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Effect of Alpha Tocopherol and Moringa Leaf Extract on Volatile Oil and Certain Chemical Components of Marjoram Grown Under Salinity Stress

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ABSTRACT

A pot experiment in split plot design was conducted in the Farm of the Floriculture plants, Horticulture Department, Faculty of Agriculture, Minia University, throughout the twice experimental periods of 2022 & 2023 to study the influence of alpha tocopherol (200 ppm) and moringa leaf extract (10%) as sub-plot on oil production and some chemical constituents of marjoram under salinity stress (0.0, 500, 1000, and 2000 ppm NaCl), as main plot.

Results showed that essential oil percent was increased with low concentrations (500 and 1000 ppm NaCl) and was decreased with the high level (2000 ppm NaCl). Volatile oil yield (plant/graze) and /season were considerably decreased with all used concentrations of NaCl. On the other side, salinity levels increased sodium (%) and proline content.

Spraying alpha tocopherol at 200 ppm and MLE at 10% considerably increased the abovementioned characters in all cases, except sodium (%). Optimal outcomes were noted across all measured variables when utilizing vitamin E.

Generally, significant effect was shown for all previous characters due to the interaction between salinity and alpha tocopherol and moringa leaf extract. It is advised to use a solution of alpha tocopherol (200 ppm) to spray marjoram plants in order to counteract the negative effects of salinized water, thereby enhancing the productivity of essential oil.

KEYWORDS: *Origanum majorana*, salinity, essential oil, pigments, vitamin E, MLE.

1. INTRODUCTION

Origanum majorana, L. is a member of Lamiaceae family. Many countries worldwide including Egypt cultivated marjoram planted. Marjoram is a versatile plant that offers numerous advantages to the pharmaceutical, fragrance, and food sectors. Sweet marjoram, known for its medicinal properties, has been shown to possess a range of pharmacological benefits such as antioxidant, antibacterial, hepatoprotective, cardioprotective, antiulcer, anticoagulant, anti-inflammatory, antiproliferative, and antifungal properties (Deans and Svoboda, 1990; Okazaki *et al*., 1998; Vagi *et al*., 2005; Al-Howiriny *et al*., 2009; Mossa and Nawwar, 2011; Mossa *et al*., 2013 and Arranz *et al*., 2015).

The development and production of aromatic plants can be impacted by ecological limitations like salt and drought stresses. Environmental conditions have been shown to influence both the yield and composition of

essential oils (EO), with some studies indicating a decrease in EO yield under salinity and a change in their composition. Conversely, other research has found an increase in these secondary metabolites under certain conditions (Shalan *et al*., 2006; Ali *et al*., 2007; Massoud *et al*., 2009; Jelali *et al*., 2011; Baâtour *et al*., 2016 and Jafari *et al*., 2022).

Vitamin E and moringa leaf extract gain a very positive influence on plant productivity. Previous reports have shown that vitamin E and extract of moringa moderate the detrimental effects of salinity stress on several plants including marjoram (Ali and Hussein, 2019, Sadiq *et al*., 2019 and Abdou and Badr, 2022) for alpha tocopherol and (Hassanein *et al*., 2019; Alkuwayti *et al*., 2020 and Mousa *et al*., 2020) regarding moringa extracts.

This study aimed to examine how vitamin E and MLE may help reduce negative impacts of salinized water on the production of volatile oils and certain chemical constituents in marjoram plants.

2. MATERIALS AND METHODS

In order to help marjoram to reduce the harmful effects of salinized water on the production of essential oils and certain chemical components in marjoram plants by vitamin E (200 ppm) and moringa leaf extract (10%), an experimental study was carried out using pots through 2022 & 2023 located in the Farm of the Ornamental plants, Faculty of Agriculture, Minia University, Egypt.

Homogeneous cuttings of *Origanum Majorana* were transferred (middle of March) in throughout the twice experimental periods, in pots (4.850 kg sandy soil in 25-cm diameter) one plant/pot. The earth's main analysis were listed in Table 1. The soil's basic properties were performed according to ICARDA (2013).

Table 1. The earth's main analysis.

Soil character	Values		Soil character	Values	
	2022	2023		2022	2023
Mechanical analysis:			**Macronutrients:**		
Sand (%)	90.00	91.00	**Total N (%)**	0.01	0.01
Silt (%)	6.90	5.70	**Available P (ppm)**	2.56	2.86
Clay (%)	3.10	3.30	**Na^+ (mg/100 g soil)**	2.44	2.53
Soil type	Sandy	Sandy	**K^+ (mg/100 g soil)**	0.71	0.75
Chemical analysis:			**Micronutrients (DTPA-Extractable):**		
pH (1:2.5)	8.26	8.31	**Fe (ppm)**	1.01	1.04
E.C. (dS/m)	1.15	1.18	**Cu (ppm)**	0.33	0.36
O.M.	0.01	0.02	**Zn (ppm)**	0.34	0.35
$CaCO_3$	14.60	13.90	**Mn (ppm)**	0.56	0.61

Twelve treatments were arranged 3 times in main and sup plots, where the main included salinized water at 0, 500, 1000 and 2000 ppm NaCl and sub-plot included alpha tocopherol (200 ppm) and MLE (10%) plus check treatment. Alpha tocopherol was released by Sigma Chemical Company, USA. Moringa leaf extract at 10 % (100 ml/l) was performed as described by Phiri and Mbewe, 2010.

Marjoram plants were watered by 500 ml each time. The stress treatments began 10 days after transplanting. Salinity started from 25th March according to the specified concentration till the experiment end. The plants were sprayed with alpha tocopherol and moringa leaf extract four times with one month interval starting from 7th May (till runoff). Marjoram was grazed triple (1st of June, 1st August and 1st October) by cropping plants above the soil surface (at 3 cm) for both seasons.

At the three grazing times, the following data were recorded: essential oil percentage per graze (Egyptian Pharmacopoeia, 1984) and were calculated per plant per graze and /season plus photosynthetic pigments content (Fadl and Sari El-Deen, 1978), Proline content (Bates *et al*., 1973) and sodium percentage (ICARDA, 2013).

Statistical analysis

The collected data was organized into tables and then analyzed statistically with the aid of MSTAT-C (1986). In this analysis, a Least

Significant Difference LSD test was conducted at 0.05 level of significant to compare the averages of the different treatments.

3. RESULTS AND DISCUSSION

3.1. Chemical components:

3.1.1. Volatile oil (%)

Our results listed in Table 2 showed that significant varying of the impact of salinity levels on volatile oil (%), where salinity treatments 500 and 1000 ppm considerably increased essential oil (%), while the high concentration (2000) significantly lessened volatile oil (%) facing control in the three grazes through both seasons.

The rise in oil percentage in plants subjected to low salt stress could be attributed to the improvement in their physiological functions, suggesting that salinity may indeed bolster this hypothesis (Ali, 2002 and Ali *et al*., 2007). Nevertheless, elevated concentrations of salt stress can interfere with various physiological processes in plants, resulting in a decrease in the production of essential oils (Trease, 1966).

It is noticed that the essential oil percent in the third graze was increased than both of first and second grazes. This increment in essential oil percent in the third graze may be due to the favorable climate condition.

Our findings are comparable to those achieved by Shalan *et al*. (2006), Ali *et al*. (2007), Massoud *et al*. (2009), Baâtour *et al*. (2010), Jelali *et al*. (2011), Baâtour *et al*. (2012), Baâtour *et al*. (2016) and Jafari *et al*. (2022) on marjoram plant.

In relation to the influence of spraying marjoram plants with vitamin E (200 ppm) and moringa leaf extract (10%), data mentioned that significant increase in essential oil percent were achieved due to both treatments facing the check treatment in the three grazes during the two seasons. With superiority for vitamin E than moringa leaf extract (Table 2).

The results prove that treatments with α-tocopherol were highly successful in boosting the (%) and overall gained of volatile oil. Alpha-tocopherol appeared to significantly improve both the production and storage of oil, as well as the enhancement in the fresh herbage of the plant (Ayad *et al*., 2009). Similarly, Ayad *et al*. (2009) on *Pelargonium spp.*, Abdou *et al*. (2012) on mint, Abdou *et al*. (2013) and Abdou and Badr (2022) on caraway, Ayyat *et al*. (2021) on *Nigella sativa* and Mohamed *et al*. (2022), on fennel.

The advantageous impacts of MLE have a simulative impact on herb growth by supplying the necessary micro and macronutrient elements to the growing plants. This plays a crucial the function in metabolic activities like essential oil, the process of photosynthesis and the subsequent formation of carbohydrates, as stated by Farooq *et al*. (2012) and Sakr *et al*. (2018). Similarly, Mohamed *et al*. (2020) on *Origanum majorana*, Abou-Sreea and Matter (2016) and Abdel-Rahman and Abdel-Kader (2020) on *Foeniculum vulgare*, Hamad *et al*. (2017) on dill, Gadallah *et al*. (2020) on geranium and Mehmood *et al*. (2021) on *Nigella sativa*.

Significant effect on essential oil (%) was observed due to the interaction between salinity and vitamin E and moringa leaf extract during the three grazes throughout both experimental periods. The best percent overall were found with marjoram watered with salinized water at 1000 ppm and sprayed with vitamin E (200 ppm) followed by MLE (10%). The alpha tocopherol come in the first place and moringa leaf extract take the second one under salinized water (1000 ppm) during three grazes in both seasons.

3.1.2. The yield of volatile oil

The data presented in Table 3 elucidated the yield of volatile oil produced by each plant during a grazing period and per season were significantly decreased comparing with control in all cases due to irrigation plants with salinized water (500 to 2000 ppm). This opposite trend to essential oil (%) (500 and 1000 ppm NaCl) due to the reduction of dry mass. The highest declines due to the highest NaCl concentration (2000 ppm) were 61.74 and 33.88% down the control in both experimental periods, respectively.

Also, in Table 3, spraying marjoram plants with vitamin E or MLE cause significant augment in volatile oil yield during the three grazes and total yield per season facing the control. Such superior treatment of vitamin E reached 65.55 and 35.88% over the control in both periods, in a sequential manner.

Table 2. Effect of alpha tocopherol and MLE on essential oil (%) of marjoram grown under salinity stress in the three cuttings during both seasons.

Sub-plots treatments (B)	Irrigation water salinity (ppm) (A)									
	0.0	500	1000	2000	Mean (B)	0.0	500	1000	2000	Mean (B)
	1st season (2023)					2nd season (2024)				
The first cut.										
Control	0.77	0.82	0.85	0.73	0.79	0.79	0.84	0.87	0.74	0.81
Vitamin E (200 ppm)	0.86	0.88	0.91	0.83	0.87	0.88	0.90	0.93	0.85	0.89
Moringa leaf extract (10%)	0.83	0.86	0.90	0.80	0.85	0.85	0.88	0.92	0.82	0.87
Mean (A)	0.82	0.85	0.89	0.79	0.84	0.84	0.87	0.91	0.80	0.86
LSD (5 %)	A: 0.02		B: 0.01		AB: 0.02	A: 0.02		B: 0.01		AB: 0.02
The second cut.										
Control	0.78	0.83	0.86	0.73	0.80	0.81	0.86	0.90	0.76	0.83
Vitamin E (200 ppm)	0.87	0.89	0.92	0.84	0.88	0.92	0.95	0.98	0.89	0.94
Moringa leaf extract (10%)	0.84	0.87	0.91	0.81	0.86	0.89	0.92	0.97	0.86	0.91
Mean (A)	0.83	0.86	0.90	0.79	0.85	0.87	0.91	0.95	0.84	0.89
LSD (5 %)	A: 0.03		B: 0.02		AB: 0.04	A: 0.02		B: 0.01		AB: 0.02
The third cut.										
Control	0.79	0.84	0.87	0.74	0.81	0.83	0.88	0.91	0.78	0.85
Vitamin E (200 ppm)	0.88	0.90	0.93	0.85	0.89	0.99	1.00	1.01	0.98	1.00
Moringa leaf extract (10%)	0.85	0.88	0.92	0.82	0.87	0.97	0.99	1.00	0.95	0.98
Mean (A)	0.84	0.87	0.91	0.80	0.86	0.93	0.96	0.97	0.90	0.94
LSD (5 %)	A: 0.03		B: 0.02		AB: 0.04	A: 0.03		B: 0.02		AB: 0.04

Table 3. Effect of alpha tocopherol and MLE on volatile oil yield per plant /graze (ml) and / season (ml) of marjoram grown under salinity stress in the three cuttings during both seasons.

Sub-plots treatments (B)	Irrigation water salinity (ppm) (A)									
	0.0	500	1000	2000	Mean (B)	0.0	500	1000	2000	Mean (B)
	1st season (2022)					2nd season (2023)				
The first cut.										
Control	0.041	0.035	0.035	0.023	0.034	0.061	0.047	0.044	0.038	0.048
Vitamin E (200 ppm)	0.063	0.064	0.054	0.050	0.058	0.069	0.058	0.059	0.052	0.059
Moringa leaf extract (10%)	0.061	0.049	0.049	0.042	0.050	0.066	0.052	0.057	0.045	0.055
Mean (A)	0.055	0.049	0.046	0.038	0.047	0.066	0.053	0.053	0.045	0.054
LSD (5 %)	A: 0.005		B: 0.004		AB: 0.008	A: 0.007		B: 0.005		AB: 0.010
The second cut.										
Control	0.075	0.061	0.033	0.018	0.047	0.073	0.061	0.055	0.041	0.058
Vitamin E (200 ppm)	0.110	0.079	0.042	0.035	0.067	0.087	0.088	0.080	0.058	0.078
Moringa leaf extract (10%)	0.106	0.077	0.043	0.028	0.063	0.084	0.069	0.068	0.053	0.069
Mean (A)	0.097	0.073	0.039	0.027	0.059	0.081	0.073	0.068	0.051	0.068
LSD (5 %)	A: 0.009		B: 0.006		AB: 0.012	A: 0.008		B: 0.004		AB: 0.008
The third cut.										
Control	0.068	0.032	0.028	0.024	0.038	0.068	0.068	0.071	0.051	0.064
Vitamin E (200 ppm)	0.137	0.058	0.053	0.042	0.072	0.124	0.097	0.083	0.069	0.093
Moringa leaf extract (10%)	0.129	0.053	0.046	0.040	0.067	0.095	0.092	0.091	0.074	0.088
Mean (A)	0.111	0.047	0.042	0.035	0.059	0.096	0.086	0.082	0.064	0.082
LSD (5 %)	A: 0.015		B: 0.009		AB: 0.018	A: 0.013		B: 0.006		AB: 0.012
Volatile oil yield per plant per season (ml)										
Control	0.185	0.129	0.097	0.065	0.119	0.202	0.177	0.170	0.130	0.170
Vitamin E (200 ppm)	0.310	0.201	0.149	0.127	0.197	0.280	0.243	0.222	0.179	0.231
Moringa leaf extract (10%)	0.296	0.179	0.137	0.110	0.180	0.246	0.214	0.215	0.172	0.212
Mean (A)	0.264	0.169	0.128	0.101	0.165	0.243	0.211	0.202	0.160	0.204
LSD (5 %)	A: 0.090		B: 0.075		AB: 0.150	A: 0.030		B: 0.015		AB: 0.030

The affirmative roles of vitamin E and MLE in increasing essential oil production were previously discussed (section: 1.1).

Many researchers pointed out that vitamin E and moringa leaf extract have a very positive impact on moderate the adverse impacts of salinity stress on various entities are significant plants including marjoram (Ali and Hussein, 2019, Sadiq *et al*., 2019 and Abdou and Badr, 2022) for alpha tocopherol and (Hassanein *et al*., 2019; Alkuwayti *et al*., 2020 and Mousa *et al*., 2020) regarding moringa extracts.

3.1.3. Chlorophyll a, b and carotenoids (mg/g fresh weight)

From data in Tables (4, 5 and 6), there was significant effect of salinity and vitamin E and MLE plus the combination between them on chl. a, b and carotenoids in the three grazes throughout both periods.

There was a noticeable decrease in chl. a, b and carotenoids due to all salinity concentrations. Such decrease occurred simultaneously with the rise in salt concentration comparing to control.

Alterations in salinity levels can impact the organization of chloroplasts and mitochondria, potentially disrupting regular metabolic processes and hindered growth, as noted by Said-Al Ahl and Mahmoud in 2010. Additionally, the presence of reactive oxygen species resulting from these changes can lead to harm to photosynthetic pigment proteins, membranes, lipids, and DNA, as highlighted by Fahmy *et al*. in 1998.

Several authors reported that salinity had negative effect on photosynthetic pigments such as Jelali *et al*. (2011) and Jafari *et al*. (2022) on *Origamum majorana* and Kiarostami *et al*. (2010), Tounekti *et al*. (2011), Langroudi and Sedaghathoor (2012), Abdelkader *et al*. (2019), Chetouani *et al*. (2019), El-Kholy *et al*. (2020), Al-Fraihat *et al*. (2023), Abdou *et al*. (2024) and Aly *et al*. (2024) on rosemary plant.

Positive effect on the three photosynthetic pigments in the three grazes during the two seasons due to vitamin E and moringa leaf extract (Tables 4, 5 and 6). Vitamin E treatment was more effective than moringa leaf extract in this concern.

The application of vitamin E from an external source resulted in elevated levels of pigments in plants, as demonstrated by Semida *et al*. (2016). In a study conducted by Farouk (2011), alpha tocopherol was found to notably improve the function of antioxidant enzymes and increase the levels of ascorbic acid, phenolic compounds, accessory pigments, calcium, potassium, and magnesium in wheat plants in contrast to those that were not treated. Comparable findings were achieved by Abdou *et al*. (2012) on *Mentha piperita*, Abdou *et al*. (2013) and Abdou and Badr (2022) on caraway, Abdou *et al*. (2014) and (2017) on sweet basil, Abdou *et al*. (2015) and (2019) on cumin, Ayyat *et al*. (2021) on black cumin and Abdou *et al*. (2022) on jojoba.

The positive role of moringa leaves extract may be due to that moringa leaves contained much more various components and elements, such as Mg (Yameogo *et al*., 2011) and cytokinins which are crucial for chlorophyll biosynthesis (Taiz and Zeiger, 2010). Consequently, the levels of pigments in *Nigella sativa* experienced a notable increase. Comparable findings were achieved by Mohamed *et al*. (2020) on *Origanum majorana*, Abou-Sreea and Matter (2016) and Abdel-Rahman and Abdel-Kader (2020) on *Foeniculum vulgare*, Hamad *et al*. (2017) on dill, Ali *et al*. (2018) on geranium, Hassanein *et al*. (2019) and Alkuwayti *et al*. (2020) on sweet basil, Mazrou (2019) on *Coriandrum sativum*, Ayyat *et al*. (2021) on *Nigella sativa* and Sardar *et al*. (2021) on stevia.

Chlorophyll a, b and carotenoids at the least contents were recorded with the samples of plants irrigated with 2000 ppm NaCl during the triple grazes in both experimental periods. But when applying such marjoram with vitamin E (first order) or MLE (second order) led to considerably increased the photosynthetic pigments.

3.1.4. Sodium (%) and proline content (mg/g DW)

There has been a notable rise in the percentage of sodium and the content of proline were detected due to irrigated plants with salinized water comparing with control with increasing in the values of both of them parallel with the increase of salinity level during both seasons.

Table 4. Effect of alpha tocopherol and MLE on chlorophyll a content (mg/g FW) of marjoram grown under salinity stress in the three cuttings during both seasons.

Sub-plots treatments (B)	Irrigation water salinity (ppm) (A)									
	0.0	500	1000	2000	Mean (B)	0.0	500	1000	2000	Mean (B)
	1st season (2022)					2nd season (2023)				
The first cut.										
Control	2.704	2.681	2.673	2.439	2.624	2.715	2.692	2.684	2.449	2.635
Vitamin E (200 ppm)	2.909	2.888	2.880	2.865	2.886	2.921	2.900	2.892	2.876	2.897
Moringa leaf extract (10%)	2.903	2.878	2.877	2.860	2.880	2.915	2.890	2.889	2.871	2.891
Mean (A)	2.839	2.816	2.810	2.721	2.796	2.850	2.827	2.822	2.732	2.808
LSD (5 %)	A: 0.021		B: 0.012		AB: 0.024	A: 0.025		B: 0.015		AB: 0.030
The second cut.										
Control	2.788	2.764	2.756	2.515	2.706	2.802	2.778	2.770	2.528	2.720
Vitamin E (200 ppm)	2.999	2.978	2.970	2.954	2.975	3.014	2.993	2.985	2.969	2.990
Moringa leaf extract (10%)	2.993	2.967	2.966	2.949	2.969	3.008	2.982	2.981	2.964	2.984
Mean (A)	2.927	2.903	2.897	2.806	2.883	2.941	2.918	2.912	2.820	2.898
LSD (5 %)	A: 0.022		B: 0.015		AB: 0.030	A: 0.022		B: 0.014		AB: 0.028
The third cut.										
Control	2.845	2.821	2.812	2.566	2.761	2.862	2.838	2.829	2.581	2.778
Vitamin E (200 ppm)	3.06	3.039	3.031	3.014	3.036	3.078	3.057	3.049	3.032	3.054
Moringa leaf extract (10%)	3.055	3.028	3.027	3.009	3.030	3.073	3.046	3.045	3.027	3.048
Mean (A)	2.987	2.963	2.957	2.863	2.942	3.004	2.980	2.974	2.880	2.960
LSD (5 %)	A: 0.023		B: 0.021		AB: 0.042	A: 0.023		B: 0.020		AB: 0.040

Table 5. Effect of alpha tocopherol and MLE on chlorophyll b content (mg/g FW) of marjoram grown under salinity stress in the three cuttings during both seasons.

Sub-plots treatments (B)	Irrigation water salinity (ppm) (A)									
	0.0	500	1000	2000	Mean (B)	0.0	500	1000	2000	Mean (B)
	1st season (2022)					2nd season (2023)				
The first cut.										
Control	0.891	0.883	0.881	0.803	0.865	0.959	0.956	0.952	0.949	0.954
Vitamin E (200 ppm)	0.959	0.953	0.951	0.941	0.951	0.961	0.954	0.952	0.918	0.946
Moringa leaf extract (10%)	0.958	0.951	0.949	0.915	0.943	0.949	0.943	0.934	0.911	0.934
Mean (A)	0.936	0.929	0.927	0.886	0.920	0.956	0.951	0.946	0.926	0.945
LSD (5 %)	A: 0.006		B: 0.004		AB: 0.008	A: 0.005		B: 0.003		AB: 0.006
The second cut.										
Control	0.919	0.911	0.908	0.828	0.892	0.990	0.987	0.983	0.979	0.985
Vitamin E (200 ppm)	0.989	0.983	0.980	0.943	0.974	0.992	0.984	0.982	0.941	0.975
Moringa leaf extract (10%)	0.988	0.980	0.978	0.937	0.971	0.980	0.974	0.969	0.935	0.965
Mean (A)	0.965	0.958	0.955	0.903	0.945	0.987	0.982	0.978	0.952	0.975
LSD (5 %)	A: 0.005		B: 0.002		AB: 0.004	A: 0.004		B: 0.003		AB: 0.006
The third cut.										
Control	0.938	0.930	0.927	0.845	0.910	1.011	1.009	1.004	1.000	1.006
Vitamin E (200 ppm)	1.010	1.003	1.000	0.993	1.002	1.013	1.005	1.003	0.995	1.004
Moringa leaf extract (10%)	1.008	1.000	0.998	0.990	0.999	1.001	0.995	0.990	0.967	0.988
Mean (A)	0.985	0.978	0.975	0.943	0.970	1.008	1.003	0.999	0.987	0.999
LSD (5 %)	A: 0.006		B: 0.004		AB: 0.008	A: 0.005		B: 0.003		AB: 0.006

Table 6. Effect of alpha tocopherol and MLE on carotenoids content (mg/g FW) of marjoram grown under salinity stress in the three cuttings during both seasons.

Sub-plots treatments (B)	Irrigation water salinity (ppm) (A)									
	0.0	500	1000	2000	Mean (B)	0.0	500	1000	2000	Mean (B)
	1st season (2022)					2nd season (2023)				
The first cut.										
Control	0.920	0.919	0.913	0.827	0.895	0.996	0.992	0.991	0.974	0.988
Vitamin E (200 ppm)	0.998	0.990	0.984	0.964	0.984	0.999	0.991	0.981	0.968	0.985
Moringa leaf extract (10%)	0.994	0.986	0.976	0.963	0.980	0.988	0.981	0.975	0.940	0.971
Mean (A)	0.984	0.977	0.971	0.959	0.973	0.994	0.988	0.982	0.961	0.981
LSD (5 %)	A: 0.006		B: 0.004		AB: 0.008	A: 0.005		B: 0.003		AB: 0.006
The second cut.										
Control	0.949	0.948	0.941	0.853	0.923	1.028	1.024	1.023	1.005	1.020
Vitamin E (200 ppm)	1.029	1.021	1.015	0.994	1.015	1.031	1.023	1.012	0.999	1.016
Moringa leaf extract (10%)	1.025	1.017	1.006	0.993	1.010	1.020	1.012	1.007	0.970	1.002
Mean (A)	1.001	0.995	0.987	0.947	0.983	1.026	1.020	1.014	0.991	1.013
LSD (5 %)	A: 0.005		B: 0.003		AB: 0.006	A: 0.006		B: 0.004		AB: 0.008
The third cut.										
Control	0.968	0.967	0.960	0.870	0.941	1.050	1.046	1.045	1.027	1.042
Vitamin E (200 ppm)	1.050	1.042	1.036	1.014	1.036	1.053	1.045	1.034	1.020	1.038
Moringa leaf extract (10%)	1.046	1.038	1.027	1.013	1.031	1.042	1.034	1.026	0.991	1.023
Mean (A)	1.021	1.016	1.008	0.966	1.003	1.048	1.042	1.035	1.013	1.034
LSD (5 %)	A: 0.005		B: 0.003		AB: 0.006	A: 0.006		B: 0.004		AB: 0.008

Salts can have a direct effect on plants by raising the levels of specific ions like sodium and chloride, which can hinder plant metabolism (Al-Fraihat et al., 2023). The presence of NaCl in water has been found to lead to a notable rise in proline content, possibly because plants tend to accumulate proline when exposed to salt stress (Ali and Attia, 2015). In harmony with our results these findings obtained by Hendawy and Khalid (2005) on sage and Tounekti et al. (2008) and Kiarostami et al. (2010), Mehrizi et al. (2011), Ali and Attia (2015), Al-Fraihat et al. (2023) and Aly et al. (2024) on Rosmarinus officinalis.

The impact of alpha tocopherol and moringa leaf extract on Na (%) and proline content was noticeably varied in both seasons. Where, vitamin E (200 ppm) and MLE (10%) led to significant decrease in Na (%) but significantly increased proline content in both seasons.

Growth biostimulants contains many growth regulators, so these substants consider as antioxidant may be it support plants to tolerate salinity by reducing toxic ions such as sodium and chloride and enhancing synthesis of some chemicals constituents like amino acids (proline)

The outcomes are nearly equivalent to those clarified by Farooq et al., 2023 and Shalaby, 2024.

The interaction effect was significant due to the main and sub plots for sodium percent and proline content comparing with control in both seasons. From Table (7), it is noticed that Na% under 2000 ppm NaCl (4.67%) which decreased to 2.84% due to alpha tocopherol (200 ppm). While proline content resulted (8.31 mg/g DW) which became 8.53 mg/g DW under spraying with alpha tocopherol (200 ppm) in the first experimental period. A similar pattern was observed in the second one.

Table 7. Effect of alpha tocopherol and MLE on sodium (%) and proline content (mg/g DW) of marjoram grown under salinity stress in the third graze during both seasons.

Sub-plots treatments (B)	Irrigation water salinity (ppm) (A)									
	0.0	500	1000	2000	Mean (B)	0.0	500	1000	2000	Mean (B)
	1st season (2023)					2nd season (2024)				
Sodium (%).										
Control	3.28	3.65	4.15	4.67	3.94	3.58	3.98	4.52	5.09	4.29
Vitamin E (200 ppm)	2.65	2.68	2.73	2.84	2.73	2.78	2.81	2.87	2.98	2.86
Moringa leaf extract (10%)	3.10	3.18	3.28	3.45	3.25	3.26	3.34	3.44	3.62	3.42
Mean (A)	3.01	3.17	3.39	3.65	3.31	3.21	3.38	3.61	3.90	3.52
LSD (5 %)	A: 0.09		B: 0.06		AB: 0.12	A: 0.12		B: 0.08		AB: 0.16
Proline content (mg/g DW).										
Control	4.27	6.24	7.25	8.13	6.47	4.01	5.87	6.82	7.64	6.08
Vitamin E (200 ppm)	4.93	6.97	7.62	8.53	7.01	4.78	6.76	7.38	8.27	6.80
Moringa leaf extract (10%)	4.49	6.69	7.45	8.28	6.73	4.31	6.41	7.15	7.95	6.46
Mean (A)	4.56	6.63	7.44	8.31	6.74	4.37	6.35	7.12	7.95	6.45
LSD (5 %)	A: 0.85		B: 0.21		AB: 0.42	A: 0.79		B: 0.15		AB: 0.30

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الملخص العربي

تأثير ألفا توكوفيرول ومستخلص أوراق المورينجا على إنتاج الزيوت الطيار وبعض المكونات الكيميائية للبردقوش المزروع تحت إجهاد الملوحة

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تم إجراء تجربة أصص بتصميم القطع المنشقة مرة واحدة في مزرعة نباتات الزينة بكلية الزراعة جامعة المنيا خلال موسمي ٢٠٢٢ و ٢٠٢٣ لدراسة تأثير ألفا توكوفيرول (٢٠٠ جزء في المليون) ومستخلص أوراق المورينجا (١٠٪) كعامل ثانوي على إنتاج الزيت الطيار وبعض المكونات الكيميائية للبردقوش تحت إجهاد الملوحة (٠,٠ و ٥٠٠ و ١٠٠٠ و ٢٠٠٠ جزء في المليون من كلوريد الصوديوم) كعامل رئيسي.

أظهرت النتائج أن نسبة الزيت الطيار زادت مع التركيزات المنخفضة من الملوحة (٥٠٠ و ١٠٠٠ جزء في المليون من كلوريد الصوديوم) وانخفضت مع المستوى المرتفع (٢٠٠٠ جزء في المليون من كلوريد الصوديوم). كما انخفض إنتاج الزيت الطيار للنبات للحشة وللموسم بشكل معنوي مع جميع تركيزات كلوريد الصوديوم المستخدمة. من ناحية أخرى، زاد محتوى الصوديوم (%) والبرولين بزيادة مستويات الملوحة.

أدى الرش الورقي بـ ألفا توكوفيرول بتركيز ٢٠٠ جزء في المليون ومستخلص أوراق المورينجا بتركيز ١٠% إلى زيادة كبيرة في الصفات المذكورة أعلاه في جميع الحالات، باستثناء النسبة المئوية للصوديوم. وقد تم الحصول على أفضل النتائج لجميع الصفات المدروسة باستخدام فيتامين هـ.

وبشكل عام، ظهر تأثيراً معنوياً لجميع الصفات السابقة نتيجة التفاعل بين الملوحة وألفا توكوفيرول ومستخلص أوراق المورينجا. وينصح باستخدام محلول ألفا توكوفيرول (٢٠٠ جزء في المليون) لرش نباتات البردقوش من أجل مواجهة الآثار السلبية للري بمياه مالحة، من خلال تعزيز إنتاجية الزيت الطيار.

الكلمات المفتاحية: أوريجانوم ماجورانا – الملوحة – الزيت الطيار – الصبغات – فيتامين هـ – مستخلص أوراق المورينجا.