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EFFECT OF VERMICOMPOST FERTILIZER AND PLANT GROWTH REGULATORS ON SOME CHEMICAL PROPERTIES, GROWTH, AND FLOWERING OF *CAMELLIA JAPONICA* PLANT

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ABSTRACT

This experiment aimed to improve the growth and flowering of *Camellia japonica* by applying vermicompost fertilizer (0%, 7.5%, 15%) and its symbols V_0 ,V_1,V_2 sequentially, and foliar application plant growth regulators (salicylic acid in concentration 0,100,200 mg L^1 and its symbols S_0,S_1,S_2 and gibberellic acid in concentration 0,150,300 mg L^{-1} and its symbols G_0,G_1,G_2 respectively). The plants were cultivated under a shade net structure of the Department of Horticulture and Garden Engineering - College of Agricultural Engineering Sciences - University of Baghdad .Using randomized Complete Block Design (RCBD). The $V_2S_2G_2$ treatment showed significant improvements in vegetative and flowering growth indicators. Plant height reached 95.3 cm, and 120.5 cm, and chlorophyll content was 252.7 mg100^{-1} g and 280.8 mg100^{-1} g, respectively, in the two seasons. The carbohydrate percentage was59.4% and 66.1%. Flowering indicators included improved dry matter percentage in flowers (11.96% and 12.18%), the concentration of anthocyanin dye also reached248.8 and 257.5 mg L^{-1} dry weight. The percentage of magnesium was 0.59% and 0.63%, and iron concentration was 123.8 mg kg^{-1} and 131.4 mg kg^{-1} in both seasons.

Key words: ***Camellia japonica*, micro nutrients, organic fertilizers, ornamental plants.**
***Part of PhD. Dissertation of 1st author.**

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INTRODUCTION

Camellia, also known as the Winter Rose (*Camellia japonica* L.), is a perennial evergreen shrub belonging to the tea family (*Theaceae*). It naturally grows in South Korea, Japan, and China (Yang et al., 2021). Camellia is considered a slow-growing ornamental flowering shrub, heights reaching between 1.5 to 6 meters. It has leathery, oval-shaped, serrated leaves arranged alternately along the stem. The shrub is known for producing large flowers in a variety of colors, including white, red, and pink, which typically bloom from late winter to early spring (Wang et al., 2020). Camellia shrubs prefer acidic soil, partial shade, and protection from direct sunlight and harsh hot winds (Kim et al., 2017). The Camellia shrub is used as a flowering potted plant to beautify balconies and windows, as well as for cut flowers. Its seeds and leaves are also used for medicinal purposes in the treatment of cancer and inflammation (Guo et al., 2018; Majumder et al., 2020). Camellia shrubs require organic fertilizers to produce a large number of high-quality flowers. Organic fertilization is one of the important methods for supplying plants with essential nutrients without negatively impacting the environment. Additionally, over-fertilization with organic matter does not harm the plant, unlike excessive use of mineral fertilizers. Vermicompost is considered a vital organic fertilizer, consisting of an active biological mixture of bacteria, enzymes, and microorganisms. Vermicompost contains essential nutrients for plants, such as nitrogen, phosphorus, potassium, and calcium, in forms

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that are soluble and easily absorbed by the plant. It also contains biologically active substances, including plant growth regulators. Vermicompost increases the organic matter in the soil, improves soil structure, enhances water retention, and provides good aeration, thereby improving root growth and promoting the spread of beneficial microorganisms in the soil (Rekha et al., 2018; Abdulrasool, 2022; Wu et al., 2023). Eskandari *et al*. (2016) found that the application of vermicompost (0%, 10%, 20%, 40%, 80%) on *Rosa hybrid* shrubs led to a significant improvement in floral longevity and the dry weight of the leaves. Salicylic acid (SA) is one of the internal growth regulators and is a phenolic compound consisting of an aromatic ring with a hydroxyl group. It plays a role in various physiological processes such as growth, metabolism, and protein synthesis. It also inhibits ethylene production and has an opposite effect to abscisic acid (ABA) in controlling stomatal opening and closing. Moreover, it enhances water and nutrient uptake from the soil by improving the transport between roots and shoots (Hayat et al, 2010). Shen et al. (2016) indicated that salicylic acid enhanced the heat tolerance of *Rhododendron* plants and had a positive effect on plant growth, chlorophyll content, and total soluble protein levels. Alam et al. (2012) showed that salicylic acid increased the NPK content in the leaves of *Catharanthus roseus* L. Gibberellins are among the most effective plant growth stimulators, especially gibberellic acid (GA_3).They plead an important role in activating and promoting cell elongation, increasing cell size, and stimulating flower formation and development, as well as increasing the number of leaves (Pal, 2019). Chandra Sekhar et al. (2020) discovered that the effect of gibberellic acid on the growth and production of *Jasminum nitidum* flowers led to a significant increase in plant height, the number of secondary branches, and flower yield. This study aimed to improve the growth and flowering of *Camellia japonica* by applying different amount of vermicompost and concentrations of gibberellic acid, and salicylic acid.

MATERIALS AND METHODS

This study was conducted at the Agricultural Research Station (B) of the College of Agricultural Engineering Sciences – University of Baghdad, Jadriyah campus, in a shade net structure (covered with saran cloth) on *Camellia japonica* saplings over two consecutive seasons, 2022/2023. The *Camellia japonica* saplings, obtained from a nursery in Baghdad, were transplanted into 12 kg plastic pots on 1/6/2022. The pots contained a garden sand substrate mixed with three levels of vermicompost, the first factor: 0%, 7.5%, and 15%, labeled as V_0, V_1, and V_2, respectively. One month after planting, the second factor, salicylic acid, was applied at concentrations 0, 100, and 200 mg L^1, labeled as S_0, S_1, and S_2. Four days later, the third factor, gibberellic acid, was foliar application concentrations 0, 150, and 300 mg L^{-1}, labeled as G_0, G_1, and G_2. A total of three foliar application were applied at 21-day intervals. Control plants were foliar application with distilled water only. Half of the recommended NPK fertilizer (20-20-20) was applied to the camellia saplings every 30 days throughout the research period. The factorial experiment (3*3*3) Randomized Complete Block Design (RCBD) with three replicates, each experimental unit pot containing 3 plants. The total number of saplings used for the two seasons (2022-2023) was 243.

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Table 1. Some chemical and physical properties of the planting soil and vermicompost fertilizer

Properties		Soil	Vermicompost	Unit
EC 1:1		0.80		dsm^{-1}
pH		7.2	7.5	-------
Available Nitrogen (N)		25.01	2.33	mg kg^{-1} soil
Available Phosphorus (P)		8.25	0.48	
Available Potassium (K)		78.50	1.65	
Organic Matter (O M)		14.3	-------	g kg^{-1}
		-------	0.99	%
Soluble Calcium (Ca^{+2})		4.03	0.45	meq L^{-1}
Magnesium (Mg^{+2})		2.52	0.25	
Soil Separates	Sand	952	----------	g kg^{-1} soil
	Silt	20	----------	
	Clay	28	----------	
Soil Texture		Sand		------

The soil and Fertilizer analyzed in the laboratories of the Soil Department at the College of Agriculture – University of Baghdad

RESULTS AND DISCUSSION

1- **Plant height (cm):** The results in Table (2) showed a significant effect of vermicompost fertilizer on plant height. The treatment V_2 resulted the highest plant height 83.9 cm and 103.6 cm, compared to the control V_0, which gave lowest values of 79.6 cm and 92.8 cm, respectively, for both seasons. Similarly, the salicylic acid spray treatment S_2 showed the highest plant height of 84.7 cm and 105.5 cm. Gibberellic acid spray G_2 treatment resulting in heights of 86.1 cm and 107.3 cm for both seasons. Regarding the two-way interactions, the V_2S_2 treatment resulted the highest plant height, with 88.1 cm and 109.9 cm, compared to the controlV_0S_0, which gave lowest values of 76.7 cm and 86.6 cm, respectively, for both seasons. Additionally, the interaction between vermicompost and gibberellic acid showed that the V_2G_2 treatment had the highest plant height, reaching 88.8 cm and 112.8 cm, while the lowest values were observed in the control V_0G_0 (74.1 cm and 84.7 cm). Moreover, the interaction between salicylic acid and gibberellic acid had a significant effect, with the S_2G_2 treatment giving the highest plant heights of 89.7 cm and 115.4 cm for both seasons. The three-way interaction $V_2S_2G_2$ recorded the highest plant height, reaching 95.3 cm and 120.5 cm, compared to the control, which gave 71.2 cm and 83.1 cm for both seasons.

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Table 2. Effect of vermicompost fertilizer application, salicylic acid, gibberellic acid on the plant height (cm) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	71.2	79.4	79.5	76.7	83.1	88.2	88.5	86.6
V_0	S_1	75.4	82.5	85.1	81.0	85.4	97.5	100.5	94.5
	S_2	75.5	82.5	85.2	81.1	85.5	100.4	105.5	97.2
	S_0	71.4	80.1	82.2	77.9	83.4	95.4	97.2	92.0
V_1	S_1	80.4	85.4	88.1	84.6	90.4	105.5	115.4	103.8
	S_2	80.5	85.5	88.4	84.8	93.2	115.2	120.2	109.5
	S_0	71.5	82.2	82.4	78.7	83.5	95.4	97.5	92.2
V_2	S_1	80.4	85.5	88.5	84.8	90.5	115.4	120.4	108.8
	S_2	80.5	88.5	95.3	88.1	93.5	115.5	120.5	109.9
L.S.D 0.05			0.29		0.17		0.29		0.17
V			V × G		V		V × G		V
V_0		74.1	81.5	83.3	79.6	84.7	95.4	98.2	92.8
V_1		77.4	83.7	86.2	82.5	89.0	105.4	110.9	101.8
V_2		77.5	85.4	88.8	83.9	89.2	108.8	112.8	103.6
L.S.D 0.05			0.17		0.10		0.17		0.10
S			S × G		S		S × G		S
S_0		71.4	80.6	81.4	77.8	83.3	93.0	94.4	90.3
S_1		78.7	84.5	87.2	83.5	88.8	106.2	112.1	102.4
S_2		78.9	85.5	89.7	84.7	90.8	110.4	115.4	105.5
L.S.D 0.05			0.17		0.10		0.17		0.10
G		76.3	83.5	86.1		87.6	103.2	107.3	
L.S.D 0.05			0.10				0.10		

2- Chlorophyll content in leaves (mg 100^{-1} g fresh weight): The results indicated a significant effect of vermicompost fertilizer on leaf chlorophyll content Table (3). The V_2 treatment produced the highest chlorophyll content in leaves, reaching 216.8 mg 100^{-1} g and 233.6 mg 100 $^{-1}$ g, compared to the control, which gave 199.1 mg 100^{-1} g and 210.4 mg 100^{-1} g, respectively, for both seasons. The results of salicylic acid spraying showed the S_2 treatment showed a significant effect in both seasons, 221.8 mg 100^{-1} g and 240.5 mg 100^{-1} g. Similarly, gibberellic acid spraying had a clear role in increasing leaf chlorophyll content, the G_2 treatment resulting 227.7 mg 100^{-1} g and 242.8 mg 100^{-1} g for both seasons. The two-way interaction between vermicompost and salicylic acid had a significant effect in both seasons, the V_2S_2 treatment yielding 229.8 mg and 251.3 mg 100^{-1} g, compared to the control V_0S_0, which gave 178.9 mg and 188.9 mg per 100 g. The interaction between vermicompost and gibberellic acid also showed a significant effect, the V_2G_2 treatment reaching the highest chlorophyll content 238.4 mg and 257.4 mg 100^{-1} g, while the lowest values were recorded in the control (177.2 mg and 184.9 mg 100^{-1} g). Additionally, the interaction between salicylic acid and gibberellic acid had a significant impact, the S_2G_2 treatment producing 242.0 mg and 264.4 mg 100^{-1} g for both seasons while the lowest values of 173.1 mg 100^{-1} g and 178.3 mg 100^{-1} g. The three-way interaction $V_2S_2G_2$ resulted the highest chlorophyll content in leaves, reaching 252.7 mg and 280.8 mg 100^{-1} g fresh weight, compared to the control, which gave 170.6 mg and 175.5 mg per 100 g fresh weight.

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Table 3. Effect of vermicompost fertilizer, salicylic acid, gibberellic acid sprays, on chlorophyll content in leaves (mg 100^{-1} g fresh weight) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	170.6	180.3	185.7	178.9	175.5	193.6	197.5	188.9
V_0	S_1	177.4	219.0	225.5	207.3	183.6	225.2	234.8	214.5
	S_2	183.5	220.7	228.8	211.0	195.6	237.7	249.6	227.7
	S_0	173.3	191.5	209.6	191.5	179.4	209.6	211.6	200.2
V_1	S_1	188.8	230.8	239.7	219.8	198.5	255.4	256.9	236.9
	S_2	193.7	235.8	244.6	224.7	206.7	259.7	262.6	243.0
	S_0	175.5	200.8	212.8	196.3	180.0	217.6	227.1	208.3
V_2	S_1	190.8	232.6	249.7	224.4	200.8	258.7	264.3	241.3
	S_2	195.8	240.9	252.7	229.8	212.4	260.6	280.8	251.3
L.S.D 0.05			3.244		1.873		1.841		1.063
V			V × G		V		V × G		V
V_0		177.2	206.7	213.3	199.1	184.9	218.9	227.3	210.4
V_1		185.3	219.4	231.3	212.0	194.8	241.6	243.7	226.7
V_2		187.4	224.8	238.4	216.8	197.7	245.7	257.4	233.6
L.S.D 0.05			1.873		1.081		1.063		0.614
S			S × G		S		S × G		S
S_0		173.1	190.9	202.7	188.9	178.3	206.9	212.1	199.1
S_1		185.7	227.5	238.3	217.2	194.3	246.5	252.0	230.9
S_2		191.0	232.4	242.0	221.8	204.9	252.7	264.4	240.5
L.S.D 0.05			1.873		1.081		1.063		0.614
G		183.3	216.9	227.7		192.5	235.4	242.8	
L.S.D 0.05			1.081				0.614		

3- Total carbohydrate percentage in leaves (%): The results showed a significant effect of vermicompost on the total carbohydrate percentage in leaves Table (4). The V_2 treatment gave the highest percentage of carbohydrates, reaching 57.1% and 60.6%, compared to the control, which gave 55.5% and 57.8%. Salicylic acid spraying also had a significant effect, the S_2 treatment resulting 57.4% and 61.5% for both seasons. Gibberellic acid spraying also played a clear role in increasing carbohydrate content, the G_2 treatment giving 57.7% and 61.9% compared to the control 54.7% and 56.4%. The two-way interaction between vermicompost and salicylic acid had a significant effect, the V_2S_2 treatment reaching 58.0% and 62.9%, compared to the control V_0S_0, which gave 53.8% and 55.6%. Similarly, the interaction between vermicompost and gibberellic acid showed a significant effect on leaf carbohydrate content, the V_2G_2 treatment producing the highest values 58.5% and 63.6%, while the lowest values were recorded in the control (53.7% and 55.5%). The interaction between salicylic acid and gibberellic acid also had a significant effect, the S_2G_2 treatment giving 58.8% and 64.0% while the lowest values of 53.9 % and 54.9 %. Regarding the three-way interaction, significant differences were observed between the treatments, the $V_2S_2G_2$ treatment recording the highest carbohydrate content 59.4% and 66.1%, while the lowest content was observed in the control (53.1% and 54.5%) for both seasons.

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Table 4. Effect of vermicompost fertilizer, salicylic acid, gibberellic acid sprays on total carbohydrate percentage in leaves (%) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	53.1	53.6	54.7	53.8	54.5	55.9	56.5	55.6
V_0	S_1	53.5	56.9	57.5	56.0	55.8	58.9	60.9	58.5
	S_2	54.5	57.2	58.1	56.6	56.3	60.5	61.2	59.4
	S_0	54.2	55.6	56.5	55.4	54.8	57.3	58.5	56.9
V_1	S_1	55.2	57.7	58.7	57.2	56.8	61.8	64.6	61.1
	S_2	56.0	58.2	58.9	57.7	57.9	63.8	64.7	62.1
	S_0	54.5	55.8	56.8	55.7	55.6	57.8	58.9	57.4
V_2	S_1	55.4	57.9	59.1	57.5	57.0	62.0	65.9	61.6
	S_2	56.3	58.4	59.4	58.0	58.7	64.0	66.1	62.9
L.S.D 0.05			0.13		0.075		0.017		0.01
V			V × G		V		V × G		V
V_0		53.7	55.9	56.8	55.5	55.5	58.4	59.5	57.8
V_1		55.1	57.2	58.0	56.8	56.5	61.0	62.6	60.0
V_2		55.4	57.4	58.5	57.1	57.1	61.2	63.6	60.6
L.S.D 0.05			0.075		0.043		0.01		0.006
S			S × G		S		S × G		S
S_0		53.9	55.0	56.0	55.0	54.9	57.0	57.9	56.6
S_1		54.7	57.5	58.4	56.9	56.5	60.9	63.8	60.4
S_2		55.6	57.9	58.8	57.4	57.6	62.8	64.0	61.5
L.S.D 0.05			0.075		0.043		0.01		0.006
G		54.7	56.8	57.7		56.4	60.2	61.9	
L.S.D 0.05			0.043				0.0.006		

4- Percentage of dry matter in flowers (%)

Table (5) showed a significant effect of vermicompost on the percentage of dry matter in flowers. The V_2 treatment gave the highest percentage of dry matter, reaching 10.57% and 11.14%, compared to the control, which gave 9.84% and 10.42%. Salicylic acid spraying also had a significant effect, the S_2 treatment resulting 10.81% and 11.36% for both seasons compared to the control 9.50% and 10.06%. Gibberellic acid spraying further increased the percentage of dry matter in flowers, the G_2 treatment resulting 10.98% and 11.45% compared to the control 9.33% and 9.96%. The two-way interaction between vermicompost and salicylic acid significantly increased the dry matter percentage, the V_2S_2 treatment giving 11.19% and 11.63%. Similarly, the interaction between vermicompost and gibberellic acid (V_2G_2) showed a significant effect, the highest values recorded 11.39% and 11.76%, while the lowest values were observed in the control (9.07% and 9.54%). The interaction between salicylic acid and gibberellic acid (S_2G_2) also had a significant effect, with the dry matter percentage reaching 11.51% and 11.94% for both seasons while the lowest values 8.71% and 9.32%. The three-way interaction $V_2S_2G_2$ resulted the highest dry matter percentage, reaching 11.96% and 12.18%, compared to the control, which gave 8.52% and 9.16% for both seasons.

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Table 5. Effect of vermicompost fertilizer, salicylic acid, gibberellic acid sprays on percentage of dry matter in flowers (%) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	8.52	9.38	9.54	9.15	9.16	9.76	9.86	9.59
V_0	S_1	9.26	10.43	10.71	10.13	9.63	11.19	11.43	10.75
	S_2	9.43	10.52	10.74	10.23	9.83	11.32	11.58	10.91
	S_0	8.76	9.94	10.18	9.63	9.33	10.52	10.87	10.24
V_1	S_1	9.74	10.91	11.66	10.77	10.28	11.63	11.97	11.30
	S_2	10.06	11.13	11.83	11.01	10.72	11.85	12.06	11.54
	S_0	8.86	9.96	10.34	9.72	9.46	10.62	10.95	10.34
V_2	S_1	9.19	11.37	11.86	10.81	10.43	11.78	12.15	11.45
	S_2	10.12	11.50	11.96	11.19	10.78	11.93	12.18	11.63
L.S.D 0.05			0.183		0.106		0.019		0.011
V			V × G		V		V × G		V
V_0		9.07	10.11	10.33	9.84	9.54	10.76	10.96	10.42
V_1		9.52	10.66	11.22	10.47	10.11	11.33	11.63	11.03
V_2		9.39	10.94	11.39	10.57	10.22	11.44	11.76	11.14
L.S.D 0.05			0.106		0.061		0.011		0.006
S			S × G		S		S × G		S
S_0		8.71	9.76	10.02	9.50	9.32	10.30	10.56	10.06
S_1		9.40	10.90	11.41	10.57	10.12	11.53	11.85	11.17
S_2		9.87	11.05	11.51	10.81	10.44	11.70	11.94	11.36
L.S.D 0.05			0.106		0.061		0.011		0.006
G		9.33	10.57	10.98		9.96	11.178	11.45	
L.S.D 0.05			0.061				0.006		

5- Anthocyanin pigment (mg 100g $^{-1}$)

The results showed that the anthocyanin pigment content was significantly affected by the vermicompost treatment Table (6). The V_2 treatment gave the highest anthocyanin content, reaching 201.3 mg $100g^{-1}$ and 235.8 mg $100g^{-1}$, compared to the control, which gave 174.5 mg L^{-1} and 216.8 mg L^{-1} dry weight. Similarly, the salicylic acid treatment S_2 significantly increased anthocyanin content, reaching 205.4 mg $100g^{-1}$ and 235.5 mg $100g^{-1}$ for both seasons. Gibberellic acid also had a clear role, the G_2 treatment gave 211.2 mg $100g^{-1}$ and 237.3 mg $100g^{-1}$ for both seasons compared to the control 160.6 mg $100g^{-1}$ and 211.9 mg $100g^{-1}$. The two-way interactions also showed significant effects. The combination of vermicompost and salicylic acid (V_2S_2) significantly increased anthocyanin content, reaching 220.9 mg $100g^{-1}$ and 246.3 mg $100g^{-1}$ for both seasons while the lowest values 145.2 mg $100g^{-1}$ and 206.6 mg $100g^{-1}$. The interaction between vermicompost and gibberellic acid (V_2G_2) also had a significant effect, the highest values recorded at 226.3 mg $100g^{-1}$ and 248.8 mg $100g^{-1}$, while the lowest values were observed in the control (152.2 mg $100g^{-1}$ and 202.9 mg $100g^{-1}$ for both seasons). The interaction between salicylic acid and gibberellic acid (S_2G_2) also showed a significant effect, with anthocyanin content reaching 229.2 mg $100g^{-1}$ and 237.8 mg $100g^{-1}$for both seasons while the lowest values 147.7 mg $100g^{-1}$ and 196.3 mg $100g^{-1}$. The three-way interaction $V_2S_2G_2$ recorded the highest anthocyanin content, reaching 248.8 mg $100g^{-1}$ and 257.5 mg $100g^{-1}$, compared to the control, which gave 145.7 mg $100g^{-1}$ and 193.7 mg $100g^{-1}$ for both seasons.

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Table 6. Effect of vermicompost fertilizer, salicylic acid, gibberellic acid sprays on Anthocyanin pigment (mg 100g^{-1}) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	145.7	155.5	161.5	154.2	193.7	209.6	216.5	206.6
V_0	S_1	152.4	192.5	207.3	184.1	200.6	235.6	238.5	224.9
	S_2	158.5	196.6	200.4	185.2	214.5	237.5	204.5	218.8
	S_0	148.0	171.9	184.5	168.1	196.7	224.9	229.6	217.0
V_1	S_1	164.3	218.4	229.6	204.1	220.9	243.5	248.5	237.6
	S_2	178.2	213.5	238.5	210.1	227.5	245.3	251.3	241.4
	S_0	149.5	175.2	187.6	170.8	198.6	226.3	233.5	219.4
V_2	S_1	168.4	226.0	242.5	212.3	223.0	246.5	255.5	241.6
	S_2	180.4	233.6	248.8	220.9	231.8	249.6	257.5	246.3
L.S.D 0.05			0.594		0.343		0.475		0.274
V			V × G		V		V × G		V
V_0		152.2	181.5	189.7	174.5	202.9	227.6	219.8	216.8
V_1		163.5	201.3	217.5	194.1	215.0	237.9	243.1	232.0
V_2		166.1	211.6	226.3	201.3	217.8	240.8	248.8	235.8
L.S.D 0.05			0.594		0.343		0.475		0.274
S			S × G		S		S × G		S
S_0		147.7	167.5	177.9	164.4	196.3	220.3	226.5	214.4
S_1		161.7	212.3	226.4	200.1	214.8	241.9	247.5	234.7
S_2		172.4	214.6	229.2	205.4	224.6	244.1	237.8	235.5
L.S.D 0.05			0.343		0.198		0.274		0.158
G		160.6	198.1	211.2		211.9	235.4	237.3	
L.S.D 0.05			0.198				0.158		

6- Percentage of magnesium in leaves (%)

The results in Table (7) showed that the addition of vermicompost significantly affected the magnesium percentage in the leaves of *Camellia japonica*. The V_2 treatment resulted the highest magnesium percentage, reaching 0.37% and 0.42% for two consecutive seasons, compared to the V_0 treatment, which had the lowest magnesium percentage 0.26% and 0.31%. Foliar application salicylic acid also showed a significant effect, the S_2 treatment gave the highest magnesium percentage 0.40% and 0.44% for both seasons. Similarly, foliar application gibberellic acid resulted a significant increase in magnesium concentration, the G_2 treatment reaching 0.42% and 0.47% for both seasons compared to the control 0.22% and 0.25%. The two-way interaction between vermicompost and salicylic acid (V_2S_2) significantly increased the magnesium percentage, reaching 0.45% and 0.50% for both seasons. Additionally, the interaction between vermicompost and gibberellic acid (V_2G_2) resulted the highest magnesium percentage, reaching 0.49% and 0.54% for two consecutive seasons while the lowest values 0.18% and 0.22%. The interaction between salicylic acid and gibberellic acid (S_2G_2) also showed a significant effect, on magnesium concentration reaching 0.51% and 0.55% for both seasons while the lowest values 0.15% and 0.19%. The three-way interaction ($V_2S_2G_2$) recorded the highest magnesium percentage, reaching 0.59% and 0.63% for two consecutive seasons while the lowest values 0.14% and 0.18%.

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Table 7. Effect of vermicompost fertilizer, salicylic acid, gibberellic acid sprays on percentage of magnesium in leaves (%) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	0.14	0.19	0.22	0.18	0.18	0.23	0.27	0.23
V_0	S_1	0.18	0.33	0.37	0.29	0.22	0.39	0.43	0.35
	S_2	0.21	0.35	0.39	0.32	0.25	0.41	0.45	0.37
	S_0	0.15	0.26	0.28	0.23	0.19	0.31	0.36	0.29
V_1	S_1	0.23	0.43	0.52	0.39	0.28	0.47	0.55	0.43
	S_2	0.27	0.45	0.55	0.42	0.33	0.49	0.58	0.47
	S_0	0.17	0.25	0.31	0.24	0.21	0.32	0.38	0.30
V_2	S_1	0.24	0.46	0.57	0.42	0.29	0.51	0.61	0.47
	S_2	0.28	0.48	0.59	0.45	0.34	0.53	0.63	0.50
L.S.D 0.05			0.019		0.011		0.019		0.011
			V × G		V		V × G		V
V									
V_0		0.18	0.29	0.33	0.26	0.22	0.34	0.38	0.31
V_1		0.22	0.38	0.45	0.35	0.27	0.42	0.50	0.40
V_2		0.23	0.40	0.49	0.37	0.28	0.45	0.54	0.42
L.S.D 0.05			0.011		0.006		0.011		0.006
			S × G		S		S × G		S
S									
S_0		0.15	0.23	0.27	0.22	0.19	0.29	0.34	0.27
S_1		0.21	0.41	0.49	0.37	0.26	0.46	0.53	0.42
S_2		0.25	0.43	0.51	0.40	0.48	0.48	0.55	0.44
L.S.D 0.05			0.011		0.006		0.011		0.006
G		0.22	0.36	0.42		0.25	0.41	0.47	
L.S.D 0.05			0.006				0.006		

7- Iron concentration in leaves (mg kg^{-1})

The data presented in Table (8) indicated that the application of vermicompost had a significant impact on the iron concentration in the leaves of *Camellia japonica*. The V_2 treatment resulted the highest iron concentration, reaching 116.4 mg kg^{-1} and 124.6 mg kg^{-1} for both seasons. Foliar application salicylic acid also significantly increased the iron concentration, the S_2 treatment reaching 117.6 mg kg^{-1} and 126.0 mg kg^{-1} for both seasons compared to the control 109.7 mg kg^{-1} and 118.3 mg kg^{-1}. Similarly, gibberellic acid spraying resulted in a significant increase, the G_2 treatment gave 118.4 mg kg^{-1} and 126.3 mg kg^{-1} for both seasons compared to the control 109.1 mg kg^{-1} and 117.6 mg kg^{-1}. The two-way interaction between vermicompost and salicylic acid (V_2S_2) resulted the highest iron concentration, reaching 119.9 mg kg^{-1} and 128.1 mg kg^{-1} for two consecutive seasons. Additionally, the interaction between vermicompost and gibberellic acid (V_2G_2) significantly increased iron concentration, reaching 120.8 mg kg^{-1} and 127.7 mg kg^{-1} for both seasons while the lowest values 107.5 mg kg^{-1} and 115.6 mg kg^{-1}. The interaction between salicylic acid and gibberellic acid (S_2G_2) also showed a significant effect, on iron concentration reaching 121.7 mg kg^{-1} and 129.6 mg kg^{-1} for both seasons. The three-way interaction ($V_2S_2G_2$) recorded the highest iron concentration, reaching 123.8 mg kg^{-1}and 131.4 mg kg^{-1} for both seasons while the lowest values 104.9 mg kg^{-1}and113.1 mg kg^{-1}.

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Table 8. Effect of vermicompost fertilizer, salicylic acid, gibberellic acid sprays on iron concentration in leaves (mg kg^{-1}) of *Camellia japonica* for both seasons 2022-2023

V	S	2022 G			VxS	2023 G			VxS
		G_0	G_1	G_2		G_0	G_1	G_2	
	S_0	104.9	108.4	108.5	107.2	113.1	116.9	117.8	115.9
V_0	S_1	108.1	116.1	117.4	113.9	116.3	123.8	125.8	122.0
	S_2	109.5	116.5	117.8	114.6	117.2	125.1	126.3	122.9
	S_0	105.1	112.2	114.5	110.6	114.5	119.6	122.5	118.9
V_1	S_1	110.3	118.3	121.6	116.7	118.8	126.5	129.8	125.0
	S_2	113.4	118.6	123.4	118.5	121.9	127.9	131.0	126.9
	S_0	105.7	112.9	114.7	111.1	114.7	121.5	123.7	120.0
V_2	S_1	110.8	119.7	123.7	118.1	119.3	129.8	127.9	125.7
	S_2	114.0	121.9	123.8	119.9	122.1	130.7	131.4	128.1
L.S.D 0.05			0.367		0.212		1.822		1.052
V			V × G		V		V × G		V
V_0		107.5	113.6	114.5	111.9	115.6	121.9	123.3	120.3
V_1		109.6	116.4	119.9	115.3	118.4	124.7	127.8	123.6
V_2		110.1	118.2	120.8	116.4	118.7	127.3	127.7	124.6
L.S.D 0.05			0.212		0.122		1.052		0.607
S			S × G		S		S × G		S
S_0		105.2	111.2	112.6	109.7	114.1	119.3	121.3	118.3
S_1		109.7	118.0	120.9	116.2	118.1	126.7	127.9	124.2
S_2		112.3	119.0	121.7	117.6	120.4	127.9	129.6	126.0
L.S.D 0.05			0.212		0.122		1.052		0.607
G		109.1	116.1	118.4		117.6	124.7	126.3	
L.S.D 0.05			0.122				0.607		

The results showed that the addition of vermicompost to the soil led to a significant increase in most of the studied traits. This can be attributed to the high humus content in the compost, which plays a role in improving the physical, chemical and biological properties of the soil. Humus enhances the soil's water retention capacity, improves its porosity and aeration and increases the water-holding capacity. Additionally, organic matter in the soil increases due to the enhanced activity of microorganisms (Mohmud et al, 2020; Rehman et al, 2023). Furthermore, humic acid found in humus provides essential plant nutrients such as calcium, iron, soluble potassium, phosphorus, nitrogen and magnesium. These nutrients are stored in the humic acid and are readily released when the plant requires them. The increase in photosynthesis and carbohydrate accumulation in the plant positively influences flowering growth traits (Adhikary, 2012; Al-Mamouri, 2020). These findings are consistent with the results of Pandey *et al*. (2017) on *Dahlia variabilis* L. and those of Mupambwa *et al*. (2016) regarding the effect of vermicompost ash on the growth and flowering of the ornamental plant *Marigold* (*Tagetes spp.*), which showed a significant increase in the number of flowers, buds and total flower yield. Foliar application with Salicylic acid led to an increase in plant height, leaves number, main stem diameter and flowering growth traits. This effect may be due to salicylic acid's role in stimulating growth and development. As a plant growth stimulant, salicylic acid contributes to the increase of plant growth regulators like Auxins and Cytokinins, which influence cell division and elongation, it also enhances ion absorption and accelerates the production of chlorophyll and carotenoid pigments, leading to an increase in essential nutrients in the leaves for plant growth (Al-atrushy, 2021). Additionally, it speeds up the process of photosynthesis and activates key enzymes involved in physiological functions within the plant (Alwan & Sadiq, 2019). The increase in carbohydrates also leads to an

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expansion in leaf area, which in turn boosts the number, size and diameter of roots, thereby improving nutrient absorption and promoting flowering growth traits (Chavoushi et al., 2020). These findings are consistent with Mohammed and Abood (2020) noted that foliar application of *Gerbera jamesonii* with salicylic acid significantly improved vegetative growth traits, including leaves number, total chlorophyll content and both dry and fresh weight of leaves. Furthermore, Damayanthi *et al*. (2023) found that using salicylic acid on three-year-old *Camellia sinensis* seedlings greatly enhanced physiological processes such as gas exchange and antioxidant activity, thereby effectively improving drought tolerance in young tea plants. The physiological impact of gibberellins on plant growth traits is attributed to their stimulatory role in increasing auxin levels in plant tissues, particularly indoleacetic acid and tryptophan, which promotes cell division (Byres et al, 1990). Additionally, gibberellins can enhance enzyme activity in the cell wall, making it more flexible, which leads to increased cell elongation and a significant increase in biomass (Hedden & Thomas, 2012).This results in increased plant height, stem diameter, and leaves number, ultimately improving photosynthesis and chlorophyll concentration in leaves. Consequently, the increase in carbohydrates positively influences flowering growth traits (Al-Hadethi et al., 2012). Furthermore, gibberellins boost transpiration, absorption, and the movement of mineral ions from the soil solution to the plant, leading to increased iron and magnesium uptake (Salih & Ibraheem, 2023). These findings align with those of El-Sayed *et al*. (2016) on the effect of gibberellic acid application on *Cycas revoluta*. Similarly, Chandra Sekhar *et al*. (2020) noted that gibberellic acid significantly increased plant height, the number of secondary branches, and flower yield in *Jasminum nitidum*. These results are consistent with Sadiq and Abdullatif (2023), who found that application *Lilium spp*. with gibberellic acid had a notable effect.

CONCLUSION

The current study demonstrated that the application of Vermicompost, Salicylic acid, and Gibberellic acid significantly enhanced the growth, flowering, and physiological traits of Camellia japonica. Vermicompost, due to its high humus content and beneficial nutrients, improved soil structure, water retention, and nutrient availability, resulting in increased plant height, leaves number, chlorophyll concentration, and overall biomass. The addition of Salicylic acid promoted vegetative growth, chlorophyll production, and nutrient uptake by activating growth regulators like Auxins and Cytokinins. Gibberellic acid contributed to cell elongation, biomass accumulation, and increased photosynthetic activity, further improving the flowering traits and nutrient absorption, particularly for iron and magnesium. Overall, the combined treatments of vermicompost, salicylic acid, and gibberellic acid significantly optimized plant growth, flowering duration, and nutrient content, suggesting their potential as effective tools for enhancing ornamental plant productivity in sustainable horticultural practices.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR/S DECLARATION

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, no figures or images that do not belong to us have been incorporated into the manuscript, and the required permissions for re-publication are included with the manuscript. -Author/s signature on the Ethical Approval Statement.

AUTHOR'S CONTRIBUTION STATEMENT

Hawraa Kazem Anid /designed the project data collection, analysis, and paper writing. Author **Ban Mohammad Ali Abood** review the article and participates in its design and analysis

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تأثير سماد Vermicompost ومنظمات النمو النباتية في بعض الصفات الكيميائية ونمو وتزهير نبات الكاميليا *Camellia Japonica*

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قسم البستنة وهندسة الحدائق – كلية علوم الهندسة الزراعية – جامعة بغداد – بغداد – العراق

المستخلص

هدف البحث تحسين نمو وازهار نبات الكاميليا *Camellia japonica* بإضافة سماد Vermicompost بثلاث مستويات (15,7.5,0)% والذي رمز له V_0 وV_1 وV_2 ورش منظمات النمو النباتية (حامض السالسليك بثلاث تراكيز 0 ,200,100 ملغم لتر$^{-1}$ والذي رمز له S_0 و S_1 وS_2 و حامض الجبرلين بالتراكيز 300,150,0 ملغم لتر$^{-1}$ والذي رمز له G_0 وG_1 وG_2)، زرعت النباتات في (الظلة القماشية) التابعة لقسم البستنة وهندسة الحدائق – كلية علوم الهندسة الزراعية – جامعة بغداد، استعمل تصميم القطاعات الكاملة العشوائية RCBD وبثلاث مكررات. اظهرت معاملة $V_2S_2G_2$ تحسناً ملحوظاً في مؤشرات النمو الخضري والتزهير وصفات الكيميائية اذ بلغ ارتفاع النبات 95.3 سم و120.5 سم، بينما كان تركيز الكلوروفيل 252.7 ملغم 100غم$^{-1}$ و 280.8 ملغم 100غم$^{-1}$ على التوالي في الموسمين. بلغت نسبة الكربوهيدرات 59.4 و 66.1 %. تضمنت مؤشرات التزهير تحسناً في النسبة المئوية للمادة الجافة في الازهار(11.96 % و 12.18%). كما بلغ تركيز صبغة الانثوسيانين (248.8 و 257.5 ملغم لتر$^{-1}$ وزن جاف). بلغت النسبة المئوية للمغنيسيوم 0.59 % و 0.63% وتركيز الحديد 123.8 ملغم كغم$^{-1}$ 131.4 ملغم كغم$^{-1}$) في الموسمين.

الكلمات المفتاحية: *Camellia Japonica*، مغذيات صغرى، الاسمدة العضوية، نباتات الزينة.

***مستل من اطروحة دكتوراه للباحث الاول.**