SIGNIFICANCE OF APPLIED ACTIVE DRY YEAST AND SOME ORGANIC FERTILIZERS ON MARJORAM PLANTS TO RATIONALIZE THE USE OF CHEMICAL FERTILIZERS

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Abstract

A filed experiment was carried out on a sandy soil at the eastern edge of Demo, El Fayoum district, El Fayoum Governorate, Egypt during two successive seasons of 2014/2015 and 2015/2016 to study the integrated effect of applied bio and organic manures, as compared to untreated soil (control) and the recommended doses of NPK-mineral fertilizers (*i*.e., 400 kg/fed ammonium sulphate + 200 kg/fed calcium superphosphate + 100 kg/fed potassium sulphate), on the growth status and chemical constituents of marjoram plants (*Origanum majorana* L.), grown by terminal cuttings, as a popular aromatic or medicinal plant. The bio-fertilizer (*active* dry yeast) was applied as foliar spray on plants at the rates of 0, 1, 2 and 4 g/L. Three local organic manures (*i.e.,* farmyard, poultry and sheep wastes**)** were added at a rate of 20 m^3/fed.

Data obtained indicated that plant growth parameters (plant height, number of branchs, herb fresh weight, yield of herb air-dry weight/plant, yield of air dry leaves weight/fed, number of roots/plant) as well as the chemical constituents (essential oil %, oil yield per plant or fed, total carbohydrates, N, P, K, Fe and Zn contents of the herb) were significantly increased by applying organic manures (*i.e.,* farmyard, poultry and sheep wastes**)**, bio-fertilizer (active dry yeast spray) and NPK chemical fertilizers as solely treatments. Similar results were also observed by using the combined treatments of bio and organic manures as well as both NPK- chemical and poultry manure that caused the best values of studied plant characters.

It was also, found that application of poultry manure resulted in greater chemical leaf nutrient contents of N, P, K, Fe and Zn and total carbohydrate contents in the three cuts than other applied treatments. Based on the results of the present investigation it could be recommended to use active dry yeast spray at a rate of 2 g/L combined with organic manure (*i.e.,* poultry wastes) at a rate of 20 m^3/fed to get the greatest values of growth parameters of marjoram plants with favorable yield of chemical constituent, *i.e.,* volatile oil percentage of herb.

Data obtained may lead to the conclusion that the integrated use of active dry yeast with organic manure could replace a significant part of NPK chemical fertilizers added to marjoram plants grown on a sandy unfertile soil under Fayoum conditions.

Key words: chemical fertilizers, organic manures, bio-fertility, active dry yeast, marjoram plants.

1. INTRODUCTION

Since few years, World face a great problem either in the human health or in the environmental pollution. This problem is partially related to the excessive use of chemical fertilizers, especially phosphatic and nitrogenous ones, to maximize crop yields. Interest in the N-excessive use, could be partially attributed to the advent of high yielding crop cultivars under assured perennial irrigation. Most of N-inorganic fertilizers is a potential by NO_{-3} losses in groundwater, which negatively affect human and animal health **(Sarhan et al., 2002)**. In this concern, **Akalan (1983)** pointed out that addition of organic manure is one of fundamental processes to minimize the nutrients losses from soil by means of leaching and denitrification as well as to improve the physico-chemical, nutritional and biological properties of the treated soil. So, sustainable farming by using such organic manure in agriculture is considered a strategy to preserve the environment and prevent chemical pollution.

Today, there is a renewed interest in organic recycling to improve soil fertility and its productivity. Moreover, the periodical application of the natural organic wastes to soils has gained momentum in the recent past and called "organic agriculture, clean agriculture and bio-agriculture". The integrated use of the natural organic manures and mineral fertilizers is considered the best option not only for reducing the previous enormous consumption of chemical fertilizers, but also maintain soil fertility status and help to sustain crop productivity **(Singh et al., 1999)**, as well as, to increase fertilizer use efficiency in the soil. Such New Agricultural Strategy alleviates the hazardous effects on the grown plants not only in agriculture fields, but also human health through toxic elements persist in the ecosystem heaving accumulated in different tropic levels of the food chain as well as the dynamic equilibrium of the biosphere **(Bhatia et al., 2001 and Palm et al., 2001).**

The soil survey data of Egypt showed a considerable decrease in soil productivity for the desert sandy soils, mainly due to low levels of organic matter content, which represents the main factors for widespread occurrence of some nutrients deficiency in the different desert regions of the world. Also, low organic matter below the critical level causes exhaustion for micronutrients through removal by plants as well as negatively influence on the availability of these micronutrients for grown crops **(Takker and Walker, 1993).** This is mainly due to the main mechanical or mineral constituent of sandy soils is the sand fraction or quartz, which is not partially capable to retain neither water nor nutrients for growing plants. Accordingly, these soils are poor not only in the nutrient bearing minerals, but also in organic matter, which are a storehouse for the essential plant nutrients, in turn the productivity of different crops tends to decrease markedly **(Metwally and Khamis, 1998)**, increasing sandy soil potential for high productivity of any crop requires a proper and justified fertilization policy particularly with regard to nutrients, where their deficiencies in the majority of Egyptian soils occur. Soil management practices of sandy soils are usually carried out through addition of natural or chemical soil amendments that have become one of the most important practices for improving physical and chemical properties of these soils, and in turn enhancing their productivity.

Many studies were carried out to investigate the beneficial effects of some materials, such as organic manures and bio-fertilizers as foliar spray. The addition of organic manure resulted in increasing soil productivity as a result of increasing the values of micronutrients (*i.e,* Fe, Mn, Zn and Cu) and cation exchange capacity in the newly reclaimed soils**(Negm *etal.,* 2003)**. Moreover, increasing soil organic matter content due to organic manure application markedly increased the dry weight and the plant contents of Fe, Mn, Zn and Cu at the vegetative and elongation stages of maize.

Recently, great attention has been focused on the possibility of using natural and safety substances to get lower pollution and enhancing growth and productivity of the plant. The foliar application of

active dry yeast as natural stimulator to improve growth and yield is getting much importance. Yeast (as natural stimulator) is characterized by its high content of protein, vitamin B, thiamin, riboflavin and pyridoxines. Also, yeast is a prolific procedure for vitamins, amino acids and cytokinin that have stimulatory effects on cell division and other growth substances **(Hegab *et al.*, 1997).** Active dry yeast releases CO_2 which reflects in improving net photosynthesis **(Ahmed *et al.*, 1998)** and convert the nonsoluble form of phosphorus to soluble one play an important role in supplying the plants with available phosphorus for plant . Active dry yeast as a natural source of cytokinin had also stimulatory effects on cell enlargement, protein and nucleic acid synthsis and chlorophyll formation (**Fathy *et al.*, (2000)**, **Tortoura (2001)**, **Mekhemar and Al-Kahal (2002); Mohamed (2005)** and **Medani (2006)** .

Several investigations were carried out on different experiments dealing with active dry yeast spray and its beneficial effect on growth and yield of medicinal and aromatic plants.**(Ahmed *et al.*, 1997** on red romy grapevines, **Somida *et al.*, 2005, El-Yazal Sawasan and Somida, 2007)**.

Many research workers had emphasized the beneficial effects of applying organic manures on growth and yield of medicinal and aromatic plants in comparison with solely applications of inorganic fertilizers **(El-Gendy *et al.*, 2001, Matter and Mohamed 2001, Somida, 2002**, **El-Yazal, *et al.*, 2005, Matter and Somida, 2006, El-Yazal Sawsan and Somida, 2007** and **El-Yazal Sawsan and Somida. 2008).**

In Egypt, marjoram (*Origanum majorana* L.) is one of the most popular aromatic, medicinal plant species of Lamiaceae and is well known for its highly aromatic ingredient used for cough-relieving, stomachache, diuretic, carminative tea blends used in food industries. Also, marjoram is most important species being utilized as a source of essential oil.

Frequent application of bio-fertilizer and organic manure are expected to maintain soil fertility and to provide the growing plants with their nutritional requirements without causing undesirable impact on the environment. Bio and organic fertilization also provide means for alleviating the problem of chemical residues in the exporting market. The present study aims to evaluate the effect of dry yeast as foliar spray combined with organic manure or NPK-mineral fertilizers on growth and yield of herb, leaves, oil and chemical constituents of marjoram (*Origanum majoran*a L.) grown on sandy soil.

2. MATERIALS and METHODS

A completely random blocks filed experiment with three replicates was carried out on a sandy soil at the eastern edge of Demo, El Fayoum district, El-Fayoum Governorate, Egypt during two successive seasons of 2014/2015 and 2015/2016 to study the integrated benefit of applying bio-fertilizer and organic manures, as compared to untreated soil (control) and the recommended doses of mineral NPK, on the growth status and chemical constituents of marjoram (*Origanum majorana* L.), which grown by terminal cuttings, as a popular aromatic or medicinal plant spices. The bio-fertilizer (*i.e.,* active dry yeast) was applied as foliar spray at the rates of 0, 1, 2 and 4g/L as well as three organic manures (*i.e.,* farmyard, poultry and sheep wastes**)** were added at a rate of 20 m^3/fed.

NPK-chemical fertilizers were applied as basal dressing in six equal doses. The first dose was added after five weeks from transplanting, the second dose after four weeks from the first one, the third dose after two weeks from the first cut, the fourth dose after three weeks from the third dose, the fifth dose after two weeks from the second cut and sixth dose after three weeks from the fifth dose.

Active dry yeast (*Saccharomyces cerevisiae*) was dissolved in 10L warm water (38°C) followed by adding 0.3% Egyptian Treacle (for activating the growth and reproduction of yeast, Table 3) and let stand for two hours before foliar application.

Organic manures were applied in three doses; the first dose of 10 m^3/fed was incorporated with the soil two weeks before planting. The second dose of 5 m^3/fed was applied as a basal dressing after the first cut, while the third one of 5 m^3/fed was applied after the second cut. Plants of

the control treatment were treated with the recommended chemical fertilizers, *i.e.*, 400 kg/ fed of ammonium sulphate (20.5%N), 200 kg/fed of calcium superphosphate (15.5% P_2O_5) and, 100 kg/fed of potassium sulphate (48% K_2O), as reported by **Mansour et al. (1999).** Some characteristics of the experimental soil, organic manures and Active dry yeast were analyzed according to the methods described by (**Klute, 1986** and **Page, 1982)**, and obtained data were presented in Tables (1), (2) and (3), respectively.

Three cuts were taken, where the first, second and third cuts were taken on 15th may, 1stAugust and 15th October, respectively in which plant height, number of branches, fresh weight of herb, yield herb air-dried weight/plant, yield of leaves air-dried weight/fed, number of roots/plant were recorded. The essential oil percentage was determined in the herb according to **British Pharmacopoeia method (1983)** by using Clevenger apparatus, and then oil yield (mL/plant), oil yield (liter/fed) were calculated.

Essential oil percentage =
Essential oil quantity (mL)/Fresh weight of sample (100 g)

Chlorophyll a, b and caroteniods (mg/100g fresh leaves) were determined according to **Welburn and Lichtenthaler (1984).** Nutrient contents were determined after wet digestion according to the method described by **Chapman and Pratt (1978).** Nitrogen and phosphorus % in plant was determined according to **A.O.A.C (1995).**

Table (1): Some physical and chemical characteristics of the experimental soil

Soil characteristics	Value	Soil characteristics.	Value
Particle size distribution %:		*Soil paste extract:*	
Sand	89.3	EC (dS/m)	3.96
Silt	6.5	*Soluble ions (meq/L):*	
Clay	4.2		
Texture class	Sand	Ca^{++}	16.34
Hydraulic Cond. (cm/h)	12.73	Mg^{++}	8.76
$CaCO_3$ equivalent %	1.18	Na^{+}	14.58
Gypsum %	0.42	K^{+}	0.21
Organic matter %	0.12	CO_3^{--}	0.00
Available nutrients (mg/kg soil):		HCO_3^{-}	2.81
N	14.43	Cl^{-}	21.72
P	3.02	SO_4^{--}	15.36
K	39.67	Soil pH (1:2.5 soil water suspension)	7.69
Fe	4.30	CEC ($cmol_c kg^{-1}$)	5.35
Mn	0.83	Moisture content at field capacity %	10.26
Zn	0.69	Moisture content at wilting percentage%	3.41
Cu	0.52	Available water %	6.85

Table (2): Some characteristics of used organic manures.

Organic manures			
Character	FYM	Sheep	Poultry
Main characteristics:			
Weight of 1 m^3 (kg)	755	459	510
Moisture content %	15.20	10.79	12.45
pH (1:10 soil:water suspension)	7.42	7.35	6.95

Organic matter %	39.22	18.46	40.12
Organic carbon %	22.80	10.73	23.32
C/N ratio %	15.30	13.25	11.72
Total macronutrients content %:			
N	1.49	0.81	1.99
P	0.52	0. 88	0.83
K	1.09	0.75	1.32
Available micronutrients content (mg kg^{-1}):			
Zn	154	173	195
Mn	225	310	251
Cu	65	72	84
F e	1395	984	1025

Table (3): Chemical analysis of used activity dry yeast and Egyptian Treacle

Character	Value
Egyptian Treacle:	
Moisture%	22.05
Total soluble solids%	77.50
Sucrose%	42.50
Reducing sugars%	35.00
Ash%	2.41
Volatile acidity%	0.32
Activity dry yeast:	
Protein%	34.87
Ash%	7.55
Glycogen%	6.54
Fats%	2.09
Cellulose%	4.92

Data presented in this investigation represent the mean of the two growing seasons, and were statistically analyzed according to **Gomez and Gomez (1983).**

3. RESULTS and DISCUSSIONS

3.1. Vegetative *growth parameters:*

3.1.1. Plant height:

Data in Table (4) indicated that applying active dry yeast at all different rates significantly increased the plant height as compared to the untreated plants in the different cuts of the tested two seasons. In contrast, the applied rates of 2 and 4g/L were, statistically, similar with respect to significant plant height at the different cuts during the tested two seasons. These results are in harmony with those reported by **Mohamed (2006)**. The NPK- chemical fertilizers also significantly increased plant height as compared to the untreated plants and surpassed both (farmyard & sheep manures) by (3.03 & 7.53%), (0.93 & 3.62%) and (1.96 & 3.79%) for the three cuts. Similar results were obtained by **Badran *et al.*, (2007)** and **Osman and El-Sawah (2009)** .

The applied organic manure sources significantly increased plant height as compared to the control plants in the three cuts, with superiority for poultry manure that significantly surpassed

(farmyard & sheep manures) by (3.82 & 8.36), (1.42 & 4.13) and (3.38 & 5.24 %) for the three cuts. Both NPK- chemical fertilizers and poultry manure (PM) were statistically similar in producing significant plant height for the three cuts. So, the greatest plant height values were achieved when *Origanum majorana L.* plants received poultry manure at the rate of 20 m^3/fed. These results are in partial agreement with the findings reported by **El–Yazal Sawsan and Somida (2007)** .

The beneficial effect of active dry yeast foliar application on growth traits plants may be due to that yeast as a natural source of cytokinins had stimulatory effects on cell division and elongation, protein and nucleic acids synthesis and chlorophylls formation **(Spencer *et al*., 1983)**. Also, yeast was found to contain carbohydrate, amino acids and lipids, several vitamins and most nutrional elements. These results are in the same line with those observed by **Fathy *et al.,* (2000) Tortoura (2001), Mekhemar and Al-Kahal (2002) and Mohamed (2005).**

The interaction effect between active dry yeast and either NPK- chemical fertilizers or organic manure fertilization significantly increased plant height as compared to the control plants for the three cuts during both tested growing seasons. Statistically and from the economical point of view, the most effective treatment that gave the tallest plants was the use of active dry yeast at a rate of 2 g/L in combination with either NPK- chemical fertilizers or poultry manure. The corresponding relative increase percentages reached (42.07 & 43.21%), (37.45 and 37.57%) and (20.05 & 21.72 %) over the control for the three cuts during both tested seasons. These results are in line with those reported **Somida *et al.* (2005)**.

3.1.2. Number of branches per plant:

It was clearly that number of branches/plant of *Origanum majorana*, L. tended to gradual increase with increasing active dry yeast rates up to 2 g /L, and then a slightly increase up 4g/L in the three cuts of both seasons. These incensements reached 21.65 & 25.93, 15.27 & 16.20 and 26.26 & 32.09% for 2 & 4 g/L of active dry yeast rates for the three cuts in the both seasons as well as the favourable effect of such applied two rates was, statistically, almost similar Table (4). Also, number of branches/plant significantly increased as a result of applied NPK- chemical fertilizers, which surpassed both the farmyard & sheep manures by 6.85 & 8.35, 3.31 & 6.91 and 9.63 & 10.57%, respectively in three cuts during the two experimental seasons. These results are in conformity with the findings reported by **Mohamed (2006)**.

Addition of poultry wastes at the rate 20 m^3/fed surpassed both farmyard & sheep manures, where the relative increase percentages in number of branches/plant reached 8.54 &10.07, 4.34 & 7.96 and 10.17 & 11.12 % for the three cuts, respectively. At the meantime, both NPK-mineral fertilizers and poultry manure were, statistically, similar for producing a significant number of branches/plant in the three cuts. So, the highest values were obtained when *Origanum majorana* L. These results are in partial agreement with the findings reported **El-Yazal Sawsan and Somida (2007)**.

The interaction between active dry yeast and either NPK- chemical fertilizers or organic fertilization significantly increased number of branches/plant as compared to the control plants for the three cuts during both tested seasons. The most effective interaction treatment that resulted in the greatest number of branches/plant was active dry yeast at 2 g/L & either NPK- chemical fertilizers or poultry manure, with relative increase percentages of 53.97 & 55.67, 34.00 & 34.73 and 58.78 & 59.37 % over the control for the three cuts of both two seasons, respectively. Also, the effect of both NPK-mineral and poultry manure combined with active dry yeast at the rate 2 g/L were statistically similar in producing significant number of branches/plant in the three cuts as compared to the other treatments. These results are in line with the findings reported **Mohamed (2005)**.

3.1.3. Herb fresh weight plant (g):

Data in Table (4) show that supplying plants with active dry yeast at the rates of 1, 2 and 4g/L of active dry yeast increased herb fresh weight/plant by 8.80, 16.97, and 18.53% in the first cut vs 3.98, 8.13 and 9.59% in the second cut and 5.76, 11.97 and 12.48 % in the third cut over the control, respectively. It is worthy to mention that both the rates of 2 and 4 g/L of active dry yeast were similarly effective in increasing herb fresh weight/plant as compared with either the low rate or the control for the three cuts during both seasons. From the economical point of view, to supply marjoram plants with 2 g/L of active dry yeast. The increase in herb fresh weight/plant as a result of active dry yeast fertilization was reported by **Mohamed (2005)** . Moreover, NPK- chemical fertilizers showed also a significantly increase in herb fresh weight/plant as compared to the control, farmyard and sheep manures by 19.30, 4.49 and 10.26 % for 1st cut vs 17.79, 4.51 and 5.62 % for 2nd cut and 10.70, 2.30 and 3.87 % for 3rd cut, as shown in Table (4). These results are in partial agreement with the findings reported by **Mohamed (2006)** .

Organic manures significantly increased herb fresh weight/plant as compared to the control plants in the three cuts of both seasons. Application of poultry manure at the applied rates gave heavy plant than the other treatments by 20.02, 0.60, 5.117 and 10.92; 18.63, 0.71, 5.26 and 6.37 or 12.61, 1.72, 4.06 and 5.66 % for the three cuts, respectively. At the meantime both NPK- chemical fertilizers and poultry manure were, statistically, equal for producing a significant herb fresh weight/plant in the first and second cuts during treated both seasons. So, the greatest values were obtained when *Origanum majorana* L. with poultry manure at a rate of 20 m^3/fed .These results are in agreement with the findings reported by **El-Gendy *et al*., (2001).**

The enhancing effect of active dry yeast on broccoli yield and its components may be due to that yeast via its cytokinins content and the high content of vitamin B and nutrient elements as well as organic compounds might play a role in distribution and translocation of metabolities from leaves towards the reproductive organs. In addition, increasing the release of CO_2 through fermentation process effectively activates the photosynthesis and accelerates the biosynthesis of carbohydrates. **(Nagodwithana, 1991)** confirmation to the obtained results were reported by **Sallam (2002) and Mohamed and El-Ganaini (2003)**.

As for the interaction effect between active dry yeast and NPK- chemical fertilizers or organic manures caused a significant increase in herb fresh weight/plant as compared to the control plants in the three cuts of both seasons. The most effective treatment that gave the greatest value of herb fresh weight/plant was active dry yeast at 2 g/L & NPK- chemical fertilizers or poultry manure, with relative increase percentages of 39.95 & 39.70, 28.70 & 29.45 and 23.53 & 26.01% over the control for the three cuts of both seasons, respectively. Both NPK- chemical fertilizers and poultry manure combined with active dry yeast at the rate 2 g/L were statistically similar for producing significant herb fresh weight/plant for the three cuts as compared to the control. These results are in line with the findings reported by **Osman and El-Sawah (2009)** .

Table (4): Effect of active dry yeast, NPK-chemical fertilizers and organic manures on some vegetative growth parameters of *Majorana marjoram* L. (as an average of the tested two seasons).

Treatment	Plant height (cm)				Number of branches/plant				Herb fresh weight /plant (g)			
	Rate of foliar spray with active dry yeast (g L^{-1})											
	0	1	2	4	0	1	2	4	0	1	2	4
First cut												
Control	52.19	55.12	57.12	57.89	14.12	16.25	18.89	20.12	225.95	245.45	268.63	271.12
NPK	65.44	69.28	74.15	74.78	18.58	20.58	21.74	22.12	275.88	295.88	316.23	318.36
FYM	63.45	67.55	71.63	72.64	16.66	18.66	20.89	21.49	250.70	290.70	305.13	307.99
PM	65.49	69.89	74.74	75.70	18.93	20.93	21.98	22.48	280.79	296.79	315.66	320.36
SM	61.10	64.19	68.28	70.20	16.93	18.43	20.13	21.11	245.45	262.45	290.21	295.99

Mean	**61.534**	**65.206**	**69.184**	**70.242**	**17.044**	**18.97**	**20.726**	**21.464**	**255.754**	**278.254**	**299.172**	**302.764**
L.S.D.	A=1.51	B=1.09	AB=2.18		A=0.75	B=0.40	AB=0.81		A=4.45	B=2.40	AB=4.80	
Second cut												
Control	52.92	54.99	56.14	56.85	22.23	24.56	26.56	27.23	333.61	352.66	368.21	372.22
NPK	66.06	68.99	72.74	73.25	25.33	28.19	29.79	29.98	399.89	414.91	429.86	435.86
FYM	67.09	68.09	71.08	72.18	24.99	26.89	28.82	28.96	381.23	394.08	412.81	419.81
PM	67.03	69.03	72.80	73.56	25.89	28.58	29.95	29.99	403.21	420.86	431.86	436.56
SM	65.07	67.07	69.07	69.99	24.99	26.49	27.19	27.29	378.79	389.79	408.25	414.23
Mean	**63.634**	**65.634**	**68.366**	**69.166**	**24.686**	**26.942**	**28.462**	**28.69**	**379.346**	**394.46**	**410.198**	**415.736**
L.S.D.	A=1.19	B=0.63	AB=1.23		A=0.54	B=0.29	AB=0.60		A=8.44	B=4.49	AB=8.98	
Third cut												
Control	50.91	52.12	54.19	54.75	12.11	13.23	15.53	17.17	201.33	217.29	222.56	223.33
NPK	57.48	59.43	61.12	61.78	15.55	17.68	19.22	19.94	222.12	236.18	248.71	249.99
FYM	55.84	58.84	59.99	60.55	13.63	15.65	17.97	18.79	218.23	228.44	243.87	244.96
PM	58.98	60.15	61.97	62.09	15.95	17.55	19.30	19.99	224.45	240.53	253.70	254.85
SM	54.14	57.91	59.15	59.85	13.97	15.45	17.87	18.18	215.12	221.19	241.95	243.12
Mean	**55.47**	**57.69**	**59.284**	**59.804**	**14.242**	**15.912**	**17.978**	**18.814**	**216.25**	**228.726**	**242.158**	**243.25**
L.S.D.	A=0.95	B=0.51	AB=1.02		A=0.42	B=0.23	AB=0.46		A=3.89	B=2.10	AB=4.20	

FYM= Farmyard manure, PM=Poultry manure, SM=Sheep manure, A=Active dry yeast,
B=organic manures, AB=Interaction effects

3.1.4. Yield of herb air-dry weight/plant:

The yield values of herb air-dry weight/plant of *Origanum majorana L.* were gradually and significantly increased with increasing the applied active dry yeast rates up to 2 g/L, then slightly increase up to 4 g/L for the three cuts of both seasons as compared with other treatments, as shown in Table (5). The relative increase percentages of herb air-dry weight/plant were by 21.85 & 23.08, 13.71 & 14.55 and 22.18 & 24.14 % for 2 & 4 g/L active dry yeast over the control for the three cuts of both seasons, respectively. Such two applied rates were statistically similar in producing significant herb air-dry weight/plant in the three cuts of both seasons. This positive response of active dry yeast has been reported by **Khalil, Mona (2002)** .

The yield of herb air-dry weight/plant of marjoram plants showed significant increase due to applied NPK- chemical fertilizers, which surpassed the farmyard & sheep manures by 5.01 & 9.19, 5.79 & 8.35 and 9.37 & 14.77 % for the three cuts of the both seasons, respectively. Similar results were obtained by **Mansour *et al*., (1999)** and **El-Yazal *et al.,* (2005)**.

Organic manures significantly increased the herb air-dry weight/plant, where poultry manure surpassed the control, NPK- chemical fertilizers, farmyard & sheep manures by 28.35, 0.35, 5.38 & 38.95; 0.41, 6.22 & 8.79 and 42.64, 1.061, 11.13 & 16.61% for the three cuts of both seasons, respectively. At the meantime, both NPK- chemical fertilizers and poultry manure were statistically similar in producing significant herb air-dry weight/plant for the three cuts. The greatest values were obtained when *Origanum majorana* L. received poultry manure at a rate of 20 m^3/fed poultry manure. These results are in agreement with the findings reported **Osman and El-Sawah (2009).**

The interaction between active dry yeast and NPK-chemical fertilizers or organic manures was significantly increased herb air-dry weight/plant as compared to the control plants in the three cuts of both seasons. From economical point of view, active dry yeast at 2 g/L in combination with NPK-mineral poultry manure, which were statistically similar in their effective roles, gave the best result for producing herb air-dried weight/plant for the three cuts as compared to the other combined treatments. Similar results were obtained by **Mohamed (2005).**

3.1.5. Yield of leaves air-dry weight/fed:

Data in Table (5) show that all applied rates of active dry yeast resulted in a significant increase in the yield of leaves air-dry weight/fed. Spraying the plants with the rates of 1, 2 and 4 g/L active dry yeast increased the yield of leaves air-dry weight/fed by (3.35, 10.61 and 11.33 %), (2.25,

6.30 and 6.44 %) and (3.76, 13.01 and 13.39 %) over the control for the first, second and third cuts, respectively. It is worthy to mention that the applied rates of 2 and 4 g/L active dry yeast were equally effective in increasing leaves air-dry weight/fed as compared with either the low rate or control for the three cuts of both seasons. Moreover, NPK- chemical fertilizers significantly increased the leaves air-dry weight/fed as compared to the control, farmyard and sheep manures by 33.43, 5.12 and 8.34; 53.63, 5.41 and 7.83 % and 22.08, 7.41 and 11.62% for the three cuts of the both seasons, respectively, Table (5).

The applied organic manures significantly increased the leaves air-dry weight/fed as compared to the control plants for the three cuts of two seasons, where applied poultry manure gave greater leaves air-dry weight/fed than the control, NPK- chemical fertilizers, FYM & sheep manures by 33.99, 0.42, 5.57 & 8.80 %; 53.78, 0.10, 5.51 &7.94 % and 22.27, 0.14, 7.57 & 11.79 % for the three cuts of both seasons, respectively. The effective role of both NPK- chemical fertilizers and poultry manure were statistically similar for producing significant leaves air-dry weight/fed for the three cuts of both seasons. So, the greatest values were obtained when *Origanum majorana* L. received poultry manure at a rate of 20 m^3/fed from poultry manure. These results are in partial agreement with those obtained by **Mohamed (2005)** and **Osman and El-Sawah (2009).**

The interaction between active dry yeast and NPK- chemical fertilizers or organic manures significantly increased leaves air-dry weight/fed as compared to the control plants in the three cuts of both seasons. The greatest leaves air-dry weight/fed was obtained from the treatment of active dry yeast at either 2 or 4 g/L in combination with NPK- chemical fertilizers or poultry manure fertilization which recorded 1045.33 and 1049.92; 1353.9285 and 1355.85 or 796.55 and 797.72 kg/fed for the three cuts of both seasons, respectively. Insignificant differences were found between active dry yeast at 2 or4 g/L plus NPK- chemical fertilizers or poultry manure. The most effective treatment which gave the greatest leaves air-dried weight/fed was achieved at the treatment of active dry yeast at 2 g/L in combination with NPK-chemical fertilizers or poultry manure, where the relative increase percentages reached 39.95 and 39.70, 28.70 and 29.45 or 23.53 and 26.01 % over the control for the three cuts of both seasons, respectively. Form the healthy point of view, it is advised to supply marjoram plants with 2 g/L of active dry yeast spray plus poultry manure to increase the leaves air-dried weight/fed of marjoram plants. Similar results were obtained by **Mohamed (2005)** and **Osman and El-Sawah (2009)** .

3.1.6. Number of roots/plant:

Significant increases in Number of roots/plant due to applied active dry yeast at the rates of 2 and 4 g/L as compared to the (control and low rate), where the relative increase percentages were (13.30 & 2.34), (13.88 & 2.87) and (24.68 & 2.37) for the 2 g/L vs (24.86 & 2.87), (24.68 & 3.13) and (24.66 & 3.90 %) for the 4 g/L for the three cuts of both seasons on marjoram plants, respectively. NPK- chemical fertilizers significantly increased the number of roots/plant as compared to the control, farmyard manure and sheep manures by 19.87, 2.82 and 10.52; 22.93, 5.96 and 8.26 or 13.12, 3.12 and 12.13 % for the three cuts of the studied two seasons, respectively.

Organic manures fertilization significantly increased number of roots/plant for marjoram plants in the three cuts of both tested seasons, where poultry manure surpassed the other treatments. It is worthy to mention that the NPK-chemical fertilizers and poultry manure were equally effective in increasing number of roots/plant as compared to the control in the three cuts of both seasons. These results are in harmony with those reported by **Abd El-Kader (1999)** and **Matter and Somida (2006)**. The interactions between active dry yeast and NPK-mineral fertilizers or organic manures significantly increased number of roots/plant as compared to the control plants in the three cuts of both seasons. Statistically, active dry yeast at a rate of 2 g/L plus NPK-mineral or poultry manure showed the best result than the other combinations from the economical point of view.

The promoting effects of active dry yeast augmenting on vegetative growth characters of marjoram plants are more attributed with a natural source of cytokinins, which had stimulatory effects on cell division and enlargement. Such favourable effect leads to increase the leaf area surface as well as enhancing the accumulation of soluble metabolites as mentioned about the role of cytokinins **(Muller and Leoped 1966).** Also, yeast as a natural source has many growth substance, *i.e.*, thiamine, riboflavin, niacin, pyridoxine, panthothenate, bioten, cholin, folic acid, vitamin B12, nutritive and non-nutritive elements of Na, Ca, Fe, Mg, K, P, S, Zn and Si as well as organic compounds of portion, carbohydrate, nucleic acid and lipids, phloem loading and phloem transport etc. Such important physiological roles enable potassium to perform its functions, which lead to an increase in various vegetative growths and yield **(Nagodawithana, 1991)**.

As for the effect of organic manures on different vegetative growth characters, yield components and oil production of marjoram plants, it is necessary to refer the physiological roles of the released macro and micronutrients on plant growth and development. Nitrogen is a constituent of most organic compounds such as amino acids, many enzymes and energy transfer materials such as chlorophyll, ADP and ATP. Growing plants must have nitrogen to form new cells and the rate of growth is proportional to the rate at which nitrogen is supplied. Thus, a severe shortage of nitrogen will affect the processes of growth and production. The other macronutrient involved in the present study is potassium that plays an important role in metabolism, growth and yield formation, where it represents an activator of enzymes as well as K ions are very mobile within the plant due to it is transported through biological membranes with high rate and specificity . More than 60 enzymes are known to require K^+ as an activator. Also, micronutrients in sort of organic manure are necessary because the soil is usually in deficient move the elements and their spray make them readily to plants.

Terminal cuttings of propagation is more easily methods of propagation to give higher product because contained the maximum number of roots **(Matter and Somida, 2006)**, and in turn increasing the absorption coefficient from the soil. Therefore, *Origanum majorana L*. enhanced different vegetative characters and chemical components by this treated method.

Table (5): Effect of active dry yeast, NPK-chemical fertilizers and organic manures on herb air-dry weight/plant, leaves air-dry weight/fed and number of roots/plant of *Majorana marjoram* L. (as an average of the tested two seasons).

Treat-ment	Herb air-dry weight/plant (g)				Leaves air-dry weight/fed (kg)				Number of roots/plant			
	Rate of foliar spray with active dry yeast (g L^{-1})											
	0	1	2	4	0	1	2	4	0	1	2	4
First cut												
Control	81.89	87.45	93.56	95.36	715.20	750.56	785.35	798.81	16.65	17.89	19.14	19.25
NPK	99.56	114.97	121.59	122.11	970.23	1003.71	1045.33	1050.21	19.89	22.11	22.65	22.75
FYM	95.19	103.60	118.30	119.23	892.33	911.42	1030.83	1036.54	19.44	21.66	21.89	21.96
PM	99.55	115.22	121.92	123.12	975.23	1009.53	1049.92	1052.21	20.47	22.67	22.74	22.89
SM	90.18	102.38	112.88	114.18	875.23	901.54	986.81	992.50	17.90	20.12	20.49	20.59
Mean	**93.274**	**104.724**	**113.65**	**114.8**	**885.644**	**915.352**	**979.648**	**986.054**	**18.87**	**20.89**	**21.382**	**21.488**
L.S.D.	A=139	B=0.75	AB=1.50		A=7.12	B=3.79	AB=7.57		A=0.39	B=0.21	AB=0.42	
Second cut												
Control	105.12	116.56	122.12	123.15	824.21	854.27	888.95	891.51	18.99	20.12	21.99	22.12
NPK	149.91	161.94	166.65	167.67	1289.76	1314.95	1353.92	1355.41	23.68	25.90	26.21	26.48
FYM	136.91	150.98	160.92	161.99	1200.63	1225.92	1306.72	1308.22	22.19	24.41	24.93	24.99
PM	150.54	162.44	167.01	168.82	1290.55	1315.62	1355.85	1357.33	23.69	25.93	26.25	26.53
SM	135.99	149.99	154.82	155.56	1192.75	1217.96	1257.84	1259.35	21.87	24.09	24.13	24.41
Mean	**135.694**	**148.382**	**154.304**	**155.438**	**1159.58**	**1185.744**	**1232.656**	**1234.364**	**22.084**	**24.09**	**24.702**	**24.906**
L.S.D.	A=1.85	B=0.98	AB=1.96		A=7.09	B=3.79	AB=7.59		A=0.47	B=0.26	AB=0.52	
Third cut												
Control	60.52	70.56	77.72	79.89	600.33	624.66	644.58	651.86	15.25	16.56	17.89	17.99
NPK	90.98	99.97	106.09	108.26	729.82	754.95	796.55	797.06	17.72	19.22	19.76	19.88

FYM	79.64	88.60	99.90	102.45	637.65	662.92	781.95	783.4	17.27	18.77	19.00	19.20
PM	91.24	102.22	108.92	109.23	730.38	755.65	797.72	799.23	17.82	19.27	19.78	19.89
SM	77.36	83.38	95.88	96.52	627.58	652.82	737.92	739.43	15.73	17.23	17.60	17.74
Mean	**79.948**	**88.946**	**97.702**	**99.27**	**665.152**	**690.2**	**751.744**	**754.196**	**16.758**	**18.21**	**18.806**	**18.94**
L.S.D.	A=1.72	B=0.92	AB=1.84		A=4.89	B=2.63	AB=5.26		A=0.31	B=0.18	AB=0.36	

FYM= Farmyard manure, PM=Poultry manure, SM=Sheep manure, A=Active dry yeast,
B=organic ``, AB=Interaction effects

3.2. Chemical components:

3.2.1. Volatile oil percentage of herb:

Data in Table (6) showed that applying active dry yeast significantly affected volatile oil percentage/plant, where applied rates of 1, 2 & 4 g/L resulted in relative increase percentages of (3.68, 6.35 & 7.02 %), (0.99, 1.66 & 1.99 %) and (1.03, 2.08 & 2.42 %) over the control for the three cuts of both seasons, respectively. Also, NPK- chemical fertilizers increased the volatile oil percentage/plant as compared to the control, farmyard & sheep manures by 7.45, 0.31 & 1.28, 9.12, 0.97 & 1.30 and 9.12, 0.67 & 1.01 % for the three cuts of both seasons, respectively. Insignificant differences between the NPK-chemical fertilizers, farmyard, poultry and sheep manures for increasing volatile oil percentage/plant were observed, as shown in Table (6). These results are in harmony with those reported by **Somida (2002)** .

As for the effect of organic manures, data reveal that there was a significant increase in volatile oil percentage/plant of marjoram, as poultry manure surpassed the other treatments for the three cuts of both seasons. It is worthy to mention that NPK- chemical fertilizers, farmyard, poultry and sheep manures were equally effective in increasing volatile oil percentage/plant as compared to the control at the three cuts of both seasons. These results are in line with those reported by **El-Nemr *et at*., (2011)** .

The interaction between active dry yeast, NPK- chemical fertilizers and organic manures significantly increased the volatile oil percentage/plant as compared to the control for the three cuts of both seasons. Active dry yeast at the rates of 2 and 4 g/L plus NPK- chemical fertilizers or poultry manure gave the best result than other combinations. Both NPK- chemical fertilizers and poultry manure combined with active dry yeast were statistically equal in producing a significant effect on oil percentage/plant as compared to the control for the three cuts of both seasons.

3.3.2. Volatile oil yield of herb/plant or fed:

Data in Table (8) show that volatile oil yield/plant in the herb of *Origanum majorana* L. was significantly affected by different applied rates of active dry yeast. Spraying plants with the rates of 1, 2 and 4 g/L increased volatile oil yield/plant by (2.33, 24.80 & 27.82 %), (5.08, 9.89 & 11.99 %) and (6.88, 14.24 & 15.20 %) over the control for the first, second and third cuts, respectively. A similar trend was observed for total volatile oil yield of herb/fed, however, spraying marjoram plants with the active dry yeast at rates 2 and 4 g/L resulted in highly significant promotion in total volatile oil yield of herb/plant or fed as compared to the control and low treatment of active dry yeast in the three cuts of both seasons. Insignificant difference was noticed between the use of 2 and 4 g/L rates of active dry yeast in the three cuts of both seasons.

NPK- chemical fertilizers significantly increased the volatile oil yield/plant in the herb as compared to the control, farmyard manure and sheep manures fertilization of marjoram plants by 28.05, 4.26 & 11.31; 28.64, 5.57 & 7.04 and 20.77, 3.02 & 4.84 %, respectively in the three cuts of the two experimental seasons, as indicated in Table (8). As for the volatile oil yield/fed, the relative increase percentages due to the use of farmyard & sheep manures were (28.00, 4.23 & 11.28 %), (28.64, 5.57 & 7.04 %) and (20.80, 2.99 & 4.92 %) over the control, respectively for the three cuts of the both seasons . These results took the same trend with **El-Ghadban (1998**), **Sakr (2001)** and **Somida (2002)** .

Application of organic manurse such as poultry manure gave greater volatile oil yield/plant or fed in the herb as compared with other treatments. Volatile oil yield/fed showed significant increase by the use of farmyard, poultry & sheep manures over the control plants by (22.80, 28.30 & 15.02 %), (21.85, 29.92 & 20.17 %) and (17.29, 23.30 & 15.14 %) for the first, second and third cuts, respectively in both seasons. It is clear that poultry manure surpassed the farmyard and sheep ones as well as such organic manure and NPK-chemical fertilizers were really statistically equal for producing significant volatile oil yield/fed in the three cuts of both seasons. So, the greatest values of volatile oil yield/fed were obtained when *Origanum majorana L*., plants received poultry manure at rates of 20 m^3/fed. These results are inpartial agreement with the findings reported by **El-Nemr *et at*., (2011).**

The interactions between active dry yeast and NPK-chemical fertilizers or organic manures, there was a significant increase in volatile oil yield/plant or fed of the herb as compared to the control plants in the three cuts of both seasons. The best result of volatile oil yield/plant in the herb in this study obtained from using active dry yeast at (2 & 4 g/L) in combination with NPK-mineral or poultry manure which recorded (1.021 & 1.037 mL/plant) and (1.026 & 1.051 mL/plant) for the first cut vs (1.341 & 1.364 mL/plant) and (1.351 & 1.371 mL/plant) for the second cut and (0.748 & 0.755 mL/plant) and (0.764 & 0.772 mL/ plant) for the third cut in both seasons, respectively. Moreover, insignificant differences were noticed between active dry yeast at 2 or 4g/L plus NPK-mineral or poultry manure, *i.e.,* either active dry yeast plus NPK-chemical fertilizers or active dry yeast plus poultry manure. Data in Table 4 show that volatile oil yield/fed in the herb of *Origanum majorana L*. showed almost the same trend observed for total volatile oil yield of herb/plant. It was significantly affected by interaction among the studied factors except the interaction between (active dry yeast x NPK-chemical fertilizers or organic manure) as compared to the control plants for the three cuts. Also, active dry yeast at the rates of 2 and 4 g/L combined with NPK-chemical fertilizers or poultry manure gave the greatest volatile oil yield/fed than the other combinations ones for the three cuts.

Table (6): Effect of active dry yeast, NPK-chemical fertilizers and organic manures on oil % of fresh herb and oil yield mL/plant or L/fed of *Majorana marjoram* L. (as an average of the tested two seasons).

Treat-ment	Oil % of fresh herb				Oil yield in mL/plant				Oil Yield in L/fed			
	Rate of foliar spray with active dry yeast (g L^{-1})											
	0	1	2	4	0	1	2	4	0	1	2	4
First cut												
Control	0.289	0.294	0.298	0.299	0.650	0.721	0.800	0.811	20.800	23.072	25.600	25.952

NPK	0.303	0.315	0.324	0.327	0.830	0.929	1.021	1.037	26.560	29.728	32.672	33.184
FYM	0.302	0.314	0.323	0.326	0.750	0.916	0.982	1.014	24.000	29.312	31.424	32.448
PM	0.304	0.316	0.325	0.328	0.850	0.899	1.026	1.051	27.200	28.768	32.832	33.632
SM	0.299	0.311	0.320	0.323	0.730	0.816	0.928	0.956	23.360	26.112	29.696	30.592
	0.2994	**0.31**	**0.318**	**0.3206**	**0.762**	**0.8562**	**0.9514**	**0.9738**	**24.384**	**27.3984**	**30.4448**	**31.1616**
L.S.D.	A=0.010	B=0.006	AB=0.012		A=0.026	B=0.015	AB=0.030		A=0.82	B=0.46	AB=0.92	
Second cut												
Control	0.281	0.284	0.288	0.289	0.937	1.001	1.060	1.075	29.984	32.032	33.920	34.400
NPK	0.308	0.310	0.312	0.313	1.231	1.286	1.341	1.364	39.392	41.152	42.912	43.648
FYM	0.305	0.308	0.310	0.311	1.162	1.213	1.279	1.305	37.184	38.816	40.928	41.760
PM	0.309	0.311	0.313	0.314	1.245	1.308	1.351	1.371	39.840	41.856	43.232	43.872
SM	0.304	0.307	0.309	0.310	1.151	1.196	1.261	1.284	36.832	38.272	40.368	41.088
	0.3014	**0.304**	**0.3064**	**0.3074**	**1.1452**	**1.2008**	**1.2584**	**1.2798**	**36.6464**	**38.4256**	**40.272**	**40.9536**
L.S.D.	A=0.009	B=0.005	AB=0.010		A=0.038	B=0.021	AB=0.042		A=0.95	B=0.52	AB=1.04	
Third cut												
Control	0.269	0.272	0.276	0.277	0.542	0.591	0.614	0.619	17.330	17.312	19.656	19.795
NPK	0.296	0.298	0.301	0.302	0.657	0.704	0.748	0.755	21.039	21.024	23.956	24.159
FYM	0.293	0.296	0.298	0.299	0.639	0.676	0.726	0.732	20.461	20.448	23.255	23.437
PM	0.297	0.299	0.301	0.303	0.668	0.719	0.764	0.772	21.331	21.344	24.436	24.710
SM	0.292	0.295	0.297	0.298	0.628	0.652	0.718	0.724	20.100	20.096	22.995	23.183
	0.2894	**0.292**	**0.2946**	**0.2958**	**0.6268**	**0.6684**	**0.714**	**0.7204**	**20.0522**	**20.0448**	**22.8596**	**23.0568**
L.S.D.	A=0.007	B=0.004	AB=0.008		A=0.038	B=0.020	AB=0.040		A=0.59	B=0.31	AB=0.62	

FYM= Farmyard manure, PM=Poultry manure, SM=Sheep manure, A=Active dry yeast, B=organic manures, AB=Interaction effects

3.2.3. Leaf plastid pigments content:

Data given in Table (7) showed that leaf plastid pigments (chlorophyll a, b and caroteniods) in the leaves of *Origanum majorana L.*, plants were significantly increased as a result of applied different rates of active dry yeast. Active dry yeast spray at the rates 1, 2 & 4 g/L increased chlorophyll a, b & caroteniods contents over the seedlings by (3.96, 6.77 & 7.76 %), (4.34, 6.77 & 8.16 %) and (4.90, 7.35 & 8.49 %) for chlorophyll a for the three cuts; (5.36, 8.85 & 10.26 %), (6.11, 9.04 & 10.51 %) and (6.72, 10.92 & 12.60 %) for chlorophyll b at three cuts (6.08, 9.27 & 11.01 %), (7.08, 9.85 & 11.69 %) and (7.19, 12.23 & 14.03 %) for caroteniods of three cuts, respectively. Moreover, insignificant difference was observed between the rates 2 and 4 g/L of active dry yeast at the three cuts of both tested seasons**.** These results are in agreement with **Mansour *et al*. (1999)** .

Findings of application of NPK-chemical fertilizers significantly increased chlorophyll a, b and caroteniods contents *of Origanum majorana L.*, plants as compared to the control, farmyard & sheep manures by (5.53, 2.36 & 4.86 %), (11.78, 2.79 & 5.56 %) and (8.05, 3.59 & 6.85 %) for chlorophyll a at the three cuts; (7.29, 3.52 & 7.90 %), (5.67, 2.29 & 6.69 %) and (11.39, 3.62 & 8.09 %) for chlorophyll b and (12.35, 2.69 & 6.41 %), (7.21, 1.13 & 5.93 %) and (11.82, 1.62 & 7.96 %) for caroteniods at the three cuts, respectively. These results are in line with those reported by **Mansour *et al*. (1999)** and **Matter and Somida (2006).** Also, chlorophyll a, b and caroteniods contents were significantly affected by organic manure types, where poultry wastes surpassed farmyard and sheep manures. The greatest values of chlorophyll a, b and caroteniods contents were obtained when *Origanum majorana L* was treated with poultry manure at rate 20 m^3/fed. These results are in partial agreement with the findings reported by **Mohamed and Matter (2001)** and **Sakr (2001) .**

Table (7): Effect of active dry yeast, NPK-chemical manures and organic fertilizers on chlorophyll a, b and caroteniods of *Majorana marjoram* L. (as an average of the tested two seasons).

Treat-	Chlorophyll a (mg/100 g leaves)	Chlorophyll b (mg/100 g leaves)	Caroteniods (mg/100 g leaves)

ment	Rate of foliar spray with active dry yeast (g L^{-1})											
	0	1	2	4	0	1	2	4	0	1	2	4
First cut												
Control	0.588	0.609	0.628	0.631	0.418	0.432	0.452	0.454	0.321	0.335	0.351	0.354
NPK	0.619	0.642	0.665	0.668	0.446	0.471	0.482	0.486	0.359	0.383	0.391	0.397
FYM	0.605	0.629	0.643	0.656	0.428	0.453	0.467	0.474	0.347	0.371	0.382	0.389
PM	0.621	0.645	0.663	0.672	0.445	0.469	0.483	0.493	0.363	0.384	0.391	0.399
SM	0.594	0.618	0.629	0.633	0.412	0.437	0.453	0.457	0.334	0.359	0.371	0.375
	0.6054	**0.6286**	**0.6456**	**0.652**	**0.4298**	**0.4524**	**0.4674**	**0.4728**	**0.3448**	**0.3664**	**0.3772**	**0.3828**
L.S.D.	A=0.019	B=0.010	AB=0.020		A=0.014	B=0.007	AB=0.014		A=0.012	B=0.006	AB=0.012	
Second cut												
Control	0.531	0.555	0.576	0.579	0.402	0.420	0.435	0.438	0.315	0.332	0.342	0.345
NPK	0.599	0.627	0.636	0.648	0.420	0.448	0.459	0.463	0.336	0.361	0.363	0.367
FYM	0.578	0.604	0.623	0.632	0.415	0.439	0.444	0.452	0.323	0.348	0.368	0.375
PM	0.602	0.628	0.638	0.646	0.419	0.449	0.459	0.467	0.337	0.362	0.367	0.378
SM	0.569	0.593	0.604	0.608	0.388	0.414	0.436	0.44	0.314	0.339	0.345	0.349
	0.5758	**0.6014**	**0.6154**	**0.6226**	**0.4088**	**0.434**	**0.4466**	**0.452**	**0.325**	**0.3484**	**0.357**	**0.3628**
L.S.D.	A=0.011	B=0.006	AB=0.012		A=0.010	B=0.005	AB=0.011		A=0.009	B=0.005	AB=0.010	
Third cut												
Control	0.512	0.530	0.545	0.548	0.335	0.358	0.372	0.375	0.262	0.275	0.288	0.292
NPK	0.551	0.577	0.588	0.593	0.375	0.399	0.414	0.418	0.285	0.309	0.325	0.329
FYM	0.524	0.551	0.573	0.580	0.365	0.388	0.393	0.401	0.278	0.302	0.320	0.329
PM	0.553	0.579	0.589	0.598	0.374	0.399	0.415	0.423	0.294	0.318	0.328	0.336
SM	0.512	0.541	0.552	0.556	0.339	0.363	0.388	0.393	0.271	0.288	0.298	0.302
	0.5304	**0.5556**	**0.5694**	**0.575**	**0.3576**	**0.3814**	**0.3964**	**0.402**	**0.278**	**0.2984**	**0.3118**	**0.3176**
L.S.D.	A=0.010	B=0.005	AB=0.011		A=0.009	B=0.0005	AB=0.010		A=0.008	B=0.004	AB=0.009	

FYM= Farmyard manure, PM=Poultry manure, SM=Sheep manure, A=Active dry yeast,
B=organic manures, AB=Interaction effects

Moreover, the active dry yeast combined with NPK-chemical fertilizers or organic manures resulted in better chlorophyll a, b and caroteniods contents than the control. The most effective treatments that gave the highest chlorophyll a, b and caroteniods contents were active dry yeast at the rates of 2 and 4 g/L combined with poultry manure, which surpassed other combinations. These results are in agreement with **Mohamed (2005)** .

3.2.4. Leaf N, P and K contents:

The obtained results in Table (8) showed that leaf N, P and K contents were significantly increased due to applied active dry yeast as foliar spray.

There was insignificant effect for applied rates of 2 and 4 g/L active dry yeast on leaf N, P and K contents. In addition, application of NPK-chemical fertilizers significantly increased leaf contents of N, P and K % as compared to the control at the three cuts of both seasons. The applied NPK-mineral surpassed the farmyard & sheep manures by (6.33 & 16.17 %), (6.32 & 18.95 %) and (6.72 & 19.74 %) for N %; (16.58 & 31.90 %), (20.00 & 36.17 %) and (24.58 & 48.48 %) for P % and (8.86 & 16.16 %), (8.83 & 17.88 %) and (8.19 & 18.16 %) for K % at the cuts, respectively. These results are in line with those obtained b**y El-Yazal Sawsan and Somida (2007)** and **Osman and El-Sawah (2009)** .

Also, leaf contents of N, P and K significantly increased by the fertilization *Origanum majorana L*. plants with organic manures, especially poultry wastes that gave the greatest leaf nutrient contents as compared to farmyard and sheep manures for the three cuts during both tested seasons. In the meantime both poultry manure and NPK-chemical fertilizers were statistically similar for producing a significant leaf mineral content of N, P and K in the three cuts. So, from the healthy and economical sides the greatest leaf contents of N, P and K were obtained when *Origanum majorana* L. plants were fertilized with poultry manure at the rate 20 m^3/fed. These results are in line with those obtained by **El-Ghadban (1998)**. Data in Table (8) show that active dry yeast spray in combination with NPK-chemical fertilizers or poultry manure resulted in greater

contents of N, P and K than other combined ones in the three cuts. The most effective treatment that showed the greatest leaf content of N, P and K was (active dry yeast as foliar spray in combination with the poultry manure), which surpassed all other combined ones in the three cuts. These results are in partial agreement with **El-Nemr *etat*., (2011)** .

Table (8): Effect of active dry yeast, NPK-chemical fertilizers and organic manures on nitrogen, phosphorus and potassium % of *Majorana marjoram* L. (as an average of the tested two seasons).

Treat-ment	Nitrogen %				Phosphorus %				Potassium %			
	Rate of foliar spray with active dry yeast (g L^{-1})											
	0	1	2	4	0	1	2	4	0	1	2	4
First cut												
Control	1.855	1.845	1.875	1.887	0.113	0.128	0.147	0.160	2.203	2.252	2.321	2.333
NPK	2.329	2.353	2.424	2.437	0.184	0.209	0.227	0.242	2.620	2.645	2.838	2.851
FYM	2.177	2.195	2.294	2.308	0.151	0.176	0.197	0.213	2.456	2.481	2.555	2.569
PM	2.335	2.364	2.436	2.541	0.185	0.210	0.229	0.335	2.637	2.662	2.841	2.945
SM	1.899	1.922	2.191	2.203	0.133	0.158	0.177	0.187	2.293	2.330	2.397	2.409
	2.0846	**2.1078**	**2.1888**	**2.2204**	**0.1342**	**0.1564**	**0.172**	**0.2032**	**2.4018**	**2.4452**	**2.5558**	**2.5872**
L.S.D.	A=0.041	B=0.022	AB=0.044		A=0.035	B=0.018	AB=0.036		A=0.034	B=0.018	AB=0.036	
Second cut												
Control	1.799	1.815	1.823	1.835	0.103	0.114	0.123	0.135	2.185	2.242	2.281	2.293
NPK	2.302	2.327	2.387	2.402	0.164	0.189	0.201	0.214	2.592	2.617	2.807	2.821
FYM	2.142	2.167	2.267	2.281	0.128	0.153	0.174	0.188	2.432	2.457	2.527	2.541
PM	2.308	2.333	2.399	2.504	0.166	0.191	0.208	0.313	2.598	2.623	2.817	2.922
SM	1.872	1.897	2.068	2.080	0.110	0.135	0.154	0.166	2.202	2.287	2.347	2.359
	2.0846	**2.1078**	**2.1888**	**2.2204**	**0.1342**	**0.1564**	**0.172**	**0.2032**	**2.4018**	**2.4452**	**2.5558**	**2.5872**
L.S.D.	A=0.033	B=0.018	AB=0.036		A=0.032	B=0.017	AB=0.034		A=0.033	B=0.017	AB=0.034	
Third cut												
Control	1.754	1.785	1.801	1.812	0.099	0.105	0.113	0.125	2.142	2.165	2.179	2.194
NPK	2.213	2.238	2.308	2.320	0.122	0.147	0.154	0.167	2.532	2.557	2.759	2.773
FYM	2.054	2.079	2.179	2.192	0.086	0.111	0.132	0.146	2.394	2.419	2.495	2.508
PM	2.216	2.241	2.312	2.416	0.129	0.154	0.156	0.261	2.538	2.563	2.762	2.865
SM	1.788	1.813	1.984	1.995	0.068	0.093	0.112	0.124	2.162	2.187	2.315	2.327
	2.005	**2.0312**	**2.1168**	**2.147**	**0.1008**	**0.122**	**0.1334**	**0.1646**	**2.3536**	**2.3782**	**2.502**	**2.5334**
L.S.D.	A=0.030	B=0.016	AB=0.032		A=0.035	B=0.018	AB=0.036		A=0.032	B=0.016	AB=0.032	

FYM= Farmyard manure, PM=Poultry manure, SM=Sheep manure, A=Active dry yeast,
B=organic manures, AB=Interaction effects

3.2.5. Leaf content of Fe and Zn :

Data in Table (9) indicate that the application of active dry yeast as foliar spray significantly increased leaf Fe and Zn contents as compared to the untreated plants in the three cuts of the two seasons. In the meantime, the highest rate of 4 g /L of active dry yeast result in greater Fe and Zn contents than other treatments in the three cuts of the two tested seasons. Also, NPK-chemical fertilizers significantly increased leaf content of Fe and Zn as compared to the untreated plants, with nonsignificant differences between the applied treatments of NPK-mineral, farmyard and sheep manures on leaf content of Fe and Zn as compared to the control plants in the three cuts, as shown in Table (9). These results agree with those obtained by **Mohamed (2005)** .

It is worthy to mention that all organic manures used in this study significantly increased leaf Fe and Zn contents as compared to the control plants in the three cuts. However, application of poultry manure at the rate 20 m^3/fed significantly increased leaf Fe and Zn contents in comparison with all treatments in the three cuts of both seasons. These results are in line with the findings reported by **El-Ghadban (1998)**. The interaction between active dry yeast as foliar spray and NPK-chemical fertilizers or organic fertilization resulted in significant increase in leaf content of Fe and Zn as compared to the control plants in the three cuts of both seasons. The most effective treatment

that gave the greatest values of Fe and Zn contents in plants was the treatment (active dry yeast at the rate 4 g/L in combination with poultry manure) for the three cuts of both seasons. Similar results were obtained by **Mohamed (2005)** .

Table (9): Effect of active dry yeast, NPK-chemical fertilizer and organic manures on iron, zinc and total carbohydrates of *Majorana marjoram* L. (as an average of the tested two seasons).

Treat-ment	Leaf content of Fe (mg g^{-1})				Leaf content of Zn (mg g^{-1})				Leaf content of total carbohydrates %			
	Rate of foliar spray with active dry yeast (g L^{-1})											
	0	1	2	4	0	1	2	4	0	1	2	4
First cut												
Control	0.321	0.346	0.366	0.379	0.189	0.196	0.206	0.217	7.552	7.625	7.685	7.697
NPK	0.440	0.485	0.520	0.553	0.216	0.220	0.224	0.237	8.293	8.309	8.316	8.329
FYM	0.378	0.423	0.458	0.492	0.206	0.210	0.214	0.228	8.120	8.150	8.181	8.195
PM	0.444	0.489	0.534	0.599	0.218	0.222	0.226	0.331	8.288	8.301	8.315	8.425
SM	0.398	0.443	0.478	0.516	0.209	0.213	0.217	0.229	7.979	8.045	8.111	8.123
	0.3962	**0.4372**	**0.4712**	**0.5078**	**0.2076**	**0.2122**	**0.2174**	**0.2484**	**8.0464**	**8.086**	**8.1216**	**8.1538**
L.S.D.	A=0.030	B=0.016	AB=0.032		A=0.022	B=0.012	AB=0.024		A=0.039	B=0.020	AB=0.041	
Second cut												
Control	0.270	0.302	0.319	0.331	0.175	0.185	0.200	0.212	7.451	7.532	7.612	7.624
NPK	0.356	0.401	0.446	0.459	0.208	0.212	0.216	0.229	8.261	8.271	8.288	8.301
FYM	0.294	0.339	0.384	0.399	0.198	0.202	0.206	0.224	8.092	8.122	8.153	8.167
PM	0.360	0.405	0.450	0.554	0.210	0.214	0.218	0.324	8.265	8.284	8.297	8.402
SM	0.314	0.359	0.404	0.416	0.201	0.205	0.209	0.221	7.951	8.017	8.083	8.095
	0.3188	**0.3612**	**0.4006**	**0.4318**	**0.1984**	**0.2036**	**0.2098**	**0.242**	**8.004**	**8.0452**	**8.0866**	**8.1178**
L.S.D.	A=0.029	B=0.016	AB=0.031		A=0.020	B=0.011	AB=0.022		A=0.037	B=0.019	AB=0.039	
Third cut												
Control	0.212	0.257	0.302	0.314	0.170	0.178	0.188	0.202	6.745	6.825	6.885	6.897
NPK	0.274	0.319	0.364	0.377	0.200	0.208	0.212	0.225	7.248	7.322	7.429	7.440
FYM	0.232	0.277	0.322	0.336	0.191	0.195	0.201	0.215	7.157	7.300	7.342	7.412
PM	0.278	0.323	0.368	0.474	0.201	0.209	0.213	0.319	7.296	7.319	7.468	7.487
SM	0.270	0.302	0.319	0.331	0.192	0.199	0.204	0.216	7.015	7.193	7.254	7.295
	0.2532	**0.2956**	**0.335**	**0.3664**	**0.1908**	**0.1978**	**0.2036**	**0.2354**	**7.0922**	**7.1918**	**7.2756**	**7.3062**
L.S.D.	A=0.027	B=0.014	AB=0.029		A=0.018	B=0. 010	AB=0.020		A=0.036	B=0.019	AB=0.038	

FYM= Farmyard manure, PM=Poultry manure, SM=Sheep manure, A=Active dry yeast, B=organic manures, AB=Interaction effects

3.2.6. Total content of carbohydrates:

Data in Table (9) clearly showed that total content of carbohydrates gradually increased as a result of increasing the rate of applied active dry yeast, however, the maximum increases in total carbohydrates were obtained at the rates of 2 and 4 g/L. There was nonsignificant differences between both applied rates 2 and 4 g/L of active dry yeast on the total carbohydrates content as compared to the other treatments. Also, data in Table (9) show that total carbohydrates content significant increased due to applied NPK-chemical fertilizers as compared to the control, farmyard and sheep manures. In addition, Application of organic manures caused a significant increase in total carbohydrates content as compared to the control, as shown in Table (9). The increase in such constituent was more pronounced in case of poultry manure than farmyard and sheep manures. These results are in line with those obtained by **Mohamed (2006)** and **El -Yazal Sawsan and Somida (2007**).

Moreover, the obtained data revealed that the active dry yeast as foliar spray application combined with NPK-mineral or organic manure resulted in the best total carbohydrates content than the control in the three cuts of both seasons. The most effective treatment that showed the greatest total carbohydrates content was the application of (active dry yeast combined with poultry manure),

which surpassed other combined ones in both cuts. These results are in agreement with those obtained by **Mohamed (2005)** .

In conclusion, it could be recommended that usage of combined treatment (active dry yeast as foliar spray + poultry manure at a rate of 20 m^3/fed) was the best in the production of *Origanum majorana L.* This treatment resulted in good growth parameters and highest content of volatile oil. This could reduce the hazard of contamination with chemical fertilizers.

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