

Optimizing Growth, Yield and Essential Oil Composition of Coriander (*Coriandrum sativum* L.) Through Integrated Compost Fertilization and Antioxidant Foliar Treatment

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ABSTRACT:

For examining the influence of various compost rates (0.0, 5.0, 10.0 and 20.0 ton/ hectare), various acid types (control as tap water, proline acid, ascorbic acid and proline + ascorbic acid each 100 ppm), an experimental field was established at Agric. Fac. experimental Farm, Misurata University, Libya during 2024/2025 year. The experimental design was split plot in three replicates. The main plots were compost rates, whereas, the sub-plot was occupied by proline and ascorbic acid. Any compost rate significantly enhances coriander height, branch number and plant fresh and dry weights, fruit yield per plant and per hectare as well as volatile oil yield characters compared to control. Moreover, the highest rate of compost (20 ton/ hectare) significantly produced the highest values in growth, fruit yield components and volatile oil production compared to control and the lowest rates under study. In the same time, any acid sources under study significantly improve coriander growth and productivity compared to control plants. The best results in this regard was noticed when coriander plants sprayed with proline + ascorbic acid treatment. In general, the profitable treatment in enhance coriander growth and fruit yield and volatile oil productivity was 20-ton compost/ hectare combined proline + ascorbic acid type. The major compound detected by GC-MS in coriander volatile oil were Beta-Myrcene, L-Linalool followed by Trans-beta-Ocimene and Beta-Ocimene.

Keywords: Coriander, compost, proline, ascorbic, growth, yield, volatile oil.

1. Introduction

The Apiaceae family, which includes coriander (*Coriandrum sativum* L.), is indigenous to the Mediterranean region, southern Europe and Asia, but it has spread to far too several other regions of the world. Coriander is a semi-erect to upright, short-season annual plant grown for its delicate leaves and dried, fragrant fruits (Anonymous, 1975). The year-round demand for

fresh coriander leaves necessitates improved plant growth and development, which raises the amount of foliage produced throughout the cool season (Behera et al., 2022). Coriander plant has been utilized as a flavoring in cosmetics, fragrances, and culinary items. Fruits of coriander have been used medicinally to treat anxiety, convulsions, sleeplessness and dyspeptic symptoms (Emamghoreishi et al., 2005).

The flavor and aroma qualities of coriander grown using organic manure are typically superior. Compost is example of organic manure that gives coriander plants vital nutrients. These minerals, which include potassium, phosphorus and nitrogen as well as several micronutrients, are essential for the growth and development of plants. These elements impact of organic manures on coriander growth and its productivity (Ghosh and Ghosh, 2014). Several researchers, including Kamal et al. (2023), Ibrahim et al. (2023) and Nath (2024), found that adding compost to the soil promoted several growth traits and chemical elements of coriander plants. Furthermore, Mishra and Khatoon (2025) reported that fertilized coriander plants with organic fertilizers significantly increased plant growth and fruits yield compared to control.

Proline plays a critical role in protein synthesis, a serious osmotic regulator and plants growth and development under abiotic stresses (Furlan et al., 2020 & Tong-Lu et al., 2022). Proline is essential for both stress tolerance and osmotic adjustment. Moreover, Poorghadir et al. (2020) pointed out that the highest values of savory (*Satureja hortensis* L.) growth and essential oil percentage were recorded in the 1.5 g/l proline treatment. In addition, Gao et al. (2025) indicated that foliar application of proline enhanced the aromatic compounds accumulation in petioles and leaves of celery (*Apium graveolens* L.). Under both favorable and unfavorable climatic conditions, ascorbic acid as foliar spray has synergistic influences on fruit yield, growth and volatile oil yield. Likewise, Matter (2009) on fennel

plants demonstrated that sprayed plant with ascorbic acids (200 ppm) significantly improved the growth, yield of fruits and oil yield compared to control. Also, Alamyel et al. (2023) showed that using ascorbic acid foliar application at 150 ppm on dill plants led to a significant augment in plant height, plant weights, umbels number and fruits yield and volatile oil production compared to control. Thus, the main aim of this study was to determine coriander growth and productivity as affected by compost, proline as well as ascorbic acid and their combinations on coriander (*Coriandrum sativum* L.) plants.

2. Methodology

At experimental farm of Agricultural Research Station, Misurata, Libya during 2024/2025 year, a field experiment was done to enhance coriander growth, fruits yield and production of volatile oil by utilizing compost and some acid types (proline or/ and ascorbic acids). Coriander fruits were sown at 24th October. Then the plants were thinned to two plants per hill fifteen days from the date of sowing. Each experimental area had six rows spaced 60 cm apart and measured 4.0 × 3.60 m. The distance between hills was 30 cm. The standards set by the growers of coriander plants in the test region were followed in all other agricultural practices. As indicated in Table (1), random soil samples were collected from the experimental field area at a depth of 0–30 cm prior to sowing in order to evaluate the physical and chemical parameters of the soil in accordance with Chapman and Pratt (1978).

Table 1. Initial physical and chemical properties of the experimental soil profile (0-30 cm depth) at the Misurata city (2024-2025)

Physical analysis										Soil texture		
Clay (%)		Silt (%)		Fine sand (%)			Coarse sand (%)			Sandy		
5.62		3.80		81.38			10.20					
Chemical analysis												
pH	E C m.mohs /cm	Organic mater (%)	Soluble cations (meq./ L)				Soluble anions (meq. /L)			Available (ppm)		
			Mg++	Ca++	K +	Na+	Cl-	HCO3-	SO4- -	N	P	K
7.95	1.24	2.11	2.25	1.31	3.12	3.42	3.60	1.18	5.23	53.8	70.3	11.2

The sixteen treatments, which included four rates of compost as organic fertilizer as main plots and four acid kinds as foliar sprays as subplots, were arranged in a split-plot design with four replicates. Moreover, the main plots were compost treatments which included (0.0, 5.0, 10.0 and 20.0 ton/ hectare). Whereas, subplots were four acid types as follow: control, proline acid, ascorbic acid and proline acid + ascorbic acid. Different compost rates were added to the soil at soil preparation. However, different acid types each at 100 ppm were sprayed three times / season, after 35, 55 and 75 days after sowing. Control plants sprayed in the same time with tap water.

Growth measurements

Twenty days after the final foliar spray, the following parameters were measured as; Plant height (cm), number of branches/plant, coriander fresh weight per plant and dry weight per plant (g).

Yield components

At harvesting the following parameters were determined as; umbels number per coriander plant, fruit yield per plant (g) and fruit yield per hectare (+ ha -1).

In addition, the volatile oil production per plant (ml) and volatile oil yield per hectare (l) were computed after Guenther's (1961) percentage of volatile oil.

Gas chromatography–mass spectrometry analysis (GC-MS)

The GC-MS system (Agilent Technologies) was equipped with gas chromatograph (7890B) and mass spectrometer detector (5977A) at Central Laboratories Network, National Research Centre, Cairo, Egypt. The GC was equipped with VF-624ms column (30 m x 250 µm internal diameter and 1.4 µm film thickness). Analysis was carried out using Hydrogen as the carrier gas at a flow rate of 1.00 ml/min at a splitless, injection volume of 1.0 µl and the following temperature program: 40 °C for 0 min; rising at 6 °C /min to 200 °C and held for 0 min; rising at 15 °C /min to 220 °C and held for 0 min; rising at 30 °C /min to 250 °C and held for 2 min. The injector and

detector were held at 250 °C. Mass spectra were obtained by electron ionization (EI) at 70 eV; using a spectral range of m/z 33-600 and solvent delay 3.50 min. The mass temperature was 230°C and Quad 150 °C. Identification of different constituents was determined by comparing the spectrum fragmentation pattern with those stored in Wiley and NIST Mass Spectral Library data.

Statistical Analysis

The Statistix Version 9 (Analytical Software, 2008) computer program was used to statistically analyze the data from the current study. Variation between the treatment means (compost rates and acid types) were considered significant when they were greater than the least significant differences (L.S.D.) at the 5% level, using Duncan's multiple range test (Duncan, 1955).

3. Results and Discussion

Coriander growth

Results recorded in Table 2 indicate that there are gradual increases in coriander height, number of branches and plant dry and fresh weights by increasing compost rate from 5, 10 to 20 tons/ hectare. The highest values in this regard (72.50 cm, 18.13 branches, 105.87 and 25.03 g / plant, gradually) were achieved when coriander plants fertilized with 20 tons/ hectare compared to the other rates under study. Generally, any compost rate significantly enhanced coriander growth traits compared to control. This could be because enriched compost improves the physical, chemical, and biological characteristics of the soil and provides a sufficient supply of N, P, K and some micronutrients during the plant growth period through organic fertilizer (Mathukia et al., 2020). Likewise, Abd EL- Kafie et al. (2020) and Kamal et al. (2023) on coriander found similar results

The obtained results showed that various acid types gave significant effect on coriander growth (Table 2). The treatment (produced significantly the highest plant height (64.31 cm), branches number per plant (16.50), plant fresh weight (96.13 g) and plant dry weight (23.20 g) compared to control and the individual type of

each proline and ascorbic acids. Moreover, spraying coriander plants with proline acid alone, ascorbic acid alone or in combination (proline + ascorbic acids) significantly enhanced plant growth traits compared to untreated plants. Gruszecki et al. (2022) reported that spraying parsley plants by 1000 mg/l of proline acid significantly increased total yield of root compared to control. Also, Magdi et al. (2025) reported that spraying coriander plants by 200 ppm of ascorbic acid gave the highest values of plant growth.

Regarding of the combination between compost and different acid types, it is clear that the produced the highest values for coriander height (76.25 cm), branches number per plant

(20.50) and plant fresh (113.50 g) and dry (27.00 g) weights when were plants fertilized with 20 tons / plant and sprayed with proline + ascorbic acids compared to the other combination treatments under study (Table 1). Under any acid type, increasing compost rate gradually enhanced plant growth traits. When compost as well as proline or/and ascorbic acids combined, they may have the better influence, producing more fresh and dry weights of coriander plant. These findings are consistent with the compost influence of fennel that was described by Abd EL- Kafie et al. (2020) as well as Gruszecki et al. (2022) on parsley concern proline and Magdi et al. (2025) on coriander concern ascorbic acid influence.

Table 2. Influence of varying compost rates and foliar-applied antioxidant signaling (proline and ascorbic acid) on the vegetative growth characteristics (plant height and biomass) of *Coriandrum sativum* L. (season 2024-2025)

Treatments Ton /ha		Plant height (cm)	Number of branches / plant	Plant fresh weight (g)	Plant dry weight (g)
		Influence of compost rate (ton/ hectare)			
Control 0+ ha -1		50.19 D	10.84 D	80.63 C	18.81 D
5+ ha-1		57.69 C	14.13 C	81.88 C	20.05 C
10+ ha-1		65.44 B	15.31 B	96.50 B	22.50 B
20+ ha-1		72.50 A	18.13 A	105.87 A	25.03 A
		Influence of acids application (100 ppm of each)			
Control		58.81 D	12.47 D	86.69 D	19.97 D
Pro		60.56 C	14.06 C	89.69 C	21.17 C
AA		62.13 B	15.38 B	92.38 B	22.05 B
Pro + AA		64.31 A	16.50 A	96.13 A	23.20 A
		Influence of combination between compost rate and acids application			
Control	Control	48.00 o	8.88 k	77.25 j	17.63 m
	Pro.	49.75 n	10.50 j	79.50 h-j	18.38 l
	AA	50.75 m	11.50 i	82.00 f-h	18.94 jk
	Pro. + AA	52.25 l	12.50 gh	83.75 fg	20.31 hi
5+ha-1	Control	55.50 k	12.50 gh	79.00 h-j	18.63 kl
	Pro.	57.00 j	13.50 fg	81.00 g-i	19.56 ij
	AA	58.25 i	14.75 e	82.50 f-h	20.50 h
	Pro. + AA	60.00 h	15.75 d	85.00 f	21.50 fg
10+ha-1	Control	62.50 g	13.50 fg	92.00 e	21.00 gh

20+ha-1	Pro.	64.25 f	14.50 ef	94.50 e	22.00 ef
	AA	66.25 e	16.00 d	97.25 d	23.00 d
	Pro. + AA	68.75 d	17.25 c	102.25 c	24.00 c
	Control	69.25 d	15.00 de	98.50 d	22.63 de
20+ha-1	Pro.	71.25 c	17.75 c	103.75 c	24.75 c
	AA	73.25 b	19.25 b	107.75 b	25.75 b
	Pro. + AA	76.25 a	20.50 a	113.50 a	27.00 a
	Control	69.25 d	15.00 de	98.50 d	22.63 de

Pro= Poline. AA= Ascorbic acid.

Fruit yield components

Results in Table 3 reveal that the coriander plants fertilized with 20/hr ton compost gave the maximum values umbels number per plant (25.88). In addition, the coriander plants fertilized with the highest rate of compost recorded the best

results for fruit yield per plant (23.69 g) and per hectare (1.895 ton). In general, all compost rates significantly enhanced fruit production of plant and hectare compared to control. The previous findings indicated a rise in the characteristics of coriander output.

Table 3. Impact of integrated soil-compost amendments and dual-acid bioastimulants on umbels, fruit yield and harvest index of *Coriandrum sativum* L.

Treatments		Number of umbels / plant	Fruit yield / plant (g)	Fruit yield / hectare (ton)
Influence of compost rate (ton/ hectare)				
Control		17.00 D	16.00 D	1.280 D
5		19.56 C	17.69 C	1.415 C
10		22.38 B	19.88 B	1.590 B
20		25.88 A	23.69 A	1.895 A
Influence of acids application (100 ppm of each)				
Control		19.44 D	17.72 D	1.418 D
Proline acid (Pro)		20.75 C	18.78 C	1.503 C
Ascorbic acid (AA)		21.75 B	19.78 B	1.583 B
Proline + Ascorbic acids		22.88 A	20.97 A	1.678 A
Influence of combination between compost rate and acids application				
Control	Control	15.50 m	14.50 m	1.160 m
	Pro.	16.50 l	15.50 l	1.240 l
	AA	17.50 k	16.50 jk	1.320 jk
	Pro. + AA	18.50 ij	17.50 hi	1.400 hi
5	Control	17.75 jk	16.13 kl	1.290 kl
	Pro.	19.00 i	17.13 ij	1.370 ij
	AA	20.00 h	18.13 gh	1.450 gh
	Pro. + AA	21.50 fg	19.38 f	1.550 f
10	Control	20.50 gh	18.25 g	1.460 g

20	Pro.	22.00 f	19.25 f	1.540 f
	AA	23.00 e	20.25 e	1.620 e
	Pro. + AA	24.00 de	21.75 d	1.740 d
	Control	24.00 de	22.00 d	1.760 d
20	Pro.	25.50 c	23.25 c	1.860 c
	AA	26.50 b	24.25 b	1.940 b
	Pro. + AA	27.50 a	25.25 a	2.020 a
	Control	24.00 de	22.00 d	1.760 d

This rise could be the consequence of the plant absorbing more vital nutrients. Additionally, compost aids in the soil's absorption and retention of water (LeaMaster et al., 1998). Moreover, by improving the soil's structure and facilitating cultivation, composting promotes the growth of roots, supplies them with nutrients, and allows plants to absorb more of them (Rashed and Darwesh, 2015). Furthermore, Gahory et al. (2022) pointed out that adding compost at a 12 m³/hr rate resulted in the greatest increases in coriander fruit yield per plant and per hectare.

When coriander plants sprayed with proline acid and ascorbic acid at 100 ppm of each recorded the best results for number of umbels per plant (22.88), fruit yield per plant (20.97 g) and per hectare (1.678 ton) compared to control and acid as solely type. Using proline acid, ascorbic acid or proline + ascorbic acids as foliar spray significantly recorded the highest values compared to control. In comparison to unsprayed plants, Poorghadir et al. (2020) found that foliar treatment of proline and phenylalanine at a 1500 ppm concentration was the most effective for total yield in *Satureja hortensis* plants. Also, Gahory et al. (2022) found that the best results in fruit yield per plant and feddan of coriander plants were exposed with ascorbic acid at 200 ppm as a foliar spray.

As for the combination between compost and proline and/ or ascorbic acid, it is recorded that the better result for umbels number (27.50) and fruits yield per plant (25.25 g) as well as fruit yield per hectare (2.020 tons) in (20-ton compost per hectare and proline + ascorbic acids) compared to control and the other ones under study (Table 3). Generally, under any acid type,

increasing compost rates from 5, 10 to 20 tons/ hectare gradually enhanced fruit yield components of coriander plants. In addition, the optimal combined treatment, according to Ibrahim et al. (2023, a), is to treat the soil with compost at a rate of 25.0 m³ ha⁻¹ before to feverfew cultivation and concurrently spray the plants with proline at a rate of 100 mg L⁻¹ during their life span.

Volatile oil production

As shown in Table 4 it is clear that the compost rate treatments i.e., 5.0, 10.0 and 20 ton/ hectare, all of them gained more volatile oil production (volatile oil %, its yield per plant and per hectare) as compared to control. Moreover, within the untreated group; the lowest values of volatile oil % (0.309 %), volatile oil yield/ plant (0.050 ml) and per hectare (3.977 l) of coriander plants were obtained by coriander plants without compost application. On the other hand, the highest values in this connection (0.425 %, 0.101 ml/plant and 8.091 l/ hectare) were noticed when coriander plants fertilized with 20 ton/ hectare compared to the other treatments under study. In the same line, Ibrahim et al. (2023, b) revealed that the compost treatment (30.0 m³. ha⁻¹) was the superior for obtaining the maximum values of oil % and oil yield per plant. Also, Kamal et al. (2023) demonstrated that fertilized coriander by 30 m³/ hectare gave the highest values of volatile oil production,

The highest volatile oil (%) value (0.386 %) was obtained when coriander plants sprayed with proline + ascorbic acids which followed by ascorbic acid (Table 4). Coriander plants sprayed with proline acid + ascorbic acid significantly enhanced volatile oil yield per plant (0.101 ml) and per hectare (6.601 l) compared to the other ones

under study. All acid types under study significantly gave the best results concern volatile oil production. Additionally, proline and ascorbic acids, which function as antioxidants and enzyme cofactors and support numerous physiological

processes like cell wall development and expansion, photosynthesis, and tolerance to environmental challenges, may reflect in the improvement of growth and fruit yield (Ibrahim et al., 2019; Saha et al., 2020).

Table 4. Quantitative evaluation of volatile oil percentage and total oil yield in *Coriandrum sativum* L. as influenced by organic fertilization and exogenous biostimulants

Treatments		Volatile oil content (%)	Volatile oil yield per plant (ml)	Volatile oil yield per hectare (l)
Influence of compost rate (ton/ hectare)				
Control		0.309 D	0.050 D	3.977 D
5		0.338 C	0.060 C	4.806 C
10		0.373 B	0.074 B	5.952 B
20		0.425 A	0.101 A	8.091 A
Influence of acids application (100 ppm of each)				
Control		0.333 D	0.060 D	4.809 D
Proline acid (Pro)		0.356 C	0.068 C	5.458 C
Ascorbic acid (AA)		0.370 B	0.074 B	5.959 B
Proline + Ascorbic acids		0.386 A	0.101 A	6.601 A
Influence of combination between compost rate and acids application				
Control	Control	0.285 l	0.041 m	3.310 m
	Pro.	0.305 k	0.048 l	3.790 l
	AA	0.318 j	0.053 jk	4.193 jk
	Pro. + AA	0.330 i	0.058 hi	4.618 hi
5	Control	0.313 jk	0.051 kl	4.038 kl
	Pro.	0.333 i	0.057 ij	4.560 ij
	AA	0.348 h	0.063 gh	5.040 gh
	Pro. + AA	0.360 fg	0.070 f	5.588 f
10	Control	0.350 gh	0.064 g	5.113 g
	Pro.	0.370 f	0.071 f	5.700 f
	AA	0.380 e	0.077 e	6.158 e
	Pro. + AA	0.393 d	0.086 d	6.838 d
20	Control	0.385 de	0.085 d	6.775 d
	Pro.	0.418 c	0.097 c	7.783 c
	AA	0.435 b	0.106 b	8.445 b
	Pro. + AA	0.463 a	0.117 a	9.360 a

Regarding of the combination between compost and different acid types, it is clear that the produced the highest values for volatile oil

percentage (0.463 %), volatile oil yield per plant (0.117 ml) and per hectare (9.360 l) weights when were coriander plants sprayed with 20 tons / plant

and sprayed with proline + ascorbic acids compared to the other combination treatments under study (Table 4). Under any acid type, increasing compost rate gradually enhanced volatile oil production traits. The enhancement of volatile oil production might be attributed for improving coriander growth and fruit yield components by adding compost which improving the soil chemical and physical properties, i.e.; soil aggregation, soil structure, hydraulic conductivity, porosity, water holding capacity, microbial activity, soil pH and air exchange (Adugna, 2016). Moreover, Ali et al. (2017) found that using 24 m³ compost /feddan combined with 100 ppm ascorbic acid resulted better fennel growth and higher volatile oil.

GC/MS analysis of volatile oil

Volatile oil Analysis extracted from fruits of coriander detected from control treatment and the other best treatment for volatile oil production is presented in Table 5. Fifteen compounds were noticed in volatile oil of control, while fourteen

compounds were detected in volatile oil when coriander plants treated with 10 ton compost + ascorbic acid as well as 20 ton compost + proline acid treatments. Also, there are thirteen compounds were detected in volatile oil when coriander plants treated with 20 ton compost + ascorbic acid as well as 20 ton compost combined with proline + ascorbic acid treatments. Whereas, the lowest compounds number were noticed in 10 ton compost + Proline + ascorbic acids treatment. The major compound detected by GC-MS in coriander volatile oil were Beta-Myrcene, L-Linalool followed by Trans-beta-Ocimene and Beta-Ocimene. Whenever, the lowest values were noticed regard Sabinene, 3-Carene, Alpha-Terpinene and (+)-2-Bornanone. Furthermore, Decanal, 2, 3-Nonadiene and Farnesol were not detected in volatile oil of coriander fruits when plants treated with 10 ton compost combined with proline + ascorbic acids. However, Apinol compound detected only in volatile oil of control treatment.

Table 5. Comparative chemical characterization of major and minor volatile constituents under optimized compost and biostimulant treatments

Identified compounds	Treatments					
	Control %	10 ton compost + AA. %	10 ton compost +Pro. + AA. %	20 ton compost + Pro. %	20 ton compost + AA. %	20 ton compost +Pro. + AA. %
Alpha.-Pinene	1.23	0.9	2.01	1.19	1.79	1.59
Beta-Myrcene	35.04	34.1	36.86	31.15	30.03	26.84
Sabinene	0.1	0.12	0.23	0.13	0.29	0.1
3-Carene	0.22	0.22	0.35	0.34	0.28	0.23
Trans-beta-Ocimene	10.14	12.8	15.69	13.95	12.99	11.57
Beta-Ocimene	10.76	14	15.66	14.04	12.6	11.33
Gamma.-Terpinene	1.21	2.03	4.42	2.99	3.63	3.63
Alpha-Terpinene	0.63	0.58	1.04	0.61	0.63	0.6
L-Linalool	38.4	33.48	22.46	34.46	36.35	42.75
(+)-2-Bornanone	0.54	0.39	1.29	0.6	1.05	0.83
Decanal	0.13	0.17	--	0.1	0.13	0.16
2,3-Nonadiene	0.27	0.04	--	0.06	0.07	0.1
Farnesol	0.06	0.34	--	0.28	0.16	0.25

2,6-Nonadien-1-ol	0.48	0.83	--	0.09	--	--
Apiol	0.77	--	--	--	--	--

4. Conclusion

In the current study the results referred to that, treating coriander plant with 20 ton / hectare of compost before sowing and sprayed three

times/ season with 100 ppm of proline and ascorbic acids improved coriander growth, fruit and volatile oil yields. The main compounds of coriander volatile oil were Beta-Myrcene, L-Linalool, Trans-beta-Ocimene and Beta-Ocimene.

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