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EFFECT OF PHOSPHORUS FERTILIZATION LEVELS AND FOLIAR APPLICATION WITH ACTIVE DRY YEAST BIO-FERTILIZER ON GROWTH, HERB YIELD, ESSENTIAL OIL PRODUCTIVITY AND CHEMICAL COMPONENTS OF SAGE (*Salvia officinalis*, L.)

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ABSTRACT

Two field experiment were carried out during two seasons of 2002/03 and 2003/04 at the Agricultural Research Station, Fac. Agric., Mansoura Univ. to study the effect of phosphorus fertilization levels (0, 15.5 and 31 kg / fed P_2O_5) and active dry yeast as a foliar spray at the rates of 0, 0.1, 0.2 and 0.3 g / L on vegetative growth and essential oil content as well as chemical composition of sage.

Results revealed that providing sage plants with different phosphorus levels exerted significant differences in the vegetative growth characters expressed as plant height, number of branches, herb fresh and dry weights per plant, herb yield, essential oil content and chemical composition compared with control. The highest vegetative growth characters resulted from fertilized plants with the highest level of phosphorus (31 kg P_2O_5 / fed). Also, it is evident that the application of active dry yeast treatments as a foliar spray improved the growth of plants. The data showed that the growth characters of sage were significantly increased when the plant received the three dry yeast applications. The highest concentration of dry yeast (0.3 %) induced significant improvement in the all growth characters compared with unsprayed plant. The treatment of the combination between the highest level of phosphorus fertilizer and active dry yeast induced considerable increments with regard to growth, herb yield, essential oil content and chemical composition.

These findings clearly indicate that phosphorus fertilizer and active dry yeast could be used as effective tools instead of chemical nitrogen fertilization and may consequently minimize pollution of agricultural environments.

INTRODUCTION

Medicinal and aromatic plants occupy a prominent position in the Egyptian cultivation because of increasing interest demand of local industry and export.

Sage (*Salvia officinalis*, L.) is a member of Fam. Lamiaceae, and it has been used as a herb of the brain and memory since ancient times to retard the processes of declining faculties and failing memory, the name Salvia is from the Latin Salvo, "I am well" a reassertion of the health-giving qualities (Keville, 1999).

Sage is an evergreen perennial shrubby plant cultivated in central Europe and found now in mild temperature climate regions. It approximately grows 60 cm height with an erect woody stalk and straight branches and has pale blue or purplish flowers. The leaves are elongated with spear shaped soft velvety texture (Greenhalgh, 1979). Essential oil components are thujone, α, β-pinene, camphor and cineole (Holla and Vaverkova, 1993). In folk medicine dried herb is taken for bloating, diarrhea, and intestinal inflammation. In Asia, it's considered a remedy for hemorrhoids, blood in the urine, bloody phlegm and it may be prescribed for excessive flow of breast milk (Furuhata *et al.*, 2000). The extract solution of common sage had a strong antioxidant and antibacterial activity for nervous and physical exhaustion and increasing mean serum iron (Lipmann and Wagner, 2001).

Phosphorus is considered as second nutrient element in both plants and microorganisms, respectively. Under phosphorus deficiency shoot growth is more depressed and various parameters or photosynthesis are impaired (Lauer *et al.,* 1989). The finely tuned homeostasis of phosphorus on chloroplasts is reason for a higher various enzymes activity of carbohydrate metabolism (Rao *et al.*, 1990). Mohamed and Abd El-Hafez (1982) reported that after fertilization with calcium super phosphate, the level of available phosphorus decreases sharply after a short period from application. They added that this case is widespread in alkaline soils, since the available P in the added fertilizer is rapidly transformed to tricalcium phosphate, thus, becomes unavailable to the plant. In spite of considerable phosphorus addition to soil, the available amount for plant is usually low. The promotive effect of P-fertilizer on growth of plants may be due to the phosphate regulates enzymatic processes, the phosphorylation of adenosin diphosphate (ADP) to adenosine triphosphate (ATP). Also, phosphate acts as an activator for some enzymes, leading to enhancement of the metabolism processes and formation of new cells (Dhillon,1978). Mousa (1990) reported that phosphorus is necessary for protoplasm formation and considerably influences the quantity of plant available nitrogen. Treated fenugreek plants with calcium super phosphate (200 kg / fed) gave the highest values of plant height, number of branches, plant fresh and dry weights (Ahmed and Zayed, 1994).

Yeast as a natural biostimulator is very safe to human, animals and environments (El-Araby, 2004). It is a natural source of many growth substances (thiamine, riboflavin, cholin, niacin, pyridoxine, folic acid and vitamin B_{12}) and most of nutrient elements (Na, Ca, Fe, K, P, S, Zn and Si), as well as, organic compounds i.e. protein, carbohydrate, nucleic acids and lipids (Nagodawithana, 1991). The various positive effects of applying dry yeast were attributed to its content of different nutrients, higher percentage of proteins, large amount of vitamin B and natural growth hormones, namely, cytokinins. In addition, application of yeast is very effective in releasing CO_2 which improved photosynthesis (Idso *et al.,* 1995). The plant height; number of branches and N, P and K contents, as well as, the volatile oil composition of black cumin were highest as affected by the treatment of 2mg yeast (Naguib and Khalil, 2002). The vegetative growth, essential oil content and composition were increased in the sprayed plants with dry yeast (El-Hindi and El-Boraie, 2004 on marigold and Heikal, 2005 on thyme). Bio-fertilization with active dry yeast at 1 g / L and calcium super phosphate at 150 kg / fed gave highest percentage of volatile oil of coriander seeds (Eid, 2001).

Interaction between phosphorus fertilizer and active dry yeast bio-fertilizer increased greatly the vegetative growth parameters and carbohydrates content as well as N, P and K percentages of *Vigna radiate,* L. (Fouda, 2005).

The objective of this work was to investigate the effect of different levels of phosphorus and active dry yeast on growth, essential oil productivity and chemical components of sage.

MATEIRAL AND MOTHEDS

The current research was conducted during two successive seasons of 2002/03 and 2003/04, at Experimental Station and Laboratory of Veget. and Floric. Dept., Fac. Agric. Mansoura Univ., aiming to study the effect of different levels of phosphorus fertilizer, active dry yeast bio-fertilizer and their interaction on vegetative growth, herb yield, essential oil productivity and chemical composition of sage.

Seeds of sage were sown in prepared nursery beds on October 15th in both seasons. The growing seedlings were transplanted after 80 days from sowing at 20 cm apart on the eastern side of row in an irrigated soil. The soil of the experimental location was of clay texture; the physical and chemical soil properties are presented in Table (A).

The experiment included 12 treatments, which were three levels of phosphorus (0, 15.5 and 31 kg P_2O_5 / fed), and four levels of spraying with active dry yeast (0, 0.1, 0.2 and 0.3 g / L), as well as their interaction. Yeast was mixed with sugar at a ratio of 1:1 per liter water and was left for 3 hours at room temperature (El-Ghamriny *et al.*, 1999).

The phosphorus fertilizer levels were randomly located in the main plot, whereas, the sub-plots were devoted for the foliar sprays with active dry yeast. The sub-plot area was 4.5 m^2, which consisted of 5 ridges. Every ridge was 1.5 m length containing 5 plants at distance of 30 cm.

Phosphorus was added during the field preparation. Active dry yeast was sprayed three times after 15, 30 and 40 days from transplanting during the two seasons.

In both seasons, the plants were harvested twice yearly by cutting the aerial parts of each plant (10 cm) above the soil surface. The first cut was May 15th (at commencement of flowering), while the second one was done on September 15th (four months after the first cut). Five plants were randomly chosen from each experimental unit at two cuts, respectively in both seasons. The vegetative growth parameters [plant height (cm), number of branches, fresh and dry weights of plants (g) and herb yield (kg)] were recorded and statistically analyzed.

The essential oil obtained from fresh herb in the first cut of the second season using 100 g samples per plant. The distillation of essential oil and the determination were described in the Egyptian Pharmacopoeia (1984). The oil content (ml/plant) and oil yield (ton/fed.) were calculated by multiplying the essential oil percentage by plant weight and by number of plants per fed. The essential oil was analyzed using Gas Liquid Chromatography equipped with a flame ionization detector for separation of volatile oil constituents. The quantitative determination of main components of oil samples were subjected to GLC analysis and calculated following the methods of Guenther and Joseph (1978), the G.L.C. analysis was carried out at the Central Laboratory of Cairo University.

Phenolic compounds of fresh leaves were determinated due to the method reported by Swain and Hillis (1959).

Herb was dried in an electric oven at 70ºC for 24 hours according to A.O.A.C. (1970), then finely ground for chemical determination of total carbohydrates according to method of Herbert *et al.* (1971).

Nitrogen percentage was determined according to micro-kjeldahl method of Jackson (1967). Phosphorus percentage was determined colorimetrically according to method of Murphy and Reily (1962). Potassium percentage was determined using the Atomic Absorption Spectrophotometer (3300) according to Wilde *et al.* (1985).

The split-plot design in a completely randomized block with 3 replicates was used in both growing seasons. Obtained data were subjected to the statistical analysis of variance (ANOVA) in split plot design as mentioned by Gomez and Gomez, (1984).

Table (A): Physical and chemical properties of the experimental soil in the two seasons (2002/03 and 2003/04).

Characters	1st season	2nd season
Soil texture	Clay	Clay
pH	8.1	8.0
Organic matter (%)	1.96	1.87
Physical (%)		
Sand	21.42	21.82
Silt	30.97	31.90
Clay	46.61	46.28
Chemical nutrients (ppm)		
N	91.12	85.92
P	15.9	27.1
K	536	524
Fe	5.21	5.15
Mn	3.42	3.61

RESULTS AND DISCUSSIONS

1- Plant growth characters

Data presented in Tables (1 and 2) indicated that providing sage plants with different phosphorus levels exerted significant differences in the vegetative growth characters expressed as plant height, number of branches, herb fresh and dry weights compared with control. The highest vegetative growth characters resulted from fertilized plants with the highest level of phosphorus (31 kg P_2O_5 / fed). Such increases may be due to the essential and vital role of this element in the different metabolic processes.

Table (1): Plant height (cm) and number of branches / plant of sage as affected by phosphorus levels, yeast spraying and their interaction during 2003 and 2004 seasons for two cuts.

Characters / Treatments		Plant height (cm)				Number of branches / plant			
		1st season		2nd season		1st season		2nd season	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
P (kg)									
0.0		36.25	32.67	36.83	36.59	20.42	28.84	19.83	28.92
15.5		42.00	44.50	43.92	45.67	25.17	32.00	25.75	32.42
31		52.84	54.00	56.25	53.50	30.25	35.42	30.83	35.58
LSD at 5%		5.84	0.78	1.40	1.24	1.40	1.03	1.74	0.92
Yeast (%)									
0.0		37.74	38.66	39.33	39.78	22.89	30.00	22.67	30.00
0.1		43.11	43.22	45.55	45.00	24.67	32.00	24.66	32.33
0.2		46.11	45.78	48.55	47.67	26.44	32.89	27.00	33.11
0.3		47.78	47.22	49.22	48.56	27.11	33.44	27.55	33.78
LSD at 5%		1.75	1.02	0.86	0.80	1.69	0.50	0.76	0.78
Interaction									
0.0	0.0	33.33	30.33	34.67	33.67	19.67	27.67	18.33	27.67
	0.1	35.33	31.67	36.33	35.67	20.00	28.00	19.33	28.33
	0.2	37.00	33.00	37.33	38.00	20.67	29.67	20.67	29.33
	0.3	39.33	35.67	39.00	39.00	21.33	30.00	21.00	30.33
15.5	0.0	38.33	33.67	37.33	38.00	21.00	29.67	21.00	28.67
	0.1	40.33	43.33	43.00	46.33	24.00	32.33	24.33	33.33
	0.2	44.00	45.33	47.33	48.67	27.33	32.67	28.33	33.67
	0.3	45.33	46.00	48.00	49.67	28.33	33.33	29.33	34.00
31	0.0	41.67	42.33	46.00	47.67	28.00	32.67	28.67	33.67
	0.1	53.67	4567	57.33	53.00	30.00	35.67	30.33	35.33
	0.2	57.33	59.00	61.00	56.33	31.33	36.33	32.00	36.33
	0.3	58.67	60.00	60.67	57.00	31.67	37.00	32.33	37.00
LSD at 5%		3.49	2.04	1.72	1.60	3.38	1.00	1.52	1.56

It is evident from the data presented in the same Tables that the application of yeast treatments as a foliar spray improved the growth of plants. The highest concentration of dry yeast (0.3 %) induced significant improvement in the previous growth characters compared with unsprayed plant. The growth characters of sage were significantly increased when the plant received the three dry yeast applications. The increases in vegetative growth characters by spraying yeast might be due to its content of tryptophan (Abd El-Latif, 1987) and precursor of IAA (Moor, 1979).

The interaction between the rates of phosphorus fertilizer and spraying active dry yeast treatments showed that there were significant differences as plant growth characters were concerned. These results were similar in the two seasons.

Table (2): Fresh and dry weight / plant (g) of sage as affected by phosphorus levels, yeast spraying and their interaction during 2003 and 2004 seasons for two cuts.

Characters / Treatments		Fresh herb / plant (g)				Dry herb / plant (g)			
		1st season		2nd season		1st season		2nd season	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
P (kg)									
0.0		191.7	196.0	194.4	198.5	39.73	41.28	40.28	41.28
15.5		260.4	265.4	266.5	271.7	56.97	59.45	56.48	59.04
31		303.1	308.0	301.8	313.5	68.94	73.11	67.64	71.62
LSD at 5%		9.56	7.16	21.84	10.71	6.33	1.74	1.02	2.04
Yeast (%)									
0.0		221.7	225.7	223.3	229.2	45.93	48.81	47.11	49.14
0.1		250.4	259.5	252.6	265.6	54.53	58.38	54.55	57.95
0.2		264.5	269.1	267.6	273.4	58.67	61.55	57.76	60.12
0.3		270.7	271.6	273.3	276.7	61.72	63.05	59.78	62.03
LSD at 5%		12.08	2.53	18.71	2.84	5.14	0.59	1.46	0.78
Interaction									
0.0	0.0	171.2	186.0	175.8	187.2	34.30	37.90	37.27	38.23
	0.1	186.7	196.3	189.9	198.4	38.00	40.93	38.53	40.93
	0.2	198.8	199.5	202.5	203.6	41.33	42.43	41.70	42.53
	0.3	210.1	202.1	209.4	204.7	45.30	43.86	43.60	43.43
15.5	0.0	201.1	199.8	203.3	203.1	41.40	42.40	42.13	42.67
	0.1	262.2	272.0	274.3	283.1	56.87	60.37	57.70	60.93
	0.2	286.9	292.9	290.0	295.7	63.20	66.50	61.60	64.20
	0.3	292.7	297.1	298.4	304.9	66.43	68.53	64.50	68.37
31	0.0	292.7	291.4	290.8	297.3	62.10	66.13	61.93	66.53
	0.1	302.4	310.2	293.7	315.2	68.73	73.83	67.43	72.00
	0.2	307.8	314.9	310.4	320.8	71.47	75.73	69.97	73.63
	0.3	309.3	315.7	312.3	320.6	73.44	76.77	71.23	74.30
LSD at 5 %		24.15	5.06	37.43	5.68	10.28	1.18	2.92	1.55

2 - Essential oil productivity

The essential oil percentage in the dried herb of sage was varied due to phosphorus fertilizer treatments (Table, 3). All levels of phosphorus fertilization increased the essential oil percentage in sage herb when compared with untreated ones. Highest oil percentages were 1.10 and 1.18 % in the first cut and 1.08 and1.14 % in second one, respectively, of the first and the second growing season. These values were obtained from plants fertilized with highest phosphorus level (31 kg P_2O_5 / fed) as compared with control. While the least oil percentages were 0.94, 0.95 % and 0.95, 0.96 %, respectively produced from control plants.

Data illustrated in (Table 3) reveal that application of 0.3 % active dry yeast caused an increase in the essential oil percentage 1.04, 1.07 % and 1.07, 1.09 %, respectively, of the two cuts in both seasons.

It is clear from data that there was non significant effect of the interaction except the treatment combination of high level of phosphorus fertilization (31 kg P_2O_5 / fed) and foliar spray with 0.03 % active dry yeast

1.20, 1.27 % and 1.17, 1.27 %, respectively, in the two cuts during both seasons. These increases of essential oil percentage might be attributed to their enhancing effect on vegetative growth, in terms of fresh yield and increased uptake of nutrients by root of plant especially phosphorus element, which is a main constituent of phosphoproteins, phospholipids, and nucleic acids. However, the most important compound in phosphate group which linked by pyrophosphate bonds is adenosine triphosphate (ATP). The energy absorbed during photosynthesis or released during respiration is utilized in the synthesis of the pyrophosphate bounds in ATP. In this form, the energy can be conveyed to various undergoing processes such as uptake activation and the synthesis of various organic compounds such as essential oil. (heikal, 2005)

Table (3): Essential oil percentage (%) and oil content/plant (cc) of sage as affected by phosphorus levels, yeast spraying and their interaction during 2003 and 2004 seasons for two cuts.

Characters / Treatments		Oil percentage (%)				Oil content / plant (cc)			
		1st season		2nd season		1st season		2nd season	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
P (kg)									
0.0		0.94	0.95	0.95	0.96	0.37	0.39	0.38	0.40
15.5		0.97	0.97	1.01	0.99	0.56	0.58	0.57	0.59
31		1.10	1.18	1.08	1.14	0.76	0.87	0.74	0.82
LSD at 5%		0.12	0.17	0.04	0.07	0.10	0.13	0.03	0.08
Yeast (%)									
0.0		0.97	0.97	0.96	0.98	0.45	0.48	0.44	0.48
0.1		0.98	1.02	0.98	1.00	0.54	0.61	0.54	0.59
0.2		1.02	1.05	1.02	1.05	0.61	0.67	0.60	0.64
0.3		1.04	1.07	1.07	1.09	0.65	0.69	0.66	0.69
LSD at 5%		0.02	0.04	0.03	0.03	0.02	0.03	0.02	0.05
Interaction									
0.0	0.0	0.92	0.93	0.94	0.94	0.32	0.35	0.33	0.36
	0.1	0.93	0.93	0.94	0.95	0.35	0.38	0.36	0.40
	0.2	0.94	0.96	0.95	0.97	0.39	0.41	0.40	0.41
	0.3	0.95	0.96	0.97	0.97	0.43	0.42	0.42	0.42
15.5	0.0	0.96	0.96	0.96	0.97	0.40	0.42	0.40	0.41
	0.1	0.96	0.97	0.98	0.98	0.55	0.58	0.56	0.60
	0.2	0.98	0.97	0.99	0.99	0.62	0.65	0.61	0.64
	0.3	0.98	0.98	1.09	1.03	0.65	0.67	0.71	0.70
31	0.0	1.02	1.03	0.99	1.02	0.63	0.68	0.61	0.68
	0.1	1.06	1.17	1.03	1.07	0.73	0.86	0.70	0.77
	0.2	1.13	1.23	1.13	1.20	0.81	0.94	0.79	0.88
	0.3	1.20	1.27	1.17	1.27	0.88	0.98	0.84	0.94
LSD at 5%		0.04	0.08	0.06	0.06	0.04	0.06	0.04	0.10

Data in Table (3) showed significant differences due to all levels of phosphorus fertilization if compared with control. The maximum essential oil yields were 0.76 and 0.87 cc / plant respectively, produced from fertilized plant with the highest level, and the least oil contents were 0.37 and 0.39 cc / plant respectively, produced from control plants of the two cuts during first season. A similar effect was obtained as the second season was concerned.

Concerning the effect of active dry yeast, data indicated that in the first season, plants treated with yeast bio-fertilizer resulted in significant increase compared with control. The highest values were produced from the highest level of yeast (0.65 and 0.69 cc / plant in the two cuts, respectively). The data recorded in the second season confirmed those of the first one. Also, the highest level of foliar spray with yeast gave the highest values of oil content (0.66 and 0.69 cc / plant in the two cuts, respectively).

Results in Table (3) revealed the effect of interaction between phosphorus and yeast levels on essential oil content. It was observed that interaction treatments increased the essential oil content. The highest values were recorded due to the treatment of high level of phosphorus combined with 0.3 % dry yeast in the two cuts, during the two seasons if compared with control. These results may be a consequent of the increase in plant fresh and dry weights as a result of bio-fertilization, as well as, the increase in the essential oil percentage.

3 - Essential oil components

Data presented in Table (4) and illustrated in Figure (1) identified 12 compounds formed from 61.35 to 88.34% of the essential oil indicating the effect of different treatments with phosphorus fertilizer, foliar spray of active dry yeast and their interactions. Thujone was the major constituent forming from 35.51 to 46.66 %, followed by β-pinene (6.32 - 11.96 %), linalool (6.20 - 8.46 %), α-pinene (2.30 - 5.29 %), camphen (2.03-4.84 %), methyl chavicol (2.89 - 3.72 %), camphar (2.22 - 3.36 %), borneol (1.89 - 3.37 %), eugenol (1.76 -2.77 %), linalyl acetate (1.25 - 3.03 %), terpinen (0.96 - 1.27 %) and cineol (0.78 – 0.96 %).

It is evident from results that phosphorus fertilization increased the percentages of α-pinene, camphen, β-pinene, thujone, cineol and linalool components in sage oil. The highest percentage of thujone was obtained from the highest levels of phosphorus (37.92 %) and yeast (44.19 %).

Concerning the effect of interaction on the components of sage oil, corresponding data in Table (4) and Figure (1) showed that all levels of phosphorus fertilizer and foliar spray of active dry yeast increased the α-and β-pinene, camphen, thujone, cineol, and linalool percentages when compared to control. On the other hand, the terpinen, methyl chavicol, linalyl acetate, camphar, borneol and eugenol were decreased if compared with control.

The highest value of thujone (46.66 %) was produced from the highest level of phosphorus fertilizer and spraying of 0.3 % yeast. The constructive effect may be due to improving mineral nutrition in addition to release plant promoting substances such as IAA, gibrillin and cytokinins, especially of yeast which could encourage plant growth, absorption of nutrients (N, P, K, Mn, Zn, Fe and Cu), efficiency of nutrient and the metabolism of photosynthesis (Reynders and Vlassak, 1982). The increment in thujone (bicyclic monoterpene) content in sage oil was due to improving mineral nutrients absorption and to be accompanied with a decrease in the other components such as cineole, terpinen, methyl chavicol, linalyl acetate, camphar, borneol and eugenol. These results agreed with those obtained by Clark and Mematy (1981) on peppermint which indicated that factors affected, apparently, photosynthesis which is an important determinate of oil composition. Also, they came to the conclusion that, physiological factors may significantly affect the composition of terpenes produced in any given environment.

Table (4) : GLC of sage plants oil as affected by phosphorus levels, yeast spraying and their interaction during 2003 season.

Components / Treatments		α -pinene	Camphene	β-pinene	Thujone	Cineol	Trpinene	Lenalool	Methyl chavicol	Linalyl acetate	Camphar	Borneol	Eugenol	Unknown	known
P (kg/fed)															
0.0		2.30	2.03	6.62	35.51	0.78	1.27	7..38	3.52	2.98	2.22	1.89	2.23	38.65	61.35
15.5		5.05	2.96	6.38	36.57	0.80	1.17	11.13	3.89	3.00	2.66	1.91	2.20	22.28	77.72
31		5.01	3.06	6.32	37.92	0.79	1.15	11.22	3.93	3.03	2.26	1.94	2.77	20.58	79.4
Yeast (%)															
0.1		5.03	4.70	10.99	43.89	0.93	1.15	8.40	2.89	1.33	2.84	2.02	2.11	13.72	86.28
0.2		5.05	3.96	11.82	44.12	0.96	1.17	6.21	3.40	1.86	3.36	3.37	1.88	12.84	87.16
0.3		5.06	4.75	11.04	44.19	0.93	1.16	8.46	3.41	1.44	3.00	2.04	1.96	12.56	87.44
Interaction															
15.5kg P_2O_5 / fed	0.1	4.89	4.18	11.96	45.21	0.93	1.07	6.27	3.13	1.88	3.20	2.89	1.91	12.48	87.52
	0.2	4.88	4.84	10.92	45.53	0.15	1.15	8.38	2.89	1.43	2.75	2.27	2.12	12.69	87.31
	0.3	4.88	4.10	11.85	45.91	0.13	1.17	6.20	3.40	1.85	2.96	3.20	1.89	12.46	87.54
31 kg P_2O_5/ fed	0.1	5.20	4.23	11.02	46.64	0.94	1.03	6.95	3.72	1.25	2.82	2.05	1.76	12.39	87.61
	0.2	5.21	4.23	11.03	46.27	0.94	1.03	6.96	3.72	1.35	3.14	2.18	2.28	11.66	88.34
	0.3	5.29	4.27	10.56	46.66	0.88	0.96	7.19	3.48	1.36	3.11	2.33	1.89	12.02	87.98

4 - Herb and oil yield

Data reported in Table (5) revealed significant differences in dried herb yield due to different levels of phosphorus fertilizer (0, 15.5 and 31 kg P_2O_5 / fed). In the first season, herb yield ranged from 0.879 to 1.533 and 0.917 to 1.625 ton / fed respectively, in the two cuts. Fertilization with the highest level produced the heaviest herb yield compared with control plants. In the second season, the greatest dried herb yield was 1.503 and 1.591 ton / fed as a total of both cuts due to the highest level of phosphorus. The least herb yield was 0.881 and 0.918 ton / fed of both cuts, obtained from control plant.

Concerning the effect of foliar spray with active dry yeast, data in Table (5) revealed that the highest level of yeast gave the heaviest herb yield which were 1.372 and 1.400 ton / fed for two cuts in the first season. In the second season, dry herb yield was 1.325 and 1.378 ton / fed in two cuts when plants were sprayed with high level of yeast.

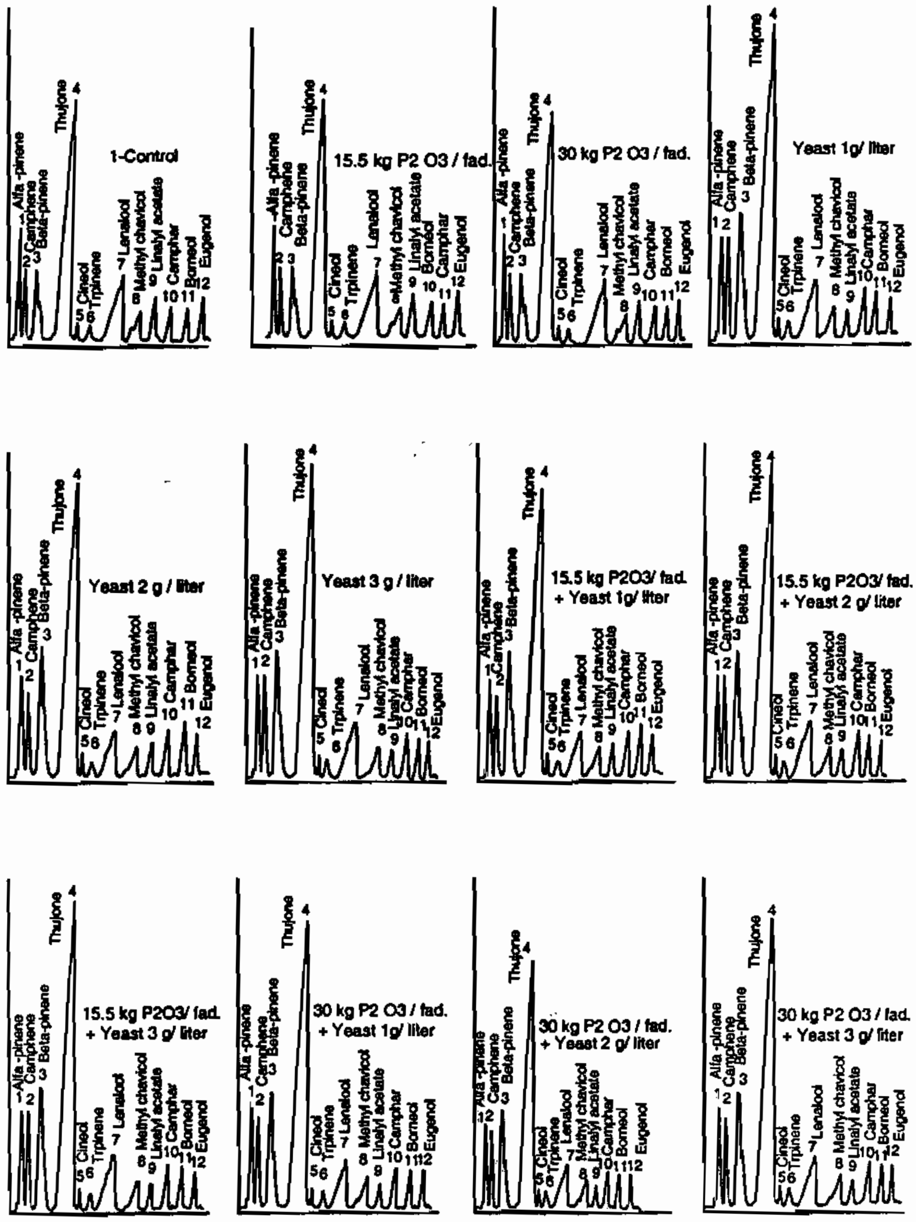

Figure (1) : GLC of sage essential oil as affected by phosphorus levels, yeast spraying and their interaction during 2003 season.

1-α-Pinene	**2-Camphen**	**3-β-Pinene**	**4-Thujone**
5- Cineol	**6- Terpinen**	**7- Linalool**	**8- Methyl chavicol**
9- Linalyl acetate	**10- Camphar**	**11- Borneol**	**12- Eugenol**

The combination between the different phosphorus levels and foliar spray with active dry yeast were significant in the two seasons.

Data presented in Table (5) show that there was a considerable effect due to the interaction between phosphorus levels and yeast compared with control in two cuts during both seasons. The heaviest values (1.633 and 1.706 ton / fed, respectively) produced from plants fertilized with high phosphorus level and sprayed with the highest level of yeast in the first cut in both seasons. This treatment combination surpassed the phosphorus fertilization or spraying dry yeast alone as dry herb yield was concerned.

Table (5): Herb yield (ton / fed) and essential oil yield (liter / fed) of sage as affected by phosphorus levels, yeast spraying and their their interaction during 2003 and 2004 seasons for two cuts.

Treatments \ Characters		Herb yield (ton / fed)				Oil yield (liter / fed)			
		1st season		2nd season		1st season		2nd season	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
P (kg)									
0.0		0.879	0.917	0.881	0.918	8.28	8.99	8.41	8.80
15.5		1.264	1.321	1.255	1.312	12.26	12.82	12.67	13.06
31		1.533	1.625	1.503	1.591	16.93	19.20	16.33	18.17
LSD at 5%		0.07	0.03	0.02	0.05	2.32	3.56	0.65	1.41
Yeast (%)									
0.0		1.017	1.085	1.032	1.092	9.97	12.08	9.92	10.74
0.1		1.212	1.297	1.212	1.288	12.10	13.56	12.02	13.01
0.2		1.299	1.368	1.283	1.336	13.43	14.74	13.33	14.30
0.3		1.372	1.400	1.325	1.378	14.45	15.33	14.60	15.31
LSD at 5%		0.06	0.01	0.03	0.01	0.44	1.13	0.63	0.45
Interaction									
0.0	0.0	0.762	0.842	0.784	0.850	7.04	7..85	7.33	8.00
	0.1	0.844	0.910	0.856	0.910	7.85	8.52	8.07	8.67
	0.2	0.902	0.944	0.926	0.945	8.67	9.04	8.81	9.11
	0.3	1.007	0.970	0.959	0.965	9.55	9.41	9.41	9.41
15.5	0.0	0.910	0.942	0.936	0.948	8.81	9.04	8.89	9.19
	0.1	1.264	1.341	1.282	1.354	12.15	12.96	12.52	13.26
	0.2	1.406	1.478	1.369	1.427	13.63	14.37	13.56	14.15
	0.3	1.476	1.523	1.433	1.519	14.45	14.89	15.71	15.63
31	0.0	1.380	1.470	1.376	1.478	14.07	15.11	13.55	15.04
	0.1	1.528	1.641	1.498	1.600	16.29	19.19	15.48	17.11
	0.2	1.589	1.683	1.555	1.636	18.00	20.81	17.63	19.63
	0.3	1.633	1.706	1.583	1.651	19.36	21.70	18.67	20.89
LSD at 5%		0.12	0.02	0.06	0.02	0.89	2.26	1.26	0.98

Concerning the effect of different levels of phosphorus on essential oil yield, data in Table (5) showed that different levels of phosphorus fertilizer gave significant increases in the essential oil yield in both cuts as compared with control. The highest values were obtained from the highest level of phosphorus (31 kg P_2O_5 / fed). It was also, clear that active dry yeast bio-fertilizer at all levels, increased significantly essential oil yield in the two cuts, during the both growing seasons.

Such increments tended to correlate with the increasing level. Concerning the interaction effect between phosphorus and yeast, it was observed that the highest increase in oil yield/fed was obtained from all combinations of phosphorus and active dry yeast. The increase in essential oil yield may be due to the increase in herb yield as previously mentioned in this study, as well as the increment in the essential oil percentage as a result of fertilizing plants with phosphorus and foliar spraying with yeast alone or their combination. This increment may be due that the mineral nutrition exerted some effects either directly on the enzyme system dealing with this conversion or indirectly by its effects on photosynthetic process.

5- Chemical analysis

Data presented in Table (6) showed the phenolic compounds percentage in leaves of sage plants as affected by different levels of phosphorus fertilization. It could be concluded that all treatments led to increase phenolic compounds if compared with control. The highest values were observed due to fertilization with 31 kg P_2O_5 / fed while the least values were obtained from plants treated with 15.5 kg P_2O_5 / fed, in both cuts, during the two growing seasons.

Concerning the effect of bio-fertilizer, data indicated that treating plants with all levels of active dry yeast caused an increase in the phenolic compounds percentages at all cuts as compared with untreated ones. The highest level (0.3 %) caused a considerable effect compared to other levels during the two growing seasons.

Interaction between phosphorus and yeast gave increases in phenolic compounds percentages. The highest values were observed in plants fertilized with phosphorus at 31 kg P_2O_5 / fed and sprayed by yeast bio-fertilizer at 0.3 % in comparison with control and other combinations. The fav· ·ble effect of phosphorus and yeast treatments on the phenolic compounds percentage in the leaves may be due to improving mineral nut·it·on (NPK) in addition to release plant promoting substances such as IAA, gibirillin and cytokinin-like substances. In this respect Haridi (1987) mentioned that application of gibberellic acid (GA_3) or Indol butyric acid (IBA) increased phenolic compounds percentage. Also, Ahmed (1988) indicated tha· ·henolic compounds were increased in geranium herb treated with N, P, K and their mixtures.

Data in Table (6) showed that the total carbohydrates percentage in dried herb of sage was increased as a result of using different levels of phosphorus treatments in comparison to the control plant. Plants treated with the highest level of phosphorus resulted highest total carbohydrates percentage, and the least increase in carbohydrate was produced from plants treated with low level during both cuts in the two seasons. These results might be due to that, phosphorus is raised in soil and plant tissues. It is known that phosphorus is a constituent of nucleic acids, phospholipids the coenzymes and is most important as a consistent of ATP, thereby, could significantly altered plant carbohydrate contents (Devlin and Withan, 1983).

Also, it was obvious that the total carbohydrate percentage was increased at all levels of yeast as compared to control in both seasons. The increment in carbohydrate metabolism may be due to that yeast is containing manganese which is known that, in some way, is involved in the oxidation-reduction processes in photosynthetic electron transport (Mengel and Kirkaby, 1987). It is clear that there was positive effect of interaction between phosphorus and yeast on total carbohydrates percentages compared to control for four cuts. Also, it was clear that, plants fertilized by 31kg P_2O_5 / fed combined with 0.3 % yeast produced the highest values of total carbohydrates percentages in the first and second cuts, during both seasons.

Table (6): Total carbohydrates and phenolic compounds percentage (%) of sage as affected by phosphorus levels, yeast spraying and their interaction during 2003 and 2004 seasons for two cuts.

P (kg/fed)	1st cut					2nd cut				
	Yeast (%)					Yeast (%)				
	0.0	0.1	0.2	0.3	Mean	0.0	0.1	0.2	0.3	Mean
	1st season									
	Total carbohydrates (%)									
0.0	18.3	19.3	19.6	19.9	19.3	18.9	19.0	18.7	18.5	18.8
15.5	19.9	20.1	20.6	20.8	20.4	19.8	20.2	20.8	21.0	20.5
31	21.4	22.2	22.5	22.7	22.2	20.8	21.2	22.4	22.8	21.6
Mean	19.9	20.5	20.9	21.1		19.8	20.1	20.6	20.8	
	Phenolic compounds (%)									
0.0	0.63	0.65	0.67	0.71	0.71	0.54	0.55	0.57	0.60	0.57
15.5	0.66	0.73	0.80	0.82	0.75	0.62	0.73	0.78	0.86	0.75
31	0.86	0.90	0.93	0.96	0.91	0.69	0.85	0.92	0.95	0.85
Mean	0.72	0.76	0.80	0.83		0.61	0.71	0.75	0.80	
	2nd season									
	Total carbohydrates (%)									
0.0	18.4	18.9	19.2	19.5	19.0	17.9	18.4	18.7	19.1	18.5
15.5	19.9	20.3	20.7	20.8	20.4	19.2	19.5	19.9	20.2	19.7
31	21.0	21.5	22.1	22.6	21.8	20.9	21.7	22.4	22.7	21.9
Mean	19.8	20.2	20.7	21.0		19.3	19.9	20.3	20.7	
	Phenolic compounds (%)									
0.0	0.62	0.68	0.73	0.81	0.71	0.56	0.60	0.65	0.72	0.63
15.5	0.82	0.86	0.90	0.95	0.88	0.74	0.76	0.86	0.89	0.81
31	0.90	0.93	0.95	0.98	0.94	0.84	0.89	0.93	0.95	0.90
Mean	0.78	0.82	0.86	0.91		0.71	0.75	0.81	0.85	

Data in Table (7) showed that phosphorus fertilizer increased the percent of N, P and K in treated sage herb compared with the untreated ones during the two experimental seasons. The highest values of N, P and K percentages were produced from treated plants with highest level of phosphorus fertilization.

Also, data in the same Table indicated that all levels of yeast caused an increase in N, P and K percentages when compared with untreated ones. The highest values of N, P and K % were found in plants sprayed with yeast at the rate of 0.3 % in two cuts during both seasons.

Regarding the effect of interaction between treatments, results in the same Table showed that there were clear differences in N, P and K percentages of sage herb by interaction between fertilization with phosphorus plus yeast during both cuts of the two seasons,. The highest values were produced due to fertilization with phosphorus at the rate of 31kg P_2O_5 / fed combined with active dry yeast at the rate of 0.3 %.

Table (7): Nitrogen, phosphor and potassium (%) in the herb of sage as affected by phosphorus levels, yeast spraying and their interaction during 2003 and 2004 seasons for two cuts.

P (kg/fed)	1st cut					2nd cut				
	Yeast (%)					Yeast (%)				
	0.0	0.1	0.2	0.3	Mean	0.0	0.1	0.2	0.3	Mean
	1st season									
	Nitrogen (%)									
0.0	1.25	1.34	1.42	1.50	1.38	1.30	1.35	1.46	1.52	1.41
15.5	1.36	1.45	1.57	1.62	1.50	1.42	1.48	1.53	1.59	1.51
31	1.40	1.53	1.60	1.65	1.54	1.45	1.50	1.61	1.67	1.56
Mean	1.34	1.44	1.53	1.59		1.39	1.44	1.53	1.59	
	Phosphor (%)									
0.0	0.21	0.23	0.29	0.28	0.25	0.22	0.25	0.28	0.31	0.27
15.5	0.30	0.34	0.36	0.37	0.34	0.33	0.35	0.38	0.39	0.36
31	0.35	0.39	0.41	0.43	0.40	0.41	0.43	0.45	0.47	0.44
Mean	0.29	0.32	0.35	0.36		0.32	0.34	0.37	0.39	
	potassium (%)									
0.0	2.35	2.48	2.53	2.61	2.49	2.34	2.46	2.52	2.59	2.48
15.5	2.65	2.86	2.94	3.11	2.89	2.64	2.82	2.91	3.10	2.87
31	2.79	3.21	3.36	3.48	3.21	2.80	3.18	3.40	3.46	3.24
Mean	2.60	2.85	2.94	3.07		2.59	2.82	2.94	3.05	
	2nd season									
	Nitrogen (%)									
0.0	1.27	1.38	1.46	1.51	1.41	1.34	1.41	1.48	1.56	1.45
15.5	1.36	1.48	1.59	1.64	1.52	1.48	1.51	1.56	1.63	1.55
31	1.41	1.50	1.61	1.67	1.55	1.52	1.58	1.63	1.68	1.60
Mean	1.35	1.45	1.55	1.61		1.45	1.50	1.56	1.62	
	Phosphor (%)									
0.0	0.22	0.24	0.29	0.30	0.26	0.24	0.27	0.28	0.29	0.27
15.5	0.33	0.35	0.36	0.38	0.36	0.35	0.39	0.40	0.41	0.39
31	0.37	0.39	0.41	0.49	0.42	0.38	0.41	0.43	0.46	0.42
Mean	0.31	0.33	0.35	0.39		0.32	0.36	0.37	0.38	
	potassium (%)									
0.0	2.41	2.49	2.58	2.67	2.54	2.39	2.48	2.61	2.66	2.53
15.5	2.74	2.91	2.98	3.21	2.96	2.81	2.87	2.94	3.25	2.96
31	2.87	3.32	3.39	3.62	3.30	2.92	3.36	3.42	3.69	3.34
Mean	2.67	2.91	2.98	3.16		2.71	2.90	2.99	3.20	

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تأثير مستويات التسميد الفوسفورى والتسميد الورقى بالخميرة النشطة على النمو ومحصول العشب وإنتاج الزيت الطيار ومكوناته الكيميائية لنبات المريمية

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أجريت تجربتين حقليتين بالمزرعة البحثية لكلية الزراعة – جامعة المنصورة خلال موسمى الزراعة المتتاليين ٢٠٠٢/٢٠٠٣ & ٢٠٠٣/٢٠٠٤ وذلك بهدف دراسة تأثير مستويات التسميد الفوسفورى (صفر ، ١٥,٥ ، ٣١ كجم فو٢أ٥ للفدان) والرش الورقى بالخميرة بمعدلات صفر ، ١ ، ٢ ، ٣ جم/لتر على صفات النمو الخضرى ومحتوى الزيت الطيار وإنتاجيته والمكونات الكيميائية للمريمية.

أظهرت النتائج أن معاملة نباتات المريمية بمستويات مختلفة من السماد الفوسفورى أعطت فروق معنوية على صفات النمو الخضرى مثل طول النبات وعدد الأفرع والوزن الطازج والجاف للنبات ومحصول العشب ومحتوى الزيت الطيار والمكونات الكيميائية مقارنة بمعاملة الكنترول.

أعلى صفات النمو الخضرى نتجت من تسميد النباتات بالمستوى الأعلى من الفوسفور (٣١ كجم فو٢أ٥ للفدان) أعطى أعلى تركيز من الخميرة (٠,٣ %) زيادة معنوية فى صفات النمو السابقة مقارنة بالنباتات الغير معاملة ، كما أظهرت النتائج أن صفات النمو الخضرى للمريمية زادت زيادة معنوية عندما تم معاملة النباتات رشاً بمستويات الخميرة الأخرى.

معاملة التفاعل بين المستوى الأعلى من السماد الفوسفورى والخميرة أعطت زيادة ملحوظة فى النمو ومحصول العشب ومحتوى الزيت الطيار والمكونات الكيميائية.

تشير النتائج بوضوح إلى إستخدام معاملات التسميد الفوسفورى والخميرة كبديل لإستخدام التسميد الكيماوى حيث تقلل تلوث البيئة الزراعية.