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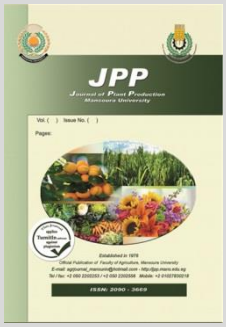
Improving Growth, Yield and Oil Productivity of Rosemary Plants Grown in Sandy Calcareous Soil by Using some Manures Organic Tea and Salicylic Acid

Ahmed, A. F.* and Abeer M. Shehata

Medicinal and Aromatic plants Researches Dept., Horticulture Research Institute, Agricultural Research Center, Egypt.



ABSTRACT

In order to study the response of rosemary plants grown in sandy calcareous soil to soil application of three organic manures tea namely, tea compost, pigeon manure tea and chicken manure tea and spraying with salicylic acid (SA) at 100, 200, 300 and 400 ppm, as well as their interactions. A field experiment was achieved in new reclamation sandy soil located at El-Shiak Fadl Village Beni-Mazar District, Minia Governorate, Egypt, during 2021 and 2022 seasons. The obtained results show that, vegetative growth, nutritional status, essential oil content, essential oil yield/plant and oil main components were significantly improved because of treated the plants with the three organic manures tea and SA treatments. In this concern the companied application of manures tea and SA were more effective than using each compound alone. The plants received pigeon manure tea combined with spraying SA at 400 ppm present the brightest results, while non-significant differences were observed between the two higher concentrations of SA (300 ppm and 400 ppm). Then, accordingly the obtained results we can recommend treating the rosemary plants grown under sandy calcareous soil with organic manure tea and spraying SA at 300 ppm three times yearly.

***Keywords*:** rosemary, organic manure tea, Salicylic acid, sandy calcareous soil.

INTRODUCTION

Rosemary (*Rosmarinus officinalis* L.) is one of the most important an evergreen aromatic herb. It is native to the Mediterranean regions (Shehata *et al*., 2019), South America, Northern Africa, Mexico and USA (Tawfeeq, 2017). Currently, its cultivation is spread in most countries all over the world and it is considered as one of the most important medicinal and aromatic plants in the world. The great importance of this plant due to it contains of essential oil. This essential oil has many important uses such as pharmaceutical industries, perfume manufacture and cosmetic compounds (Singh and Guleria, 2013; Tawfeeq, 2017 and Shehata *et al*., 2019). It is well reported that, Rosemary plant has a several medical characteristics such as carminative, stomachic, nervine spasmodic, stimulant (Al-Sereiti *et al*., 1999; Tawfeeq, 2017 and Shehata *et al*., 2019). Furthermore, the leaves have antioxidant properties and also it uses as Salmonella infection control in meat products (Singh and Guleria, 2013; Donald and McKeague, 2015).

In Egypt, through an ambitious plan set by the ministry of Agriculture to cultivate a large sector of newly reclaimed desert lands, which are characterized by a lack of organic matter and high level of calcareous (in term of active lime content) with a limited amount of water. Then, the role of using the organic fertilization to reduce these constraints emerges is an imperative. One of the most modern and harmless organic fertilization, uses in worldwide, is using the extracted of fermented manure organic fertilizers, also called manure organic tea (Mahmoud, 2011 and Omar *et al*., 2012). An addition to using organic manure tea as improving of physical properties of the soil, the organic manure is a safety source of mineral nutrients for cultivated plants (Mahmoud, 2011). Liquid organic manure teas are simply liquid extracts rich in the mineral nutrients, organic compounds, some growth retardants and beneficial micro-organisms (Omar *et al*., 2012; Donald and McKeague, 2015). This liquid tea can be uses through fertigation systems, as foliar sprays or as a soil application.

Some of the interesting of the previous researches have shown that, the use of organic fertilizers tea ensures many benefits for the soil properties and the plant growth and productivity, which can be summarized in the following lines: It suppresses diseases in organic agriculture systems (Haggag and Saber, 2007). Stimulation of root growth and development of plants (Hibar *et al*., 2006); it significantly increases the yield and fruit quality of plants (Gomaa, 2020). Spraying organic fertilizers tea enhancing the main leaves pigments chlorophyll and macro nutrients content (Ghobrial *et al*., 2009) and organic fertilizers tea considered as a good source of antioxidants (Donald and McKeague, 2015).

Calcareous stress considered as a major agricultural limiting factor, especially in new reclamation desert land, and may by influence several plant cultivation success as well as chemical composition and bioactivity of rosemary essential oil (El-Esawi *et al*., 2017). In this concern, spraying salicylic acid (SA), as growth regulator has an antioxidant effect, can limits the harmful effect of calcareous stress on rosemary plants as well as enhancing the chemical composition of essential oil.

In the present investigation focused on using of three organic fertilizers tea namely: plant compost tea, pigeon manure tea and chicken manure tea as a soil application and

* **Corresponding author.**
E-mail address: adelfahmi_2008@yahoo.com
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SA, as foliar spraying, at four gradual concentrations (100, 200, 300 and 400 ppm) on growth, yield and essential oil of rosemary (*Rosemary officinallis* L.*)* plants, grown under sandy calcareous soil were examined.

MATERIALS AND METHODS

The current study was carried out during two successive experimental seasons 2021 and 2022 at privet farm located at El-Shiak Fadl Village, Beni-Mazar District, Minia Governorate, Egypt. Rosemary plants were cultivated in sandy calcareous soil. Then, the plant samples were analyzed in Medicinal and Aromatic Plants Laboratory in Sides Research Station Ben- Suief Governorate, Agricultural Research Center. Before the starting of the experiment, composite soil and water samples were collected and analyzed. The data of physic-chemical analysis of soil and water samples are shown in Table 1.

Table 1. physical and chemical analysis of soil and water samples

Soil analysis		Irrigation water analysis	
Character	**Value**	**Character**	**Value**
Sand %	80.1	E.C (µS/cm)	759
Silt %	11.4	Hardness	16.5
Clay %	8.5	pH	7.66
Organic matter %	0.94	Ca (mg/L)	31.5
Total N %	0.07%	K (mg/L)	7.03
pH level	8.79	Na (mg/L)	78.9
Active lime	$CaCO_3$ %19.2	Alkalinity (mg/L)	182
E.C. "m. mhos/cm"	2.88	Chlorides (mg/L)	121
Available P ppm	11.3	Nitrate (mg/L)	11.0
Exch. K+ mg/100 g	3.09	Sulphates (mg/L)	53.1

Plant materials and experimental design

Rosemary soft cuttings were obtained from the Medicinal and Aromatic Plants Department, Sides Research Station (Beni Suief Governorate). These cuttings were grown under greenhouse conditions at the beginning of October 2020. Then, the seedlings were transferred and transplanted in the experimental field in mid-March, during the two experimental seasons. The present experiment was arranged in randomized complete block design (RCBD), in the form of split plots design (Snedecor and Cochran, 1990). Where, the organic manures tea placed in the main plots, while salicylic acid (SA) occupied the split plots. The experimental plot area in field was 3.0 X 3.6 m included six ridges. Each ridge was 60 cm in wide and 3 meters in length.

Preparation of organic manure tea

Fresh plant compost was obtained from Minia composting facility (Obour compost) El-Minia. The chicken manure was obtained from El-Dakahlia poultry Company El-Minia and the pigeon manure was obtained from pigeon towers in surrounding areas, where the pigeon and chicken are not being fed hormones or manufactured diets for poultry feed. The organic manures (plant compost, chicken and pigeon manure) were placed in burlap bags (2 kg/bag), each bag placed in plastic barrel filled with water (20 liters/barrel). 150 g of molasses and 10 g of MgSO4 per barrel were added. Then, the plastic barrels were covered with plastic cover to complete the fermentation process. After three weeks of fermentation, the organic manures teas were ready for use (Gomaa, 2020 and Pant *et al*., 2012). These organic manures tea were added to rosemary plants three times yearly (at the end of March, the end of April and the end of May), at a rate of 25 ml/plant as a soil application. Table 2 shows the chemical analysis of the three organic manures tea, which used in the present study.

Table 2. Chemical properties of the three organic manures tea.

Content	Tea compost	Pigeon manure tea	Chicken manure tea
pH	7.72	7.62	7.59
EC ($dS.m^{-1}$)	1.34	1.54	1.49
Total N (ppm)	211	289	233
Phosphorus (ppm)	298	370	310
Potassium (ppm)	278	310	315
Fe (ppm)	7.9	9.52	8.11
Cu (ppm)	3.3	4.4	2.5
Zn (ppm)	2.12	1.99	1.66
Mn (ppm)	0.07	0.12	0.08

Treatments

The present experiment included two factors: the first factor (A) is the organic manure teas treatments (25 ml/plant tea compost, 25 ml/plant pigeon manure tea and 25 ml/plant chicken manure tea), the second factor (B) SA at 100, 200, 300 and 400 ppm SA as well as the interactions between the factors, while the untreated plants were used as control. Furthermore, the regular agricultural practices that commonly carried out in rosemary plants, as usual in the region (chemical fertilization, irrigation and pest management), were applied in this study.

Measured data

The plants herbs were harvested in two separated cuts; the first was carried out in the end of Jun and the second was carried in the end of October, during the two experimental seasons. All the data presented in this study (concerning the vegetative growth parameters, mineral elements) are the average of the two cuts.

Vegetative growth Characteristics

Before cutting the rosemary herb (first and second cuts), during the two seasons, the average plant height (cm), average number of shoots per plant and average shoot length (cm) were recorded. After cutting the plants, the herb fresh weight of each plant individually was recorded and the average fresh weight of herb was calculated. The herbs were washed and air dried, so, it was dried in oven at 70 °C overnight, until constant weight. Then, the dry weight of each herb was recorded.

Nutrients elements determination

10 g of dried rosemary leaves were randomly taken from each herb, ground to fine powder and conserved to until mineral elements determination. N, P, K, Fe, Mn and Zn were determined according to the methods described by Martin-Préval *et al.,* (1984) and A.O.A.C (1990).

Determination of essential oil and its components

In this study the essential oil and its contents were determined in the second cut only. Samples of dried herb was accurately weighed and subjected to hydrodistillation with sterile water for 3 h using a Clevenger-type apparatus as reported by Erich (1982). The percentage of oils calculated and then the oil yield per plant was calculated. Furthermore, the volatile oil major compounds were determined by Gas Chromatography analysis, according to the program described by Chamorro *et al*., (2008).

Statistical Analysis

The obtained data are, statistically, analyzed by using Statistic version 8.1 software. Analytical Software, (2005). Differences between means were determined using the Least Significant Difference (L.S.D. at 0.05) test.

RESULTS AND DISCUSSION

Results

Vegetative growth parameters

The effect of the three manure organic tea (tea compost, pigeon manure tea and chicken manure tea) and SA at 100, 200, 300 and 400 ppm, as well as their interactions on vegetative growth parameters of rosemary plants, during 2021 and 2022 seasons are presented in Tables 3 and 4. Data shows that the three organic manures tea and salicylic acid concentrations significantly enhanced rosemary plants growth in terms of plant height (cm), number of branches/ plant and branch length (cm) in comparison to untreated plants (Table 3). The results showed also that organic manures tea treatments showed a significant superiority rather than salicylic acid treatments. Furthermore, the plants received the tea compost present betters plant higher and branch length rather than those received pigeon manure tea or chicken manure tea, during the two experimental seasons. While the plants received pigeon manure tea present the better number of branches per plant. Regarding the effect of salicylic acid (SA) on the vegetative growth of rosemary plants, it was observed that a significant influence of salicylic acid treatments on the investigated traits in both seasons. Increasing SA concentrations from 100 to 400 ppm was capable to enhancing all vegetative parameters i.e., plant height (cm), number of branches/plant and branch length (cm). While non-significant differences were obtained between the two highest concentrations of SA (300 ppm and 400 ppm) neither in the first nor in the second season (Table 3).

Table 3. Effect of organic manure tea and SA concentrations as well as their interactions on plant height and number of branches / plant and branch length of rosemary grown in sandy calcareous soil, during two seasons

Plant height (cm)

	First season					Second season				
Treatments	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**
0.0 ppm SA	31.2	46.1	41.5	40.2	39.8	29.5	57.6	51.4	50.1	47.2
100 ppm SA	43.1	59.6	55.7	50.6	52.2	39.7	62.3	58.8	56.2	54.3
200 ppm SA	51.3	68.7	60.5	56.4	65.6	52.8	71.5	62.3	60.7	61.8
300 ppm SA	59.7	73.4	67.1	62.2	67.4	62.4	77.9	71.1	65.3	69.2
400 ppm SA	62.2	76.5	69.4	64.4	68.1	65.4	80.1	71.9	66.4	70.9
Mean A	49.5	64.8	58.4	54.8		50.1	69.9	63.1	59.7	
LSD at 5%		A= 5.5 ; B= 4.1 ; AB= 8.3					A= 5.1 ; B= 4.5 ; AB= 8.9			

Number of branches / plant

	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	5.6	9.9	13.3	14.9	10.9	5.3	16.9	17.1	19.2	14.6
100 ppm SA	9.6	14.0	15.9	16.1	13.9	10.2	18.9	20.2	19.9	17.3
200 ppm SA	12.9	17.4	19.2	19.2	17.2	14.7	21.1	23.7	21.9	20.4
300 ppm SA	15.1	20.3	23.7	21.8	20.2	17.8	23.6	26.8	24.8	23.3
400 ppm SA	15.8	21.6	24.4	22.7	21.1	18.3	24.3	26.1	24.9	23.4
Mean A	11.8	16.6	19.3	18.9		13.3	20.9	22.8	22.2	
LSD at 5%		A= 1.9 ; B= 1.4 ; AB= 2.9					A= 1.7 ; B= 1.1 ; AB= 2.2			

Branch length (cm)

	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	10.5	12.7	11.2	12.1	11.6	9.9	12.9	11.7	14.1	12.2
100 ppm SA	14.2	14.9	14.7	15.2	14.7	16.2	17.1	15.9	16.6	16.5
200 ppm SA	17.3	16.1	15.9	15.9	16.3	18.9	21.1	20.4	21.7	20.5
300 ppm SA	19.5	19.7	18.5	18.8	18.2	20.0	22.9	22.1	22.4	21.9
400 ppm SA	19.6	20.1	19.2	19.6	19.6	21.1	23.5	21.9	21.5	22.0
Mean A	16.2	16.7	15.9	16.3		17.2	19.5	18.4	19.3	
LSD at 5%		A= 2.1 ; B= 1.2 ; AB= 2.8					A= 1.9 ; B= 1.3 ; AB= 2.5			

The investigated interactions had a significant effect on the vegetative growth parameters. Treated rosemary plants with tea compost and 400 ppm SA was responsible for producing the maximum values of plant height (76.5 and 80.1 cm) and branch length (20.1 and 23.5 cm) during the two experimental seasons, respectively. While rosemary plants received pigeon manure tea in combustions with 400 ppm SA were gave the highest values of number of branches/plant (24.4 and 26.1) during the two experimental seasons, respectively. On the opposite side, untreated plants produced the lowest values of plant height (31.2 and 29.5 cm), number of branches/plant (5.6 and 5.3) and branch length (10.5 and 9.9 cm), during the two experimental seasons, respectively.

Data illustrated in Table 4 shows the effect of three organic manures tea and SA at four concentrations as well as their interactions on herb fresh and dry weight during 2021 and 2022 seasons. The data shows that, treated rosemary plants with three organic manures tea or SA were capable to improve the herb fresh and dry weight significantly rather than the control treatment.

In among manure organic teas, there were no significant differences in Herb fresh weight and Herb dry weight between the three manure organic teas in both seasons.

SA promotion was associated with increasing their concentration from 100 to 400 ppm. However, non-significant differences were obtained when increasing the SA

concentrations from 300 to 400 ppm in the two experimental seasons, the interactions between organic manures tea and SA treatments had a significant effect on herb fresh weight (g) and herb dry weight (g) of rosemary plants, in the two experimental seasons. The highest herb fresh weight (149.2 and 158.4 g) and herb dry weight (35.8 and 38.4 g) were obtained when the rosemary plants treated with pigeon manure tea in combination with SA at 400 ppm, during the two experimental seasons, respectively. On other hand un-treated rosemary plants present the lowest fresh weight of herb (65.4 and 62.5 g) and herb dry weight (15.5 and 14.5 g) in both seasons, respectively.

Table 4. Effect of three organic manure tea and SA concentrations as well as their interactions on herb fresh weigh (g) and herb dry weight (g) of rosemary grown in sandy calcareous soil, during two seasons

Herb fresh weight (g)										
	First season					Second season				
Treatments	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**
0.0 ppm SA	65.4	80.3	88.2	79.1	78.3	62.5	89.7	91.1	89.2	83.1
100 ppm SA	75.7	107.5	105.3	103.5	98.0	79.9	109.1	108.3	112.2	102.4
200 ppm SA	83.4	128.4	130.4	133.3	118.8	89.4	135.5	119.2	120.3	116.1
300 ppm SA	109.7	139.5	139.1	140.6	132.2	111.3	146.3	140.7	139.4	134.4
400 ppm SA	112.6	144.1	149.2	144.5	137.6	121.7	150.2	158.4	143.1	143.4
Mean A	89.4	119.9	122.4	120.2		92.9	126.2	123.5	120.8	
LSD at 5%		A= 9.2 ;	B= 7.4 ;	AB= 15.1			A= 8.6 ;	B= 6.6 ;	AB= 13.2	
Herb dry weight (g)										
	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	15.5	20.2	20.3	18.1	18.5	14.4	21.5	21.8	21.9	19.9
100 ppm SA	19.9	23.5	25.3	24.8	23.4	19.2	26.2	25.9	28.1	24.8
200 ppm SA	22.5	29.5	31.3	31.6	28.8	21.5	32.5	28.6	32.1	28.7
300 ppm SA	26.7	32.1	33.4	32.8	31.3	26.7	35.0	33.9	34.8	32.8
400 ppm SA	27.9	33.1	35.8	34.4	32.8	29.0	36.1	38.4	31.2	33.7
Mean A	22.5	27.7	29.2	28.3		22.2	30.3	29.6	29.5	
LSD at 5%		A= 2.1 ;	B= 1.8 ;	AB= 3.6			A= 2.6 ;	B= 1.7 ;	AB= 3.4	

Nutrients elements

Data presented in Tables 5 and 6 shows the response of rosemary plants to soil application of three organic manures tea and spraying SA as well as their interactions, during 2021 and 2022 seasons. The obtained data shows that, using the three manures tea significantly improved the macro (N, P and K) and micro (Fe, Mn and Zn) nutrients rather than untreated plants. These findings were true during the two experimental seasons.

Table 5. Effect of three organic manure tea, SA concentrations and their interactions on Nitrogen, phosphorus and potassium % of dry herb of rosemary grown in sandy calcareous soil, during two seasons

Nitrogen %										
	First season					Second season				
Treatments	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**
0.0 ppm SA	1.55	1.69	1.71	1.69	1.66	1.54	1.72	1.68	1.70	1.66
100 ppm SA	1.60	1.79	1.82	1.79	1.75	1.70	1.88	1.74	1.77	1.77
200 ppm SA	1.72	1.89	1.88	1.84	1.83	1.77	1.93	1.84	1.86	1.85
300 ppm SA	1.79	1.99	1.90	1.89	1.89	1.89	1.99	1.90	1.94	1.93
400 ppm SA	1.81	2.09	2.01	1.92	1.96	1.90	2.04	1.98	1.90	1.95
Mean A	1.69	1.89	1.86	1.83		1.79	1.92	1.83	1.83	
LSD at 5%		A= 0.12 ;	B= 0.11 ;	AB= 0.21			A= 0.18 ;	B= 0.12 ;	AB= 0.23	
Phosphorus %										
	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	0.16	0.20	0.22	0.20	0.20	0.17	0.21	0.23	0.22	0.21
100 ppm SA	0.19	0.22	0.24	0.21	0.22	0.19	0.23	0.25	0.23	0.23
200 ppm SA	0.20	0.23	0.28	0.23	0.24	0.21	0.23	0.28	0.25	0.24
300 ppm SA	0.21	0.27	0.30	0.26	0.26	0.22	0.26	0.31	0.27	0.27
400 ppm SA	0.21	0.28	0.31	0.28	0.27	0.22	0.28	0.32	0.28	0.28
Mean A	0.19	0.24	0.27	0.24		0.20	0.24	0.29	0.25	
LSD at 5%		A= 0.02 ;	B= 0.03 ;	AB= 0.06			A= 0.01 ;	B= 0.04 ;	AB= 0.07	
Potassium %										
	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	1.37	1.60	1.59	1.59	1.54	1.42	1.61	1.66	1.65	1.59
100 ppm SA	1.45	1.77	1.72	1.76	1.68	1.50	1.76	1.79	1.77	1.71
200 ppm SA	1.58	1.82	1.80	1.79	1.75	1.60	1.88	1.84	1.78	1.78
300 ppm SA	1.67	1.84	1.89	1.83	1.81	1.69	1.93	1.88	1.82	1.83
400 ppm SA	1.69	1.89	1.90	1.91	1.85	1.71	1.92	1.92	1.89	1.86
Mean A	1.55	1.78	1.78	1.78		1.58	1.82	1.81	1.78	
LSD at 5%		A= 0.12 ;	B= 0.11 ;	AB= 0.23			A= 0.13 ;	B= 0.10 ;	AB= 0.21	

Table 6. Effect of three organic manure tea, SA concentrations and their interactions on iron, manganese and zinc contents of dry herb of rosemary grown in sandy calcareous soil, during two seasons

Fe (ppm)

	First season					**Second season**				
Treatment	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**
0.0 ppm SA	49	60	56	52	54	51	66	62	58	59
100 ppm SA	56	69	69	61	64	61	76	70	65	68
200 ppm SA	66	88	79	69	87	64	91	76	69	75
300 ppm SA	71	105	92	84	88	75	95	89	82	85
400 ppm SA	77	110	99	91	94	79	109	103	93	96
Mean A	64	86	79	71		66	87	80	73	
LSD at 5%		A= 6 ; B= 3.5 ; AB= 7					A= 7 ; B= 5 ; AB= 10			

Mn (ppm)

	First season					Second season				
Treatment	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	18	25	24	26	23	20	31	29	29	27
100 ppm SA	27	34	33	34	32	33	34	31	33	33
200 ppm SA	32	41	44	41	40	38	43	39	42	40
300 ppm SA	38	50	51	49	47	44	53	50	49	49
400 ppm SA	40	51	53	50	48	50	55	51	53	52
Mean A	31	40	41	40		37	43	40	41	
LSD at 5%		A= 5 ; B= 3 ; AB= 6					A= 4 ; B= 4.5 ; AB= 9			

Zn (ppm)

	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	20	30	24	25	25	21	32	26	25	26
100 ppm SA	22	39	29	29	30	28	41	33	30	33
200 ppm SA	28	41	37	35	35	31	45	34	34	36
300 ppm SA	35	48	40	41	41	35	51	37	38	40
400 ppm SA	37	51	43	40	43	36	54	39	43	43
Mean A	28	42	35	34		30	45	34	34	
LSD at 5%		A= 5 ; B= 3.1 ; AB= 6					A= 4 ; B= 4 ; AB= 8			

Furthermore, concerning herb nitrogen, iron and zinc contents, the plants received tea compost present a superiority than those treated with pigeon manure tea or chicken manure tea. While the plants treated with pigeon manure tea present superiority in herb phosphorus content than those treated with tea compost and chicken manure tea. The same table also showed that, increasing SA concentration from 100 ppm to 400 ppm was parallel to increasing the herb N, P, K, Fe, Mn and Zn contents, during the two experimental seasons. On the opposite side, non-significant differences were obtained as a result of increasing SA concentration from 300 ppm to 400 ppm, neither in the first season nor in the second seasons.

Volatile oil content and yield

Data concerning the effect of the three organic manure tea and SA treatments as well as their combination on the volatile oil % and oil yield (ml/plant) of rosemary plants (*Rosmarinus officinalis* L.*)* grown in sandy calcareous soil, during 2021 and 2022 seasons, are shown in Table 7. Data clear that, subjected rosemary plants to three soil application of tea compost, pigeon manure tea and chicken manure tea caused a significant increase in oil % and oil yield (ml/plant), in both experimental seasons. It is also noticed that, treating rosemary with pigeon manure tea significantly was accompanied with improving oil% and oil yield (ml/plant) relative to the control or other organic manure tea treatments.

Regarding SA treatments, the oil % and oil yield/plant significantly increased because of increasing the concentration used from 100 to 400 ppm. Non-significant differences were obtained because of increasing SA concentration from 300 ppm to 400 ppm in both seasons.

The interactions of the three organic manure tea and SA treatments were significant percentage of oil and oil yield of rosemary plants, in the two seasons, except those between the two highest concentrations of salicylic acid (300 and 400 ppm). During the two experimental seasons, the best oil percentage (1.36 and 1.37%) and oil yield per plant (1.16 and 1.27 ml/plant) were produced due to treated rosemary plants with pigeon manure tea in combination with SA at 400 ppm, during the two seasons respectively. On the opposite side the minimum oil % (1.01 and 1.02 %) and oil yield (0.51 and 0.47 ml/plant) were obtained from untreated rosemary plants.

Main components of essential oil

The major components Rosemary essential oil varied significantly in relation to organic manure tea and Salicylic acid treatments as shows in Table (8). Data demonstrate that, the three main compounds of essential oil (α-Pinen %, Camphene % and 1-8 Cineol) significantly improved because of treated rosemary plants with the three

organic manures tea and salicylic acid in comparison with untreated plants, during 2021 and 2022 seasons. In the same context, increasing salicylic acid concentrations from 100 ppm to 400 ppm was associated with significant increasing of the main three volatile oil. However, non-significant differences were observed between the two higher SA concentrations (300 ppm and 400 ppm).

Table 7. Effect of three organic manure tea, SA concentrations and their interactions on volatile oil content and oil yield (ml) per plant of rosemary grown in sandy calcareous soil, during two seasons

Volatile oil %										
	First season					Second season				
Treatments	**Without organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**	**Without organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**
0.0 ppm SA	1.01	1.13	1.14	1.09	1.09	1.02	1.16	1.17	1.11	1.12
100 ppm SA	1.08	1.19	1.21	1.15	1.13	1.10	1.21	1.24	1.18	1.28
200 ppm SA	1.11	1.25	1.27	1.20	1.21	1.18	1.26	1.30	1.22	1.24
300 ppm SA	1.17	1.29	1.33	1.25	1.26	1.21	1.31	1.36	1.27	1.28
400 ppm SA	1.19	1.30	1.36	1.26	1.28	1.22	1.33	1.37	1.29	1.30
Mean A	1.11	1.23	1.26	1.19		1.14	1.25	1.29	1.21	
LSD at 5%		A= 0.04 ;	B= 0.03 ;	AB= 0.07			A= 0.05 ;	B= 0.05 ;	AB= 0.10	
Yield of volatile oil (ml) / plant										
	First season					Second season				
Treatments	Without organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	0.51	0.66	0.66	0.59	0.61	0.47	0.70	0.71	0.71	0.65
100 ppm SA	0.65	0.76	0.82	0.81	0.76	0.62	0.85	0.86	0.83	0.79
200 ppm SA	0.73	0.96	1.02	1.03	0.94	0.70	1.06	0.99	1.00	1.03
300 ppm SA	0.88	1.04	1.09	1.07	1.02	0.87	1.14	1.19	1.17	1.10
400 ppm SA	0.90	1.07	1.16	1.12	1.07	0.95	1.23	1.27	1.21	1.17
Mean A	0.73	0.90	0.95	0.92		0.72	0.99	2.0	0.98	
LSD 5%		A= 0.09 ;	B= 0.08 ;	AB= 0.16			A= 0.8 ;	B= 0.07 ;	AB= 0.15	

Table 8. Effect of three organic manures tea, SA concentrations and their interactions on essential oil components of rosemary grown in sandy calcareous soil, during two seasons

α-Pinen %										
	First season					Second season				
Treatments	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**	**Without Organic fertilizers**	**Compost tea**	**Pigeon manure tea**	**Chicken manure tea**	**Mean B**
0.0 ppm SA	8. 1	9.6	9.7	9.5	9.2	7.9	9.9	10.2	9.7	9.4
100 ppm SA	8.8	10.2	10.7	10.1	10.0	8.2	10.4	10.9	10.1	9.9
200 ppm SA	9.3	10.8	11.8	10.9	10.7	8.4	10.9	11.5	11.2	10.5
300 ppm SA	9.7	11.7	12.1	11.6	11.3	9.9	11.7	12.7	11.8	11.3
400 ppm SA	9.8	11.9	12.5	11.9	11.5	10.1	11.9	12.9	12.0	11.7
Mean A	9.2	10.8	11.3	10.8		8.9	11.0	11.6	11.0	
LSD at 5%		A= 1.4 ;	B= 0.6 ;	AB= 1.16			A= 1.1 ;	B= 0.7 ;	AB= 1.46	
Camphene %										
	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	20.2	23.4	23.1	24.7	22.8	19.7	25.3	24.9	24.7	23.5
100 ppm SA	22.1	23.9	24.9	25.3	24.1	21.7	27.3	27.9	26.9	25.9
200 ppm SA	22.9	26.9	26.7	26.5	24.1	23.3	26.9	28.7	27.9	26.7
300 ppm SA	24.3	27.8	28.0	27.9	26.7	27.2	29.9	30.2	29.2	29.1
400 ppm SA	24.5	28.2	28.3	27.9	27.3	26.5	30.2	31.1	30.2	29.5
Mean A	22.8	26.1	26.2	26.5		23.7	27.9	28.6	27.8	
LSD at 5%		A= 2.4 ;	B= 1.3 ;	AB= 2.6			A= 1.9 ;	B= 1.02 ;	AB= 2.0	
1-8 Cineol										
	First season					Second season				
Treatments	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B	Without Organic fertilizers	Compost tea	Pigeon manure tea	Chicken manure tea	Mean B
0.0 ppm SA	17.5	20.9	25.5	22.1	21.5	18.9	22.4	27.7	24.9	23.5
100 ppm SA	20.2	29.9	35.1	31.6	29.2	22.1	33.2	33.9	34.4	30.9
200 ppm SA	24.3	35.4	41.2	39.0	34.9	26.7	40.5	42.1	41.0	37.6
300 ppm SA	27.9	46.2	48.4	42.8	41.3	29.1	46.9	48.4	43.3	41.9
400 ppm SA	28.3	47.5	49.3	44.1	42.3	30.1	47.7	50.2	44.9	43.2
Mean A	23.6	36.0	39.9	35.9		25.4	38.1	40.5	37.7	
LSD at 5%		A= 2.9 ;	B= 2.5 ;	AB= 4.4			A= 1.8 ;	B= 1.7 ;	AB= 3.5	

The interaction between the three organic manure tea and SA concentrations was significant in the two experimental seasons (Table 8). It was clear that, in the present study untreated plants produced the lowest concentrations of the three main oil compounds (8.15 and 7.9% for α-Pinen; 20.1 and 19.7% for Camphene; 17.55 and 18.9 for 1-8 Cineol) during 2021 and 2022 seasons, respectively. The single or compared treatments of rosemary plants with organic manures tea and SA remarkably increased the percentage of the three main volatile compounds rather than untreated plants. However, the plants received pigeon manure tea combined with spraying SA at 400 ppm produced the highest percentages of the three main compounds (12.5 and 12.9% α-Pinen; 28.5 and 31.1% for Camphene; 49.35 and 50.2% for 1-8 Cineol), during the two experimental seasons, respectively.

Discussion

As known sandy soil has poor physical properties such as high bulk density, low water holding capacity and low total porosity, also it has poor chemical properties like, high pH, low EC, low nutrients content, low organic matter content and a low C/N ratio. Many pervious researches indicated that manures organic amendments had a considerable effect on both the physical and chemical properties of sandy soil and can be improved sandy soil quality. (Civeira, 2010; Khan *et al*., 2010; Jones *et al*., 2010; Ali 2011; Arthur *et al*., 2011; D'Hose *et al*., 2012).

Our results clearly indicated that, treatments of manure organic teas were more effective in increasing plant height, number of branches /plant, branch length and herb fresh and dry weight, as well as improve macro and micro nutrients in plants.

The important role of organic manure in enhancing the growth of rosemary plants could be attributed to the stimulation of root growth, which promoted water absorption, as well as the uptake of different nutrients, and their translocation throughout the plant tissues. This promotion surely reflected on enhancing rosemary herb N, P, K, Fe, Mn, Cu and Zn contents under calculus sandy soil. This conclusion agrees with the findings of Abdelaziz *et al*., (2007), Jelacic *et al*., (2007), Singh and Guleria, (2013), Valiki and Ghanbari, (2015) and Mostafa, (2019), on rosemary plants.

Regarding to oil content and quality, the reason for increment the amount of oil in herb is that, manure organic teas have high amount of nitrogen, carbon, potassium content and micronutrient (Fe, Zn, Cu, Mn), which increased essential oil content, essential oil yield and the three main compounds in oil. These results are in harmony with those reported by Abdullah *et al*., (2012), Valiki *et al*., (2015) and Mostafa, (2019) on Rosemary plants.

Salicylic acid (SA) is a natural growth regulator of vascular plants that affects different physiological and metabolic processes, e.g., transpiration, photosynthesis, ion uptake, and transportation (Ibrahim *et al*., 2019). Salicylic acid can be increased the yield of vegetable species by reducing stress-induced growth reduction (Khan *et al*., 2015). It was reported that the positive effects of SA may be related to changes in the hormonal status (Shakirova *et al*., 2003 and Abreu and Munné-Bosch, 2009) or by improving of photosynthesis, transpiration, and stomatal conductance (Abreu and Munné-Bosch, 2009 and Stevens, 2006), in addition, antioxidant enzyme activities and osmoregulation (Faried *et al*., 2019).

Our experiment showed that plants were sprayed with salicylic acid resulted enhancing in the studied vegetative characteristics. The increase in vegetative growth that we have observed was probably due to the reduction in leaf transpiration to increase leaf diffusive resistant which finally increases relative water content (Karlidag *et al*., 2009) or reacting to stress through compatible osmolytes building up in plants tissues (Kabiri *et al*., 2014).These results are in agreement with those reported by Fetouh, (2016) on rosemary, Hassan and Ali, (2014) on gladiolus.

Regarding volatile oil, SA treatment increased the volatile oil percentage and oil yield of rosemary plant. This may be related to the increase in plant growth occurred by SA, population changes of oil gland in leaf, and the advantageous role of SA on mono or sesquiterpene biosynthesis, (Rowshan *et al*., 2010). Similar results were obtained by (Kazemi and Shirzadeh, 2012 and Fetouh, 2016) they observed that the treatment of SA was significantly improved the volatile oil of rosemary.

CONCLUSION

Considering the vegetative growth, mineral statues, oil yield and oil chemical composition of rosemary plants grown under sandy calcareous soil, to get the optimum characters of rosemary plants under experimental conditions or resampling conditions, it may be recommended to use manure organic tea (tea compost, pigeon manure tea or chicken manure tea) three times yearly as soil application in combination with spraying salicylic acid at 300 ppm three times yearly.

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تحسين نمو المحصول وانتاجيه الزيت لنباتات الحصالبان المنزرعه فى الاراضى الرمليه الجيريه باستخدام بعض الاسمده العضويه وحامض السيلسيلك

عادل فهمى احمد وعبير محمد شحاته

قسم بحوث النباتات الطبيه والعطريه – معهد بحوث البساتين- مركز البحوث الزراعيه- مصر

الملخص

اجرى هذا البحث بهدف دراسه استجابه نباتات الحصالبان المنزرعه فى الاراضى الرمليه الجيريه لمعامله التربه بثلاث اسمده عضويه وهى كمبوست الشاى وسماد مخلفات الحمام وسماد مخلفات الدواجن وكذلك رش النباتات بحامض السيلسيلك بمعدلات ١٠٠و٢٠٠و٣٠٠و٤٠٠ جزء فى المليون بالاضافه الى التداخل بينهم تم تنفيذ تجربه حقليه فى اراضى جديده مستصلحه تقع فى قريه الشيخ فضل مركز بنى مزار محافظه المنيا خلال موسمين ٢٠٢١و٢٠٢٢ واشارت النتائج المتحصل عليها الى تحسين فى النمو الخضرى ومحتوى العناصر ومحتوى الزيت ومحصول الزيت وكذلك المكونات الاساسيه للزيت نتيجه المعامله بالثلاث انواع من الاسمده العضويه وحامض السيلسيلك وكان استخدامهما معا اكثر تأثيرا عن استخدام كل منهم منفردا ، اعلى قيم للنتائج تم الحصول عليها من خلال معامله النباتات بسماد مخلفات الحمام والرش بحامض السيلسيلك بمعدل ٤٠٠ جزء فى المليون مع ملاحظه عدم وجود فروق معنويه بين اعلى تركيزين لحامض السيلسيلك ٣٠٠ و٤٠٠ جزء فى المليون ، لذلك وطبقا للنتائج المتحصل عليها يمكن ان يوصى معامله نباتات الحصالبان المنزرعه فى اراضى رمليه جيريه باحد الاسمده العضويه وكذلك الرش بحامض السيلسيلك بمعدل ٣٠٠ جزء فى المليون ثلاث مرات سنويا