Effect of Diammonium Phosphate (DAP) Fertilization on Growth of Sage Plant (*Salvia officinalis* L.) and Concentration of Volatile Oil

تأثير سماد فوسفات ثنائي الأمونيوم (داب) في نمو نبات الميرمية *Salvia officinalis* L. وتركيز الزيت الطيار

Hussein Mahmood Shukri
Biotechnology Research Center/ AL-Nahrain University
حسين محمود شكري
مركز بحوث التقنيات الإحيائية/ جامعة النهرين

E-mail shukrihussein3@Gmail.com

Abstract

This work was carried out to study the effect of Diammonium Phosphate (DAP) fertilizer during spring 2014 to produce the volatile oil from sage plant. Four levels of DAP (21%P, 18%N) (0, 100, 200 and 300 Kg/ha) were used on sage plants. The experiment was designed according to complete randomized design (CRD). The measurements of plant heights, Fresh and dry weights, surface area of the aerial leaves and active compound concentration were recorded as control before flowering. Results revealed significant differences ($p \leq 0.05$) in Plants height, fresh and dry weights and surface area between treatments. In the control group measures were (18.00cm, 100.22 g/pot, 18.55 g/pot and 5.22 cm^2) respectively. The highest values were reported with 300 kg/ha treatment (26.50 cm, 118.25, 21.86 g/pot and 7.21 cm^2) respectively. Volatile concentration was measured using Clevenger with steam distillation apparatus. Diammonium Phosphate addition levels showed different effect on Volatile oil content in aerial part (Shoots). The lowest was (1.68%) for 300 kg/ha, and the highest was (3.07%) in 100 Kg/ha.

Key words: Volatile oil, DAP, Sage (*Salvia officinalis*).

الملخص

أجريت التجربة في ربيع 2014 لدراسة تأثير استخدام السماد المركب فوسفات ثنائي الأمونيوم (داب) (P%21,N%18) في نمونبات الميرمية وانتاج المادة الفعالة زيت الفولاتايل (Volatile oil). زرعت نباتات الميرمية في أصص سعة 5 كغم تحتوي على تربة رملية مزيجه في الظلة السلكية و استخدمت أربع مستويات من سماد الداب كمصدر للفسفور (100, 200 و 300 كغم /هكتار) . صممت التجربة وفق تصميم تام التعشية CRD. عند اكتمال نمو النباتات قبل التزهير تم قياس أرتفاع النباتات و الوزن الطري و الوزن الجاف للنبات لكل اصيص والمساحة السطحية للاوراق و قياس المادة الفعالة (Volatile oil) في الجزء الخضري. اظهرت النتائج وجود اختلافات معنوية على مستوى المعنوية 0.05 بين المستويات السمادية اذ بلغت القيم لارتفاع النبات, الوزن الطري, الوزن الجاف والمساحة السطحية للاوراق في معاملة السيطرة 18.00 سم, 100.22 غم/أصيص , 18.55 غم/أصيص و5.22سم^2 على التوالي وكانت أعلى القيم في معاملة التسميد 300 كغم/هكتار 26.50 سم ,118.25 غم/أصيص و 7.21سم^2 على التوالي. بلغ تركيز المادة الفعالة (Volatile oil) 1.68% عند معاملة 300 كغم/هكتار وبلغ اعلا تركيز 3.07% عند معاملة 100كغم/هكتار.

الكلمات المفتاحية : ميرمية , سماد فوسفات ثنائي الامونيوم, زيت الفالوتايل

Introduction

Fertilizer's material of natural or synthetic origin applied to soils to supply nutrients essential to plants growth. Conservative estimates report 30 to 50% of crop yields are attributed to fertilizer.Diammonium phosphate (DAP) is the most widely used phosphate fertilizer. It has high nutrient content, easy to handle and store. Diammonium Phosphate comes as a granule contains 18-46-0 (18% N, 46% phosphorus pent oxide (P_2O_5), and no potassium oxide (K_2O), Its Molecular formula is $(NH_4)_2HPO_4$, and the Molecular weight is 132.056 g/mol [1].

In alkaline soil conditions, one ammonia molecules in DAP will revert to ammonia, making it an excellent fit for low pH or alkaline soil. DAP itself is alkaline with a high pH, exceeding (7.5). It is soluble in water, insoluble in ethanol, easy to resolve in damp air, the ammonia volatilize, it become ammonium dihydrogen phosphate. Especially suitable for the area lack of rain.

Salvia officinalis (sage, garden sage, or common sage) is a perennial, evergreen sub shrub, with woody stems, grayish leaves, and blue to purplish flowers. It is a member of the family Lamiaceae and is native to the Mediterranean region, though it has naturalized in many places throughout the world. It has a long history of medicinal and culinary use, and in modern times as an ornamental garden plant [2]. The common name "sage" is also used for a number of related and unrelated species. Scientific classification Table (1).

Table (1): Scientific classification of Sage Salvia officinalis. [Harrison, 2012]

Kingdom	Plantae
(unranked)	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Lamiaceae
Genus	*Salvia*
Species	*S. officinalis*

S. officinalis has been used since ancient times for snakebites and increasing women's fertility, It was called *salvia*, *S. salvatrix* (sage the savior) by the Romans,. The plant had a high reputation throughout the middle Ages, referring to its healing properties and value. It is recommended as a diuretic, haemostatic and used as a local anesthetic and tonic. The plant can be toxic when used in excess or when taken for long periods [3,4].

Jaber *et al*. found significant effect of phosphorus and sulfur fertilizers on bread wheat growth and yield [5].

Negahban et al reported an increase in axillaries shoots , number of flower per plant and the Essential Oil yield to a maximum at 9.6% DAP fertilizer level [6]

Rahmani *et al* Showed that the extract yields of pot Marigold was the highest in the treatment where Nitrogen fertilization applied at maximum rate [7].

The aims of study was to study the effect of DAP fertilizer on growth and yield (fresh and dry weight) of Sage plants and effect on concentration of active compound Volatile oil in each treatment.

Materials and methods:

Biological experiment was carried out at the Campus of Al-Nahrain University, in Lath house in spring 2014, sage plants planted in 5Kg pots using Sandy Loam soil. The experiment was designed according to One Way ANOVA. Complete Randomized Design (CRD) [8]. Using SPSS Version 10. Data Editor [9].

Seeds were obtained from Amman - Jordan markets, with 98% purity.

Four levels of DAP 21%P, 18%N (0, 100, 200 and 300 Kg/ha) were added before planting, mixed with soil.

T1: control without DAP

T2: 100 Kg DAP/ha. (20 kg P/ha +118 kg N/ha)

T3: 200 Kg DAP/ha. (40 kg P/ha +136 kg N/ha)

T4: 300 Kg DAP/ha. (60 kg P/ha +154 kg N/ha)

Urea 46% N, 100Kg/H, were added in two timing before and after 45 days planting, as source for nitrogen and Potassium Sulfide 41% K, 100Kg/H, as a source for Potassium before planting.

Before flowering, the heights of plants, fresh and dry weights, surface areas using Surface areas meter type Minolta and the active oil components in the leaves of the sage were measured.

All collected aerial samples of *S. officinalis* were dried, weighted, powdered and processed for Volatile oil estimation using Clevenger with steam distillation apparatus. [10]

Chemical and Physical characteristics (Electrical Conductivity, pH, Cationic Exchangeable Capacity, Dissolved salts, Lime, Gypsum and Soil Texture) were measured: [11, 12] Table (2).

Table (2): Chemical and Physical characteristics for the soil used in the experiment

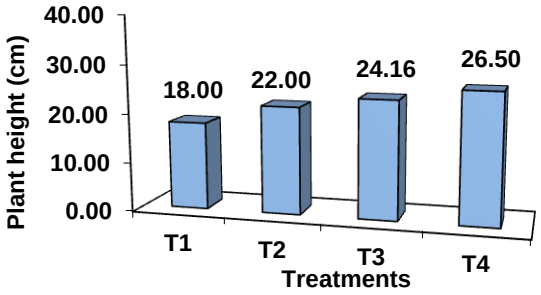
Criteria		Value	Unit
pH		7.56	-
Electrical Conductivity EC		1.33	$dS.m^{-1}$
Cationic Exchangeable Capacity CEC		5.98	$Cmol.kg^{-1}$ soil
Organic matter		4.30	
Gypsum		0.35	$g.kg^{-1}$ soil
Lim		44	
Dissolved Cations	Ca^{++}	5.80	$mmol_c.l^{-1}$
	Mg^{++}	3.30	
	Na^{+}	4.70	
	K^{+}	0.1	
Dissolved Anions	Cl^{-}	5.80	$mmol_c.l^{-1}$
	HCO^{-}	3.40	
	$SO_4^{=}$	4.74	
	$CO_3^{=}$	Nil	
Particle Size Analysis	Clay	50	$g.kg^{-1}$
	Silt	100	
	Sand	850	
Soil Texture		Sandy Loam	
Balk density		1.33	$Mg.m^{-3}$ soil
Water volume Ø$cm^3.cm^{-3}$			
0.4000			Saturation (0) kilopascal
0.2200			Field capacity(33) Kilopascal
0.1300			(1500) Kilopascal
0.1500			75% Field capacity
0.0900			Available Water

Results and Discussion

The results show significant increase ($p \leq 0.05$) in height of sage plants treated with DAP fertilizer T2, T3 and T4 (22.00, 24.16, 26.50 cm) respectively compared with control group T1. (10.00 cm) Figure (1). Also the results revealed significant increase ($p \leq 0.05$) in fresh and dry weight in sage plants treated with DAP fertilizer in treated group T3,T4 compared with control group T1 and T2. Figure (2,3).These results agree with [5,6,7,13]. The increase in fresh and dry weight of aerial part of sage plant reflex the increase in height and size as positive effect of nitrogen fertilizer and activity of meristematic tissues and its role in cellular division and entry in chlorophyll compound and form many compounds and enzymes witch effect in an increase in plant growth and the effect of phosphorus information and diffusion of sales and participation in stimulate and evolution the roots causing increase plant deficiency to absorption nutrients from the soil [5,13].

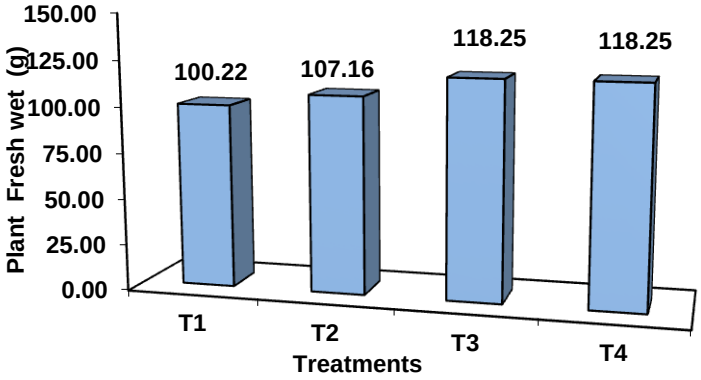
Figure (4), shows significant effect of DAP treatments on leaves surface area among the four treatments ($P<0.05$), the lowest mean was in T1 (5.215cm^2), and the highest mean was in T4 (7.214cm^2).

Figure (5) showed that the Volatile oil percent decrease significantly ($p \leq 0.05$) in T3 and T4 compared with T2. The decrease in the active compound in T3 & T4 due to the relative increase in the size of aerial parts (shoots) in these treatments. The optimal combination of DAP fertilizers for *S. officinalis* is 100 Kg/ha for best active compound yield (volatile oil), and 200 – 300 Kg /ha for large vegetative growth of sage.



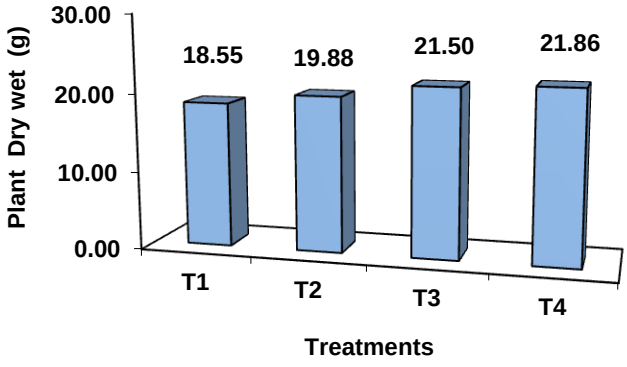
LSD.0.05=1.8828

Fig. (1): Effect of fertilizer treatment on plant height cm



LSD.0.05=8.4129

Fig. (2): Effect of fertilizer treatment on plant fresh weight g/pot



LSD.0.05=1.4693

Fig. (3) Effect of fertilizer treatment on plant dry weight g/pot

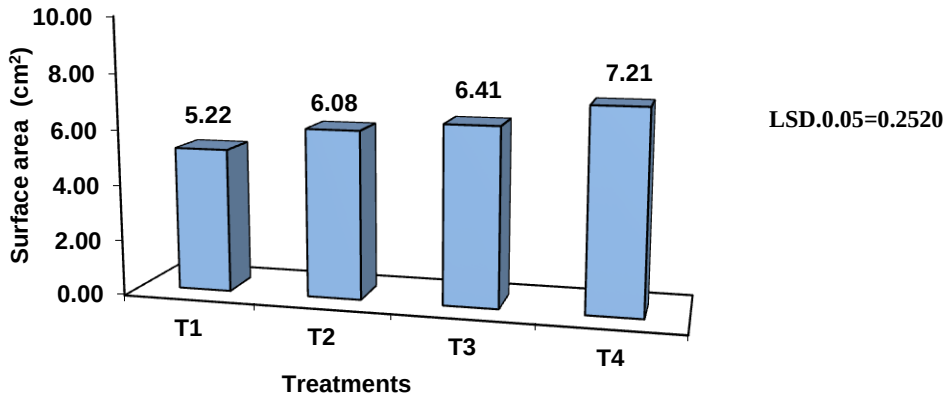


Fig. (4): Effect of Fertilizer Treatment on Surface area cm^2

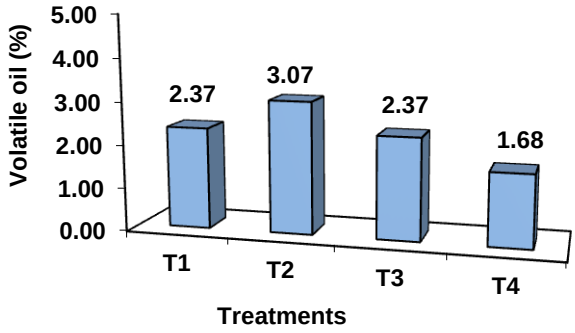


Fig. (5) Effect of Fertilizer Treatment on Volatile oil %

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