Influence of Vermicomposting Rates Application and Microelements on Growth, Yield and Quality of Globe Artichoke

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ABSTRACT

The field experiment on Globe artichoke was conducted at the Agricultural Research Center Farm (Kaha) in Egypt in two successive winter seasons (2020/2021 and 2021/2022). The present study investigated the effects of the application of vermicompost in the soil at different rates. with the combination of foliar application of microelements and Vermi-wash to varying rates on plant growth, fresh and dry weight, yield components, and chemical constituents of globe artichoke. The experiment was performed in a split-plot design; the vermicompost was added (in main plots) at different rates (1, 1.5, and 2 ton/fed.) compared to a recommended dose of compost (2 ton/fed. as a control). The subplots were foliar spraying with 1- water as a control, 2- Microelments, (Fe, Mn, Cu and Zn) at 50 g/100 liter of water and Vermi-wash10 liter/100 liter of water after 60-80-100-120 day after planting and The results showed that the interactions between (vermicompost 1.5 ton/fed and spraying vermi-wash treatments) recorded the highest total yield value Meanwhile, the combinations of (compost + vermi-wash and with microelements) recorded the lowest values of flower head yield. While the highest values for the early crop was obtained from fertilizing at a rate of 1 ton/ton vermicompost + vermin wash. Foliar spraying application of Vermi-wash and 2ton/fed. of compost increased inulin percentage. On the other hand, foliar application of micronutrients along with 1 ton/fed.of vermicompost resulted higher dry matter percentage.

Keywords: Vermicompost- Vermi wash- Microelements- Artichoke- Organic fertilization.

INTRODUCTION

The globe artichoke, scientifically known as *Cynara scylmus* L., is a perennial herbaceous plant endemic to the Mediterranean region. Most artichoke cultivation in Egypt occurs during March and April, so the optimal period for exporting to European markets falls between December and February. The early productivity from December to February is crucial for worldwide artichoke production as it directly impacts the net revenue due to strong demand and pricing during this period. Biofertilizers and organic amendments are considered environmentally acceptable sources of plant nutrients, but they are less effective in promoting crop yield than chemical fertilizers (Alshaal et al., 2019 and Bassouny and Abbas, 2019). The study was conducted by Wakindiki et al.(2019). Compost and other organic manures are anticipated to enhance soil structure, aeration, and plant nutrition by gradually releasing nutrients (Hitha et al., 2021). Worm composting is seen as a feasible alternative. This product exhibits a lower pH value and a more limited C/N ratio than compost (Alshehrei et al., 2021). Biogas, an organic supplement, can enhance soil fertility and promote plant growth (Farid et al., 2018). Organic composts made from animal and food wastes have been extensively and regularly utilized in agriculture for several goals, including increasing crop productivity as an alternative source and enhancing soil quality, carbon sequestration and addressing environmental concerns. The globe is facing a substantial threat in the form of environmental degradation. The extensive utilization of chemical fertilizers primarily contributes to environmental degradation, soil fertility depletion, reduced agricultural productivity and soil degradation (Iqbal et al., 2019). Vermicompost is an organic fertilizer that is created via the combined efforts of earthworms and the microorganisms they live within a mutually beneficial relationship. Through an intricate process, organic matter derived from any type of organic waste undergoes fragmentation, decomposition, and stabilization, forming a finely structured material resembling peat. This material possesses a high porosity level and a notable capacity to retain water (Mohite et al., 2024). Vermicomposts are particularly notable for their significant concentration of soluble mineral nutrients that plants can easily absorb. They also have a high proportion of organic matter, which is nutrient-rich. Additionally, vermicomposts contain a variety of microorganisms that promote the rapid breakdown of minerals, resulting in a gradual release of even more plant-accessible nutrients in the soil (Joshi et al., 2015). In addition to supplying mineral nutrients, vermicomposts have several advantageous impacts on plant growth. Vermicomposts often include a variety of mineral nutrients in a concentrated form that plants can readily absorb. However, they do not provide a complete and balanced range of minerals that plants need. Consequently, efforts have been undertaken to enhance the physiological integrity of vermin-composts by supplementing them with mineral nutrients. An alternative method to enhance the reliability of the process involves adjusting the mineral nutrients during the preparation of the feedstock prior to vermicomposting. For instance, adding rock phosphate or clinoptilolite zeolite has been suggested for using vermicompost in organic cultivation (Ratnasari et al., 2023). However, implementing this approach may be challenging in practical production settings. Xiya et al. (2024) added inorganic additions to enhance vermicomposting. Another potential avenue could be enhancing the production of well-balanced vermicompost products by incorporating supplementary organic fertilizers. Vermicompost exhibited elevated levels of plant-accessible potassium (K) and magnesium (Mg), while guano shown a notable degree of mineralization and was abundant in phosphorus (P), calcium (Ca), sulfur (S), manganese (Mn), zinc (Zn), copper (Cu), and molybdenum (Mo). The use of bat guano in organic fertilizer containing vermicompost greatly amplified the stimulating impact of vermicompost on the growth and development of winter rye and potato plants (Xiya et al., 2024). The impact of guano was influenced by its concentration, with a stronger effect observed at larger application rates of the organic fertilizer. This suggests that increasing levels of plant-available nutrients have a favorable role in situations where nutrient availability is limited. The promotion of plant development was strongly linked to the presence of abundant microbial activity in bat guano, which in turn resulted in further advantageous effects of the organic fertilizer produced (Singh et al., 2022 and Xiya et al, 2024). The aim of this investigation is to study the effect of vermicompost applications and foliar application of some different micronutrients compounds and vermi-wash on growth, yield and chemical constituents in global artichoke plants (*Cynara scolymus* L.) cv. Herious.

MATERAILS AND METHODS

This work was carried out in Agricultural Research Center, Kaha Research farm, El-Kaliobia governorate, Egypt, during two winter successive seasons of 2020/2021 and 2021/2022.

Plant Material:

Transplant of artichoke were cultured in April at 40 cm apart in both seasons. The experimental plot size was 20m^2 (three dripper lines with 6m length each 70 cm distance between each two dripper lines). One line was used to measure the vegetative growth parameters; the other two were for other traits. The agricultural practices were conducted according to the recommendation of the Ministry of Agriculture and Land Reclamation, Egypt for artichoke commercial production. Compost fertilization program commonly used for globe artichoke crop was adopted. This experiment included 12 treatments, which were the combinations between four doses of organic fertilizers (vermicompost and compost) and three foliar applications; 1-Tap water as a control, 2- micronutrients and 3- vermi-wash. The treatments were arranged in a split-plot design with three replicates, organic fertilizers treatments were randomly assigned in the main plots, while the foliar spray was randomly distributed in the sub-plots.

Treatments:

Organic fertilizers:-

1. Control (2 ton/ fed.) the recommended dose of compost.
2- 1 ton/fed. Vermicompost.
3- 1.5 ton/fed. Vermicompost.
4- 2 ton/fed. Vermicompost.

Foliar application treatments:

1. Control (spraying plants with tap water).
2. Microelements (Fe, Mn, Cu and Zn) at 50 g/100 liter water after 60-80-100-120 day after planting
3. Vermi-wash at 10 liter /100 liter water after 60-80-100-120 day after planting

Vermicompost and Vermi-wash process:

The vermicompost and vermi-wash stock solution were prepared according to Manyuchi et al. (2013) and Pilli et al. (2019). The vermi-wash was collected through vermicomposting process. The vermi-wash was filtered using nets to remove any residues or dust that could cause blocking of drippers before being diluted to the desired EC.

Table (1). The properties of compost and vermicompost.

Item	Compost	Vermicompost
Density (%)	0.77	0.86
Mositure (%)	18	22
pH 1:10	8.43	8.62
Ec (ds/m) 1:10	4.06	6.34
OM (%)	28.39	32.03
OC (%)	17.32	19.54
Ash (%)	81.61	77.98
C/N ratio	18.2	12.6
Total N (%)	0.95	1.55
N-NH4 (ppm)	129	48
N-NO3 (ppm)	65	157
Total P (%)	0.63	2.22
Total K (%)	1.18	1.90
Total Ca (%)	1.08	1.2
Total Mg (%)	0.89	0.95

Table (2). The chemical composition of vermicompost

	Macro nutrients ppm					Micro nutrients ppm					
Vermi-liquid	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	B	Pb
	128	181	322	111	48.6	0.25	0.04	0.01	0.04	0.21	0.047

Table (3). Soil physical and chemical properties for experimental site.

Physical Properties (%)		Chemical (available) (ppm)	
Clay	61.52	N	82.80
Silt	17.73	P	5.25
Sand	20.75	K	200.12
Texture class	Clay loam	pH (1- 2.5 suspension)	7.50

*Analysis of soil character is done according to the method by Jackson (1973).

Measurements:-

Vegetative Parameters:-

Data were recorded 120 days after planting; five plants from each treatment were randomly selected for measuring: plant height and lateral shoots number/plant.

Dry Matter:-

Random samples of the total yield of edible parts (receptacles) were selected to determine dry matter content percentage (calculated by drying 100 grams of fresh heads in an oven at 70°C till a constant weight) according to A.O.A.C. (1985).

Yield and its components: Flower head yield and quality were recorded by harvesting time.

a- Early yield (EY):

Data was calculated from the start of harvest until the end of February. Early yield was expressed as a number of heads/fed. Five flower heads were randomly chosen from each plot in both seasons to evaluate early yield characters, as following: Fresh weight (g) and diameter (cm) of the flower head, as well as receptacle weight (g) and diameter (cm).

b- Total yield:

It was calculated from the start of harvest until the end of harvest (on May 15) expressed as a number of heads/fed, including early yield. Five flower heads were collected from each plot in both seasons to investigate the quality parameters of total yield as following: flower head weight (g) and diameter (cm), as well as receptacle weight (g) and diameter (cm).

Chemical analysis of flower heads:

Inulin: Inulin was determined according to Winton and Winton (1958) methods.

Mineral contents:

Total nitrogen, phosphorus and potassium were determined according to methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

Statistical analysis:

The experimental design was a split plot with 3 replicates where vermicompost rates and control were assigned as main plots and foliar application as subplots. Data analysis was done by using SAS program for statistical analysis. The differences among means for all traits were tested for significance at 5 % level, according to Snedecor and Cochran (1980).

RESULTS

Vegetative growth:-

The highest values of plant height obtained from the interaction between vermi-wash foliar application and the third level of vermicompost (2 ton/fed.) was (78.66 cm) in the first season and by using vermi-wash with recommended compost (control) and foliar application with micronutrients and the first level of vermicompost (1ton /fed.) and with the third level of vermicompost (2 ton/fed.), representing (78.29, 76.5 and 78.50 cm), respectively in the second season. Meanwhile the lowest value of plant height (63.33) was observed from the interaction between foliar applications with micronutrients and the recommended compost 2 ton/fed. (control) in the first season, as well as applying water with the first level (1ton /fed.) and second one of (1.5 ton/fed.) of vermicompost showed (64.5 and 65.5 cm), respectively, in the second season. As for offshoots number /plant, data showed the highest values with the foliar application of vermi-wash and the recommended Compost 2 ton per fed. (control) in the first season **Table (4).**

Yield and its components:

Early yield and its components:

According to **Table (5),** all vermi-compost treatments performed more effectively than the control compost in regard to early yield. The application of vermi-compost at 2 ton per fed produced the best results. It gave (3687 and 3511) flower heads number per fed, while the control produced the lowest result (2133 and 1,333) flower heads per fed over the two seasons, respectively. Regarding foliar application treatments, findings demonstrate that the highest values of flower heads number per fed were obtained from vermi-wash (3667 and 2900) followed by micro elements (3083 and 2700) and the control treatment (3000 and 1533), respectively in two seasons.

Table (4). Effect of vermicomposting (ton/fed.) **application rates and foliar applications on vegetative growth parameters of global artichoke during the two growing seasons of 2020/2021 and 2021/2022.**

Treatments		Plant height (cm)		Offshoot No./plant	
		1st season	2nd season	1st season	2nd season
Compost (control)	Water	68.88 e	59.83 g	3.44ab	3.94 a
	Micro	63.33 i	70.45 b-d	4.10ab	3.99 a
	Vermi	68.55ef	78.29a	4.44a	4.27 a
1 ton/fed Vermi compost	Water	70.32 de	64.51f	2.99 bc	3.13 a
	Micro	71.00 d	76.5 a	3.66ab	3.77 a
	Vermi	64.88 hi	67.23 ef	3.66a-c	4.15 a
1.5 ton/fed Vermi compos	Water	65.54 gh	65.50f	3.22bc	3.16 a
	Micro	74.64 c	72.27 bc	3.55abc	3.83 a
	Vermi	76.65 b	73.44 b	3.55a-c	4.16 a
2 ton/fed Vermi compost	Water	66.98 fg	70.32cd	3.55abc	3.99 a
	Micro	74.65 c	68.56de	3.33bc	3.883 a
	Vermi	78.66 a	78.50 a	3.39a-c	3.50 a

Values within the column or rows followed by the same capital or small letter/s do not significantly differ from each other according to Duncan, s multiple range test at 5% level

Table (5). Effect of vermicomposting (ton/fed) application rates and foliar applications on early yield and its components of early yield of and its components global artichoke during the two growing seasons of 2020/2021 and 2021/2022

Treatments / Foliar application	Organic fertilizers (ton/fed.)									
	Frist season					**Second Season**				
	Compost 1	Vermi 1	Vermi 1.5	Vermi 2	Mean	Compost 1	Vermi 1	Vermi 1.5	Vermi 2	Mean
	Early yield flower heads No. / fed									
Control (water)	1400.0 J	2800.0 h	3000.0 G	4800.0 b	**3000 C**	800 I	1200 h	2000 F	2133 e	**1533C**
Micronutrients	2800.0 h	3533.3 C	2800.0 h	3200.0 F	**3083 B**	1600 g	2400 d	2000 F	4800 a	**2700B**
Vermi	2200.0 I	4000.0 C	4866.6 a	3600.0 d	**3667°**	1600 g	3600 b	2800 C	3600 B	**2900°**
Means (B)	**2133 D**	**3444 C**	**3556 B**	**3687A**		**1333 D**	**2400 B**	**2267 C**	**3511°**	
	Flower head weight (g)									
Control (water)	358.06°	301.64f	343.84b	327.57d	**332.8 A**	159.60 I	179.97 E	182.00 cd	196.22 a	**179.4°**
Micronutrients	285.91h	278.54i	288.64g	255.59k	**277.2C**	182.87 C	194.43 B	166.69 g	159.19 I	**175.8°**
Vermi	334.19c	312.05e	250.22 l	273.31j	**292.4B**	175.25 F	196.56 a	163.38 h	180.50 dc	**178.9°**
Means(B)	**326.1 A**	**297.4B**	**294.2 C**	**285.5A**		**172.6 C**	**190.3 A**	**170.7C**	**178.6 B**	
	Flower head diameter(cm)									
Control (water)	7.18 a	5.55abc	5.71abc	4.96c	**5.85 A**	7.74 a	7.72 a	7.50 a	7.84 a	**7.71°**
Micronutrients	6.14 abc	5.72abc	6.33abc	5.31bc	**5.87A**	6.04 a	7.73°	6.92 a	6.58 a	**6.81°**
Vermi	6.71ab	5.99abc	6.06abc	5.97abc	**6.18°**	7.01 a	7.95 a	6.14 a	6.71 a	**7.01°**
Means(B)	**6.67°**	**5.75 A**	**6.03 A**	**5.41 A**		**7.01A**	**7.81°**	**6.85`1°**	**7.04°**	
	Receptacle weight (g)									
Control (water)	78.94 b	59.12 f	63.85 e	54.49 h	**64.10B**	64.92 b	47.73 f	43.05 g	41.83 g	**49.39B**
Micronutrients	63.95 e	65.08 d	83.87 a	56.58 g	**67.37A**	68.94 a	61.74 c	64.91 b	53.09 e	**62.17°**
Vermi	67.49 c	51.08 I	67.83 c	57.08 g	**60.87C**	42.63 g	55.77 d	46.89 f	46.45 f	**47.54B**
Means(B)	**70.13°**	**58.43B**	**71.85A**	**56.05B**		**58.83A**	**55.08 A**	**51.62C**	**47.12D**	
	Receptacle diameter (cm)									
Control (water)	4.66 a	4.32 a	4.26 a	4.24 a	**4.37A**	5.82 a	6.01 a	5.23 a	5.98 a	**5.76°**
Micronutrients	4.31 a	4.56 a	5.45 a	4.08 a	**4.00A**	5.58 a	6.26 a	6.10 a	6.13 a	**6.02°**
Vermi	4.57 a	4.15 a	3.33 a	4.15 a	**4.05A**	5.44 a	5.58 a	6.40 a	5.65 a	**5.76°**
Means(B)	**4.51 A**	**4.34 A**	**4.35 A**	**4.16A**		**5.61A**	**5.95 A**	**5.91 A**	**5.9°**	

Values within the column or rows followed by the same capital or small letter/s do not significantly differ from each other according to Duncan, s multiple range test at 5% level

The results of first season showed that combination between Vermi-wash as a foliar application and 1.5 ton/fed of vermicompost had the highest value of early yield (4866.6 heads /fed) compared to all treatments with significant differences. In contrast, combination between foliar application with water and compost (control) recorded the lowest value of early yield (1400 heads/fed) in the first season.

In the second season, the highest value was obtained from using foliar application with micronutrients at level 2 ton/fed. of vermicompost (4800 heads /fed), followed by that combination of vermi-wash + 2 ton/fed of vermicompost (3600 heads /fed), and the lowest value (8001 heads /fed) was recorded from the combination between foliar application with water + compost (control). Generally, highly significant differences between all treatments in both seasons were observed **(Table 5).**

Flower head weight:-

In the first season**,** when one ton of compost (control) was applied to feddan of artichoke plants, the flower head weight increased significantly in comparison to the other treatments. Whereas, In the second season, the vermi-compest treatment 1 ton per fed., reflecting a significant increase in the flower head weight over the remainder treatments**.**

Data in **Table (5)** showed that the highest value of flower head weight in the first season was obtained with the interaction between (compost + water) 358.06(g), with significant differences comparing to the other treatments followed by the combination between (1.5 ton/fed. of vermi-compost + water) 343.84 g. While in the second season, the highest value of this trait was obtained from the combination of (1ton of vermicompost + Vermi-wash) 196.56 g followed by the combination of (2 ton /fed. of vermicompost + water) 196.22 (g) without significance difference between them and with highly significant differences among all of other treatments.

Flower head diameter:

Table (5) shows that the vermi-compost and spraying treatments had no significant influence on floral head diameter when compared to the control treatment in both seasons..

Generally, results showed that no significant differences were observed between most of all treatments in both seasons. The combination of 1 ton/fed. of vermicompost+ Vermiwash achieved a high value compared with all treatments without significance **Table (5).**

Receptacle weight:

It was also discovered that adding compost and/or 1.5 tons/fed. of vermi-compost surpassed and produced significantly higher flower head weight (g) than the other treatments in the first season, whereas the control treatment and vermi-compost 2 tons/fed produced significantly greater flower head weight in the second season than the other treatments

The interactions between (1.5 ton/fed. of vermicompost + micronutrients) were superior to all other treatments. It recorded the highest receptacle weight value (83.87 g), with significant differences among all treatments in the first seasons, followed by a combination of compost (control) + water (78.94). The contrary was observed in the second season, combination of compost (control) + microelements (68.94 g) was superior to all the other treatments, with significant differences followed by the interactions between compost (control) + water (64.92) and (1.5 ton/fed.) of vermicompost + micronutrients (64.91) with significant differences among all treatments, **Table (5).**

Receptacle diameter:

No Significant differences were found between all treatments in both seasons. However, combining microelement in the first year and vermi-wash in the second year with1.5 ton/fed. of vermicompost produced higher values than all treatments (Table 5).

Total yield:

During the two growing seasons, the spray and vermicompost treatments (1, 1.5 and 2 tons/fed) exceeded the control treatment in the term of total yield expressed as number of flower head per fed, despite the absence of significant differences between them.

As for foliar application treatments, no significant differences were observed between them during the first season. Whereas, in the second season, the vermy-wash treatment showed the highest number of flower head per fed comparing to other spraying treatments.

Referring to the interaction treatments, the highest total yield values were recorded with the interactions between (vermi-compost 1 ton/fed and spraying vermi-wash treatments) expressed as 45530 and 61670 flower heads/fed, during the two growing seasons, respectively. Meanwhile, the combinations of (compost + vermi-wash and with microelements) recorded the lowest values of flower head yield (25400 and 42470 /fed) during the two seasons, respectively **(Table 6).**

Flower head weight:-

Table (6) shows that over the course of the two seasons, the compost treatment (control) has a larger weight (g) in terms of the flower head than the other treatments. While spraying with micro-elements and vermi-wash showed a greater weight flower head than the treatment of water spraying in the first season. Data in **Table (6)** showed that the interactions between vermi-wash + compost (307.1 g) in the first season and spraying water + compost (317.7 g) in the second one, ha the highest values among all treatments. Data in **Table (6)** showed that the interactions between 1.5 ton/fed. of vermin-compost and spraying water (201.5 g) and 1 ton/fed. of vermin-compost and spraying vermi-wash (225.6 g)had the lowest values of flower head weight among all treatments during the two growing seasons respectively.

Flower head and receptacle diameter:-

In both seasons, there were no significant differences between the examined characteristics for flower head and receptacle diameter (cm).

Receptacle weight:-

According to the results in **Table (6),** data recorded during the two growing seasons indicated that, applications of vermicompost resulted in a significant rise in receptacle weight (g) over the compost (control). Also spraying of vermi-wash led to a significant increase in this characteristic comparing to the control treatment.

The interaction between (1.5 ton/fed vermin-compost plus vermi-wash) was superior to all the other treatments. They recorded the highest receptacle weight value (58.33 g), with significant differences among all treatments in the first season. The lowest recorded value of (36.33 g) was obtained from the (control + vermi-wash) treatment. Whereas, spraying with water (control) + 2 ton/fed of vermicompost and vermi-wash + 2 ton/fed. of vermicompost were superior to all the other treatments, expressed as 74.91 and 74.14 g, respectively, with significant differences in the second season. The lowest value of (56.02 g) was recorded with the control (water spray).

Table (6). Effect of vermicomposting (ton/fed) **application rates and foliar applications on total yield and its component of global artichoke during the two growing seasons.**

Treatments / Foliar application	Organic fertilizers (ton/fed)									
	Frist season					**Second Season**				
	Compost (control)	Vermicompost 1 t/fed	Vermicompost 1.5 t/fed	Vermicompost 2 t/fed	Main	Compost (control)	Vermicompost 1 t/fed	Vermicompost 1.5 t/fed	Vermicompost 2 t/fed	Main
Total yield (heads no /Fed)										
Control (water)	39170 de	32530 gh	36690 f	41730 cd	**37520 A**	44880 f	50670 d	59640 b	48110 e	**50820 B**
Microelements	41170 bc	30530 hi	38730 ef	30870 hi	**35320 A**	42470 g	58660 b	51000 d	52660 c	**51200 B**
Vermi-wash	25400 j	45530 a	33530 g	43330 b	**36947 A**	44330 f	61670 a	52730 c	51330 d	**52515 A**
Main	**35246 B**	**36300 A**	**36320 A**	**38640 A**		**43890 D**	**57000 A**	**54456 A**	**50700 C**	**50820 B**
Flower head weight (g)										
Control (water)	235.1 h	266.1 e	201.5 j	264.7 e	**241.8C**	317.7 a	238.2 h	229.6 i	290.8 c	**269.0A**
Microelements	295.1 b	271.0 d	281.7 c	236.1 h	**271.0A**	261.4 e	294.8 b	253.7 f	235.9 h	**261.4B**
Vermi-wash	307.1 a	257.6 f	241.6 g	220.2 i	**256.6BA**	276.6 d	225.6 j	249.1 g	275.0 d	**256.6C**
Main	**279.1A**	**264.9B**	**241.6C**	**240.3C**		**285.2A**	**252.C**	**244.1D**	**267.2B**	
Flower head diameter (cm)										
Control (water)	8.72 a	8.34 a	8.09 a	7.98 a	**8.28 A**	7.74 a	7.76 a	7.50 a	7.84 a	**7.71°**
Microelements	7.32 a	8.29 a	6.39 a	8.60 a	**7.65 A**	6.04 a	7.73 a	6.92 a	6.58 a	**6.81°**
Vermi-wash	7.87 a	7.72 a	7.67 a	8.34 a	**7.90 A**	7.26 a	7.95 a	6.14 a	6.71 a	**7.01°**
Main	**7.97A**	**8.11A**	**7.38B**	**8.30 A**		**7.01A**	**7.81°**	**6.85A**	**7.04°**	
Receptacle weight (g)										
Control (water)	44.61 c	41.27 dc	40.00 e	41.75 dc	**41.91B**	56.02 h	52.64 i	73.10 b	74.91 a	**64.17B**
Microelements	50.77 b	45.08 c	40.83 e	49.83 b	**46.61°**	58.25 g	58.96 g	68.62 c	64.39 de	**62.55C**
Vermi-wash	36.33 f	51.91 b	58.33 a	43.36 cd	**47.48°**	63.24 f	65.07 d	63.66 ef	74.14 a	**66.53°**
Main	**43.90C**	**46.09°**	**46.38°**	**44.90B**		**59.17C**	**58.89C**	**68.46B**	**71.14°**	
Receptacle diameter (cm)										
Control (water)	4.21 a	3.64 a	3.69 a	4.67 a	**4.05A**	5.66 ab	5.28 ab	4.41 b	4.57 b	**4.98°**
Microelements	3.53 a	3.77 a	3.18 a	3.67 a	**3.54A**	4.85 ab	5.69 ab	4.97 ab	5.50 ab	**5.25°**
Vermi-wash	3.08 a	4.94 a	3.91 a	3.63 a	**3.66A**	6.35 a	5.57 ab	5.50 ab	5.68 ab	**5.78°**
Main	**3.60°**	**4.12A**	**3.59A**	**3.99°**		**5.62A**	**5.51°**	**4.96A**	**5.25°**	

Values within the column or rows followed by the same capital or small letter/s do not significantly differ from each other according to Duncan' s multiple range test at 5% level.

Chemical componanets of flower hesd:

Table (7) shows that the addition of vermi-compost had no apparent effect on nitrogen or potassium contents when compared to the control treatment. In addition data in the same table showed that, the treatments of 1 and 2 tons of vermin-compost per fed. had significant increases in the phosphorus content of the receptacle over the other treatments. Also, adding 1 ton of vermin-compost per fed. resulted in a significant increase in the percentage of the material, showing that the addition of vermin-compost fertilizer affected both the dry matter content and the inulin percentage spraying mineral elements and vermi-compost- wash on artichoke plants caused a considerable increase in N, P, K, and inulin content when compared to the control treatment. Results showed that all combinations treatments with spraying water gave the lowest N content. On the other hand, using all of other combination treatments showed significant increasing in this content without significant differences between them **(Table 7).**

Generally in **(Table 7)** results show that, using microelements and vermi-wash as a foliar applications with all organic fertilizers resulted in a higher value of P content with significant differences comparing to other treatments.

Generally, in the same table, vermi-wash as a foliar application with all organic fertilizers recorded the highest values of K content followed by the spraying of microelements. Whereas the lowest K content was obtained from spraying water. Data in **Table (7)** show that the highest value of inulin content was recorded with the combination of microelements and vermi-wash as foliar applications and all organic fertilizers with significant differences comparing to other treatments. Results in **(Table 7)** showed that the highest dry matter % resulted from the combination of water spray (control) and/or micronutrients + 1 ton /fed of vermicompost and the combination of 1.5 ton/fed of vermicompost + vermi-wash without significant differences between them. The lowest values were obtained with micronutrients + compost and vermi-wash with 2ton/fed of vermicompost.

Table (7). Effect of vermicomposting (ton/fed) application rates and foliar applications on globe artichoke flower heads.

Treeatmeents / Foliar application	Organic fertilizers (ton/fed.)				
	Compost (control)	Vermicompost 1 t/fed	Vermicompost 1.5 t/fed	Vermicompost 2 t/fed	Main
			Nitrogen (N, %)		
Control (water)	1.55 b	1.60b	1.57b	1.56ba	**1.57 B**
Micrelements	1.85 a	1.86a	1.83°	1.92a	**1.86 A**
Vermi wash	1.95 a	2.00a	2.00a	2.10a	**2.01 A**
Main	**1.78 A**	**1.82A**	**1.80°**	**1.86A**	
			Phosphor (P, %)		
Control (water)	0.36b	0.34b	0.30b	0.40 b	**0.35 B**
Microelements	0.78°	0.90a	0.86°	1.02a	**0.89 A**
Vermi wash	0.89°	0.98a	0.91°	0.93a	**0.92 A**
Main	**0.67 B**	**0.74 A**	**0.69 B**	**0.78 A**	
			Potasium (K, %)		
Control (water)	2.60b	2.56bc	2.42bc	2.60bc	**2.54B C**
Microelements	3.65b	3.45b	3.55b	3.72b	**3.59 B**
Vermi wash	4.97°	4.38b	5.66°	4.68a	**4.92 A**
Main	**3.74°**	**3,46A**	**3,87°**	**3.66A**	
			Anulin (%)		
Control (water)	0.89b	0.90b	0.87b	0.89b	**0.88B**
Microelements	1.08°	1.08a	0.98ab	1.07a	**1.01A°**
Vermi wash	1.23°	1.04a	0.97ab	0.91ab	**1.05°A**
Main	**1.06 A**	**1.00 A**	**0.94 AB**	**0.95A**	
			Dry matter (%)		
Control (water)	17.93cd	30.90a	21.21bc	20.28bcd	**22.85°**
Microelements	12.6e	31.21a	17.20d	19.95cd	**20.24B**
Vermi wash	18.13cd	23.60b	30.90°	12.07e	**21.17B**
Main	**16.22C**	**28.57A**	**23.10B**	**17.43C,**	

Values within the column or rows followed by the same capital or small letter/s do not significantly differ from each other according to Duncan' s multiple range test at 5% level

DISCUSSION

The current agricultural system relies extensively on fertilization to meet market demand, despite the fact that excessive fertilization has a detrimental impact on soil health and crop output. Organic fertilizers obtained from agricultural byproducts, livestock manure, food waste, and similar sources have been extensively studied and proven to enhance both crop output and soil quality, thus promoting sustainable agriculture.

This study attempted to identify the ideal application range for organic compost and vermicompost, together with combinations of liquid vermi spraying, micronutrients, and water (control), in order to enhance the growth, yield, and nutrient uptake of Artichoke plants. The utilization of vermicomposts as primary fertilizers in situations where there is a deficiency of mineral nutrients can result in enhanced plant growth, increased biomass accumulation, and improved yield. These benefits can be attributed to the direct impact of an augmented availability of mineral elements that are essential for plant development. The findings are consistent with the study conducted by Abd El-Rheem et al. (2019), they indicated that increasing the application of vermin-compost from 1 to 5 tons per Fadden led to a significant enhancement in both plant length and the number of leaves, hence positively impacting the yield characteristics of Artichoke. Furthermore, the findings revealed that plants treated with vermin liquid exhibited the greatest level of importance as compared to those treated with water and micronutrients as a foliar spray. The findings are consistent with the Kasahun et al. (2021). However, the data on the quantity of offshoots did not show any significant results for the treatment variables of vermicompost levels and foliar spray applications. The data in table 6 demonstrated that the combination of applying 2ton /Fadden of vermicompost and using vermi-wash as a foliar spray resulted in the most favorable outcomes for plants compared to other combinations. Furthermore, the data indicated that the combination of applying 2ton of compost as a control treatment and using vermin liquid as a foliar spray resulted in the greatest number of offshoots compared to other interactions during the first season. The observed enhancements in growth parameters of artichoke plants can be attributed to the properties of vermicompost, which is produced through the process of composting or pulverizing organic materials with the help of earthworms. According to Rajiv et al. (2010), it has a rich abundance of vital plant nutrients and has the ability to enhance soil condition and quality. Oyega and Balaji Bhaskar (2023) observed a significant enhancement in plant growth traits following the application of vermicompost in the soil; it was attributed to the influence of plant growth and biological fertility parameters. The interaction between earthworms and microbial communities can boost microbial activities, while also leveraging metabolism. This leads to an increased release of accessible nutrients and microbial metabolism in the soil.

Comparing the impact of composts and vermicomposts on plant growth and yield is challenging due to the typically distinct chemical composition of these products (Márk et al., 2019) or the artificial balancing of their mineral composition (Doan et al. 2013). When the same initial organic material was utilized to create compost and vermicompost, it became apparent that these methods had distinct and notable impacts on the physical and chemical characteristics of the end products. Specifically, vermicompost exhibited elevated levels of various mineral nutrients (N, P, K, Cu), whereas composts displayed higher concentrations of water-soluble K and electrical conductivity. A recent study by Ievinsh et al. (2020) examined the impact of compost and vermicompost on the cultivation of herbs in an organically certified greenhouse using organically certified soil. Both products were derived from identical sources, namely cow manure and grass biomass, and exhibited very equivalent levels of all essential mineral nutrients for plants as well as the overall concentration of soluble salts. The vermicompost exhibited notably elevated levels of Ca, Zn, and Cu, while the compost demonstrated increased concentrations of K and Fe. The growth and biomass production of Dracocephalum moldavica, Melissa officinalis, Nepeta cataria, and Thymus vulgaris were more effectively encouraged by the vermicompost treatment, when the amendment rate was kept constant. The results clearly demonstrate that the combined use of vermi liquid and micronutrients significantly boosted both the overall yield and yield components. The promotion of growth and yield productivity can be linked to the increased availability and content of nutrients, such as nitrogen, phosphorus, and potassium, in the soil (Xiya et al., 2024). The findings were consistent with the results reported by Ozyazici (2013) and Ratnasari et al. (2023). The results additionally demonstrated that the use of compost stimulates a positive impact on the yield and various components of artichoke production. The increase in head weight may be caused by microelement and vermi-wash which may affect the metabolism of auxin, which is crucial for many physiological processes, including cell elongation, maturation, and meristematic tissue growth (Mengel and Kirby, 2001) .Microelements affects physiological and metabolic functions within plant cells, changing the nutrient concentration and translocation (Tariq and Mott, 2007). The increased efficacy of compost can be attributed to a higher concentration of essential plant nutrients such as nitrogen (N), phosphorus (P), potassium (K), and magnesium (Mg), as well as the reinforcement of root structures caused by the application of compost(Mengistu et al., 2018). The superiority of vermicompost over compost can be attributed to changes in the balance between chemical forms of nitrogen, specifically ammonium and nitrate. Vermicomposts predominantly contain nitrate, which contributes to their higher quality despite having the same nitrogen concentration as compost. However, composts predominantly consist of ammonium (Xiya et al., 2024). The effective role of vermicompost for good growth and high yield production was due to vermicompost has a high nutrients content and growth regulators comparing it with compost, because the vermicompost contained a suitable concentration of different growth regulators such as indole acetic acid and cytokinin which significantly improved plant growth and increasing yield of lettuce by comparing it with the compost (Abd El-Rheem et al., 2019). The greater ability of vermicomposts compared to composts to influence plant growth can also be attributed to variations in microorganisms (Zarrabi et al., 2018). Vermicomposts typically exhibit increased microbial diversity and abundance, maybe attributed to the substantial presence of earthworm symbionts (Grantina-Ievina et al., 2013). Conversely, several bacteria in the rhizosphere generate plant hormones. The vermicomposts' fine particle shape clearly creates a large immobilizing surface, which enhances their ability to slowly release nutrients and prevents nutrient loss through leaching. It is widely recognized that some structures of organic materials have the ability to effectively immobilize many ions, hence reducing their availability to plants. Indeed, under some circumstances, the reactivation of trapped elements can occur, triggered by alterations in soil redox potential, pH, or the secretion of root exudates. The presence of humic compounds has primarily been linked to the last mechanism. Hence, the addition of vermicompost to soil that has a low concentration of organic matter can greatly alter the accessibility of specific minerals for plants. However, the positive effects of these modifications can vary considerably. The vermicompost treatment may stimulate the uptake of specific mineral elements by activating transport systems in the plasmatic membrane of root cells. However, the significance of this process has not been substantiated thus far from a physiological perspective. Enhanced absorption of nutrients per individual root is proposed as one of the processes responsible for the promotion of plant growth related with vermicompost. The vermicompost is likely to contain organic acids and compounds created by microorganisms, which can aid in the absorption of minerals by plant roots (Pii et al., 2015).

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الملخص العربي

دراسة تأثير إضافة مستويات الفيرموكمبوست والرش بالعناصر الصغرى على النمو والمحصول والجودة لمحصول الخرشوف

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كان الدافع وراء إيجاد مصادر جديدة للمواد العضوية وتطوير تقنيات التسميد العضوي وتحسين كفاءة إعادة التدوير هو الحاجة إلى تعزيز المادة العضوية بالتربة للإنتاج المستدام لتتناسب مع الأمن الغذائي في الاراضي شبه القاحلة، أي مصر. أجريت التجربة الحقلية على الخرشوف في مزرعة مركز البحوث الزراعية (قها) في مصر في موسمين شتويين متتاليين (2021-2022).

بحثت الدراسة الحالية تطبيق استخدام سماد الفيرمي كمبوست في التربة بمعدلات مختلفة مع استخدام الرش الورقي للعناصر الصغري وشاي الفيرمي كمبوست بمعدلات مختلفة على نمو النبات والوزن الطازج والجاف ومكونات المحصول والمكونات الكيميائية للخرشوف. كان تصميم التجربة قطع منشقه، وأضيف السماد العضوي (الفيرمي كومبوست) (في القطع الرئيسية) بمعدلات مختلفة (1، 1.5 و2 طن/فدان) مقارنة بالجرعة الموصى بها من السماد العضوي(الكمبوست) (2 طن / فدان. ككنترول). وكانت القطع المنشقه تشمل الرش الورقي بكلا من العناصر الصغري (حديد – زنك – منجنيز– نحاس) 50جم على 100 لتر ماء وشاي الفيرمي كومبوست 10 لتر لكل 100 لتر ماء والمياه ككنترول.

أظهرت النتائج ان التفاعل بين كلا من شاي الفيرميكومبست + التسميد الفيرميكومبست بمعدل 1.5 طن للفدان أعطي أعلي قيم للمحصول الكلي بينما التسميد بمعدل 2 طن/فدان كومبوست + شاي الفيرمي أعطى أقل نتائج في المحصول الكلي وصفاته، بينما أعلي قيم للمحصول المبكر تم التحصل عليها من التسميد بمعدل 1 طن/فدان فيرمي كومبوست + شاي الفيرمي، استخدام التسميد بمعدل 1 طن/فدان فيرمي كومبوست + شاي الفيرمي أدي إلي زياده محتوي النورات من الانيولين، بينما الماده الجافه للنورات زادت عند استخدام التسميد الورقي بالعناصر الصغري + 1طن/فدان فيرمي كمبوست.