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Enhancing Volatile Oil Components and Productivity of Dill (*Anethum graveolens*, L.) Plants as Affected by Compost and Ascorbic Acid

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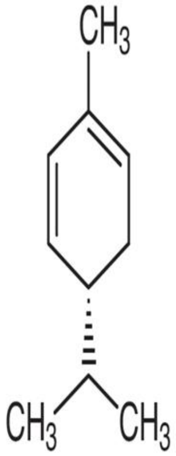
Abstract: The Experimental Farm, Fac. Agric., Al-Azhar Univ., Assiut, Egypt, conducted field experiments in 2021/2022 and 2022/2023. These field experiments examined the effects of compost application rates (0, 5, 10, and 15 tons/ha), NPK fertilizer levels, and ascorbic acid concentrations of 50, 100, and 150 ppm. The study examined the impact of these treatments, alone and in combination, on dill (*Anethum graveolens* L.) plant growth, yield, and volatile oil content. The obtained results showed that the use of compost at all levels and NPK resulted a significant increase in plant height, branches number/ plants, herb fresh and dry weight g/ plant, number of umbels/ plant, fruit yield g/ plant and ton/ ha., volatile oil percentage and volatile oil ml/ plant and l /ha. of dill plant. Applying the high level of compost (15 tons/ ha.) gave the highest values of these previous traits. Obviously, foliar application with ascorbic acid led to a significant augment in above mentioned parameters. The highest values of these parameters were detected by ascorbic acid at 150 ppm. The interaction effect on all studied parameters was statistically significant, obviously, the utilize of combined treatments led to a significant augment in these tested characteristics. The chemical compounds of the oil, we noted that the compounds Carvone, Apiol, D-Limonene and α-Phellandrene have the highest percentages of this compounds compared to other compounds. Most effective treatments in increasing these traits were revealed when adding compost at 15 tons/ ha. plus, foliar application with ascorbic acid at the high concentration (150 ppm).

Key words: Dill, *Anethum graveolens*, Compost, Ascorbic acid, Volatile oil.

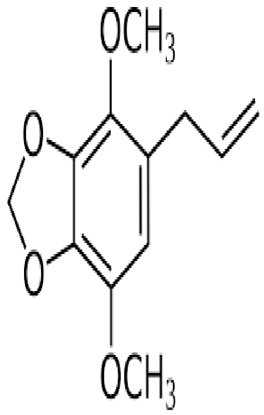
INTRODUCTION

Dill (*Anethum graveolens*, L.) plant, is an herbaceous plant of the Apiaceae family that has been mostly imported from the Eastern Mediterranean **(Sokhangoy *et al*., 2012).** Dill plant leaves are one of the most often used green herbs. It is used in perfume, domestic cosmetics, and medicine uses. It has a decent taste and a high quantity of nutrients for an altitude (**Rashed, 2002**). Dill leaves might be used to prepare foods like salads, soups, and seafood that are popular in Egypt. Dill fruits might be used to flavor bread and pickles (**Elsayed *et al*., 2020**).

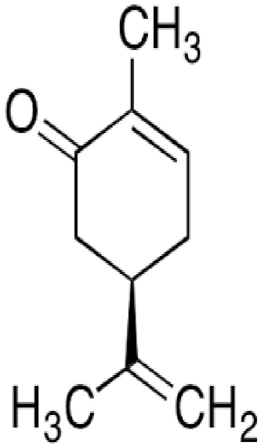
Carvone, Apiol and D-Limonene and α-Phellandrene are the most important components of the volatile oil of the dill plant, as their have various medicinal and therapeutic uses.



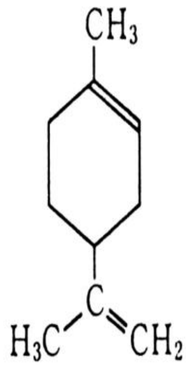
Carvone



Apiol



D-Limonene



α-Phellandrene

Among the important agronomic systems that have been proved to enhance the vegetative growth, fruit yield, and oil yield of dill plants are organic and ascorbic acid. The utilization of organic manures is crucial for optimizing the yield and quality of medicinal and aromatic plants. Moreover, the application of organic manures offers a safe and environmentally friendly approach, ensuring the well-being of both human health and the surrounding ecosystem. The method involves the regulated recycling of organic materials, such as plant and animal waste, as well as food leftovers. The long-term application of inorganic fertilizer has a detrimental impact on soil structure. Therefore, it has been suggested by **Dauda *et al*. (2008)** and **Suresh *et al*. (2004)** that organic manures can be utilized as a viable substitute for mineral fertilizers in order to enhance soil structure and microbial biomass. In recent times, a variety of fertilizers, including compost, have been extensively employed in different regions globally.

The application of organic fertilizer is preferable to mineral fertilization for improving the quality of medicinal and aromatic plants, and organic farming has become a quality standard that small farmers in Egypt can match (**Abou El-Fadl *et al*., 1990)**. The use of organic fertilization is more acceptable than the use of inorganic fertilizers, and small farmers in Egypt could effectively match the high standards of organic farming. Several researchers have found that organic fertilization increases herb dry weight and umbels number as well as seed yield, volatile oil% and yield. These investigators also provided by **Khalid and Shafei (2005)** on dill plant, **Badran and Safwat (2004) and Azzaz *et al.* (2009)** on fennel**, Shehata *et al* (2011)** on snap bean **Rekaby (2013)** on coriander, **Hassan (2005)** on guar and fenugreek plants.

Ascorbic acid, often known as Vitamin C, plays a crucial role in the growth and upkeep of connective tissues. The aforementioned factor assumes a significant function in the process of bone creation, the facilitation of wound healing, and the preservation of optimal gum health. Vitamin C assumes a crucial position in several metabolic processes, encompassing the activation of folic acid, a B vitamin, In addition, the process of converting cholesterol into bile acids and transforming the amino acid tryptophan into the neurotransmitter serotonin is observed. This substance functions as an antioxidant, providing protection to the body against harm caused by free radicals. It is utilized as a therapeutic agent in numerous diseases and ailments. Vitamin C has a crucial role in bolstering the immune system, mitigating the intensity of allergic reactions, and aiding in the combat against infections (**Shailja and colleagues, 2013)**.

Vitamin C, or ascorbic acid, is a well-known biostimulant and antioxidant that can shield plants from harm from contaminants and aerobic metabolism. As an enzyme cofactor, it works. Ascorbic acid also helps plants resist a variety of plant diseases, including bacteria, nematodes, fungi, and parasitic plants (**Oertli, 1987; Mahdy, 1994**). In addition to these and other crucial functions, ascorbic acid also controls growth and photosynthesis and provides antioxidant defense and photoprotection (**Blokhina *et al*., 2003**). Many researchers concluded that the use of ascorbic acid improved the yield of many medicinal and aromatic plants, such as **Shala (2012)** on Caraway, **Helmy (2016)** on cumin and **Ali *et al.* (2016)** on fennel plant.

The objective of this study was to examine the influence of compost, ascorbic acid (Vitamin C) and their interactions on dill growth, fruit yield, and oil production.

MATERIALS AND METHODS

This experiment was conducted at the Farm Faculty of Agriculture, Al-Azhar University, Assiut, Egypt, throughout the two successive seasons of 2021/2022 and 2022/2023 in order to improve the development and production of the dill plant. The experiment included two factors: the 1st was compost and the 2nd was ascorbic acid, as well as, their interactions.

Experimental Design

The statistical design of this study utilized a split-plot design with three replicates, using a randomized complete blocks design (RCBD) with fertilization kinds (five types) as the main plot and ascorbic acid concentrations (four concentrations) as the sub-plot. There were 20 treatments total for the fertilization kinds and ascorbic acid concentration interactions.

Material and Culture of Plants

Dill seeds were obtained from the Agricultural Research Centre of the Department of Medicinal and Aromatic Plants in Dokky, Giza, Egypt. On November 10th, during the two seasons, fruits were immediately sowed in the plot 3 x 2.7 meters made up the experimental unit area. Each experimental unit had four rows that were each 2.7 meters long, 60 cm separated the ridges, while 30 cm apart in the hills. Each hill received about 5-6 fruits, which were subsequently trimmed to 2 plants/ hill. As a result, the experimental unit included 64 plants. The physical and chemical properties of the experimental farm soil are tabulated in Table 1 as reported by **Chapman and Pratt (1978)**.

Table 1. The physical and chemical properties of the used soil

Characters	Value		Characters	Value	
	2021	2022		2021	2022
Clay %	49.25	48.88	CaCo3 %	2.59	2.51
Silt %	35.52	36.60	PH (1:2.5)	7.53	7.47
Sand %	15.23	14.52	E.C m/mhos/cm	1.21	1.30
Organic matter %	2.47	2.68	Total N %	0.17	0.15
texture	Clay loam	Clay loam	Available P %	2.76	3.00
			Exchange K (mg/100 g soil)	2.38	2.27
			Exchange Ca++ (mg/100 g soil)	34.3	32.11
			Exchange Na (mg/100 g soil)	2.27	2.21

Time and Fertilization Rate

In order to prepare the soil for cultivation, compost levels of 0, 5, 10 and 15 tons per hectare were added. This compost fertilizer, known as compost El-Neel, was purchased from New Minia City. According to **Black *et al.* (1965)**, the physical and chemical characteristics of the applied compost were identified, and they are displayed in Table 2. The three NPK rates that were advised dos were ammonium sulphate (20.5% N), calcium superphosphate (15.5% P_2O_5), and potassium sulphate (48.5% K_2O): 200, 200, and 100 kg/hectare, respectively. During soil preparation, phosphorus fertilizer was adding in its entirety. Whereas fertilizers for nitrogen and potassium were administered 30, 60 and 90 days following the date of planting in 3 equal amounts.

Table (2). The physical and chemical properties of the used compost

Properties	Value		Properties	Value	
	2021	2022		2021	2022
Dry weight of 1 m3	450 kg	450	Total N (%)	1.5	1.6
Moisture (%)	25-30	25-30	Total P (%)	0.9	0.88
pH (1:10)	7.7	7.9	Total K (%)	1.4	1.31
E.C. (m mhose/cm)	2-3.4	2-3.5	Fe (ppm)	290	297
Organic matter %	39	38.5	Mn (ppm)	29.2	30.3
Organic carbon %	19.8	20.7	Cu (ppm)	150	151
C/N ratio	13.7	13.8	Zn (ppm)	152	175

Ascorbic acid application

Ascorbic acid treatments were as follows: Control (no sprayed plants), 50, 100 and 150 ppm. The plants were foliar sprayed with ascorbic acid three times as follows: January 10th, January 25th and February 8st for the 1st, 2nd and 3rd sprays, respectively, in the two seasons. Tap water was sprayed on the untreated plants (the control).

Sampling and Data Collection

Three months after dill was sowed, three randomly chosen plants from each experimental unit were used to calculate the following variables: plant height (cm), branch number/plants, and herb fresh and dry weight (g/plant). The number of umbels per plant, fruit production (g/ plant) and fruit yield (tons/ ha), as well as the volatile oil percentage in the fruits, were all recorded at the time of harvesting on the first week of April in both seasons.

Volatile oil isolate

In order to extract essential oil (EO), seeds from each treatment over both seasons were collected, weighed, and then 100 g from each repeat of all transactions were used. Three hours of hydro distillation (HD) with a Clevenger type apparatus (**Clevenger, 1928**). In terms of a relative percentage (v/w), EO content was calculated. Additionally, dry weight was used to determine the overall EO Where ml/100 plants. During the two seasons of each treatment, the extracted EOs from *Anethum graveolens* were collected and dried for use in chemical determination assays.

GC and GC–MS conditions

Gas chromatography-mass spectrometry (GC – MS) analysis

The samples were subjected to analysis using gas chromatography (Agilent 8890 GC System) in conjunction with a mass spectrometer (Agilent 5977B GC/MSD). The GC system was equipped with an HP-5MS fused silica capillary column, which had 30 m length and 0.25 mm internal diameter, and 0.25 mm film thickness. The starting oven temperature was set at 50 °C. It was thereafter programmed to increase from 50 to 220°C at a pace of 5°C per minute. Following this, the temperature was further increased from 220°C to 280°C at a rate of 20°C per minute. Finally, the temperature was kept at 280°C for a duration of 5 minutes. The carrier gas employed in this study was helium, with a flow rate of 1.0 mL/min. The essential oil was solubilized in diethyl ether at a concentration of 30 µL essential oil per mL diethyl ether. Subsequently, 1 µL of this solution was introduced into the gas chromatograph (GC) at a split ratio of 1:50. The injection temperature was recorded as 230 °C. Mass spectra were acquired using the electron impact mode (EI) with energy of 70 electron volts (eV), and the mass-to-charge ratio (m/z) was scanned within the range of 39 to 500 atomic mass units (amu). The identification of the isolated peaks was accomplished through a process of matching them with data obtained from the library of mass spectra, namely the National Institute of Standards and Technology (NIST).

Statically Analysis

The collected data was organized into tables and subjected to statistical analysis using the **MSTATE-C method (1986)**, with the L.S.D. test at a significance level of 5%. This analysis was conducted to determine any significant differences among the various treatments, as outlined by **Mead *et al.* (1993)**.

RESULTS AND DISCUSSION

Growth parameters

Data recorded in Table 3 reveal that the effect of compost at rats 0, 5, 10, and 15 tons/ha. on growth parameters dill (*Anethum greavelans* L.) plants were significantly increased compared to unfertilized in both seasons. However, the best growth resulted from fertilizing with compost 15 ton/ha. Generally, growth parameters were improved gradually with increasing compost rates. The application of compost at 15 tons/ ha. gave the best plant height, branches number /plant and fresh and dry weights of herb by 22.80, 93.44, 37.67, and 23.08% in the first season, and 24.25, 98.44, 38.20, and 29.20 % in the second season, respectively, in both seasons over the control.

These results are in accordance with those found by **Gahory et al. (2022)** and **Ashwini and Jain (2017).** on *Coriandrum sativum* L. plant, **Abe El-Latif (2002)** on *Carum carvi*, **Sharaf and Khattab (2004)** on fennel, **Sakr (2005)** on *Cassia acutifolia* plants and **Hassan *et al.* (2015)** on rosemary.

Data recorded in Table 3 reveal the effect of foliar application of ascorbic acid (AA) concentrations at 0,50,100 and 200 ppm on plant height (cm), branches number /plant as well as fresh and dry weights of herb (g) of dill (*Anethum graveolens* L.) plants was significantly increase compared to untreated in the both season. However, the best growth resulted from spraying with AA (3) at 200 ppm. Generally, growth parameters enhanced gradually with increasing ascorbic acid concentrations.

The foliar application of ascorbic acid at 200 ppm gave the best plant height (cm), number of branches/plant, fresh and dry weights of herb (g) by 8.07, 22.89, 6.95% and 15.09 % in the first season and 8.96, 27.59, 8.64 and 16.73 % in the second season, respectively, over the control in both seasons.

These results are in line with those found by **Pundarikakshudu and Bhavsar (1990), Hassan *et al.* (2019)** and **Nosir (2021)** on dill (*Anethum graveolens* L.) plant, **Hemdan (2008)** on anise (*Pimpinella anisum* L.), **Gahory *et al*. (2022), Massoud *et al.* (2016), Said-Al-Ahl *et al.* (2014)** and **Hesami *et al.* (2012)** on coriander plant, **Talaat *et al*. (2014)** on *Ammi visnaga* and **Bashir *et al.* (2023)** on Pea plant ،

Results under discussion in Table 3 indicate that a combination of the two studied factors was significant in both seasons. However, the highest values of growth parameters were produced by using 200 ppm ascorbic acid in combination with compost at the rate of 15 tons/ha. compared to the other combinations in this study in the both seasons.

Yield parameters

The tabulated information in Table 4 presents the quantitative values for the number of umbels per plant, seed yield per plant in grams, and the corresponding yield in tons per hectare. The impact on dill (*Anethum graveolens* L.) plants was shown to be statistically significant across all compost levels for the duration of the two study seasons. It was evident that each of these factors played a substantial role in enhancing the yield parameters. Furthermore, the most prominent variables observed were the quantity of umbels per each plant and the overall seed yield per plant (measured in grams) and per hectare (measured in metric tons). The observed results were acquired through the application of a high rate of fertilizer (15 tons/ha) to dill plants. This resulted in a range of increases, namely 79.39%, 45.09%, and 44.92% in the first season, and 67.38%, 48.37%, and 48.28% in the second season, as compared to the control.

Hassan *et al*. (2015) on dill, **Sanjeeva *et al*. (2018)**, **Ali and Hassan (2014)** on *Nigella sativa* L. plants, **Abd El-Azim *et al.* (2017)** on fennel and **Mostafa (2018)** on dragonhead plant indicated the efficiency of compost on increasing yield components.

Table (3). Effect of compost levels and ascorbic acid concentration on the growth of dill (*Anethum graveolens* L.) plants during the 2021\2022 and 2022/2023 seasons

Compost (A)	Ascorbic Acid ppm (AA) (B)									
	0	50	100	150	Mean (A)	0	50	100	150	Mean (A)
	First season					Second season				
Plant height (cm)										
Control	62.7	65.3	68.7	71.7	67.1	64.7	67.3	71.3	77.0	70.1
NPKRD	78.0	80.3	81.7	83.7	80.9	81.3	82.0	84.3	86.0	83.4
Com. 1	68.0	69.3	70.7	73.0	70.3	70.7	71.7	74.3	77.0	73.4
Com. 2	76.7	78.7	79.7	81.7	79.2	79.0	80.0	81.3	84.0	81.1
Com. 3	80.0	81.3	83.3	85.0	82.4	84.0	86.3	88.3	89.7	87.1
Means (B)	73.1	75.0	76.8	79.0		75.9	77.5	79.9	82.7	
L.S.D 0.05		A: 1.40	B:0.60	AB:1.30			A: 1.70	B:0.50	AB:1.10	
Number of branches/plants										
Control	5.8	6.0	6.2	6.5	6.1	5.9	6.2	6.5	6.9	6.4
NPKRD	10.0	10.3	11.2	13.4	11.2	9.6	11.1	12.2	14.0	11.7
Com. 1	6.6	6.8	7.1	7.9	7.1	6.9	7.5	7.8	8.5	7.7
Com. 2	8.6	8.9	9.2	9.7	9.1	9.9	10.1	10.7	11.4	10.5
Com. 3	10.5	11.0	12.0	13.7	11.8	11.0	12.3	13.0	14.5	12.7
Means (B)	8.3	8.6	9.1	10.2		8.7	9.4	10.0	11.1	
L.S.D $_{0.05}$		A= 0.20	B= 0.10	AB= 0.20			A= 0.40	B= 0.30	AB= 0.70	
Fresh weight (g/plant)										
Control	82.0	84.3	87.0	90.7	86.0	86.3	88.3	90.3	94.0	89.8
NPKRD	112.0	116.3	117.0	118.7	116.0	116.3	120.3	121.7	125.7	121.0
Com. 1	105.2	107.3	109.8	111.5	108.4	106.2	107.5	110.7	112.7	109.3
Com. 2	111.5	112.9	118.2	119.5	115.5	112.0	113.0	119.1	120.8	116.2
Com. 3	114.3	118.7	119.7	121.0	118.4	117.7	122.0	124.7	132.0	124.1
Means (B)	105.0	107.9	110.3	112.3		107.7	110.2	113.3	117.0	
L.S.D $_{0.05}$		A= 3.8	B= 0.7	AB= 1.7			A= 2.3	B= 1.0	AB= 2.3	
Dry weight (g/plant)										
Control	21.7	21.7	22.0	22.9	22.1	21.9	22.5	22.8	23.2	22.6
NPKRD	24.0	25.2	26.8	28.3	26.1	25.7	26.8	28.4	30.5	27.8
Com. 1	22.3	23.6	25.2	26.0	24.2	24.1	25.0	26.3	27.0	25.6
Com. 2	22.8	24.3	25.2	26.5	24.7	24.3	25.7	28.0	29.3	26.8
Com. 3	25.0	26.2	27.7	30.0	27.2	26.5	28.0	30.3	32.8	29.4
Means (B)	23.2	24.2	25.4	26.7		24.5	25.6	27.2	28.6	
L.S.D $_{0.05}$		A= 0.70	B= 0.30	AB= 0.70			A= 0.60	B= 0.40	AB= 0.90	

Com. 1= 5, Com. 2= 10 and Com. 3= 15 ton/ha. of compost.

Ascorbic acid spraying had a substantial impact on the growth characteristics of dill in both seasons, according to data in (Table 4). According to the data, the largest seed yields are ton/ha, g/plant, and umbels per plant. According to data that has been compiled, seed yields of tons/ha and grams per plant are the highest umbels per plant. In both seasons, foliar spraying with ascorbic acid 200 ppm AA increased these measurements more effectively than the other treatments. In terms of numbers, this pre-treatment raised this fraction above that of the unsprayed plants for the first and second experimental seasons, respectively, by 15.57, 16.34, and 16.41% and 27.71, 18.18, and 17.85%. **Abd El-Salam (2014)** on sweet basil, **Mostafa (2018)** on dragonhead plant, **Abdou and Badry (2022)** on caraway plants and **Mohamed / (2022)** on basil plant investigated the impact of ascorbic acid treatment on the enhancement of yield characteristics.

In two seasons, the interaction effect of compost and ascorbic acid treatments on all dill yield parameters led to significant increases in all output measurements. As shown in Table (4), the most successful treatments were given to plants with 15 tons/ ha compost rate and 200 ppm ascorbic acid rate.

Table (4). Effect of compost levels and ascorbic acid concentration on the yield parameters of dill (*Anethum graveolens* L.) plants during the 2021/2022 and 2022/2023 seasons

Compost (A)	Ascorbic Acid ppm (AA) (B)									
	0	50	100	150	Mean (A)	0	50	100	150	Mean (A)
	First season					Second season				
Number of umbels/plants										
Control	12.2	13.0	13.3	13.8	13.1	13.0	13.8	14.5	15.2	14.1
NPKRD	21.2	22.0	23.0	23.7	22.5	23.0	24.0	25.0	26.3	24.6
Com. 1	13.0	14.0	15.0	15.8	14.5	14.0	16.2	17.2	17.6	16.2
Com. 2	15.0	16.0	16.7	18.0	16.4	16.7	18.0	18.8	19.7	18.3
Com. 3	22.0	23.0	24.0	25.0	23.5	16.3	25.0	26.0	27.0	23.6
Mean (B)	16.7	17.6	18.4	19.3		16.6	19.4	20.3	21.2	
L.S.D $_{0.05}$		A= 0.20	B= 0.20	AB= 0.40			A= 1.20	B= 1.00	AB= 2.40	
Seeds weight (g/plant)										
Control	15.2	16.3	18.2	19.6	17.3	16.2	18.1	19.2	20.1	18.4
NPKRD	22.7	23.6	24.7	25.7	24.1	23.3	24.3	25.7	26.6	25.0
Com. 1	19.4	20.3	21.4	22.4	20.9	19.9	21.0	22.0	23.1	21.5
Com. 2	20.3	21.1	22.3	23.3	21.8	20.7	21.7	23.1	24.0	22.4
Com. 3	23.5	24.6	25.7	26.7	25.1	24.5	25.7	29.5	29.5	27.3
Mean (B)	20.2	21.2	22.5	23.5		20.9	22.1	23.9	24.7	
L.S.D $_{0.05}$		A= 1.20	B= 0.30	AB= 0.70			A= 1.20	B= 0.60	AB= 1.30	
Seeds yield (ton/ha.)										
Control	1.198	1.291	1.441	1.546	1.369	1.283	1.427	1.514	1.591	1.454
NPKRD	1.791	1.864	1.949	2.028	1.908	1.844	1.923	2.028	2.099	1.973
Com. 1	1.533	1.607	1.693	1.772	1.651	1.572	1.659	1.738	1.823	1.698
Com. 2	1.607	1.668	1.765	1.844	1.721	1.633	1.712	1.824	1.896	1.766
Com. 3	1.857	1.941	2.033	2.107	1.984	1.936	2.028	2.331	2.331	2.156
Mean (B)	1.597	1.674	1.776	1.859		1.653	1.750	1.887	1.948	
L.S.D $_{0.05}$		A= 0.097	B= 0.025	AB= 0.056			A= 0.094	B= 0.047	AB= 0.105	

Com. 1= 5, Com. 2= 10 and Com. 3= 15 ton/ha. of compost.

Volatile oil production

Table 5 shows how much volatile oil is made (volatile oil percentage, EO yield ml/plant, and liter/ha.). When compost was added at all stages during the two growing seasons, dill (*Anethum graveolens* L.) had a big effect. This coefficient went up gradually as the amounts of organic fertilizer went from 19.82 to 73.13 to 73.02 in the first season to 19.49 to 76.98 to 76.99 in the second season, compared to the control. **Ali and Hassan (2014)** on black cumin, **Hamdan (2008)** on anise, **Abdullah *et al.* (2012)** and **Hassan *et al*. (2015)** on rosemary and **Mostafa (2018)** results on dragonhead plant are similar to these results on organic fertility.

Table 5 displays the results of ascorbic acid applications, showing that foliar spraying with AA considerably enhanced the percentage of volatile oil and the output of volatile oil in ml/plant and liter/ha for both seasons, as compared to unsprayed plants. Both the total volatile oil output (l/ha) and the individual plant yield (ml/plant) were found to rise significantly when plants were sprayed with 200 ppm AA. As demonstrated in control's 6.91, 24.05, and 24.02 first season and 7.33, 26.46, and 26.38 second season, respectively. These fertilization results using organic materials are comparable to those obtained by **Ali *et al*. (2006)** on anise plant, **Ruta *et al.* (2012**) on dill plant and **Mostafa (2018)** on dragonhead plant.

Regarding the interplay between the two factors being examined, it was observed that there was a signifiacnt impact on all assessments of the volatile oil content in dill plants during both seasons. The data presented in Table 5 demonstrate that the inclusion of a high rate of compost with 200 ppm AA resulted in the most successful treatments in comparison to other treatments for both seasons.

Table (5). Effect of compost levels and ascorbic acid concentration on the volatile oil production of dill (*Anethum graveolens,* L.) plants during the 2021\2022 and 2022/2023 seasons

Compost (A)	Ascorbic Acid ppm (AA) (B)									
	0	50	100	150	Mean (A)	0	50	100	150	Mean (A)
	First season					Second season				
Volatile oil percentage										
Control	2.093	2.207	2.270	2.313	2.221	2.223	2.297	2.393	2.403	2.329
NPKRD	2.530	2.600	2.660	2.723	2.628	2.657	2.697	2.780	2.883	2.754
Com. 1	2.170	2.203	2.247	2.260	2.220	2.267	2.320	2.337	2.400	2.331
Com. 2	2.223	2.293	2.310	2.347	2.293	2.320	2.373	2.393	2.440	2.382
Com. 3	2.563	2.663	2.677	2.737	2.660	2.673	2.773	2.783	2.903	2.783
Mean (B)	2.316	2.393	2.433	2.476		2.428	2.492	2.537	2.606	
L.S.D $_{0.05}$	A= 0.051	B= 0.024	AB= 0.054			A= 0.049	B= 0.035	AB= 0.078		
Volatile oil ml/plant										
Control	0.319	0.361	0.414	0.454	0.387	0.363	0.415	0.459	0.484	0.430
NPKRD	0.574	0.614	0.657	0.700	0.636	0.621	0.657	0.714	0.767	0.690
Com. 1	0.422	0.448	0.482	0.508	0.465	0.453	0.488	0.515	0.556	0.503
Com. 2	0.453	0.485	0.517	0.549	0.501	0.480	0.515	0.553	0.586	0.533
Com. 3	0.603	0.656	0.690	0.731	0.670	0.655	0.712	0.821	0.857	0.761
Mean (B)	0.474	0.513	0.552	0.588		0.514	0.557	0.612	0.650	
L.S.D $_{0.05}$	A= 0.023	B= 0.008	AB= 0.018			A= 0.033	B= 0.017	AB= 0.038		
Volatile oil L /ha.										
Control	25.21	28.53	32.74	35.84	30.58	28.64	32.80	36.25	38.24	33.98
NPKRD	45.37	48.51	51.92	55.30	50.27	49.03	51.89	56.43	60.58	54.48
Com. 1	33.34	35.42	38.11	40.11	36.75	35.78	38.57	40.70	43.91	39.74
Com. 2	35.79	38.35	40.86	43.36	39.59	37.91	40.66	43.69	46.31	42.14
Com. 3	47.65	51.79	54.50	57.72	52.91	51.78	56.26	64.83	67.70	60.14
Mean (B)	37.47	40.52	43.63	46.47		40.63	44.04	48.38	51.35	
L.S.D $_{0.05}$	A= 1.793	B= 0.645	AB= 1.445			A= 2.621	B= 1.331	AB= 2.981		

Com. 1= 5, Com. 2= 10 and Com. 3= 15 ton/ha. of compost.

Volatile oil components

The results of the gas chromatographic analysis (GC/MS) of dill oil, which were obtained from the study, prove that it consists of (15) compounds. When comparing the values of the chemical compounds of the oil, we note that the compounds Carvone - Apiol - D-Limonene - α-Phellandrene have the highest percentages of volatile oil compounds compared to other compounds. The highest mean was for Carvone compound (40.61) in treatment (Com. 2+AA 150 ppm)، while the highest mean was for Apiol compound (31.10) in treatment (Com. 3+AA 150 ppm)، and the highest ratios were for compound D- Limonene (19.9) in treatment (Com. 3+AA 150 ppm)، while the highest percentage of α-Phellandrene compound (7.72) in treatment 10 tons of compost +AA 150 ppm). This shows the clear effect of the treatments in increasing the proportions of some of the main compounds of dill oil. Also, the treatments have a clear effect on some compounds, and this agrees with what was reached by **(Mahfouz *et al*. 2007) (Msaada et al 2007),** where they found an increase in the percentage of oil and the proportions of essential oil components by fertilization, and this is attributed to the integration between the two types of fertilization and its reflection on the provision of all nutrients to the plant, and this result is consistent with what the researcher **(Mahfouz *et al*. 2007)** said, that fertilization caused an increase in the compounds in the fennel plant.

Table (6). Effect of Compost levels and Ascorbic acid concentration on the volatile oil components of Dill (*Anethum graveolens*, L.) plants during the 2021\2022 and 2022/2023 seasons

No	Compound	R T	Treatments				
			Control	Com. 2+AA 100	Com. 2+AA 150	Com. 3+AA 100	Com. 3+AA 150
1	α-Pinene	6.365	0.54	0.50	0.42	0.37	0.34
2	Ethylhexanol	6.483	1.74	1.78	-	-	-
3	β-Pinene	7.744	0.34	0.29	-	0.32	0.40
4	α-Phellandrene	8.127	5.51	5.56	7.72	4.40	4.65
5	p-Cymene	8.671	0.79	0.82	1.00	0.47	0.69
6	D-Limonene	8.791	14.13	14.10	13.15	17.41	19.9
7	(+)-2-Bornanone	12.081	1.15	1.19	0.90	0.99	0.95
8	Dill ether	13.225	2.18	2.14	2.72	2.11	1.60
9	trans-Dihydrocarvone	13.752	3.22	3.31	3.05	3.27	2.60
10	Carvone	14.931	37.15	36.04	40.61	34.75	30.62
11	Piperitone	15.171	8.24	8.31	7.40	7.84	7.20
12	β-Caryophyllene	19.359	0.46	0.39	-	-	-
13	Apiol	24.446	20.40	21.33	22.83	28.1	31.10
14	2,6,10-Trimethyltetradecane	26.157	0.54	0.61	-	-	-
15	n-Hexadecanoic acid	26.844	2.80	2.80	-	-	-
Number of identified compounds			16		11	12	12
Total % of identified compounds			100		100	100	99.52

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