EVALUATING THE PRODUCTIVITY OF *SALVIA OFFICINALIS* L. PLANTS USING OF FERTILIZERS AND SPRAYING WITH VITAMINS

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The study was conducted at El-Kasasin Research Station belonging to Ismailia Governorate, during the 2019 and 2020 seasons on *Salvia officinalis* plants. The experiment design was split plots, the main plots were two levels of vermicompost 2, 4 m^3, and control treatment, while the subplots were springing with some vitamins; C, B1, and mixture of vitamin C + B1, and the control treatment. Consequences revealed that there was a significant effect resulting from the use of vermicompost at a rate of 4 m^3 on all vegetative growth characteristics and essential oil compared to untreated plants. Alternatively, there was a significant effect on the characteristics of plant growth including plant height (cm), the number of branches, fresh and dry weights per plant (g) and per feddan (tons) and oil production included oil percentage in leaves dry weight; oil content per plant (ml) and per feddan (L) resulted from spraying with a mixture of vitamin C + B1 compared to the other treatments and control plants. Also, a significant effect has resulted from the interaction between adding vermicompost and spraying with vitamins on all growth characteristics, essential oil, and essential oil compounds, where the treatment recorded 4 m^3 vermicompost + spraying with the vitamins mixture C + B1 compared to the other treatments and untreated plants. The results showed that, treatment of 4 m^3 vermicompost + the vitamins mixture C + B1 recorded the highest values in both thujone (57.102%) and camphor (13.657%), while the compound 1.8-cineole recorded 3.256%, camphene recorded 1.846% and caryophyllene recorded 4.160%.

Keywords: *Salvia officinalis*, vermicompost, vitamins, vitamin C, vitamin B1

INTRODUCTION

Sage "*Salvia officinalis* L." (Lamiaceae) is one of the most important medicinal plants in the Mediterranean basin, southern and central Europe,

used in many medical fields, such as anti-bacterial and anti-fungal, and anti-virus. Boiled leaves are used to activate digestion processes, reduce sweat, reduce blood sugar, and anthelmintic, treat diarrhea, and are used as an anti-asthma (Miura et al., 2001). It is believed in folk medicine, that sage activates the action of the female hormone "estrogen", which is used as an excellent treatment for menopausal problems, helping the body adapt to the hormonal changes taking place. The dry leaves are also used in cooking to improve the taste of many foods, as they contain many nutrients such as iron, magnesium, calcium....etc. (Perry et al., 1999; Adams et al., 2007 and Garcia et al., 2016).

Vermicompost is the result of a digestion process after the complete decomposition of organic matter, in addition to the ability of worms to overcome and digest the harmful residues present in the organic matter, and it is sufficient alone to meet the plant needs of major and minor elements and works to facilitate and chelate the solid elements in the soil to benefit the plant as reported by Ranjbar et al. (2014) and Soltani et al. (2015) on *Calendula officinalis*, Mohmmad et al. (2018) on coriander and fenugreek and Fallahi et al. (2018) on basil plants.

Vitamins are substances that improve the growth and productivity of agricultural and horticultural crops. Vitamins are organic substances that exist in many forms and are considered essential and complementary to healthy growth to help build tissues as they help them to perform their proper functions through their participation in physicochemical reactions to continue the various functions of the plant as well as to grow new tissues, one of the most important vitamins used is vitamin B and C as reported by Joshi and Pal (2010) on *Lycopersicum esculentum,* Manh and Wang (2013) on *Cucumis melo* and Sahel et al. (2014) on *Capsicum annuum.*

The main objective of the research is to study the effect of adding vermicompost, spraying with vitamin C and vitamin B1, and the interaction between them on leaf production, oil yield, and the active components of sage essential oil under reclaimed ground conditions.

MATERIALS AND METHODS

The study was conducted at El-Kasasin Research Station belonging to Ismailia Governorate, Agricultural Research Center in the Department of Medicinal and Aromatic plants during 2019 and 2020 seasons on *Salvia officinalis* plants.

Seedlings were sown on March 15th and 20th in both seasons; respectively. The seedlings were sown in hills of 25 cm and rows of 60 cm (28000 plants/feddan). The experiment design was split plots with three replicates, the main plots were two levels of vermicompost (verm.) 2, 4 m^3 and control treatment, while the subplots were springing with some vitamins; vitamin C (vit. C), vitamin B1 (vit. B1) and mixture of vit. C+B1, in addition to the control treatment. The drip automatic system was used in the experiment

at 4 liters per hour. The treatments were applied vermicompost during soil preparation. The vitamins were sprayed once every month, and the control treatment was sprayed with distilled water. All plants received normal agricultural practices if needed. The experimental soil was sandy in texture "87.13% sand, 7.24% silt and 5.56% clay" and chemical properties were available N, P and K of 7.3, 2.8 and 13.4 mg/kg, soluble ions (meq/l), cations (Ca^{2+} , Mg^{2+} , Na^{+} and K^{+} at 1 5.7, 2.6, 7.0 and 0.8) and anions (Cl^{-} , HCO_3 and SO_4^{2-} 7.6 at 2.8 and 5.6), respectively, pH 7.08 and EC dSm^{-1} 1.6 mmhos/cm, according to Amal et al. (2017).

Statistical analysis was done using software programs statistix[9] according to Rania (2016) on *Cyamopsis tetragonoloba* and Rania and Abd El-Azim (2017) on lemongrass. The plants were harvested twice, at 75 days after planting in the first cut and after 75 days from the first cut in the second cut, in the first and second seasons, respectively.

Data recorded

Plant growth included plant height (cm), number of branches, fresh and dry weights per plant (g) and per feddan (tons).

Oil production included oil percentage in leaves dry weight according to Rania (2015) on *Ocimum basilicum*, oil content per plant (ml) and per feddan (L) and volatile oil composition using G.L.C. according to Abd El-Azim et al. (2017 and 2016) on *Foeniculum vulgare*.

RESULTS

1. Plant Growth

1.1. Plant height

1.1.1. Effect of vermicompost

In general, by increasing the vermicompost, all the growth characteristics under study were increased, and from this, it was concluded that there was the main effect of vermicompost that all plant growth parameters, the plant height was enhanced significantly with increasing vermicompost (Table 1). In the first season, the highest value was recorded in vermicompost of 4 m^3 verm. where plant height was recorded at 67.59 cm and 68.61 cm in the first and second cuts, respectively. While, in the second season the plant height was given maximum values of 66.94 cm and 70.55 cm in both cut seasons, respectively, in the same treatment. These results are established with those reported by Chandan and Azad (2015) on vegetable crops and Sahel *et al.* (2014) on *Capsicum annuum.*

1.1.2. Effect of vitamins

Concerning the main effect of vitamins, data in Table (1) show that treating plants with vitamins resulted in a significant increase in all plant growth parameters compared with the control treatments. The effect of vitamins where the highest value was recorded in plant height at mix vit.

C+B1, which was 60.13 cm, while plant height, 56.76 cm at vit.B1was recorded compared to the control treatment 47.56 cm in the first cut of the first season. As for the second cut, the plant height recorded 61.83 cm at the level of the vitamins mix vit.C+B1, while the plant height recorded 57.54 cm at vit. B1 compared to the control treatment of 48.24 cm in the first season.

Table (1). Effect of vermicompost and vitamins and their interaction on plant height of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
		Effect of Vermicompost on plant height			
Control		40.20 ^{C}	41.08 ^{C}	43.48 ^{C}	48.61 ^{C}
2 m^3 Verm.		56.19 ^{B}	56.81 ^{B}	56.02 ^{B}	57.94 ^{B}
4 m^3 Verm.		67.59 ^{A}	68.61 ^{A}	66.94 ^{A}	70.55 ^{A}
		Effect of vitamins on plant height			
Control		47.56 ^{D}	48.24 ^{D}	49.93 ^{D}	54.50 ^{D}
Vit. C		54.20 ^{C}	54.40 ^{C}	53.71 ^{C}	57.11 ^{C}
Vit. B1		56.76 ^{B}	57.54 ^{B}	56.98 ^{B}	60.56 ^{B}
Mix vit. (C+B1)		60.13 ^{A}	61.83 ^{A}	61.30 ^{A}	63.96 ^{A}
		Effect of interaction between vermicompost and vitamins plant height			
Control	**Control**	27.17 ^{I}	28.77 ^{H}	35.05 ^{J}	45.32 ^{K}
	Vit. C	42.60 ^{H}	41.65 ^{G}	40.99 ^{I}	47.59 ^{J}
	Vit. B1	44.43 ^{GH}	44.05 ^{G}	46.84 ^{H}	49.54 ^{I}
	Mix vit. (C+B1)	46.60 ^{G}	49.84 ^{F}	51.04 ^{G}	51.99 ^{H}
2 m^3 Verm.	**Control**	51.97 ^{F}	52.59 ^{EF}	52.48 ^{G}	53.78 ^{H}
	Vit. C	55.13 ^{EF}	54.41^{E}	55.12 ^{F}	56.80 ^{G}
	Vit. B1	57.10 ^{E}	58.92 ^{D}	57.06 ^{F}	59.80 ^{F}
	Mix vit. (C+B1)	60.57 ^{D}	61.34 ^{CD}	59.41 ^{E}	61.32 ^{E}
4 m^3 Verm.	**Control**	63.53 ^{CD}	63.35 ^{C}	62.25 ^{D}	64.42 ^{D}
	Vit. C	64.87 ^{C}	67.14 ^{B}	65.02 ^{C}	66.95 ^{C}
	Vit. B1	68.73 ^{B}	69.64 ^{B}	67.05 ^{B}	72.28 ^{B}
	Mix vit. (C+B1)	73.22 ^{A}	74.32 ^{A}	73.45 ^{A}	78.56 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

In addition, the same result was obtained in the second season the highest value was recorded in plant height at mix v C+B1, which was 61.30 cm, while 56.98 cm at v B1was recorded compared to the control treatment 49.93 cm in the first cut. As for the second cut, the plant height recorded at 6.96 cm is at the level of the vitamins mix vit. C+B1, while plant height vit. B1 60.56 cm compared to the control treatment 54.50 cm. Similar

consequences were detailed by Ranjbar et al. (2014) and Soltani et al. (2015) on *mixed.*

1.1.3. Effect of interactions

Data in Table (1) indicate that the interaction between vermicompost and vitamins had a significant effect on plant height. In the first cut, The highest values of plant height 73.22 cm and 73.45 cm were recorded when plants were applicated at 4 m^3 verm. and treated with mixed vitamins C+B1 competed to control plant 68.53 cm and 62.25 cm for two seasons, respectively. As for the second cut, the highest values of plant height 74.32 cm and 78.53 cm competed with control plants 63.35 cm and 64.42 cm for two seasons, respectively. This result you get from treatment when applied the plants were applied at 4 m^3 verm. and treated with vitamins mix C+B1. The positive reaction of Salvia officinalis, L. plants to the interaction between vermicompost and vitamins was in synchronization with those acquired by Ranjbar et al. (2014) and Sahel et al. (2014) on *Capsicum annuum*.

1.2. Number of branches

1.2.1. Effect of vermicompost

Information in Table (2) designate that, the vermicompost had a significant effect on a number of branches. In the first cut, the highest values of a number of branches 28.58 and 27.58 were recorded when plants were applicated at 4 m^3 verm. compared to control plants 13.33 and 16.00 for two seasons, respectively. As for the second cut, the highest values of a number of branches 28.00 and 27.83 competed to control plant 14.83 and 16.50 for two seasons, respectively; this result was obtained as a result of adding at 4 m^3 verm. These results are in harmony with those obtained by Manh and Wang (2013) on *Cucumis melo*.

1.2.2. Effect of vitamins

In general, the main effect of vitamins is that all plant growth parameters, the number of branches were enhanced significantly by applying vitamins (Table 2). In the first season, the highest value was recorded in mix. of vitamins C+B1, where a number of branches were recorded of 24.11 and 24.44 compared to the untreated plant of 17.22 and 18.33 in the first and second cuts, respectively. While in the second season the number of branches was 24.89 and 25.00 in both cut seasons, respectively; compared to control plant that was 19.22 and 19.22 in the first and second cuts, respectively. Similar results were recorded by Abd El-Aziz et al. (2007) on *Syngonium podophyllum* and Hamada and Khulaef (2000) on *Vibia faba*.

1.2.3. Effect of interaction

Concerning the main effect of the interaction between vermicompost and vitamins, data in table (2) show that treating plants with the vermicompost and vitamins resulted in a significant increase in all plant growth parameters compared with the control treatments. The effect of the interaction between vermicompost and vitamins where the highest value was recorded in a number of branches at 4 m^3 verm. and mix. of C+B1 vitamins, which was 32.67

compared to the control treatment of 8.33 in the first cut during the first season. As for the second cut, the number of branches recorded 32.00 is at the 4 m^3 verm. plus mix. of C+B1 vitamins treatment, compared to the control treatment of 11.33 in the second cut during the first season. Furthermore, the same result was obtained in the second season; the highest value was recorded in a number of branches at 4 m^3 verm. with mix. of C+B1vitamins, which was 32.33 compared to the control treatment of 13.00 in the first cut. As for the second cut, the number of branches was 33.33 is at the same treatment compared to the control treatment of 14.00 (Table 2). The progressive response of *Salvia officinalis* plants to the interaction between vermicompost and vitamins was in bringing together with those assimilated by Hamid et al. (2018) on basil plants and Joshi and Pal (2010) on *Lycopersicum esculentum*.

Table (2). Effect of vermicompost and vitamins and their interaction on a number of branches of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on number of branches					
Control		13.33 ^{C}	14.83 ^{C}	16.00 ^{C}	16.50 ^{C}
2 m^3 Verm.		21.08 ^{B}	21.50 ^{B}	22.00 ^{B}	21.58 ^{B}
4 m^3 Verm.		28.58 ^{A}	28.00 ^{A}	27.58 ^{A}	27.83 ^{A}
Effect of vitamins on number of branches					
Control		17.22 ^{D}	18.33 ^{D}	19.22 ^{D}	19.22 ^{D}
Vit. C		20.33 ^{C}	20.67 ^{C}	21.00 ^{C}	21.00 ^{C}
Vit. B1		22.33 ^{B}	22.33 ^{B}	22.33 ^{B}	22.67 ^{B}
Mix vit. (C+B1)		24.11 ^{A}	24.44 ^{A}	24.89 ^{A}	25.00 ^{A}
Effect of interaction between vermicompost and vitamins on number of branches					
Control	**Control**	8.33 ^{K}	11.33 ^{L}	13.00 ^{I}	14.00 ^{J}
	Vit. C	13.33 ^{J}	14.67 ^{K}	16.00 ^{H}	16.00 ^{I}
	Vit. B1	15.00 ^{I}	15.67 ^{J}	16.67 ^{H}	17.33 ^{H}
	Mix vit. (C+B1)	16.67 ^{H}	17.67 ^{I}	18.33 ^{G}	18.67 ^{G}
2 m^3 Verm.	**Control**	19.00 ^{G}	19.00 ^{H}	20.00 ^{F}	19.33 ^{G}
	Vit. C	20.67 ^{F}	21.00 ^{G}	21.67 ^{E}	21.33 ^{F}
	Vit. B1	21.67 ^{EF}	22.33 ^{F}	22.33 ^{E}	22.67 ^{E}
	Mix vit. (C+B1)	23.00 ^{DE}	23.67 ^{E}	24.00 ^{D}	23.00 ^{E}
4 m^3 Verm.	**Control**	24.33 ^{D}	24.67 ^{D}	24.67 ^{CD}	24.33 ^{D}
	Vit. C	27.00 ^{C}	26.33 ^{C}	25.33 ^{C}	25.67 ^{C}
	Vit. B1	30.33 ^{B}	29.00 ^{B}	28.00 ^{B}	28.00 ^{B}
	Mix vit. (C+B1)	32.67 ^{A}	32.00 ^{A}	32.33 ^{A}	33.33 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

1.3. Fresh weight per plant

1.3.1. Effect of vermicompost

Data in table (3) show that fresh weight per plant (g) increased in a gradual and significant trend as the vermicompost increased up to 4 m^3 verm. the per plant which gave the highest values of these characteristics. On the other hand, the fresh weight per plant recorded 368.17 g and 364.63 g in the first cut in the first and second seasons, respectively. While the fresh weight per plant was recorded 378.93 g and 377.26 g in the second cut in the first and second season, respectively. Related consequences were recorded by Joshi and Pal (2010) on *Lycopersicum esculentum*.

1.3.2. Effect of vitamins

Data in table (3) indicate that fresh weight per plant (g) was significantly increased when treating plants with vitamins compared with the control treatment. In the first season, the highest values in the fresh weight per plant were 297.72 g and 321.66 g in the first and second cuts; respectively. Furthermore, the highest values in the fresh weight per plant were 220.49 g and 318.79 g in the first and second cuts throughout the second season; respectively, were obtained when applied plants with mixed C+B1 vitamins for both cuts in the two seasons. These outcomes are in accord with those obtained by El-Awadi et al. (2016) on the lupine plant and Noaman et al. (2017) on *Sorghum bicolor.*

1.3.3. Effect of interaction

The combined effect between vermicompost and vitamins (Table 3) shows that the highest values of fresh weight per plant were obtained when plants were treated at 4 m^3 verm. plus spraying with mix of C+B1 vitamins. So, the highest values of fresh weight per plant were 415.00 g and 415.20 g in both cuts in the first season, respectively. As for the second season, the highest values of fresh weight per plant were 408.97 g and 408.45 g in both cuts, respectively. The tolerant reply of *Salvia officinalis* plant to interaction between vermicompost and vitamins was in bringing together with those confirmed by Abd El-Aziz et al. (2007) on *Syngonium podophyllum* and Chandan and Azad (2015) on vegetable crops.

1.4. Fresh weight per feddan

1.4.1. Effect of vermicompost

Data in table (4) illustrate the vermicompost in the fresh weight per feddan (tons) revealed that all treatments gave the highest significant increase in the fresh weight per feddan (tons). the treatment 4 m^3 verm. was given the highest value of dry weight per plant 10.31 tons and 10.61 tons in both cuts during two seasons, respectively; combined with other treatments in both seasons. These results are in agreement with those obtained by Chandan and Azad (2015) on vegetable crops and Alam (2006).

1.4.2. Effect of vitamins

Regarding the main effect of vitamins, data in table (4) show that treating plants with vitamins resulted in a significant increase in the fresh weight per feddan (tons) compared to control treatments. The effect of vitamins where the highest value in the fresh weight per feddan (tons) was recorded 8.34 tons and 9.01 tons at using mix vit. C+B1, in the first and second cut during the first season, respectively; associated with the control treatment 6.17 tons and 7.23 tons in the first and second cut during the second season, respectively. On the other hand, the same treatment in the second season was recorded at 8.50 tons in the first cut and was recorded at 8.93 tons at thein the second cut, compared to the untreated plant at 6.17 tons and 7.23 tons in the first and second cut during the second season, respectively. These results are in affording with those achieved by Mohmmad et al. (2018) on coriander and fenugreek and Hamid et al. (2018) on basil plants.

Table (3). Effect of vermicompost and vitamins and their interaction on fresh weight per plant (g) and *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on fresh weight per plant (g)					
Control		155.88 ^{C}	190.27 ^{C}	156.08 ^{C}	193.75 ^{C}
2 m^3 Verm.		244.19 ^{B}	288.13 ^{B}	267.36 ^{B}	289.60 ^{B}
4 m^3 Verm.		368.17 ^{A}	378.93 ^{A}	364.63 ^{A}	377.26 ^{A}
Effect of vitamins on fresh weight per plant (g)					
Control		212.12 ^{D}	256.13 ^{D}	220.49 ^{D}	258.26 ^{D}
Vit. C		240.68 ^{C}	276.21 ^{C}	253.53 ^{C}	275.35 ^{C}
Vit. B1		273.79 ^{B}	289.10 ^{B}	273.39 ^{B}	295.08 ^{B}
Mix vit. (C+B1)		297.72 ^{A}	321.66 ^{A}	303.36 ^{A}	318.79 ^{A}
Effect of interaction between vermicompost and vitamins on fresh weight per plant (g)					
Control	**Control**	113.58 ^{K}	163.35 ^{L}	110.99 ^{L}	163.65 ^{L}
	Vit. C	141.73 ^{J}	184.41 ^{K}	154.10 ^{K}	186.14 ^{K}
	Vit. B1	171.70 ^{I}	188.24 ^{J}	167.85 ^{J}	200.28 ^{J}
	Mix vit. (C+B1)	196.49 ^{H}	225.09 ^{I}	191.37 ^{I}	224.94 ^{I}
2 m^3 Verm.	**Control**	206.79 ^{H}	254.76 ^{H}	224.85 ^{H}	260.98 ^{H}
	Vit. C	225.29 ^{G}	278.94 ^{G}	257.26 ^{G}	275.46 ^{G}
	Vit. B1	263.00 ^{F}	294.12 ^{F}	277.60 ^{F}	298.96 ^{F}
	Mix vit. (C+B1)	281.67 ^{E}	324.69 ^{E}	309.74 ^{E}	322.98 ^{E}
4 m^3 Verm.	**Control**	316.00 ^{D}	350.29 ^{D}	325.61 ^{D}	350.15 ^{D}
	Vit. C	355.00 ^{C}	365.29 ^{C}	349.24 ^{C}	364.45 ^{C}
	Vit. B1	386.67 ^{B}	384.94 ^{B}	374.71 ^{B}	386.00 ^{B}
	Mix vit. (C+B1)	415.00 ^{A}	415.20 ^{A}	408.97 ^{A}	408.45 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

Table (4): Effect of vermicompost and vitamins and their interaction on fresh weight per feddan (tons) of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on fresh weight per feddan (tons)					
Control		4.37 C	5.33 C	4.37 C	5.43 C
2 m³ Verm.		6.84 B	8.07 B	7.49 B	8.11 B
4 m³ Verm.		10.31 A	10.61 A	10.21 A	10.56 A
Effect of vitamins on fresh weight per feddan (tons)					
Control		5.94 D	7.17 D	6.17 D	7.23 D
Vit. C		6.74 C	7.73 C	7.10 C	7.71 C
Vit. B1		7.67 B	8.09 B	7.65 B	8.26 B
Mix vit. (C+B1)		8.34 A	9.01 A	8.50 A	8.93 A
Effect of interaction between vermicompost and vitamins on fresh weight per feddan (tons)					
Control	**Control**	3.18 K	4.58 L	3.11 L	4.58 L
	Vit. C	3.97 J	5.16 K	4.31 K	5.21 K
	Vit. B1	4.81 I	5.27 J	4.70 J	5.61 J
	Mix vit. (C+B1)	5.50 H	6.30 I	5.36 I	6.30 I
2 m³ Verm.	**Control**	5.79 H	7.13 H	6.30 H	7.31 H
	Vit. C	6.31 G	7.81 G	7.20 G	7.71 G
	Vit. B1	7.36 F	8.23 F	7.77 F	8.37 F
	Mix vit. (C+B1)	7.89 E	9.09 E	8.67 E	9.04 E
4 m³ Verm.	**Control**	8.85 D	9.81 D	9.12 D	9.80 D
	Vit. C	9.94 C	10.23 C	9.78 C	10.20 C
	Vit. B1	10.83 B	10.78 B	10.49 B	10.81 B
	Mix vit. (C+B1)	11.62 A	11.63 A	11.45 A	11.44 A

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

1.4.3. Effect of interactions

Data in table (4) indicate that the interaction between vermicompost and vitamins had a significant effect on the fresh weight per feddan (tons) In the first season, the highest fresh weight per feddan was recorded as 11.62 tons and 11.45 tons compared with the control treatment of 3.18 tons and 3.11 tons during both cuts, respectively. As for the second season, the highest dry weight per plant (g) was recorded at 11.63 tons and 11.44 tons related to the control plant of 4.58 tons and 4.58 tons during the two cuts, respectively. This result is obtained from the treatment when the plants are applied to 4 m^3 verm. and treated with mix. of vit. C+B1 during the two cuts and seasons. These consequences are in affording with those succeeded by Hamada and Khulaef (2000) on *Vibia faba* and Jadia and Fulekar (2008).

1.5. Dry weight per plant

1.5.1. Effect of vermicompost

Data explained the vermicompost in the dry weight per plant (g) in table (5) and revealed that all treatments gave the highest significant increase in the dry weight per plant. The treatment is 4 m^3 verm. was given the highest value of dry weight per plant of 83.38 g and 87.15 g in both cuts during the two seasons, respectively; combined with the other treatments in both seasons. Similar consequences were detailed by Jadia and Fulekar (2008) and Sahel et al. (2014) on *Capsicum annuum*.

Table (5). Effect of vermicompost and vitamins and their interaction on dry weight per plant (g) of *Salvia officinalis*, L. plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on dry weight per plant (g)					
Control		16.31 ^{C}	25.03 ^{C}	14.16 ^{C}	25.96 ^{C}
2 m^3 Verm.		42.93 ^{B}	57.08 ^{B}	50.17 ^{B}	57.78 ^{B}
4 m^3 Verm.		83.38 ^{A}	87.15 ^{A}	82.68 ^{A}	87.22 ^{A}
Effect of vitamins on dry weight per plant (g)					
Control		33.91 ^{D}	47.12 ^{D}	36.34 ^{D}	48.07 ^{D}
Vit. C		42.50 ^{C}	52.45 ^{C}	45.12 ^{C}	52.16 ^{C}
Vit. B1		53.34 ^{B}	57.94 ^{B}	52.34 ^{B}	60.01 ^{B}
Mix vit. (C+B1)		60.41 ^{A}	68.16 ^{A}	62.20 ^{A}	67.69 ^{A}
Effect of interaction between vermicompost and vitamins on dry weight per plant (g)					
Control	**Control**	4.82 ^{K}	18.39 ^{K}	3.01 ^{L}	18.28 ^{K}
	Vit. C	11.53 ^{J}	20.85 ^{K}	11.43 ^{K}	20.25 ^{K}
	Vit. B1	21.43 ^{I}	24.77 ^{J}	17.73 ^{J}	29.12 ^{J}
	Mix vit. (C+B1)	27.46 ^{H}	36.12 ^{I}	24.47 ^{I}	36.18 ^{I}
2 m^3 Verm.	**Control**	30.23 ^{H}	45.97 ^{H}	36.66 ^{H}	48.60 ^{H}
	Vit. C	36.72 ^{G}	53.63 ^{G}	46.60 ^{G}	53.24 ^{G}
	Vit. B1	49.02 ^{F}	59.26 ^{F}	52.91 ^{F}	60.25 ^{F}
	Mix vit. (C+B1)	55.75 ^{E}	69.45 ^{E}	64.50 ^{E}	68.99 ^{E}
4 m^3 Verm.	**Control**	66.69 ^{D}	77.00 ^{D}	69.35 ^{D}	77.33 ^{D}
	Vit. C	79.26 ^{C}	82.87 ^{C}	77.35 ^{C}	82.99 ^{C}
	Vit. B1	89.56 ^{B}	89.80 ^{B}	86.37 ^{B}	90.63 ^{B}
	Mix vit. (C+B1)	98.03 ^{A}	98.92 ^{A}	97.65 ^{A}	97.90 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

1.5.2. Effect of vitamins

On the topic of the main effect of vitamins, data in table (5), illustrate that treating plants with vitamins resulted in a significant increase in the dry weight per plant compared to control treatments. The highest value in the dry

weight per plant recorded 60.41 g and 68.16 g using mix. of vit. C+B1, in the first and second cut during the first season, respectively. However, the same treatment in the second season recorded 62.20 g in the first cut and 67.69 g in the second cut, compared to the control treatment in the first cut of 33.91 g and 36.34 g in the first cut and 47.12 g and 48.07 g in the second cut during both seasons, respectively. Identical penalties were exhaustive by Hamid et al. (2018) on basil plants and Mohmmad et al. (2018) on coriander and fenugreek.

1.5.3. Effect of interactions

Information in table (5) points to that, the interaction between vermicompost and vitamins had a significant effect on the dry weight per plant (g) in the first cut. The highest dry weight per plant recorded 98.03 g and 97.65 g compared with the control treatment of 4.82 g and 3.01 g during both seasons, respectively. As for the second cut, the highest dry weight per plant (g) recorded 98.92 g and 97.90 g compared with the control plant of 18.39 g and 18.28 g during the two seasons, respectively. This result is obtained from the treatment when the plants were applied to 4 m^3 verm. and were treated with the mix. of vit. C+B1. The positive reaction of *Salvia officinalis* plants to an interaction between vermicompost and vitamins was in synchronization with those acquired by Alam (2006) and El-Awadi et al. (2016) on the lupine plant.

1.6. Dry weight per feddan

1.6.1. Effect of vermicompost

Data in table (6) show that dry weight per feddan (tons) increased in a gradual and significant trend as the vermicompost increased up to 4 m^3 verm. per plant, which gave the highest values of these characteristics. On the other hand, the dry weight per feddan was 0.457 tons and 0.397 tons in the first cut in the first and second seasons, respectively. Even though the dry weight per feddan recorded 2.440 tons and 2.442 tons in the second cut in the first and second season, respectively. The positive reaction of *Salvia officinalis* plants to the interaction between vermicompost and vitamins was in synchronization with those acquired by Joshi and Pal (2010) on *Lycopersicum esculentum* and Manh and Wang (2013) on *Cucumis melo*.

1.6.2. Effect of vitamins

Records in table (6) designate that dry weight per feddan (tons) was significantly increased when treating plants with vitamins compared with the control treatment. In the first season, the highest values in the dry weight per feddan recorded 1.691 tons and 1.908 tons in the first and second cuts; respectively. Whereas the highest values in the dry weight per feddan recorded 1.742 tons and 1.895 tons in the first and second cuts in the second season; respectively. They were obtained when plants were applied with mix. of vit. C+B1 for both cuts and the two seasons. Similar consequences were detailed by Fallahi et al. (2018) on basil plants and Al-Douri and Basheer (2021) on *Prunus amygdalus* var. Amara.

Table (6). Effect of vermicompost and vitamins and their interaction on dry weight per **feddan (tons)** of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on dry weight per feddan (tons)					
Control		0.457 ^{C}	0.701 ^{C}	0.397 ^{C}	0.727 ^{C}
2 m^3 Verm.		1.202 ^{B}	1.598 ^{B}	1.405 ^{B}	1.618 ^{B}
4 m^3 Verm.		2.335 ^{A}	2.440 ^{A}	2.315 ^{A}	2.442 ^{A}
Effect of vitamins on dry weight per feddan (tons)					
Control		0.950 ^{D}	1.319 ^{D}	1.017 ^{D}	1.346 ^{D}
Vit. C		1.190 ^{C}	1.468 ^{C}	1.263 ^{C}	1.460 ^{C}
Vit. B1		1.493 ^{B}	1.622 ^{B}	1.465 ^{B}	1.680 ^{B}
Mix Vit. (C+B1)		1.691 ^{A}	1.908 ^{A}	1.742 ^{A}	1.895 ^{A}
Effect of interaction between vermicompost and vitamins on dry weight per feddan (tons)					
Control	**Control**	0.135 ^{K}	0.515 ^{K}	0.084 ^{L}	0.512 ^{K}
	Vit. C	0.323 ^{J}	0.583 ^{K}	0.320 ^{K}	0.567 ^{K}
	Vit. B1	0.600 ^{I}	0.693 ^{J}	0.497 ^{J}	0.815 ^{J}
	Mix Vit. (C+B1)	0.769 ^{H}	1.011 ^{I}	0.685 ^{I}	1.013 ^{I}
2 m^3 Verm.	**Control**	0.846 ^{H}	1.287 ^{H}	1.026 ^{H}	1.361 ^{H}
	Vit. C	1.028 ^{G}	1.502 ^{G}	1.305 ^{G}	1.491 ^{G}
	Vit. B1	1.373 ^{F}	1.659 ^{F}	1.481 ^{F}	1.688 ^{F}
	Mix Vit. (C+B1)	1.561 ^{E}	1.944 ^{E}	1.806 ^{E}	1.932 ^{E}
4 m^3 Verm.	**Control**	1.867 ^{D}	2.156 ^{D}	1.942 ^{D}	2.165 ^{D}
	Vit. C	2.219 ^{C}	2.320 ^{C}	2.166 ^{C}	2.324 ^{C}
	Vit. B1	2.508 ^{B}	2.514 ^{B}	2.418 ^{B}	2.538 ^{B}
	Mix Vit. (C+B1)	2.745 ^{A}	2.770 ^{A}	2.734 ^{A}	2.741 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

1.6.3. Effect of interaction

The united effect between vermicompost and vitamins (Table 6) showed that the highest values of dry weight per feddan were obtained when plants were treated at 4 m^3 verm. and spraying with mix. of vit. C+B1. So, the highest values of dry weight per feddan were 2.745 tons and 2.770 tons in both cuts in the first season. As for the second season, the highest values of dry weight per feddan were 2.734 tons and 2.741 tons in both cuts, respectively. The above-revealed results established with those obtained by Joshi and Pal (2010) on *Lycopersicum esculentum* and Noaman et al. (2017) on *Sorghum bicolor*.

2. Oil Production

2.1. Oil percentage

2.1.1. Effect of vermicompost

The data of oil percentage in both cuts and seasons are shown in table (7). The oil percentage was significantly increased with vermicompost application. The highest values of oil percentage were related to the model vermicompost (4 m^3 verm.). On the other hand, the highest value was recorded with 4 m^3 verm., where oil percentage recorded 1.49% and 1.62% in the first cut, in both seasons, respectively. While, in the second cut the oil percentage recorded 1.49% and 1.68% in both seasons, respectively. These results established with those reported by Manh and Wang (2013) on *Cucumis melo* and Sahel et al. (2014) on *Capsicum annuum*.

Table (7). Effect of vermicompost and vitamins and their interaction on oil percentage of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on % oil					
Control		0.63 ^{C}	0.67 ^{C}	0.57 ^{C}	0.77 ^{C}
2 m^3 Verm.		1.08 ^{B}	1.09 ^{B}	1.10 ^{B}	1.16 ^{B}
4 m^3 Verm.		1.49 ^{A}	1.49 ^{A}	1.62 ^{A}	1.68 ^{A}
Effect of vitamins on % oil					
Control		0.86 ^{D}	0.87 ^{D}	0.85 ^{D}	0.99 ^{D}
Vit. C		1.01 ^{C}	1.01 ^{C}	0.98 ^{C}	1.07 ^{C}
Vit. B1		1.15 ^{B}	1.17 ^{B}	1.15 ^{B}	1.31 ^{B}
Mix vit. (C+B1)		1.26 ^{A}	1.28 ^{A}	1.40 ^{A}	1.45 A
Effect of interaction between vermicompost and vitamins on % oil					
Control	**Control**	0.28 ^{K}	0.34 ^{K}	0.28 ^{J}	0.54 ^{J}
	Vit. C	0.58 ^{J}	0.59 ^{J}	0.48 ^{I}	0.71 ^{I}
	Vit. B1	0.78 ^{I}	0.83 ^{I}	0.63 ^{H}	0.89 ^{H}
	Mix vit. (C+B1)	0.90 ^{H}	0.93 ^{H}	0.88 ^{G}	0.95 ^{G}
2 m^3 Verm.	**Control**	0.97 ^{H}	0.98 ^{H}	0.94 ^{G}	1.06 ^{F}
	Vit. C	1.04 ^{G}	1.04 ^{G}	1.06 ^{F}	1.11 ^{F}
	Vit. B1	1.12 ^{F}	1.12 ^{F}	1.14 ^{E}	1.21 ^{E}
	Mix vit. (C+B1)	1.20 ^{E}	1.20 ^{E}	1.24 ^{D}	1.28 ^{D}
4 m^3 Verm.	**Control**	1.32 ^{D}	1.30 ^{D}	1.34 ^{C}	1.37 ^{C}
	Vit. C	1.40 ^{C}	1.41 ^{C}	1.40 ^{C}	1.41 ^{C}
	Vit. B1	1.55 ^{B}	1.56 ^{B}	1.67 ^{B}	1.82 ^{B}
	Mix vit. (C+B1)	1.70 ^{A}	1.70 ^{A}	2.08 ^{A}	2.12 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

2.1.2. Effect of vitamins

Oil percentage as affected by vitamins treatments was reported in table (7), it was found that treating plants with vitamins resulted in a significant increase compared with the control plants for both cuts in the first and second seasons. Otherwise, in the first cut, the maximum oil percentage was 1.26% and 1.40% during the two seasons, while, in the second cut the highest value of oil percentage of 1.28% and 1.45% during the two seasons, respectively were recorded when applying the mix. of vit. C+B1. Analogous consequences were detailed by Abo-Marzoka et al. (2016) on maize and Zeinab et al. (2014) on *Phaseulus vulgaris*.

2.1.3. Effect of interactions

Data in table (7) reveals that there were significant differences in the oil percentage as a result of the differences in the interaction between vermicompost and vitamin treatments where the highest significant difference was recorded in the first season, when applying vermicompost at 4 m^3 plus mix. of C+B1 vitamins. The oil percentage recorded 1.70% and 1.70% compared to the control treatment of 0.28% and 0.34%, in the first and second cuts, respectively. Whereas the highest significant difference was recorded in the second season when the same treatment recorded 2.08% and 2.12% compared to the control treatment of 0.28% and 0.54% in the first and second cuts, respectively. The positive reaction of *Salvia officinalis* plants to the interaction between vermicompost and vitamins was in synchronization with those acquired by Ranjbar et al. (2014) and Sahel et al. (2014) on *Capsicum annuum* and Mohmmad et al. (2018) on coriander and fenugreek.

2.2. Oil content per plant (ml)

2.2.1. Effect of vermicompost

Results in table (8) show that increasing vermicompost produced an increase in oil content per plant (ml). These increments were significant in most cases for both cuts and the two seasons. In the first season, the highest average oil content per plant was 1.26 ml and 1.31 ml in the first and second cuts, respectively. While in the second season the highest average oil content per plant was 1.37 ml and 1.49 ml as a result of treating plants with 4 m^3 verm. Similar consequences were detailed by Joshi and Pal (2010) on *Lycopersicum esculentum* and Chandan and Azad (2015) on vegetable crops.

2.2.2. Effect of vitamins

Regarding oil content per plant in leaves, data in table (8) show that all vitamin treatments exhibited a stimulatory effect on oil content per plant accumulation in leaves compared with the control treatment. The differences between the treatments and the control were significant for both cuts in the two seasons. The highest values of oil content per plant were 0.86 ml and 0.95 ml in the first and second cuts during the first seasons; respectively. Even though, the highest values of oil content per plant were 1.02 ml and 1.10 ml in the first and second cuts during the second seasons, respectively. This resulted from plants added with mix.of vit. C+B1for both cuts in the two

seasons. These results are in line with those obtained by Abd El-Aziz et al. (2007) on *Syngonium podophyllum* and Hamid et al. (2018) on basil plants.

Table (8). Effect of vermicompost and vitamins and their interaction on oil content per plant (ml) of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
		oil/plant			
Control		0.13 ^{C}	0.18 ^{C}	0.10 ^{C}	0.21 ^{C}
2 m^3 Verm.		0.47 ^{B}	0.63 ^{B}	0.56 ^{B}	0.68 ^{B}
4 m^3 Verm.		1.26 ^{A}	1.31 ^{A}	1.37 ^{A}	1.49 ^{A}
		Effect of vitamins on oil/plant			
Control		0.40 ^{D}	0.51^{D}	0.43 ^{D}	0.56 ^{D}
Vit. C		0.52 ^{C}	0.67 ^{C}	0.55 ^{C}	0.64 ^{C}
Vit. B1		0.70 ^{B}	0.76 ^{B}	0.72 ^{B}	0.88 ^{B}
Mix vit. (C+B1)		0.86 ^{A}	0.95 ^{A}	1.02 ^{A}	1.10 ^{A}
		Effect of interaction between vermicompost and vitamins on oil/plant			
Control	**Control**	0.02 ^{K}	0.06 ^{L}	0.01 ^{K}	0.10 ^{K}
	Vit. C	0.07 ^{J}	0.13 ^{K}	0.06 ^{JK}	0.15 ^{K}
	Vit. B1	0.17 ^{I}	0.20 ^{J}	0.11 ^{J}	0.26 ^{J}
	Mix vit.	0.25 ^{H}	0.34 ^{I}	0.22 ^{I}	0.35 ^{I}
2 m^3 Verm.	**Control**	0.29 ^{H}	0.45 ^{H}	0.35 ^{H}	0.52 ^{H}
	Vit. C	0.38 ^{G}	0.56 ^{G}	0.50 ^{G}	0.59 ^{G}
	Vit. B1	0.55 ^{F}	0.67 ^{F}	0.61 ^{F}	0.73 ^{F}
	Mix vit.	0.67 ^{E}	0.83 ^{E}	0.80 ^{E}	0.89 ^{E}
4 m^3 Verm.	**Control**	0.88 ^{D}	1.00 ^{D}	0.93 ^{D}	1.06 ^{D}
	Vit. C	1.11 ^{C}	1.17 ^{C}	1.08 ^{C}	1.17 ^{C}
	Vit. B1	1.39 ^{B}	1.41 ^{B}	1.44 ^{B}	1.65 ^{B}
	Mix vit.	1.66 ^{A}	1.68 ^{A}	2.03 ^{A}	2.07 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

2.2.3. Effect of interaction

Data in table (8) indicate that the interaction treatments had a significant increase in oil content per plant in dry leaves of *Salvia officinalis* plants compared with the control treatment. The uppermost values of oil content per plant were 1.66 ml and 1.68 ml in the first and second cuts in the first season; respectively. While the highest values of oil content per plant were 2.03 ml and 2.07 ml in the first and second cuts in the second season; respectively. These results were produced from plants treated with 4 m^3 verm. + mix. of vit. C+B1. These results holded for the first and second cuts for both seasons. The positive reaction of *Salvia officinalis* plants to an interaction between vermicompost and vitamins was in synchronization with those acquired by Ranjbar et al. (2014) and Sahel et al. (2014) on *Capsicum annuum*.

2.3. Oil content per feddan

2.3.1. Effect of vermicompost

Data illustrated the vermicompost in the yield of oil content per feddan (l). Table (9) reveales that all treatments gave the highest significant increase in the oil content per feddan (l). The treatment of 4 m^3 verm. was given the highest value of yield of oil content per feddan of 35.328 l and 36.78 1 in both cuts, respectively; during the first season and 38.398 l and 41.708 l in two cuts, respectively; during the second season, combined with other treatments in the first and second cuts during both seasons. These results established with those reported by Alam (2006) and Jadia and Fulekar (2008).

2.3.2. Effect of vitamins

Regarding the main effect of vitamins, data in table (9) show that treating plants with different vitamins resulted in a significant increase in the oil content per feddan (l) compared to control treatments. Effect of vitamins where the highest value in the oil content per feddan (l) was recorded at the treatment of mix. of vit. C+B1, which was 24.054 l and 26.607 l, followed by an increase in the oil content per feddan (l) that recorded 19.653 l and 21.253 l with vit. B1, compared to the control treatment of 11.109 l and 14.147 l in the first and second cuts during the first season, respectively. However, the maximum value in the oil content per feddan (l) was recorded with the treatment mix. of vit. C+B1, which was 28.457 l and 30.847 l associated with the control treatment of 11.986 l and 15.604 l in the first and second cuts during the second season, respectively. Similar consequences were detailed by Soltani et al. (2015) on *Calendula officinalis* and Fallahi et al. (2018) on basil plants.

2.3.3. Effect of interactions

Data in table (9) indicate that the interaction between vermicompost and vitamins had a significant effect on the oil content per feddan (l). In the first season, the highest oil content per feddan (l) recorded 46.587 l and 47.113 l compared with the control treatment of 0.470 l and 1.787 l during both cuts, respectively. As for the second season, the highest yield of oil content per feddan (l) was 56.927 l and 58.063 l compared with the control plant of 0.277

l and 2.767 l during both seasons, respectively; This result is obtained from the treatment when the plants are applied to 4 m^3 verm. and treated with mix. of vit. C+B1. The positive reaction of *Salvia officinalis* plants to the interaction between vermicompost and vitamins was in synchronization with those acquired by Soltani et al. (2015) on *Calendula officinalis* and Fallahi et al. (2018) on basil plants.

Table (9). Effect of vermicompost and vitamins and their interaction on oil content per feddan (l) of *Salvia officinalis* plant during the two seasons of 2019 and 2020.

Treatments		Season 1		Season 2	
		Cut 1	Cut 2	Cut 1	Cut 2
Effect of vermicompost on oil / feddan					
Control		3.500 ^{C}	5.116 ^{C}	2.762 ^{C}	5.959 ^{C}
2 m^3 Verm.		13.236 ^{B}	17.566 ^{B}	15.731 ^{B}	19.033 ^{B}
4 m^3 Verm.		35.328 ^{A}	36.781 ^{A}	38.398 ^{A}	41.708 ^{A}
Effect of vitamins on oil / feddan					
Control		11.109 ^{D}	14.147 ^{D}	11.986 ^{D}	15.604 ^{D}
Vit. C		14.597 ^{C}	17.277 ^{C}	15.253 ^{C}	17.820 ^{C}
Vit. B1		19.653 ^{B}	21.253 ^{B}	20.158 ^{B}	24.663 ^{B}
Mix vit. (C+B1)		24.054 ^{A}	26.607 ^{A}	28.457 ^{A}	30.847 ^{A}
Effect of interaction between vermicompost and vitamins on oil / feddan					
Control	**Control**	0.470 ^{K}	1.787 ^{L}	0.277 ^{K}	2.767 ^{K}
	Vit. C	1.900 ^{J}	3.517 ^{K}	1.573 ^{JK}	4.107 ^{K}
	Vit. B1	4.720 ^{I}	5.787 ^{J}	3.163 ^{J}	7.290 ^{J}
	Mix vit. (C+B1)	6.897 ^{H}	9.373 ^{I}	6.033 ^{I}	9.673 ^{I}
2 m^3 Verm.	**Control**	18.680 ^{E}	23.33 ^{E}	22.410 ^{E}	24.803 ^{E}
	Vit. C	15.340 ^{F}	18.647 ^{F}	16.953 ^{F}	20.380 ^{F}
	Vit. B1	8.183 ^{H}	12.613 ^{H}	9.713 ^{H}	14.447 ^{H}
	Mix vit. (C+B1)	10.740 ^{G}	15.670 ^{G}	13.847 ^{G}	16.503 ^{G}
4 m^3 Verm.	**Control**	24.673 ^{D}	28.040 ^{D}	25.967 ^{D}	29.600 ^{D}
	Vit. C	31.150 ^{C}	32.643 ^{C}	30.340 ^{C}	32.850 ^{C}
	Vit. B1	38.900 ^{B}	39.327 ^{B}	40.357 ^{B}	46.320 ^{B}
	Mix vit. (C+B1)	46.587 ^{A}	47.113 ^{A}	56.927 ^{A}	58.063 ^{A}

Averages that share the same alphabet do not differ from each other significantly according to Duncan's test at the 5% level.

2.4. Volatile oil composition using GLC

2.4.1. Effect of vermicompost

Data in figs. (1 and 4) show that there were basic compounds that appeared in the essential oil of the sage plant, which led to a noticeable increase in the components of the oil when studying the effect of vermicompost on the productivity of the sage plant. Thujone, which is the main compound in the essential oil of sage, gave the highest percentage and

reached 25.456% when treated with 4 m^3 verm. While the percentage in untreated plants was 22.34%.

2.4.2. Effect of vitamins

Figs. (2 and 4) show that the treatment with vitamins affected the basic compounds with the essential oil of the sage plant, the basic compound thujone increased by 30.659% when treated with a mixture of vitamin C and B1 followed by 25.478% when treated with B1. Also, an increase in the second important compound in sage oil, camphor was found and recorded 14.698% when treated with a mixture of vitamins C+B1, and also a noticeable increase in caryophyllene compound was found, which reached 11.657% when spraying with vitamin C alone combined with the control.

2.4.3. Effect of interactions

Figs. (3 and 4) show the effect of the interaction between vermicompost and spraying with vitamins on the components of the essential oil of sage, where it was found that there are five main compounds in the essential oil, namely 1,8-cineole thujone, camphene, camphor, and caryophyllene. Thujone is the main component of the essential oil, with a ratio ranging from 57.102% to 22.355 % followed by camphor, with a rate ranging from 27.661% to 15.364 %, then 1.8-cineole, which recorded 18.365% to 3.256%, then caryophyllene, scored 13.657% to 4.160%, then camphene, scored 3.864% to 1.546%. The treatment of 4 m^3 verm. + mix of vit. (C+B1) recorded the highest values in both thujone (57.102%) and camphor (13.657%), while 1.8-cineole recorded 3.256%, camphene recorded 1.846% and caryophyllene recorded 4.160%.

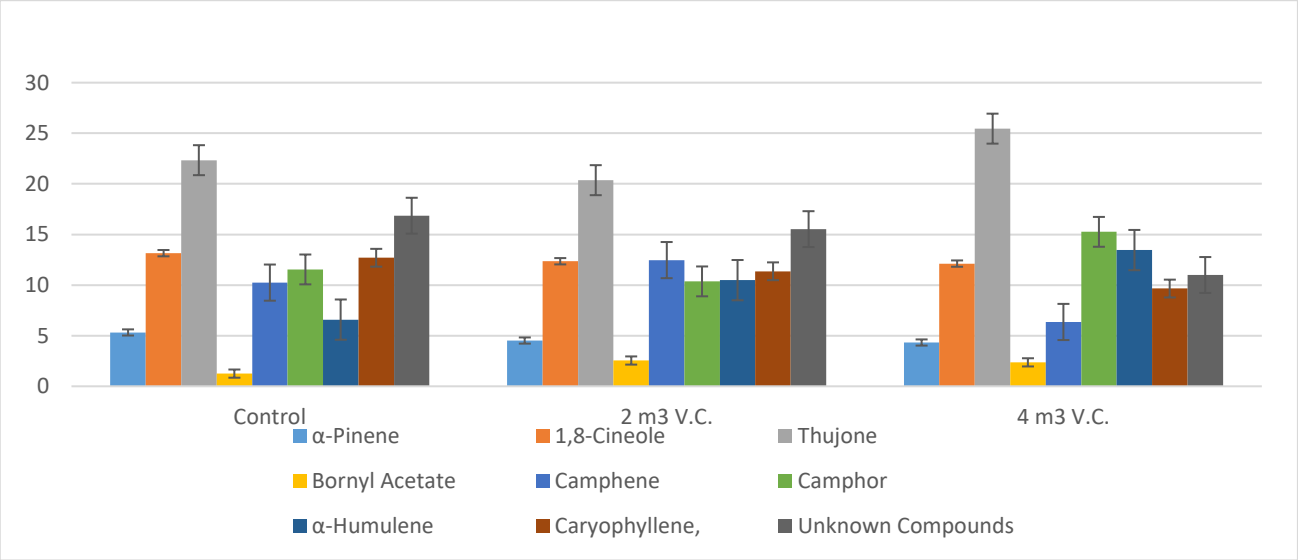

Fig. (1). Effect of vermicompost volatile oil composition of *Salvia officinalis* using GLC in the second cut during 2019/2020 season.

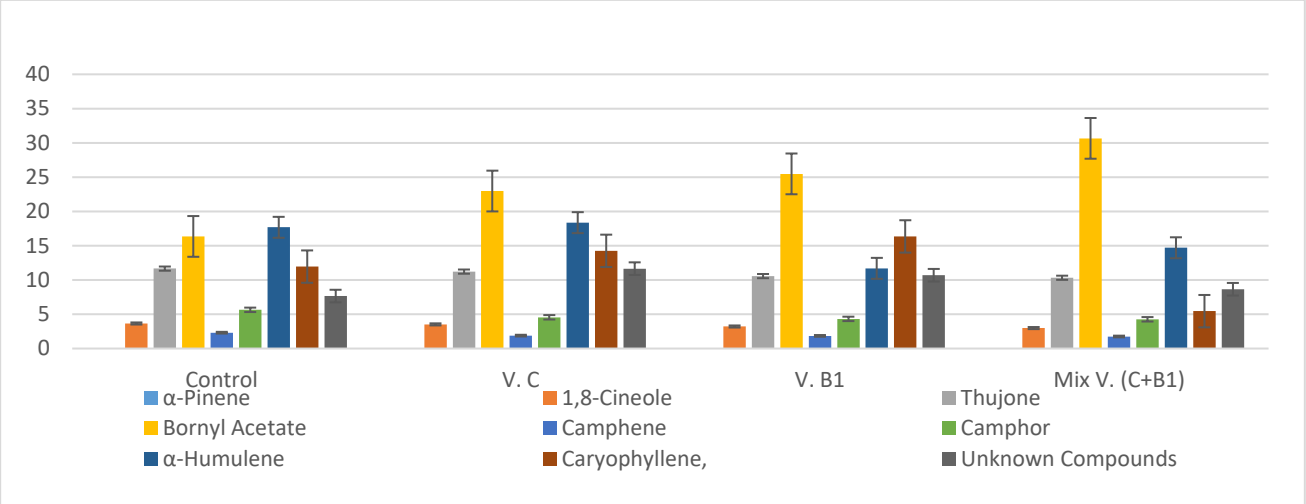

Fig. (2). Effect of vitamins on volatile oil composition of *Salvia officinalis* using GLC in the second cut during 2019/2020 season.

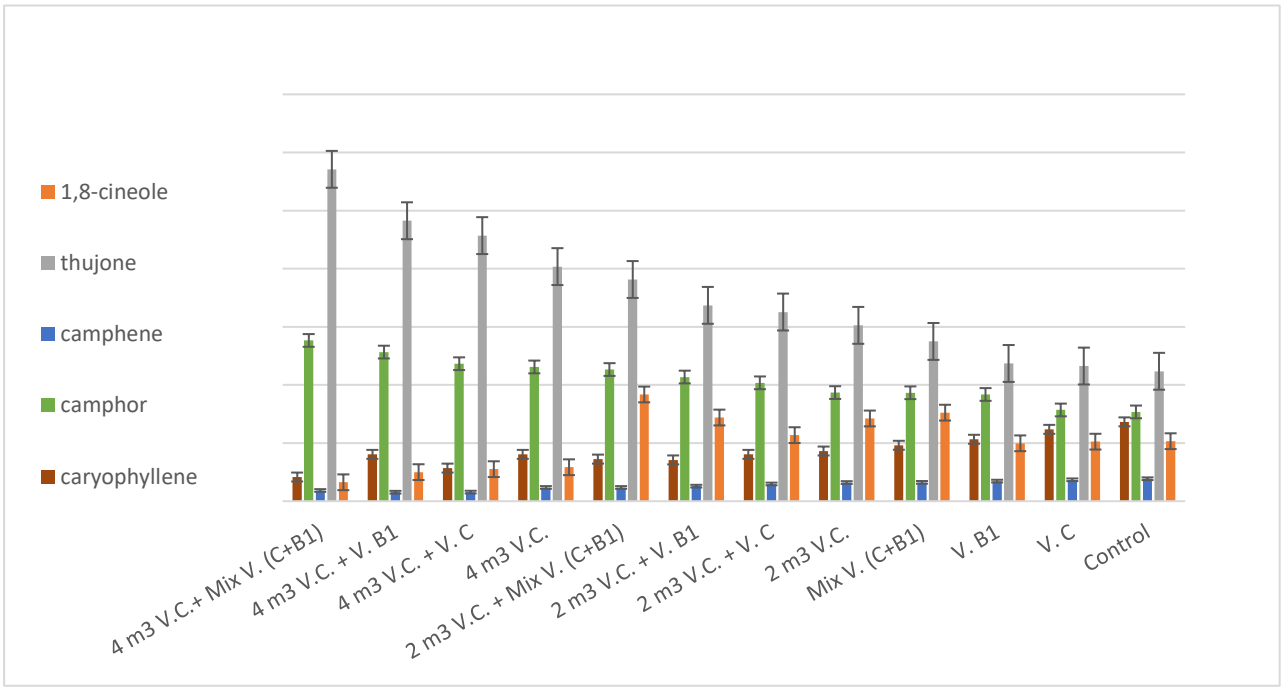

Fig. (3). Effect of interaction between vermicompost and vitamins on volatile oil composition of *Salvia officinalis* using GLC in the second cut during 2019/2020 season.

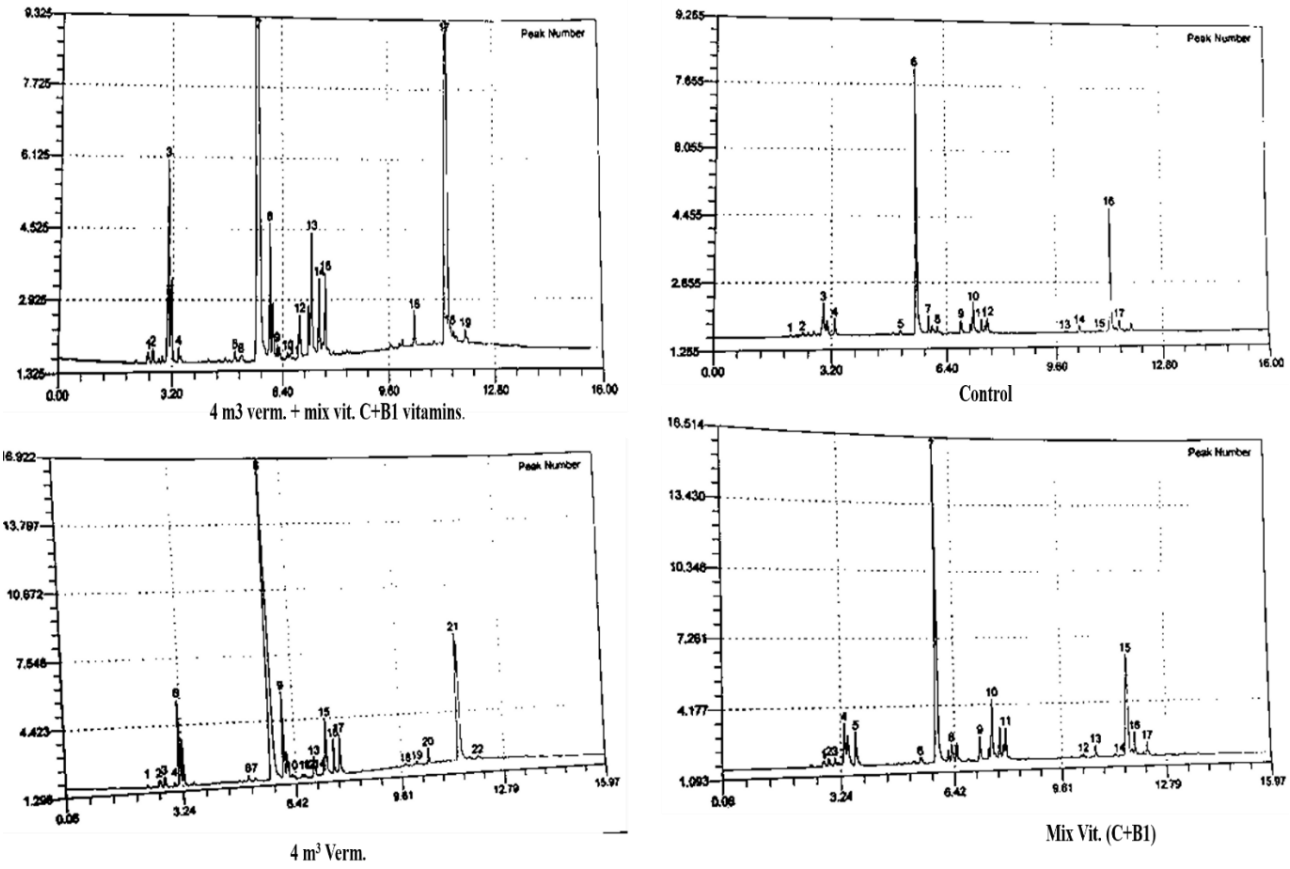

Fig. (4). Effect of vermicompost and vitamins and their interaction on volatile oil composition using GLC analysis of extracted *Salvia officinalis* oil in the second cut during 2019/2020 season.

DISCUSSION

The main objective of the research is to study the effect of adding vermicompost and spraying with vitamin C and vitamin B1 and the interaction between them on leaf production, oil yield, and active components of sage essential oil under reclaimed ground conditions. The results obtained show that there is a significant effect when using vermicompost, and this moral effect increased with an increase in the rate of addition to vermicompost.

An increase was observed in plant growth included "plant height (cm), number of branches, fresh and dry weights per plant (g) and per feddan (tons)" as well as an increase in Oil production included "oil percentage in leaves dry weight ; oil content per plant (ml) and per feddan (L) and volatile oil composition using G.L.C. and the best treatment was when applying 4 m^3

Verm., which led to a significant increase in all the traits under study in the earrings during the first and second season, and this is due to increase in yield resulting from the use of vermicompost is due to the fact that The application of vermicompost reduces the loss of nutrients through leaching from the soil by changing the physical and chemical properties of the soil, which increases the available NPK elements in the soil and this is due to the fact that vermicompost contains a larger amount of nutrients such as N, P, K, Ca, Mg , Na, Zn, Fe, Cu and Mn, and it also affects the total microbial content in the soil significantly, which improves plant growth indicators such as plant height, the number of branches i therefore vermicompost can be a natural product, source of plant nutrients and easy for absorption through the roots that appeared in the increase in the weight of the fresh and dry leaves / plant (cm) / feddan (tons), so the plants become more active for the photosynthesis process, which contributes to this to improve the qualities of the crop, Similar consequences were detailed by Manh and Wang (2013) on *Cucumis melo* and Sahel et al. (2014) on *Capsicum annuum*, which appeared in the increase in the proportion of oil with leaves, which led to an increase in the plant's oil content / plant / feddan. On the other hand, the increase in growth and return on the quality of the crop resulting from the use of vermicompost as a result of providing all the nutrients necessary for the plant and not losing them in the soil quickly as a result of its work on improving the properties of the soil. These results established with those reported by Joshi and Pal (2010) on *Lycopersicum esculentum*, Chandan and Azad (2015) on vegetable crops, Alam (2006) and Jadia and Fulekar (2008).

In general, the increase in the yield resulting from the use of the mixture of vitamin C + B1 is due to the encouragement of the vegetative and fruitful growth of plants, where its effect on plant growth is similar to the effect of growth regulators, as well as their role in stimulating the processes of respiration and cell division, which was reflected in an increase in plant height and an increase in The number of branches was spraying with vitamin C led to an increase in the secretion of organic acids from the roots to the soil, which led to an increase in the solubility of most nutrients in the rhizosphere, which led to the encouragement of the photosynthesis process as a result of the increased ability of plants to absorb larger quantities of nutrients from the soil. On the one hand, the significant effect of spraying with vitamin B1 in increasing the growth characteristics under study is due to the increase of cytokinins and gibberellins and initiators of pyrophosphate thiamine which the plant needs in the metabolism of carbohydrates and amino acids.

The result of applying spraying with a mixture of vitamin C + B1 led to an increase in the vegetative growth indicators represented in the height of the plant and the number of branches, and this appeared in an increase in the fresh and dry weight of leaves/plant / feddan, which increased the oil yield represented in the percentage of oil and oil content/plant / feddan. These results established with those reported by Ranjbar et al. (2014), El-Awadi et

al. (2016) on the lupine plant, Hamid et al. (2018) on basil plants, Mohmmad et al. (2018) on coriander and fenugreek and Al-Douri, and Basheer (2021) on *Prunus amygdalus* var. Amara.

The increase in plant yield as a result of using vermicompost and a mixture of vitamins C and B1 is because vermicompost leads to the liberation of a large number of nutrients and nutrients necessary for plant growth, Hamid et al. (2018) in basil plants. Vitamins also work to increase growth through their work as enhancers and growth regulators similar to the action of auxins and gibberellins and thus encourage its growth, which is reflected In an increase in the height of the plant and an increase in the number of branches, and thus an increase in the number of leaves on the branches, increasing photosynthesis, followed by an increase in metabolism, and this appears in the form of an increase in the fresh and dry weight of leaves/plant / feddan followed by an increase in the oil yield, which is represented in the percentage oil and plant oil content/plant / feddan.

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تقييم إنتاجية نباتات المريمية بإستخدام الأسمدة والرش بالفيتامينات

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أجريت الدراسة في محطة بحوث القصاصين التابعة لمحافظة الإسماعيلية، مركز البحوث الزراعية بقسم النباتات الطبية والعطرية خلال موسمي ٢٠٢٠/٢٠١٩ ٢٠٢١/٢٠٢٠ على نباتات المريمية. كان تصميم التجربة قطاعات منشقة مرة واحدة مقسمة بثلاث مكررات، وكانت المعاملة بالسماد الفيرمي كمبوست في القطع الرئيسية ويشمل (كنترول، ٢ و٤ م^{٣}) ، بينما كانت القطع الفرعية الرش بالفيتامينات وتشمل (كنترول، فيتامين C وفيتامين B1) . تم حصاد النباتات مرتين، بعد ٧٥ يومًا من الزراعة في الحشة الأولى وبعد ٧٥ يومًا خلال الحشة الثانية، خلال الموسمين الأول والثاني على التوالي. كشفت النتائج أن هناك تأثير معنوي ناتج عن استخدام الفيرمي كمبويت بمعدل ٤ م^{٣} على جميع خصائص النمو الخضري والزيت العطري مقارنة بالنباتات غير المعالجة. من ناحية أخرى، كان هناك تأثير معنوي على خصائص نمو النبات مثل "ارتفاع النبات (سم)، عدد الأفرع، الوزن الطازج والجاف لكل نبات (جم) ولكل الفدان (طن)" كذلك إنتاج الزيت مثل "النسبة المئوية للزيت؛ إنتاج الزيت لكل نبات (مل) ولكل الفدان (لتر) وذلك عند الرش بمزيج من فيتامين B1 + C مقارنة بالمعاملات الأخرى ونباتات الكنترول. كما كان هناك تأثير معنوي نتيجة التفاعل بين إضافة السماد الدودي والرش بالفيتامينات على جميع خصائص النمو والزيوت العطرية ومركبات الزيوت العطرية، حيث سجلت المعاملة ٤ م^{٣} بالإضافة إلى الرش بمزيج الفيتامينات B1 + C مقارنة بالعلاجات الأخرى والنباتات غير المعالجة. كما أظهرت النتائج أن استخدام الفيرمي كمبوست بمعدل ٤ م^{٣} مع الرش بمزيج من فيتامين B1 + C قد سجلت أعلى قيم من مكونات الزيت الرئيسية، فسجل الثيوجول وهو المركب الرئيسي لزيت المريمية ٥٧.١٠٢٪ في حين أعطى الكافور وهو ثاني مركب للزيت العطري ١٣.٦٥٧٪، بينما سجل المركب ١، ٨ سينيول ٣.٢٥٦٪، كامفين ١.٨٤٦٪ ، كاريوفيلين ٤.١٦٠٪.