Minia J. of Agric. Res. & Develop.
Vol. (٣٢) No. ٢ pp ٣٥٥-٣٨٠,
٢٠١٢

FACULTY OF AGRICULTURE

PHYSIOLOGICAL STUDIES ON SAGE PLANT

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Received ٢٨ May ٢٠١٢ Accepted ٨ July ٢٠١٢

ABSTRACT

A field experiment was carried out during the two successive seasons of ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ to study the effects of farm yard manure (FYM) at ٠.٠, ١٥, ٢٥ and ٣٥ m^3 / fed. and biofertilization treatments (phosphorein, Minia Azotein, active dry yeast (ADYY), phosphorein + Minia Azotein, phosphorein + active dry yeast and control), as well as, their interaction on the vegetative growth, essential oil and chemical composition of *Salvia officinalis* plants.

Results showed that the application of FYM significantly increased plant height, number of branches / plant / cut, herb fresh and dry weights / plant and / fed., essential oil (%), essential oil yield / plant and / fed., leaves content of chlorophyll a, b and carotenoids, as well as, the percentages of N, P and K in the herb for both cuts during the two seasons. The superiority in all previous traits was for the plants grown in the soil fertilized with ٣٥ m^3 / fed. of FYM as compared with the control.

It was also clear that all biofertilization treatments significantly increased all investigated parameters compared with untreated plants. The most effective treatment was (phosphorein + active dry yeast).

The interaction between FYM and biofertilization treatments was significant in most cases, for all previous parameters. The best

interaction treatment was obtained from fertilizing plants with FYM (٣٥ m^3 / fed.) in combination with phos. + ADY.

INTRODUCTION

Sage (*Salvia officinalis*, L.) belongs to family Lamiaceae. It is considered as remedy for coughs and bad colds, it is included in gargles and mouth washes. The fresh leaves are used to whiten the teeth, while the dried leaves are used cosmetically for restore the natural color to hair that is turning grey (Daisley, ١٩٨٢). It has been used for different disorders including respiratory infections menstrual difficulties and digestive complaints. It is also believed to strengthen the sense and the memory. It is still current in the British pharmacopoeia as a specific for inflammations of the mouth tongue and throat. It is used in some pharmaceutical preparations such as mouth washes, gargles, tooth pastes, employed as a fragrance components in soaps, shampoo, detergents, antiperspirants, colognes and perfumes, especially men's fragrances. The oil and oleoresin are used extensively for flavouring foods (mainly, meat products), soft drinks alcoholic beverages, especially vermouth. It also serves as a source of natural anti – oxidants (Lawless, ١٩٩٢; Turgut *et al.,* ٢٠٠٩ and Chrpova *et al.,* ٢٠١٠).

Many authors studied the effect of organic manure treatments on growth, essential oil and chemical composition of aromatic herb plants as El–Leithy *et al.* (٢٠٠٦); Shala (٢٠٠٧); and Khalil *et al.* (٢٠٠٨) on *Salvia officinalis*; Mishra and Negi (٢٠٠٩) on *Salvia sclarea*; Sukhmal *et al.* (٢٠٠٦) on *Mentha arvensis*; Abdou *et al.* (٢٠١١) on clove basil and Abdou *et al.* (٢٠١٢) on *Menta piperita* who found that organic fertilization treatments significantly increased vegetative growth traits, essential oil parameters, as well as, chemical composition compared with control (unfertilized plants).

Biofertilization has become in the last few decades a positive alternative to chemical fertilizers.

The effect of active dry yeast on improving growth and productivity was shown by El–Hindi and El–Boraie (٢٠٠٥) on marjoram plants; Salman (٢٠٠٦) on sweet basil and Ismail (٢٠٠٨) on black cumin. The positive effects of the other used biofertilizers namely, phosphorein and Minia Azotein were supported by the studies

of Abou El–Ela (٢٠٠٤) on sage plants; Helmy (٢٠٠٨) on *Nigella sativa*; Abdou *et al.* (٢٠٠٩) on borage plants and Abdou and Ashour (٢٠١٢) on jojoba plants.

Therefore, the present work aimed to evaluate the response of *Salvia officinalis* plants to FYM and biofertilization treatments.

MATERIALS AND METHODS

This experiment was carried out during the two successive seasons of ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ at the Floriculture Farm, Fac. Agric., Minia Univ. to investigate the effect of organic and biofertilization treatments, as well as, their interaction on the vegetative growth, essential oil yield and some chemical composition of *Salvia officinalis*, L. plants.

١- Plant material:

Seeds of *Salvia officinalis* were obtained from the Research Center of Medicinal and Aromatic Plant Section, Giza (Egypt) and were sown, in an unheated glasshouse, on ١٢th December for the two experimental seasons in clay pots of ١٠ cm diameter (٢ seeds / pot) containing a clay : sand as a ratio of ٢ : ١ by volume. The seedlings at the stage of ٣ – ٤ leaves and ٨ – ١٠ cm. in height were transplanted (١ plant / hill) in the experimental field on ١٥th March in both seasons.

٢- Layout of the experiment:

The experiment was arranged in a randomized complete blocks in a split–plot design with three replicates. The main plots (A) included four levels of farmyard manure (FYM), while six biofertilization treatments occupied the sub plots (B). Therefore, the interaction treatments (A x B) were ٢٤ treatments. The experimental unit (plot) was ٢ x ٢ m. and containing ٤ rows, ٥٠ cm. apart. The seedlings were cultivated in hills, ٢٥ cm. apart between plants in the row, therefore, each plot contained ٣٢ plants.

The physical and chemical analysis of the used soil in both seasons are shown in Table (A).

Table A : Physical and chemical properties of the experimental soil at ٠ – ٣٠ cm depth during the two seasons of ٢٠٠٩/٢٠١٠ and ٢٠١٠/٢٠١١

Soil Character	Value	
	First season ٢٠٠٩/٢٠١٠	Second season ٢٠١٠/٢٠١١
Sand %	٢٨.٢٠	٢٨.٩٨
Silt %	٣٠.٧٠	٢٩.٨٧
Clay %	٤١.١٠	٤١.١٥
Soil type	Clay loam	Clay loam
Organic matter %	١.٦٥	١.٥٩
Ca Co_3 %	٢.٠٩	٢.١٠
pH (١ : ٢.٥)	٧.٨٣	٧.٧٧
E. C. (m mhos / cm)	١.٠٤	١.٠٧
Total N %	٠.٠٩	٠.٠٨
Available P %	١٥.١٤	١٥.٦٩
Exch. K^+ mg/١٠٠ g	٢.١٢	٢.٨٤
Exch. Ca^{++} mg/١٠٠ g	٣١.٧٥	٣١.١٥
Exch. Na^+ mg/١٠٠ g	٢.٣٩	٢.٥٠
DTPA Ext. ppm — Fe	٨.٥٥	٨.٣٨
DTPA Ext. ppm — Cu	٢.٠٦	٢.٠٥
DTPA Ext. ppm — Zn	٢.٧٧	٢.٨٩
DTPA Ext. ppm — Mn	٨.٢٦	٨.١٧

٣- Treatments:

٣-١- Main plots (A):

The main plots (A) included the following four levels of farmyard manure (FYM) :

(١) FYM. : without organic manure, (٢) $FYM_{١}$: Farmyard manure at ١٥ $m^{٣}$ / fed., (٣) $FYM_{٢}$: Farmyard manure at ٢٥ $m^{٣}$ / fed., (٤) $FYM_{٣}$: Farmyard manure at ٣٥ $m^{٣}$ / fed.

Farmyard manure was obtained from a private animal farm and added during preparing the soil for cultivation in the two experimental seasons. The analysis of FYM was done according to Black *et al.* (١٩٦٥) and is shown in Table (B).

Table B: Chemical analysis of the farmyard manure in the present study for ٢٠٠٩/٢٠١٠ and ٢٠١٠/٢٠١١ seasons.

Content of FYM	٢٠٠٩ / ٢٠١٠	٢٠١٠ / ٢٠١١
Organic matter %	٢٧.٢٥	٢٧.٧٥
Carbon %	١٥.٦٠	١٥.٧٥
Total N %	٠.٨٣	٠.٩٤
C / N ration	١٨.٨٠	١٦.٧٦
Humidity %	٨.١١	٧.٩٩
P %	٠.٢٦	٠.٢٩
K %	١.١١	١.٢١
Fe (ppm)	٩٧٩.٤	٨١٨.٦
Zn (ppm)	٢٧١.١	٢٦٩.٢
Mn (ppm)	٢٢٧.٣	٢٣٧.٥
PH.	٧.٤٥	٧.٢١
E.C. (m. mhose / cm)	١.٠٨	١.٠٦

٣-٢- Sub plots (B):

The sub plots were devoted into six treatments of biofertilizers as follows :

(١)- Control (without any fertilizers). (٢)- Phosphorein (Phos.) at ٠.٢ g / plant. (٣)- Minia Azotein (M.A.) at ٥٠ ml / plant. (٤)- Active dry yeast (ADY) at ٥ g / l. (٥)- Phosphorein + Minia Azotein (٢ + ٣). (٦)- Phosphorein + Active dry yeast (٢ + ٤).

Fresh and active two biofertilizers namely, phosphorein (containing phosphate dissolving bacteria which was obtained from Ministry of Agric.), Minia Azotein (M.A.) (containing *Azotobacter*

bacteria, free fixed nitrogen) which was obtained from the Laboratory of Biofertilizers, Dept. of Genetics, Fac. Agric., Minia Univ.) were applied, either separately or in a mixture, twice to the soil around each plant at ٠.٢ g / plant of phosphorein (after mixing phosphorein with double amounts of sand for easy distribution) and ٥٠ ml / plant of M.A. (١ ml contains $١٠^{٨}$ cells of bacteria). The first dose was added after ٢ weeks from transplanting (April ١^{st}), while the second one was applied after ٢ weeks from the first cut (July ٣٠^{th}) in both seasons and then plants were irrigated immediately.

Active dry yeast was applied as a foliar spray (٥ g / l.) twice also at the same schedule mentioned in the two biofertilizers treatments. The plants were sprayed till run off. The dry matter of active dry yeast (*Saccharomyces cervisia*), was ٩٥ % and live cells were ١١.٦ × $١٠^{٩}$ / g. The yeast suspension was prepared by dissolving dry yeast and sugar together (١ : ١ w / w) in worm water (٣٨ ºC) and let it stand for two hours before spraying to enhance yeast activity (Skoog and Miller, ١٩٥٧). Chemical analysis of the dry yeast is presented in Table (C).

Table C: Chemical analysis of the used active dry yeast.

Protein %	Ash %	Glycogen %	Fats %	Cellulose %
٣٤.٨٧	٧.٥٥	٦.٥٤	٢.٠٩	٤.٩٢

Other agricultural practices were performed regularly as usual

٤- Harvesting:

During each experimental season the plants were harvested twice. In each harvest, the plants were cut ١٠ cm. above the soil surface. The first cut was done on ١٦^{th} July. Meanwhile, the second cut was done in October ٢٥^{th} in the two growing seasons.

٥- Data recorded:

٥-١- Vegetative growth parameters:

The following data were recorded at the harvesting time of each cut :

(١)- Plant height (cm), (٢)- Number of branches / plant. In addition, the following data of vegetative growth characters were also calculated : (٣)- Total fresh weight of herb (g / plant / season),

(٤)- Total dry weight of herb (g / plant / season), (٥)- Fresh weight of herb (ton / fed. / season), (٦)- Dry weight of herb (ton / fed. / season).

٥-٢- Chemical composition:

(١)- Chlorophyll a, b and carotenoids in the fresh leaves (mg / g. fresh weight), (٢)- N, P and K (%) in the dry herb, (٣)- Essential oil percentage, (٤)- Essential oil yield per plant / season (ml), (٥)- Total essential oil yield (liter / fed. / season).

٦- Chemical analysis:

٦-١- Determination of photosynthetic pigments (mg / g. fresh weight) :

The three plant pigments namely; chlorophyll a, b and carotenoids were determined in the fresh leaves of the middle branches. During the first week of June for the first cut and last week of September for the second cut in the two experimental seasons, a weight of ٠.٥ g of the fresh leaves in the three replicates for each treatment was taken. The photosynthetic pigments chlorophyll a, b and carotenoids were extracted by methanol alcohol according to Moran (١٩٨٢), using the spectrophotometer at wave length of ٦٥٦, ٦٦٥ and ٤٥٢.٥ um, respectively.

٦-٢- Determination of N, P and K percentages:

Herbs were picked on July ١st for the first cut and on October ١٠th for the second cut of each season and washed several times with tap water, followed by distilled water. The herbs were oven dried at ٧٠°C till constant weight, then they were ground in Willy mill to fine powder, then weighed ٠.٢ g of fine powder and it was digested using a mixture of hydrogen peroxide (H_2O_2) and concentrated sulphuric acid (H_2SO_4) (٤ : ١٠). The clear digestion was quantitively to ١٠٠ ml volumetric flask. In this solution the following elements were determined:

- N was determined by using the modified micro-kjeldahl method as described by Wilde *et al.* (١٩٨٥).
- Phosphorus % was determined by the spectrophotometer at wave length of ٦٥٠ um according to the method of Chapman and Pratt (١٩٧٥).
- K % was estimated using flame-photometry method according to Cottenie *et al.* (١٩٨٢).

٦-٣- Determination of essential oil:

٦-٣-١- Determination of the essential oil percentage in random samples obtained from the dry herb of each treatment was carried out in each cut during the two experimental seasons according to the method described by British Pharmacopoeia (١٩٦٣) by distilling ٢٥ g of herb for ٣ hours, in order to

extract the essential oil. The essential oil percentage was calculated as follows :

$$= \frac{\text{Volume of oil in gradated tube (ml)}}{\text{Weight of sample}} \times ١٠٠$$

٦-٣-٢- Essential oil yield / plant (ml) was calculated as:

$$\frac{\text{Oil percentage x herb fresh weight}}{١٠٠}$$

٦-٣-٣- Essential oil yield / fed. (L) = oil yield / plant x number of plants / feddan

٧- Statistical analysis:

The obtained data were tabulated and statistically analyzed according to **MSTAT–C (١٩٨٦)** and the L.S.D. test at ٥ % was followed to compare between the means.

RESULTS AND DISCUSSION

Effect on vegetative growth :

Data presented in Tables (١, ٢, ٣ and ٤) showed that plant height (cm), number of branches / plant / cut and total herb fresh and dry weights / plant (g / plant) and per fed. (t. / fed.) were significantly increased due to all FYM treatments over control in both seasons. The highest values for the six characters were obtained when FYM was applied at ٣٥ $m^{٣}$ / fed. This positive effect of FYM on growth may be due to its high nutritional value and its role in the improvement of physical, chemical and biological properties of soil under investigation. Similar results were found by El–Leithy *et al.* (٢٠٠٦) and Shala (٢٠٠٧) on sage plants and Abdou *et al.* (٢٠١٢) on *Mentha piperita*.

Data in Tables (١, ٢, ٣ and ٤) disclosed that all biofertilization treatments significantly promoted all previous growth traits. The most effective treatment was phos. + ADY. The enhancing effect of using ADY and phos. may be due to the influence of hormones on increasing cell division and enlargement (Lethan, ١٩٦٩ and El –

Sheekh, ١٩٩٧). In agreement with these results were those obtained by El–Hindi and El–Boraie (٢٠٠٥) on marjoram plants; Helmy (٢٠٠٨) and Ismail (٢٠٠٨) on *Nigella sativa* and Abdou and Ashour (٢٠١٢) on jojoba plants.

Table ١ : Effect of FYM and biofertilization treatments on plant height (cm) of *Salvia officinalis*, L. in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM_0	FYM_1	FYM_2	FYM_3	Mean (B)	FYM_0	FYM_1	FYM_2	FYM_3	Mean (B)
Control	٢٩.١٣	٣٥.٣٣	٣٨.٤٣	٤٠.٥٣	٣٥.٨٦	٢٦.٢٠	٣٢.١٠	٣٥.٠٠	٣٧.٢٠	٣٢.٦٣
Phos.	٣٣.١٣	٣٩.٢٧	٤٢.٣٧	٤٤.٧٧	٣٩.٨٨	٢٩.٣٠	٣٥.٨٠	٣٨.٧٠	٤١.٥٠	٣٦.٣٣
M.A.	٣٤.٨٣	٤١.١٧	٤٦.٢٠	٤٩.٣٣	٤٢.٨٨	٣١.٠٠	٣٧.٦٠	٤٢.٥٠	٤٣.٨٠	٣٨.٧٣
ADY	٣٦.٣٧	٤٢.٧٧	٤٧.٩٠	٥١.٠٠	٤٤.٥١	٣٢.٦٠	٣٨.٥٠	٤٤.٣٠	٤٤.٩٠	٤٠.٠٨
Phos.+M.A.	٣٧.٥٣	٤٣.٥٠	٤٨.٦٠	٥٢.١٠	٤٥.٤٣	٣٣.٩٠	٣٩.٤٠	٤٥.١٠	٤٦.٧٠	٤١.٢٨
Phos.+ADY	٣٨.٢٧	٤٤.٣٠	٤٩.٥٠	٥٣.١٠	٤٦.٢٩	٣٤.٧٠	٤٠.٢٠	٤٦.٠٠	٤٧.٣٠	٤٢.٠٥
Mean (A)	٣٤.٨٨	٤١.٠٦	٤٥.٥٠	٤٨.٤٧		٣١.٢٨	٣٧.٢٧	٤١.٩٣	٤٣.٥٧	
L.S.D.at ٥٪	A: ١.٣٢	B: ٠.٩٥	AB: ١.٩٠			A: ٠.٨٦	B: ٠.٩٨	AB: ١.٩٦		
Second season										
Control	٢٩.٨٠	٣٦.٢٠	٣٩.٤٠	٤١.٦٠	٣٦.٧٥	٢٧.٠	٣٢.٩	٣٦.١	٣٨.١	٣٣.٥٥
Phos.	٣٣.٩٠	٤٠.١٠	٤٣.٥٠	٤٥.٨٠	٤٠.٨٣	٣٠.١	٣٦.٥	٣٩.٨	٤٢.٤	٣٧.٢٠
M.A.	٣٥.٨٠	٤٢.٠٠	٤٧.٦٠	٥٠.٥٠	٤٣.٩٨	٣١.٩	٣٨.٤	٤٣.٥	٤٤.٧	٣٩.٦٣
ADY	٣٧.١٠	٤٣.٧٠	٤٩.٥٠	٥٢.٣٠	٤٥.٦٥	٣٣.٣	٣٩.٤	٤٥.٢	٤٥.٦	٤٠.٨٨
Phos.+M.A.	٣٨.٣٠	٤٤.٦٠	٥٠.٣٠	٥٣.٠٠	٤٦.٥٥	٣٤.٧	٤٠.٤	٤٦.٢	٤٧.٨	٤٢.٢٨
Phos.+ADY	٣٩.٠٠	٤٢.٠٢	٥١.٣٠	٥٣.٨٠	٤٧.٤٠	٣٥.٦	٤١.٣	٤٧.١	٤٨.٣	٤٣.٠٨
Mean (A)	٣٥.٦٥	٤٢.٠٢	٤٦.٩٣	٤٩.٥٠		٣٢.١٠	٣٨.١٥	٤٣.٠٠	٤٤.٤٨	
L.S.D.at ٥٪	A: ١.٥٠	B: ٠.٨٦	AB: ١.٧٢			A: ٠.٨٤	B: ٠.٨٢	AB: ١.٦٤		

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٢ : Effect of FYM and biofertilization treatments on number of branches / plant of *Salvia officinalis,* L. in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	١١.١	١٣.٣	١٤.٨	١٥.٨	١٣.٨	٢٢.٨	٢٧.٥	٣٠.٩	٣٣.١	٢٨.٦
Phos.	١٢.٢	١٤.٥	١٦.١	١٧.٠	١٥.٠	٢٥.٠	٣٠.١	٣٣.٦	٣٥.٧	٣١.١
M.A.	١٢.٤	١٤.٨	١٦.٥	١٧.٦	١٥.٣	٢٥.٤	٣٠.٦	٣٤.٥	٣٧.٠	٣١.٩
ADY	١٢.٩	١٥.٥	١٧.٣	١٨.٥	١٦.١	٢٦.٥	٣٢.١	٣٦.٢	٣٨.٩	٣٣.٤
Phos.+M.A.	١٣.٠	١٥.٧	١٧.٥	١٨.٨	١٦.٣	٢٦.٧	٣٢.٥	٣٦.٦	٣٩.٥	٣٣.٨
Phos.+ADY	١٣.٣	١٦.١	١٨.٤	١٩.٣	١٦.٨	٢٧.٣	٣٣.٣	٣٨.٥	٤٠.٥	٣٤.٩
Mean (A)	١٢.٥	١٥.٠	١٦.٨	١٧.٨		٢٥.٦	٣١.٠	٣٥.١	٣٧.٥	
L.S.D.at ٥٪	A: ٠.١٧	B: ٠.٢١	AB: ٠.٤٢			A: ٠.٢٢	B: ٠.٢٧	AB: ٠.٥٤		
Second season										
Control	١١.٦	١٣.٩	١٥.٣	١٦.٠	١٤.٢	٢٣.٩	٢٨.٩	٣٢.١	٣٣.٩	٢٩.٧
Phos.	١٢.٧	١٥.٠	١٦.٦	١٧.٣	١٥.٤	٢٦.٢	٣١.٢	٣٤.٨	٣٦.٧	٣٢.٢
M.A.	١٣.٠	١٥.٥	١٧.١	١٧.٩	١٥.٩	٢٦.٨	٣٢.٢	٣٥.٩	٣٨.٠	٣٣.٢
ADY	١٣.٥	١٦.١	١٧.٨	١٨.٦	١٦.٥	٢٧.٨	٣٣.٥	٣٧.٤	٣٩.٤	٣٤.٥
Phos.+M.A.	١٣.٧	١٦.٤	١٨.١	١٩.٤	١٦.٩	٢٨.٢	٣٤.١	٣٨.٠	٤١.١	٣٥.٤
Phos.+ADY	١٤.١	١٦.٩	١٩.٠	٢٠.١	١٧.٥	٢٩.١	٣٥.٢	٣٩.٩	٤٢.٦	٣٦.٧
Mean (A)	١٣.١	١٥.٦	١٧.٣	١٨.٢		٢٧.٠	٣٢.٥	٣٦.٤	٣٨.٦	

L.S.D.at ٥٪	A: ٠.٢٥	B: ٠.٢٢	AB: ٠.٤٤	A: ٠.٤٠	B: ٠.٢٣	AB: ٠.٤٦

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٣ : Effect of FYM and biofertilization treatments on total herb fresh weights per plant and per feddan / season of *Salvia officinalis,* L. during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	Herb fresh weight (g / plant / season)									
	First season					Second season				
	FYM$_0$	FYM$_1$	FYM$_2$	FYM$_3$	Mean (B)	FYM$_0$	FYM$_1$	FYM$_2$	FYM$_3$	Mean (B)
Control	١١٢.٩٠	١٦١.٥٠	١٩٦.٠٠	٢٢٥.٤٠	١٧٣.٩٥	١٢٥.٥٠	١٧١.٥٠	٢٠٦.٢٠	٢٣٥.٤٠	١٨٤.٦٥
Phos.	١٣٣.٩٠	١٩٣.٨٠	٢٣٥.٥٠	٢٧٢.٨٠	٢٠٩.٠٠	١٤٧.٩٠	٢٠٥.٩٠	٢٤٦.٧٠	٢٨٤.٦٠	٢٢١.٢٨
M.A.	١٤٨.١٠	٢١٦.٠٠	٢٦٢.٦٠	٢٨٩.٩٠	٢٢٩.١٥	١٦٣.٣٠	٢٢٨.٦٠	٢٧٤.٨٠	٣٠٤.٢٠	٢٤٢.٧٣
ADY	١٥٦.٣٠	٢٢٨.٠٠	٢٧٥.٩٠	٣٠٥.٧٠	٢٤١.٤٨	١٧٣.٦٠	٢٤٣.٢٠	٢٩٠.١٠	٣٢٠.٩٠	٢٥٦.٩٥
Phos.+M.A.	١٦٣.٢٠	٢٣٦.٢٠	٢٨٦.٢٠	٣١٥.٥٠	٢٥٠.٢٨	١٨٠.٣٠	٢٥١.٢٠	٣٠١.٢٠	٣٣٣.٥٠	٢٦٦.٥٥
Phos.+ADY	١٧٣.٤٠	٢٤٨.٩٠	٣٠١.٥٠	٣٣٤.٣٠	٢٦٤.٥٣	١٩٣.٤٠	٢٦٦.٦٠	٣١٨.٨٠	٣٥٤.٥٠	٢٨٣.٣٣
Mean (A)	١٤٧.٩٧	٢١٤.٠٧	٢٥٩.٦٢	٢٩٠.٦٠		١٦٤.٠٠	٢٢٧.٨٣	٢٧٢.٩٧	٣٠٥.٥٢	
L.S.D.at ٥٪	A: ٥.٧٣		B: ٣.٠٢		AB: ٦.٠٤	A: ٠.٩٠		B: ١.٦٢		AB: ٣.٢٥
Herb fresh weight (ton / feddan / season)										
Control	٣.٦١	٥١.٧	٦.٢٧	٧.٢١	٥.٥٧	٤.٠٢	٥.٤٩	٦.٦٠	٧.٥٣	٥.٩١
Phos.	٤.٢٨	٦٢.٠	٧.٥٤	٨.٧٣	٦.٦٩	٤.٧٣	٦.٥٩	٧.٨٩	٩.١١	٧.٠٨
M.A.	٤.٧٤	٦٩.١	٨.٤٠	٩.٢٨	٧.٣٣	٥.٢٣	٧.٣٢	٨.٧٩	٩.٧٣	٧.٧٧
ADY	٥.٠٠	٧٣.٠	٨.٨٣	٩.٧٨	٧.٧٣	٥.٥٦	٧.٧٨	٩.٢٨	١٠.٢٧	٨.٢٢
Phos.+M.A.	٥.٢٢	٧٥.٦	٩.١٦	١٠.١٠	٨.٠١	٥.٧٧	٨.٠٤	٩.٦٤	١٠.٦٧	٨.٥٣
Phos.+ADY	٥.٥٥	٧٩.٦	٩.٦٥	١٠.٧٠	٨.٤٦	٦.١٩	٨.٥٣	١٠.٢٠	١١.٣٤	٩.٠٧
Mean (A)	٤.٧٣	٦.٨٥	٨.٣١	٩.٣٠		٥.٢٥	٧.٢٩	٨.٧٣	٩.٧٨	
L.S.D.at ٥٪	A: ٠.١٨		B: ٠.١٠		AB: ٠.١٩	A: ٠.٠٣		B: ٠.٠٥		AB: ٠.١٠

- Phos. : Phosphorein

- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٤ : Effect of FYM and biofertilization treatments on total herb dry weights per plant and per feddan / season of *Salvia officinalis,* L. during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	Herb dry weight (g / plant / season)									
	First season					Second season				
	FYM$_0$	FYM$_1$	FYM$_2$	FYM$_3$	Mean (B)	FYM$_0$	FYM$_1$	FYM$_2$	FYM$_3$	Mean (B)
Control	٤١.٢٨	٥٨.٩٩	٧٠.٣٤	٨٠.٣٨	٦٢.٧٥	٤٦.٠٢	٦٢.٨٠	٧٤.٦٩	٨٣.٩٨	٦٦.٨٧
Phos.	٤٨.٨٢	٧٠.٧٠	٨٤.١٤	٩٦.٨١	٧٥.١٢	٥٤.١٥	٧٥.٢٧	٨٩.١١	١٠١.٢٠	٧٩.٩٣
M.A.	٥٤.٠٧	٧٨.٧٥	٩٣.٤٠	١٠٢.٣٠	٨٢.١٣	٥٩.٧٠	٨٣.٦٠	٩٨.٩٩	١٠٧.١٨	٨٧.٣٧
ADY	٥٧.٠٤	٨٣.١٧	٩٧.٧٣	١٠٧.٢٧	٨٦.٣٠	٦٣.٣٨	٨٨.٦٦	١٠٤.٠٧	١١٢.٠٣	٩٢.٠٤
Phos.+M.A.	٥٩.٢٣	٨٦.١٣	١٠٠.٩٤	١١٠.٠٨	٨٩.١٧	٦٥.٧٤	٩١.٤٦	١٠٧.٧٥	١١٣.٩٠	٩٤.٧١
Phos.+ADY	٦٣.٢٣	٩٠.٧٢	١٠٥.٨٦	١١٦.٣٣	٩٤.٠٤	٧٠.٤٢	٩٦.٩٤	١١٣.٨٩	١٢١.٥٥	١٠٠.٧٠
Mean (A)	٥٤.٠٠	٧٨.٠٨	٩٢.٠٧	١٠٢.٢٠		٥٩.٩٠	٨٣.١٢	٩٨.٠٨	١٠٦.٦٤	
L.S.D.at ٥٪	A: ٠.٧٤	B: ٠.٦٣	AB: ١.٢٧			A: ٠.٦٥	B: ٠.٤٨	AB: ٠.٩٦		
Herb dry weight (t. / feddan / season)										
Control	١.٣٢	١.٨٩	٢.٢٥	٢.٥٧	٢.٠١	١.٤٧	٢.٠١	٢.٣٩	٢.٦٩	٢.١٤
Phos.	١.٥٦	٢.٢٦	٢.٦٩	٣.١٠	٢.٤٠	١.٧٣	٢.٤١	٢.٨٥	٣.٢٤	٢.٥٦
M.A.	١.٧٣	٢.٥٢	٢.٩٩	٣.٢٧	٢.٦٣	١.٩١	٢.٦٨	٣.١٧	٣.٤٣	٢.٨٠
ADY	١.٨٣	٢.٦٦	٣.١٣	٣.٤٣	٢.٧٦	٢.٠٣	٢.٨٤	٣.٣٣	٣.٥٨	٢.٩٥
Phos.+M.A.	١.٩١	٢.٧٦	٣.٢٣	٣.٥٢	٢.٨٥	٢.١٠	٢.٩٣	٣.٤٥	٣.٦٤	٣.٠٣
Phos.+ADY	٢.٠٢	٢.٩٠	٣.٣٩	٣.٧٢	٣.٠١	٢.٢٥	٣.١٠	٣.٦٤	٣.٨٩	٣.٢٢
Mean (A)	١.٧٣	٢.٥٠	٢.٩٥	٣.٢٧		١.٩٢	٢.٦٦	٣.١٤	٣.٤١	
L.S.D.at ٥٪	A: ٠.٠٢	B: ٠.٠٢	AB: ٠.٠٤			A: ٠.٠٢	B: ٠.٠٢	AB: ٠.٠٤		

- Phos. : Phosphorein
- M.A. : Minia Azotein

ADY : Active Dry Yeast

The interaction between FYM and biofertilization treatments was significant for all studied vegetative growth traits in both seasons. The highest values were obtained due to FYM (٣٥ m^3 / fed.) in combination with phos. + ADY.

Effect on essential oil productivity :

The results in Tables (٥and ٦) indicated that FYM at the three used levels (١٥, ٢٥ and ٣٥ m^3 / fed.) significantly promoted essential oil % in both cuts and essential oil yield (ml / plant and liter / fed.) in dried herb of sage plants over those of control plants during both seasons. The highest values were obtained with application of FYM at ٣٥ m^3 / fed.

The above results are in agreement with those obtained by Khalil *et al.* (٢٠٠٨) on sage plants, Mishra and Negi (٢٠٠٩) on *S. sclarea* and Sukhmal *et al.* (٢٠٠٦) on *Mentha arvensis*.

Data indicated also that all treatments used of biofertilizers significantly increased essential oil (%) in both cuts and essential oil yield / plant and / fed. in both seasons compared with untreated control plants. The plants treated with phos. + ADY had yield essential oil more than the plants treated with other biofertilizers treatments. Similar results were obtained by Abou El–Ela (٢٠٠٤) on sage plants; Salman (٢٠٠٦) on sweet basil and Helmy (٢٠٠٨) on black cumin plants.

The interaction effect on essential oil % and yield was significant. The highest values were obtained when plants supplied with ٣٥ m^3 / fed. FYM in combination with phos. + ADY.

Effect on chemical constituents :

It is clear from data in Tables (٧, ٨, ٩, ١٠, ١١ and ١٢) that all three tested FYM treatments significantly increased the contents of chlorophyll a, b and carotenoids, as well as, percentages of N, P and K over those of unorganic fertilized plants in both cuts during both seasons. Among such three FYM treatments, the high level of FYM (٣٥ m^3 / fed.) gave the highest values. These results are in accordance with the previous studies obtained by El–Leithy *et al.* (٢٠٠٦) and Shala (٢٠٠٧) on sage plants and Sukhmal *et al.* (٢٠٠٦) and Abdou *et al.* (٢٠١٢) on *Mentha* spp.

Table ٥ : Effect of FYM and biofertilization treatments on oil percentage of *Salvia officinalis*, L. in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	١.٦١	١.٦٤	١.٦٩	١.٧٥	١.٦٧	١.٦٢	١.٦٥	١.٧٦	١.٨١	١.٧١
Phos.	١.٧٠	١.٧٤	١.٨١	١.٨٨	١.٧٨	١.٧٣	١.٧٥	١.٩٤	٢.١١	١.٨٨
M.A.	١.٧٣	١.٧٧	١.٨٥	١.٩٣	١.٨٢	١.٧٤	١.٧٧	٢.٠١	٢.٢٥	١.٩٤
ADY	١.٨٠	١.٨٤	١.٩٢	١.٩٧	١.٨٨	١.٨١	١.٨٥	٢.٢٢	٢.٣٢	٢.٠٥
Phos.+M.A.	١.٨٠	١.٨٥	١.٩٤	٢.٢٢	١.٩٥	١.٨٢	١.٨٥	٢.٢٤	٢.٤٨	٢.١٠
Phos.+ADY	١.٨٤	١.٩١	٢.١٨	٢.٣٤	٢.٠٧	١.٨٥	١.٩٩	٢.٣٩	٢.٦٩	٢.٢٣
Mean (A)	١.٧٥	١.٧٩	١.٩٠	٢.٠٢		١.٧٦	١.٨١	٢.٠٩	٢.٢٨	
L.S.D.at ٥٪	A: ٠.٠١	B: ٠.٠٢	AB: ٠.٠٣			A: ٠.٠٢	B: ٠.٠١	AB: ٠.٠٢		
Second season										
Control	١.٦٩	١.٧٦	١.٨٤	١.٩٥	١.٨١	١.٨٠	١.٩١	١.٩٩	٢.١٢	١.٩٦
Phos.	١.٧٨	١.٨٥	١.٩٣	٢.٠٤	١.٩٠	١.٨٩	٢.٠٠	٢.١٠	٢.٢٣	٢.٠٦
M.A.	١.٨٧	١.٩٤	٢.٠٢	٢.١٣	١.٩٩	١.٩٩	٢.١٠	٢.٢١	٢.٣٤	٢.١٦
ADY	١.٩٦	٢.٠٤	٢.١٤	٢.٢٦	٢.١٠	٢.٠٩	٢.٢٢	٢.٣٣	٢.٤٧	٢.٢٨
Phos.+M.A.	١.٩٨	٢.٠٦	٢.١٥	٢.٣٥	٢.١٤	٢.١٢	٢.٢٥	٢.٣٨	٢.٥٥	٢.٣٣
Phos.+ADY	٢.١٠	٢.٢١	٢.٣٢	٢.٤٧	٢.٢٨	٢.٢٥	٢.٣٩	٢.٥٣	٢.٧٨	٢.٤٩
Mean (A)	١.٩٠	١.٩٨	٢.٠٧	٢.٢٠		٢.٠٢	٢.١٥	٢.٢٦	٢.٤٢	

L.S.D.at ٥٪	A: ٠.٠١	B: ٠.٠٢	AB: ٠.٠٤	A: ٠.٠٢	B: ٠.٠٢	AB: ٠.٠٤

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٦ : Effect of FYM and biofertilization treatments on total oil yield per plant (ml) and per feddan (l) / season of *Salvia officinalis*, L. during ٢٠٠٩/٢٠١٠ and ٢٠١٠/٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	Oil yield (ml / plant / season)									
	First season					Second season				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	٠.٦٦٧	٠.٩٧١	١.٢١٦	١.٤٣٣	١.٠٧٢	٠.٨٠٥	١.١٥٧	١.٤٣٦	١.٧١٦	١.٢٧٩
Phos.	٠.٨٣٨	١.٢٣٤	١.٥٨٣	١.٩٤٢	١.٣٩٩	٠.٩٩٧	١.٤٥٥	١.٨٠٣	٢.١٧٠	١.٦٠٦
M.A.	٠.٩٣٨	١.٣٩٤	١.٨١٠	٢.١٥٤	١.٥٧٤	١.١٥٦	١.٦٩٦	٢.١٠٣	٢.٤٠٦	١.٨٤٠
ADY	١.٠٣٠	١.٥٣٥	٢.٠٣٧	٢.٣٢٠	١.٧٣٠	١.٢٨٧	١.٨٩٧	٢.٣٣٦	٢.٦٦٢	٢.٠٤٦
Phos.+M.A.	١.٠٧٨	١.٥٩٤	٢.١٢٣	٢.٦٠١	١.٨٤٩	١.٣٥٢	١.٩٨٠	٢.٤٥٢	٢.٨٠٤	٢.١٤٧
Phos.+ADY	١.١٦٧	١.٧٧٣	٢.٤٢٩	٢.٩٤٨	٢.٠٧٩	١.٥٣٨	٢.٢٣٨	٢.٧٧٣	٣.٢١٢	٢.٤٤٠
Mean (A)	٠.٩٥٣	١.٤١٧	١.٨٦٦	٢.٢٣٣		١.١٨٩	١.٧٣٧	٢.١٥١	٢.٤٩٥	
L.S.D.at ٥٪	A: ٠.٠٢١ B: ٠.٠١٧ AB: ٠.٠٣٤					A: ٠.٠١٥ B: ٠.٠٢١ AB: ٠.٠٤٢				
Oil yield (liter / feddan / season)										
Control	٢١.٣٥	٣١.٠٦	٣٨.٩٠	٤٥.٨٦	٣٤.٢٩	٢٥٧٧	٣٧.٠٢	٤٥.٩٦	٥٤.٩١	٤٠.٩٢
Phos.	٢٦.٨١	٣٩.٤٩	٥٠.٦٥	٦٢.١٥	٤٤.٧٧	٣١٨٩	٤٦.٥٥	٥٧.٧٠	٦٩.٤٣	٥١.٣٩
M.A.	٣٠.٠٣	٤٤.٦١	٥٧.٩١	٦٨.٩٣	٥٠.٣٧	٣٦٩٨	٥٤.٢٦	٦٧.٢٩	٧٧.٠١	٥٨.٨٨
ADY	٣٢.٩٥	٤٩.١٢	٦٥.١٩	٧٤.٢٣	٥٥.٣٧	٤١١٩	٦٠.٧١	٧٤.٧٥	٨٥.١٩	٦٥.٤٦
Phos.+M.A.	٣٤.٥١	٥٠.٩٩	٦٧.٩٥	٨٣.٢٣	٥٩.١٧	٤٣٢٦	٦٣.٣٤	٧٨.٤٧	٨٩.٧٤	٦٨.٧١
Phos.+ADY	٣٧.٣٤	٥٦.٧٤	٧٧.٧٤	٩٤.٣٣	٦٦.٥٤	٤٩٢٠	٧١.٦٣	٨٨.٧٤	١٠٢.٧٨	٧٨.٠٩
Mean (A)	٣٠.٥٠	٤٥.٣٣	٥٩.٧٢	٧١.٤٥		٣٨.٠٥	٥٥.٥٩	٦٨.٨٢	٧٩.٨٤	

L.S.D.at ٥٪	A: ٠.٦٦	B: ٠.٥٤	AB: ١.٠٨	A: ٠.٤٧	B: ٠.٦٧	AB: ١.٣٥

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٧ : Effect of FYM and biofertilization treatments on chlorophyll a (mg / g. F.W.) of *Salvia officinalis*, L. leaves in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	١.٣٨٠	١.٤٧٠	١.٥٤١	١.٦٠٢	١.٤٩٨	١.٤٦٨	١.٥٥٩	١.٦٢٤	١.٦٧٩	١.٥٨٣
Phos.	١.٤٦٠	١.٥٥٥	١.٦٢٧	١.٦٨٩	١.٥٨٣	١.٥٥٨	١.٦٥٣	١.٧٢٣	١.٧٨١	١.٦٧٩
M.A.	١.٥٢٠	١.٦٢٠	١.٦٩٣	١.٧٥٣	١.٦٤٧	١.٦١٣	١.٧١٠	١.٧٨١	١.٨٤١	١.٧٣٦
ADY	١.٥٩٠	١.٦٩٥	١.٧٦٩	١.٨٣٠	١.٧٢١	١.٦٧٨	١.٧٧٩	١.٨٥٢	١.٩١٤	١.٨٠٦
Phos.+M.A.	١.٦٥٠	١.٧٦٠	١.٨٣١	١.٨٩٢	١.٧٨٣	١.٧٣٩	١.٨٤٢	١.٩٠٢	١.٩٦٧	١.٨٦٣
Phos.+ADY	١.٧٢٠	١.٨٣٥	١.٩٠٨	١.٩٧١	١.٨٥٩	١.٨١٤	١.٩٠٩	١.٩٧٤	١.٩٩٩	١.٩٢٤
Mean (A)	١.٥٥٣	١.٦٥٦	١.٧٢٨	١.٧٩٠		١.٦٤٥	١.٧٤٢	١.٨٠٩	١.٨٦٤	
L.S.D.at ٥٪	A: ٠.٠٥١ B: ٠.٠٥٤ AB: ٠.١٠٨					A: ٠.٠٤١ B: ٠.٠١٦ AB: ٠.٠٣٢				
Second season										
Control	١.٣٩١	١.٤٨٣	١.٥٥٩	١.٦١٥	١.٥١٢	١.٤٧٦	١.٥٦٥	١.٦٣٠	١.٦٨٨	١.٥٩٠
Phos.	١.٤٧٢	١.٥٦٤	١.٦٣٨	١.٦٩٨	١.٥٩٣	١.٥٦٩	١.٦٦١	١.٧٣٠	١.٧٩٣	١.٦٨٨
M.A.	١.٥٣٤	١.٦٢٨	١.٧٠٨	١.٧٦٧	١.٦٥٩	١.٦٢١	١.٧١٣	١.٧٩٥	١.٨٥٤	١.٧٤٦
ADY	١.٥٩٩	١.٧٠٠	١.٧٨١	١.٨٤١	١.٧٣٠	١.٦٨٥	١.٧٨٨	١.٨٦٤	١.٩٢٣	١.٨١٥
Phos.+M.A.	١.٦٦٤	١.٧٧١	١.٨٤٣	١.٨٩٩	١.٧٩٤	١.٧٤٥	١.٨٤٩	١.٩١١	١.٩٧٨	١.٨٧١
Phos.+ADY	١.٧٣٤	١.٨٤٠	١.٩١٧	١.٩٨٣	١.٨٦٩	١.٨٢١	١.٩١٩	١.٩٨١	٢.٠٢١	١.٩٣٦
Mean (A)	١.٥٦٦	١.٦٦٤	١.٧٤١	١.٨٠١		١.٦٥٣	١.٧٤٩	١.٨١٩	١.٨٧٦	

L.S.D.at ٥٪	A: ٠.٠٥٣ B: ٠.٠٤٢ AB: ٠.٠٨٤	A: ٠.٠٥١ B: ٠.٠٢٢ AB: ٠.٠٤٤

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٨ : Effect of FYM and biofertilization treatments on chlorophyll b (mg / g. F.W.) of *Salvia officinalis*, L. leaves in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	٠.٤٤٠	٠.٤٧٠	٠.٤٩٣	٠.٥١٤	٠.٤٧٩	٠.٤٦٩	٠.٥٠٠	٠.٥٢١	٠.٥٤٠	٠.٥٠٨
Phos.	٠.٤٦٧	٠.٤٩٨	٠.٥٢٢	٠.٥٤٣	٠.٥٠٨	٠.٤٩٩	٠.٥٣١	٠.٥٥٤	٠.٥٦٣	٠.٥٣٩
M.A.	٠.٤٨٦	٠.٥٢٠	٠.٥٤٤	٠.٥٦٤	٠.٥٢٩	٠.٥١٧	٠.٥٥٠	٠.٥٧٣	٠.٥٩٤	٠.٥٥٩
ADY	٠.٥١٠	٠.٥٤٥	٠.٥٦٩	٠.٥٩٠	٠.٥٥٤	٠.٥٣٩	٠.٥٧٣	٠.٦٠١	٠.٦١٨	٠.٥٨٣
Phos.+M.A.	٠.٥٣٠	٠.٥٦٧	٠.٥٩٠	٠.٦١١	٠.٥٧٥	٠.٥٥٨	٠.٦٠٠	٠.٦١٤	٠.٦٣٦	٠.٦٠٢
Phos.+ADY	٠.٥٥٣	٠.٥٩١	٠.٦١٦	٠.٦٣٧	٠.٥٩٩	٠.٥٨٥	٠.٦١٦	٠.٦٣٨	٠.٦٤٦	٠.٦٢١
Mean (A)	٠.٤٩٨	٠.٥٣٢	٠.٥٥٦	٠.٥٧٧		٠.٥٢٨	٠.٥٦٢	٠.٥٨٤	٠.٦٠١	
L.S.D.at ٥٪	A: ٠.٠١٢ B: ٠.٠١٣ AB: ٠.٠٢٦					A: ٠.٠١١ B: ٠.٠١٢ AB: ٠.٠٢٤				
Second season										
Control	٠.٤٥٤	٠.٤٨٤	٠.٥٠٩	٠.٥٢٨	٠.٤٩٤	٠.٤٨٢	٠.٥١٢	٠.٥٣٣	٠.٥٥٢	٠.٥٢٠
Phos.	٠.٤٨١	٠.٥١١	٠.٥٣٦	٠.٥٥٦	٠.٥٢١	٠.٥١٣	٠.٥٤٣	٠.٥٦٧	٠.٥٨٧	٠.٥٥٣
M.A.	٠.٥٠١	٠.٥٣٢	٠.٥٥٩	٠.٥٧٩	٠.٥٤٣	٠.٥٣٠	٠.٥٦١	٠.٥٨٨	٠.٦٠٨	٠.٥٧٢
ADY	٠.٥٢٣	٠.٥٥٦	٠.٥٨٣	٠.٦٠٣	٠.٥٦٦	٠.٥٥١	٠.٥٨٦	٠.٦١١	٠.٨٣١	٠.٦٤٥
Phos.+M.A.	٠.٥٤٥	٠.٥٨٠	٠.٦٠٤	٠.٦٢٣	٠.٥٨٨	٠.٥٧١	٠.٦٠٦	٠.٦٢٧	٠.٦٤٩	٠.٦١٣
Phos.+ADY	٠.٥٦٨	٠.٦٠٣	٠.٦٢٩	٠.٦٥١	٠.٦١٣	٠.٦٠٠	٠.٦٢٩	٠.٦٥٠	٠.٦٦٤	٠.٦٣٦
Mean (A)	٠.٥١٢	٠.٥٤٤	٠.٥٧٠	٠.٥٩٠		٠.٥٤١	٠.٥٧٣	٠.٥٩٦	٠.٦٤٩	

L.S.D.at ٥٪	A: ٠.٠١٣ B: ٠.٠١٤ AB: ٠.٠٢٨	A: ٠.٠٢٠ B: ٠.٠٠٨ AB: ٠.٠١٦

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ٩ : Effect of FYM and biofertilization treatments on carotenoids (mg / g. F.W.) of *Salvia officinalis*, L. leaves in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	٠.٤٨٠	٠.٥١٠	٠.٥٣٤	٠.٥٥٤	٠.٥٢٠	٠.٥٠٨	٠.٥٣٩	٠.٥٦١	٠.٥٧٩	٠.٥٤٧
Phos.	٠.٥٠٨	٠.٥٣٨	٠.٥٦٣	٠.٥٨٣	٠.٥٤٨	٠.٥٢٨	٠.٥٧١	٠.٥٩٣	٠.٦١٤	٠.٥٧٧
M.A.	٠.٥٢٧	٠.٥٦٠	٠.٥٨٥	٠.٦٠٤	٠.٥٦٩	٠.٥٥٨	٠.٥٩١	٠.٦١٤	٠.٦٣٣	٠.٥٩٩
ADY	٠.٥٥٠	٠.٥٨٥	٠.٦١٠	٠.٦٣١	٠.٥٩٤	٠.٥٧٩	٠.٦١٤	٠.٦٣٧	٠.٦٥٧	٠.٦٢٢
Phos.+M.A.	٠.٥٧٠	٠.٥٩٩	٠.٦٣٣	٠.٦٥٢	٠.٦١٤	٠.٥٩٩	٠.٦٣٥	٠.٦٥٥	٠.٦٧٥	٠.٦٤١
Phos.+ADY	٠.٥٩٣	٠.٦٣٢	٠.٦٥٦	٠.٦٧٧	٠.٦٤٠	٠.٦٢٥	٠.٦٥٧	٠.٦٧٨	٠.٦٨٧	٠.٦٦٢
Mean (A)	٠.٥٣٨	٠.٥٧١	٠.٥٩٧	٠.٦١٧		٠.٥٦٦	٠.٦٠١	٠.٦٢٣	٠.٦٤١	
L.S.D.at ٥٪	A: ٠.٠١٥ B: ٠.٠١٢ AB: ٠.٠٢٤					A: ٠.٠١٦ B: ٠.٠١٣ AB: ٠.٠٢٦				
Second season										
Control	٠.٤٨٤	٠.٥١٤	٠.٥٣٩	٠.٥٥٨	٠.٥٢٤	٠.٥١٢	٠.٥٤١	٠.٥٦٣	٠.٥٨٣	٠.٥٥٠
Phos.	٠.٥١٠	٠.٥٤١	٠.٥٦٦	٠.٥٨٦	٠.٥٥١	٠.٥٤٤	٠.٥٧٤	٠.٥٩٧	٠.٦١٩	٠.٥٨٤
M.A.	٠.٥٣١	٠.٥٦٣	٠.٥٨٩	٠.٦٠٩	٠.٥٧٣	٠.٥٦١	٠.٥٩٢	٠.٦١٨	٠.٦٣٩	٠.٦٠٣
ADY	٠.٥٥٤	٠.٥٨٧	٠.٦١٤	٠.٦٣٤	٠.٥٩٧	٠.٥٧٣	٠.٥١٦	٠.٦٤١	٠.٨٦٢	٠.٦٤٨
Phos.+M.A.	٠.٥٧٥	٠.٦١٠	٠.٦٣٥	٠.٦٥٣	٠.٦١٨	٠.٦٠٢	٠.٦٣٦	٠.٦٥٧	٠.٦٧٩	٠.٦٤٤
Phos.+ADY	٠.٥٩٧	٠.٦٣٣	٠.٦٥٩	٠.٦٨٢	٠.٦٤٣	٠.٦٢٨	٠.٦٥٩	٠.٦٨١	٠.٦٩٥	٠.٦٦٦
Mean (A)	٠.٥٤٢	٠.٥٧٥	٠.٦٠٠	٠.٦٢٠		٠.٥٧٠	٠.٥٨٦	٠.٦٢٦	٠.٦٨٠	

L.S.D.at ٥٪	A: ٠.٠١٦ B: ٠.٠١٤ AB: ٠.٠٢٨	A: ٠.٠١٢ B: ٠.٠٠٨ AB: ٠.٠١٦

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ١٠ : Effect of FYM and biofertilization treatments on nitrogen % of *Salvia officinalis*, L. in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	٢.٥٢	٢.٥٣	٢.٥٥	٢.٥٧	٢.٥٤٣	٢.٧٣	٢.٧٤	٢.٧٩	٢.٨٣	٢.٧٧٣
Phos.	٢.٥٥	٢.٥٧	٢.٥٨	٢.٦٠	٢.٥٧٥	٢.٧٦	٢.٧٨	٢.٨٤	٢.٨٦	٢.٨١٠
M.A.	٢.٦٤	٢.٦٩	٢.٧١	٢.٧٢	٢.٦٩٠	٢.٨٢	٢.٨٥	٢.٩١	٢.٩٤	٢.٨٨٠
ADY	٢.٦٦	٢.٧٠	٢.٧٣	٢.٧٣	٢.٧٠٥	٢.٨٦	٢.٩١	٢.٩٧	٢.٩٨	٢.٩٣٠
Phos.+M.A.	٢.٦٩	٢.٧٤	٢.٧٧	٢.٧٨	٢.٧٤٥	٢.٨٩	٢.٩٦	٢.٩٨	٢.٩٩	٢.٩٥٥
Phos.+ADY	٢.٧١	٢.٧٦	٢.٧٧	٢.٧٨	٢.٧٥٥	٢.٩٢	٢.٩٨	٢.٩٨	٢.٩٩	٢.٩٦٨
Mean (A)	٢.٦٢٨	٢.٦٦٥	٢.٦٨٥	٢.٦٩٧		٢.٨٣٠	٢.٨٧٠	٢.٩١٢	٢.٩٣٢	
L.S.D.at ٥٪	A: ٠.٠١١		B: ٠.٠١٢		AB: N.S	A: ٠.٠١٨		B: ٠.٠١٤		AB: N.S
Second season										
Control	٢.٥٧	٢.٥٩	٢.٦٢	٢.٦٥	٢.٦٠٨	٢.٧٣	٢.٧٤	٢.٧٧	٢.٧٩	٢.٧٥٨
Phos.	٢.٦٠	٢.٦٣	٢.٦٦	٢.٦٨	٢.٦٤٣	٢.٧٥	٢.٧٩	٢.٨١	٢.٨٢	٢.٧٩٣
M.A.	٢.٦٩	٢.٧٢	٢.٧٦	٢.٧٩	٢.٧٤٠	٢.٨٦	٢.٨٩	٢.٩١	٢.٩٣	٢.٨٩٨
ADY	٢.٦٩	٢.٧٤	٢.٧٨	٢.٨٠	٢.٧٥٣	٢.٨٧	٢.٨٩	٢.٩٣	٢.٩٤	٢.٩٠٨
Phos.+M.A.	٢.٧٤	٢.٧٩	٢.٨٢	٢.٨٣	٢.٧٩٥	٢.٨٩	٢.٩٥	٢.٩٨	٢.٩٨	٢.٩٥٠
Phos.+ADY	٢.٧٦	٢.٨٢	٢.٨٣	٢.٨٤	٢.٨١٣	٢.٩٣	٢.٩٦	٢.٩٨	٢.٩٩	٢.٩٦٥
Mean (A)	٢.٦٧٥	٢.٧١٥	٢.٧٤٥	٢.٧٦٥		٢.٨٣٨	٢.٨٧٠	٢.٨٩٧	٢.٩٠٨	

L.S.D.at ٥٪	A: ٠.٠١٢	B: ٠.٠١٩	AB: N.S	A: ٠.٠١٠	B: ٠.٠١٥	AB: N.S

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ١١ : Effect of FYM and biofertilization treatments on phosphorus % of *Salvia officinalis*, L. in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	٠.٢٠	٠.٢٢	٠.٢٣	٠.٢٤	٠.٢٢٣	٠.٢٣	٠.٢٥	٠.٢٦	٠.٢٧	٠.٢٥٣
Phos.	٠.٢٥	٠.٢٦	٠.٢٨	٠.٢٩	٠.٢٧٠	٠.٢٨	٠.٣٠	٠.٣١	٠.٣٢	٠.٣٠٣
M.A.	٠.٢٤	٠.٢٦	٠.٢٧	٠.٢٨	٠.٢٦٣	٠.٢٨	٠.٢٩	٠.٣٠	٠.٣١	٠.٢٩٥
ADY	٠.٢٦	٠.٢٧	٠.٢٩	٠.٣٠	٠.٢٨٠	٠.٢٩	٠.٣١	٠.٣٢	٠.٣٣	٠.٣١٣
Phos.+M.A.	٠.٢٦	٠.٢٧	٠.٢٩	٠.٣٢	٠.٢٨٥	٠.٣٠	٠.٣١	٠.٣٣	٠.٣٤	٠.٣٢٠
Phos.+ADY	٠.٢٧	٠.٢٨	٠.٢٩	٠.٣٤	٠.٢٩٥	٠.٣٠	٠.٣٢	٠.٣٤	٠.٣٥	٠.٣٢٨
Mean (A)	٠.٢٤٧	٠.٢٦٠	٠.٢٧٥	٠.٢٩٥		٠.٢٨٠	٠.٢٩٧	٠.٣١٠	٠.٣٢٠	
L.S.D.at ٥٪	A: ٠.٠١٩		B: ٠.٠١١		AB: N.S	A: ٠.٠٠٩		B: ٠.٠٠٨		AB: N.S
Second season										
Control	٠.٢١	٠.٢٢	٠.٢٤	٠.٢٥	٠.٢٣٠	٠.٢٤	٠.٢٥	٠.٢٦	٠.٢٧	٠.٢٥٥
Phos.	٠.٢٦	٠.٢٨	٠.٢٩	٠.٣١	٠.٢٨٥	٠.٢٩	٠.٣٢	٠.٣٣	٠.٣٤	٠.٣٢٠
M.A.	٠.٢٥	٠.٢٧	٠.٢٨	٠.٢٩	٠.٢٧٣	٠.٢٨	٠.٢٩	٠.٣١	٠.٣٢	٠.٣٠٠
ADY	٠.٢٧	٠.٢٩	٠.٣٠	٠.٣٢	٠.٢٩٥	٠.٣٠	٠.٣٢	٠.٣٣	٠.٣٥	٠.٣٢٥
Phos.+M.A.	٠.٢٨	٠.٢٩	٠.٣١	٠.٣٢	٠.٣٠٠	٠.٣١	٠.٣٣	٠.٣٥	٠.٣٦	٠.٣٣٨
Phos.+ADY	٠.٢٨	٠.٣٠	٠.٣١	٠.٣٣	٠.٣٠٥	٠.٣٢	٠.٣٤	٠.٣٥	٠.٣٧	٠.٣٤٥
Mean (A)	٠.٢٥٨	٠.٢٧٥	٠.٢٨٨	٠.٣٠٣		٠.٢٩٠	٠.٣٠٨	٠.٣٢٢	٠.٣٣٥	

L.S.D.at ٥٪	A: ٠.٠١٤	B: ٠.٠٠٧	AB: N.S	A: ٠.٠١٢	B: ٠.٠٠٩	AB: N.S

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

Table ١٢ : Effect of FYM and biofertilization treatments on potassium % of *Salvia officinalis*, L. in the first and second cuts during ٢٠٠٩ / ٢٠١٠ and ٢٠١٠ / ٢٠١١ seasons.

Biotreatments	Farmyard manure (FYM) levels (m^3 / fed.)									
	First season									
	First cut					Second cut				
	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)	FYM ٠	FYM ١	FYM ٢	FYM ٣	Mean (B)
Control	١.١٢	١.١٤	١.١٤	١.١٥	١.١٣٨	١.١٣	١.١٤	١.١٤	١.١٦	١.١٤٣
Phos.	١.١٥	١.١٦	١.١٦	١.١٦	١.١٥٨	١.١٦	١.١٧	١.١٨	١.١٩	١.١٧٥
M.A.	١.١٦	١.١٨	١.١٨	١.١٩	١.١٧٨	١.١٧	١.١٩	١.٢٠	١.٢١	١.١٩٣
ADY	١.٢٠	١.٢٣	١.٢٤	١.٢٤	١.٢٢٨	١.٢٢	١.٢٥	١.٢٦	١.٢٧	١.٢٥٠
Phos.+M.A.	١.٢٦	١.٢٨	١.٢٨	١.٢٩	١.٢٧٨	١.٢٧	١.٢٩	١.٣٠	١.٣٢	١.٢٩٥
Phos.+ADY	١.٢٦	١.٢٩	١.٢٨	١.٣٠	١.٢٨٣	١.٢٨	١.٣٠	١.٣١	١.٣٣	١.٣٠٥
Mean (A)	١.١٩٢	١.٢١٣	١.٢١٣	١.٢٢٢		١.٢٠٥	١.٢٢٣	١.٢٣٢	١.٢٤٧	
L.S.D.at ٥٪	A: ٠.٠٠٧		B: ٠.٠١٠		AB: N.S	A: ٠.٠١٢		B: ٠.٠٢١		AB: N.S
Second season										
Control	١.١٣	١.١٤	١.١٥	١.١٥	١.١٤٣	١.١٤	١.١٥	١.١٧	١.١٨	١.١٦٠
Phos.	١.١٦	١.١٦	١.١٧	١.١٨	١.١٦٨	١.١٧	١.١٨	١.١٩	١.٢١	١.١٨٨
M.A.	١.١٦	١.١٨	١.١٩	١.٣١	١.٢١٠	١.١٨	١.٢٠	١.٢١	١.٢٢	١.٢٠٣
ADY	١.٢١	١.٢٤	١.٢٥	١.٢٧	١.٢٤٣	١.٢٢	١.٢٥	١.٢٨	١.٢٩	١.٢٦٠
Phos.+M.A.	١.٢٦	١.٢٨	١.٣٠	١.٣١	١.٢٨٨	١.٢٨	١.٣٠	١.٣١	١.٣٣	١.٣٠٥
Phos.+ADY	١.٢٧	١.٢٩	١.٣١	١.٣٢	١.٢٩٨	١.٢٨	١.٣١	١.٣٢	١.٣٤	١.٣١٣
Mean (A)	١.١٩٨	١.٢١٥	١.٢٢٨	١.٢٥٧		١.٢١٢	١.٢٣٢	١.٢٤٧	١.٢٦٢	

L.S.D.at ٥٪	A: ٠.٠٢٨	B: ٠.٠١٨	AB: N.S	A: ٠.٠١٣	B: ٠.٠١٥	AB: N.S

- Phos. : Phosphorein
- M.A. : Minia Azotein
- ADY : Active Dry Yeast

The three photosynthetic pigments contents and the three elements (NPK) percentages were significantly increased due to five used treatments of biofertilizers. The best treatment was phos. + ADY followed by the treatment od phos. + M.A. These findings are in agreement with those of Helmy (٢٠٠٨) on *Nigella sativa* and Abdou and Ashour (٢٠١٢) on jojoba plants.

The interaction between main and sub-plot treatments was significant for chlorophyll a, b and carotenoids in both cuts during both seasons, where the highest values were obtained due to $FYM_٣$ with phos. + ADY or phos. + M.A. and $FYM_٢$ in combination with phos. + ADY.

In general, the values of all studied parameters (except, plant height) in the second cut were higher than those of the first cut in both seasons. That variation may be due to removing the terminal buds or the direct and indirect effects of environmental conditions, especially temperature and light period on the physiological and biochemical processes in the plants, as well as, more decomposition of FYM during the time of second cut consequently increased growth and oil %.

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دراسات فسيولوجية على نبات المريمية

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- أجريت هذه التجربة الحقلية خلال موسمى ٢٠٠٩ / ٢٠١٠ و ٢٠١٠ / ٢٠١١ لدراسة تأثيرات السماد الحيوانى (صفر و ١٥ و ٢٥ و ٣٥ م^{٣} / فدان) ومعاملات التسميد الحيوى (الفوسفورين والمنيا أزوتين والخميرة النشطة والفوسفورين + المنيا أزوتين والفوسفورين + الخميرة النشطة) بالإضافة إلى التفاعل بينهما على صفات النمو الخضري والزيت الطيار والمحتوى الكيميائى لنباتات المريمية .
- أظهرت النتائج أن النباتات المعاملة بالسماد الحيوانى زادت معنوياً فى ارتفاع النبات (سم) وعدد الفروع / للنبات / للحشة والعشب الطازج والجاف للنبات (جم / نبات) وللفدان (طن / فدان) والنسبة المئوية للزيت الطيار ومحصول الزيت الطيار للنبات وللفدان (ملليتر / نبات ولتر / فدان) ومحتوى الأوراق من كلوروفيل أ

وكلوروفيل ب والكاروتينويدات بالإضافة إلى النسب المئوية للنتروجين والفوسفور والبوتاسيوم فى الحشتين خلال موسمى النمو . كان التفوق فى كل الخصائص السابق ذكرها للنباتات النامية فى التربة المسمدة بمعدل ٣٥ م^{٣} / فدان من السماد الحيوانى مقارنة بمعاملة الكنترول .

- اتضح أيضاً أن كل معاملات التسميد الحيوى زادت معنوياً كل صفات النمو الخضرى والزيت والتركيب الكيماوى (كل الصفات المدروسة) وكانت الأكثر فاعلية معاملة الفوسفورين + الخميرة النشطة .
- كان تأثير التفاعل معنوياً بين معاملات التسميد العضوى والتسميد الحيوى فى معظم الحالات لكل الصفات السابقة وقد تبين أن أحسن معاملة تفاعل هى الناتجة من نباتات مسمدة بالسماد الحيوانى (٣٥ م^{٣} / فدان) مع خليط من الفوسفورين والخميرة النشطة وهو ما توصى بة الدراسة لتسميد المريمية .