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PHYSIOLOGICAL STUDIES ON CLOVE BASIL PLANT

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ABSTRACT

This experiment was conducted at the Floriculture Nursery at the Experimental Farm and the Laboratory of Floriculture, Fac. of Agric., Minia Univ. during the two successive seasons of 2010 and 2011 to study the effect of FYM (Farmyard manure), bio. and / or salicylic acid, as well as, mineral NPK fertilization treatments on vegetative growth, oil production and chemical composition of clove basil plant.

The obtained results indicated that the application of FYM significantly increased plant height (cm), number of branches / plant, herb fresh weight in each cut (g / plant / cut), herb fresh weight in each season (g / plant / season) and total herb fresh weight per feddan for each season (ton. / fed. / season), essential oil (%), essential oil yield / plant / cut (ml) and per plant / season (ml), as well as per fed. / season (liter), content of chlorophyll a, b and carotenoids (mg / g. fresh weight) in the fresh leaves, as well as, the percentages of N, P and K in the dry herb. The superiority in all previous traits was for treatment of FYM at high level (45 m^3 / fed.) as compared with the other levels including the control.

The plants treated with mineral NPK or a mixture of effective microorganisms (E.M.) and phosphorein (Phos.) plus salicylic acid gave the best results of all tested parameters in both cuts of the two growing seasons. Regarding the percentage of essential oil in the fresh herb, the treatment of E.M. + Phos. + Sal. was more effective than the other treatments.

The interaction between the main-plots (FYM treatments) and sub-plots (bio, Salicylic acid and NPK treatments) had significant effect on the previous parameters. The highest values, in most cases, were obtained due to the high level of FYM (45 m^3 / fed.) in combination with mineral NPK and E.M. + Phos. + Sal.

INTRODUCTION

The clove basil plant (*Ocimum gratissimum*, L.) belonging to Family Lamiaceae is an aromatic, perennial herb. It is used commonly for flavoring many food products, general tonic, anti – diarrhea agent. The leaf oil when mixed with alcohol is applied as a lotion for skin infection and taken internally for bronchitis. The dried leaves are snuffed to alleviate headaches and fever among other uses (Iwu, 1993). Leaves extract used for urinary tract, wound, skin and antibacterial and antifungal. Essential oil is an important insect repellent, it applied against fever, inflammations of the throat, ears or eyes, stomach pain, influenza, diarrhea and skin diseases. It is being tested as an antibiotic and antioxidant activities (Biasi *et al.,* 2009).

Many authors studied the effect of organic manure fertilization treatments on growth, essential oil (percent and yield) and chemical composition of several plant species as Jacoub (1999); El–Gendy *et al.* (2001); Kandeel *et al.* (2002); Mohsen (2002) on sweet basil plants; El–

Ghadban *et al.* (2003) and El–Sanafawy (2007) on *Majorana hortensis*; Heikal (2005) on *Thymus vulgaris*; El–Maadawy (2007) on *Tagetes erecta*; El–Leithy *et al.* (2007) on *Origanum syriacum*; Abdalla (2009) on coriander plants and Abdou *et al.* (2009a) and (2009d) on caraway and fennel plants, respectively who concluded that organic fertilization treatments significantly increased vegetative growth traits, volatile oil parameters and chemical composition compared with control.

The beneficial effects of bio-fertilizer treatments on vegetative growth traits, essential oil and chemical composition of some aromatic plants were obtained by Youssef *et al.* (2004) on sage plants; Abdou *et al.* (2004a; 2004b and 2009d) on fennel plants; El–Leithy *et al.* (2007) on *Origanum syriacum*; El–Maadawy (2007) on *Tagetes erecta*; Erika *et al.* (2008) on marjoram plants, El–Shora (2009) and Abd El–Hadi (2009) on *Mentha* spp.; Abdou *et al.* (2009a) on caraway plants. They found that bio-fertilization treatments (N_2 – fixing bacteria and / or phosphate dissolving bacteria) led to an increment in vegetative growth parameters, essential oil (percent and yield), as well as, chemical constituents (chlorophyll a, b and carotenoids contents and N, P and K % in the leaves of plants).

The effect of salicylic acid was investigated on several medicinal and aromatic plants, it was found that the vegetative growth traits, oil (percent and yield) and some chemical composition increased due to salicylic acid application on some various plants, such as *Tagetes minuta* (Ali, 2004); caraway plants (Al–Shareif, 2006 and Abdou *et al.,* 2009a);coriander plants (Ayat, 2007); sweet basil and marjoram plants (Abd El–Lateef, 2007) and geranium plants (Ibrahim, 2010).

Many research worker gained best growth, yield, oil percentage, oil yield and chemical constituents for several aromatic plants when mineral NPK was used, such as Khafaga *et al.* (2000); Mohsen (2002); Singh *et al.* (2004); Abd El–Lateef (2007); El–Sanafawy (2007) and Rao *et al.* (2007) on sweet basil; Mahfouz (2003) and El–Hindi and El–Boraie (2005) on marjoram plants; Shala (2007) on sage plants; Abdelaziz (2007) on rosemary plants; Abdalla (2009) on coriander plants; Ardelan *et al.* (2010) on *Satureja hortensis* and Ibrahim (2010) on geranium plants.

This study was designed to study the effect of using FYM, bio. and/or salicylic acid, as well as, mineral NPK on the some vegetative growth characteristics, essential oil percent and yield and chemical composition of clove basil plants.

MATERIALS AND METHODS

A field experiment was carried out during the two growing seasons of 2010 and 2011 at the Floriculture Nursery and the Laboratory of Floriculture, Faculty of Agriculture, Minia University to study the response of clove basil plants to FYM, bio. and/or salicylic acid, as well as, mineral NPK fertilization treatments. The seedlings of clove basil plants at the stage of 4 – 5 leaves and 12 – 13 cm in height were planted in the experimental field on the middle of March in both seasons.

The layout of this experiment was split plot design with three replicates. The experimental unit (plot) was 2 x 2 m and containing 5 rows, 40 cm apart, and the seedlings were cultivated in hills, 40 cm apart, therefore, each plot contained 25 plants. Farmyard manure levels (0, 25, 35 and 45 m^3/fed.) were assigned to the main-plots and seven treatments (control, phosphorein, E.M., E.M. + phosphorein, salicylic acid, E.M. + phosphorein + salicylic acid and mineral NPK) occupied the sub-plots. The physical and chemical analyses of the used soil in both seasons are shown in Table (A). Farmyard manure (FYM) was obtained from a private animal farm and added during preparing the soil to cultivation in the two experimental seasons. The chemical analysis of FYM was done according Black *et al.* (1965) and is shown in Table (B).

Fresh and active two biofertilizers were used in this research. Phosphorein (Phos.), which containing phosphate dissolving bacteria, was obtained from Ministry of Agric., while E.M. (Effective microorganisms) was obtained from Laboratory of Bio., Dept. of Genetics, Fac. of Agric., Minia Univ. The biofertilizers were applied either separately or in a mixture twice to the soil around each plant at 5 kg / fed. of Phos. and 50 ml / plant of E.M. (1 ml contains 10^7 cells of bacteria). The first dose was added after 2 weeks from transplanting and the second one after 2 weeks from the first cut in both seasons and then plants were irrigated immediately. Salicylic acid (Sal.) at 150 ppm was applied as a foliar spry twice also at the same schedule mentioned in the biofertilizers treatments (the plants were sprayed till run off).

Table (A): Physical and chemical properties of the experimental soil at 0–30 cm depth in 2010 and 2011 seasons

Soil properties	Value	
	2010	2011
Sand %	28.20	28.98
Silt %	30.70	29.87
Clay %	41.10	41.15
Soil type	Clay loam	Clay loam
Organic matter %	1.62	1.54
Ca Co_3 %	2.09	2.11
pH (1 : 2.5)	7.82	7.75
E. C. (m mhos / cm)	1.04	1.08
Total N %	0.08	0.06
Available P %	15.12	15.67
Exch. K^+ mg/100 g	2.11	2.85
Exch. Ca^{++} mg/100 g	31.74	31.12
Exch. Na^+ mg/100 g	2.40	2.51
Fe	8.54	8.23
DTPA Cu	2.06	2.01
Ext. ppm Zn	2.75	2.87
Mn	8.26	8.11

Chemical fertilizer was used as a mixture of ammonium nitrate (33.5 % N), calcium superphosphate (15.5 % P_2O_5) and potassium sulphate (48 % K_2O) at the rates of 300, 250 and 150 kg / fed. respectively, and added in two equal doses, also at the same schedule mentioned in the treatments of

biofertilizers and / or Salicylic acid. All other agricultural practices were carried out as prevailing in the region.

Table (B): Chemical analysis of the applied farmyard manure in 2010 and 2011 seasons

Content of FYM	First season (2010)	Second season (2011)
Organic matter %	27.0	27.50
Carbon %	15.70	15.81
Total N %	0.82	0.91
C / N ratio	19.15	17.37
Humidity %	8.01	7.89
P %	0.25	0.28
K %	1.09	1.18
Fe ppm	980.3	838.5
Zn ppm	274.2	271.10
Mn ppm	225.4	234.10
pH.	7.44	7.38
E. C. (m. mhose /cm)	1.08	1.06

The plants were harvested twice, the first cut was done on 10th of July and the second cut was done on October 13th in the two growing seasons. The following data were recorded during both seasons:

- Vegetative growth characters: Plant height (cm), number of branches per plant and herb fresh weight (g / plant) were determined for each cut. In addition, total herb fresh weight (g / plant) and (ton / fed.) for each season were calculated.
- Essential oil determination: Essential oil % in fresh herb, according to British Pharmaocopeia (1963), and essential oil yield (ml / plant) were determined for each cut. Moreover, essential oil yield (ml / plant) and (liter / fed.) for each season were calculated.
- Chemical analysis: For each cut, chlorophyll a, b and carotenoids (mg / g fresh weight) in the fresh leaves were determined according to Moran (1982). Nitrogen % was determined by using the modified micro – kjeldahl method as described by Wilde *et al.* (1985). P % was estimated according to Chapman and Pratt (1975), while K % was determined using flame – photometer method according to Cottenie *et al.* (1982). All data were tabulated and statistically analyzed according to MSTAT–C (1986) and the L.S.D. test at 5 % was followed to compare between the means.

RESULTS AND DISCUSSION

Effect on vegetative growth :

Data in Tables (1, 2, 3 and 4) indicated that plant height, number of branches / plant / cut, herb fresh weight / plant / cut and per plant / season, as well as, per fed. / season were significantly increased due to all farmyard manure (FYM) treatments over control (without FYM) in both cuts and in the two growing seasons. The highest values for the five characters were obtained when FYM was added at the rate of 45 m^3 / fed. (FYM_3). In addition, significant differences were also detected between the four levels of FYM for the five previous characters, except, between FYM_3 and FYM_2 for herb fresh

weight / plant / cut in the second cut during second season, it was not significant. The superiority of the treatments of FYM in enhancing the vegetative growth may be attributed to the mode of action of organic manure on the physical and chemical soil characters. FYM can improve soil, water and plant relations through modifying bulk density, total porosity and soil water retention (Abd El–Moez *et al.,* 1999). Also, organic materials are degraded in the soil and consequently the nutrients became available which leading to increase the plant growth (Saha *et al.,* 1995). These results are in agreement with those of El–Gendy *et al.* (2001) and Mohsen (2002) on sweet basil; El–Maadawy (2007) on *Tagetes erecta*; El–Leithy *et al.* (2007) on *Origanum syriacum* and Abdalla (2009) on coriander plants.

It is evident from data in Tables (1, 2, 3 and 4) that all six used treatments (sub-plots) significantly increased vegetative growth traits in comparison with the control (without any treatment) in both cuts during the two growing seasons. The highest values were obtained due to the treatment of mineral NPK fertilization followed by the mixture of biofertilizers (E.M. + Phos.) plus salicylic acid without significant differences between them.

The superiority of NPK treatment and the treatment of biofertilizers + salicylic acid in promoting the vegetative growth may be attributed to the increase of N, P and K in root zone from chemical fertilizers. Effective microorganisms (E.M.) increase soil available N, consequently increase formation of metabolites which encourage the plant growth (Sperenat, 1990). Furthermore, the phosphate solublizing bacteria (phosphorein) has enormous potential to solubilize about 50 – 60 % of fixed phosphorus in the soil by secreting organic acids within a short time (Vyas and Vyas, 1994). While, salicylic acid has direct involvement in plant growth (Gorddon *et al.,* 1997). The increase in vegetative growth due to mineral NPK was deduced by Singh *et al.* (2004) on sweet basil; El–Hindi and El–Boraie (2005) on *Majorana hortensis* and Ardelan *et al.* (2010) on *Satureja hortensis*. Meanwhile, the role of biofertilizers in increasing vegetative growth traits was also stated by Abdou *et al.* (2009a) and (2009c) and (2009d) on caraway, guar and fennel plants, respectively. In this respect, Ali (2004) on *Tagetes minuta*; Al–Shareif (2006) on caraway and Ibrahim (2010) on geranium proved that salicylic acid treatment increased all vegetative growth traits.

The interaction between main-plot and sub-plot was significant for the five studied characters of vegetative growth in the two cuts during both seasons. The best interaction treatments were obtained due to FYM_3 + NPK or FYM_3 + E.M. + Phos. + Sal. (for plant height and number of branches / plant / cut) and FYM_3 with NPK or E.M. + Phos. + Sal. or FYM_2 with NPK (for fresh weight of herb / plant / cut), as well as, FYM_3 or FYM_2 in combination with NPK or E.M. + Phos. + Sal. for fresh weight of herb / plant / season and per feddan / season (Tables 1, 2, 3 and 4). In general the best vegetative growth for all treatments was obtained in the second cut in comparison with first cut in the two growing seasons. This may be due to more decomposition of organic materials at the end of the seasons.

Table (1): Effect of FYM, bio. and/or salicylic acid and NPK treatments on plant height of *Ocimum gratissimum* L. plant in the first and second during 2010 and 2011 seasons

Treatments	Plant height (cm)									
	First season (2010)									
	First cut					Second cut				
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	36.03	42.55	47.05	50.55	**44.05**	37.55	44.15	48.55	51.75	**45.50**
Phos.	40.28	47.06	51.70	54.70	**48.44**	41.55	48.36	53.30	55.55	**49.69**
E.M.	41.55	48.61	52.25	56.10	**49.63**	42.75	50.01	55.46	57.05	**51.32**
Phos. + E.M.	42.93	50.22	54.00	57.74	**51.22**	44.06	51.73	57.31	58.85	**52.99**
Sal.	43.65	50.95	54.81	58.35	**51.94**	44.65	52.35	58.02	59.36	**53.60**
Phos.+E.M.+ Sal.	46.55	54.88	58.33	61.75	**55.38**	47.28	56.37	61.55	62.95	**57.04**
NPK	47.28	55.65	59.05	62.15	**56.03**	48.15	57.05	62.10	64.18	**57.87**
Mean (B)	**42.61**	**49.99**	**53.88**	**57.33**		**43.71**	**51.43**	**56.61**	**58.53**	
L.S.D. at 5 %	**A: 0.94**		**B: 1.30**		**AB: 2.66**	**A: 0.63**		**B: 0.99**		**AB: 1.98**
	Second season (2011)									
Control	37.18	43.78	48.49	52.20	**45.41**	38.30	44.80	49.65	53.50	**46.56**
Phos.	41.11	47.65	52.25	55.60	**49.15**	41.00	48.30	52.15	56.82	**49.57**
E.M.	42.35	49.05	53.95	56.95	**50.58**	42.68	50.00	54.18	58.67	**51.38**
Phos. + E.M.	43.70	50.75	55.75	58.86	**52.27**	44.65	51.65	56.09	60.62	**53.25**
Sal.	44.30	51.37	56.66	59.48	**52.95**	45.15	52.25	56.86	61.05	**53.83**
Phos.+E.M.+ Sal.	47.28	55.48	60.47	63.67	**56.73**	48.35	56.05	60.95	65.86	**57.80**
NPK	49.15	56.15	60.98	64.08	**57.59**	49.55	56.85	61.55	66.25	**58.55**
Mean (B)	**43.58**	**50.60**	**55.51**	**58.69**		**44.24**	**51.41**	**55.92**	**60.40**	
L.S.D. at 5 %	**A: 0.87**		**B: 1.03**		**AB: 2.06**	**A: 0.49**		**B: 0.87**		**AB: 1.74**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (2): Effect of FYM, bio. and/or salicylic acid and NPK treatments on number of branches of *Ocimum gratissimum*, L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Number of branches / plant									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	9.35	10.15	10.75	11.05	**10.33**	10.25	11.10	11.81	12.22	**11.35**
Phos.	9.87	10.70	11.33	11.45	**10.84**	10.65	11.55	12.44	12.65	**11.82**
E.M.	10.10	11.05	11.73	11.90	**11.20**	10.97	11.95	12.95	13.16	**12.26**
Phos. + E.M.	10.57	11.70	12.48	12.70	**11.86**	11.52	12.65	13.75	14.01	**12.98**
Sal.	10.68	11.85	12.66	12.91	**12.03**	11.70	12.76	13.86	14.12	**13.11**
Phos. + E.M. + Sal.	12.05	13.05	13.46	14.06	**13.16**	12.69	13.77	14.99	15.08	**14.14**
NPK	12.40	13.45	13.55	14.16	**13.39**	13.09	14.17	15.09	15.11	**14.37**
Mean (B)	**10.71**	**11.71**	**12.28**	**12.61**		**11.55**	**12.56**	**13.56**	**13.76**	
L.S.D. at 5 %	**A: 0.12**	**B: 0.29**		**AB: 0.57**		**A: 0.18**	**B: 0.24**		**AB: 0.45**	
	Second season (2011)									
Control	9.65	10.53	11.04	11.29	**10.63**	10.63	11.55	12.30	12.75	**11.81**
Phos.	10.06	11.00	11.59	11.70	**11.09**	11.08	12.06	12.85	13.17	**12.29**
E.M.	10.31	11.25	12.02	12.17	**11.44**	11.43	12.66	13.47	13.84	**12.85**
Phos. + E.M.	10.66	11.95	12.83	13.02	**12.12**	12.05	13.48	14.38	14.75	**13.67**
Sal.	10.79	12.08	12.98	13.18	**12.26**	12.21	13.63	14.46	14.87	**13.79**
Phos. + E.M. + Sal.	11.63	12.99	13.83	14.19	**13.16**	13.26	14.59	15.25	15.65	**14.69**
NPK	12.73	13.70	13.80	14.40	**13.58**	14.12	15.11	15.35	15.84	**15.11**
Mean (B)	**10.83**	**11.93**	**12.59**	**12.85**		**12.11**	**13.30**	**14.01**	**14.41**	
L.S.D. at 5 %	**A: 0.25**	**B: 0.22**		**AB: 0.44**		**A: 0.32**	**B: 0.23**		**AB: 0.46**	

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (3): Effect of FYM, bio. and/or salicylic acid and NPK treatments on herb fresh weight of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Fresh weight of herb (g / plant)									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	140.07	167.84	196.76	227.79	**183.12**	165.33	195.28	225.38	253.91	**209.98**
Phos.	160.26	191.83	223.15	251.42	**206.67**	183.17	217.86	250.14	273.49	**231.17**
E.M.	177.96	220.3	254.80	280.42	**233.37**	201.51	248.58	282.73	302.96	**258.95**
Phos. + E.M.	207.07	254.83	292.17	314.97	**267.26**	225.9	284.49	320.24	338.93	**292.39**
Sal.	219.25	267.15	305.84	327.10	**279.84**	235.07	295.19	329.80	346.47	**301.63**
Phos. + E.M. + Sal.	260.48	311.72	356.54	371.16	**324.98**	285.27	340.88	380.27	387.76	**348.55**
NPK	278.96	327.79	374.16	383.97	**341.22**	299.06	356.59	398.57	400.95	**363.79**
Mean (B)	**206.29**	**248.78**	**286.20**	**308.12**		**227.90**	**277.02**	**312.45**	**329.21**	
L.S.D. at 5 %	**A: 13.75**		**B: 23.0**		**AB: 46**	**A: 11.10**		**B: 21.05**		**AB: 42.10**
Second season (2011)										
Control	152.44	182.30	211.99	244.91	**197.91**	182.65	214.55	245.96	280.99	**231.04**
Phos.	170.07	206.53	237.99	267.25	**220.46**	202.99	238.28	273.14	301.28	**253.92**
E.M.	188.00	236.55	270.78	293.49	**247.21**	224.26	271.73	305.89	324.47	**281.59**
Phos. + E.M.	213.21	272.27	308.15	324.3	**279.48**	248.93	309.27	346.28	352.80	**314.32**
Sal.	225.72	282.82	320.10	332.62	**290.32**	262.29	318.97	358.73	362.37	**325.59**
Phos.+E.M.+ Sal.	265.19	330.80	372.19	377.77	**336.49**	302.71	367.27	411.41	414.73	**374.03**
NPK	287.70	345.73	384.49	389.60	**351.88**	320.47	384.03	429.01	424.60	**389.53**
Mean (B)	**214.62**	**265.29**	**300.81**	**318.56**		**249.19**	**300.59**	**338.63**	**351.61**	
L.S.D. at 5 %	**A: 10.67**		**B: 19.58**		**AB: 38.32**	**A: 14.42**		**B: 18.6**		**AB: 37.2**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (4): Effect of FYM, bio. and / or salicylic acid and NPK treatments on total herb fresh weight per plant and feddan per season of *Ocimum gratissimum* L. plant during 2010 and 2011 seasons

Treatments	First season (2010)					Second season (2011)				
	Total fresh weight of herb / plant / season (g / plant)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	305.40	363.12	422.14	481.70	**393.09**	335.09	396.85	457.95	525.90	**428.95**
Phos.	343.43	409.69	473.29	524.91	**437.83**	373.06	444.81	511.10	568.53	**474.38**
E.M.	379.47	468.87	537.53	583.38	**492.31**	412.26	508.28	576.67	617.96	**528.79**
Phos. + E.M.	433.97	539.32	612.41	653.90	**559.90**	462.14	581.54	654.43	677.1	**593.80**
Sal.	454.32	562.35	635.64	673.57	**585.97**	488.01	601.79	678.83	694.99	**615.91**
Phos.+E.M.+ Sal.	545.75	652.60	736.81	758.92	**673.52**	565.90	698.07	783.60	788.16	**708.93**
NPK	578.02	684.38	772.73	784.92	**705.01**	606.58	729.96	813.5	814.20	**741.06**
Mean (B)	**434.34**	**525.76**	**598.65**	**637.33**		**463.29**	**565.9**	**639.44**	**669.55**	
L.S.D. at 5 %	**A: 22.04**		**B: 31.51**		**AB: 63.02**	**A: 29.93**		**B: 32.18**		**AB: 64.36**
Total fresh weight of herb / fed. / season (ton / fed.)										
Control	7.64	9.08	10.58	12.04	**9.84**	8.38	9.92	11.45	13.15	**10.72**
Phos.	8.14	10.24	11.83	13.12	**10.83**	9.33	11.12	12.78	14.21	**11.86**
E.M.	9.49	11.72	13.44	14.59	**12.31**	10.31	12.71	14.37	15.45	**13.21**
Phos. + E.M.	10.82	13.48	15.31	16.35	**13.99**	11.45	14.54	16.36	16.93	**14.82**
Sal.	11.36	14.06	15.89	16.84	**14.54**	12.20	15.04	16.97	17.37	**15.40**
Phos.+E.M.+ Sal.	13.64	16.32	18.42	18.97	**16.84**	14.15	17.45	19.59	19.70	**17.72**
NPK	14.45	17.11	19.32	19.62	**17.63**	15.16	18.25	20.34	20.36	**18.53**
Mean (B)	**10.79**	**13.14**	**14.97**	**15.93**		**11.57**	**14.15**	**15.98**	**16.74**	
L.S.D. at 5 %	**A: 0.93**		**B: 0.80**		**AB: 1.60**	**A: 0.71**		**B: 0.83**		**AB: 1.66**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Effect on essential oil productivity :

The obtained results in Tables (5, 6 and 7) indicated that FYM as organic fertilizer at the three levels (25, 35 and 45 m^3 / fed.) significantly increased essential oil percentage and essential oil yield (ml / plant either / cut or / season and liter / fed. / season) in clove basil fresh herb over those of control plants in the two cuts during both seasons. The highest values were obtained from the high level of FYM (45 m^3 / fed.). In general, the values of essential oil % and oil yield / plant / cut in the second cut of both seasons were higher than those in the first cut. This may be due to the direct effect of FYM or indirect effect of environmental conditions, especially temperature and light period on the physiological and biochemical processes in the plants consequently oil percentage that reflect on oil yield. In agreement with these results were those found by Jacoub (1999) and Mohsen (2002) on sweet basil and Abdalla (2009) on coriander plants.

Data in the same Tables indicated also that the treatments of bio. and / or Sal., as well as, NPK significantly increased oil % and oil yield (per plant / cut, per plant / season and per fed./ season) in the two growing seasons compared with control (without any addition). Concerning the essential oil %, the obtained data showed that the treatment of E.M. + Phos. + Sal. was more effective than other treatments. This treatment gave the highest values of essential oil % followed by Sal. treatment then mineral NPK without significant differences among them.

Table (5): Effect of FYM, bio. and/or salicylic acid and NPK treatments on essential oil percentage of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Essential oil (%)									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	0.68	0.71	0.75	0.77	**0.727**	0.69	0.73	0.76	0.79	**0.743**
Phos.	0.69	0.72	0.77	0.79	**0.743**	0.71	0.77	0.79	0.81	**0.771**
E.M.	0.71	0.74	0.80	0.81	**0.765**	0.73	0.79	0.83	0.85	**0.800**
Phos. + E.M.	0.74	0.75	0.80	0.83	**0.780**	0.73	0.80	0.85	0.86	**0.810**
Sal.	0.76	0.79	0.85	0.87	**0.818**	0.78	0.85	0.91	0.92	**0.845**
Phos.+ E.M. + Sal.	0.77	0.80	0.86	0.87	**0.825**	0.79	0.87	0.91	0.93	**0.865**
NPK	0.75	0.78	0.83	0.84	**0.800**	0.76	0.82	0.89	0.91	**0.876**
Mean (B)	**0.729**	**0.755**	**0.809**	**0.826**		**0.742**	**0.804**	**0.849**	**0.867**	
L.S.D. at 5 %	**A: 0.016**		**B: 0.028**		**AB: 0.056**	**A: 0.012**		**B: 0.035**		**AB: 0.070**
Second season (2011)										
Control	0.69	0.72	0.76	0.78	**0.738**	0.72	0.77	0.80	0.82	**0.778**
Phos.	0.71	0.75	0.79	0.80	**0.763**	0.75	0.80	0.84	0.87	**0.815**
E.M.	0.73	0.78	0.80	0.82	**0.783**	0.75	0.81	0.85	0.89	**0.825**
Phos. + E.M.	0.74	0.81	0.82	0.84	**0.803**	0.76	0.83	0.86	0.92	**0.843**
Sal.	0.77	0.84	0.86	0.88	**0.838**	0.79	0.88	0.92	0.98	**0.893**
Phos.+E.M. + Sal.	0.77	0.85	0.87	0.88	**0.843**	0.81	0.89	0.94	0.99	**0.908**
NPK	0.76	0.82	0.84	0.85	**0.817**	0.78	0.86	0.88	0.95	**0.868**
Mean (B)	**0.739**	**0.796**	**0.820**	**0.836**		**0.767**	**0.835**	**0.870**	**0.917**	
L.S.D. at 5 %	**A: 0.015**		**B: 0.027**		**AB: 0.054**	**A: 0.033**		**B: 0.040**		**AB: 0.080**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (6): Effect of FYM, bio. and/or salicylic acid and NPK treatments on essential oil yield (ml/plant) of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Essential oil yield (ml / plant)									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	0.95	1.19	1.48	1.75	**1.34**	1.14	1.43	1.94	2.01	**1.63**
Phos.	1.11	1.38	1.72	1.99	**1.55**	1.30	1.68	1.98	2.22	**1.79**
E.M.	1.26	1.63	2.04	2.27	**1.80**	1.47	1.96	2.35	2.58	**2.09**
Phos. + E.M.	1.53	1.91	2.34	2.61	**2.10**	1.65	2.28	2.72	2.91	**2.39**
Sal.	1.67	2.11	2.60	2.85	**2.31**	1.83	2.51	3.00	3.19	**2.63**
Phos.+ E.M. + Sal.	2.01	2.49	3.07	3.23	**2.70**	2.25	2.97	3.46	3.61	**3.07**
NPK	2.09	2.56	3.11	3.23	**2.75**	2.27	2.92	3.55	3.65	**3.10**
Mean (B)	**1.52**	**1.90**	**2.33**	**2.56**		**1.70**	**2.25**	**2.71**	**2.88**	
L.S.D. at 5 %	**A: 0.020**		**AB: 0.024**		**AB: 0.048**	**A: 0.014**		**B: 0.024**		**AB: 0.048**
	Second season (2011)									
Control	1.05	1.31	1.61	1.91	**1.47**	1.32	1.65	1.97	2.30	**1.81**
Phos.	1.21	1.55	1.88	2.14	**1.69**	1.52	1.91	2.29	2.62	**2.09**
E.M.	1.37	1.85	2.17	2.41	**1.95**	1.68	2.20	2.60	2.89	**2.34**
Phos. + E.M.	1.58	2.21	2.53	2.72	**2.26**	1.89	2.57	2.98	3.25	**2.67**
Sal.	1.74	2.38	2.75	2.93	**2.45**	2.07	2.81	3.30	3.55	**2.93**
Phos.+E.M.+ Sal.	2.04	2.81	3.24	3.32	**2.85**	2.45	3.27	3.87	4.11	**3.42**
NPK	2.19	2.84	3.23	3.31	**2.89**	2.50	3.30	3.78	4.03	**3.40**
Mean (B)	**1.60**	**2.13**	**2.49**	**2.68**		**1.92**	**2.53**	**2.97**	**3.25**	
L.S.D. at 5 %	**A: 0.018**		**B: 0.028**		**AB: 0.056**	**A: 0.020**		**B: 0.016**		**AB: 0.032**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (7): Effect of FYM, bio. and/or salicylic acid and NPK treatments on essential oil yield per plant (ml) and feddan (litre) per season of *Ocimum gratissimum* L. plant during 2010 and 2011 seasons

Treatments	First season (2010)					Second season (2011)				
	Essential oil yield / plant / season (ml)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	2.09	2.62	3.42	3.76	**2.97**	2.37	2.96	3.58	4.21	**3.28**
Phos.	2.41	3.06	3.70	4.21	**3.35**	2.73	3.46	4.17	4.76	**3.78**
E.M.	2.73	3.59	4.39	4.85	**3.89**	3.05	4.05	4.77	5.30	**4.29**
Phos. + E.M.	3.18	4.19	5.06	5.52	**4.49**	3.47	4.78	5.51	5.97	**4.93**
Sal.	3.50	4.62	5.60	6.04	**4.94**	3.81	5.19	6.05	6.48	**5.38**
Phos.+E.M.+ Sal.	4.26	5.46	6.53	6.84	**5.77**	4.49	6.08	7.11	7.43	**6.28**
NPK	4.36	5.48	6.66	6.88	**5.85**	4.69	6.14	7.01	7.34	**6.30**
Mean (B)	**3.22**	**4.15**	**5.05**	**5.44**		**3.52**	**4.67**	**5.46**	**5.93**	
L.S.D. at 5 %	**A: 0.03**		**B: 0.04**		**AB: 0.08**	**A: 0.04**		**B: 0.05**		**AB: 0.010**
	Essential oil yield / fed. (liter)									
Control	52.25	65.50	85.50	94.00	**74.31**	59.25	74.00	89.50	105.25	**82.00**
Phos.	60.25	76.50	92.50	105.25	**83.63**	68.25	86.50	104.25	119.00	**94.50**
E.M.	68.25	89.75	109.75	121.25	**97.25**	76.25	101.25	119.25	132.50	**107.31**
Phos. + E.M.	79.50	104.75	126.50	138.00	**112.19**	86.75	119.50	137.75	149.25	**123.31**
Sal.	87.50	115.50	140.00	151.00	**123.50**	95.25	129.75	151.25	162.00	**134.56**
Phos.+E.M.+ Sal.	106.50	136.50	163.25	171.00	**144.31**	112.25	152.00	177.75	185.75	**156.94**
NPK	109.00	137.00	166.50	172.00	**146.13**	117.25	153.50	175.25	183.50	**157.38**
Mean (B)	**80.46**	**103.64**	**126.29**	**136.07**		**87.89**	**116.64**	**136.43**	**148.18**	
L.S.D. at 5 %	**A: 2.33**		**B: 1.75**		**AB: 3.50**	**A: 2.74**		**B: 1.18**		**AB: 2.36**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Regarding essential oil yield (per plant / cut or per plant / season and / fed. / season), the treatment of mineral NPK followed by the treatment of E.M. and Phos. plus Sal. gave significantly the highest values of oil yield in both seasons, in comparison with the other treatments.

The improvement in the essential oil % in the fresh herb as a result of application the bio-fertilization with salicylic acid could be explained through the interpretations of Youssef *et al.* (2004) on sage and El–Shora (2009) on spearmint plants, who demonstrated that the growth hormones producing by microorganisms improved essential oil content and yield. Moreover, Ibrahim (2010) on geranium plants stated that salicylic acid and its chemical derivatives (acetylsalicylic acid) have been reported to enhance the productivity of some secondary metabolites, also it enhance vegetative growth of plants and consequently reflected on the productivity of oil.

The role of mineral NPK in promoting essential oil yield was reported by Mahfouz (2003) on marjoram plants; Abd El–Lateef (2007); Rao *et al.* (2007) on *Ocimum basilicum* and Ardelan *et al.* (2010) on *Satureja hortensis*. While, the increase of oil yield as a result of used biofertilizers, was also reported by Youssef *et al.* (2004) on sage plants; Erika *et al.* (2008) on marjoram plants and El–Shora (2009) on *Mentha piperita*. In the meantime, Abdou *et al.* (2009a) on caraway plants and Abd El–Lateef (2007) on sweet basil and marjoram plants proved that the essential oil yield / plant for three cutting increased about two fold on a fresh weight with salicylic acid at 10^{-4} M in case of basil and 10^{-3} M in marjoram relative to untreated control.

The interaction between main-plot (FYM) and sub-plot (bio and/or salicylic acid, as well as, NPK fertilization) was significant in both cuts in the two seasons for essential oil % or essential oil yield (per plant / cut, per plant / season and per fed./ season) as illustrated in Tables (5, 6 and 7). The interaction treatment of FYM_3 x E.M. + Phos. + Sal. resulted the highest essential oil percentages, while the highest values of essential oil yield (per plant / cut, per plant / season and per feddan / season) were obtained due to adding FYM at the highest level (45 m^3 / fed.) in combination with mineral NPK or E.M. + Phos. + Sal.

Effect on chemical constituent :

Photosynthetic pigments :

Data in Tables (8, 9 and 10) indicated that all three FYM treatments significantly improved the contents of chlorophyll a, b and carotenoids (mg / g fresh weight) in the fresh leaves of clove basil plants in the two cuts during both experimental seasons over those of the untreated control plants. Among such three FYM fertilization treatments, the high level (45 m^3 / fed.) gave the highest values in both cuts during the two seasons. Similar results were obtained by Kandeel *et al.* (2002) on sweet basil plants; Sakr (2005) on *Cassia acutifolia*; Abdalla (2009) on coriander plants and Abdou *et al.* (2009d) on fennel plants.

Table (8): Effect of FYM, bio. and/or salicylic acid and NPK treatments on chlorophyll a content (mg/g fresh weight) in the leaves of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Chlorophyll a content (mg / g fresh weight)									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	2.104	2.116	2.140	2.161	**2.130**	2.318	2.354	2.378	2.390	**2.360**
Phos.	2.139	2.162	2.188	2.203	**2.173**	2.343	2.381	2.413	2.423	**2.390**
E.M.	2.151	2.177	2.203	2.221	**2.188**	2.355	2.396	2.425	2.436	**2.403**
Phos. + E.M.	2.166	2.195	2.221	2.239	**2.205**	2.375	2.420	2.445	2.457	**2.424**
Sal.	2.184	2.216	2.245	2.266	**2.228**	2.404	2.451	2.474	2.485	**2.454**
Phos.+E.M.+ Sal.	2.205	2.240	2.271	2.291	**2.252**	2.425	2.476	2.495	2.516	**2.478**
NPK	2.219	2.255	2.287	2.305	**2.267**	2.441	2.494	2.521	2.528	**2.496**
Mean (B)	**2.167**	**2.194**	**2.222**	**2.241**		**2.380**	**2.425**	**2.450**	**2.462**	
L.S.D. at 5 %	**A: 0.022**	**B: 0.026**		**AB: 0.052**		**A: 0.024**	**B: 0.027**		**AB: 0.054**	
	Second season (2011)									
Control	2.256	2.304	2.335	2.358	**2.313**	2.382	2.434	2.467	2.491	**2.442**
Phos.	2.282	2.342	2.371	2.392	**2.347**	2.413	2.489	2.505	2.518	**2.481**
E.M.	2.295	2.360	2.387	2.407	**2.362**	2.431	2.510	2.525	2.539	**2.502**
Phos. + E.M.	2.306	2.376	2.401	2.421	**2.376**	2.447	2.528	2.544	2.561	**2.521**
Sal.	2.330	2.412	2.435	2.455	**2.408**	2.479	2.569	2.584	2.603	**2.559**
Phos.+E.M.+ Sal.	2.348	2.431	2.456	2.476	**2.428**	2.501	2.594	2.609	2.623	**2.582**
NPK	2.360	2.447	2.468	2.487	**2.441**	2.513	2.608	2.615	2.628	**2.591**
Mean (B)	**2.311**	**2.382**	**2.408**	**2.428**		**2.452**	**2.533**	**2.550**	**2.566**	
L.S.D. at 5 %	**A: 0.024**	**B: 0.026**		**AB: 0.052**		**A: 0.017**	**B: 0.019**		**AB: 0.038**	

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (9): Effect of FYM, bio. and/or salicylic acid and NPK treatments on chlorophyll b content (mg/g fresh weight) in the leaves of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Chlorophyll b content (mg / g fresh weight)									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	0.691	0.696	0.705	0.714	**0.702**	0.757	0.772	0.781	0.787	**0.774**
Phos.	0.700	0.712	0.722	0.730	**0.716**	0.768	0.782	0.791	0.796	**0.784**
E.M.	0.708	0.716	0.727	0.738	**0.722**	0.774	0.791	0.798	0.801	**0.791**
Phos. + E.M.	0.714	0.723	0.734	0.742	**0.728**	0.782	0.799	0.807	0.807	**0.799**
Sal.	0.721	0.731	0.743	0.752	**0.737**	0.794	0.810	0.818	0.818	**0.810**
Phos.+E.M.+ Sal.	0.729	0.740	0.753	0.761	**0.746**	0.801	0.819	0.827	0.824	**0.818**
NPK	0.736	0.746	0.758	0.765	**0.751**	0.807	0.826	0.833	0.829	**0.824**
Mean (B)	**0.714**	**0.723**	**0.735**	**0.743**		**0.783**	**0.800**	**0.808**	**0.809**	
L.S.D. at 5 %	**A: 0.008**	**B: 0.016**		**AB: N.S**		**A: 0.016**	**B: 0.017**		**AB: N.S**	
	Second season (2011)									
Control	0.730	0.750	0.761	0.767	**0.752**	0.783	0.801	0.813	0.817	**0.803**
Phos.	0.742	0.764	0.774	0.777	**0.764**	0.796	0.820	0.831	0.840	**0.822**
E.M.	0.748	0.771	0.779	0.783	**0.770**	0.808	0.825	0.836	0.847	**0.829**
Phos. + E.M.	0.754	0.778	0.786	0.791	**0.777**	0.814	0.837	0.841	0.855	**0.837**
Sal.	0.765	0.794	0.801	0.812	**0.793**	0.821	0.849	0.858	0.871	**0.850**
Phos.+E.M.+ Sal.	0.771	0.802	0.809	0.818	**0.800**	0.830	0.853	0.865	0.879	**0.857**
NPK	0.777	0.808	0.814	0.821	**0.805**	0.834	0.859	0.869	0.884	**0.862**
Mean (B)	**0.755**	**0.781**	**0.789**	**0.795**		**0.812**	**0.835**	**0.845**	**0.856**	
L.S.D. at 5 %	**A: 0.012**	**B: 0.015**		**AB: N.S**		**A: 0.010**	**B: 0.012**		**AB: 0.024**	

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (10): Effect of FYM, bio. and/or salicylic acid and NPK treatments on carotenoids content (mg/g fresh weight) in the leaves of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Carotenoids content (mg / g fresh weight)									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	0.721	0.731	0.744	0.745	**0.735**	0.739	0.776	0.798	0.812	**0.781**
Phos.	0.731	0.743	0.760	0.761	**0.749**	0.750	0.784	0.812	0.824	**0.793**
E.M.	0.736	0.754	0.765	0.768	**0.756**	0.756	0.787	0.813	0.827	**0.796**
Phos. + E.M.	0.742	0.760	0.770	0.775	**0.762**	0.770	0.792	0.816	0.828	**0.802**
Sal.	0.748	0.767	0.780	0.783	**0.770**	0.786	0.805	0.829	0.839	**0.815**
Phos.+E.M.+ Sal.	0.755	0.774	0.788	0.793	**0.778**	0.799	0.807	0.830	0.841	**0.819**
NPK	0.761	0.780	0.791	0.797	**0.782**	0.807	0.810	0.832	0.843	**0.823**
Mean (B)	**0.742**	**0.758**	**0.771**	**0.775**		**0.772**	**0.794**	**0.819**	**0.831**	
L.S.D. at 5 %	**A: 0.009**		**B: 0.012**		**AB: N.S**	**A: 0.014**		**B: 0.008**		**AB: N.S**
	Second season (2011)									
Control	0.767	0.778	0.794	0.802	**0.785**	0.820	0.841	0.852	0.872	**0.846**
Phos.	0.773	0.790	0.808	0.817	**0.797**	0.833	0.862	0.874	0.881	**0.863**
E.M.	0.779	0.801	0.815	0.822	**0.804**	0.840	0.869	0.881	0.888	**0.869**
Phos. + E.M.	0.785	0.809	0.822	0.836	**0.813**	0.852	0.872	0.887	0.895	**0.876**
Sal.	0.797	0.824	0.836	0.847	**0.826**	0.864	0.889	0.899	0.909	**0.890**
Phos.+E.M.+ Sal.	0.804	0.830	0.842	0.858	**0.834**	0.873	0.894	0.907	0.916	**0.897**
NPK	0.805	0.831	0.841	0.861	**0.834**	0.876	0.899	0.914	0.918	**0.902**
Mean (B)	**0.787**	**0.809**	**0.823**	**0.834**		**0.851**	**0.875**	**0.888**	**0.897**	
L.S.D. at 5 %	**A: 0.012**		**B: 0.011**		**AB: N.S**	**A: 0.011**		**B: 0.013**		**AB: N.S**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

It is evident from data in Tables (8, 9 and 10) that all six tested treatments of bio. and / or salicylic acid, as well as, NPK significantly increased chlorophyll a, b and carotenoids contents over control treatment in the two cuts during the two growing seasons, except the treatment of phosphorein during second cut of first season for chlorophyll b, as there was no significant difference. The highest values of chlorophyll a were obtained from treatments of mineral NPK followed by E.M. + Phos. + Sal. While, the maximum contents of chlorophyll b and carotenoids in both cuts and in both seasons were obtained due to the treatments of NPK followed by E.M. + Phos. + Sal. then Sal. without significant differences among them.

The greatest effect of NPK on increasing photosynthetic pigments was recorded by Khafaga *et al.* (2000) and Mohsen (2002) on sweet basil plants; Shala (2007) on *Salvia officinalis*; Abdalla (2009) on coriander and Ibrahim (2010) on geranium plants. Biofertilization treatments were effective in increasing pigments contents as reported by Abdou *et al.* (2004a) and (2004b) on fennel plants; Abd El–Hadi *et al.* (2009) on *Mentha* spp. and Ashour (2010) on jojoba plants. Moreover, Al–Shareif (2006) and Abdou *et al.* (2009a) on caraway plants; Ayat (2007) on coriander plants; Abd El–Lateef (2007) on sweet basil and marjoram plants and Ibrahim (2010) on geranium plants pointed out that salicylic acid treatments enhanced the photosynthetic pigments in the fresh leaves of plants.

The interaction between main-plot and sub-plot (A x B) was significant in both cuts, in both seasons for chlorophyll a, it was also significant, only in the second cut during the second season for chlorophyll b, while, it was not significant for carotenoids in all cases. The highest values of

chlorophyll a were obtained from the interaction treatment of FYM_3 + NPK, while adding FYM_3 in combination with NPK followed by E.M. + Phos. + Sal. then Sal. or adding FYM_2 with NPK gave the highest values of chlorophyll b.

N, P and K %:

Data in Tables (11, 12 and 13) indicated that fertilizing clove basil plants with FYM at three levels of 25, 35 and 45 m^3 / fed. significantly led to enhance the percentages of the three elements of N, P and K in the dry herb of plants in comparison with the control plants (without fertilizers). The highest values were obtained from the treatment of high level of FYM (45 m^3 / fed.).

The promoting effect of organic manure was found by many authors such as, El–Ghadban *et al.* (2003) and El–Sanafawy (2007) on marjoram plants; Heikal (2005) on *Thymus vulgaris*; Abdalla (2009) on coriander plants and Abdou *et al.* (2009a), (2009b) and (2009d) on caraway, borage and fennel plants.

Data in Tables (11, 12 and 13) also indicated that all six tested treatments (Phos., E.M., E.M. + Phos., Sal., E.M. + Phos. + Sal. and NPK) significantly increased N, P and K % in the dry herb of plants over the control in both cuts during the two growing seasons. The highest values of N and K % were obtained due to the treatments of NPK followed by the mixture of the two biofertilizers plus salicylic acid. Regarding the phosphorus percentage, significantly highest values were found in the dry herb of plants which fertilized by NPK, biofertilizers plus salicylic acid, the mixture of biofertilizers only and phosphorein.

Table (11): Effect of FYM, bio. and/or salicylic acid and NPK treatments on nitrogen % in dry herb of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Nitrogen %									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	1.621	1.632	1.651	1.674	**1.645**	1.725	1.742	1.797	1.828	**1.773**
Phos.	1.652	1.673	1.682	1.695	**1.676**	1.756	1.785	1.835	1.857	**1.808**
E.M.	1.744	1.785	1.805	1.818	**1.788**	1.821	1.859	1.914	1.945	**1.885**
Phos. + E.M.	1.755	1.796	1.825	1.833	**1.802**	1.854	1.898	1.958	1.967	**1.919**
Sal.	1.713	1.744	1.766	1.797	**1.755**	1.864	1.910	1.965	1.981	**1.930**
Phos.+E.M.+ Sal.	1.786	1.837	1.867	1.878	**1.842**	1.897	1.956	1.978	1.985	**1.954**
NPK	1.807	1.858	1.871	1.883	**1.855**	1.921	1.979	1.981	1.988	**1.967**
Mean (B)	**1.725**	**1.761**	**1.781**	**1.797**		**1.732**	**1.876**	**1.918**	**1.936**	
L.S.D. at 5 %	**A: 0.014**		**B: 0.015**		**AB: N.S**	**A: 0.016**		**B: 0.019**		**AB: N.S**
	Second season (2011)									
Control	1.673	1.687	1.724	1.751	**1.709**	1.724	1.748	1.779	1.792	**1.761**
Phos.	1.704	1.729	1.759	1.776	**1.742**	1.757	1.791	1.805	1.818	**1.793**
E.M.	1.792	1.822	1.855	1.891	**1.840**	1.856	1.887	1.910	1.934	**1.897**
Phos. + E.M.	1.799	1.842	1.882	1.899	**1.856**	1.867	1.897	1.937	1.941	**1.911**
Sal.	1.810	1.853	1.895	1.907	**1.866**	1.880	1.908	1.955	1.963	**1.927**
Phos.+E.M.+ Sal.	1.841	1.897	1.923	1.932	**1.898**	1.897	1.957	1.978	1.988	**1.955**
NPK	1.864	1.919	1.928	1.936	**1.912**	1.934	1.969	1.988	1.999	**1.973**
Mean (B)	**1.783**	**1.821**	**1.852**	**1.870**		**1.845**	**1.880**	**1.907**	**1.919**	
L.S.D. at 5 %	**A: 0.015**		**B: 0.018**		**AB: 0.036**	**A: 0.012**		**B: 0.015**		**AB: 0.030**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (12): Effect of FYM, bio. and/or salicylic acid and NPK treatments on phosphorus % in dry herb of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Phosphorus %									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	0.101	0.116	0.127	0.139	**0.121**	0.131	0.145	0.157	0.166	**0.150**
Phos.	0.152	0.164	0.175	0.189	**0.170**	0.184	0.199	0.212	0.222	**0.204**
E.M.	0.143	0.155	0.168	0.176	**0.161**	0.175	0.189	0.201	0.210	**0.194**
Phos. + E.M.	0.159	0.173	0.187	0.198	**0.179**	0.192	0.208	0.222	0.233	**0.214**
Sal.	0.124	0.141	0.152	0.168	**0.146**	0.158	0.172	0.185	0.194	**0.177**
Phos.+E.M.+ Sal.	0.162	0.171	0.189	0.197	**0.180**	0.197	0.214	0.229	0.241	**0.220**
NPK	0.169	0.178	0.189	0.199	**0.184**	0.204	0.221	0.236	0.248	**0.227**
Mean (B)	**0.144**	**0.157**	**0.170**	**0.181**		**0.177**	**0.193**	**0.206**	**0.216**	
L.S.D. at 5 %	**A: 0.011**		**B: 0.021**		**AB: 0.042**	**A: 0.013**		**B: 0.024**		**AB: 0.048**
Second season (2011)										
Control	0.112	0.124	0.137	0.150	**0.131**	0.140	0.150	0.161	0.172	**0.156**
Phos.	0.163	0.176	0.190	0.205	**0.184**	0.194	0.220	0.226	0.233	**0.218**
E.M.	0.154	0.166	0.179	0.192	**0.173**	0.184	0.194	0.205	0.216	**0.200**
Phos. + E.M.	0.172	0.186	0.201	0.217	**0.194**	0.203	0.216	0.230	0.245	**0.224**
Sal.	0.135	0.147	0.160	0.173	**0.154**	0.167	0.177	0.188	0.200	**0.183**
Phos.+E.M.+ Sal.	0.176	0.191	0.207	0.224	**0.200**	0.212	0.228	0.245	0.263	**0.237**
NPK	0.183	0.198	0.214	0.231	**0.207**	0.219	0.235	0.252	0.271	**0.244**
Mean (B)	**0.156**	**0.170**	**0.184**	**0.199**		**0.188**	**0.203**	**0.215**	**0.229**	
L.S.D. at 5 %	**A: 0.013**		**B: 0.023**		**AB: 0.046**	**A: 0.012**		**B: 0.027**		**AB: 0.054**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Table (13): Effect of FYM, bio. and/or salicylic acid and NPK treatments on potassium % in dry herb of *Ocimum gratissimum* L. plant in the first and second cut during 2010 and 2011 seasons

Treatments	Potassium %									
	First cut					Second cut				
	First season (2010)									
	FYM_0	FYM_1	FYM_2	FYM_3	Mean A	FYM_0	FYM_1	FYM_2	FYM_3	Mean A
Control	1.222	1.235	1.240	1.250	**1.237**	1.231	1.243	1.249	1.257	**1.245**
Phos.	1.253	1.256	1.255	1.260	**1.256**	1.264	1.268	1.277	1.286	**1.274**
E.M.	1.258	1.275	1.280	1.288	**1.275**	1.270	1.288	1.296	1.306	**1.290**
Phos. + E.M.	1.302	1.332	1.338	1.344	**1.329**	1.315	1.346	1.358	1.369	**1.347**
Sal.	1.344	1.345	1.349	1.353	**1.348**	1.358	1.359	1.369	1.381	**1.367**
Phos.+E.M.+ Sal.	1.356	1.375	1.380	1.389	**1.375**	1.371	1.390	1.402	1.416	**1.395**
NPK	1.362	1.385	1.384	1.396	**1.382**	1.377	1.400	1.413	1.426	**1.404**
Mean (B)	**1.300**	**1.315**	**1.318**	**1.326**		**1.312**	**1.328**	**1.338**	**1.349**	
L.S.D. at 5 %	**A: 0.007**		**B: 0.011**		**AB: N.S**	**A: 0.009**		**B: 0.015**		**AB: 0.030**
Second season (2011)										
Control	1.227	1.239	1.245	1.254	**1.241**	1.238	1.251	1.267	1.279	**1.259**
Phos.	1.259	1.262	1.266	1.283	**1.268**	1.271	1.275	1.285	1.298	**1.282**
E.M.	1.264	1.282	1.290	1.307	**1.286**	1.275	1.296	1.305	1.319	**1.299**
Phos. + E.M.	1.309	1.339	1.351	1.367	**1.342**	1.320	1.354	1.377	1.392	**1.361**
Sal.	1.351	1.352	1.365	1.377	**1.361**	1.362	1.366	1.382	1.398	**1.377**
Phos.+E.M. + Sal.	1.364	1.383	1.398	1.408	**1.388**	1.376	1.398	1.413	1.428	**1.404**
NPK	1.370	1.393	1.407	1.416	**1.397**	1.384	1.408	1.418	1.433	**1.411**
Mean (B)	**1.306**	**1.321**	**1.332**	**1.345**		**1.318**	**1.335**	**1.350**	**1.364**	
L.S.D. at 5 %	**A: 0.010**		**B: 0.014**		**AB: 0.028**	**A: 0.012**		**B: 0.016**		**AB: 0.032**

Phos. = phosphorein E.M. = Effective microorganisms Sal. = salicylic acid

Many authors came to similar results that NPK fertilization augmented N, P and K % in leaves and herb of different plants such as, *Ocimum basilicum* **(**Mohsen, 2002 and El–Sanafawy, 2007) and *Rosmarinus officinalis* (Abdelaziz *et al.,* 2007). While, the roles of biofertilizers in promoting N, P and K % were also reported by many authors on different plants such as borage (Hafez, 2003 and Abdou *et al.,* 2009b); *Origanum syriacum* (El–Leithy *et al.,* 2007); *Tagetes erecta* (El–Maadawy, 2007); guar (Abdou *et al.,* 2009c) and moghat plants (Hussain, 2011). The effect of salicylic acid on N, P and K % was also disclosed by Al–Shareif (2006) and Abdou *et al.* (2009a) on *Carum carvi*; Ayat (2007) on coriander plants and Ibrahim (2010) on geranium plant.

The interaction between FYM and bio. and / or Sal., as well as, NPK was significant for N % (only in the two cuts during second season), and also for P % (in the two cuts during both seasons), as well as, it was significant in the second cut of the first season and in the two cuts of the second one for K %. The highest values of N % were obtained from adding any level of FYM with NPK, the high and medium level of FYM with biofertilizers plus salicylic acid. The highest values of P % were obtained due to the interaction treatments of FYM_3 + NPK, FYM_3 + biofertilizers + Sal. and FYM_3 + biofertilizers, as well as, FYM_3 + Phos. (in the second season). While, fertilized plants with any level of FYM with NPK or using the high or medium levels of FYM in combination with E.M. + Phos. + Sal. led to maximum K % in the dry herb of *Ocimum gratissimum* plants.

Finally, it could be recommended to supply clove basil plants with FYM at 45 or 35 m^3 / fed. in combination with mineral NPK fertilization (300 kg / fed of ammonium nitrate + 250 kg / fed. of calcium superphosphate + 150 kg / fed. of potassium sulphate) for the traditional cultivation system. On the other hand, for bio-organic cultivation system (clean agriculture). It could be recommended, economically and environmentally, to adding FYM at 45 m^3 / fed. to the soil of clove basil plants and treating the plants with a mixture of E.M. + phosphorein + salicylic acid at 150 ppm.

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دراسات فسيولوجية على نبات الريحان القرنفلى

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أجرى هذا البحث فى مشتل ومعمل الزينة بكلية الزراعة جامعة المنيا خلال موسمى الزراعة ٢٠١٠ و٢٠١١ لدراسة تأثير التسميد البلدى والسماد الحيوى و/أو حمض السالساليك وكذلك التسميد المعدنى (NPK) على النمو الخضرى وإنتاج الزيت والتركيب الكيماوى لنبات الريحان القرنفلى.

ولقد أوضحت النتائج المتحصل عليها الآتى:

- أدت إضافة السماد البلدى إلى زيادة معنوية فى ارتفاع النبات (سم)، عدد الأفرع / نبات، الوزن الطازج للعشب فى الحشة (جم / نبات / حشة)، الوزن الطازج للعشب فى الموسم (جم / نبات / موسم)، الوزن الطازج الكلى للعشب فى الموسم للفدان (طن / فدان / موسم)، النسبة المئوية للزيت الطيار، محصول الزيت الطيار للنبات فى الحشة (مليلتر / نبات / حشة)، محصول الزيت الطيار للنبات فى الموسم (مليلتر / نبات / موسم)، المحصول الكلى للزيت الطيار فى الموسم للفدان (لتر / فدان)، محتوى الأوراق من كلورفيل أ ، ب والكاروتينويدات (مجم / جم وزن طازج) وكذلك النسبة المئوية لكل من النيتروجين، الفوسفور والبوتاسيوم فى العشب الجاف. ولقد كان التفوق فى كل الخصائص السابق ذكرها للمعاملة بالمستوى العالى من السماد البلدى (٤٥ م^{٣} / فدان) مقارنة بالمعاملات الأخرى.
- أعطت النباتات المعاملة بالتسميد المعدنى (NPK) أو خليط الكائنات الدقيقة النشطة (E.M.) والفوسفورين مع حمض السالساليك أفضل النتائج فى جميع القياسات المدروسة فى الحشتين خلال موسمى النمو. فيما يتعلق بالنسبة المئوية للزيت فى العشب الطازج، فلقد كانت المعاملة بخليط الحيوى + حمض السالساليك أكثر فاعلية من المعاملات الأخرى.
- كانت معاملات التفاعل بين العامل الرئيسى (السماد البلدى) والعامل الثانوى (التسميد الحيوى والمعدنى وحمض السالساليك) الأكثر فاعلية على نتائج القياسات. حيث سجلت أعلى القيم فى معظم القياسات محل الدراسة نتيجة استخدام المستوى العالى من السماد البلدى (٤٥ م^{٣} / فدان) مع التسميد المعدنى (NPK) أو خليط السماد الحيوى + حمض السالساليك.
- فى ظل نظام الزراعة التقليدية، فإنه يمكن التوصية بتسميد نباتات الريحان القرنفلي بسماد الحيوان بمعدل ٤٥ أو ٣٥ م^{٣} / فدان مع السماد المعدني (٣٠٠ كجم / فدان نترات الأمونيوم + ٢٥٠ كجم / فدان كالسيوم سوبر فوسفات + ١٥٠ كجم / فدان سلفات البوتاسيوم).
- أما فيما يتعلق بالزراعة الحيوية العضوية (الزراعة النظيفة)، فإنه من الناحية الاقتصادية والبيئية يمكن التوصية بإضافة السماد الحيواني عند ٤٥ م^{٣} / فدان للتربة مع معاملة النباتات بخليط من الفوسفورين (٥ كجم / فدان) + E.M. (٥٠ مليلتر / نبات) ورشها بحمض السالساليك بتركيز ١٥٠ جزء فى المليون للحصول على أفضل النتائج.

قام بتحكيم البحث

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