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Original Article

The efficiency of salicylic acid and poultry manure on growth and volatile oil production of *Coriandrum sativum* L. plants

Eficiência do ácido salicílico e do esterco de aves no crescimento e produção de óleo volátil de plantas de *Coriandrum sativum* L.

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Abstract

This research was conducted during the two experimental seasons 2021/2022 and 2022/2023 to explore the effect of salicylic acid (SA) concentrations at 0.75.150 and 300 ppm, fertilization of poultry manure (PM) on rats 0, 5, 10/ and 20 m^3/ha as well as their interactions on growth, yield and volatile oil components of Coriander (*Coriandrum sativum* L.). It resulted in a significant increase in plant growth traits in terms of plant height, number of branches, fresh and dry weed weight, number of threads, and seed yield per plant and hectare, when plants were treated with fine particles at a high concentration (300 ppm). While the highest values for volatile oil production were when spraying at a concentration of 200 parts per million, it was also proven that poultry manure at all levels was more effective in increasing the previously studied traits. All tested variables were significantly affected by the interaction coefficients. In this respect, most of the combination therapies significantly increased all aspects examined. Moreover, foliar application at 300 ppm SA plus high level (20 m^3/ha) was the most effective treatment for growth and yield characteristics while oil production was better at 200 ppm concentration with the same level of poultry manure. GC-MS analysis of the volatile oil indicated that poultry manure and foliar applications with salicylic acid concentrations also affected the major constituents. The combination of SA at 200 and 300 ppm plus PM at the higher level (20 m^3/ha) resulted in increased percentages of major components compared to the untreated plants and the other treatments.

Keywords: salicylic acid, poultry manure, coriander, *Coriandrum sativum* L.

Resumo

Esta pesquisa foi realizada durante as duas temporadas experimentais de 2021 a 2022 e de 2022 a 2023, com o objetivo de explorar o efeito das concentrações de ácido salicílico (AAS) a 0,75,150 e 300 ppm, a adubação com esterco de aves (PM) em ratos 0, 5, 10/ e 20 m^3/ha, bem como suas interações no crescimento, produtividade e componentes voláteis do óleo de Coentro (*Coriandrum sativum* L.). Tais análises resultaram em um aumento significativo nas características de crescimento das plantas em termos de altura da planta, número de ramos, peso fresco e seco das ervas daninhas, número de fios e rendimento de sementes por planta e hectare, quando tratadas com partículas finas em alta concentração (300 ppm). Embora os valores mais elevados para a produção de óleo volátil tenham ocorrido quando a pulverização foi feita numa concentração de 200 ppm, também foi comprovado que o esterco de aves em todos os níveis foi mais eficaz no aumento das características previamente estudadas. Todas as variáveis testadas foram afetadas significativamente pelos coeficientes de interação. Com relação à isto, a maioria das terapias combinadas aumentaram significativamente todos os aspectos examinados. Além disso, a aplicação foliar a 300 ppm de AAS, o mais alto nível (20 m^3/ha), foi o tratamento mais eficaz para características de crescimento e rendimento, enquanto a produção de óleo foi mais eficaz na concentração de 200 ppm, com o mesmo nível de esterco de aves. A análise GC-MS do óleo volátil indicou que o esterco de aves e as aplicações foliares com concentrações de ácido salicílico também afetaram os constituintes principais. A combinação de SA a 200 e 300 ppm mais PM no nível mais elevado (20 m^3/ha) resultou em percentagens aumentadas de componentes principais em comparação com as plantas não tratadas e em relação aos outros tratamentos.

Palavras-chave: ácido salicílico, esterco de aves, coentro, *Coriandrum sativum* L.

1. Introduction

Coriander, *Coriandrum sativum* L. plants are considered one of the most important medicinal and aromatic plants. It belongs to the Family Apiaceae (Umbellifera), widely grown in eastern Mediterranean countries. The coriander seeds contain 0.2-1.0% essential oil, which contains 65-70% linalool (coriander) and pinene the fruits are used for flavoring food products, pharmaceutics, and perfumes. Aromatic leaves of coriander are used as garnish and in

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salsas and guacamoles. They enhance the flavor of salads, tacos, and burritos. The essential oil of coriander is used for flavoring liqueurs and alcoholic beverages. Helps stimulate and increase digestive secretions useful as a carminative contributes to the treatment of intestinal disorders and has antispasmodic and expectorant properties. *Coriandrum sativum* contains various phytochemicals such as polyphenols, vitamins, and many phytosterols, which account for its properties including anticancer, anti-inflammatory, antidiabetic, and analgesic effects, The volatile oils extracted from the coriander plant are used in many food uses, meat and fish products, pickles, drinks, and desserts due to their distinct aroma and high activity against free radicals. Coriander plants also have significant hepatoprotective and antiangiogenic potential (Iqbal et al., 2018; Mahleyuddin et al., 2021).

South Asia is the world's greatest maker of coriander moreover a looming exporter to nations like the USA, the Middle East, the EU, also South East Asia. It grows best climates moreover it can grow in any type of soil like light, well-drained, moist, loamy soil, and also light to heavy black soil (Verma et al., 2011).

Salicylic acid (SA) has an important effect on the pathogenic defense response of many plant species. Where ascorbic acid is a mediator of the oxidative burst that leads to cell death in the hypersensitive response it serves as an important indicator of the development of systemic acquired resistance (Shirasu et al., 1997). There are also many studies demonstrating the key role of ascorbic acid in modulating plant response to many abiotic stresses (Yalpani et al., 1994; Senaratna et al., 2000). The known effect of ascorbic acid is to increase the temperature in thermogenic plants (Raskin et al., 1987). When treating mustard plants with exogenous ascorbic acid, improved their heat tolerance and adaptation to the surrounding climate (Dat et al., 1998). In maize plants, using ascorbic acid-induced antioxidant enzymes, in turn, increased the plants' cold tolerance (Janda et al., 1999). Recent studies have used transgenic Arabidopsis expressing the salicylate hydroxylase (Nah G) gene to reduce SA levels and monitor its response to ozone (O3). This event showed that ascorbic acid is important for O3 tolerance by maintaining the redox state within the cell and allowing for defensive responses (Sharma et al., 1996). However, using Cvi-0, an Arabidopsis genotype that accumulated high levels of SA, SA was shown to activate an oxidative burst and cell death pathway leading to O3 sensitivity (Rao and Davis, 1999).

Organic fertilizer is very important for the production of medicinal and aromatic plants in terms of quantity and quality in terms of clean agricultural production, and it is also very safe for human health and the environment. This is done by recycling organic waste such as plant and animal waste and food scraps in a controlled process. Excessive inorganic fertilizer affects soil structure. Hence, compost can act as a suitable alternative to mineral fertilizers to improve soil structure, plant nutrients (Dauda et al., 2008) and microbial biomass (Dhull et al., 2004). Recently, many organic fertilizers have been used in most countries of the world, and poultry manure is one of the organic fertilizers.

Poultry manure is available in many places and can be used well to produce vegetables and medicinal and aromatic plants. As poultry is applied to farmland, it serves as a source of macro- and micronutrients such as N and P for major crops (Nyakatawa and Reddy, 2000; Pederson et al., 2002). Poultry manure contains high concentrations of some trace elements such as copper, zinc, and acetic acid (Van der Watt et al., 1994; Moore et al., 1998). The high proportion of nitrogen and other nutrients in a balanced manner is the reason why poultry manure is the best type of natural organic fertilizer.

Organic fertilizer improves the chemical and physical properties of the soil, increases the fertility of sandy soil, reduces the loss of nutrients, and is a good source of nutrients for it. Therefore, organic fertilizer in general plays an important role in the growth, yield, and chemical components of many medicinal and aromatic plants. In this regard, Khalid and Shafei (2005) on dill plants, Salem and Awad (2005) and Gahory et al. (2022) on coriander plants, Beshr et al. (2006) on Silybum marianum plants, Rehab et al. (2009) on watercress and parsley plants, Harb et al. (2011) on black cumin plants, Khalid et al. (2014) Garden Eggs (*Solanum Melongena*). They found that compost had a positive response to the growth and chemical components of these plants.

2. Material and Methods

This experiment was conducted at the farm of the Muhammadiyah project, Ma'an, Jordan during two successive seasons 2021/2022 and 2022/2023 to study the effect of fertilization (poultry manure at rats 0, 5, 10, and 20 m^3/ha. and Salicylic acid (SA) concentrations at 0, 75,150, and 300 ppm, as well as their interactions on growth, yield, and volatile oil of coriander (*Coriandrum sativum* L.), four soil samples were randomly taken from the surface of the experimental soil (0-25 cm depth) before planting in order to identify the physical and chemical properties according to the methods of Black (1965) and Page et al. (1982). Data from soil analysis are presented in Tables 1 and 2.

2.1. Experimental design

The experiment distributed in a split plot in a randomized complete block design (RCBD) with three replicates was followed in this experiment. The main plot was Salicylic acid (SA) concentrations at 0, 75,150, and 300 ppm were sprayed three times, as follows: December 15th, December 30th, and January. 15th for the first, second, and third sprays, respectively, of the two experimental seasons. The plants were foliar sprayed till runoff. While fertilization poultry manure at rats 0, 5, 10, and 20 m^3/ha. were assigned as subplots poultry manure was added and mixed with the soil before sowing while preparing the soil for cultivation. Coriander seeds were sown on 5th November of bath season. Each sub-plot of 3.0 x 3.0 m contained 5 rows and 60 cm apart. The planting distance was 30 cm between plants. After 35 days from planting, the plants were thinned to two plants per hill. Before cultivation, all other agricultural practices were carried out as recommended. Data recorded at the first week of May, data were recorded for plant height (cm),

Table 1. Soil physical and chemical analysis of the experimental soil during the 2020/2021 and 2021/2022 seasons.

Soil properties		Season	
		2021/2022	2022/2023
Physical analysis	**Particle size distribution (%)**		
	Coarse sand	4.95	4.85
	Fine sand	75.55	75.65
	Silt	11.95	12.65
	Clay	7.55	6.85
	Texture class	Sandy	Sandy
Chemical Analysis	EC. dsm^{-1} (1:1 ex.)	0.91	0.88
	pH (1:1 w/v)	7.82	7.92
	Organic matter (%)	0.75	0.84
	Saturation capacity (%)	27.49	27.85
	EC. dsm^{-1} (1:1 ex.)	0.91	0.88
	Available nutrients (mg/kg)		
	N	50.4	52.3
	P	6.22	6.85
	K	87.8	85.6

Table 2. Chemical analysis of poultry manure during the 2021/2022 and 2022/2023 seasons.

Ser.	Component	Poultry manure	
		2021/2022	2022/2023
1	pH	7.8	8.4
2	E.C. (m. mhos/cm.)	2.28	2.33
3	Organic matter %	37.5	38.7
4	Organic carbon %	24.7	25.3
5	C: N Ratio	10: 1	11: 1
6	Total nitrogen %	2.9	3.2
7	Total phosphorus %	1.5	1.7
8	Total potassium%	2.55	2.64
9	Fe ppm	2820	2840
10	Mn ppm	355	362
11	Zn ppm	405	411
12	Cu ppm	39	46

E.C. = Electrical conductivity.

number of branches/plant, fresh and dry weights of herb (g), number of umbels/plant, seed yield/plant (g), and seed yield/ha. (Kg). Volatile oil %, volatile oil yield /ha. (L) were calculated and components of volatile oils.

Mature poultry manure was added and mixed with the soil before sowing during preparing the soil for cultivation.

2.2. Volatile oil isolation

Seeds were harvested from each treatment separately during the two growing seasons, and 100 gm was taken from each sample for all treatments (HD) for 3 hours using a Clevenger (1928) device. The volatile oil content was calculated as a relative percentage (v/w). In addition, the total volatile oil in ml/100 plants was calculated using dry weight. Essential oils extracted from A. abrotanum were collected during both seasons of each treatment and anhydrous sodium sulfate drying of chemically determined constituents.

2.3. Gas chromatography-mass spectrometry (GC-MS)

Some samples are superior in growth and yield was selected for analysis using gas chromatography (Agilent 8890 GC System), coupled to a mass spectrometer (Agilent

5977B GC/MSD) and equipped with an HP-5MS fused silica capillary column (30 m, 0.25 mm i.e. 0.25 film thickness). millimeter). The oven temperature was initially held at 50°C, then programmed from 50 to 220°C at a rate of 5°C/min and from 220°C to 280°C at a rate of 20°C/min, then held for 5 minutes at 280 Celsius. Helium was used as the carrier gas, with a flow rate of 1.0 mL/min. The essential oil was dissolved in diethyl ether (30 µl essential oil/ml diethyl ether), and then 1 µl of this solution was injected into the GC at a split ratio of 1:50. The injection temperature was 230 °C. Mass spectra were obtained in electron impact (EI) mode at 70 eV and a m/z scan range from 39 to 500 AM. Isolated peaks were identified by matching them with data from the mass spectra library (National Institute of Standards and Technology, NIST).Statistical analysis:

All obtained data were tabulated and statistically analyzed according to MSTATE-C (Michigan State University, 1986) and the means were compared using the L.S.D. test at 5% according to Mead et al. (1993).

3. Results and Discussion

3.1. Growth parameters

Data recorded in Table 3 reveal the effect of foliar application of Salicylic acid (SA) concentrations at 0,75,150 and 300 ppm on plant height (cm), number of branches/plant, fresh and dry weights of herb (g) of coriander (*Coriandrum sativum*L.) plants was significantly

Table 3. Effect of Salicylic acid, poultry manure (PM), and interaction on the growth of Coriander plants during the 2020\2021 and 2021/2022 seasons.

Salicylic acid (A)	Poultry manure (B)									
	Plant height (cm)									
	Control	PM 1	PM 2	PM 3	Mean(B)	Control	PM 1	PM 2	PM 3	Mean(B)
	First season					Second season				
Control	42.0	43.3	50.0	53.0	47.1	43.0	45.0	52.7	56.0	49.2
SA (1)	43.0	45.0	52.7	54.0	48.7	44.0	47.0	54.7	57.3	50.8
SA (2)	48.0	49.7	57.0	59.3	53.5	51.0	52.0	59.7	62.7	56.3
SA (3)	49.0	51.7	59.3	62.0	55.5	52.3	54.3	62.3	65.3	58.6
Mean(A)	45.5	47.4	54.8	57.1		47.6	49.6	57.3	60.3	
L.S.D 0.05	A:2.2 B:1.6 AB:3.2					AB:3.4 B:1.7 A:1.6				
	Number of branches/plants									
Control	3.8	4.6	5.1	5.4	4.7	4.2	5.3	6.0	6.0	5.4
SA (1)	4.1	5.1	5.5	5.8	5.1	4.5	5.7	6.5	6.7	5.9
SA (2)	4.4	5.5	6.1	6.1	5.5	4.7	6.3	7.0	6.8	6.2
SA (3)	5.2	5.7	6.3	6.7	6.0	5.9	6.6	7.3	7.7	6.9
Mean(A)	4.4	5.2	5.7	6.0		4.8	6.0	6.7	6.8	
L.S.D 0.05	A:0.8 B:0.7 AB:1.4					B:0.8 AB:1.6 A:1.0				
	Fresh weight (g/plant)									
Control	73.7	75.0	76.7	79.0	76.1	77.7	79.0	80.0	82.7	79.8
SA (1)	75.3	77.0	78.0	80.3	77.7	79.7	80.0	82.0	83.3	81.3
SA (2)	77.3	79.0	80.7	83.0	80.0	81.3	82.7	85.0	85.3	83.6
SA (3)	79.7	81.0	82.3	85.0	82.0	83.7	84.0	86.7	87.7	85.5
Mean (B)	76.5	78.0	79.4	81.8		80.6	81.4	83.4	84.8	
L.S.D 0.05	A:3.2 B:1.6 AB:3.2					AB:4.6 B:2.3 A:1.1				
	Dry weight (g/plant)									
Control	16.0	16.3	16.4	16.9	16.4	16.6	17.1	17.0	17.6	17.1
SA (1)	16.1	16.5	16.6	17.1	16.6	16.7	17.3	17.4	17.8	17.3
SA (2)	16.3	16.8	17.0	17.6	16.9	16.9	17.6	17.9	18.1	17.6
SA (3)	16.7	17.1	17.6	18.1	17.4	17.3	17.9	18.7	18.7	18.2
Mean(A)	16.3	16.7	16.9	17.4		16.9	17.4	17.8	18.1	
L.S.D 0.05	A:0.3 B:0.5 AB:1.0					A:0.5 B:0.5 AB:1.1				

PM 1 = 5; PM 2 = 10; PM 3 = 20 m^3/ha of poultry manure; SA (1) = 100; SA (2) = 200; SA (3) = 300 ppm.

increase compared to untreated in both season. However, the best growth resulted from spraying with SA (3) at 300 ppm. and SA (2) at 200 Generally, growth parameters enhanced gradually with increasing Salicylic acid concentrations.

The foliar application of salicylic acid at 300 ppm gave the best plant height (cm), number of branches/plant, fresh and dry weights of herb (g) by 17.83,27.66,7.75% and 6.10% in the first season and 19.11,27.78, 7.14 and 6.43% in the second season, respectively, over the control in both seasons.

These results are in accordance with those found by Gahory et al. (2022), Hekmat Massoud et al. (2016), Said-Al Ahi et al. (2014) and Hesami et al. (2012) on coriander plant, Talaat et al. (2014) on *Ammi visnaga*, Al-Shareif (2006) on caraway plants, Helmy (2008) on black cumin plants, Hemdan (2008) on anise plants and Ahmad et al. (2023) on Pea plant,

From the data presented in Table 3, it is clear that, poultry manure fertilization at rats 0, 5, 10, and 20 m^3/ha. on growth parameters coriander (*Coriandrum sativum* L.) plants were significantly increased compared to unfertilized in both seasons. However, the best growth resulted from fertilizing with poultry manure 20 m^3/ha. Generally, growth parameters were improved gradually with increasing poultry manure rates. The application of poultry manure at 20 m^3/ha. Gave the best growth by 25.49, 36.36, 6.93, and 6.74% in the first season, and 26.68, 41.67, 5.21, and 7.10% in the second season, respectively, over the control in both seasons.

These results are in accordance with those found by Gahory et al. (2022) and Ashwini and Jain (2017) on coriander plant, Yuonis et al. (2004) on *Ammi Visnaga*, Abd El-Latif (2002) on *carum carvi*, Mohamed and Ahmed (2003) on *Foeniculu vulgare*, Sharaf and Khattab (2004) on fennel, Sakr (2005) on *Cassia acutifolia* plants.

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 salicylic acid at 300 ppm in combination with poultry manure at the rate of 20 m^3/ha. Compared to the other combination treatments in this study in the first and second seasons.

3.2. Yield parameters

The obtained data in Table 4 demonstrate that the yield parameters of the coriander (*Coriandrum sativum* L.) plant highly significantly increased by using all salicylic acid treatments compared with the control (without foliar application). Furthermore, salicylic acid treatment of 300 ppm recorded the highest values of umbels number/plant, fruit yield per plant, and fruit yield per hectare compared to the other treatments in both seasons. Generally, yield parameters were increased gradually with increasing citric acid levels in the first and second seasons. The foliar application of salicylic acid at 300 ppm. and 200 ppm gave the best umbels number/plant, fruit yield per plant, and fruit yield per hectare by 17.78, 22.40%, and 21.76% in the first season and 20.83, 23.70 and 23.61 in the second season, respectively, over the control in both seasons.

These results are in line with those found by Gahory et al. (2022), Hekmat Massoud et al. (2016), Said-Al Ahi et al. (2014), and Hesami et al. (2012), and Coriander, Talaat et al. (2014) on khella, Abd El-Latif (2007) on borage, Abd El-al (2009) on sweet pepper, Ghaly and Abd El- Sayed (2009) on guar and Ahmad et al. (2023) on Pea plant.

Data presented in Table 4 show that, all poultry manure treatments highly significantly increased umbels number/plant, fruit yield per plant, and fruit yield per hectare compared to control in the two consecutive seasons. Moreover, yield parameters of coriander (*Coriandrum sativum* L.) were increased by using poultry manure fertilization at a rate of 20 m^3/hectare compared with the others ones under study by 32.94, 20.00 and 19.82% in the first season, and 29.33, 20.44 and 20.82% in the second season, respectively, over the control in both seasons.

These results are in harmony with those reported by Gahory et al. (2022), Ashwini and Jain (2017), Rekaby (2013) and Osman (2000) the coriander plant, Yuonis et al. (2004) on *Ammi visnaga*, Shoor et al. (2010) on *Nigella sativa* and Abd-El Naeem (2008) on caraway.

The data given in Table 4 suggest that yield parameters were increased by all combination treatments between salicylic acid treatments and organic fertilization rate compared to control (without organic and salicylic acid treatment) in both seasons. However, combination treatment between poultry manure at 20 m^3/ha. rate and 300 ppm salicylic acid level treatment increased yield parameters compared to the other combination treatments under study.

3.3. Volatile oil production

From the data presented in Table 5, it is clear that, in most cases, volatile oil percentage and yield volatile oil/Hectare (L) in coriander fruit highly significantly increased by using all salicylic acid concentrations compared with control (without foliar application). Furthermore, the volatile oil percentage and yield of volatile oil/Hectare (L) was increased with salicylic acid treatment of 200 ppm by 33.99 & and 62.69% and 35.80 & and 60.58% over control in the first and second seasons. Compared to the other concentrations in both seasons, respectively.

These results are in line with those found by Gahory et al. (2022), Said-Al Ahi et al. (2014), Hesami et al. (2012), and Hekmat Massoud et al. (2016) on coriander, Talaat et al. (2014) on khella, Abd El-Latif (2007) on borage, Abd El-al (2009) on sweet pepper, Ghaly and Abd El- Sayed (2009) on guar and Ahmad et al. (2023) on Pea plant. Al-Fraihat et al. (2023a) on black cumin (*Nigella sativa* L.) plants.

The obtained data in Table 5 demonstrate that all poultry manure fertilizer treatments highly significantly increased volatile oil percentage and yield volatile oil/Hectare (L) of coriander fruits compared to control in the two seasons. With, increasing poultry manure fertilizer rate from 20 m^3/ha. increased above mentioned parameters by 111.9 & 152.7% and 104.5 & and 144.4% over control in the first and second seasons. Compared to the other levels in both seasons respectively.

Table 4. Effect of Salicylic acid, poultry manure (PM), and interaction on the seed yield of Coriander plants during the 2020\2021 and 2021/2022 seasons.

Salicylic acid ppm(A)	Poultry manure m³/ha. (B)									
	Umbels number/plant									
	Control	PM 1	PM 2	PM 3	Mean(B)	Control	PM 1	PM 2	PM 3	Mean(B)
	First season					Second season				
Control	8.0	8.3	9.5	10.0	9.0	8.4	8.7	10.3	10.9	9.6
SA (1)	8.3	9.0	10.0	11.2	9.6	8.6	9.7	10.9	12.4	10.4
SA (2)	8.7	9.5	10.5	11.7	10.1	9.0	10.1	11.3	12.8	10.8
SA (3)	9.0	10.0	11.1	12.5	10.6	9.7	11.0	12.1	13.4	11.6
Mean(A)	8.5	9.2	10.3	11.3		8.9	9.9	11.1	12.4	
L.S.D 0.05	A:0.8 B:0.7 AB:1.4					AB:1.6 A:1.0 B:0.8				
	Seed yield/plant (g)									
Control	11.4	12.0	13.0	13.7	12.5	11.9	13.0	14.1	15.0	13.5
SA (1)	12.0	12.5	13.5	14.2	13.0	13.5	13.4	14.6	15.8	14.3
SA (2)	12.5	13.0	15.0	15.5	14.0	13.7	14.1	16.5	17.0	15.3
SA (3)	14.0	14.5	16.0	16.5	15.3	15.7	15.4	17.3	18.3	16.7
Mean(A)	12.5	13.0	14.4	15.0		13.7	14.0	15.6	16.5	
L.S.D 0.05	A:0.5 B:1.4 AB:2.8					A:0.7 B:1.5 AB:3.0				
	Seed yield/ Hectare (ton)									
Control	0.915	0.960	1.040	1.093	1.002	0.955	1.040	1.125	1.200	1.080
SA (1)	0.960	1.000	1.080	1.133	1.043	1.080	1.072	1.171	1.267	1.147
SA (2)	1.000	1.040	1.200	1.240	1.120	1.093	1.125	1.320	1.360	1.225
SA (3)	1.120	1.160	1.280	1.320	1.220	1.253	1.235	1.387	1.467	1.335
Mean (B)	0.999	1.040	1.150	1.197		1.095	1.118	1.251	1.323	
L.S.D 0.05	A:83.6 B:67.6 AB:135.1					A:72.3 B:80.9 AB:161.9				

PM 1 = 5; PM 2 = 10; PM 3 = 20 m³/ha of poultry manure. SA (1) = 100; SA (2) = 200; SA (3) = 300 ppm.

Table 5. Effect of Salicylic acid, poultry manure (PM), and interaction on the volatile oil production of Coriander plants during the 2020\2021 and 2021/2022 seasons.

Salicylic acid (A)	Poultry manure (B)									
	Volatile oil %									
	Control	PM 1	PM 2	PM 3	Mean(B)	Control	PM 1	PM 2	PM 3	Mean(B)
	First season					Second season				
Control	0.133	0.217	0.317	0.343	0.253	0.150	0.247	0.337	0.367	0.275
SA (1)	0.210	0.233	0.327	0.430	0.300	0.237	0.257	0.350	0.453	0.324
SA (2)	0.237	0.267	0.367	0.487	0.339	0.260	0.287	0.390	0.530	0.367
SA (3)	0.227	0.257	0.353	0.453	0.323	0.247	0.270	0.377	0.473	0.342
Mean(A)	0.202	0.243	0.341	0.428		0.223	0.265	0.363	0.456	
L.S.D 0.05	A:0.045 B:0.068 AB:0.136					A:0.052 B:0.052 AB:0.104				
	Volatile oil/Hectare (L)									
Control	1.23	2.08	3.33	3.76	2.60	1.44	2.59	4.05	4.40	3.12
SA (1)	2.03	2.35	3.55	4.88	3.20	2.56	2.77	4.11	5.79	3.81
SA (2)	2.69	3.09	4.72	6.43	4.23	3.28	3.55	5.41	7.79	5.01
SA (3)	2.27	2.67	4.27	5.65	3.71	2.72	3.07	4.99	6.45	4.31
Mean(A)	2.05	2.55	3.97	5.18		2.50	2.99	4.64	6.11	
L.S.D 0.05	A:0.80 B:0.41 AB:0.82					A:0.56 B:1.08 AB:2.16				

PM 1 = 5; PM 2 = 10; PM 3 = 20 m³/ha of poultry manure. SA (1) = 100; SA (2) = 200; SA (3) = 300 ppm.

Table 6. The interaction effect of farmyard manures and some bio-fertilizers on volatile oils components of coriander plants during the 2021/2022 season.

No	Compound	R T	control	Treatments			
				SA (2)+ PM 2	SA (2)+ PM 3	SA (3)+ PM 2	SA (3)+ PM 3
1	α-Pinene	6.37	4.22	6.33	4.17	6.11	6.16
2	β-Pinene	7.435	0.4	0.60	0.60	0.71	0.72
3	p-Cymene	8.676	-	4.50	4.29	4.10	4.3
4	D-Limonene	8.779	-	4.36	0.94	1.02	1.05
5	γ-Terpinene	9.603	8.62	9.58	11.33	10.36	11.45
6	Linalool	10.833	54.43	59.27	67.77	65.88	66.34
7	(+)-2-Bornanone	12.081	1.28	0.90	0.63	1.25	1.11
8	Terpinen-4-ol	12.985	0.57	--	--	0.62	0.56
9	Dill ether	13.225	3.88	--	--	-	--
10	Decanal	13.689	2.87	--	0.8	0.65	0.57
11	trans-Dihydrocarvone	13.746	0.49	--	--	-	--
12	(-)-Carvone	14.839	10.18	3.33		0.55	0.51
13	Geraniol	15.068	0.94	0.71	0.85	0.85	0.78
14	Piperitone	15.136	2.48	--	--	-	--
15	Geranyl acetate	18.467	5.32	5.63	7.39	7.22	5.97
16	2-Dodecenal	20.555	--	--	0.65	-	--
17	Apiol	24.4	5.15	4.77	0.59	-	--
Number of identified compounds			16	11	12	13	12
Total % of identified compounds			100	100	100	99.32	99.52

PM 1 = 5; PM 2 = 10; PM 3 = 20 m^3/ha of poultry manure. SA (1) = 100; SA (2) = 200; SA (3) = 300 ppm.

The stimulating effect of organic manure in increasing essential oil yield was reported by Gahory et al. (2022) on coriander plants, Ali et al. (2017) on fennel plants, Al-Fraihat et al. (2023b) on rosemary *Rosmarinus officinalis* L. plants, Abdullah et al. (2012), on rosemary *Rosmarinus officinalis* L. plants, Mansour et al. (2002) on spearmint and marjoram plants, Al-Fraihat et al. (2011) on marjoram plants, El-Gendy et al. (2001) on Sweet basil plants and Gharibe et al. (2008) on Marjoram (*Majorana hortensis*) Plant, Darwish et al. (2011) on *Salvia officinalis* plants.

Data of both seasons in Table 5 indicate a combination of foliar application by 200 ppm salicylic acid level and the addition of poultry manure at 20 m^3/ha. the rate increased volatile oil percentage and yield volatile oil/Hectare (L) compared to the other combination treatments under study in the first and second seasons.

3.4. Volatile oil components

The results of the GC/MS chromatography analysis of coriander oil, which were obtained from the study, prove that it consists of (17) compounds and shows the table of 4 chemical compounds of the pilot oil in the dry coriander fruits under the conditions of the study. When comparing the values of the chemical vehicles of the oil, we notice the distinction of Linalool - γ-Terpinene - α-Pinene - P-Cymene - Geranyl Acetate with the highest rates of pilot oil compounds compared to other vehicles in Table 6. The highest average of Linalool (67, 77) was at the transaction (12). (Upon transaction SA (2)+ PM 3, while the highest proportions of the P-Cymene (4,50) treatment for treatment SA (2)+ PM 2, and the highest proportions of the geranyl Acetate (7,39) were recorded for treatment SA (2)+ PM 3. This shows the clear effect of transactions in increasing the proportions of some of the main compounds of coriander oil. Also, transactions have a clear impact on some vehicles, and this corresponds to what (Mahfouz and Sharaf Eldin, 2007; Msaada et al., 2007), where they found an increase in the percentage of oil and the proportions Between the types of fertilization and its reflection on providing all the elements of the plant, and this result is compatible with what the researcher (Mahfouz and Sharaf Eldin, 2007) that fertilization is the latest increase in vehicles in the fennel plant.

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