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EFFICACY OF SOME ORGANIC- AND BIO-FERTILIZERS ON GROWTH,YIELD AND ITS QUALITY OF SWEET BASIL (*Ocimum bailicum* L.) PLANTS.

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ABSTRACT

Two field experiments were conducted at the Experimental and Agric. Res. Center, Fac. of Agric., Mansoura University during the two growing seasons 2012/2013 and 2013/2014 aiming at testing the possibility of partly replacing the costly and hazardous chemical fertilizers with less costly and environment friendly organic and bio-fertilizers to satisfy the fertilizer requirements of Sweet basil (*Ocimum basilicum*) plants. Results indicated that organic and bio-fertilizers compensated for the omitted chemical fertilizers. With omission of half dose of chemical fertilizers, the best herb fresh and dry as well as essential oil yield were obtained when farmyard manure (FYM) at $30m^3$/fed was combined with the mixture of effective microorganisms (EM) bio-fertilizer. Essential oil quality was maximum under the fertilizer regime which combined FYM at $30m^3$/fed with microbein and half dose of the chemical fertilizer where linalool and methylchavicol percents were maximum. Based on the obtained results, it could be concluded that half dose of the chemical fertilizers requirements of sweet basil plants could be replaced by $30m^3$/fed FYM, preferably, in combination with EM bio-fertilizers to reduce production costs and at the same time maintain herb and essential oil yield as well as enhance essential oil quality.

Keyword: Sweet basil, *Ocimum basilicum*, Organic fertilizers, Biofertilizers, growth, yield.

INTRODUCTION

Medicinal and Aromatic plants play an important role in economic, social, cultural and ecological aspects of local communities all over the world. They can provide people with medicines to prevent or cure diseases and maintain health as safe, natural pharmaceutics. The genus *Ocimum* belongs to the family Laminaceae and is characterized by a great variability of both morphology and chemotypes(Lawrence,1988).*Ocimum basilicum* L. (basil or sweet basil) has the most economic importance and is cultivated and utilized throughout the world(Marotti *et al*.,1996). Traditionally, basil is a popular culinary herb used in food preparation and oral care products (Lachowicz *et al*., 1996; Machale *et al*.,1997), the volatile oil of the plants used in perfumery. Medicinally, basil is useful to care carminative, headache, coughs, warts, worms and kidney malfunction (Morales and Simon., 1996; Grayer *et al*.,1996).In addition, It is used an anti-microbial(Bozin *et al*., 2006), insecticidal (Bowers and Nishida., 1980;Serin and Ozguven., 1997), anti-inflammatory (Magalhaes *et al*.,2010), anti-carcinogenic (Lee, 2005) and anti-fungal(Dambolena *et al*., 2010). Farmyard manures improve soil properties through increasing moisture-holding capacity (Mayyard,1994) and positively

modulate soil chemical properties by lowering PH whereas increasing C/N ratio, cation exchange capacity hence facilitate ion uptake by plant roots. (Bvoungyeul *et al*.,1996),likewise organic manures contain high level of relatively available nutrients which stimulate plant growth and improve soil structure and biodiversity(Enwall *et al.,*2005; Birkhofera *et al*.,2008).Basil isa nutrients –highly demand plant, hence, its yield is dependent on the quality and quantity of soil fertilization. Chemical fertilizers cause serious environmental and health impacts. On the other hand, Bio-fertilizers which may be stuffed with bacteria, fungi or yeast not only provide the plants with essential macro and micro elements, but also improve the physical, chemical and biological characteristics of soil (El-Shafie and EL-Shika., 2003).In addition, via their enhancement of the plants microbial rhizosphere, they may stimulate plant growth through providing natural growth enhancers such as vitamins, aminoacids, auxins, cytokinins and gibberellins (El-Merich *et al*.,1997).

The present investigation aimed at testing the possibility of replacing environmentally hazardous chemical fertilizers with environment friendly bio and organic manures to maintain growth and productivity of sweet basil (*Ocimum basilicum* L.) plants.

MATERIALS AND METHODS

This study was conducted at the Experimental and Agric Research Center, Faculty of Agriculture, Mansoura University during two successive seasons, 2012/2013 and 2013/2014,aiming to study the effect of replacing half of the chemical fertilization requirements with either chemical fertilization (NPK),organic fertilizer (FYM) which consists of poultry and cattle manures (1:1), bio-fertilizers having different sources of nitrogen fixing bacteria (microbein) and modern fertilization (EM) solely or in combinations on vegetative growth, essential oil and chemical composition of sweet basil (*Ocimum basilicum* var. basilicum) plants.

Plant material and products:

Seeds of *Ocimum basilicum* var. basilicum were sown in the nursery on February 11th and the seedlings having 2-3pairs of leaves were transplanted on March 15th in the both seasons. Experimental area was divided into plots; every plot area was (3m *5m). Every plot contains 5 ridges with 60 cm apart. Every ridge contains 16 seedlings cultivated 30cm distance.

The soil:

Physical and chemical analyses of the experimental soil as well as the organic manure (FYM) during the two seasons was determined according to Jackson (1973) and presented in tables (1) and (2).

Table (1): Physical and chemical properties of the experimental soil in the two seasons of 2012/2013 and 2013/2014.

Soil texture	Clay (%)	Silt (%)	Sand (%)	Organic Matter (%)	PH	Available nutrients (ppm)					
						N	P	K	Zn	Fe	Mn
Clay	40.7	33.2	26.1	2.14	8.15	48.9	12.5	358	1.42	8.35	12.2
Loam	40.4	33.6	25.3	2.23	8.12	52.6	14.2	386	1.35	7.79	12.3

Table (2): Analytical data of the organic manures (poultry and cattle manure) during the two seasons 2012 and 2013.

Organic fertilizer / Parameters	Farmyard (FYM)			
	poultry manure		Cattle manure	
	1st season	2nd season	1st season	2nd season
Density(Kg/m^3)	332.00	340.00	265.00	260.00
Humidity (%)	6.90	8.70	7.60	8.00
Total nitrogen(%)	3.35	4.16	1.20	1.18
Ammonia (mg/kg)	10.10	9.30	1.17	1.27
Nitrate (mg/kg)	71.30	75.90	917.00	930.10
Total phosphorus (%)	0.49	0.73	0.39	0.68
Total potassium (%)	2.15	1.90	1.75	1.87
Organic matter (%)	45.34	30.76	45.19	39.47
Organic carbon (%)	43.12	31.32	27.95	22.95
C/N ratio	15.00/1.00	15.10/1.00	18.30/1.00	19.70/1.00
Fe (ppm)	834.20	854.90	973.60	988.30
Mn (ppm)	196.80	212.50	342.50	927.80
Cu (ppm)	50.10	41.20	42.90	43.00
Zn (ppm)	78.38	79.29	80.30	79.30

Chemical fertilization:

NPK was added at equal doses as a recommended dose of the Ministry of Agriculture for sweet basil plant.

Organic fertilizer material (FYM):

Organic fertilizer was a mixture of well-decayed poultry and cattle manure at (1:1 v: v). It was applied at the rates of 10, 20 and 30 m^3/fed in two doses, The first dose was added during the soil preparation, and the second one was applied after the first cut for the two seasons.

Bio-fertilizer material:

Microbein:

It is a commercial name of the product which consists of *Azotobacter sp.*, *Rhizobium sp., Azospirillum sp.,* Azolla or blue green algae.Microbein was obtained from the General Organization for Agricultural Equalization Fund (G.O.A.E.F), Ministry of Agriculture, Egypt.It was addedafter one month from transplanting and after the first cut the soil inoculation was repeated by bacteria fertilizers at 4kg/fed during the both seasons.

Effective Micro-Organisms (EM):

Recently, modern bio-fertilizers were applied as a mixture of effective micro- organisms under name of (EM) as one product the Ministry of Agriculture; it was a mixture of the following microorganisms according to Diver, S. (2001).It was applied as foliar spray on leaves after one month from planting at rate of (3L/fed).

The treatments of the conducted experiment were as following:

1-Control (Full dose of NPK as recommendation by the Ministry ofAgriculture, Egypt)
2- 1/2 NPK+ FYM 10 m^3/fed3- 1/2 NPK+FYM 20 m^3/fed
4- 1/2 NPK+FYM 30 m^3/fed5- 1/2 NPK+ microbein (4kg/fed)
6-1/2 NPK+ FYM 10 m^3/fed + microbein (4kg/fed)
7- 1/2 NPK + FYM 20 m^3/fed + microbein (4kg/fed)
8- 1/2 NPK+ FYM 30 m^3/fed + microbein (4kg/fed)
9- 1/2 NPK+EM (3L/fed)
10- 1/2 NPK+ FYM 10 m^3/fed + EM (3L/fed)
11-1/2 NPK+ FYM 20 m^3/fed + EM (3L/fed)
12-1/2 NPK+ FYM 30m^3/fed + EM (3L/fed)

Sampling:

Three cuts were taken, the first one was on June 15 th and the second cut was done on August 15th and third cut was done on October 15 th in both seasons.

The essential oil percentage of herb at every cut was estimated according to Guenter (1965). Gas Liquid Chromatography (GLC) was also used on same oil samples during the first season in Medicinal and Aromatic plants Dept., Research center, Giza, Egypt.

Statistical analysis:

All values of the obtained data recorded as means for five replicates and subjected to the statistical analysis of variance (ANOVA) as mentioned by (Gomez and Gomez., 1984),using the least significant difference (L.S.D).

RESULTS AND DISSUCION

Vegetative growth:

Plant height (cm):

Data presented in Table (3) showed that treated sweet basil plants with organic manure (FYM) at rates of 10, 20 and30m^3/fed, recorded less values of plant height comparing with control plants .The treatments of (FYM) at rate 30m^3/fed recorded the tallest one at three cuts during both two seasons (57.33, 57.81, 61.32 - 57.80, 57.81 and 62.30 /cm) but it was less than control plants (60.36, 65.30, 68.64 - 53.30, 62.64 and 65.00 /cm)in three cuts for the growing two seasons, respectively. These results are supported by Hussein *et al.*, (2008) on *Majorana hortensis,* Moench, Shalan (2009) on marjoram plants.

Number of branches/plant:

Data in Table (4) showed that (FYM) treatments at rates (10, 20 and 30m^3/fed) at three cuts for both seasons resulted in less values than control ones. On other hand, the treatment of 1/2NPK+30 m^3/fed (FYM) was the highest one.The interaction1/2NPK+ microbein +FYM30m^3/fed caused the highest values (18.90, 18.60, 19.63, 19.93 and 17.73)at three cuts in both seasons, respectively .Recent bio-fertilizer (EM) caused the higher values at treatment of interaction (1/2NPK+EM+FYM 30m^3/fed) at three cuts in both seasons, respectively. The results were in agreement with those reported by

Shalan (2009) on marjoram &Dapour and Shalan (2013) on *Rosmarinus officinalis* and *Mentha piperita* L.,

Fresh weight (g/plant):

Data in Table (5) cleared that all fertilization treatments pronounced effects on fresh weight of herb. Significantly heaviest fresh weight of herb resulted from the treatment of (FYM) 30m^3/fed for three cuts of both seasons and (1/2NPK + FYM 10m^3/fed) resulted in less values than obtained of control plants and other treatments, While the most value was obtained from treatments of interaction 1/2NPK+FYM 30m^3/fed + microbein in three cuts for both seasons, respectively.The interaction of (1/2NPK+EM+FYM30m^3/fed) resulted the heaviest fresh weight of plant (g) such as recorded (535.53, 535.33, 683.00 – 542.63, 569.92, 690.06 g/plant) in three cuts for both seasons, respectively. The differences between the treatments each other's and control plants were significant comparing with control plants. These results are in accordance with those obtained by Hamed(2004)on *Origanum syriacum*, EL-Sanafawy(2007) on*Ocimum basilicum*.

Dry weight (g/plant):

Data of the effect of fertilization treatments on dry weight of herb (g/plant) of *Ocimum basilicum* L., for the three cuts during two seasons are shown in Table (6).Organic fertilization (FYM) at different rates resulted in less values than obtained in control plants recorded (117.30, 142.33, 145.33-118.58,143.54 and 147.57g/plant) in three cuts for both seasons, respectively. The interaction (1/2NPK+microbein + FYM 10m^3/fed)، (1/2NPK+ microbein + FYM 30m^3/fed) recorded the heaviest plants comparing with other treatments in three cuts in both seasons, respectively. The interaction of (1/2NPK+ EM+ FYM 30m^3/fed) recorded the heaviest plants comparing with other treatments for three cuts in both seasons, respectively. These results coincided with those obtained by Hasanin (2007) on strawberry, on marjoram and Salem (2012) on onion plants.

Essential oil production:

Essential oil percentage (%):

Table (7) showed that the essential oil percentage in the dried herb varied in response to the different levels of organic manure treatment. The highest rate organic manure (FYM) 30m^3/fed led to the highest oil percentage comparing with the respective value of the chemical fertilizer NPK treatment (control). The interaction of1/2NPK+ microbein + FYM 30m^3/fed recorded the highest values at three cuts for both seasons (0.75, 0.73, 0.55 – 0.75, 0.75 and 0.54%) in three cuts for both seasons, respectively. The super effect was detected in response to application of EM solely followed by interaction1/2 NPK+ EM+ FYM 30m^3/fed (0.79, 0.76 – 0.81, 0.76 – 0.69, 0.57 / 0.79, 0.76 – 0.57, 0.77 – 0.69 and 0.70%) for three cuts in both seasons. These results are in accordance with those reported by Eisa (2004) on Salvia plants and Shalan *et al.,* (2006) on *Thymus vulgaris.*

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Table (7): Effect of organic and bio-fertilizers on essential oil percentage (%) in dried leaves of *Ocimum basilicum* L., plants for three cuts, during both seasons 2012/2013 and 2013/2014.

Organic manure (A) / Bio-fertilization(B)	First season 2012/2013											
	Cut1st (FYM)m3/fed				Cut2nd (FYM)m3/fed				Cut3rd (FYM)m3/fed			
	Con.	10	20	30	Con.	10	20	30	Con.	10	20	30
Con.	0.76	0.66	0.67	0.73	0.79	0.65	0.66	0.69	0.65	0.45	0.48	0.52
Micro.	0.69	0.70	0.74	0.75	0.70	0.66	0.71	0.73	0.63	0.50	0.55	0.55
EM	0.79	0.68	0.75	0.76	0.81	0.71	0.74	0.76	0.69	0.69	0.60	0.57
Second season 2013/2014												
	Con.	10	20	30	Con.	10	20	30	Con.	10	20	30
Con.	0.76	0.67	0.69	0.70	0.77	0.65	0.69	0.70	0.68	0.44	0.46	0.50
Micro.	0.70	0.68	0.68	0.75	0.70	0.66	0.66	0.75	0.62	0.48	0.48	0.54
EM	0.79	0.69	0.73	0.76	0.75	0.71	0.77	0.77	0.69	0.70	0.74	0.70

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons

Essential oil content (ml)/plant:

Data in Table (8) indicate the effect of organic fertilizer (FYM) levels and bio-fertilizers (microbein +EM) on essential oil content /plant in both seasons. The highest essential oil content resulted from with1/2NPK+ FYM 30m^3/fed in three cuts for both seasons, respectively,comparing with control plants. The maximum oil content of herb /plant produced from plants treated with interaction of (1/2NPK+EM+FYM 30m^3/fed) (1.07, 1.11, 1.02, 1.08, 1.16 and 1.30 ml/plant) in three cuts for both seasons, respectively. These results are in harmony with those obtained by Shalan(2009) on *Majorana hortensis* L. and Sakr *et al*., (2012) on marjoram plants.

. Oil yield (L/fed):

Data of the effect of fertilization treatments on oil yield /fed of *Ocimum basilicum* L., in three cuts during the two seasons are presented in Table (9). The highest oil yield /fed resulted from the treatments of (1/2NPK+EM+FYM30m^3/fed) and (1/2NPK+EM+FYM20m^3/fed) then (1/2NPK+EM+FYM10m^3/fed) interactions in the three cuts as well as the total /fed in both seasons, respectively. These findings are in agreement with those Naga (2005) on *Foeniculum vulgare* L., and *Carum carvi*, EL-Sanafawy (2007) on *Ocimum basilicum* and *Origanum majorana.*

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Table (9): Effect of organic and bio-fertilizers on essential oil yield (L/fed) in dried leaves of *Ocimum basilicum* L., plants for three cuts, during both 2012/2013and2013/2014.

Fertilization / Treatments	Oil yield (L/fed)							
	First season				Second season			
	Cut 1st	Cut 2nd	Cut 3rd	Total (fed/year)	Cut 1st	Cut 2nd	Cut 3rd	Total (fed/year)
Con.	19.94	25.09	21.06	66.09	20.16	24.64	21.06	65.86
FYM10m^3/fed	14.11	15.01	11.20	40.32	14.34	15.23	10.08	39.65
FYM20m^3/fed	15.68	16.80	11.87	44.35	15.68	17.70	13.89	47.27
FYM30m^3/fed	18.14	18.14	14.34	50.62	17.70	19.04	14.34	51.08
Micro.	15.68	18.59	17.02	51.29	15.90	18.04	17.47	51.51
Micro.+FYM10m^3/fed	15.90	18.14	13.88	44.92	15.90	18.14	13.66	47.70
Micro.+FYM20m^3/fed	19.71	19.94	15.46	55.11	18.37	18.59	13.89	50.85
Micro.+FYM30m^3/fed	20.38	20.61	15.68	56.67	20.61	18.59	15.68	54.88
EM	22.40	23.30	19.94	65.64	22.40	21.73	20.16	64.29
EM+FYM10m^3/fed	19.71	22.62	16.58	58.91	20.16	22.62	24.42	67.20
EM+FYM20m^3/fed	23.30	23.97	23.30	67.57	23.07	25.09	29.12	77.28
EM+FYM30m^3/fed	23.97	24.86	22.85	71.68	24.19	25.98	29.12	79.29

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons.

Volatile oil components:

The chromatograms resulted from G.L.C analysis illustrated in Figures (1up to12) and Table (10) chemical compounds of the volatile oil such as monoterpenes and phenyl propanoids(Lachowicz *et al.,* 1997).

Table (10): Effect of organic and bio fertilization on volatile oil components of *Ocimum bacilicum* L. plants at 3rd cut in2013/2014 season by GLC apparatus

Treatments / Component	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
α-Pinene	1.32	1.12	1.23	0.95	1.35	1.25	1.30	1.23	1.28	0.86	1.35	1.12
β-Pinene	1.15	1.45	1.58	1.65	1.62	1.98	2.01	1.34	2.01	1.38	2.15	1.45
Limonene	1.23	1.35	-	4.22	-	-	-	1.37	-	4.56	-	1.35
Ocimene	13.5	16.8	16.5	15.3	18.4	14.5	15.8	17.6	13.8	17.5	14.3	16.8
Linalool	36.2	41.5	30.1	32.5	36.5	36.8	37.8	42.8	35.8	36.2	37.2	41.5
Linalyl acetate	1.13	1.05	0.68	1.20	0.74	-	-	1.01	1.35	1.18	1.28	1.05
α-Terpineol	2.40	1.32	0.86	1.65	1.02	2.31	2.12	1.24	3.58	2.05	3.74	1.32
Benzyl acetate	2.50	2.49	4.25	-	4.65	3.25	3.46	1.52	1.35	-	1.54	2.49
Nerolidol	3.41	3.15	5.28	2.05	5.68	1.98	1.86	3.21	1.12	2.13	1.21	3.15
Famesol	0.52	0.67	0.35	1.02	0.38	0.54	0.48	0.62	-	0.98	-	0.67
Methyl chavicol	34.2	26.3	29.5	31.5	22.5	28.5	27.9	25.8	30.2	26.6	29.8	26.3
Eugenol	1.02	1.21	0.75	2.13	1.02	1.42	1.09	1.13	1.38	2.45	1.49	1.21
Methyl cinnamate	0.61	0.84	1.35	-	1.64	-	-	0.93	2.04	-	2015	0.84

T_1=Con T_2=FYM10m^3/fed T_3=FYM20m^3/fed.
T_4=FYM30m^3/fed T_5=Micro. T_6= Micro. + FYM10m^3/fed.
T_7= Micro. + FYM20m^3/fed T_8= Micro. + FYM30m^3/fed.
T_9= EM 3L/fed. T_{10}= EM 3L/fed+ FYM10m^3/fed.
T_{11}= EM3L/fed+ FYM20m^3/fed. T_{12}= EM3L/fed+ FYM30m^3/fed.

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G.L.C identified (13) components of volatile oil Linalool was the main compound which achieved 42.8% when plants treated with 1/2 NPK+ FYM 30 m^3/fed + microbein (4kg/fed)., while methyle chavicol was the second chief component which recorded 34.2% with control plants (full dose of NPK), followed 31.5% with plants treated with1/2NPK+ FYM 30 m^3/fed., while ocimene was the third important component which recorded 18.4% when plants fertilized with 1/2 NPK+ microbein (4kg/fed) solely. These results were in agreement with those reported by Massoud (2007b) on *Ocimum basilicum* and Massoud (2012) on *Mentha piperita* and *Majorana hortensis* L.,

CONCLUSION

It can be recommended to fertilize *Ocimum basilicum* L., plants combined with FYM 30m^3/fed and modern fertilization (EM) gave the best vegetative growth and essential oil yield with the highest quality.

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دراسة تأثير كفاءة بعض الأسمدة الحيوية والعضوية مقارنة بالأسمدة الكيماوية على نمو ومحصول وجودة نبات الريحان

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*** قسم النبات الزراعي – كلية الزراعة-جامعة المنصورة***

**** بحوث النباتات الطبية والعطرية- معهد بحوث البساتين- مركز البحوث الزراعية.**

أجرى هذا البحث بهدف دراسة تأثير كلا من السماد الكيماوي (حسب توصيات وزارة الزراعة) والسماد العضوي (الخليط من سماد الدواجن والماشية بنسب متساوية) والسماد الحيوي بصورة منفردة أو متداخلة على الصفات الخضرية والزيت الطيار لنبات الريحان الحلو (الصنف الأبيض) وقد أجريت التجربة في مشتل النباتات الطبية والعطرية ومعمل قسم النبات الزراعي ، كلية الزراعة – جامعة المنصورة ومعهد بحوث البساتين ،مركز البحوث الزراعية خلال موسمين متتالين 2013/2012، 2014/2013 .

ولقد أوضحت النتائج المتحصل عليها أن المعاملة بالتسميد العضوي بجميع مستوياته سواء كانت منفردة أو متداخلة مع كلا من (الميكروبين،EM) إلى زيادة كل الصفات الخضرية الموجودة بالبحث.

كما أوضحت النتائج أن إضافة الجرعات الموصى بها من السماد الكيماوي أدت لزيادة ملحوظة في ارتفاع النبات ، الوزن الطازج والجاف للنبات في جميع الحشات خلال موسمي الزراعة بينما النباتات المعاملة بالسماد البلدي بمعدل 2/1 جرعة السماد الكيماوي+30م^3/ف أعطت زيادة في ارتفاع النبات وعدد الأفرع والوزن الطازج والجاف .

أعطت المعاملة بالسماد العضوي بمعدل 30 م^3/ف منفردة أو متداخلة مع الميكروبين زيادة في النسبة المئوية للزيت الطيار للنباتات في جميع الحشات خلال موسمي الزراعة مقارنة بالكنترول .

التفاعل بين (2/1 جرعة السماد الكيماوي + السماد العضوي بمعدل 30م^3/ف + EM) حقق أفضل نتائج للنسبة المئوية للزيت الطيار (بالملل /نبات)وكذلك اجمالى إنتاج الزيت (باللتر/ف)

عند إجراء التحليل الكروماتوجرافى للزيت الطيار للريحان وجد إنه يتكون من 13 مركب ، والتفاعل بين (2/1 جرعة السماد الكيماوي + الميكروبين +السماد العضوي بمعدل 30م^3/ف) لحدوث زيادة في المكون الأساسي للزيت وهو الليناليول يليه الميثيل شافيكول ثم الأوسيمين.

Table (3): Effect of organic and bio-fertilizers on plant height (cm) of *Ocimum basilicum* L., plants for three cuts, during both seasons 2012/2013 and 2013/2014.

Organic manure (A) / Bio- fertilization (B)	First season 2012/2013														
	cut 1st (FYM)m3/fed					Cut2nd (FYM)m3/fed					Cut3rd (FYM)m3/fed				
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	60.36	50.60	52.66	57.33	55.24	65.30	52.51	55.70	57.81	57.83	68.64	52.90	56.60	61.32	59.87
Micro.	62.61	63.72	65.60	68.80	65.18	66.30	64.21	66.82	69.79	50.21	69.90	71.60	72.70	74.00	72.05
EM	65.90	68.08	70.83	72.67	69.37	68.00	70.83	72.00	74.22	71.26	70.06	72.67	74.61	76.06	73.35
Mean(B)	62.96	60.8	63.03	66.27		66.53	62.52	64.84	67.27		69.53	65.72	67.97	70.46	
L.S.D at (0.05)	A 1.57		B 1.08		A*B 2.15	A 0.90		B 0.60		A*B 1.01	A 1.01		B 1.09		A*B 2.06
	Second season 2013/2014														
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	53.30	51.62	53.60	57.80	54.08	62.64	53.56	55.90	57.81	57.48	65.00	54.23	56.81	62.30	59.59
Micro.	63.00	64.80	66.00	69.90	65.93	66.61	65.32	67.30	69.99	67.31	70.51	72.47	74.00	77.36	73.59
EM	65.61	69.09	71.83	73.77	70.08	68.34	72.84	74.61	76.84	73.16	71.09	74.01	77.00	79.90	75.5
Mean(B)	60.64	61.84	63.81	67.16		65.86	63.91	65.94	68.21		68.87	66.90	69.27	73.19	
L.S.D at (0.05)	A 1.30		B 1.10		A*B 2.03	A 0.80		B 0.70		A*B 1.03	A 1.03		B 1.06		A*B 2.03

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons.

Table (4): Effect of organic and bio-fertilizers on number of branches/plant of *Ocimum basilicum* L., plants for three cuts, during both seasons 2012/2013 and 2013/2014.

Organic manure (A) / Bio-fertilization (B)	First season 2012/2013														
	Cut1 st (FYM)m3/fed					Cut2nd (FYM)m3/fed					Cut3rd (FYM)m3/fed				
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	14.39	9.58	12.94	13.83	12.69	17.56	10.33	13.91	14.90	14.18	22.30	11.56	14.66	16.66	16.30
Micro.	11.06	13.62	15.71	18.90	14.82	14.67	15.34	16.97	18.60	16.40	14.99	13.87	17.69	19.37	16.48
EM	15.62	17.39	19.45	21.00	18.37	16.54	8.66	20.62	24.66	20.12	17.99	19.73	22.63	25.30	21.41
Mean(B)	13.69	13.53	16.03	17.91		16.26	14.78	17.17	19.39		18.43	15.05	18.33	20.44	
L.S.D at (0.05)	A 1.60		B 2.50		A*B 2.80	A 2.20		B 2.60		A*B 3.40	A 3.01		B 2.07		A*B 6.15
Second season 2013/2014															
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	15.01	10.71	13.22	14.92	13.47	17.66	11.36	14.33	15.60	14.74	23.68	12.67	15.76	15.76	17.76
Micro.	11.22	13.63	16.21	19.63	15.17	14.92	15.67	17.67	19.93	17.05	14.99	15.96	17.73	17.73	17.32
EM	15.67	17.80	20.50	22.60	76.97	16.78	19.56	21.90	24.90	20.79	18.90	19.92	23.71	23.71	22.24
Mean(B)	**13.97**	**14.05**	**16.64**	**19.05**		**16.45**	**15.53**	**17.97**	**20.14**		**19.19**	**16.18**	**19.07**	**19.07**	
L.S.D at (0.05)	**A 1.50**		**B 2.30**		**A*B 3.10**	**A 2.30**		**B 2.70**		**A*B 3.50**	**A 2.79**		**B 2.18**		**A*B 4.35**

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons.

Table (5): Effect of organic and bio-fertilizers on fresh weight (g/plant) of *Ocimum basilicum* L., plants for three cuts, during both seasons 2012/2013 and 2013/2014.

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons.

Organic manure (A) / Bio-fertilization (B)	First season 2012/2013														
	Cut1st					Cut2nd					Cut3rd				
	(FYM)m3/fed					(FYM)m3/fed					(FYM)m3/fed				
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	ean (A)
Con.	445.73	362.75	400.01	422.63	407.78	540.84	395.92	430.66	450.72	454.54	552.23	410.33	450.22	470.00	470.70
Micro.	384.06	390.34	453.00	461.32	422.18	450.75	465.32	476.32	480.12	468.13	460.76	409.23	476.06	483.12	457.29
EM	482.61	490.91	532.61	535.53	510.42	485.43	540.00	546.90	556.33	532.17	490.11	599.96	663.00	683.00	609.02
Mean(B)	437.47	414.77	461.87	473.16		492.34	467.08	484.63	455.72		501.03	493.17	529.76	545.37	
L.S.D at (0.05)	A 33.36		B 59.55		A*B 119.10	A 33.10		B 49.40		A*B 98.90	A 30.66		B 40.11		A*B 90.12
	Second season 2013/2014														
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	450.60	365.62	430.00	432.30	419.63	545.44	389.66	435.00	460.66	457.69	560.77	420.23	461.32	486.60	482.23
Micro.	389.60	395.82	460.11	469.20	428.68	460.79	469.55	476.11	486.09	473.14	480.11	485.21	489.66	495.14	487.53
EM	485.11	495.06	536.40	542.63	514.8	490.00	545.62	556.32	569.92	540.47	496.76	599.99	670.22	690.06	614.26
Mean(B)	441.77	418.83	475.50	481.38		498.74	468.28	489.14	505.56		512.55	501.81	540.4	557.23	
L.S.D at (0.05)	A 41.70		B 34.83		A*B 69.65	A 27.49		B 40.08		A*B 80.15	A 28.18		B 36.11		A*B 83.12

Table (6): Effect of organic and bio-fertilizers on dry weight (g/plant) of *Ocimum basilicum* L., plants for three cuts, during both seasons 2012/2013 and 2013/2014.

Organic manure (A) / Bio-fertilization (B)	First season 2012/2013														
	Cut1st (FYM)m3/fed					Cut2nd (FYM)m3/fed					Cut3rd (FYM)m3/fed				
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	117.30	95.46	105.29	111.22	107.32	142.33	104.19	113.33	118.61	119.62	145.32	110.59	118.48	123.68	124.52
Micro.	101.07	102.72	119.21	121.40	111.1	118.62	122.45	125.35	126.35	123.19	121.25	123.48	125.28	127.14	124.29
EM	127.00	129.19	139.77	140.93	134.22	127.74	142.11	143.92	146.40	140.04	128.98	157.88	174.47	179.74	160.27
Mean(B)	115.12	109.12	121.42	124.52		129.56	122.92	127.53	130.45		131.85	130.65	139.41	143.52	
L.S.D at (0.05)	A 10.88		B 18.32		A*B 36.65	A 11.95		B 15.11		A*B 30.23	A 10.60		B 13.10		A*B 26.07
Second season 2013/2014															
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	118.58	96.22	113.16	113.76	110.43	143.54	102.54	114.47	121.22	120.44	147.57	110.59	121.40	128.05	126.90
Micro.	102.53	104.16	121.08	123.47	112.81	121.26	123.57	125.29	127.92	124.51	126.34	127.69	128.86	130.30	128.30
EM	127.66	130.28	141.16	142.80	135.48	128.95	143.58	146.40	149.98	142.23	130.73	157.89	176.37	181.49	161.62
Mean(B)	116.26	110.22	125.13	126.68		131.25	123.23	128.72	133.04		134.88	132.06	142.21	146.61	
L.S.D at (0.05)	A 9.58		B 10.19		A*B 20.38	A 10.68		B 8.51		A*B 17.02	A 11.12		B 15.20		A*B 28.17

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons.

Table (8): Effect of organic and bio-fertilizers on essential oil yield (ml /plant) in dried leaves of *Ocimum basilicum* L., plants for three cuts, during both seasons 2012/2013and 2013/2014.

Organic manure (A) / Bio-fertilization (B)	First season 2012/2013														
	Cut1st					Cut2nd					Cut3rd				
	(FYM)m^3/fed					(FYM)m^3/fed					(FYM)m^3/fed				
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	0.89	0.63	0.70	0.81	0.76	1.12	0.67	0.75	0.81	0.84	0.94	0.50	0.53	0.64	0.65
Micro.	0.70	0.71	0.88	0.91	0.80	0.83	0.81	0.89	0.92	0.86	0.76	0.62	0.69	0.70	0.69
EM	1.00	0.88	1.04	1.07	1.00	1.04	1.01	1.07	1.11	1.70	0.89	1.09	1.04	1.02	1.01
Mean(B)	0.86	0.74	0.87	0.93		1.10	0.83	0.90	0.95		0.86	0.74	0.75	0.79	
L.S.D at (0.05)	A 0.09		B 0.05		A*B 0.10	A 0.09		B 0.06		A*B 0.12	A 0.08		B 0.04		A*B 0.10
	Second season 2013/2014														
	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)	Con.	10	20	30	Mean (A)
Con.	0.90	0.64	0.80	0.79	0.78	1.10	0.68	0.79	0.85	0.86	1.01	0.45	0.56	0.64	0.67
Micro.	0.71	0.71	0.82	0.92	0.79	0.85	0.81	0.83	0.95	0.86	0.78	0.61	0.62	0.70	0.68
EM	1.00	0.90	1.03	1.08	1.03	0.97	1.01	1.12	1.16	1.07	0.90	1.09	1.30	1.30	1.15
Mean(B)	0.87	0.75	0.88	0.93		1.01	0.83	0.91	0.99		0.90	0.72	0.83	0.88	
L.S.D at (0.05)	A 0.02		B 0.05		A*B 0.10	A 0.05		B 0.05		A*B 0.11	A 0.07		B 0.06		A*B 0.011

Control plants received full dose of NPK, whereas other all treatments received 1/2 dose of full dose from NPK during both two seasons.

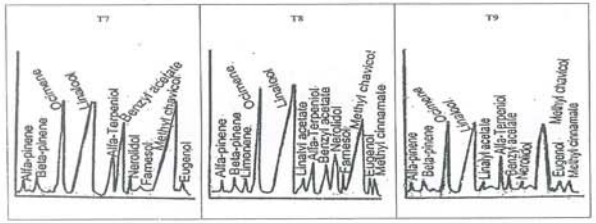

Fig. (7):G.L.C analysis of volatile oil of plants treated with microbein + FYM at dose of 20 m^3/fed.

Fig.(8):G.L.C analysis of volatile oil of plants treated with microbein + FYM at dose of 30 m^3/fed.

Fig.(9):G.L.C analysis of volatile oil of plants treated with EM 3 L/fed.

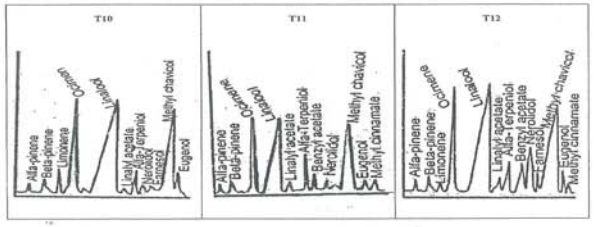

Fig. (10): G.L.C analysis of volatile oil of plants treated with EM 3 L/fed. + FYM at dose of 10 m^3/fed.

Fig. (11): G.L.C analysis of volatile oil of plants treated with EM 3 L/fed. + FYM at dose of 20 m^3/fed.

Fig. (12): G.L.C analysis of volatile oil of plants treated with EM 3 L/fed. + FYM at dose of 30 m^3/fed.

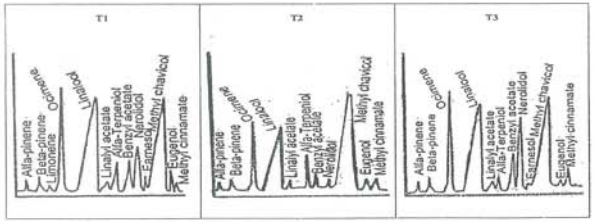

Fig. (1): G.L.C analysis of volatile oil of control plants treated with full dose of (NPK).

Fig. (2): G.L.C analysis of volatile oil of plants treated with FYM at dose of 10 m^3/fed..

Fig. (3): G.L.C analysis of volatile oil of plants treated with FYM at dose of 20 m^3/fed..

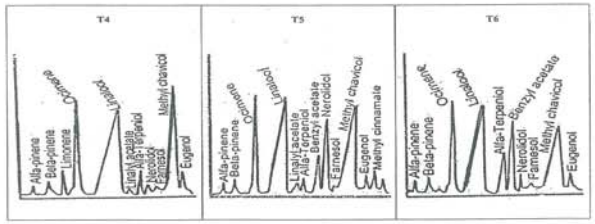

Fig. (4): G.L.C analysis of volatile oil of plants treated with FYM at dose of 30 m^3/fed..

Fig. (5): G.L.C analysis of volatile oil of plants treated with microbein.

Fig.(6):G.L.C analysis of volatile oil of plants treated with microbein + FYM at dose of 10 m^3/fed.