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EFFECT OF ORGANIC FERTILIZER AND BIOFERTILIZATION ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF MARJORAM PLANTS UNDER NEWLY RECLAIMED SOIL CONDITIONS

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ABSTRACT

Two pot experiments were carried out during two successive seasons 2000 and 2001 to investigate the effect of organic fertilizer (compost) at three rates; 2.5,5 and 7.5 ton/fed. with or without inoculation with mixture of biofertilizers (namely; *Azotobacter chroococcum*; *Azospirillum brasilense* and *Bacillus polymyxa*) compared with the recommended dose of NPK (control) on growth, yield and chemical composition of marjoram plants. Data obtained clearly revealed that plants treated with the highest level of compost (7.5 ton /fed.) either alone or combination of biofertilizers recorded a considerable increments with regard to growth characters, macronutrients, phytohormones;(IAA, GA3, and CK) and essential oil components; (α-terpineol, α-terpenolene, Linalool, Geraniol, Cineole, Linalyl acetate and Citronellol). In addition, the correlative significant increases attained 15.8, 19.9 and 14.4% for herb fresh weight (g/plant) and 19.8 , 16.9 and 14.7% for herb dry weight (g/plant) in first , second and third cuts, respectively , as well as in both essential oil percentage (26%) and oil yield/plant (52%) in fresh herb at the highest compost level as compared to the control treatment. Also, marjoram plants which received the highest level of compost in combination with biofertilizers mixture significantly supposed the control plants in herb fresh weight (g/plant) by 22.1 ,29.1 and 32.1% and herb dry weight (g/plant) by 25, 32.6 and 40% in first , second and third cuts , respectively, as well as the essential oil percentage by 38% and oil yield per plant by 79% .On the other hand , the present data disclosed that nearly the same marjoram fresh and dry weight (g/plant) as well as essential oil percentage and oil yield per plant of the control plant could be obtained if marjoram plants receiving the lowest and moderate amount of compost fertilizer alone or combined with inoculation of biofertilizers mixture. These findings clearly indicate that organic fertilizer and biofertilizers could be used as an effective tools completely replacing of the applied chemical fertilizers and consequently minimize the pollution of the agricultural environment.

Keywords : biofertilizer, marjoram, organic fertilizer

INTRODUCTION

Medicinal plants occupy a prominent position, because of the increasing demand of the local industry and export. In order to cover such increase, an increasing interest in the cultivation of medicinal and aromatic plants has been shown in Egypt. Recently, a considerable attention has been directed in the newly reclaimed lands to improve the growth and the yield of various aromatic and medicinal plants.

Marjoram plants (*Origanum majorana* H. or *Majorana hortensis* L.) is considered as an, important medicinal crop in Egypt with high production and great applications. The air dried leaves and flowering tops are used as condiment for seasoning soups dressing, sties, poultry and sausage. It is also used as a stimulating in tooth pastes, whooping cough and larynx infections.

In the recent years, the safe agriculture is one of the main attitudes in the world (El-Kouny, 2002). Also, recently there has been an increasing awareness of the undesirable impact of mineral fertilizers on the environment, as well as the potentially dangerous effects of chemical residues in plant tissues on the health of human and animal consumers. As a result of this awareness, strict regulations and restrictions have been imposed in several countries (especially in the European markets) prohibiting the import of "chemically-grown" products. This has led growers of medicinal and aromatic plants in many countries to adopt organic and biological agricultural methods (for fertilization, pest controls, ... etc).

Composting of agricultural residues by supplying the natural microbial flora present on them with their requirements of inorganic nutrients such as nitrogen and phosphorous and by applying a proper moistening and turning, resulted in a final product with high ability to improve soils and enhance plant growth reported by Lampkin (1990), Abdel-Wahab (1999), Mohamed and Matter (2001) and Badran (2002). Moreover, compost with its content of humic substances and microbial materials, has been shown to improve soil physical, chemical and microbiological conditions, moisture content, and reduce leaching of nutrients, water run-off and soil erosion (Amin *et al.* 1999).

Over the last, two decades, the biofertilizers are increasingly used in modern agriculture due to the extensive knowledge in rhizosphere biology and the discovery of the promotive function of special groups of microorganisms such as *Azospirillum, Azotobacter, Acetobacter Bacillus, Serratia* and *Pseudomonas* known as plant growth promoting rhizobacteria (PGPR). They appear to be frequent colonizers of important medicinal crops including Ammi visnaga, Lemongrass and Palmarorsa (Masheshwari *et al.*, 1995, El-Sawy *et al.* 1998 and Harridy *et al.*, 2001).Such beneficial effects of these plant growth promoting rhizobacteria (PGPR) could be attributed to the biological nitrogen fixation and production of phytohormones (gibberellins and cytokinins like substances as well as auxins) that promote root development and proliferation, resulting in efficient uptake of water and nutrients (Tien *et al.*, 1979, Hartmann *et al.*, 1983 and Haahtela *et al.*, 1990).

The beneficial effects of rhizobacteria on medicinal crops recently increased due to their potential use as biofertilizers (Okon and Labandera-Gonzalez, 1994 and Kumar *et al.*, 1998). Thus, the extensive researches in this field strongly indicated that application of bacterial inoculants as biofertilizers resulted in improvement of growth and productivity for medicinal crops, in addition to the reduction of their N-requirements to 50% of the recommended dose Harridy and Mervat (1998). Therefore, the aim of the present study was to investigate the effects of compost solely or combined with inoculation mixture of biofertilizers. i.e. *Azotobacter chroococcum, Azospirillum brasilense* and *Bacillus polymyxa* on the growth, oil yield and chemical composition of marjoram plants and to compare this effects with that of recommended NPK fertilization.

MATERIALS AND METHODS

Two pot experiments were conducted in the Medicinal and Aromatic plant Research Department, Dokki, Horticulture Research Institute (HRI), Agricultural Research Center (ARC) during the two successive seasons 2000 and 2001. In both experiments, marjoram seedlings (12-15 cm in height, with 10-12 leaves) were planted on the 20th of March, 2000 in the first season and on the 14th of March, 2001 in the second one in pots of 30 cm. in diameter filled with sandy soil (Obtained from the shabrament area, Giza). Some physical and chemical properties of the soil under study in both seasons before planting were shown in Table (1).

Table (1): Some physical and chemical properties of experimental soil.

Parameter	Value
Sand (%)	86.4
Silt (%)	7.2
Clay (%)	6.1
Texture grade	**Sandy**
pH (soil paste)	7.6
EC (dS/m at 25°C)	0.37
Cations (meq / L)	
Ca^{++}	0.94
Mg^{++}	0.53
Na^{+}	0.59
K^{+}	0.28
Anions (meq /L)	
$CO^{=}_3$	0.00
HCO^{-}_3	1.41
Cl^{-}	0.29
$SO^{=}_4$	0.65
Total-N (%)	0.030
Organic-C (%)	0.37

The marjoram seeds had been sown in outdoor nursery beds with a sandy soil, where they germinated within 7-10 days. Marjoram seedling [50-60 days after germination] were obtained from the Experimental Station of the Horticulture Research Institute in South Al-Tahrir.

The plants were given the recommended agronomic management, except fertilization. Both two pot experiments during the two successivseasons included seven treatments with four replicates as follows :

1) *R.Q.F. (control).
2) Compost at rate of 25 g/pot (equivalent to 2.5 ton/fed).. C_1.
3) Compost at rate of 50 g/pot (equivalent to 5 ton/fed).. C_2.
4) Compost at rate of 75 g/pot (equivalent to 7.5 ton/fed).. C_3.
5) C_1 + *Mixture of biofertilizers (C_1 + Bio).
6) C_2 + Mixture of biofertilizers (C_2+Bio).
7) C_3 + Mixture of biofertilizers (C_3 + Bio).

Where:

*R.Q.F.= The recommended quantities of NPK fertilizer which are 200 kg/fed. ammonium sulphate (20.5%N); 150 kg/fed. calcium superphosphate (15.5% P_2O_5) and 50 kg/fed potassium sulfate (48% K_2O). feddan= 4200m^2.

*Mixture of biofertilizers = *Azotobacter chroococcum; Azospirillum brasilense* and *Bacillus polymyxa*.

These treatments were distributed in complete randomized blocks design according to Gomez and Gomez (1984).

Three bacterial cultures contains 1x10^8 CFU/ml from each of *Bacillus polymyxa*; *Azospirillum brasilense* and *Azotobacter chroococcum* were prepared individually in Biofertilizer unit, soils, water and Environ. Res. Inst., Dept. of Microbiology (A.R.C.). Then, they are mixed together in liquid form at equal portions. Roots of marjoram seedlings were dipped into the mixture of biofertilizers immediately before planting. And then this mixture was added to plant rhizosphere at rate of 10 ml per pot for inoculated treatments (5, 6 and 7) at 30 and 60 days after planting.

The compost used (prepared from poultry manure and agricultural residues) was obtained from Soils, Water and Environ. Res. Instit., ARC. The main characteristics of the compost was shown in Table (2).

The compost and NPK fertilization treatments were divided into two doses. The first dose from compost was incorporated with the potting medium two weeks before planting, while the first dose of NPK was added two weeks after planting. The second dose from NPK and compost were applied before the first cut by two weeks (75 days from planting).

In each season, three cuts (samples) were taken from the plants at 90, 150 and 210 days after planting by cutting the vegetative parts of all plants 5 cm. above the soil surface. In each sample, plant height, number of branches/plant; and herb fresh and dry weight/plant were recorded. In addition , soil samples were collected after marjoram harvesting from each treatment , then air dried and analyzed for organic – C, total –N, dehydrogenase activity, CO_2 evolution and available phosphorus.

The mean values of growth in both seasons were statistically analyzed and the means were compared using L.S.D. values at 5% level (Gomez and Gomez, 1984).

Table (2): Chemical analysis of compost in both seasons.

Property	Value
PH (1:5)	8.11
EC (1:5 extract) dS/m	8.21
Organic-C%	12.54
Organic matter %	21.57
Total-N%	1.41
C/N ratio	8.89
Total-P%	1.19
N-NH^+_4 (ppm)	274.7
N-NO^-_3 (ppm)	33.1
Total counts of bacteria	$2.5X10^7$
Total counts of fungi	$7X10^5$
Total counts of actinomycetes	$3.5X10^5$
Phosphate dissolving bacteria	$2X10^6$
Dehydrogenase activity (mg TPF/100g)	32.5
Nitrogenase activity (nmol C_2H_4/g/hr)	123.6
E_4/E_6 (aqueous extract 1:10)	3.64
Seed germination test for cress seeds after 48 hr. (%)	79.5

Analysis :

Soil: Mechanical and chemical analysis of soil before planting was carried out according to Black *et al.* (1965). Biological and chemical properties of soil after planting was determined according to Page *et al.* (1982).

Compost: All chemical and microbiological characteristics of compost were executed according to page *et al.* (1982).

Plant: Total N,P and K in marjoram shoot were determined using wet digestion by mixture from pure $HClO_4$ and H_2SO_4 at ratio 1:1 according to Jackson (1973).

Freeze-dried marjoram leaves (equivalent 6 g F.W.) were ground to a fine powder with a mortar and pestle. The powdered material was extracted three times (1 x 3 h. 2 x 1 h) with methanol (80% v/v, 10 ml./g F.W.), supplemented with butylated hydroxy toluene (2. (6)-Di-tret-Butyl-P-cresol) as an antioxidant, at 4? C in darkness. The extract was centrifuged at 4000 rpm. The supernatant was transferred into flasks wrapped with aluminum foil and the residue was again twice extracted. The supernatants were combined and the volume was reduced to 10 ml at 35? C under vacuum. The aqueous extract was adjusted to pH 8.6 and extracted three times with an equal volume of pure ethyl acetate. The combined alkaline ethyl acetate extract was dehydrated over anhydrous sodium sulphate then filtered. The filtrate was evaporated to dryness under vacuum at 35? C and redissolved in 1 ml absolute methanol. The methanol extract was used after methylation according to Plamer *et al.* (1981) for the determination of cytokinins. The remaining aqueous extract was acidified to pH 2.6 and extracted as previously described by ethyl acetate. The methanol extract was used after methylation according to Fales and Jaouni (1973) for determination of gibberalic acid (GA) and indole-acetic acid (IAA). The quantification of the endogenous phytohormones was carried out with Ati-Unicum gas-liquid chromatography, 610 Series, equipped with flame ionization detector according to the method described by Vogel (1975). The fractionation of phytohormones was conducted using a coiled glass column (1.5 m x 4 mm.) packed with 1% OV-17. Gases flow rates were 30, 30,330 ml/min., for nitrogen, hydrogen and air, respectively. For cytokinins fractionation, the temperatures were for injector 260? C, detector 300? C and column initially for 3 min. at 220? C then programmed at 20? C/min. for 220? C to 240? C. then isothermally at 240? C for 8 min. For IAA and GA, the initial column temperature was 200? C for 3 min. then programmed at 20? C/min. for 200? C to 220? C, then isothermally at 220? C for 4 min, then programmed at 20? C/min. for 220 to 240? C, then isothermally at 240? C for 6 min. The peaks identification and quantification of phytohormones were performed by using external authentic hormones and a Microsoft program to calculate the concentrations of the identified peaks.

The oil percentage was determined in the fresh herb using the method described by the British Pharmacopoeia (1963), and the essential oil yield per plant was calculated in proportion to the herb fresh weight (Oil yield/plant = plant fresh weight x oil percentage).

Chemical analysis for essential oil was conducted by using Ati-Unicum gas liquid chromatography (GLC), 610 series, to determine their main constituents as described by Bunzen *et al.*, (1969) and Hoftman (1967).

It is to be mentioned here that, the average values of the various characters determined in the two successive seasons were only tabulated and discussed in the present investigation.

RESULTS AND DISCUSSION

Growth characters

Growth characters in all cuts of marjoram plants were influenced by compost treatments at different levels either alone or combination with mixture of biofertilizer (Table 3).

In general, results indicated that all growth characters in all cuts significantly increased at the highest compost level (7.5 ton/fed.) as compared to the plants receivingthe recommended dose of NPK. These increments attained, 15.8, 19.9 and 14.4% for herb fresh weight (g/plant) and 19.8, 16.9 and 14.7% for herb dry weight (g/plant) in first, second and third cuts, respectively, as compared to the control. It is worth to mention that the other combination treatments altering showed positive effect on growth characters, but they did reached to the level of significancy.

This positive effect of compost may be due to its high nutritional value and its role in the improvement of physical, chemical and biological properties of soil under investigation. These results are coincide with those obtained by Abd El-Moez *et al.* (1999), Abd El-Moez and Saleh (1999), Mansour *et al.* (1999), Mohamed & Matter (2001) and Harridy *et al.* (2001).

When the different doses of compost fertilizer were associated in combination with biofertilizer mixture, positive responses in all growth characters; *i.e.* plant height, number of branches/plant and both of herb fresh and dry weight (g/plant) in all cuts were recorded against control. Under the highest combination level of compost and biofertilizer mixture(plants receiving 7.5 ton/fed compost with inoculated by bioferilizer mixture), such positive responses recorded significant increments over all other treatments in all cuts. These increments attained (22.1,29.1 and 32.1%) for herb fresh weight, and (25, 32.6 and 40%) for herb dry weight) in first, second and third cuts, respectively, as compared to the control. also, it is be mentioned here that, the positive effects of the other combination treatments on all studied growth characters failed to reach the 0.05 level of significance.

The favorable effects of the combination between compost fertilizer and biofertilizers may be explained on the basis of the beneficial effects of bacteria on the nutrient availability, vital enzymes, hormonal stimulating effects on plant growth or the increasing of photosynthetic activity (Bashan and Levanony; 1990 ; Jlick, 1995; Ghallab and Salem, 2001).

3.2 Chemical analysis

The effect of different treatments on the essential oil percentage (mL/100 g. F.W herb.); oil yield/plant; concentrations of N,P,K, IAA, GA_3 and CK in the shoots of marjoram plants grown in the second season (Table 4) were similar to those recorded for growth parameters.

Table (3): Biological yielding of marjoram plants as affected by different levels of compost alone or in combination with biofertilizer (combined analysis for two seasons).

Growth characters	Plant height (cm)			No. of branches /plant			Herb fresh weight (g/plant)				Herb dry weight (g/plant)			
Cuts / Treatments	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	Total fresh weight (g/plant	1st	2nd	3rd	Total dry weight (g/plant)
Control (NPK)	15.58	20.17	27.23	13.72	18.43	21.51	11.61	14.14	19.50	45.25	3.35	7.31	11.90	22.56
C_1 (2.5 ton/fed)	14.89	18.99	25.96	12.85	17.29	20.25	10.51	12.81	17.89	41.21	4.55	6.71	10.73	21.99
C_2 (5 ton/fed)	15.15	19.48	26.35	13.11	17.95	21.11	11.21	13.24	18.18	42.63	4.89	7.01	11.24	23.14
C_3 (7.5 ton/fed)	16.95	21.55	28.88	14.89	19.79	23.42	13.45	18.95	22.31	54.71	6.41	8.55	13.65	38.61
C_1 + MB	16.21	20.98	27.91	14.39	19.23	22.17	12.89	15.43	20.85	49.17	5.99	7.91	12.64	26.54
C_2 + MB	16.52	21.31	28.45	14.72	19.65	22.85	13.01	16.05	21.11	50.17	6.18	8.11	13.01	27.30
C_3 + MB	18.85	26.25	37.58	17.56	24.89	30.33	14.18	18.26	25.75	58.19	6.69	9.69	16.66	33.04
L.S.D. 0.05	0.97	1.25	1.37	1.13	1.37	1.46	1.88	1.98	2.01	3.45	1.01	1.19	1.27	2.86

C= Compost MB= Mixture of biofertilizers

The data clearly show the correlative significant increases in both essential oil percentage (26%) and oil yield/plant (52%) in fresh herb at the highest compost level as compared to the control treatment. On the other hand insignificant differences were detected between the other levels of compost (2.5 and 5 ton/fed.) and the control.

Marjoram plants which received the highest level of compost in combination with biofertilizer mixture significantly surpassed the control plants in the essential oil percentage by (38%) and oil yield per plant by (79%), mean while, the positive effect of the other combination treatments on oil yield per plant and the essential oil percentage was insignificant. Similar trend was also observed with macro nutrients and phytohormones. These results are in agreement with those obtained by Jacoub (1999) on *Ocimum basillicum L.* and *Thymus vulgaris L.* plants and Monsour *et al.* (1999) on spearmints and marjoram plants. The effect of compost on increasing the volatile oil percentage of shoots might be attributed to their enhancing effect on vegetative growth, in terms of the fresh yield and increasing the uptake of nutrient by roots of plant especially phosphorus element (P element is a main constituent of phospholipids, phosphoroteins, nucleic acid and coenzymes. However, the most important compound in which phosphate groups one linked by pyrophosphate bonds is adenosine triphosphate (ATP). The energy absorbed during photosynthesis or released during respiration is utilized in the synthesis of the pyrophosphate bonds in adenosine triphosphate (ATP). In this form, the energy can by conveyed to various undergoing processes such as activation uptake and the synthesis of various organic compounds such as volatile oils. Similar results were recorded by Mohamed and Matter (2001) on marigold plants.

Table (4): Chemical parameters in the shoots of marjoram plant as affected by different levels of compost or in combination with biofertilizer.

Chemical parameters	Oil % (ml/100g F.Wt.)	Oil yield (ml/plant)	N (mg/g D.w.)	P (mg/g Dw.)	K (mg/g D.w.)	IAA (µg/g F.w.)	GA3 (µg/g Fw.)	CK (µg/g Fw.)
Control	0.34	0.048	28.75	3.99	29.89	10.66	8.95	7.69
C1 (2.5 ton/fed.)	0.29	0.042	26.55	2.81	27.33	9.53	7.76	6.53
C2 (5 ton/fed.)	0.31	0.044	27.19	3.34	28.72	9.85	7.95	6.71
C3 (7.5 ton/fed.)	0.43	0.073	28.21	3.75	29.11	10.19	8.49	7.02
C1 + MB	0.36	0.056	29.31	4.18	31.42	11.05	9.53	8.25
C1 + MB	0.39	0.063	30.36	4.79	32.11	11.67	9.86	8.67
C1 + MB	0.47	0.086	40.83	5.28	34.42	13.79	10.74	9.45
L.S.D. 0.05	0.06	0.017	N.S	N.S	N.S	N.S	N.S	N.S

C = Compost ; MB = Mixture of biofertilizer N.S = insignificant differences
IAA = Indole-3 acetic acid GA_3= Gibberelic acid CK = Cytokinins
D.w, F.w = Dry and fresh weight, respectively.

Increasing N, P and K concentrations by compost fertilization may be due to increased plant capacity to absorb nutrients. This might be attributed to the increase in root surface per unit of soil volume, as well as, the high capacity of the plants supplied with compost fertilizer in building metabolites, which in turn contribute much to the increase of nutrient uptake (Abd El-Moez *et al.*, 1999).

The promotive effects of the combination between compost fertilizer and biofertilization on the oil yield per plant and the percentage of essential oil might attributed to their enhancing effect on vegetative growth. These results are accordance with those obtained by both Masheshwari *et al.*, (1995) on palmarost plants and Harridy *et al.* (2001), who found an increase in oil of lemongrass plants inoculated with *Azotobacter* 0.0 NPK.

In general, the present investigation showed that application of compost at any rate, but in combination with mixture of biofertilizers led to synergistic effect on micronutrients accumulation, if compared with their corresponding control (without biofertilizers), but the maximum benefits was obtained from the highest level of compost and biofertilizers which surpassed all other treatments. This means that the inoculation of marjoram plants resulted in a promotive effect on root development and consequently their function in the uptake of both water and nutrients. Similar results were reported by Harridy *et al.* (2001) on lemongrass and Hanafy Ahmed *et al.*, (1999). Moreover, Omar *et al.* (1991) reported that inoculation with *Azospirllium* cultures stimulated the uptake and accumulation of the nutrients from the soil. Dashti *et al.* (1997) suggested that the promotive mechanism of growth and nitrogen fixation induced by plant growth promoting rhizobacteria (PGPR) included both direct and indirect effects. The direct effects include an increase in the mobilization of insoluble nutrients followed by enhancement uptake by soybean plants and production of plant growth regulators that stimulate plant growth. The indirect effects include positive effects on symbiotic nitrogen fixation by enhancement of root nodule number or mass. More supportive evidences for the obtained results were found in the work of Ghallab and Salem (2001), who found that mixture of *Azospirllium and Serratia* inoculation greatly enhanced the uptake of N, P,K and Fe, as well as, accumulation of these minerals in the wheat plants.

The promotive effects of the biofertilization especially the biofertilizer mixture with the compost at 7.5 ton/fed. on phytohormons may be attributed to the production of growth promotive substance from rhizospheric microorganisms such as IAA and GA_3 (Ghulam *et al.*, 1998). In fact, application of external hormones either synthetic or purified from bacterial culture to plants has a promotive effects on root development and morphology (Kucey, 1988 and Fallik *et al.*, 1989).

Mohamed and Amera (2000) concluded that tomato inoculation with *Bacillus spp.* and *Pseudomonas* isolates alone or in combination with NPK rates enhanced fruit weight, total yield and its quality. Saleh *et al.*, (2001) and Ghallab and Salem (2001) found that wheat plants fertilwith the recommended dose of nitrogen (100 kg N/fed.) and those which received 50% of the recommended nitrogen dose combined with *Azospirllium* inoculation, recorded highly significant increases in dry weight, grain yield and nitrogen content of shoots over the control plants.

Chemical composition of oil

Table (5) shows that the highest contents of ?-.terpineol (the main component), as well as that of some other important components; *i.e.* ?-terpenolene, linalool, geraniol, cineole, linalyl acetate and citronellol were obtained from plants fertilized with the highest level of compost in combination with biofertilizer mixture followed with compost at 7.5 ton/fed. and then lowest and moderate doses of compost in combination with biofertilizer mixture, compared to the control. This finding strongly confirm the previous conclusion drawn about essential oil percentage, oil yield and concentrations of macronutrient and phytohormones (Table 4). Also, almost no differences between the moderate compost level (5 ton/fed.) and the control. In contrast, the different fertilizer treatments generally decreased the contents of ?–pinene, ?-pinene, Limonene, terpinene-4-ol and ?–trepinyl acetate, compared to the control. The previous obtained results are in agreement with those obtained by Mansour *et al.* (1999) and Harridy *et al.*, (2001).

Soil properties after marjoram harvesting :

Changes in some soil properties as affected by organic and biofertilization are presented in Table (6). Results exhibited that application of compost tended to enhance the soil contents of nitrogen, phosphorus and organic matter. Moreover, the biological activity which indicated by dehydrogenase activity and CO_2 evolution were greatly increased due to compost addition. Increasing parameters indicating the great effects of organic materials on the biological activity of such new reclaimed soils which reflected by enhancing the dehydrogenase activity in correlation with carbon mineralization. These findings are in agreement with Wittling *et al.* (1995) and Goyal *et al.* (1999). In addition, most of the parameters increased with increasing the application rate of compost.

Application of biofertilizers displayed an increase in some soil parameters and not affect others, this in case of treatments received the lowest compost level and that not received compost. Moreover, at combination between high levels of compost and biofertilizers had clear effects on soil parameters under investigation.

Table (5): Effect of different levels of compost and combination between compost and biofertilizer on the essential oil components in *origanum majoranm* H. plant.

Components / Treatments	α-pinene	β-pinene	Limonene	Cineole	Linalool	α-terpineol	Terpinene-4-ol	Citronellol	Linalyl acetate	α-terpinyl acetale	Geraniol	α-terpenolene	Unidentified (U)
Conrol (NPK)	5.72	12.95	12.77	1.06	1.41	56.99	1.61	0.50	0.43	3.65	1.43	0.67	0.81
C_1(2.5 ton/ fed)	0.35	4.81	2.03	0.91	1.33	53.17	1.01	0.46	0.39	1.18	1.33	0.61	3.51
C_1 (5 ton/ fed)	1.19	5.85	2.45	0.99	1.39	55.86	1.15	0.49	0.41	1.36	1.41	0.65	4.99
C_1(7.5 ton/ fed)	1.42	6.40	4.16	1.51	1.91	65.61	1.49	0.91	0.95	2.29	1.84	1.94	10.51
C_1 + MB	1.39	5.43	2.98	1.16	1.16	58.85	1.43	0.59	0.74	2.02	1.61	1.11	14.24
C_2 + MB	1.46	6.71	3.14	1.23	1.79	60.18	1.46	0.75	0.85	2.17	1.78	1.28	15.35
C_3 + MB	2.23	7.54	7.67	1.90	2.03	73.49	1.55	1.21	1.67	2.47	1.98	3.31	16.71

C = Compost; MB = Mixture of biofertilizer

Table (6): Changes in soil properties after marjoranm harvesting.

Treat-ments	O.C %	O.M %	Total N %	Dehydrogen-ase Mg TPF/ 100 g soil	CO_2 – evolution mg/SOg soil	Available P (ppm)	C/N ratio
1st season							
NPK	0.45	0.77	0.031	67.7	32.3	13.4	14.5
C_1	0.79	1.36	0.046	134.4	42.6	15.8	17.2
C_1 + Inoc	6.67	1.15	0.047	141.7	48.4	21.2	14.3
C_2	0.67	1.15	0.044	351.0	69.6	22.1	15.20
C_2 + Inoc	0.97	1.67	0.046	252.7	67.5	19.5	21.1
C_3	0.91	1.57	0.067	318.1	64.6	21.6	14.7
C_3 + Inoc	0.89	1.53	0.054	327.5	71.9	22.5	16.5
2nd season							
NPK	0.45	0.77	0.031	59.4	36.3	15.3	14.5
C_1	0.79	1.36	0.044	203.1	40.3	20.4	18.0
C_1 + Inoc	0.73	1.26	0.048	193.4	59.8	19.4	15.2
C_2	0.71	1.22	0.049	240.1	56.8	23.6	14.5
C_2 + Inoc	0.99	1.70	0.051	285.5	56.4	18.5	19.4
C_3	0.91	1.57	0.071	292.8	70.7	20.7	12.8
C_3 + Inoc	1.01	1.74	0.061	306.3	65.3	19.3	16.6

In fact, the beneficial effects of biofertilizers in respect to soil properties may be interpreted by two reasons, first the beneficial effects of PGPR mainly exert on plant growth and rhizosphere. Second, the used compost has appreciable biological properties and high microbial population including used biofertilizers (Table 2). Such enriched organic materials may be used as PGPR in solid or liquid form (Brinton *et al*., 1996 and Alvarez *et al*., 1997).

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تأثير التسميد العضوى والتسميد الحيوى على النمو و المحصول و التركيب الكيماوى لنباتات البردقوش تحت ظروف الأراضى حديثة الاستصلاح

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تم إجراء تجربتين أصص خلال موسمي ٢٠٠٠ ، ٢٠٠١ لدراسة تأثير ثلاث معدلات من التسميد العضوى تشمل ٢,٥ ، ٥ ، ٧,٥طن / فدان مع أو بدون تلقيح خليط من التسميد الحيوي مقارنة بالمعدلات الموصى بها من التسميد النيتروجيني والفوسفاتي والبوتاسي (كتجربة مقارنة) علي النمو و المحصول و التركيب الكيماوي لنباتات البردقوش المنزرعة في التربة الرملية.

أظهرت النتائج أن معاملة نباتات البردقوش بالمستوي العالي من الكمبوست (٧,٥ طن / فدان) إما منفردا أو بالتلقيح مع خليط التسميد الحيوي سجلت زيادة كبيرة في قياسات صفات النمو النباتية (الأوكسينات و الجبريللينات و السيتوكينينيات) و المكونات الأساسية للزيت الطيار (الفا تربينول ، الفا تربينولين ، لينالول جيرانيول ، سيانول ، لينانيل اسيتات ، سيترونيلول).

وقد سجلت النباتات المعاملة بالمستوى العالي من الكمبوست زيادة معنوية في الوزن الغض للنبات متفوقة على نباتات المقارنة (المسمدة بالكميات الموصي بها من السماد الكيماوي فقط) بنسبة بلغت (١٥,٨ – ١٩,٩ – ١٤,٤ %) و كذلك الوزن الجاف للنبات بنسبة (١٩,٨ – ١٦,٩ – ١٤,٧ %) في الحشة الأولى و الثانية و الثالثة و أيضاً النسبة المئوية للزيت الطيار للنباتات الغضة (٢٦ %) و محصول الزيت للنباتات الغضة (٥٢ %) و أظهرت النتائج أيضا أن المعاملة بالمستوى العالي للكمبوست مختلطا بالتسميد الحيوي قد أدت إلى زيادة معنوية بلغت (٢٢,١ – ٢٩.١ – ٣٢,١ %) للوزن الغض للنبات و (٢٥ – ٣٢,٦ – ٤٠ %) للوزن الجاف للنبات في الحشة الأولى و الثانية و الثالثة على التوالي و بلغت نسبة الزيادة في الزيت الطيار للنبات الغض (٣٨ %) ونسبة الزيادة في محصول الزيت للنبات الغض (٧٩ %) بالمقارنة بتجربة المقارنة. و أمكن الحصول على محصول العشب الغض و الجاف و النسبة المئوية للزيت الطيار و محصول الزيت في النبات الغض بما يعادل الناتج من نباتات المقارنة دون نقص معنوي و ذلك بمعاملة النباتات بالمستوي المنخفض و المتوسط من الكمبوست (٢,٥–٥ طن/فدان) منفردا أو مختلطا بالسماد الحيوي.

وتشير النتائج إلى إمكانية الاستخدام الناجح للأسمدة الحيوية و العضوية (الكمبوست) كبديل فعال و آمن بدلا من الأسمدة الكيماوية دون أن تتأثر الصفات الكمية و النوعية للمحصول وهذا يؤدي إلى الحد من تكلفة الانتاج والحد من التلوث البيئي الناتج عن اضافة الأسمدة المعدنية للنباتات.