Agrotechniques in Industrial Crops

Journal Homepage: https://atic.razi.ac.ir

Vermicompost as Growing Media Replacement for *Polianthes tuberosa* var Pearl Production

Ali Salehi Sardoei[1], Mehrdad Babarabi*[2], Hadi Ghasemi[3]

[1]*Department of Horticulture, Faculty of Horticulture Sciences, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran*
[2]*Department of Agriculture, Minab Higher Education Complex, Hormozgan University, Bandar Abbas, Iran*
[3] *Environmental Horticulture Department, University of Florida, Gainesville, Florida, USA*

ARTICLE INFO

Original paper

Article history:
Received: 28 Dec 2022
Revised: 12 Feb 2023
Accepted: 27 Mar 2023

Keywords:
Linear regression
Pearson correlation
Polianthes tuberosa
Post-harvest
Production bulblets/plant
Vermicompost

ABSTRACT

Vermicompost improves soil physicochemical qualities, lowers pollution, and increases plant stability. An experiment was carried out in a perfectly randomized factorial design with three replications in field conditions at Islamic Azad University, Gorgan Branch, to investigate the effect of vermicompost on the properties of cut tuberose flowers. Four fertilizer treatments (control, 20%, 25%, and 30%) were used in the experiments. Morphophysiological variables such as bulb sprouting time, stem length, spike length, stem diameter, number of the floret, number of daughter bulbs, flowering time, and vase life were monitored from bulb sprouting to harvest. Vermicompost levels were found to be significant in all measured features. The 30% vermicompost treatment produced the greatest stem length, spike length, number of daughter bulbs, and vase life. When compared to the control, the 30% treatment resulted in a 1.9-fold increase. The maximum number of the floret, 40.33, was also associated with the 20% vermicompost treatment. When compared to the control and other treatments, the 25% vermicompost treatment boosted stem length (9.61 cm) and decreased bulb shooting time (10.7 days) and flowering time (131.3 days after planting). In general, the results showed that the vermicompost treatment increased the growth and bulb characteristics of cut tuberose flowers under the ecological conditions of the Gorgan region.

DOI: 10.22126/ATIC.2023.9121.1096

1. Introduction

Vermico Tuberose is a bulb flower that is commonly used as a cut flower. Its cultivation in Iran is expanding because of the very favorable climatic conditions for this gorgeous and fragrant plant, as well as the availability of ideal markets for its export (Kumari *et al.*, 2018). Iran, with its very suitable climate diversity and a temperature difference of 40 degrees Celsius between the country's coldest and hottest regions, cheap and suitable energy and labor force, adequate light levels (more than 250 days of bright and sunny skies with 120 to 150 thousand lux), and proximity to consumer markets, is very suitable for producing various ornamental plants and cut flowers (Mortazavi *et al.*, 2016). *Polianthes tuberosa* is the scientific name for tuberose, a perennial herbaceous plant of the Agavaceae family and the monocot subfamily. Cytological tests verify its classification in the Agavaceae family (Barb-Gonzalez *et al.*, 2012).

Composting has recently been reported as a beneficial, rapid, and cost-effective technology for handling organic residues in diverse resources (Ebrahimi *et al.*, 2021). Composting improves soil structure, strengthens soil content, and allows the soil to hold more water for longer periods. Compost also inhibits surface soil erosion and helps to maintain environmental balance (Mahmud *et al.*, 2020). Compost, farm manure, and plant wastes, among other organic elements, improve the physical and chemical qualities of soil, as well as its fertility (Hassan *et al.*,

* Corresponding author.
E-mail addresses: mehrdad.babarabi@hormozgan.ac.ir

2022). Vermicomposts contain nutrients like phosphorus, potassium, calcium, and magnesium in a form that plants may easily absorb (Atiyeh *et al.*, 2002). Vermicomposts have also been found to contain active biological compounds that function as growth regulators. Tomato growth has been boosted even with a low level of vermicompost due to physical and nutritional aspects such as growth regulators produced by vermicompost because growth regulators are active at low concentrations and with full access to nutrients (Wang *et al.*, 2017). According to research, utilizing vermicompost increases the amount of essential oil and improves the quality of basil (Naiji and Souri, 2018) and coriander (Serri *et al.*, 2021). This lightweight organic fertilizer has no weed seeds or odors. Its processing is simpler than that of biocompost and can be completed in a short period (Atiyeh *et al.*, 2000). Vermicompost contains useful aerobic microorganisms such as nitrogen-fixing bacteria but is free of anaerobic bacteria, fungi, and harmful microorganisms. Vermicompost is created from pit materials that have high air permeability, drainage capacity, and water retention capacity, as well as high levels of nutrient absorption. Vermicomposts had lower soluble salt concentration, better cation exchange capacity, and higher humic acid content than raw materials (Atiyeh *et al.*, 2002; Lim *et al.*, 2015). Organic matter in the form of animal manure enhances soil organic carbon levels and has direct and indirect effects on soil characteristics and processes (Vandecasteele *et al.*, 2016). An investigation on snapdragon plants revealed that adding vermicompost to the soil boosted flowering characteristics (Najarian and Souri, 2020). Organic and animal manure, compost, and other organic fertilizers are used in organic farming instead of chemical fertilizers (Ye *et al.*, 2023). Compost and non-compost organic fertilizers boost crop seed yield (Alvarez *et al.*, 2017). In addition to nutrients and organic matter, compost and vermicompost contain significant levels of humic compounds, which boost the availability of specific nutrients, particularly iron and zinc, and have a direct effect on plant metabolism, resulting in higher growth and yield (Esmaielpour *et al.*, 2017). Given the widespread usage of cut tuberose flowers in green spaces and potted plants, a study was devised and carried out in Gorgan city's ecological circumstances to explore the influence of organic biological fertilizer, vermicompost, on some growth parameters.

2. Materials and methods

This investigation was carried out in December 2020 at the Gorgan branch of the Islamic Azad University's research farm and it was implemented in the pot method. Tuberose cuttings with an average diameter of 4 cm and a length of 5 cm were acquired from the Dezful city growing center in Iran. The experiment was designed in a completely randomized design with three replications, and each replication employed four pots with a volume of four liters and one cutting in each pot. Vermicompost was treated at four levels: 0% (control), 20%, 25%, and 30% of the pot capacity. In November, tuberose bulbs were planted. The growth substrate was made up of sand and clay soil (in a 1:1 volume ratio). Depending on the treatment, different volumes of vermicompost were made and added to the substrate (Salehi Sardoei *et al.*, 2014). Gorgan University of Agricultural Sciences and Natural Resources soil science laboratory studied the vermicompost. Table 1 shows the findings of the vermicompost analysis. The cuttings were disinfected for 15 minutes before planting in a Benomyl fungicide solution containing one gram of Benomyl powder per liter of distilled water.

Table 1. Chemical analysis results of the vermicompost used in the experiment.

pH	Salinity (dS/m)	Organic carbon%	Organic matter %	N %	K %	P %	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
6.3	2.45	23.98	4.351	1.3	0.73	0.61	2.45	28.98	41.35	1.3	0.73	0.61

During the bulb's growth cycle, the average temperature fluctuated from 17˚C+2 during the day in December to 40 ˚C +2 in August. Irrigation was done manually according to the needs of the plant (1000cc for each pot). After the growing phase finished, digital calipers were used to record characteristics such as the time of appearance of the flowering stem (from planting to the observation of the blooming stem) and the diameter of the flower stem. The vase life of the flowers was determined in days and was based on the color change and wilting of the petals, wilting of the flowers, and increased bending of the flower necks from the first day of placing in the solution until the flowers lost their ornamental value. The data variance was computed at a 0.05 significant level using the statistical program SAS (version 4.9). Duncan's test was performed to compare means, and the graphs were created using Excel 2013 software.

3. Results

Table 1 shows the descriptive statistics for the tuberose flower features evaluated. The features of spike length and the number of daughter bulbs had the most variety among the tested groups based on standard deviation values. The spike length had a range of variation of 4.46, and the number of daughter bulbs had a range of 4.09, indicating considerable differences between populations (Table 2). Post-harvest Vase life and stem diameter exhibited lower values based on standard error values. The range for post-harvest longevity was 0.13, while the range for stem diameter was 0.12, indicating significant differences between populations (Table 2).

The analysis of variance revealed a significant difference (at the P>0.001 level) in bulb shooting time, stem length, number of daughter bulbs, and post-harvest longevity between the vermicompost treatments (Table 3). In terms of stem diameter, number of the floret, and flowering time, there was a significant difference (at the P>0.005 level of probability) between the vermicompost treatment levels (Table 3).

Table 2. Descriptive statistics of various traits in Polianthes tuberosa var Pearl.

Morphophysiological variables	Minimum	Maximum	Mean	Standard Deviation	Standard Error
Bulb sprouting time	10	17	12.91	2.57	0.74
Stem length	55	73	63	1.6	5.54
Spike length	49	35	41.91	4.46	1.28
Stem diameter	8.46	10.07	9.29	0.42	0.12
Number of floret	38	41	39.75	0.75	0.33
Number of daughter bulbs	9	21	14.75	4.09	1.18
Flowering time	129	137	133.91	2.35	0.67
Vase life	6.2	7.5	6.9	0.47	0.13

Table 3. Analysis of variance for the effect of Vermicompost treatments on *Polianthes tuberosa* var. Pearl.

	df	Bulb sprouting time	Stem length	Spike length	Stem diameter	Number of florets	Number of daughter bulbs	Flowering time	Vase life
Treatment	3	22.97**	97.11**	62.08**	0.440*	0.972*	54.97**	14.75*	0.723**
Error	8	0.5	5.83	4.08	0.083	0.417	2.41	2.08	0.037
Coefficient of variation %	-	5.47	3.83	4.82	3.10	1.62	10.53	1.07	2.80

**, * and $^{n.s}$ are significant at the 1%, 5% and non-significance levels, respectively

The use of vermicompost fertilizers (Fig. 1) resulted in higher levels of stem length and diameter, spike length, number of Florent, number of daughter bulbs, flowering time, and vase life when compared to the control treatment. Furthermore, the germination period was shortened. The 25% vermicompost treatment had the shortest bulb sprouting time, with an average of 10 or 7 days, which did not exhibit a statistically significant difference with the 25% and 30% vermicompost treatments but did show a significant difference with the control treatment (Fig. 1).

The length of the stem was greatly extended by raising the level of vermicompost to 30% (Fig. 1). This increase was found across all three vermicompost fertilizer ratios (Fig. 1). The 30% volume vermicompost treatment efficiently maintained spike length at a greater level compared to other treatments, though other levels also demonstrated a significant difference despite the increasing trend (Fig. 1). The stem diameter, like the stem length, was greatest at 25 and 30% vermicompost levels, although there was no statistically significant difference (Fig. 1). The control treatment (no vermicompost) produced the fewest floret, however applying vermicompost was more effective in creating floret in the spike (Fig. 1). The number of daughter bulbs grew as the degree of vermicompost increased. The creation and reproduction of daughter bulbs in the tuberose plant are critical for the production of cut flowers, with an average of 19 allocated to the 30% volume treatment with vermicompost (Fig. 1). The lowest blooming time was 131.3 days for the 25% volume ratio of vermicompost, which reduced the flowering time by five days compared to the control treatment (Fig. 1).

Although no statistically significant difference was discovered in the use of vermicompost, the 25 and 30% levels of vermicompost had the longest vase life of cut tuberose flowers (Fig. 1).

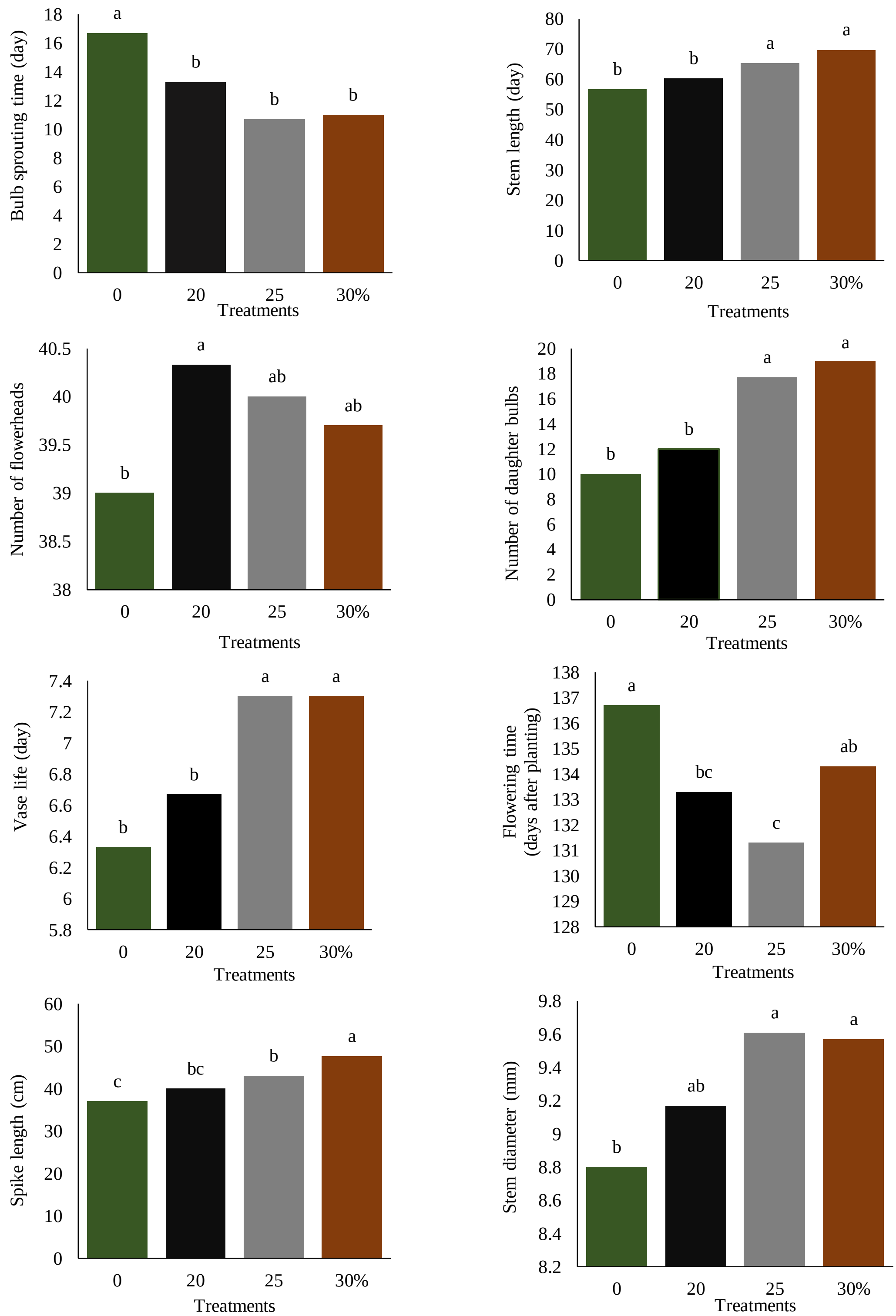

Figure 1. The effect of Vermicompost treatments on *Polianthes tuberosa* var Pearl under Gorgan natural conditions.

Table 4, shows the Pearson correlation coefficients between the traits evaluated. Flowering time exhibited the most positive and significant link with bulb shooting time (0.689*), spike length with stem length (0.772**), stem diameter with stem length (0.752**), daughter bulb number with stem length (0.870**), post-harvest vase life with stem length (0.779**), spike length with stem diameter (0.694*), daughter bulb number (0.870**), post-harvest vase life (0.766**), stem diameter with daughter bulb number (0.854**), post-harvest vase life (0.678*), and daughter bulb number with post-harvest lifespan (0.878**).

Fig. 2 depicts the relationship between vase life and stem length, bulb shooting time, stem diameter, spike length, number of daughter bulbs per plant, number of floret, and flowering time. A one-unit change in stem length, bulb shooting time, stem diameter, spike length, number of daughter bulbs per plant, number of the floret, and flowering time resulted in changes in vase life of 0.8066, 0.9723, 0.6595, 0.7867, 0.9707, 0.4158, and 0.4549 units, according to the regression coefficient.

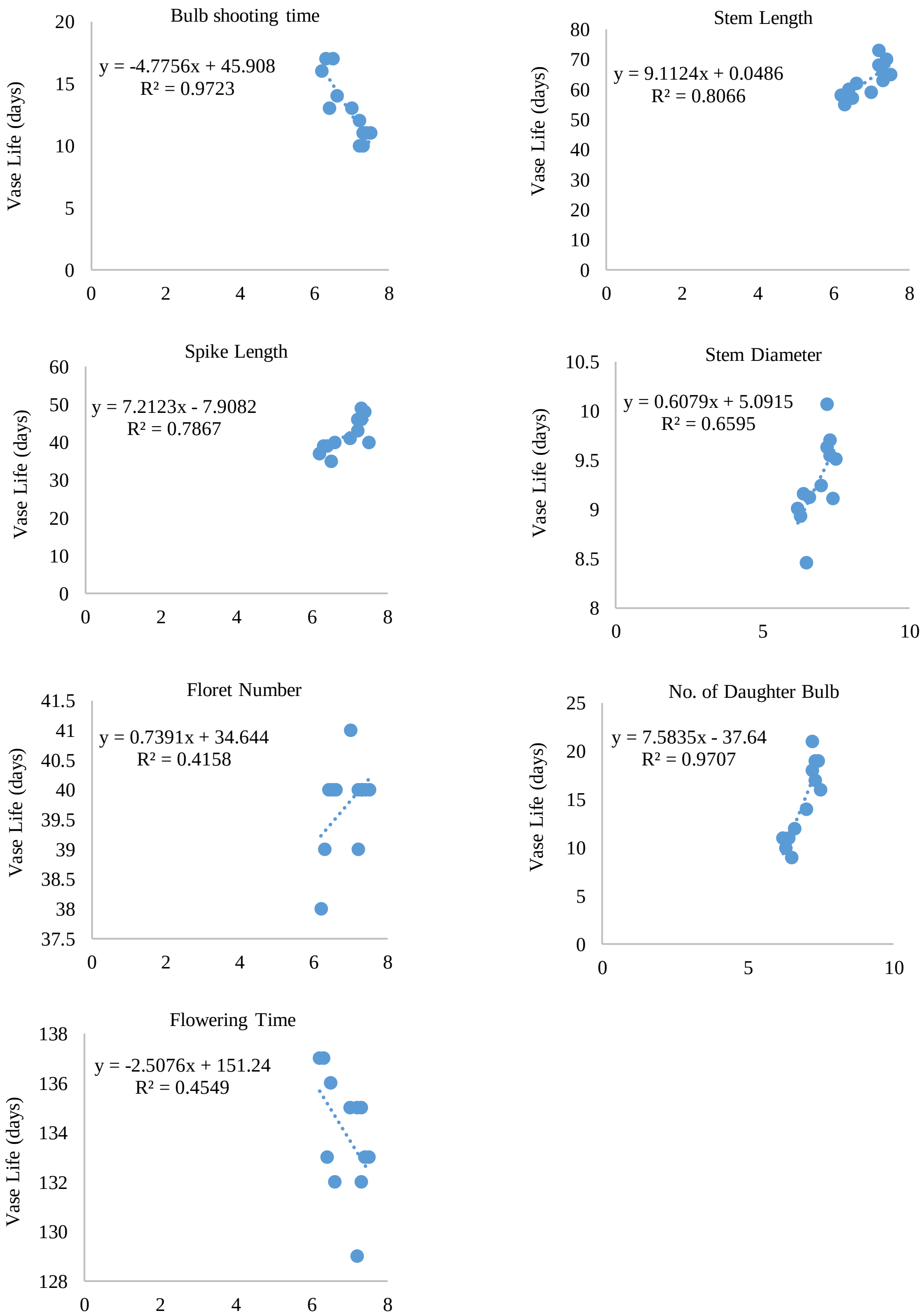

Figure 2. Results of vase life regression linear against traits other.

Table 4. Pearson correlation coefficients between the traits under study in vermicompost.

Traits	bulb sprouting time	Stem Length	Spike Length	Stem Diameter	Floret Number	No. of daughter bulb	Flowering Time	Vase Life
bulb shooting time	1							
Stem Length	-0.790**	1						
Spike Length	-0.800**	0.772**	1					
Stem Diameter	-0.769**	0.752**	0.694*	1				
Florent No.	-4.33	0.087	0.210	0.026	1			
No. of daughter bulb	-0.848**	0.906**	0.870**	0.854**	0.155	1		
Flowering Time	0.689*	-0.495	-0.330	-0.425	-0.474	-0.474	1	
Vase Life	-0.879**	0.779**	0.766**	0.678*	0.465	0.878**	-0.505	1

4. Discussion

The nutritional impacts of livestock manure improve the physical structure of the soil, increase root development, reduce erosion and runoff, and assist keep moisture in the soil (Goldani and Kamali, 2016). It can also cause an increase in growth characteristics such as plant height. Manure, as opposed to compost, had a greater influence on boosting the number of flowers and the period of flowering, according to a paper by Salehi Sardoei et al. (2014). Arancon et al. (2006) also observed an increase in vegetative growth and plant height in strawberries as a result of using animal fertilizer. In their experiment on strawberries, Arancon et al. (2006) reported an increase in vermicompost, dry weight, leaf area, number of stems, and number of flowers compared to chemical fertilizer treatment. The desirable effect of vermicompost compared to compost is likely due to the higher availability of both low and high-consumption nutrients (Salehi Sardoei, 2014).

Humic compounds in vermicompost are environmentally benign elements that stimulate plant growth and protect soil from water stress-induced deterioration by improving the physical and chemical properties of soil (Alvarez *et al*., 2017; Wang *et al*., 2017; Serri *et al*., 2021).

Humic chemicals stimulate cell division and secondary root development, which increases plant growth (in terms of height, weight, and dryness). Furthermore, the usage of vermicompost boosts flower yield by increasing soil nutrients and providing the plant's ability to absorb them, which increases nutrient uptake efficiency. Compost's beneficial effects have also been linked to changes in the physical, chemical, microbial, and biological properties of the cultivation environment, as well as pH regulation and a significant increase in water-holding capacity in the root environment (Pathma and Sakthivel, 2012; Vyas *et al*., 2022). The use of vermicompost appears to have increased the number and length of spikes as well as the number and length of lateral branches due to the production of growth-promoting substances, increased growth-regulating hormones, and an increase in the activity of microorganisms in the soil, which has led to an increase in the number and length of spikes as well as the number and length of lateral branches (Salehi Sardoei *et al*., 2014). In the present research, it appears that increasing the amount of vermicompost produced circumstances for increased cellular activity at the growth points, resulting in an increase in the number and length of spikes as well as the number and length of lateral branches of the plant. The results of all fertilizer treatments revealed an increase in the flowering and bulb features of cut tuberose flowers. Researchers investigated the use of organic fertilizers to boost the vegetative and reproductive growth of common sage plants in an experiment (Samani *et al*., 2019). They discovered that using vermicompost increased germination, decreased growth duration, and improved measured metrics in Lilium flowers (Ladan Moghadam *et al*., 2012).

Previous research has demonstrated that treating Marigold flowers with vermicompost improves plant length, stem diameter, branch number, leaf number, flower diameter, and flower number (Atiyeh *et al*., 2002). Furthermore, researchers discovered that using vermicompost in Lisianthus flowers enhanced the width of the flowering stem, which is compatible with the findings of this study (Bahaloo *et al*., 2018). Because of its nutrients and plant growth regulators, the application of vermicompost in Snapdragon flowers extended the vase life of the flowers, which is consistent with the current study. Nourian et al. (2018) *Crossandra undulaefolia* showed similar results, with vermicompost and compost treatments increasing plant height, leaf and flower quantity (Jokar and Hassanpour Asil, 2021). The results of the researchers' experiment show that the 30% vermicompost treatment on tuberose led to an increase in stem length and the number of florets in spike. The growth-promoting effect of vermicompost is due to the provision of nutrients in these treatments. Vermicompost affects plant growth through various methods, some of which are related to the physical or chemical properties of vermicompost in improving soil, and some are due to the ability of humic acids present in vermicompost, which act as growth regulators, and also because of the humic substances present in vermicompost, which act as plant growth hormones after absorption, which is in line with the present results (Bahaloo *et al.*, 2018).

Humic, fulvic, and other organic acids produced by microorganisms in vermicompost can boost plant development (Hosseinzadeh *et al.*, 2016). Vermicompost was found to cause the formation of chemicals comparable to auxin in a study on the impact of vermicompost on plants (Dashti *et al.*, 2019). Because the amino acid tryptophan is a precursor to the manufacturing of auxin hormones, the presence of zinc in its structure is critical (Amiri *et al.*, 2017). Because vermicompost is high in nutrients like zinc, it can stimulate plant development, particularly by influencing the manufacture of hormones like auxin, resulting in increased plant height (Hosseinzadeh *et al.*, 2016). The cytokinin hormone has been demonstrated to boost potassium uptake in jujube plants (*Ziziphus rotundifolia*) in studies, and Vermicompost contains plant growth hormones such as cytokinins (Hosseinzadeh *et al.*, 2017). As a result, with its plentiful nutrients and high water retention capacity, vermicompost may enhance nutrient uptake in leaves and lessen the detrimental effects of stress. The usage of vermicompost fertilizer had varying effects on the number of florets in this study. Plants grown in low vermicompost ratios increase root volume to compensate for limited nutrient availability. Seedling growth is reduced in beds containing large amounts of vermicompost due to excessive salt levels or maybe in reaction to high concentrations of plant growth hormones such as auxin and humic acid produced by microorganisms (Manh and Wang, 2014). Humic compounds stimulate plant development at low concentrations (Ortiz *et al.*, 2015). In this study, it appears that vermicompost has a beneficial effect on plant growth characteristics and has resulted in an increase in the number of daughter bulbs due to its high water-holding capacity and desirable availability of both high and low-consuming nutrients.

In fact, the number of daughter bulbs has grown due to improved mineral and water intake and its subsequent effect on photosynthesis. One of the stress-sensitive signs is stem diameter growth. The largest diameter stems were seen in pots with 25 and 30% vermicompost (Fig. 1). It has been found that vermicompost improves the physical, chemical, and biological aspects of the growing medium, which results in increased plant development when compared to the control treatment (Chanda *et al.*, 2011). Improved nutrient uptake by plants treated with vermicompost suggests that root growth improvement or nutrient uptake per unit root may be one of the processes involved in plant growth stimulation (Pant *et al.*, 2009). The findings indicate that vermicompost protects rice plants under stress conditions, presumably through physical and chemical interactions between humic acid and the plant root system (Garcia *et al.*, 2014).

5. Conclusion

The application of vermicompost increased the attributes measured. Despite the fact that the 20% volume vermicompost treatment had a positive effect on some growth parameters, the 25% and 30% volume treatments were more effective in reducing bulb sprouting time and flowering time, as well as increasing the length of the flowering stem, length of the spike, number of florets, and vase life. Based on the findings of this study, it is possible to conclude that the use of vermicompost, particularly at a volume ratio of 30%, improved the growth status and bulb output of the tuberose plant.

Conflict of Interests

All authors declare no conflict of interest.

Ethics approval and consent to participate

No human or animals were used in the present research.

Consent for publications

All authors read and approved the final manuscript for publication.

Availability of data and material

All the data are embedded in the manuscript.

Authors' contributions

All authors had an equal role in study design, work, statistical analysis and manuscript writing.

Informed Consent

The authors declare not to use any patients in this research.

Funding/Support

This study was supported by the Islamic Azad University, Gorgan Branch, Iran.

Acknowledgement

This article was achieved based on the material and equipment of Islamic Azad University, Gorgan Branch, which the authors thank it.

References

Alvarez J.M., Pasian C., Lal R., Lopez R., Fernández M. 2017. Vermicompost and biochar as growing media replacement for ornamental plant production. Journal of Applied Horticulture 19: 205-214. http://dx.doi.org/10.37855/jah.2017.v19i03.37

Amiri H., Ismaili A., Hosseinzadeh S.R. 2017. Influence of vermicompost fertilizer and water deficit stress on morpho-physiological features of chickpea (*Cicer arietinum* L. cv. Karaj), Compost Science and Utilization 25(3): 152-165. https://doi.org/10.1080/1065657X.2016.1249313

Arancon N.Q., Edwards C.A., Lee S., Byrne R. 2006. Effects of humic acids from vermicomposts on plant growth. European journal of soil biology 42(S1): 65-69. https://doi.org/10.1016/j.ejsobi.2006.06.004

Atiyeh R.M., Arancon N., Edwards C.A., Metzeger J.D. 2000. Influence of earthworm processed pig manure on the growth and yields of greenhouse tomatoes. Bioresource Technology 75(3): 175-80. https://doi.org/10.1016/S0960-8524(00)00064-X

Atiyeh R.M., Arancon N.C., Edwards A., Metzger J.D. 2002. The influence of earthworm processed pig manure on the growth and productivity of marigolds. Bioresource Technology 81(2): 103-108. https://doi.org/10.1016/S0960-8524(01)00122-5

Bahaloo Z., Reezi S., Rabiei G.R., Saeedi K. 2018. The positive effects of vermicompost and humic acid on quantitative and qualitative traits of lisianthus (*Eustoma grandiflorum*) after transplanting. Journal of Science and Technology of Greenhouse Culture 8(4): 17-25. (In Farsi). https://dx.doi.org/10.29252/ejgcst.8.4.17

Barba-Gonzalez R., Rodriguez-Dominguez J.M., Castaneda-Saucedo M.C., Rodriguez, A., Van-Tuyl M., Tapia-Campos E. 2012. Mexican Geophytes I. The Genus Polianthes. Floriculture and Ornamental Biotechnology 6: 122-128. https://doi.org/10.22059/ijhst.2022.330660.504

Chanda G.K., Bhunia G., Chakraborty S.K. 2011. The effect of vermicompost and other fertilizers on cultivation of tomato plants. Journal of Horticulture and Forestry 3(2): 42-45. https://doi.org/10.5897/JHF.9000110

Dashti M., Dehestani Ardakani M., Shirmardi M., Momenpour A. 2019. Effect of cow manure and vermicompost on increasing salt tolerance of golden rain tree. Journal of Forest Research and Development 5(4): 541-556. (In Farsi). https://doi.org/10.30466/jfrd.2019.120793

Ebrahimi M., Souri M.K., Mousavi A., Sahebani N. 2021. Biochar and vermicompost improve growth and physiological traits of eggplant (*Solanum melongena* L.) under deficit irrigation. Chemical and Biological Technologies in Agriculture 8(1): 1-14. https://doi.org/10.1186/s40538-021-00216-9

Esmaielpour B., Rahmanian M., Heidarpour O., Shahriari M.H. 2017. Effect of vermicompost and spent mushroom compost on the nutrient and essential oil composition of basil (*Ocimum basilicum* L.). Journal of Essential Oil Bearing Plants 20(5):1283-1292. https://doi.org/10.1080/0972060X.2017.1396931

Garcia A.C., Santos L.A., Izquierdo F.G., Rumjanek V.M., Castro dos Santos F.S., de Souza L.G.A., Berbara R.L.L. 2014. Potentialities of vermicompost humic acids to alleviate water stress in rice plants (*Oryza sativa* L.). Journal of Geochemical Exploration 136: 48-54. https://doi.org/10.1016/j.gexplo.2013.10.005

Goldani M., Kamali M. 2016. Evaluation of Culture Media Including Vermicompost, Compost and Manure under Drought Stress in Iranian Petunia (Petunia hybrida). Plant Productions 39(3): 91-100. (In Farsi). https://doi.org/10.22055/ppd.2016.12335

Hassan S.A.M, Taha R.A., Zaied N.S.M., Essa E.M., Kh M. 2022. Effect of vermicompost on vegetative growth and nutrient status of acclimatized Grand Naine banana plants. Heliyon 8(10):e10914. https://doi.org/10.1016/j.heliyon.2022.e10914

Hosseinzadeh S.R., Amiri H., Esameili A. 2017. Effect of different levels of vermicompost on morphologic characteristics and concentration of elements of *Cicer arietinum* L. cv. Pirouz under water stress. Environmental Stresses in Crop Science 10(4): 531-545. (In Farsi). https://doi.org/10.22077/escs.2017.120.1030

Hosseinzadeh S.R., Amiri H., Ismaili A. 2016. Effect of vermicompost fertilizer on photosynthetic characteristics of chickpea (*Cicer arietinum* L.) under drought stress. Photosynthetica 54(1): 87-92. https://doi.org/10.1007/s11099-015-0162-x

Jokar N.K., Hassanpour Asil M. 2021. Effect of Gibberellic Acid and Vermicompost on Growth and Flowering of Daffodil Flower. *Journal of Crops Improvement* 23(1): 183-198. (In Farsi). https://doi.org/10.22059/jci.2020.296530.2341

Kumari S., Raghupathi B., Sarika K., Deb P. 2018. Effect of Different Preservatives on Vase-Life of Cut Tuberose (*Polianthes tuberosa* L.) cv. Calcultta Single. International Journal of Current Microbiology and Applied Sciences 7(1): 1651-1657. http://dx.doi.org/10.20546/ijcmas.2018.701.200

Ladan Moghadam A.R., Oraghi Ardebili Z., Saidi F. 2012. Vermicompost induced changes in growth and development of *Lilium Asiatic* hybrid var. Navona. African Journal of

Agricultural Research 7(17): 2609-2621. https://doi.org/10.5897/AJAR11.1806

Mahmud M., Abdullah R., Yaacob J.S. 2020. Effect of vermicompost on growth, plant nutrient uptake and bioactivity of ex vitro pineapple (*Ananas comosus* var. MD2). Agronomy 10(9):1333. https://doi.org/10.3390/agronomy10091333

Manh V.H., Wang C.H. 2014. Vermicompost as an important component in substrate: effects on seedling quality and growth of muskmelon (*Cucumis melo* L.). APCBEE Procedia 8: 32-40. http://dx.doi.org/10.1016%2Fj.apcbee.2014.01.076

Mortazavi S.N., Bagheri F., Bahadoran M. 2016. Some characteristics of tuberose as affected by pre-harvest application of calcium chloride and gibberellic acid. Advances in Horticultural Science 30: 69-74. https://doi.org/10.13128/ahs-19131

Naiji M., Souri M.K. 2018. Nutritional value and mineral concentrations of sweet basil under organic compared to chemical fertilization. Acta Scientiarum Polonorum Hortorum Cultus 17(2): 167-175. http://dx.doi.org/10.24326/asphc.2018.2.14

Najarian A., Souri M.K. 2020. Influence of sugar cane compost as potting media on vegetative growth, and some biochemical parameters of *Pelargonium× hortorum*. Journal of Plant Nutrition 43(17): 2680-2684. https://doi.org/10.1080/01904167.2020.1783305

Nourian N., Rouhollahi I., Karimi M. 2018. Evaluation of organic fertilizer from water hyacinth (*Eichhornia crassipes*) as substrate for *Lilium* sp. Journal of Horticultural Science and Technology 19(3): 267-276. (In Farsi). http://dorl.net/dor/20.1001.1.16807154.1397.19.3.1.5

Ortiz N., Armada E., Duque E., Roldan A., Azcón R. 2015. Contribution of arbuscular mycorrhizal fungi and/or bacteria to enhancing plant drought tolerance under natural soil conditions: Effectiveness of autochthonous or allochthonous strains. Journal of plant physiology 174: 87-96. https://doi.org/10.1016/j.jplph.2014.08.019

Lim S.L., Wu T.Y., Lim P.N., Shak K.P. 2015. The use of vermicompost in organic farming: overview, effects on soil and economics. Journal of the Science of Food and Agriculture 95(6): 1143-1156. https://doi.org/10.1002/jsfa.6849

Pant A.P., Radovich T.J., Hue N.V., Talcott S.T., Krenek K.A. 2009. Vermicompost extracts influence growth, mineral nutrients, phytonutrients and antioxidant activity in pak choi (*Brassica rapa* cv. Bonsai, Chinensis group) grown under vermicompost and chemical fertiliser. Journal of the Science of Food and Agriculture 89(14): 2383-2392. http://dx.doi.org/10.1002/jsfa.3732

Pathma J, Sakthivel N. 2012. Microbial diversity of vermicompost bacteria that exhibit useful agricultural traits and waste management potential. Springerplus 4(1): 26. https://doi.org/10.1186%2F2193-1801-1-26

Salehi Sardoei A., Roien, A., Sadeghi, T., Shahadadi F., Sattaei Mokhtari T. 2014. Effect of Vermicompost on the Growth and Flowering of African Marigold (*Tagetes erecta*). American-Eurasian J. Agric. & Environ 14(7): 631-635, 2014. http://dx.doi.org/10.5829/idosi.aejaes.2014.14.07.12366

Salehi Sardoei, A. 2014. Vermicompost effects on the growth and flowering of marigold (*Calendula officinalis* L.). European Journal of Experimental Biology 4(1): 651-655.

Samani M.R., Pirbalouti A.G., Moattar F., Golparvar A.R. 2019. L-Phenylalanine and bio-fertilizers interaction effects on growth, yield and chemical compositions and content of essential oil from the sage (*Salvia officinalis* L.) leaves. Industrial Crops and Products 137: 1-8. https://doi.org/10.1016/j.indcrop.2019.05.019

Serri F., Souri M.K., Rezapanah M. 2021. Growth, biochemical quality and antioxidant capacity of coriander leaves under organic and inorganic fertilization programs. Chemical and Biological Technologies in Agriculture 8(1): 1-8. https://doi.org/10.1186/s40538-021-00232-9

Vandecasteele B., Sinicco T., D'Hose T., Vanden Nest T., Mondini C. 2016. Biochar amendment during composting or compost storage affects compost quality and N losses but not P plant uptake. Journal of Environmental Management 168:200-209. https://doi.org/10.1016/j.jenvman.2015.11.045

Vyas P., Sharma S., Gupta J. 2022. Vermicomposting with microbial amendment: implications for bioremediation of industrial and agricultural waste. BioTechnologia 103(2): 203-215. https://doi.org/10.5114/bta.2022.116213

Wang X.X., Zhao F., Zhang G., Zhang Y., Yang L. 2017. Vermicompost improves tomato yield and quality and the biochemical properties of soils with different tomato planting history in a greenhouse study. Frontiers in Plant Science 8: 1978. https://doi.org/10.3389/fpls.2017.01978

Ye J., Wang Y., Kang J., Chen Y., Hong L., Li M., Jia Y., Wang Y., Jia X., Wu Z., Wang H. 2023. Effects of Long-Term Use of Organic Fertilizer with Different Dosages on Soil Improvement, Nitrogen Transformation, Tea Yield and Quality in Acidified Tea Plantations. Plants 12(1): 122. https://doi.org/10.3390/plants12010122

HOW TO CITE THIS ARTICLE

Salehi Sardoei A., Babarabi M., Ghasemi H. 2023. Vermicompost as Growing Media Replacement for *Polianthes tuberosa* var Pearl Production. *Agrotechniques in Industrial Crops* 3(1): 44-52. 10.22126/ATIC.2023.9121.1096