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# IMPROVING PRODUCTIVITY OF WILD MINT (*Mentha longifolia* L.) PLANTS BY USING HUMIC ACID UNDER SALINE WATER IRRIGATION CONDITIONS

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## ABSTRACT

This study was carried out on *Mentha longifolia* L. Fam. Lamiaceae (Labiatae) at the Farm of North Sinai Research Station, El-Sheikh Zwaid city during the two successive seasons of 2014/2015 and 2015/2016 to improve growth, productivity and oil production as well as chemical composition of *Mentha longifolia* L. plant under North Sinai conditions by using humic acid (0, 3 and 6 Litre.fed$^{-1}$) under different levels of saline water (Tap water, 2048 ppm and 4224 ppm). Generally the highest values of vegetative growth parameters, oil production and chemical composition were obtained by using tap water and fertilizing with humic acid at 6 l.fed$^{-1}$ in first experiment. But under arid and semi-arid conditions like North Sinai Governorate, humic acid could offer an economical and simple application to salt sensitive plant, it can be use saline water at 2048 ppm + humic acid at 6 l.fed$^{-1}$ to decrease water salinity stress without decreasing in yield or oil production of *Mentha longifolia* L.

**Key Words:** Saline water, humic acid and *Mentha longifolia* L.

## INTRODUCTION

*Mentha longifolia* L. Hudson is an aromatic perennial herbs 40-120 cm hight with musty scent and belongs to Lamiaceae (mint family) and grows mostly in semi-shady places on moist soils **(Sher and Khan, 2007).** Definition of plant tolerance to salinity may change depending on the agronomic or ecological importance of the plant. Within an agronomic context, plant salt tolerance is referred to as the capability of a plant to withstand the effects of salt concentration in the root-zone or within the plant with none or minimum reductions in growth or yield **(Maas, 1990; Shannon and Grieve, 1999).** From the ecological perspective, plant tolerance to salinity is the capability of plant to complete its life cycle in saline environment **(Parida and Das, 2005).** Reduction in cell elongation and division in leaves reduces their final size, resulting in a decrease in leaf area **(Matsuda and Riazi, 1981; Alarcon *et al.*, 1993 and Munns and Tester, 2008)**. Leaf area reduction could be caused by the decrease in turgor in the leaves, as consequence of changes in cell wall properties or reduction in photosynthetic rate **(Franco *et al.*, 1997).** In North Sinai, Egypt, water irrigation of the Mediterranean Region characterized by high salinity and low quality. Salinity inhibits plant growth and productivity by a range of mechanisms; include osmotic effects, direct ion toxicity and interference with the uptake of nutrients **(Shannon *et al.*, 1994)**.

The major functional groups of humic substance include carboxyl, phenolic

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hydroxyl, alcoholic hydroxyl, ketone and quinoid **(Russo, and Berlyn, 1990).** Humic substances are well known as stimulators of plant germination and growth **(Dell'Amico *et al.*, 1994)**. It was also reported that humic acid application positively affected the plant parameters of plant grown in salinity condition **(Türkmen *et al.*, 2005)**. Humic substances used for plant nutrition, enhance root, plant growth and seed yield.

However, humic acid had significant impact on plant height, number of branchs, dry weight and yield of basil. Humic acid increase root growth by increasing cell elongation or root cell membrane permeability therefore increased water and nutrients uptake by increase root surface area, so improving plant growth, development and carbohydrates content **(Said-Al Ahl *et al.*, 2016)**.

The objective of this study was to improve growth, productivity and oil production as well as chemical composition of *M. longifolia* L. plant by using humic acid under saline water irrigation conditions in North Sinai region.

# MATERIALS AND METHODS

The present study was carried out on *M. longifolia* L. Fam. Lamiaceae (Labiatae) at the Farm of North Sinai Research Station - Desert Research Center, 30 Km East El-Arish City (North Sinai Governorate) during the two successive seasons of 2014/2015 and 2015/2016 to improve growth, productivity and oil production as well as chemical composition of *M. longifolia* L. plant by using humic acid under saline water irrigation conditions in North Sinai region.

**Plant material and procedure**

Seedlings of *M. longifolia* L. were obtained from North Sinai Research Station - Desert Research Center, North Sinai Governorate. Homogenous seedlings of 12-15 cm height were transplanted to the field on 26th April 2014 and 30th April 2015 at distances of 40 cm between hills (one plant/hill) and 100 cm between rows (at 10500 plants/fed.). Organic fertilizer (compost) was added as basic dose for two experiments at the rate of 15 $m^3$ per fed. Drip irrigation system was applied in the whole experiment using droppers (4 $l.h^{-1}$) for one hour every 2 days, using water salinity at 2048 ppm.

**Soil and water analyses**

Some mechanical and chemical characteristics of the soil at the experimental site are tabulated in Table 1. The soil samples representing the experiment area was taken at 0-30 cm depth. The water analysis (the second and third levels of water salinity) is shown in Table 2. taken from the irrigation weels water sample was used from North Sinai Station, but, the first level (tap water) was taken from the company of drinking water in El-Sheikh Zwaid.

**Water salinity and humic acid treatments**

The Treatments were included the following:

1. Tap water + without humic acid.
2. Tap water + 3 $litre.fed^{-1}$ humic acid.
3. Tap water + 6 $litre.fed^{-1}$ humic acid.
4. Saline water at 2048 ppm + without humic acid.
5. Saline water at 2048 ppm +3 $litre.fad.^{-1}$ humic acid.
6. Saline water at 2048 ppm + 6 $litre.fed^{-1}$ humic acid.
7. Saline water at 4224 ppm + without humic acid.
8. Saline water at 4224 ppm + 3 $litre.fed^{-1}$ humic acid.
9. Saline water at 4224 ppm + 6 $litre.fed^{-1}$ humic acid.

**Table (1): Some initial chemical and physical characteristics of experimental farm soil at 0-30 cm depth.**

| Chemical analysis | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cations (meq.$l^{-1}$) | | | | Anions (meq.$l^{-1}$) | | | | ECe (d.$Sm^{-1}$) | pH | Organic matter (%) | $CaCO_3$ (g.$kg^{-1}$) |
| $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $Cl^{-}$ | $Co_3^{--}$ | $Hco_3^{-}$ | $So_4^{--}$ | | | | |
| 1.04 | 0.35 | 1.56 | 0.17 | 1.05 | - | 0.87 | 1.20 | 0.31 | 7.81 | 0.023 | 1.45 |

| Mechanical analysis | | | | |
|---|---|---|---|---|
| Clay | Silt | Fine sand | Coarse sand | Soil texture |
| 2.64 (%) | 1.45 (%) | 95.61 (%) | 0.30 (%) | Sandy soil |

**Table (2): Some initial chemical and physical characteristics of irrigation water.**

| Water Treatment | EC (dS.$m^{-1}$) | EC (ppm) | pH | Cations (meq.$l^{-1}$) | | | | Anions (meq.$l^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{-}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{-}$ |
| $S_1$ | 1.10 | 704 | 7.4 | 5.40 | 1.60 | 3.28 | 0.42 | - | 4.0 | 3.0 | 3.7 |
| $S_2$ | 3.20 | 2048 | 7.8 | 6.60 | 5.50 | 19.95 | 0.21 | - | 4.5 | 20.0 | 7.2 |
| $S_3$ | 6.60 | 4224 | 7.8 | 10.80 | 6.00 | 35.20 | 0.29 | - | 3.5 | 37.59 | 11.2 |

$S_1$= Tap water, $S_2$= Saline water at 2048 ppm, $S_3$= Saline water at 4224 ppm.

Humic acid as a liquid was obtained from seed outlet in Agricultural Research Center, Giza, Egypt, “Super Canada" produced by the Egyptian Canadian for Humate Trade and Agricultural Consultancies in Egypt, its content from humic acid active 8%, folic acid active 1%, other organic materials 72.3% and neutral pH. Humic acid added with water irrigation system, it was added for 8 times started from 45 days after planting date and repeated every 15 days.

### Statistical analysis

The layout of this experiment was split plot design with three replications, since water salinity levels were assigned to the main plots, while humic acid concentrations were arranged in the sub-plots. All collected data were analyzed with analysis of variance (ANOVA) procedure using MSTAT-C statistical software package **(Michigan state University, 1983).** Differences between means were compared by using Duncan multiple range test at 0.05 **(Duncan, 1955).**

### Observations and Measurements

### Vegetative Growth measurements

a) Plant height (cm).
b) Number of branches per plant.
c) Herb fresh weight/plant (g).
d) Herb dry weight/plant (g).

$$\text{Yield per plant (ml)} = \frac{\text{oil percentage} \times \text{Herb dry weight}}{100}$$

### Yield and oil yield measurements

### Oil yield per plant was calculated as follows

$$\text{oil yield per feddan (L.)} = \text{oil yield}/_{\text{plant}} \times \text{number of plants.Fed}^{-1}$$

Determination of oil yield per feddan (L.) was calculated as follows Gas chromatography-mass spectrometry (GC-MS) analysis.

The chemical composition of the samples were performed using Trace GC 1310-ISQ mass spectrometer (Thermo Scientific, Austin, TX, USA) with a direct capillary column TG–35MS (30 m x 0.25 mm x 0.25 µm film thickness). The column oven temperature was initially held at 55°C and then increased by 5°C /min to 300°C with hold 5 min. The injector temperature were kept at 250°C. Helium was used as a carrier gas at a constant flow rate of 1 ml/min. The solvent delay was 2 min and diluted samples of 1 µl were injected automatically using Autosampler AS3000 coupled with GC in the split mode. Mass spectra were collected at 70 eV ionization voltages over the range of m/z 50–650 in full scan mode. The ion source and transfer line temperatures were set at 200 and 300°C, respectively. The components were identified by comparison of their retention times and mass spectra with those of WILEY 09 and NIST 11 mass spectral database.

## RESULTS AND DISCUSSION

### Vegetative growth parameters

As for the interaction effect between water salinity stress and humic acid on some vegetative growth parameters on *Mentha longifolia* L., results in Table 3 show that the vegetative growth parameters (plant height, number of branches per plant, plant fresh and dry weights) were decreased by increasing water salinity level under low concentration of humic acid. It can concluded that irrigation with tap water and fertilizing with humic acid at 6 $l.fed^{-1}$ significantly increased all vegetative growth parameters and recorded the highest values of plant height, number of branches/plant and plant fresh and dry weights, during first either for first cut (67.40 cm, 44.93, 234.07g and 88.12 g, respectively) or second cut (69.97 cm, 46.03, 243.17g and 94.20g, respectively). Also, similar result were obtained during second season either for first cut (66.67 cm, 45.27, 235.56 g and 90.96 g, respectively) or second cut (75.77 cm, 50.21, 237.64g and 91.03g, respectively).

These results are similar to those found by **Hendawy *et al.* (2015)** who evaluated the response of *Mintha piperita* var. citrata to foliar fertilization under Egyptian conditions. They sprayed the plants with aqueous solution of the test nutrient compounds humic acid (0. 2.5 and 5 g.l) and amino spot (0, 1 and 1.5 ml).observed that, humic acid and/or amino spot fertilizer (Algae extract) had a significant effect on growth characters during both cuts. They demonstrated that there was a clear significantly positive trend in increasing growth characters by spraying of humic acid.

Generally, the decrease in vegetative growth parameters (plant height, number of branches per plant, plant fresh and dry weights) during the two seasons salinity stress may be attributed to several factors. The decline in dry weight in response to increased salinity may be attributed to a combination of osmotic and specific ion effects of Cl and Na. Also, **Moradi and Zavareh (2013)** on chickpea stated that plant dry weight was decreased with increasing salinity. The reduction in plant growth under saline conditions may either be due to decrease in the availability of water or increase in sodium chloride toxicity which associated with increasing salinity. Growth inhibition by salt stress also occurs due to the diversion of energy from growth to the maintenance. **Munns (2002)** reported that the reduction in dry weight of cotton tissues reach to 60% under salt stress conditions.

**Table (3): Interaction effect between water salinity stress and humic acid on *Mentha longifolia* L. vegetative growth parameters during 2014-2015 and 2015-2016 seasons.**

| Salinity levels | Humic conc. | Plant height (cm) | | Number of branches /plant | | Herb fresh weight /plant (g) | | Herb dry weight /plant (g) | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 |
| **First cut** | | | | | | | | | |
| $S_1$ | $H_0$ | 51.87 cd | 50.53 e | 27.53 de | 28.33 ef | 137.41 e | 127.78 c-e | 51.52 g | 49.45 cd |
| | $H_1$ | 61.67 b | 63.13 b | 39.73 b | 42.07 ab | 226.30 ab | 219.89 ab | 80.04 b | 80.39 ab |
| | $H_2$ | 67.40 a | 66.67 a | 44.93 a | 45.27 a | 234.07 a | 235.56 a | 88.12 a | 90.69 a |
| $S_2$ | $H_0$ | 47.87 ef | 46.67 f | 25.67 ef | 26.33 ef | 119.26 f | 116.67 de | 44.31 h | 44.97 cd |
| | $H_1$ | 52.00 cd | 53.93 d | 30.27 d | 34.93 cd | 206.67 c | 201.11 b | 70.96 d | 73.74 b |
| | $H_2$ | 54.60 c | 57.27 c | 35.47 c | 38.40 bc | 216.67 b | 214.44 ab | 75.42 c | 76.54 ab |
| $S_3$ | $H_0$ | 39.80 g | 40.13 g | 20.73 g | 22.53 f | 95.00 g | 100.56 e | 36.69 i | 37.87 d |
| | $H_1$ | 45.13 f | 48.27 ef | 23.53 fg | 28.27 ef | 142.22 e | 136.67 cd | 58.41 f | 52.96 c |
| | $H_2$ | 50.53 de | 49.67 ef | 27.60 de | 29.53 de | 151.48 d | 153.89 c | 62.47 e | 58.22 c |
| **Second cut** | | | | | | | | | |
| $S_1$ | $H_0$ | 49.30 ef | 52.42 d | 28.50 d | 30.04 de | 141.80 f | 135.69 f | 58.62 f | 53.23 ef |
| | $H_1$ | 63.63 b | 66.44 b | 41.73 b | 43.39 b | 232.57 b | 226.30 b | 91.94 b | 84.15 ab |
| | $H_2$ | 69.97 a | 75.77 a | 46.03 a | 50.21 a | 243.17 a | 237.64 a | 94.20 a | 91.03 a |
| $S_2$ | $H_0$ | 46.13 g | 48.04 e | 26.77 d | 27.59 e | 123.72 g | 119.92 g | 53.73 g | 47.68 f |
| | $H_1$ | 54.33 d | 58.26 c | 34.30 c | 37.42 c | 210.46 d | 206.11 d | 78.52 d | 74.44 c |
| | $H_2$ | 57.33 c | 64.40 b | 38.47 b | 42.35 b | 223.70 c | 218.31 c | 89.88 c | 80.65 bc |
| $S_3$ | $H_0$ | 40.27 h | 42.06 f | 22.60 e | 23.72 f | 90.34 h | 102.69 h | 37.60 h | 37.42 g |
| | $H_1$ | 48.33 fg | 49.79 de | 26.43 d | 29.43 de | 144.32 f | 141.09 f | 59.14 f | 56.87 de |
| | $H_2$ | 51.40 e | 51.44 de | 29.60 d | 32.21 d | 155.12 e | 156.62 e | 62.44 e | 62.20 d |

**Means followed by the same letter(s) within each column are not significantly different at the 0.05 level, according to Duncan's multiple range test.**

**$S_1$:** Tap water, **$S_2$:** Water salinity at 2048 ppm, **$S_3$:** Water salinity at 4224 ppm, **$H_0$:** Without humic acid, **$H_1$:** (3 $l.fed^{-1}$) humic acid, **$H_2$:** (6 $l.fed^{-1}$) humic acid.

It can be concluded that under water stress, turgor pressure decreased and closure of stomata takes place causing decreased photosynthesis **(Gale and Zeroni, 1984)**. Ionic toxicity of $Na^+$ and $Cl^-$ is considered to be the other reason for decreasing shoot fresh weight with increasing salinity **(Bhatti *et al.*, 1983; Ibrahim, 2003)**.

Also, **Boris *et al.* (2010)** concluded that humic substances provided a bio-stimulating effect on growth of cucumber. In this respect, physiological mechanisms through which humic substances exert their effects may depend on hormones and, in particular, on the presence of auxin or auxin like components in their structure and, consequently its effect on plant growth and development **(Eyheraguibel *et al.*, 2008)**.

Accordingly, **Chen *et al.* (2004**) pointed that the direct effects of humic substances depends on biochemical actions on cell wall, membrane or cytoplasm, mainly hormonal acting, in manner similar to plant growth substances **(Kaya *et al.*, 2005)** and agricultural humic substances are reputed to drought tolerance, enhance nutrient uptake and overall plant performance resulting in increasing leaf area and biomass production, so this was in agreement with the findings of the present work.

Moreover, **Mora *et al.* (2010)** mentioned that, the ability of humic substances to increase shoot growth in different plant species cultivated under diverse growth conditions might be attributed to H+-ATPase activity and nitrate root-shoot distribution that, in turn, causes changes in the root-shoot distribution of certain cytokinins, polyamines and abscisic acid, thus affecting shoot growth.

## Yield and oil yield measurements

Regarding the response of fresh herb yield/fed, dry herb yield /fed, Essential oil percentage, Essential oil per plant and Content plant Essential oil yield per feddan to the interaction effect between water salinity levels and humic acid concentrations, results of Table 4 reveal that in most cases the low water salinity (tap water) with adding humic acid at 6 $l.fed^{-1}$ treatment caused the maximum significant increases in fresh herb yield/fed, dry herb yield/fed, Essential oil percentage, Essential oil per plant and content plant essential oil yield per feddan (2457.78 $kg.fed^{-1}$,925.26 $kg.fed^{-1}$, 4.93%, 4.346 ml and 45.633 $L.fed^{-1}$) and (2473.33 $kg.fed^{-1}$, 952.23 $kg.fed^{-1}$, 4.89%, 4.436 ml and 46.578 $L.fed^{-1}$) for the first cut, and (2553.33 $kg.fed^{-1}$,989.08 $kg.fed^{-1}$, 4.64%, 4.372 ml and 45.906 $L.fed^{-1}$) and (2495.19 $kg.fed^{-1}$,955.86 $kg.fed^{-1}$, 4.61%, 4.197 ml and 44.068 $L.fed^{-1}$) for the second cut, in both seasons, respectively, followed by low water salinity (tap water) with adding humic acid at 3 $l.fed^{-1}$ treatment, in the two cuts during both seasons. While, high salinity water without humic acid treatment had the least values in this concern.

On the other hand, other interactions induced intermediate values. These results are in agreement with those reported by **Massoud *et al.* (2010)** on Marjoram (*Majorana hortensis*) plant, since they showed that essential oil percentage was greatly influenced by level of field capacity and using of humic acid. Hence, at the three cuts in the two seasons, treating the plants of marjoram with humic acid at the level of 100% field capacity had enhancing effect on oil formation of herb.

## Analysis of *Mentha longifolia* volatile oil components by GC-MS

Results represented in Table 5 show the results obtained by using Gas chromatography/mass spectrometry (GC-MS) analysis for two treatments. These selected treatments are $S_1H_2$ treatment, which caused the highest volatile oil percentage, and $S_3H_0$ treatment, which achived the lowest volatile oil percentage. The samples of the essential oil during the first cut in the second season and subjected to GC-MS analysis.

**Table (4): Effect of saline water irrigation, humic acid and their interactions on herb yield and oil production of *Mentha longifolia* L. during 2014-2015 and 2015-2016 seasons.**

| Salinity T. | Humic T. | Fresh herb yield (kg/fed.) | | Dry herb yield (kg/fed.) | | Essential oil (%) | | Essential oil (ml) | | Essential oil yield (L.fed.) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 | 2014/2015 | 2015/2016 |
| **First cut** | | | | | | | | | | | |
| | $H_0$ | 1442.78 e | 1341.67c-e | 541.00 g | 519.24 cd | 2.54 f | 2.86 de | 1.308 g | 1.416 de | 13.73 g | 14.87 de |
| $S_1$ | $H_1$ | 2376.11ab | 2308.83 ab | 840.42 b | 844.05 ab | 4.78 a | 4.55 b | 3.823 b | 3.658 ab | 40.14 b | 38.41 ab |
| | $H_2$ | 2457.78 a | 2473.33 a | 925.26 a | 952.23 a | 4.93 a | 4.89 a | 4.346 a | 4.436 a | 45.63 a | 46.58 a |
| | $H_0$ | 1252.22 f | 1225.00 de | 465.23 h | 472.22 cd | 2.19 g | 2.39 e | 0.971 h | 1.073 de | 10.19 h | 11.27 de |
| $S_2$ | $H_1$ | 2170.00 c | 2111.67 b | 745.05 d | 774.27 b | 3.78 c | 4.05 bc | 2.685 d | 2.987 bc | 28.19 d | 31.36 bc |
| | $H_2$ | 2275.00 b | 2251.67 ab | 791.93 c | 803.69 ab | 4.37 b | 4.59 bc | 3.299 c | 3.510 ab | 34.64 c | 36.86 ab |
| | $H_0$ | 997.50 g | 1055.83 e | 385.27 i | 397.61 d | 2.05 g | 2.20 e | 0.753 i | 0.832 e | 7.91 i | 8.74 e |
| $S_3$ | $H_1$ | 1493.33 e | 1435.00 cd | 613.35 f | 556.10 c | 2.73 e | 3.08 de | 1.592 f | 1.629 de | 16.72 f | 17.10 de |
| | $H_2$ | 1590.56 d | 1615.83 c | 655.95 e | 611.35 c | 3.14 d | 3.77 cd | 1.962 e | 2.196 cd | 20.60 e | 23.06 cd |
| **Second cut** | | | | | | | | | | | |
| | $H_0$ | 1488.90 f | 1424.82f | 615.46 f | 558.95 ef | 2.29 ef | 2.45 de | 1.340 f | 1.303 d-f | 14.07 f | 13.68 d-f |
| $S_1$ | $H_1$ | 2442.02 b | 2376.12 b | 965.42 b | 883.61 ab | 4.02 b | 4.15 b | 3.692 b | 3.489 b | 38.766 b | 36.63 b |
| | $H_2$ | 2553.33 a | 2495.19 a | 989.08 a | 955.86 a | 4.64 a | 4.61 a | 4.372 a | 4.197 a | 45.906 a | 44.07 a |
| | $H_0$ | 1299.03 g | 1259.11 g | 564.19 g | 500.59 f | 2.12 fg | 2.15 e | 1.138 g | 1.024 ef | 11.949 g | 10.75 ef |
| $S_2$ | $H_1$ | 2209.87 d | 2164.20 d | 824.41 d | 781.62 c | 2.67 d | 3.72 b | 2.095 d | 2.772 c | 21.997 d | 29.11 c |
| | $H_2$ | 2348.89 c | 2292.22 c | 943.69 c | 846.79 bc | 3.78 c | 3.98 b | 3.393 c | 3.208 bc | 35.626 c | 33.68 bc |
| | $H_0$ | 948.54 h | 1001.04 h | 394.77h | 392.90 g | 2.01 g | 2.00 e | 0.754 h | 0.750 f | 7.917 h | 7.88 f |
| $S_3$ | $H_1$ | 1515.41 f | 1481.45 f | 620.96 f | 597.17 de | 2.44 e | 2.69 cd | 1.444 f | 1.532 de | 15.162 f | 16.09 de |
| | $H_2$ | 1628.71 e | 1644.52 e | 655.64 e | 653.05 d | 2.87 d | 3.11 c | 1.793 e | 1.933 d | 18.827 e | 20.29 d |

**Means followed by the same letter(s) within each column are not significantly different at the 0.05 level, according to Duncan's multiple range test.**

**$S_1$:** Tap water, **$S_2$:** Water salinity at 2048 ppm, **$S_3$:** Water salinity at 4224 ppm, **$H_0$:** Without humic acid, **$H_1$:** (3 $l.fed^{-1}$) humic acid, **$H_2$:** (6 $l.fed^{-1}$) humic acid.

**Table (5): Effect of water salinity and humic acid on chemical composition of *Mentha longifolia* volatile oil using GC-MS.**

| No. | Compound name | $S_1H_2$ | $S_3H_0$ |
|---|---|---|---|
| 1 | **α-Pinene** | **1.03** | **0.91** |
| 2 | Camphene | 0.04 | - |
| 3 | Sabinene | 0.80 | 0.75 |
| 4 | **p-Pinene** | **1.70** | **1.64** |
| 5 | α-Myrcene | 0.17 | 0.08 |
| 6 | D-Limonene | 0.35 | 0.20 |
| 7 | **1,8-Cineole** | **15.02** | **18.95** |
| 8 | trans Sabinene hydrate | 0.09 | - |
| 9 | 2-Cyclohexen-1-ol,1-methyl-4-(1-methylethyl)-, cis- | - | 0.07 |
| 10 | cis-Sabinol | 0.27 | 0.23 |
| 11 | cis-Verbenol | 0.15 | 0.14 |
| 12 | **Menthone** | **30.20** | **27.93** |
| 13 | Linalyl propionate | 0.33 | - |
| 14 | 3-Cyclohexene-1-methanol,à,à,4-trimethyl-, (S)- (CAS) | - | 0.62 |
| 15 | **Isopulegone** | **0.81** | **1.20** |
| 16 | 3-Cyclohexen-1-ol,4-methyl-1-(1-methylethyl)- (CAS) | - | 0.95 |
| 17 | **α-Terpineol** | **1.18** | **1.75** |
| 18 | 1-Eicosanol (CAS) | - | 0.35 |
| 19 | 1-Dodecanol, 3,7,11-trimethyl- | - | 0.09 |
| 20 | Bicyclo[3.1.1]hept-3-en-2-one,4,6,6-trimethyl- | 0.07 | - |
| 21 | Cyclohexanone,2-isopropyl-2,5-dimethyl- | 0.17 | - |
| 22 | **Pulegone** | **46.01** | **39.92** |
| 23 | α-Terpinyl propionate | - | 0.26 |
| 24 | p-Cymen-3-ol | - | 0.61 |
| 25 | Myrtenyl acetate | 0.05 | - |
| 26 | 1-Cyclohexanone,2-methyl-2-(3-methyl-2-oxobutyl) | 0.04 | - |
| 27 | 4-(2,2,6-Trimethyl-bicyclo[4.1.0]hept-1-yl)-butan-2-one | 0.02 | - |
| 28 | 2-Cyclohexen-1-one,3-methyl-6-(1-methylethylidene)-(CAS) | 0.05 | - |
| 29 | Caryophyllene | 0.21 | 0.14 |
| 30 | ç-Muurolene | 0.10 | - |
| 31 | ç-Cadinene (CAS) | - | 0.12 |
| 32 | Caryophyllene oxide | 0.51 | 0.79 |
| 33 | 2,5,9-Trimethylcycloundeca-4,8-dienone | - | 0.09 |
| 34 | Cubenol | 0.04 | 0.08 |
| 35 | ë-Cadinene (CAS) | 0.45 | 0.71 |
| 36 | 1H-Dibenzo[a,i]fluorene, eicosahydro- | - | 0.19 |
| 37 | Arteannuin b | 0.06 | - |
| **Total** | | **99. 92** | **98.77** |

It can be showed that, 37 compounds were identified were collected the major component was pulegone followed by menthone, 1,8-Cineole, p-Pinene, α-Pinene, α-Terpineol and isopulegone. These components represent 95.95 - 92.30 % of wild mint oil extracted from both treatment.

It can be seen that with $S_1H_2$ treatment, the major component of oil was pulegone (46.01%), followed by menthone (30.20%), 1,8-Cineole (15.02%), p-Pinene (1.70%), α-Terpineol (1.18%), α-Pinene (1.03%) and isopulegone (0.81%).

While, when wild mint plants were treated by $S_3H_0$ treatment, the major component was pulegone (39.92%), followed by menthone (27.93%), 1,8-Cineole (18.95 %), α-Terpineol (1.75 %), p-Pinene (1.64 %), isopulegone (1.20 %) and α-Pinene (0.91%).

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**الملخص العربى**

# تحسـين إنتاجـية نباتات الحـبق باستخـدام حامـض الهيوميك تحـت ظـروف الـري بالميـاه المالحـة

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أجريت هذه الدراسة على نبات الحبق أحد نباتات العائلة الشفوية في مزرعة محطة بحوث شمال سيناء (الشيخ زويد) التابعة لمركز بحوث الصحراء، خلال الموسمين المتعاقبين ٢٠١٤/٢٠١٥ و٢٠١٥/٢٠١٦ بهدف تحسين نمو وإنتاجية الزيت وكذلك المكونات الكيميائية لنبات الحبق تحت ظروف شمال سيناء باستخدام حمض الهيوميك (صفر، ٣ و٦ لتر/فدان) تحت مستويات مختلفة من الماء المالح (ماء الصنبور، ٢٠٤٨ جزء في المليون و٤٢٢٤ جزء في المليون) وقد أظهرت النتائج أن استخدام حامض الهيوميك بمعدل ٦ لتر/فدان له آثار إيجابية على نبات الحبق من حيث زيادة النمو الخضري وإنتاجية الزيت والمحصول، والمعاملة بحامض الهيوميك يمكن أن تخفف من الآثار الضارة للإجهاد الناتج عن الري بالماء المالح. توفر مياه الصنبور الظروف المثالية لري النباتات ولكن في ظل الظروف القاحلة وشبة القاحلة كما هو الحال في محافظة شمال سيناء يمكن لحامض الهيوميك أن يقدم تطبيق اقتصادي وبسيط لمقاومة الإجهاد الملحي حيث يمكن استخدام ماء مالح (٢٠٤٨ جزء في المليون) + (حامض هيوميك بمعدل ٦ لتر/فدان) لتقليل آثار الاجهاد الملحي دون إنخفاض في المحصول أو إنتاج الزيت.

**الكلمات الإسترشادية:** إنتاجية، نباتات الحبق، حامض الهيوميك، الري بالمياه المالحة.

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