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Original research

Effect of vermicompost as growth media on tuberose (*Polianthes tuberosa* L.) plant

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Abstract:

A pot experiment was conducted in the Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt during the two seasons of 2022/2023 and 2023/2024 to investigate the influence of vermicompost on the vegetative growth, flowering, bulb production and chemical composition responses of tuberose *Polianthes tuberosa* L plant. A completely randomized design was used incorporated four replicates. Four vermicompost percentages i.e. control, 10, 20 and 30% (v/v) were applied. Morphophysiological characteristics i.e. leaves number, leaf length, fresh and dry weight of leave, leaf area, days to flowering time, spike length, spike fresh and dry weight, rachis length, number of florets/plant, flower diameter, number of new bulbs/plant, fresh weight of hill, diameter of new bulbs and fresh weight of new bulb, as well as chemical compositions such as N,P, K, carbohydrate contents and polyphenols were recorded for tuberose from bulb sprouting to harvest. The results indicated that the plants which received 30% vermicompost produced the highest values of all vegetative growth parameters. Applying 30% vermicompost also registered the highest values of all flowering traits. The best results for bulb production and the higher percentages of N, P, K, and carbohydrate as well as chlorophyll a & b, carotenoids and polyphenols were also associated with the 30% vermicompost treatment as compared with the other levels. Generally, the obtained results showed that applying vermicompost improved the growth characteristics, flowering parameters, bulb production and chemical constituents of tuberose under the ecological conditions of the Aswan region with recommendation of applying 30% of vermicompost in the growth media.

Keywords: *Polianthes tuberosa* L, vermicompost, growth characteristics, flowering trait.

1- Introduction

Polianthes tuberosa L. is the scientific name for tuberose, belongs to the Agavaceae family and a monocot subfamily **(Barb-Gonzalez et al., 2012).** Tuberose is one of the most important perennial summer bulbs in Egypt. It is easy to grow and produce a large number of bulbs, which allows for rapid spread. The plant has a high coordination and export value.

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It can be grown in gardens and flower beds and produces fragrant flowers. Its flowers, which bloom on the spike from bottom to top, are leathery in texture and trumpet-shaped, suitable as cut flower and can withstand shipping shocks upon export. In Egypt, the plant can give an additional production of flowers in the fall in addition to its main flowering period in the summer.

Vermicompost is produced by feeding of earthworms on the various biological and plant residues. Vermicompost has appropriate amounts of nitrogen, phosphorus and potassium as well as many micronutrients for improving plant growth and development. Also, it contains nutrients like magnesium and calcium in a form that plant may easily absorb **(Atiyeh et al., 2002).** Many active compounds that act as plant growth regulators were found in vermicompost to stimulate plant growth and development. Vermicompost acts as an organic fertilizer that does not contain weed seeds or odor. The method of producing vermicompost is easier and need shorter period than other bio/organic alternatives **(Atiyeh et al., 2000).** Vermicompost contains many beneficial microorganisms such as nitrogen-fixing bacteria, while does not contain pathogenic microorganisms such as fungi or bacteria. Vermicompost is characterized by its good drainage, high water retention capacity, easy absorption of nutrients, and high air permeability. It has a low level of soluble salts, a good exchange capacity for cations, and a high level of humic acids compared to the raw materials **(Atiyeh et al., 2002; Lim et al., 2015).** The maximum growth traits of tuberose as plant height, leaf length, fresh and dry weights, as well as maximum flowering characteristics like number of florets per spike, spike and rachis length, and yield of flowers were produced with adding vermicompost at a rate of 1.5 ton/ha with a fertilization program **(Basant et al., 2020)**. Increasing vermicompost rates significantly improves tuberose prodction features. Vermicompost application led to greater vegetative growth, flowering aspects and number of daughter bulbs **(Sardoei et al., 2023)**. Therefore, the present investigation aims to investigate the effect of adding different levels of vermicompost to the growing media on the growth parameters, flowering, and bulb productivity as well as chemical characteristics of tuberose grown under Aswan conditions, Southern Egypt.

2. Materials and methods

A pot experiment was conducted during the two seasons of 2022/ 2023 and 2023/2024 at Floriculture Nursery, Faculty of Agriculture and Natural Resources, Aswan University, Aswan, Egypt (23°59'53.0"N 32°51'29.5"E). The main objective was to evaluate the effects of vermicompost on the vegetative growth, productivity and chemical compositions of tuberose (*Polianthus tuberosa* L.). Bulbs of tuberose was bought from a commercial-nursery in Al Kanater El Khayria, Qalubia governorate, Egypt. Healthy tuberose bulbs, weighing about 25 g with a diameter of 2.5-3.0 cm were soaked in a fungicide solution before being planted in PVC pots of 30 cm diameter and packed with one of the used media. The growth media consisted of sandy and clay soil (1:1) mixed with different vermicompost level (0, 10, 20 or 30% v/v). The current experiment was arranged as a completely randomized design (CRD) using 4 treatments × 4 replicates = 16 plots, each plot contains 3 pots = 48 pots. On 10th March for the two seasons, bulbs were planted in the growing media. Each plant received split treatment with 2 g calcium nitrate, 4 g calcium superphosphate, and 4 g potassium sulphate **(Giri and Sashikala, 2018).** The chemical fertilizers were applied to all experimental units of tuberose plants in two doses, thirty-five and forty-five days following bulb planting. Tables (1 & 2) showed the physical and chemical properties of used soils analyzed according to **Salehi Sardoei et al. (2014),** while the chemical properties of vermicompost were inTable (3).

Table 1: The physical and chemical properties of the used sandy soil under study.

Soil properties																	
Physical properties				Chemical properties Soluble cations (mmol/l)				Chemical properties Soluble anions (mmol/l)				pH (1:1 soil suspension)	EC (dS/cm)	N (ppm)	P (ppm)	K (ppm)
Clay (%)	Silt (%)	Sandy (%)	Textural class	Ca^{++}	Mg^{++}	K^+	Na^+	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}					
3.00	0.00	97.00	Sandy	3.06	1.02	0.83	0.76	0.00	7.10	3.60	0.40	8.7	0.33	25.0	35.6	56.0

Table 2: Analysis of the used clay soil and its physical and chemical properties

Particle size distribution		**Soluble cations and anions ($mmol_cL^{-1}$)**	
Coarse-sand	7.10 %	Ca^{++}	6.25
Fine-sand	24.90 %	Mg^{++}	3.28
Silt	25.75 %	Na^+	4.98
Clay	42.25 %	K^+	1.45
Textural class	Clay	CO_3^{--}	---
pH (1:2.5) soil –water suspension	8.2	HCO_3^-	1.60
E.C soil paste extract (dS/m)	1.10	Cl^-	10.09
Organic matter (mg/kg)	11.20	N (ppm)	75.0
Organic carbon (mg/kg)	7.35	P (ppm)	63.4
C.E.C ($cmmol_c$/kg)	33.20	K (ppm)	216.0

Table 3: The chemical analysis of vermicompost under study.

Vermicompost	
Organic matter (%)	73.83
Total nitrogen (%)	1.23
C/N ratio	1:34.8
pH	7.32
EC (mmohs/cm)	4.03

2.1. Vegetative, flowering and bulb characteristics

Measurements of the vegetative growth, flowering, bulb production and chemical compositions were taken from randomly selected tuberose plants as follows:

2.1.1. Growth characteristics: leaf length (cm), leaves fresh and dry weights per plant, and number of leaves per plant at flowering time as well as leaf area index (cm^2) were recorded.

2.1.2. Flowering Characteristics: number of days to flowering (days), length of spike (cm), fresh weight of spike (g), dry weight of spike (g), length of rachis (cm), florets number/flowering spike and flower diameter (cm).

2.1.3. Bulb production: number of new formed bulbs, fresh weight of hill (g), fresh weight of newly formed bulbs (g) and diameter of newly formed bulbs (cm).

2.2. Chemical constituents:

2.2.1. Photosynthetic pigments

Samples of ten fresh leaves were randomly gathered for each treatment, and the content of chlorophyll a &b and carotenoids was determined according to**(Metzner et al., 1965).**

2.2.2. N, P, and K analysis

To estimate N, P and K elements, 0.2 g of dry leaves were ground and wet-digested in concentrated (1:1, v/v) H_2SO_4:H_2O_2 by using a heating digester (DK, Velp Scientific Srl, Italy) and the resulting extract is used to estimate these elements. To measure nitrogen content, the semi-micro kjeldahl method is used **(Black et al., 1965).** Phosphorus and potassium contents were measured **(Chapman and Pratt, 1961).** To estimate phosphorus, the color density is measured using a spectrophotometer at a wavelength 470 nm and calculated using the standard curve of potassium dihydrogen orthophosphate (KH_2PO_4). Meanwhile, potassium was estimated by using a flame photometer, which is standardized with a standard solution.

2.2.3. Total carbohydrates

Total carbohydrates (%) in dry leaves of tuberose were evaluated colorimetrically according the method of **(Dubois et al., 1956).**

2.2.4.Total polyphenols determination

Total polyphenol has been measured in tuberose leaves using Folin-Ciocalteu reagent **(Ghedadba *et al*., 2015).** The reduced form of the phenolic compounds leads to format a complex blue colored, which is measured colorimetrically at a wavelength of 765 nm. Mix of 0.2 ml of the extract (1 mg/l) with 1 ml of Folin-Ciocalteu reagent diluted to 1 to 10. Incubate for 4 minutes, then add 0.8 ml of sodium carbonate, 75 mg/l. Absorbance is measured after 2 hours of incubation at room temperature at 765 nm. The calibration curve is obtained under the same conditions using a wide range of gallic acid solution concentrations as 10-160 µg.ml/l. Total phenolic level is estimated using regression curve:

$$y= 0.0091x + 0.0125$$

y: absorbance and x: concentration of gallic acid, R^2=0.9945, and expressed in microgram equivalent of gallic acid/ mg of extract (µg EAG.mg/l E).

2.2.5.Statistical analysis

Statistical analysis of the data was done using analysis of variance **(Snedecor and Cochran, 1980).** Least significance difference (LSD) was used to differentiate means at 5% level of probability. To compare the differences between means, a computer program of Statistics version 9 was used **(Analytical software, 2008).**

3. Results and discussion

3.1. Growth characteristics

3.1.1. Leaves number/plant, length and fresh weight

Table (4) showed the effect of vermicompost levels on number of leaves, leaf length and leaves fresh weight of tuberose plants during the two studied seasons. Application of vermicompost levels showed significant differences in these parameters. Number of leaves/plant, leaf length and leaves fresh weight gradually increased by increasing the vermicompost level from 0 up to 30% in the growing media. The highest values of leaves number/plant (61.2 and 61.3), leaves length (46.2 and 46.3 cm) and leave fresh weight (253.6 and 255.4 g) of tuberose plants were produced with 30% vermicompost in the 1st and 2nd seasons, respectively, followed by those treated with the 20% vermicompost. Meanwhile, the lowest values of these traits were produced from plants grown in a medium without adding vermicompost (control) in the two seasons.

Table 4: Number of leaves/plant, leaves length (cm) and leaves fresh weight (g/plant) of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost(%)	Number of leaves/plant		Leaf length (cm)		Leaves fresh weight (g/plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	48.5	48.4	33.6	33.7	172.0	172.7
10	54.4	54.5	39.5	39.6	210.8	212.0
20	58.7	58.8	43.7	43.8	238.3	240.0
30	**61.2**	**61.3**	**46.2**	**46.3**	**253.6**	**255.4**
LSD 5%	0.02	1.48	0.01	0.67	1.12	8.02

3.1.2. Leaves dry weight and leaves area

As shown in Table (5), there were significant differences between the means of leaves dry weight and leaves area of tuberose in response to different vermicompost treatments. The higher level (30%) of vermicompost caused higher increment in leaves dry weight (81.8 and 81.9 g) and leaves area (63.1 and 63.6 cm^2) of tuberose than the other levels in the 1st and 2nd seasons, respectively. Also, treating plants with 20% vermicompost ranked second in terms of improving the leaves dry weight (76.4 and 76.6 g) and leaves area (60.8 and 60.7 cm^2) in the 1st and 2nd seasons, respectively. Meanwhile, the lowest values were recorded with the control.

Table 5: Leaves dry weight (g/plant) and leaves area (cm^2) of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (%)	Leaves dry weight (g/plant)		Leaves area (cm^2)	
	1st season	2nd season	1st season	2nd season
0	54.6	54.8	51.7	52.0
10	67.4	67.5	57.0	59.6
20	**76.4**	**76.6**	**60.8**	**60.7**
30	**81.8**	**81.9**	**63.1**	**63.6**
LSD 5%	0.03	0.90	0.25	0.22

In the present study, applying of vermicompost appears to improve the growth characteristics of tuberose in terms leaf length, fresh and dry weights of leaves per plant, leaf number per plant and leaf area index as shown in Tables (4 &5). In addition, tuberose plants received vermicompost at a rate of 30% outgrew those treated with the other levels. Recently experiment on *P. tuberosa* showed that vermicompost levels improved the vegetative growth attributes **(Sardoei et al., 2023)**. The positive effect of vermicompost is related to the higher availability of nutrients **(Salehi Sardoei, 2014).** Vermicompost contains humic compounds that stimulate plant growth and improve physical and chemical characteristics of the soil **(Wang et al., 2017; Serri et al., 2021).** Humic compounds induce the cell division and development of secondary root, which improves the plant growth i.e. plant height, and fresh and weight.

Furthermore, applying of vermicompost increases tuberose growth by improving the soil nutrients and giving the plant the capability to absorb them, which increases the efficiency of nutrient uptake. The beneficial effect of vermicompost is due to the changes in the chemical, physical, microbial, and biological characteristics of the growth medium, as well as pH regulation **(Pathma and Sakthivel, 2012; Vyas et al., 2022).**

3.2. Flowering responses

3.2.1. Number of days to flowering, spike length and spike fresh weight

Table (6) showed the effect of different vermicompost levels on the number of days to flowering, spike length and spike fresh weight of *Polianthes tuberosa* plants. There were significant differences between the means of these flowering aspects of tuberose in response to the different vermicompost levels. Data outlined in this table demonstrated that adding of vermicompost resulted in the shortest number of days to flowering compared to the control. It is obviously, that the plants received vermicompost at a rate of 30% proved the earlier time to flowering (99.0 and 97.8 days), while the longest time to flowering (119.0 and 118.9 days) resulted from the control plants. Tuberose plants treated with vermicompost at a higher level (30%) produced higher spike length (83.8 and 84.0 cm) and spike fresh weight (123.5 and 124 g) than those treated with the other levels in the 1st and 2nd seasons, respectively.

Table 6: Number of days to flowering (days), spike length (cm) and spike fresh weight (g) of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (%)	Number of days to flowering (days)		Spike length (cm)		Spike fresh weight (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	119.0	118.9	63.1	63.4	85.0	85.6
10	114.5	113.6	72.8	73.0	103.1	103.7
20	108.2	107.8	79.7	79.9	115.9	116.5
30	**99.0**	**97.8**	**83.8**	**84.0**	**123.5**	**124.0**
LSD 5%	0.83	3.06	0.02	0.72	0.03	1.35

3.2.2. Spike dry weight, rachis length, number of florets and flower diameter

Data in Table (7) clearly showed that applied vermicompost levels significantly affected spike dry weight, rachis length, number of florets/plant and flower diameter in tuberose plants. Generally, plants treated with the higher level (30%) increased these flowering characters compared to the other levels. Spike dry weight, rachis length, number of florets and flower diameter were gradually increased by increasing the vermicompost level from 0 up to 30%. The higher spike dry weight (33.0 and 33.1 g), rachis length (27.9 and 28.0 cm), florets number (40.4 and 40.7) and flower diameter (5.2 and 5.4 cm) of tuberose plants were registered with 30% level in the 1st and 2nd seasons, respectively, followed by those treated with 20% level. Meanwhile, the lowest values of these traits were produced with the control.

Table 7: Spike dry weight (g), rachis length (cm), number of florets/plant and flower diameter of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (VC) (%)	Spike dry weight (g)		Rachis length (cm)		Number of florets/plant		Flower diameter (cm)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	16.3	16.3	20.9	20.9	24.9	25.2	4.2	4.4
10	24.1	24.2	24.2	24.3	32.2	32.5	4.6	4.9
20	29.7	29.8	26.5	26.6	37.3	37.6	5.0	5.2
30	**33.0**	**33.1**	**27.9**	**28.0**	**40.4**	**40.7**	**5.2**	**5.4**
LSD 5%	0.01	0.23	0.01	0.61	0.01	0.59	0.03	0.04

Our results pointed out that vermicompost led to improve flowering characteristics, including flowering time, length of spike, spike fresh and dry weights, rachis length, florets number per flowering spike, and flower diameter as shown in Tables (6 & 7). These results were in agreed with the previous results showed that vermicompost levels improved the flowering characteristics in tuberose. Applying vermicompost at rate of 30%, followed by rate of 20% registered the best results of flowering aspects when compared to the untreated plants **(Sardoei et al., 2023)**. The positive effects of vermicompost is due to the higher availability of nutrients **(Salehi Sardoei, 2014).** Vermicompost contains humic compounds led to stimulate plant growth and improve physical and chemical characteristics of the soil **(Wang et al., 2017; Serri et al., 2021).** Applying of vermicompost increases the flower characters by improving nutrients in the soil and giving the plant the capability for absorbing them, which improves the efficiency of nutrient uptake. The increment in flowering characteristics by vermicompost is caused by the production of growth-promotion substances and induced growth-regulation hormones, as well as increased the micro-organisms activities in the soil **(Salehi Sardoei et al., 2014)**. Previous studies revealed that applying of organic fertilizers led to improve the flowering characteristics **(Atiyeh et al., 2002; Ladan Moghadam et al., 2012; Bahaloo et al., 2018; Samani et al., 2019; Sardoei et al., 2023)**, which is a good line with our study.

3.3. Bulb production

Number of new bulbs/plant, fresh weight of hill, diameter of new bulbs and fresh weight of new bulbs:

Data in Table (8) showed the influence of different vermicompost levels on the number of new bulbs/plant, fresh weight of hill, diameter of new bulbs and fresh weight of new bulbs of tuberose. These parameters were significantly affected by vermicompost levels during both seasons. Higher values of the number of new bulbs per plant (13.8 and 13.9), fresh weight of hill (779.15 and 783.10 g), diameter of new bulbs (5.11 and 5.13 cm) and fresh weight of new bulbs (135.4 and 135.8 g) were registered with 30% level of vermicompost compared to the other treatments in the 1st and 2nd seasons, respectively. On the contrary, the least values were registered with plants grown without vermicompost in the two seasons.

Table 8: Number of new bulbs/plant, fresh weight of hill (g), diameter of new bulbs (cm) and fresh weight of new bulb (g) of *Polianthes tuberosa* L as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (%)	Number of new bulbs/plant		Fresh weight of hill (g)		Diameter of new bulbs (cm)		Fresh weight of new bulbs (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season

0	9.9	9.9	376.60	380.80	3.80	3.82	86.7	87.1
10	11.8	11.8	565.51	569.59	4.41	4.43	109.5	110.0
20	12.9	13.1	699.24	705.13	4.85	4.87	125.8	126.2
30	**13.8**	**13.9**	**779.15**	**783.10**	**5.11**	**5.13**	**135.4**	**135.8**
LSD 5%	0.29	0.11	2.38	12.30	0.03	0.01	0.02	0.98

Results revealed that vermicompost led to improve bulb production characters (Table 8). Humic and fulvic acids and others produced in vermicompost by microorganisms improved plant growth and development **(Hosseinzadeh et al., 2016).** Humic acids at low concentrations resulted in stimulating plant growth and development **(Ortiz et al., 2015).** Our study revealed that vermicompost has a positive effect on the tuberose growth parameters and has caused an improve in the number of new bulbs/plant, fresh weight of hill, diameter of new bulbs and fresh weight of new bulb due to its high water-holding ability and contain reasonable amounts of nutrients **(Sardoei et al., 2023).** Also, increased uptake of nutrients by tuberose plants applied with vermicompost proved that the increment in root growth or nutrient uptake may be due to stimulating plant growth **(Pant et al., 2009).** The number of new bulbs has grown due to induced nutrients and available water and its subsequent improved photosynthesis. The highest values of bulb characters were seen in pots with 30% vermicompost. These results suggested that vermicompost improved the chemical, physical and biological characters in the growing medium, which resulted in improved plant development as compared to the other treatments **(Chanda et al., 2011; Sardoei et al., 2023)**.

3.4. Chemical composition

3.4.1.N, P and K contents

Table 9 displayed the result of investigation on the effect of vermicompost levels on the nitrogen, phosphorus and potassium percentages of tuberose leaves. Likewise, higher values of N (1.99 and 1.99 %), P (0.52 and 0.52%) and K (2.50 and 2.51%) were produced when tuberose planted in a medium consisting of 30% vermicompost in the 1st and 2nd seasons, respectively. Conversely, the lowest contents of these elements resulted from planting in a medium without vermicompost addition. From results, it is clear that adding vermicompost led to improve the plant's element content, especially by adding a level of 30%. These results suggested that the positive effect of vermicompost may be due to its important elements, such as nitrogen, phosphorus and potassium as compared to the control. The availability of these important elements in the growing media facilitates its absorption by plants. These impotent nutrients are component of most vital processes in the plant, which helps in cell division, elongation and stimulating plant growth **(Dahiya et al., 2001; Yadav et al., 2005; Basant et al., 2020).** Also, the improvement in the plant's element content may be due to the fact that vermicompost in the growing media serves as an important source of macro-and microelements. These findings were in confirmation with that recorded by various researches **(Chaudhari et at., 2013; Kumar, 2014; Kumar and Saravanan, 2019; Choudhury and Sarangi, 2020).**

3.4.2.Chlorophyll a & b and Carotenoids (mg/g FW)

The levels of vermicompost application showed significant differences in the chlorophylls a & b and carotenoids of tuberose leaves under study as presented in Table (10). These parameters were gradually improved by increasing the vermicompost levels from 0 up to 30% in a growing medium. The highest values of chlorophylls a & b and carotenoids were produced from 30% level in the two studied seasons. Meanwhile, the least values of these characters were registered with tuberose plants grown in media without vermicompost addition. The high values of the chlorophyll a & b and carotenoids may be due to the fact that the growing medium containing vermicompost is prepared for the plant to absorb water and nutrients and grow well, including an increase in the leaves area index, which improves the rate of photosynthesis **(Yadav et al., 2005; Kumar, 2015b; Yadav et al., 2023).**

Table 9: Nitrogen content (%), phosphorus content (%) and potassium (%) of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (%)	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	1.85	1.86	0.40	0.40	1.83	1.83
10	1.91	1.91	0.45	0.45	2.14	2.15
20	1.94	1.94	0.49	0.50	2.37	2.37
30	**1.99**	**1.99**	**0.52**	**0.52**	**2.50**	**2.51**
LSD 5%	0.003	0.007	0.004	0.009	0.002	0.009

Table 10: Chlorophylls a & b and carotenoids (mg/g FW) of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (%)	Chlorophylls a (mg/g FW)		Chlorophyll b (mg/g FW)		Carotenoids content (mg/g FW)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
0	0.845	0.850	0.597	0.596	0.619	0.596
10	0.916	0.930	0.654	0.653	0.644	0.653
20	0.974	0.980	0.691	0.693	0.661	0.693
30	**1.003**	**1.010**	**0.716**	**0.717**	**0.671**	**0.717**
LSD 5%	0.008	0.008	0.003	0.008	0.001	0.008

3.4.3. Total carbohydrates and polyphenols content

Table (11) proved that applying of vermicompost in a growing medium has significant effect on total carbohydrates and polyphenols contents of tuberose leaves. Plants received vermicompost at a rate of 30% produced the highest percentages of total carbohydrates (26.14 and 26.50 %) and polyphenols content (29.58 and 29.70 µg EAG/mg E) compared to the other levels in the 1st and 2nd seasons, respectively. Additionally, the least value of these components in tuberose leaves recorded with the control. The positive effects of vermicompost on total carbohydrates and polyphenols in tuberose plants may be related to the different organic acids like humic, fulvic and others that produced by microorganisms in vermicompost. Also, vermicompost contains different nutrients like zinc, this induces plant growth and hormone synthesis as auxin, which increases the chemical compositions and plant height **(Hosseinzadeh et al., 2016 and 2017).** Vermicompost may improve nutrient uptake in the leaves and improve the biological, physical, and chemical characteristics of the growing media, which increased the plant growth and chemical constituents in the plants as compared to the comparison treatment **(Chanda et al., 2011; Choudhury and Sarangi, 2020).**

Table 11: Total carbohydrates (%) and polyphenols content (µg EAG/mg E) of *Polianthes tuberosa* L. as affected by vermicompost application during the two seasons of 2022/2023 and 2023/2024.

Vermicompost (%)	Total carbohydrates (%)		Polyphenols content (µg EAG/mg E)	
	1st season	2nd season	1st season	2nd season
0	20.14	20.30	29.20	29.20
10	23.05	23.30	29.33	29.40
20	25.08	25.40	29.58	29.60
30	**26.14**	**26.50**	**29.58**	**29.70**
LSD 5%	0.186	0.541	0.05	0.09

Conclusion

The application of vermicompost in the growing media improved the attributes measured of tuberose plants. Despite the positive effect of vermicompost at all levels on the studied growth, flowering, bulb productivity and chemical composition characteristics, the 30% and 20% volume rates were more effective in improving all studied parameters. According to the results, we conclude that applying of vermicompost in the growing media, particularly at a level of 30% (v/v), improved the vegetative growth, flowering aspects, bulb output and chemical composition in tuberose plants.

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