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IMPROVING *OCIMUM BASILICUM* PRODUCTIVITY IN NEWLY RECLAIMED SOILS USING POULTRY MANURE AND SALICYLIC ACID

Yossef A. Mahmoud [1], Elsayed H. Hamad [1], Atef A. S. Abdel-Kader [2]
Horticulture Department, Faculty Agriculture, Al-Azhar University, Assiut, Egypt 1
Department Medicinal and Aromatic Plants, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt 2

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Correspondence Email:
yy0101685@gmail.com

ABSTRACT

This study investigated the impacts of poultry manure (PM) as an organic manure and salicylic acid (SA) as a plant growth stimulant on sweet basil growth and essential oil over two growing seasons (2023 and 2024). Poultry manure was applied to the soil at rates of 0.0, 4.0, 8.0, and 12.0 m³/fed, while salicylic acid was applied as a foliar spray [0 (control), 50, 100, 150, and 200 ppm] .The results demonstrated that both poultry manure (PM) application at all levels and foliar spraying with salicylic acid (SA) at all concentrations significantly increased plant height, number of branches per plant, dry weights of both herb and leaves, essential oil content, and N, P, and K percentages in the leaves dry across all three harvests in both seasons. The highest PM level (12 m³/fed) consistently resulted in the highest growth values. Furthermore, the 150 ppm SA treatment was the most effective foliar application for enhancing the studied traits across all cuts. Significant interaction effects were observed for all examined parameters. The treatment with the greatest PM level (12 m³/fed) and 150 ppm SA was shown to be the most beneficial for all cuts.

INTRODUCTION

Sweet basil (*Ocimum basilicum*), often called the "king of herbs," is a vital medicinal and aromatic plant from the Lamiaceae family, native to tropical and subtropical regions. Its widespread cultivation is driven by its high economic value and diverse applications in traditional medicine, culinary uses, cosmetics, and natural insect repellents (Dzida, 2010; Dou *et al*., 2018; Walters and Currey, 2015; Esetlili *et al*., 2016; Marotti *et al*., 1996; Prakasa Rao, 2009). Key bioactive components in basil, such as 1.8-cineole, linalool, and camphor, contribute to its use in food flavoring, dental products, biopesticides, and pharmaceutical formulations (Akgul, 1989; Pascual-Villalobos and Ballesta-Acosta, 2003; Bufalo *et al*., 2015; O'Callaghan *et al*., 1972). Additionally, basil exhibits antioxidant, antimicrobial, and anticancer activities, which are attributed to its vitamins and flavonoid content (Taie and Radwan, 2010; Sgheri *et al*., 2010).

Poultry manure (PM) is highlighted as a valuable organic fertilizer that enhances crop yield by improving soil nutrient content and physical properties, such as organic matter content and water retention. Its nutrient-rich composition supports beneficial soil microbes, boosting plant growth and nutrient uptake, although its bulkiness may sometimes limit its use (Mohammad Amanullah, Sukkar, and

Muthukrishnan, 2010; Najib and Aziz, 2004; Ravikumar and Krishnamurthy, 1975; Malik *et al*., 2011; El-Ghadban *et al*., 2002; Somida, 2002).

Salicylic acid (SA), a plant hormone and phenolic acid with a benzene ring bonded to hydroxyl and carboxyl groups, plays a crucial role in enhancing plant growth and stress tolerance. It activates Systemic Acquired Resistance (SAR), enabling plants to better withstand biotic and abiotic stresses such as drought, extreme temperatures, heavy metal toxicity, and salt stress (Hassoon and Abduljabbar, 2019; Simaei *et al*., 2012; Kumar, 2014). Najafian *et al*. (2009) reported that foliar application of salicylic acid at three concentrations (150, 300, and 450 mM) on thyme significantly influenced key plant traits. The application of 150 mM SA resulted in increased dry weight of the vegetative biomass, enhanced photosynthesis, and improved plant tolerance to salt stress conditions.

This research aims to investigate the combined effects of PM and SA on the growth, yield, and essential oil production of sweet basil grown in newly reclaimed soils.

MATERIALS AND METHODS

This study evaluated the impacts of poultry manure (PM) and salicylic acid (SA) on the growth, yield, and essential oil content of sweet basil (*Ocimum basilicum* L.) over two growing seasons (2023 and 2024). The experiments were carried out on newly reclaimed soil along Western Desert Road at the Abu Qurqas Center in Minia Governorate, Egypt (27°58'27.1"N, 30°27'57.8"E). A split-plot design was used, with four PM rates assigned to main plots and five SA rates to subplots, resulting in 20 treatment combinations, each replicated three times for robust statistical analysis. Sweet basil seeds from the Agricultural Research Center in Giza were sown in a nursery on March 10th of each season. Seedlings were transplanted 45 days later (April 24th) into 1.8 x 2.5 m plots arranged in three rows, spaced 60 cm apart and basil seedlings were planted in hills, 25 cm between each hill. Each plot had 30 plants, equivalent to a density of 26,666 plants per fed. Five soil samples were collected at depths of 0-20 cm and 20-50 cm before planting to analyze the soil's physical and chemical properties (results in Table 1).

Table (1): Soil properties measured at the experimental site before planting.

	Distribution of particle sizes			Texture	pH (1:2.5)	EC (dSm^{1}) 1:2.5	$CaCO_3$%
	Sand %	Silt %	Clay %				
Depth (0-20 cm)	79.30	11.30	9.40	Sandy	7.94	2.50	9.9
	Cation (meq L^{-1})				Anion (meq L^{-1})		
	Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	SO_4^{--}
	10.5	0.5	6.0	3.0	0.79	17.9	1.31
Depth (20-50 cm)	Distribution of particle sizes			Texture	pH (1:2.5)	EC (dSm^{1}) 1:2.5	$CaCO_3$%
	Sand %	Silt %	Clay %				
	81.20	10.70	8.10	Sandy	7.90	2.70	14.8
	Cation (meq L^{-1})				Anion (meq L^{-1})		
	Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	SO_4^{--}
	13.2	0.5	7.2	4.1	0.85	20.4	3.75

Poultry manure was applied during soil preparation at rates of 0.0, 4.0, 8.0, and 12.0 m^3 per fed (designated as 0.0, PM1, PM2, and PM3, respectively) for both growing seasons. The manure, obtained from a private farm in Minia Governorate, Egypt, was analyzed for its nutrient content as detailed in Table 2.

Table (2): Properties of the poultry manure used in the study

Organic matter%	pH	EC mm /cm	Total N %	Available mg/kg					
				P	K	Zn	Mn	Cu	Fe
72.10	6.48	4.22	3.22	35	712	157	119	24	1967

The experiment involved nine foliar spray applications of salicylic acid (SA) across two growing seasons, with treatments at control (no spray), 50, 100, 150, and 200 ppm (designated as control, SA1, SA2, SA3, and SA4). SA was applied twice per harvest on the following dates: May 24th, June 13th, July 8t , July 28th, August 22nd , and September 12th , corresponding to three cuts. The three harvests were conducted on July 2nd, August 16th, and October 1st. Spraying continued until runoff was observed, and all applications adhered to standard agricultural practices.

The study period involved irrigating sweet basil plants as required using a drip irrigation system with 4L/h drippers.

Table (3): The irrigation water's chemical properties used for sweet basil cultivation.

pH (1:5)	EC (1:2.5)	TDS	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	SO_4^{--}	HCO_3^-	CO_3^-
-	dSm^{-1}	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
7.61	3.32	315.18	30.89	7.88	29.24	9.87	24.51	11.00	20.10	22.27

For each harvest, plants were cut 10 cm above the soil, and various parameters were recorded, including plant height, branch count, dry weights of herb and leaf, and total herb and leaf yields (ton/fed). Essential oil was extracted according to the British Pharmacopoeia (1963), with its yield expressed in l/fed. Additionally, nitrogen, phosphorus, and potassium percentages in dry leaf samples from the third cut were determined following AOAC (1990) guidelines. All data on growth, yield, oil production, and chemical composition were statistically analyzed using Statistic version 9 (Analytical Software, 2008) based on the methodology of Mead *et al*. (1993), and mean comparisons were performed using the LSD test at a 5% significance level.

RESULTS AND DISCUSSION

Growth parameters

Across two growing seasons, poultry manure (PM) application significantly enhanced sweet basil growth by increasing plant height and branch count compared to untreated plants. Higher PM rates consistently produced taller plants and more branches across all three harvests, with the highest rate (12 m^3/fed) yielding the best results. In the first season, plant heights reached 51.7, 53.6, and 55.1 cm across the first, second, and third cuts, respectively, while in the second season, heights were 54.3, 56.6, and 58.2 cm. The highest branch counts recorded were 35.8, 39.8, and 45.1 in the first season, and 44.1, 48.5, and 59.3 in the second season. These findings underscore the significant impact of PM on sweet basil growth, likely due to its role in supplying essential nutrients, improving soil structure, and reducing bulk density (Benjamin et al., 2017). Moreover, these results align with earlier research on basil

(El-Sayed *et al*., 2015), coriander (Ahmed *et al*., 2017), caraway (Mahmoud *et al*., 2017), garlic (Dena and Raida, 2018), and green onions (Noura, 2021).

Similarly, foliar application of salicylic acid (SA) significantly enhanced sweet basil's growth, as evidenced by increased plant height and branch count across all three harvests (Tables 4 and 5). All tested SA concentrations outperformed the control, with the 150-ppm treatment producing the most pronounced improvements. Under this treatment, plant heights reached 46.8 and 49.4 cm at the first cut, 48.3 and 51.3 cm at the second cut, and 50.3 and 53.3 cm at the third cut across the two seasons. Branch counts increased to 30.1 and 39.0 at the first cut, 33.5 and 42.3 at the second cut, and 40.1 and 50.2 at the third cut. These results confirm the efficacy of foliar-applied SA in boosting plant growth, which is consistent with findings in species such as *Ocimum gratissimum* (Abdou *et al*., 2011), *Carum carvi* (Abdou *et al*., 2013), *Nigella sativa* (Abd El-Khalek *et al*., 2023), and *Gladiolus* (Saja and Ammar, 2020).

Table (4): Mean plant height in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	**Poultry manure levels (m^3/fed) (A)**									
	Control	**PM1**	**PM2**	**PM3**	**Mean (SA)**	**Control**	**PM1**	**PM2**	**PM3**	**Mean (SA)**
	First season					Second season				
	First cut									
Control	33.3	35.8	39.7	44.4	38.3	36.0	38.4	42.4	47.1	41.0
SA1	36.3	37.5	40.9	50.0	41.2	38.9	40.1	43.5	52.6	43.8
SA2	39.1	41.6	44.3	53.3	44.6	41.8	44.3	47.0	56.0	47.2
SA3	41.8	43.3	46.1	56.0	46.8	44.4	45.9	48.8	58.6	49.4
SA4	40.3	41.6	45.7	54.7	45.6	42.9	44.3	48.3	57.4	48.2
Mean (PM)	38.2	40.0	43.4	51.7		40.8	42.6	46.0	54.3	
LSD 0.05	PM: 1.6		SA: 1.2		PMxSA: 2.3	PM: 1.6		SA: 1.2		PMxSA: 2.3
	Second cut									
Control	34.5	36.9	40.9	46.1	39.6	37.5	39.9	43.9	49.1	42.6
SA1	37.6	38.8	42.3	51.8	42.6	40.6	41.8	45.2	54.7	45.6
SA2	40.4	42.6	46.0	55.5	46.1	43.4	45.6	48.9	58.5	49.1
SA3	43.3	44.9	47.5	57.5	48.3	46.2	47.9	50.4	60.5	51.3
SA4	41.6	43.0	47.0	57.2	47.2	44.5	45.9	50.0	60.1	50.1
Mean (PM)	39.5	41.2	44.7	53.6		42.4	44.2	47.7	56.6	
LSD 0.05	PM: 2.7		SA: 1.7		PMxSA: 3.3	PM: 2.7		SA: 1.6		PMxSA: 3.2
	Third cut									
Control	37.2	39.7	42.5	47.9	41.8	40.2	42.7	45.6	51.0	44.9
SA1	40.2	41.8	44.1	53.0	44.8	43.2	44.8	47.1	56.1	47.8
SA2	42.9	45.6	46.9	57.2	48.2	45.9	48.7	50.0	60.2	51.2
SA3	45.8	47.7	48.5	59.0	50.3	48.9	50.7	51.5	62.0	53.3
SA4	44.1	45.3	48.3	58.6	49.1	47.1	48.4	51.3	61.6	52.1
Mean (PM)	42.0	44.0	46.1	55.1		45.1	47.1	49.1	58.2	
LSD 0.05	PM: 1.7		SA: 1.6		PMxSA: 3.2	PM: 1.7		SA: 1.6		PMxSA: 3.3

The interaction between poultry manure and salicylic acid (SA) significantly enhanced sweet basil's growth, as shown in Tables 4 and 5. The optimal treatment was 12 m^3 per fed of PM combined with 150 ppm SA, which produced the highest plant height and branch count across all three harvests over both growing seasons. While most combined treatments outperformed the control, the control (no poultry manure) with 50 ppm SA showed minimal improvement. Among all cuts, the third one consistently yielded the maximum values for these traits, followed by the second cut, then the first cut.

Table (5): Mean branches number/plant in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	Poultry manure levels (m^3/fed) (A)									
	Control	PM1	PM2	PM3	Mean (SA)	Control	PM1	PM2	PM3	Mean (SA)
	First season					Second season				
	First cut									
Control	16.9	20.6	26.4	30.2	23.5	24.4	28.8	35.3	38.5	31.8
SA1	18.5	21.9	27.5	33.2	25.3	26.8	30.2	36.8	40.8	33.6
SA2	20.5	24.3	29.5	36.1	27.6	28.6	32.8	38.2	45.1	36.2
SA3	22.7	25.9	31.7	40.1	30.1	30.8	35.2	40.8	49.0	39.0
SA4	22.2	24.5	30.5	39.5	29.2	30.2	33.2	40.4	47.1	37.7
Mean (PM)	20.2	23.4	29.1	35.8		28.2	32.0	38.3	44.1	
LSD 0.05	PM: 2.2		SA: 1.3		PMxSA: 2.6	PM: 2.5		SA: 1.5		PMxSA: 3.0
	Second cut									
Control	19.8	23.4	28.4	34.5	26.5	27.1	31.0	36.5	43.0	34.4
SA1	21.2	24.4	33.1	37.3	29.0	29.5	31.6	38.5	45.6	36.3
SA2	23.1	27.3	33.4	40.4	31.1	31.4	34.8	42.5	49.6	39.6
SA3	24.8	28.8	36.0	44.4	33.5	33.9	37.0	45.4	53.1	42.3
SA4	23.7	28.0	35.4	42.5	32.4	33.1	34.8	43.6	51.3	40.7
Mean (PM)	22.5	26.4	33.3	39.8		31.0	33.8	41.3	48.5	
LSD 0.05	PM: 2.8		SA: 2.0		PMxSA: 3.9	PM: 2.3		SA: 1.8		PMxSA: 3.7
	Third cut									
Control	24.9	32.3	35.7	40.1	33.3	31.4	36.1	44.1	52.9	41.1
SA1	26.2	34.5	37.9	43.7	35.6	34.3	37.4	46.4	57.2	43.8
SA2	28.0	36.8	39.6	45.5	37.5	37.0	40.9	50.2	59.3	46.8
SA3	31.3	38.4	42.0	48.8	40.1	39.0	42.8	54.9	64.2	50.2
SA4	30.1	37.3	41.3	47.5	39.0	37.4	41.9	52.2	63.1	48.6
Mean (PM)	28.1	35.9	39.3	45.1		35.8	39.8	49.6	59.3	
LSD 0.05	PM: 1.1		SA: 1.7		PMxSA: 3.3	PM: 1.5		SA: 1.5		PMxSA: 3.0

Weight and yield of herb dry

Tables 6 and 7 demonstrate that both poultry manure (PM) and foliar-applied salicylic acid (SA) significantly enhanced sweet basil's herb dry weight and yield over two growing seasons. Increasing PM rates led to higher herb dry weights and yields at every harvest. The highest PM rate tested (12 m^3/fed) produced maximum dry weights, 67.0 g and 73.2 g at the first harvest, 109.1 g and 111.3 g at the second, and 116.4 g and 120.9 g at the third harvest in 2023 and 2024, respectively, along with yields of 7.80 tons/fed in 2023 and 8.14 tons/fed in 2024, whereas the control (no PM) recorded the lowest values. These improvements support previous findings that PM supplies essential nutrients to boost dry matter production (Ogbonna and Ubi, 2007; El-Naggar *et al*., 2015; Amhakhian and Isaac, 2016; Mahmoud *et al*., 2017).

Similarly, foliar application of SA enhanced herb dry weight and yield compared to untreated plants. All SA concentrations increased herb dry weight, with the 150-ppm treatment being most effective. Under this treatment, dry herb weights reached 62.1 g and 66.4 g at the first harvest, 95.3 g and 96.7 g at the second, and 103.1 g and 107.2 g at the third harvest in 2023 and 2024, respectively, while corresponding yields were 6.95 tons/fed in 2023 and 7.21 tons/fed in 2024. These results are consistent with earlier research on *Ocimum gratissimum* (Abdou *et al*., 2011) and *Nigella sativa* (Abd El-Khalek *et al*., 2023), confirming the beneficial effects of SA on herb weight.

Tables 6 and 7 reveal that the combined application of 12 m³/fed of PM and 150 ppm of SA resulted in the highest herb dry weights (g/plant/harvest), with values of 71.7 and 76.7 g (first harvest), 117.5 and 119.2 g (second harvest), and 122.1 and 128.5 g (third harvest) in the first and second seasons, respectively. This combined treatment also produced the highest yields, reaching 8.30 tons/fed and 8.65 tons/fed in the first and second seasons, respectively Table (7).

Table (6): Mean herb dry weight (g)/plant/cut in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	Poultry manure levels (m^3/fed) (A)									
	Control	PM1	PM2	PM3	Mean (SA)	Control	PM1	PM2	PM3	Mean (SA)
	First season					Second season				
	First cut									
Control	39.9	51.3	60.3	62.7	53.6	44.2	51.5	61.9	69.1	56.7
SA1	43.8	52.7	62.8	64.8	56.0	47.1	57.3	66.8	70.1	60.3
SA2	46.5	56.3	65.8	66.3	58.7	49.0	58.5	69.5	74.1	62.8
SA3	48.2	58.7	69.7	71.7	62.1	52.0	62.2	74.8	76.7	66.4
SA4	47.6	57.7	67.5	69.5	60.6	50.3	60.3	70.4	75.8	64.2
Mean (PM)	45.2	55.3	65.2	67.0		48.5	58.0	68.7	73.2	
LSD 0.05	PM: 2.9		SA: 2.3	PMxSA: 4.6		PM: 2.0		SA: 2.3		PMxSA: 4.5
	Second cut									
Control	64.2	84.4	88.0	99.3	84.0	67.5	81.3	89.8	101.2	85.0
SA1	71.1	83.7	92.4	104.7	88.0	71.4	87.0	94.0	106.0	89.6
SA2	74.0	84.4	96.3	109.5	91.0	74.9	84.6	98.2	111.7	92.3
SA3	76.9	87.9	98.9	117.5	95.3	78.6	88.0	100.9	119.3	96.7
SA4	76.5	85.2	97.4	114.3	93.4	76.6	87.2	98.7	118.2	95.2
Mean (PM)	72.6	85.1	94.6	109.1		73.8	85.6	96.3	111.3	
LSD 0.05	PM: 2.3		SA: 3.3	PMxSA: 6.7		PM: 3.1		SA:2.6		PMxSA: 5.2
	Third cut									
Control	68.2	83.9	94.7	109.0	89.0	73.7	84.1	97.6	112.3	91.9
SA1	73.5	90.8	100.8	112.4	94.4	78.1	93.8	105.3	116.9	98.5
SA2	78.1	91.3	104.5	117.2	97.8	82.8	95.8	107.6	120.7	101.7
SA3	84.7	96.0	109.7	122.1	103.1	87.4	98.6	114.4	128.5	107.2
SA4	84.2	93.2	107.2	121.1	101.4	86.4	96.3	110.0	125.9	104.6
Mean (PM)	77.7	91.0	103.4	116.4		81.7	93.7	107.0	120.9	
LSD 0.05	PM: 3.4		SA: 2.3	PMxSA: 4.5		A : 3.8		B : 2.7		AB : 5.4

Leaves dry weight (g)/plant/cut and yield/fed

Tables 8 and 9 indicate that increasing poultry manure (PM) application rates significantly boosted both leaf dry weight and yield in sweet basil over two growing seasons. The highest PM rate (12 m³ per fed) resulted in the greatest leaf dry weights; 34.1, 54.3, and 58.8 g/plant at the first, second, and third cuts in 2023, and 36.2, 58.0, and 63.4 g/plant in 2024. This treatment also achieved the highest leaf yields of 3.92 ton/fed in 2023 and 4.20 ton/fed in 2024. These findings align with previous research such as Okoli and Nweke (2015), which demonstrated that higher PM application rates significantly enhance vegetative growth.

Table (7): Mean herb dry yield ton/fed in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	Poultry manure levels (m^3/fed) (A)				
	Control	PM1	PM2	PM3	Mean (SA)
	First season				
Control	4.60	5.85	6.48	7.22	6.04
SA1	5.02	6.06	6.83	7.52	6.36
SA2	5.30	6.19	7.11	7.81	6.60
SA3	5.59	6.47	7.42	8.30	6.95
SA4	5.56	6.30	7.25	8.13	6.81
Mean (PM)	5.21	6.17	7.02	7.80	
LSD 0.05	PM: 0.16	SA: 0.16	PMxSA: 0.33		
	Second season				
Control	4.94	5.79	6.65	7.54	6.23
SA1	5.24	6.35	7.09	7.81	6.63
SA2	5.51	6.37	7.34	8.17	6.85
SA3	5.81	6.63	7.74	8.65	7.21
SA4	5.69	6.50	7.44	8.53	7.04
Mean (PM)	5.44	6.33	7.25	8.14	
LSD 0.05	PM: 0.18	SA:0.14	PMxSA: 0.28		

Table (8): Mean leaves dry weight (g)/plant/cut in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	Poultry manure levels (m^3/fed) (A)									
	Control	PM1	PM2	PM3	Mean (SA)	Control	PM1	PM2	PM3	Mean (SA)
	First season					Second season				
	First cut									
Control	15.5	20.6	27.3	31.4	23.7	19.5	24.8	31.2	33.6	27.3
SA1	18.2	23.4	31.5	33.5	26.7	21.3	27.1	33.7	35.4	29.4
SA2	19.6	24.5	33.0	34.4	27.9	21.4	27.3	34.3	36.8	29.9
SA3	21.1	26.6	36.0	35.9	29.9	23.6	28.8	38.3	38.2	32.2
SA4	20.8	25.8	33.5	35.2	28.8	23.1	28.2	35.2	37.2	30.9
Mean (PM)	19.0	24.2	32.3	34.1		21.8	27.2	34.5	36.2	
LSD 0.05	PM: 1.2	SA: 1.1	PMxSA: 2.2			PM: 0.9	SA: 1.1	PMxSA: 2.1		
	Second cut									
Control	28.4	33.8	40.5	49.7	38.1	29.6	36.5	44.7	51.3	40.5
SA1	31.2	36.6	43.9	52.2	41.0	32.5	41.7	47.2	55.0	44.1
SA2	32.9	36.8	46.8	55.1	42.9	33.5	43.4	50.8	59.0	46.7
SA3	34.8	38.4	48.8	57.8	44.9	36.1	47.1	54.0	63.3	50.1
SA4	33.4	37.9	46.9	56.8	43.8	35.9	43.8	51.6	61.7	48.3
Mean (PM)	32.1	36.7	45.4	54.3		33.5	42.5	49.7	58.0	
LSD 0.05	PM: 1.9	SA: 1.6	PMxSA: 3.3			PM: 2.6	SA: 1.7	PMxSA: 3.4		
	Third cut									
Control	33.1	42.4	45.9	54.1	43.9	34.8	45.5	52.0	59.3	47.9
SA1	35.9	45.2	49.2	57.2	46.9	40.1	50.1	55.5	60.5	51.6
SA2	37.5	46.1	51.8	58.9	48.6	42.9	51.4	57.9	64.1	54.1
SA3	39.8	48.6	54.1	62.9	51.3	45.9	53.5	60.7	67.3	56.8
SA4	38.4	46.3	51.8	60.7	49.3	45.0	52.0	58.3	65.8	55.3
Mean (PM)	36.9	45.7	50.6	58.8		41.8	50.5	56.9	63.4	
LSD 0.05	PM: 1.3	SA: 2.1	PMxSA: 4.2			PM: 1.9	SA: 2.9	PMxSA: 5.8		

Across both growing seasons and all harvests, foliar spraying with salicylic acid (SA) improved leaf dry weight compared to the control (Tables 8 and 9). The 150-ppm SA treatment consistently yielded the highest leaf dry weight and yield per fed, establishing it as the optimal concentration. Specifically, this treatment resulted in leaf dry weights of 29.9 and 32.2 g at the first cut, 44.9 and 50.1 g at the second cut, and 51.3 and 56.8 g at the third cut for 2023 and 2024, respectively, while control plants consistently recorded the lowest values.

The interaction of poultry manure (PM) and salicylic acid (SA) significantly enhanced leaf dry weight and yield in both growing seasons (Tables 8 and 9). Most combined treatments led to substantial increases in these parameters compared to the control, with the combination of 12 m³/fed PM and 150 ppm SA emerging as the most effective treatment across all harvests.

Table (9): Mean leaves dry yield (ton)/fed in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	**Poultry manure levels (m³ /fed) (A)**				
	Control	**PM1**	**PM2**	**PM3**	**Mean (SA)**
			First season		
Control	2.05	2.58	3.03	3.60	2.82
SA1	2.27	2.81	3.32	3.81	3.05
SA2	2.40	2.86	3.51	3.96	3.18
SA3	2.55	3.03	3.70	4.18	3.36
SA4	2.47	2.93	3.53	4.07	3.25
Mean (PM)	2.35	2.84	3.42	3.92	
LSD 0.05	PM: 0.10	SA: 0.08	PMxSA: 0.16		
			Second season		
Control	2.24	2.85	3.41	3.85	3.09
SA1	2.51	3.17	3.64	4.02	3.33
SA2	2.61	3.26	3.81	4.26	3.49
SA3	2.82	3.45	4.08	4.50	3.71
SA4	2.77	3.31	3.87	4.39	3.58
Mean (PM)	2.59	3.21	3.76	4.20	
LSD 0.05	PM:0.08	SA: 0.08	PMxSA: 0.15		

Essential oil production parameters (%/plant/cut and l/fed/season)

Tables 10 and 11 reveal that increasing poultry manure (PM) application rates significantly enhanced the essential oil percentage and yield in sweet basil leaves across all three harvests over two growing seasons. At the highest PM rate (12 m³/fed), the essential oil percentage reached 1.225 and 1.261% in the first cut, 1.534 and 1.559% in the second cut, and 1.625 and 1.702% in the third cut for the first and second seasons, respectively, while the oil yield peaked at 58.94 and 65.24 l/fed/season. These findings support previous research on aromatic plants such as coriander (Hamza *et al*., 2021; Rasouli *et al*., 2022), basil (El Gohary *et al*., 2023; Sayarer *et al*., 2023), and caraway (Omer *et al*., 2020).

In addition, foliar application of salicylic acid (SA) significantly enhanced essential oil production. Although most SA concentrations improved the essential oil percentage relative to the control, the 150-ppm treatment was the most effective.

Under 150 ppm SA, essential oil percentages were 1.159 and 1.192% at the first cut, 1.408 and 1.457% at the second cut, and 1.484 and 1.524% at the third cut in the two seasons, with corresponding yields of 47.5 and 53.88 l/fed. In contrast, the control treatments yielded lower percentages and yields. These results are consistent with previous findings in aromatic plants such as coriander (Hassan and Ali, 2010; Rekaby, 2013) and *Nigella sativa* (Abd El-Khalek *et al.*, 2023).

Table (10): Mean essential oil percentage/plant/cut in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	**Poultry manure levels (m^3/fed) (A)**									
	Control	**PM1**	**PM2**	**PM3**	**Mean (SA)**	**Control**	**PM1**	**PM2**	**PM3**	**Mean (SA)**
	First season					Second season				
	First cut									
Control	0.916	1.048	1.095	1.172	1.058	0.914	1.083	1.124	1.196	1.079
SA1	0.928	1.087	1.137	1.176	1.082	0.937	1.125	1.171	1.199	1.108
SA2	0.971	1.106	1.172	1.231	1.120	0.984	1.136	1.207	1.288	1.154
SA3	1.040	1.115	1.193	1.289	1.159	1.032	1.189	1.229	1.315	1.192
SA4	1.011	1.114	1.143	1.257	1.131	1.029	1.137	1.209	1.308	1.170
Mean (PM)	0.973	1.094	1.148	1.225		0.979	1.134	1.188	1.261	
LSD 0.05	PM: 0.046	SA: 0.045	PMxSA: 0.091			PM: 0.044	SA: 0.043	PMxSA: 0.087		
	Second cut									
Control	1.048	1.205	1.378	1.450	1.271	1.059	1.305	1.419	1.478	1.315
SA1	1.075	1.209	1.445	1.460	1.297	1.095	1.333	1.471	1.480	1.345
SA2	1.131	1.253	1.525	1.524	1.358	1.153	1.348	1.538	1.567	1.402
SA3	1.162	1.290	1.556	1.624	1.408	1.193	1.368	1.590	1.679	1.457
SA4	1.154	1.276	1.400	1.610	1.360	1.166	1.359	1.477	1.589	1.398
Mean (PM)	1.114	1.247	1.461	1.534		1.133	1.342	1.499	1.559	
LSD 0.05	PM: 0.022	SA: 0.030	PMxSA: 0.059			PM: 0.034	SA: 0.044	PMxSA:0.088		
	Third cut									
Control	1.061	1.322	1.444	1.531	1.339	1.138	1.357	1.477	1.581	1.388
SA1	1.110	1.337	1.494	1.537	1.369	1.183	1.367	1.550	1.635	1.434
SA2	1.144	1.339	1.574	1.624	1.420	1.217	1.371	1.598	1.692	1.470
SA3	1.207	1.379	1.603	1.747	1.484	1.289	1.384	1.613	1.808	1.524
SA4	1.198	1.378	1.602	1.683	1.465	1.257	1.367	1.524	1.792	1.485
Mean (PM)	1.144	1.351	1.543	1.625		1.217	1.370	1.552	1.702	
LSD 0.05	PM: 0.032	SA: 0.048	PMxSA: 0.095			PM: 0.067	SA: 0.039	PMxSA: 0.079		

The interaction between PM and SA had a statistically significant effect on essential oil production in sweet basil leaves across all harvests in both seasons. Overall, all combined treatments boosted essential oil production compared to the control, with the exception of the treatment combining no PM with 50 ppm SA in some instances. Essential oil production increased progressively from the first to the third cut. Notably, the combination of 12 m³/fed PM and 150 ppm SA was the most effective, achieving the highest essential oil production across all cuts, as shown in Tables 10 and 11.

Table (11): Mean yield of essential oil (l)/fed in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	**Poultry manure levels (m^3/fed) (A)**				
	Control	**PM1**	**PM2**	**PM3**	**Mean (SA)**
			First season		
Control	21.06	31.62	40.53	51.13	**36.09**
SA1	24.07	34.75	46.08	54.28	**39.80**
SA2	26.45	35.94	51.06	59.22	**43.17**
SA3	29.44	38.99	54.85	66.70	**47.50**
SA4	28.15	37.53	49.86	63.37	**44.73**
Mean (PM)	25.84	35.77	48.48	58.94	
LSD 0.05	PM: 1.34		SA: 1.08	PMxSA: 2.16	
			Second season		
Control	23.69	36.32	46.75	55.97	40.68
SA1	27.54	41.24	51.99	59.40	45.04
SA2	29.86	42.67	56.57	66.19	48.82
SA3	33.77	46.09	61.47	74.17	53.88
SA4	32.64	43.37	55.38	70.48	50.47
Mean (PM)	29.50	41.94	54.43	65.24	
LSD 0.05	PM: 1.67		SA: 1.52	PMxSA: 3.04	

Nitrogen, phosphorus and potassium percentages

Table 12 shows that both poultry manure (PM) and salicylic acid (SA) significantly increased the nitrogen (N), phosphorus (P), and potassium (K) percentages in dried sweet basil leaves across two growing seasons.

PM applications at 4, 8, and 12 m³ per fed all improved these nutrient levels compared to the control, with the highest PM rate (12 m³/fed) yielding the maximum N, P, and K percentages. This dose-dependent response confirms that higher PM levels enhance nutrient accumulation in sweet basil. These findings align with previous research on medicinal plants such as *Calendula officinalis* (Vieira *et al*., 2002), *Ocimum basilicum* and *Origanum majoranum* (El-Sanafawy, 2007), *Thymus vulgaris* (Ateia *et al*., 2009), and *Ammi visnaga* (Mahmoud, 2017).

Foliar spraying with salicylic acid (SA) significantly improved nutrient content in sweet basil, with the 150-ppm SA treatment yielding the highest percentages of nitrogen, phosphorus, and potassium compared to unsprayed plants. All SA concentrations enhanced nutrient levels relative to the control, supporting its role in promoting physiological processes associated with nutrient uptake (Abd El-Khalek *et al*., 2023).

Moreover, the interaction between poultry manure (PM) and SA revealed a synergistic effect on nutritional percentages. As PM levels increased, nutrient percentages consistently rose across both seasons, regardless of SA concentration. The optimal combination (12 m³/fed PM with 150 ppm SA), produced the highest levels of N, P, and K, demonstrating that the integrated use of organic manure and SA optimizes nutrient status in sweet basil.

Table (12): Mean N, P and K percentages in sweet basil as affected by PM and SA and their interactions during the 2023 and 2024 seasons

Salicylic acid (B)	Poultry manure levels (m³/fed) (A)									
	Control	PM1	PM2	PM3	Mean (SA)	Control	PM1	PM2	PM3	Mean (SA)
	First season					Second season				
	N %									
Control	1.82	2.08	2.43	2.67	2.25	2.28	2.50	2.54	2.63	2.49
SA1	1.95	2.20	2.49	2.84	2.37	2.32	2.52	2.60	2.72	2.54
SA2	2.11	2.45	2.59	2.87	2.50	2.36	2.53	2.65	2.80	2.58
SA3	2.19	2.42	2.52	2.97	2.52	2.37	2.54	2.69	2.85	2.61
SA4	2.10	2.41	2.50	2.90	2.47	2.35	2.52	2.64	2.74	2.56
Mean (PM)	2.03	2.31	2.50	2.85		2.34	2.52	2.62	2.75	
LSD 0.05	PM: 0.09		SA: 0.08	PMxSA: 0.15		PM: 0.10		SA: 0.06	PMxSA: 0.12	
	P %									
Control	0.394	0.440	0.446	0.472	0.438	0.427	0.441	0.479	0.505	0.463
SA1	0.418	0.445	0.457	0.495	0.454	0.434	0.470	0.490	0.511	0.476
SA2	0.426	0.457	0.476	0.508	0.467	0.459	0.490	0.509	0.527	0.496
SA3	0.419	0.452	0.475	0.510	0.464	0.447	0.476	0.504	0.532	0.490
SA4	0.415	0.446	0.461	0.509	0.458	0.445	0.472	0.502	0.527	0.486
Mean (PM)	0.415	0.448	0.463	0.499		0.443	0.470	0.497	0.520	
LSD 0.05	PM: 0.021		SA: 0.026	PMxSA: 0.052		PM: 0.017		SA: 0.012	PMxSA: 0.024	
	K %									
Control	1.89	1.94	2.22	2.42	2.12	2.04	2.28	2.31	2.41	2.26
SA1	2.01	1.99	2.27	2.59	2.22	2.10	2.30	2.40	2.50	2.32
SA2	2.04	2.24	2.34	2.65	2.32	2.14	2.35	2.42	2.57	2.37
SA3	2.17	2.26	2.27	2.69	2.35	2.16	2.33	2.44	2.62	2.39
SA4	2.07	2.22	2.25	2.59	2.28	2.12	2.30	2.42	2.52	2.34
Mean (PM)	2.04	2.13	2.27	2.58		2.11	2.31	2.40	2.52	
LSD 0.05	PM: 0.12		SA: 0.08	PMxSA:0.16		PM:0.09		SA: 0.06	PMxSA:0.12	

CONCLUSIONS

The results above suggest that treating sweet basil with PM at a rate of 12 m³ per fed along with 150-ppm SA optimizes productivity. This study provides evidence that this integrated approach may be a viable cultivation technique for aromatic crops.

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CONFLICT OF INTEREST

The authors state that there are no conflicts of interest related to this publication.

تحسين إنتاجية الريحان الحلو في الأراضي المستصلحة حديثًا باستخدام سماد الدواجن وحمض الساليسيليك

يوسف عنتر محمود [1]، السيد حماد عامر [1]، عاطف عبده سيد [2]
قسم البساتين / كلية الزراعة / جامعة الأزهر / فرع أسيوط / مصر [1]
قسم بحوث النباتات الطبية والعطرية / معهد بحوث البساتين / مركز البحوث الزراعية الجيزة / مصر [2]

الخلاصة

دَرَسَتْ هذه الدراسة تأثيرات سماد الدواجن كسماد عضوي وحمض الساليسيليك كمنشط لنمو النبات على نمو الريحان الحلو وإنتاج الزيت العطري خلال موسمي نمو (2023 و2024). تم تطبيق سماد الدواجن على التربة بمعدلات 0.0، 4.0، 8.0، و12.0 متر مكعب/فدان، بينما تم تطبيق رش ورقي بحمض الساليسيليك بنسب (0، 50، 100، 150، و200 جزء في المليون). أظهرت النتائج أن تطبيق سماد الدواجن على جميع المستويات والرش الورقي بحمض الساليسيليك بكافة التراكيز أدى بشكل ملحوظ إلى زيادة في ارتفاع النبات، وعدد الفروع لكل نبات، والأوزان الجافة للعشب والأوراق، ومحتوى الزيت العطري، ونسب النيتروجين والفوسفور والبوتاسيوم في الأوراق الجافة خلال جميع الحشات في كلا الموسمين. وقد أدى أعلى مستوى من سماد الدواجن (12 متر مكعب/فدان) باستمرار إلى تحقيق أعلى قيم للنمو. علاوة على ذلك، كان تطبيق حمض الساليسيليك بتركيز 150 جزء في المليون هو الأكثر فعالية في تطبيق الرش الورقي لتعزيز الصفات المدروسة خلال جميع الحشات. كما لوحظت تأثيرات تفاعلية ذات دلالة إحصائية لجميع المعايير المدروسة. وتبين أن المعاملة التي جمعت بين أعلى مستوى من سماد الدواجن (12 متر مكعب/فدان) وحمض الساليسيليك بتركيز 150 جزء في المليون هي الأكثر فعالية بشكل عام خلال جميع الحشات.

الكلمات المفتاحية: الريحان الحلو، سماد الدواجن، حمض الساليسيليك، الزيت الطيار.

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