increasing salinity levels up to 4000 ppm or 6000 ppm resulted in highly significant decrease compared with control plants. The lowest decrease was by using 6000 ppm salinity level during two seasons. Similar results were previously recorded by Youssef and Rady (2000) on *Rosmarinus offiicinalis* plants.

Table 6. Essential oil percentage of fresh herb weight on Majorana hortensis L. as affected by saline irrigation water, some nutritional compounds and their interactions during 2003 and 2004 seasons.

Salinity (S) ppm	First season 2003						Second season 2004					
	Nutritional compounds						Nutritional compounds					
	0	Novitrein	Citrein	Askobein	Anciabein	S mean	0	Novitrein	Citrein	Askobein	Anciabein	S mean
Cont.*	0.46	1.10	0.80	0.73	0.70	0.76	0.51	1.30	0.91	0.80	0.70	0.84
2000	0.40	1.00	0.70	0.69	0.64	0.69	0.41	1.00	0.70	0.68	0.63	0.68
4000	0.38	0.91	0.70	0.67	0.63	0.66	0.37	0.92	0.68	0.65	0.62	0.65
6000	0.26	0.30	0.30	0.26	0.23	0.27	0.26	0.30	0.29	0.27	0.22	0.27
MT means	0.38	0.83	0.63	0.59	0.55	--	0.39	0.88	0.65	0.60	0.54	--
LSD at 5%	S= 0.05 MT= 0.06 S x MT= 0.12						S= 0.07 MT= 0.08 S x MT= 0.16					

* Control (tap water).

Results presented in Table (6) also indicated that application marjoram plants with components of Novtrein, Citrein, Askobein and Anciabein, solely, was effective in enhancing essential oil percentage comparing to control plants in both seasons. The

superior in this regard was that of spraying Novtrein followed by Citrein, Askobein and Anciabein, respectively, in both seasons. Similar findings were previously recorded by Morsy (1999) on *Thymus vulgaris*.

As for the interaction effects, the same table indicated that all previous compounds combined with water salinity at 2000 ppm or 4000 ppm increased leaves essential oil percentage. The highest value was recorded at application of spraying with Novitrein combined with 2000 ppm or 4000 ppm, respectively followed by interactions of both Citrein, Askobein and Anciabein under two salinity levels 2000 ppm and 4000 ppm. The recorded results were highly significant if compared with control plants or salinity levels solely in both seasons of study.

Accordingly, the interaction between both of Novtrein, Citrein, Askobein and Anciabein, combined with the lowest salinity water level (2000 ppm) was the best to produce the highest percentage of essential oil in both seasons. Such results proved that the applied constituents of mentioned compounds especially trace-elements and organic acids, beside Macro-elements could be counteracted the depressive effect of irrigation water salinity on leaves essential oil.

3.2. Chemical structure of essential oil:

The gas liquid chromatography determination of distillation oil obtained from herb of marjoram plant was shown in Table (7). Data indicated that chemical composition of marjoram volatile oil was as follows:

Terpinene-4-ol, ∝- Terpinene, Y- Terpinene, 1,8 Cineole, Sabinene, β-Caryophellene, Terpineolene, D-Linalool, ∝-Terpineol, ∝-Pinene, d-Limonene, P-Cymene, Myrcene and β-Pinene, respectively. The reduction in main components of essential oil of marjoram plants was excepting owing to the opposite stress of salinity water levels on biosynthetic reactions of volatile oil. It noticed that 2000 ppm level was the lowest harmful effect on main components percentage, while the level of 6000 ppm saline water irrigation led to disappear some components as indicated in Table (7).

Table 7. The principle components percentage of *Majorana hortensis* L. essential oil as affected by saline irrigation water and some nutritional compounds (Novitrein, Citrein, Askobein, Anciabein).

Oil content	Salinity levels (ppm)				Nutritional compounds			
	Cont.*	2000	4000	6000	Novitrein	Citrein	Askobein	Anciabein
Terpinene4-ol	12.9	10.63	8.71	2.19	18.76	17.31	15.32	14.63
∝- Terpinene	10.7	8.45	5.94	1.91	17.39	16.80	14.11	12.96
Y- Terpinene	8.6	6.32	3.86	0.93	15.64	15.00	13.23	10.06
1,8 Cineole	6.9	4.91	2.91	0.61	14.76	13.98	12.11	9.19
Sabinene	2.6	1.9	0.93	0.09	9.39	8.71	6.32	5.45
β-Caryophellene	2.0	1.8	0.70	0.06	7.96	5.36	4.21	2.22
Terpineolene	1.8	1.5	0.69	0.01	5.63	4.12	4.00	2.19
D-Linalool	1.3	1.0	0.53	--	4.98	4.00	3.91	2.00
∝-Terpineol	1.2	0.9	0.46	--	3.96	3.29	3.00	1.00
∝-Pinene	1.0	0.8	0.30	--	3.61	3.18	2.98	0.97
d-Limonene	0.9	0.6	--	--	3.50	3.00	2.66	0.91
P-Cymene	0.8	0.5	--	--	2.91	2.73	2.43	0.75
Myrcene	0.6	0.4	--	--	2.63	2.31	2.00	0.43
β-Pinene	0.5	0.2	--	--	1.97	1.63	1.00	0.21

* Control (tap water).

Otherwise, compounds of Novtrein, Citrein, Askobein and Anciabein because its contents of macro-elements, some organic acids and trace-elements i.e., iron, manganese and zinc caused enhancing in main active principles of volatile oil of marjoram plants. The highest values obtained at application of Novtrein, Citrein, Askobein and Anciabein, respectively. The obtained results are compared with those of control plants.

RECOMMENDATION

As marjoram shown moderately tolerance to salinity, plants can be irrigated with saline water level up to 2000 ppm without significant reduction in most characters. Otherwise, the level up to 6000 ppm caused a reduction in the growth, oil percentage (%) and the main components of essential oil.

Spraying marjoram plants with Novtrein, Citrein, Askobein or Anciabein, every of all solely, caused increasing growth and essential constitutes and the highest values realized at application Novtrein, Citrein, Askobein and Anciabein, respectively. The interaction treatment between 2000 ppm salinity level and Novtrein recorded the highest values concerning growth and essential oil constituents.

Accordingly, it could be overcome the harmful effect of saline water level up to 4000 ppm by spraying marjoram plants with compounds of Novitrein, Askobein or dressing Anciabein, respectively.

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تأثير الملوحة وبعض المركبات المغذية على نمو وانتاج نبات البردقوش

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قسم بحوث النباتات الطبية والعطرية ــ معهد بحوث البساتين ــ مركز البحوث الزراعية بالجيزة

تم إجراء هذه الدراسة على شتلات البردقوش فى موسمين زراعيين متتاليين ٢٠٠٣، ٢٠٠٤ بمزرعة البحوث بكفر البرامون محافظة الدقهلية بهدف دراسة مدى تحمل نبات البردقوش للإجهاد الملحى الناتج من الرى بمستويات مختلفة من الملوحة (٢٠٠٠، ٤٠٠٠، ٦٠٠٠ جزء فى المليون) واستخدام مركبات مغذية من إنتاج وزارة الزراعة تحتوى على خليط من بعض العناصر الكبرى وبعض العناصر النادرة المخلبية مثل (الحديد والمنجنيز والزنك) وكانت هذه المركبات فى صورة تغذية ورقية كالنوفترين والسترين والأسكوبين ومركبات أخرى للتسميد الآزوتى الذى يتحلل ببطء طول فترة حياة النبات مثل الأنسيابين (٤٠% أزوت) وكذا تأثير التفاعل بين هذه العوامل على نمو ونسبة البقاء ونسبة وجودة الزيت العطرى لنبات البردقوش وكانت أهم النتائج

تأثير معاملات ملوحة ماء الرى والمركبات السمادية على النمو الخضرى للنبات.

أدت معاملات ملوحة الرى إلى حدوث نقص معنوى فى صفات النمو مثل ارتفاع النبات، وعدد الأفرع الجانبية والوزن الطازج والجاف للعشب/ نبات وزاد هذا النقص بزيادة مستويات الملوحة فى ماء الرى وعلى العكس من ذلك أدى استخدام المركبات السمادية المذكورة إلى زيادة معنوية فى صفات النمو المدروسة. وقد أظهرت نباتات البردقوش تحملا جيدا للملوحة المنخفضة حيث أدى استخدام مستوى ٢٠٠٠ جزء فى المليون إلى نقص طفيف فى نسبة البقاء بينما أدت المستويات الأعلى ٤٠٠٠ ، ٦٠٠٠ جزء فى المليون إلى موت عدد متزايد من النباتات ونقص فى نسبة البقاء. وقد زادت نسبة البقاء لنباتات البردقوش باستخدام التغذية الورقية بمركبات النوفترين والسترين والأسكوبين وكذلك التسميد الآزوتى بطئ التحلل بمركب الأنسيابين. وكانت أفضل المعاملات والتى نوصى بها وحققت الأعلى فالذى يليه كانت عند مستوى ملوحة ٢٠٠٠ جزء فى المليون متداخلة مع كل من النوفترين والسترين والأسكوبين ثم الأنسيابين كلا منها منفردة تحت مستوى ٢٠٠٠ جزء فى المليون ملوحة فى ماء الرى.

تأثير معاملات ملوحة ماء الرى والمركبات السمادية على النسبة المئوية ومكونات وجودة الزيت العطرى لنبات البردقوش

فقد أدى استخدام الماء المالح إلى نقص طفيف فى النسبة المئوية للزيت العطرى المستخلص من الأوراق الجافة لنباتات البردقوش عند مستوى ٢٠٠٠ جزء فى المليون وزاد التأثير سلبيا بزيادة تركيز الملوحة فى ماء الرى إلى ٤٠٠٠ ثم ٦٠٠٠ جزء فى المليون وكان هذا السلوك الفسيولوجى

متطابقا على مكونات الزيت العطرى التى تم التعرف عليها بالتحليل الكروماتوجرافى حيث اختفت بعض مكونات الزيت العطرى عند مستوى ملوحة ٤٠٠٠ ثم ٦٠٠٠ جزء فى المليون. وعلى جانب أخر أدت التغذية الورقية للتغلب نسبيا وبصورة واضحة على التأثير الضار للملوحة فى ماء الرى وبذلك تكون التوصية النهائية للبحث هى ضرورة استخدام التغذية الورقية عند استخدام ماء مالح فى الرى بمركبات نوفترين الأعلى تغذية يليه كل من السترين ثم الأسكوبين وذلك للتغلب على الأضرار الفسيولوجية نتيجة إستخدام ماء رى مالح تحت ظروف منطقة الزراعة.