The effect of different types of vermicompost fertilizers in some Physical and Chemical properties of the soil in Al-Hasaka Governorate

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Abstract

This study aimed to evaluate the effect of different types of vermicompost (produced from sheep, cow, and horse manure) applied at increasing rates (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) on some physical and chemical properties of soil in Al-Hasakah Governorate. The results showed that horse manure vermicompost was the most effective in improving the physical properties of the soil, significantly reducing bulk density and increasing porosity and water holding capacity (field capacity), with the treatment using 1.2 t ha^{-1} of horse vermicompost recording the highest increase in these properties. Chemically, sheep manure vermicompost excelled in improving soil properties by reducing pH and salinity, thereby enhancing soil fertility and chemical environment quality. The physical improvements, particularly in water holding capacity, are attributed to the increased organic matter, which improves soil structure and micropore distribution, thus enhancing water use efficiency by plants and their tolerance to water stress.

Keywords:

Vermicompost, water holding capacity, bulk density, porosity, organic matter.

Introduction:

Hassakeh Governorate is one of the most prominent agricultural regions in Syria, significantly contributing to the local economy and providing a primary source of income for its residents through the cultivation of essential and commercial crops. Among these non-strategic crops, cumin holds an important economic position due to its extensive use in cooking, food industries, and pharmaceuticals, along with its high export value in local and international markets (Banerjee & Sarkar, 2003). Cumin is a major source of income for many farmers, who rely on cultivating high-economic-yield crops. Achieving good productivity from this crop is closely linked to soil fertility and the availability of essential nutrients, necessitating the adoption of sustainable agricultural practices that preserve soil quality and health under challenging climatic and environmental conditions (Hassanzadehdelouei *et al*., 2013).

In recent years, interest has grown in producing medicinal and aromatic plants free from chemical residues, to ensure the safety of the products from both health and environmental perspectives (Abou-Bakr & Mostafa, 2011). Cumin (Cuminum cyminum L.) is one of the most important medicinal spice crops. It belongs to the Apiaceae family and is widely used in medicinal and aromatic applications. Cumin is classified as a short-lived annual herbaceous plant, sown in the spring season, and requires moderate climatic conditions for optimal growth.

Cumin cultivation is considered a high-return agricultural activity when managed according to sound scientific principles, making it of interest to a wide segment of farmers. However, this crop is directly affected by climatic fluctuations, which necessitates the development of appropriate agricultural and management practices to

achive high productivity and enhanced seed performance.

Soil organic matter is a critical component for ensuring soil fertility and the sustainability of its productivity. It contributes to improving soil structure, increasing aggregate stability, and enhancing its ability to retain moisture. With the advancement of the green revolution, excessive reliance on chemical fertilizers has led to the degradation of physical and chemical soil properties and increasing environmental pollution (Pandey *et al*., 2008; Albiach *et al*., 2000).

The physical properties of soil are fundamental factors that significantly affect soil health and agricultural productivity. These properties include bulk density, particle density, porosity, field water capacity, soil structure, and water retention. Studying these parameters is essential to understand how the soil interacts with its surrounding environment, particularly in terms of its effects on plant growth and yield.

Therefore, adopting sustainable agricultural practices requires an understanding of the vital role of organic matter in maintaining soil health. Organic fertilizers improve the physical, chemical, and biological properties of the soil and provide essential nutrients to plants, thereby enhancing soil productivity and crop quality. They are improving soil structure by binding soil particles, increasing the cation exchange capacity (CEC), enhancing water retention, facilitating phosphorus availability, and stimulating microbial activity (Acharya & Mandal, 2000). The slow release of nutrients from organic fertilizers helps reduce losses and ensures temporal synchronization between nutrient availability and plant uptake, thus improving nutrient use efficiency and contributing to increased yield.

Among the modern organic fertilizers, vermicompost is considered one of the most effective and sustainable methods in organic farming due to its ability to improve soil fertility, supply nutrients to plants, and reduce environmental pollution (Chatterjee *et al.*, 2014). Vermicompost is relatively rich in nutrients and releases them at a rate that meets the needs of the current crop. It also enhances soil physical properties and serves as an effective means to convert agricultural and food organic waste into high-quality fertilizer. It increases organic carbon levels, moisture content, and both macro- and micronutrient concentrations, in addition to promoting plant growth through natural growth regulators.

In light of the importance of transitioning toward organic agriculture and the growing demand for organic fertilizers due to their multiple benefits in improving soil fertility and crop productivity, this study aims to provide a scientific contribution by evaluating the effects of using different types of vermicompost prepared from sheep, cow, and horse manure on improving certain physical and chemical properties of the soil.

Objectives of the Study:

- The effect of vermicompost (prepared from sheep, cow, and horse manure) on certain physical properties of the experimental field soil, such as bulk density, porosity, and field capacity.
- The effect of vermicompost (prepared from sheep, cow, and horse manure) on certain chemical properties of the experimental field soil, such as organic carbon content, electrical conductivity (EC), and pH.

Materials and Methods:

The place and date of the research:

This study was conducted over two consecutive agricultural seasons (2023–2024 and 2024–2025) in fields affiliated with the Agricultural Extension Unit in the town of Bwaizarah, under the Directorate of Agriculture in Al-Hasakah Governorate. The study site is located within the second stability zone, at a latitude of 36.5876° N and a longitude of 40.8387° E. The experimental field was precisely located at the coordinates 36°35'15.3"N and 40°50′19.3″E, at an elevation of 452 meters above sea level. The region receives an average annual rainfall of approximately 350 mm and is considered an important agricultural area for crops such as cumin.

befor to treatment application, soil samples were collected from several locations within the experimental field at a depth of 0–30 cm to determine the initial physical and chemical properties of the soil throughout the study period. These samples were mixed thoroughly to form a composite sample representative of the site. This composite sample was then analyzed to determine its physical and chemical characteristics, Table (1).

Table (1): Physical and chemical properties of the soil at the study site during the two growing seasons.

2025-2024			2024-2023			The physical and chemical properties
Clay %	Silt %	Sand %	Clay %	Silt %	Sand %	Mechanical composition
41.5	30.0	28.5	41.6	29.25	29.15	
Clay			Clay			
1.29			1.32			Bulk density (g/cm³)
2.62			2.67			Particle density (g/cm³)
50.76			50.56			Total porosity (%)
7.7			7.8			pH
0.84			1.06			EC (m mhos/cm)
0.0460			0.0425			Total nitrogen (N) %
18.4			17.85			Available phosphorus (P) ppm
221			205			Available potassium (K) ppm
0.551			0.437			Organic carbon (C)%
21			23.5			Calcium carbonate %
11.97			10.28			C/N
2.64			2.46			Zn ppm
6.2			5.91			Fe ppm
2.96			2.32			Mn ppm

1.8	1.47	Cu ppm

The analysis results indicate that the soil maintained its texture classification within the clay category, with a slight improvement in certain physical and chemical properties between the two seasons. Bulk density and electrical conductivity (EC) decreased, while total porosity and organic carbon content increased. Additionally, an enhancement was observed in the concentrations of essential macronutrients (N, P, K) and micronutrients (Zn, Fe, Mn, Cu), suggesting that the soil conditions were suitable for conducting the study and achieving its objectives.

Fertilizer and Plant Material used:

A. Preparation of Vermicompost:

Vermicompost was prepared in small plastic containers specifically designated for experimental purposes, aiming to provide a suitable environment for the reproduction and activity of the red earthworm species Eisenia fetid (Edwards *et al.*,1996). a. Initially, the bottom of each container was lined with a layer of dry organic materials, including fallen tree leaves, paper scraps, newspapers, chopped wheat straw, dry plant residues, shredded pieces of paper bags, and small fragments of dried palm fronds. This layer filled approximately half the volume of the container. A small amount of partially decomposed compost was also added to activate microbial activity and accelerate the decomposition process.

Subsequently, about 500 g of a sand-soil mixture were added to the organic layer to improve the physical structure and enhance aeration. The contents were then moistened with water until the moisture level resembled that of a squeezed wet sponge an optimal condition for worm activity. Through careful balancing of the used materials, the carbon-to-nitrogen (C/N) ratio of the organic substrate was adjusted to range between 25:1 and 30:1, the ideal range for worm activity, thus accelerating the decomposition process and improving the quality of the resulting vermicompost.

Approximately 2,000 individuals of Eisenia fetida (equivalent to about 5 kg) were introduced into each container. According to data from the University of New Mexico, these worms can consume up to 2.5 kg of food waste per day (Lazcano et al., 2008). Plant-based kitchen waste was then evenly distributed over the container surface, while avoiding the addition of undesirable materials such as citrus peels, onion, garlic, and meat residues due to their negative effects on worm health and their tendency to attract flies. It is preferable that the added organic residues are slightly warm to promote biodegradation and reduce unpleasant odors.

Throughout the preparation period, moisture and aeration conditions were regularly monitored to maintain a stable and suitable environment, resulting in a mature, homogeneous vermicompost rich in beneficial organic matter. The produced vermicompost used in the experiment was analyzed, and the results are presented in Table (2).

Table (2): Chemical properties of vermicompost produced from sheep, cow and horse manure.

Substrate used	Earthworm used	PH	EC (ds/m)	C (%)	N (%)	C/N	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Sheep dung	E. foetida	7,2	2.6	26.89	1.49	18	1.36	1.26	2.77	0.63	0.1	595	265	185	46
Cow dung	E. foetida	7.5	1.29	32.25	1.68	19.19	1.42	1.48	5.91	1.02	0.15	502	253	381	178
Horse dung	E. foetida	7,97	1.07	39.51	1.62	24.38	0,54	0.83	1.6	0.47	0.08	209	98	174	127

B. Preparation of Cumin Seeds:

A total of 4 kg of local Syrian cumin seeds were used in the experiment. The seeds were collected from fresh, high-vigor, disease-free fruits. Prior to sowing, the seeds were treated with a fungicidal disinfectant at a rate of 4 g/kg using the dusting method, in preparation for use in the field trial.

Field Experiment:

Land preparation began in late November each year. Two successive plowing operations were conducted at a depth of 25–30 cm, followed by two operations to break up soil clods and improve surface leveling. Subsequently, two additional plowing operations were carried out, and the soil surface was carefully leveled. The 450 m² plot was then divided into experimental units according to a factorial design based on a randomized complete block design (RCBD).

In early January, the vermicompost was applied approximately one week before planting. The designated quantities for each treatment (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) were evenly distributed over the surface of the experimental plots and incorporated into the topsoil at a depth of 10–15 cm to ensure interaction between the organic material and the soil., as incorporation enhances compost-soil integration and promotes microbial activity.

On January 15, sowing was carried out mechanically using a seed drill, placing Cuminum cyminum L. seeds at a depth of 2–3 cm along planting rows. Surface irrigation (furrow irrigation) was applied when rainfall was insufficient to meet the crop's water requirements. Manual weeding was conducted two to three times during the growing season, depending on weed density.

About two weeks before harvest, soil samples were collected from the 0–20 cm root zone. Ten random soil cores were taken from each experimental unit and combined to form a composite sample for physical and chemical analysis.

Cumin was harvested 120 days after sowing, when signs of maturity appeared on the plants. Three plants were randomly selected from each experimental plot to measure morphological traits. Plant height (cm) was measured at mid-growth, when plants had reached full vegetative development but before full maturity. Seed yield per plant (g) was measured directly after harvest, following seed collection and drying. Total yield (kg/dunum) was calculated based on the harvested seed weight from the entire experimental plot.

Experimental Design:

The experiment was conducted using a randomized complete block design (RCBD) with three replications. A total of 13 treatments were tested, consisting of four application rates (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) of three types of vermicompost (from sheep, cow, and horse manure), in addition to a check treatment. This resulted in a total of 39 experimental units. Each plot measured 10 m², with adequate spacing between treatments and replications.

Analyses and Measurements: The analyses were conducted at the laboratories of the General Commission for Scientific Agricultural Research (GCSAR) in Damascus – Soil Research Department.

Soil Analyses:

Physical Analyses:

- **Mechanical Composition:** Determined using the hydrometer method, and soil texture was classified based on the USDA soil texture triangle.
- **Bulk Density:** Measured using the paraffin wax method.
- **Particle Density:** Determined using the pycnometer method (Black and Hartge, 1986).

  Total Porosity (%): Calculated based on the relationship between bulk and particle density using the equation:
  Total Porosity (%) = (1 − Bulk Density / Particle Density) × 100 (Hillel, 1982)

- **Air-Filled Porosity (%):** Calculated as the difference between total porosity and field capacity on a volumetric basis.
- **Solid Space (%):** Calculated as = (ρB / ρb)
- **Field Capacity (%):** Calculated using the formula:
  Field Capacity (%) = (Wet Weight − Dry Weight) / Dry Weight × 100 (Cassel and Nielsen, 1986).

Chemical Analyses:

- **pH:** Measured using a pH meter in the saturated paste extract.
- **Electrical Conductivity (EC):** Determined using a salinity meter in the saturated paste extract.
- **Organic Carbon (%):** Determined by the wet oxidation method using potassium dichromate.
- **Calcium Carbonate (%):** Measured using a calcimeter.
- **Total Nitrogen (N):** Determined using the Kjeldahl method (Bremner and Mulvaney, 1982).
- **Available Phosphorus:** Determined using the Olsen method (Olsen et al., 1954).
- **Exchangeable Sodium and Potassium:** Measured using a flame photometer.
- **Exchangeable Calcium and Magnesium:** Determined by titration with versenate solution; murexide was used as an indicator for calcium, and Eriochrome Black T for calcium and magnesium together.
- **Total Sulfur:** Determined using the wet digestion method with a mixture of nitric and perchloric acids, followed by turbidity measurement of barium sulfate ($BaSO_4$) precipitate after adding barium chloride ($BaCl_2$), using a spectrophotometer at a wavelength of 420 nm to estimate sulfur content in the samples.
- **Micronutrients (Fe, Zn, Mn, Cu):** Extracted using DTPA (diethylenetriaminepentaacetic acid) solution and measured using an Atomic Absorption Spectrophotometer (AAS).

Statistical Analysis:

Experimental data were analyzed using the statistical software **GenStat**. Analysis of variance (ANOVA) was performed to test the significance of differences among treatments, and the **Least Significant Difference (L.S.D)** test was used at the 0.05 significance level for mean comparisons.

Results and Discussion

1. Effect of Vermicompost Treatments on Selected Physical Properties of Soil:

1-1 -Effect of Different Types of Vermicompost on Soil bulk density (g/cm³):

Soil bulk density is an important physical property that affects soil permeability, aeration, and root distribution. The results showed that the addition of vermicompost led to a decrease in bulk density values compared the check treatment, the effect being more pronounced as the application rate increased. It was also observed that the type of vermicompost used had a different impact on bulk density, reflecting the variations in the organic composition of each type and its effect on soil bulk density.

Table **(3):** Effect of Vermicompost Treatments on Soil Bulk Density

	2025-2024				2024-2023			
Average	Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost	**Average**	Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost	Type / quantity t ha^{-1}
1.29[d]	**1.29[g]**	**1.29[g]**	**1.30[g]**	**1.31[e]**	**1.30[e]**	**1.31[e]**	**1.31[e]**	**Check**
1.253[c]	**1.23[cd]**	**1.26[ef]**	**1.27[fg]**	**1.28[d]**	**1.25[d]**	**1.29[e]**	**1.3[e]**	**0.3**

1.233^{b}	1.20^{b}	1.24^{de}	1.26^{ef}	1.2633 c	1.24^{cd}	1.26^{d}	1.29^{e}	**0.6**
1.2244 b	1.19^{b}	1.23^{cd}	1.2533^{ef}	1.2367 b	1.21^{ab}	1.24^{cd}	1.26^{d}	**0.9**
1.1989 a	1.16^{a}	1.21^{bc}	1.2267^{cd}	1.22^{a}	1.19^{a}	1.22^{bc}	1.2567^{d}	**1.2**
	1.214^{a}	1.246^{b}	1.26^{c}		1.24^{a}	1.2640^{b}	1.2833^{c}	**Average**
A=0.00514 B=0.0063 A*B=0.01148				**A=0.00518 B=0.00669 A*B=0.01158**				**L.S.D 0.05**
R 1.2 R*Units 0.6				R 1.3 R*Units 0.5				**CV%**

Note: Within each column or row, values followed by the same letter are not significantly different at the 0.05 probability level ($P \leq 0.05$).

From shows the results of soil bulk density under the influence of adding different types of vermicompost (sheep, cow, horse) at increasing rates (0.3, 0.6, 0.9, and 1.2 t ha-1) during two consecutive growing seasons (2023–2024 and 2024–2025). The results indicated significant differences between treatments in terms of compost type and application rate, with all additions generally contributing to a reduction in soil bulk density compared to the check treatment Table (3).

In the first season, the highest average bulk density was recorded in the check treatment (1.31 g/cm³), while values gradually decreased with increasing vermicompost rates, reaching the lowest value in the 1.2 t ha^{-1} horse vermicompost treatment (1.19 g/cm³), representing a 9.16% reduction. The same trend was observed in the second season, where the highest average bulk density was 1.29 g/cm³ in the check, decreasing to 1.16 g/cm³ in the 1.2 t ha^{-1} horse vermicompost treatment, a reduction of 10.07%.

Regarding the effect of vermicompost type, horse vermicompost was superior in reducing bulk density compared to cow and sheep vermicomposts. Its overall average bulk density in the first season was 1.24 g/cm³, compared to 1.26 and 1.28 g/cm³ for cow and sheep vermicompost, respectively. This ranking repeated in the second season, with average bulk densities of 1.21, 1.25, and 1.26 g/cm³ for horse, cow, and sheep vermicompost, respectively.

Statistical analyses showed that some differences between treatments were not significant, indicating a clear similarity in effects among certain treatments, consistent with findings by (Singh *et al*., 2017), (Maheshwarappa *et al*., 1999), (Marinari *et al*., 2000). However, all treatments exhibited a downward trend in bulk density, confirming the cumulative and sustainable effect of vermicompost application, as also supported by (Manickam 1993) and (Bazzoffi *et al*., 1998).

This reduction in bulk density is explained by the positive influence of vermicompost on improving soil structure, enhancing total porosity, increasing root penetration, and improving the balance between water and air within the soil, which positively affects its moisture retention capacity (Thiruneelakandan *et al*., 2015). (Widmer *et al*. 2002) explained that vermicompost modifies the soil pore system, improving water and air transport dynamics within the soil profile, thereby providing a favorable physical environment for plant growth. (Tripathi *et al*., 2014) and (Pant *et al*., 2017) confirmed that the reduction in soil bulk density is attributed to the presence of active organic compounds such as polysaccharides, fulvic acids, and gums, which enhance aggregate stability. (Manickam 1993) noted that soluble carbohydrates and proteins linked to glomalin were key aggregating agents that reduce disintegration mechanisms, especially water cracking and micro-fissuring, with stronger effects observed in fine loamy soils.

These complexes form from the union of organic compounds (e.g., humic and fulvic acids) with clay minerals (smectite, illite) via bonds with trivalent metal ions, often Fe^{3+} or Al^{3+}. The results indicate that the role of polysaccharides in soil structural stability was limited in this study compared to the more significant role of organic matter bound to clay particles through complexation with aluminum or iron ions.

It is noteworthy that the superior effect of horse vermicompost in reducing bulk density is attributed to its distinct physical properties, being rich in fibers and having a coarse texture. This enhances soil aeration, reduces fine particle cohesion, and increases total porosity, all contributing to lower bulk density and creating optimal conditions for plant growth, thus providing a greater capacity to improve soil structural composition compared to the other vermicompost types.

1-2- Effect of Different Types of Vermicompost on the Studied Total Porosity of the Soil (% Porosity):

Total porosity is one of the most important physical properties of soil, as it is closely linked to its ability to aerate roots and retain water (Singh *et al*., 2017) which directly impacts plant growth and productivity. The addition of organic matter to the soil, particularly vermicompost, plays a significant role in improving soil structure and breaking down soil aggregates, thereby contributing to an increase in the soil's porosity.

Table (4) shows the effect of vermicompost treatments on soil porosity.

Average	2025-2024			Average	2024-2023			
	Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost		Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost	Type / quantity $t\ ha^{-1}$
50.70^{d}	50.70^{h}	50.70^{h}	50.70^{h}	50.63^{e}	50.63^{g}	50.63^{g}	50.63^{g}	Check
51.96^{c}	52.87^{cd}	51.54^{g}	51.46^{g}	51.54^{d}	52.65^{bc}	50.95^{g}	51.01^{g}	0.3
52.59^{b}	53.85^{b}	52.12^{ef}	51.79^{fg}	51.94^{c}	52.85^{b}	51.91^{de}	51.07^{fg}	0.6
52.87^{b}	54.23^{b}	52.51^{de}	51.86^{fg}	52.50^{b}	53.64^{a}	52.31^{cd}	51.54^{ef}	0.9
53.57^{a}	55.04^{a}	53.28^{c}	52.39^{de}	52.91^{a}	54.05^{a}	53.08^{b}	51.60^{e}	1.2
	53.34^{a}	52.03^{b}	51.64^{c}		52.76^{a}	51.78^{b}	51.17^{c}	Average
A= 0.2217 B= 0.2862 A × B =0.4957				A= 0.2344 B= 0.3026 A × B =0.5241				L.S.D 0.05
R 1 R*Units 0.6				R 1.2 R*Units 0.6				CV%

Note: Within each column or row, values followed by the same letter are not significantly different at the 0.05 probability level ($P \leq 0.05$).

Table (4) illustrates the effect of adding different types of vermicompost (sheep, cow, horse) at increasing application rates (0.3, 0.6, 0.9, and 1.2 $t\ ha^{-1}$) on the total soil porosity percentage over two consecutive growing seasons. The results showed that all vermicompost treatments significantly improved soil porosity compared to the check treatment, with this improvement gradually increasing as the amount of applied compost increased, particularly when using horse vermicompost.

In the first season, the lowest porosity value was recorded in the check treatment (50.63%), which gradually increased to 52.91% at the 1.2 $t\ ha^{-1}$ rate, representing an overall increase of 4.50%. The highest porosity (54.05%) was observed in the 1.2 t ha^{-1} horse vermicompost treatment, showing an increase of 6.77% over the check. In the second season, porosity in the check was 50.70%, rising gradually to 53.57% at the highest application rate, an overall increase of 5.66%. The highest porosity in this season (55.04%) was also recorded in the 1.2 t ha^{-1} horse vermicompost treatment, representing an 8.57% increase.

Comparing the types of vermicompost, horse vermicompost outperformed the others in increasing porosity, with average porosities of 52.76% and 53.34% in the first and second seasons, respectively, followed by cow and then sheep vermicompost. This improvement is attributed to the fibrous structural composition of horse vermicompost, which enhances soil structure and increases pore space.

The statistical differences shown in the L.S.D test indicate that increases in total porosity were statistically significant, especially at higher application rates (900 and 1.2 t ha-1), confirming the importance of organic matter in improving the physical properties of soil. This increase can be explained by several interrelated factors, including decreased bulk density due to the breakdown of fine soil particles, formation of more stable and less cohesive soil aggregates, lower density of organic matter compared to mineral materials, and stimulation of biological and microbial activity in the soil.

These results align with findings by (Maheshwarappa *et al*., 1999) and (Sharma *et al*. ,2002), who reported that adding organic materials improves soil structure and porosity. Similarly, Sheikh and (Dwivedi, 2018) and Aechra *et al*., 2022) indicated that accumulation of organic matter causes structural changes in pore distribution. Studies by (Singh *et al*., 2017) ، (Marinari *et al*., 2000) also showed that increased porosity is linked to a rise in medium-sized rounded pores (30–50 and 50–500 micrometers) and a decrease in very large pores.

Pores ranging from 50 to 500 micrometers are the most important for improving aeration, drainage, and water retention, while growing roots require pores of 100–200 micrometers for free growth (Greenland, 1977). Improved porosity resulting from vermicompost application enhances soil aeration, balances air-water dynamics, increases available water retention, and creates a favorable environment for root growth and beneficial microorganisms, thus improving soil fertility and sustainability.

This has been confirmed by studies of (Baldia, 2014) ، (Jabbar, 2013), who considered high porosity a key indicator of improved soil physical quality. The main reason for this improvement is the inverse relationship between bulk density and porosity, where a decrease in bulk density corresponds to an increase in porosity. This study found a strong negative correlation between bulk density and total porosity (r = -0.804), supporting the hypothesis of the positive effect of organic matter on soil structure, pore space, and aggregate stability (Marinari *et al.*, 2000).

1-3- Effect of Different Types of Vermicompost on Soil Moisture Water Holding Capacity (MWHC %):

Field capacity is one of the fundamental physical properties of soil that directly affects the efficiency of water use by plants. It reflects the soil's ability to retain available water after excess water has drained away. Organic matter, especially vermicompost, contributes to improving soil structure and enhancing its water-holding capacity by increasing aggregate stability and porosity**.**

Table (5) Effect of Vermicompost Treatments on Soil Moisture Water Holding Capacity

	2025-2024				**2024-2023**			
Average	**Horse manure vermicompost**	**Cow manure vermicompost**	**Sheep manure vermicompost**	**Average**	**Horse manure vermicompost**	**Cow manure vermicompost**	**Sheep manure vermicompost**	Type / quantity t ha^{-1}
33.46^{d}	**33.46^{h}**	**33.46^{h}**	**33.46^{h}**	**33.41^{e}**	**33.41^{g}**	**33.41^{g}**	**33.41^{g}**	**Check**
34.30^{c}	**34.90^{cd}**	**34.02^{g}**	**33.9^{7g}**	**34.01^{d}**	**34.75^{bc}**	**33.63^{g}**	**33.66^{g}**	**0.3**
34.71^{b}	**35.54^{b}**	**34.40^{ef}**	**34.18^{fg}**	**34.28^{c}**	**34.88^{b}**	**34.26^{de}**	**33.71^{fg}**	**0.6**
34.89^{b}	**35.79^{b}**	**34.66^{de}**	**34.23^{fg}**	**34.65^{b}**	**35.40^{a}**	**34.52^{cd}**	**34.02^{ef}**	**0.9**
35.36^{a}	**36.33^{a}**	**35.17^{c}**	**34.58^{de}**	**34.92^{a}**	**35.68^{a}**	**35.03^{b}**	**34.06^{e}**	**1.2**
	35.20^{a}	**34.34^{b}**	**34.08^{c}**		**34.82^{a}**	**34.17^{b}**	**33.77^{c}**	**Average**
A= 0.1461 B= 0.1887 A × B =0.3268				**A= 0.1545 B= 0.1995 A × B =0.3455**				**L.S.D 0.05**

R 1 R*Units 0.6	R 1.2 R*Units 0.6	**CV%**

Note: Within each column or row, values followed by the same letter are not significantly different at the 0.05 probability level ($P \leq 0.05$).

from Table (5) the of soil moisture water holding capacity (MWHC) under the effect of adding different types of vermicompost (sheep, cow, horse) increasing application rates (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) during two consecutive growing seasons (2023–2024 and 2024–2025). The results showed significant differences among treatments depending on the type and amount of organic fertilizer applied, with all treatments contributing to an increase in water holding capacity compared to the check treatment, which recorded the lowest values in both seasons.

In the first season, the water holding capacity was lowest in the check treatment (33.41%), while it gradually increased with higher vermicompost rates, reaching the highest value (35.68%) in the treatment with 1.2 t ha-1 of horse vermicompost, representing an increase of 6.79%. A similar trend was observed in the second season, where the check treatment recorded 33.46%, and the highest value (36.33%) was also observed in the 1.2 t ha^{-1} horse vermicompost treatment, with an increase of 8.58%.

The effect of vermicompost type, horse vermicompost clearly outperformed the others in raising water holding capacity, with an overall average of 34.82% in the first season, compared to 34.17% and 33.77% for cow and sheep vermicompost, respectively. The same ranking persisted in the second season, with values of 35.20 %, 34.34 %, and 34.08%, respectively. This superiority is attributed to the unique physical properties of horse vermicompost, characterized by its low bulk density and high aeration, which improve soil pore structure and enhance its water retention capacity.

The increase in water holding capacity is explained by the improved soil structure resulting from the increased organic matter content, which leads to better pore distribution and higher water retention efficiency. (Turner *et al*., 1994) noted that a higher organic matter content enhances soil water retention, although this does not necessarily guarantee improved availability of this water to plants, highlighting the need for further studies to assess plant-available water under these modifications.

Soil water holding capacity (WHC) is determined by several factors, notably the number of pores, their size distribution, and specific surface area. The increased aggregation resulting from vermicompost addition enlarges the volume of micropores, thereby improving field capacity. Studies by (Kladivko & Nelson 1979) and (Tiarks *et al*., 1974) confirmed these effects, emphasizing that higher organic matter enhances soil pore structure. These findings align with those of (Singh *et al*., 2017) and (Sheikh & Dwivedi 2018), who reported that organic fertilization significantly improves field capacity, especially in light-textured soils.

Statistically, despite significant differences among some treatments, the closeness of values across certain concentrations or types reflects a gradual and cumulative effect that strengthens with higher application rates. The low coefficient of variation indicates data homogeneity and result consistency, supporting their reliability and accuracy.

Regarding the studied soils, classified as relatively non-aggregated, the most significant effects of treatments are likely due to the physical and chemical properties of the added organic matter, such as degree of decomposition, particle size, and moisture content. It is expected that these organic amendments' effects will evolve over time due to ongoing organic matter decomposition in the soil, underscoring the importance of long-term studies to evaluate the sustainability of these impacts.

The vermicompost, especially that derived from horse manure, is an effective means of improving soil field capacity, positively influencing water use efficiency and plant tolerance to water stress. Nonetheless, further research involving different soil types and crops is necessary to determine optimal factors for maximizing the benefits of organic amendments on soil water properties.

2-Effect of Vermicompost on Some Chemical Properties of Soil:

Vermicompost is considered one of the most important organic fertilizers that play a key role in improving the chemical properties of soil, which positively reflects on soil fertility and crop productivity. Therefore, studying its effect on soil is essential to achieve sustainable agriculture and increase the efficiency of natural resource use.

2-1-Effect of Different Types of Vermicompost on Soil pH:

Soil reaction is considered one of the key indicators of soil health, as it is expressed by the degree of acidity or alkalinity (pH), which directly affects the availability of nutrients and the effectiveness of microbial activity within the soil. The pH value reflects the concentration of hydrogen ions (H^+) and is measured on a logarithmic scale, meaning that each unit change in pH represents a tenfold change in the degree of acidity or alkalinity.

Table (6) Effect of Vermicompost Treatments on Soil pH

Average	2025-2024			Average	2024-2023			
	Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost		Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost	Type / quantity t ha^{-1}
7.70 e	7.7^{i}	7.71^{i}	7.7^{i}	7.75 e	7.74^{i}	7.75^{i}	7.75^{i}	Check
7.50 d	7.56^{h}	7.48^{g}	7.45^{fg}	7.71 d	7.74^{hi}	7.7^{h}	7.69^{gh}	0.3
7.36 c	7.41^{ef}	7.38^{e}	7.3^{d}	7.47 c	7.64^{g}	7.4^{d}	7.37^{cd}	0.6
7.31 b	7.41^{ef}	7.3^{d}	7.22^{c}	7.36 b	7.52^{f}	7.32^{c}	7.25^{b}	0.9
7.09 a	7.27^{cd}	7.03^{b}	6.96^{a}	7.27 a	7.46^{e}	7.24^{b}	7.1^{a}	1.2
	7.47^{c}	7.38^{b}	7.33^{a}		7.62^{c}	7.48^{b}	7.43^{a}	Average
A= 0.02054 B= 0.02651 A × B =0.04592				A= 0.02286 B= 0.02951 A × B =0.05111				L.S.D 0.05
R 0.1 R*Units 0.4				R 0.2 R*Units 0.4				CV%

Note: Within each column or row, values followed by the same letter are not significantly different at the 0.05 probability level ($P \leq 0.05$).

The effect of adding different types of vermicompost (derived from sheep, cattle, and horse manure) at increasing rates (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) on soil pH during two consecutive growing seasons (2023–2024 and 2024–2025). The results showed significant differences between treatments due to the type and amount of organic fertilizer applied, with all treatments contributing to lowering pH values compared to the check treatment, which recorded the highest pH in both seasons Table (6).

In the first growing season, the check treatment recorded the highest pH value at 7.75. Gradual increases in vermicompost application rates led to a clear decrease in pH values, with the lowest pH observed 7.10 under the treatment of 1.2 t ha^{-1} of sheep vermicompost, reflecting a decrease of 8.39% compared to the check. The pH dropped to 7.24 for the same amount of cattle vermicompost, representing a 6.58% decrease, while the horse vermicompost treatment recorded a pH of 7.46, a 3.74% reduction.

The same trend continued in the second season, where the check treatment had a pH of 7.70, compared to 6.96 at 1.2 t ha^{-1} of sheep vermicompost, a decrease of 9.61%. The cattle vermicompost treatment recorded a pH of 7.03 (an 8.70% decrease), and the horse vermicompost treatment 7.27, a decrease of 5.58% compared to the check.

Regarding the effect of vermicompost type, sheep vermicompost showed the highest efficacy in lowering soil pH, with an average pH of 7.43 in the first season, compared to 7.48 for cattle and 7.62 horse vermicompost. This order was repeated in the second season, with averages of 7.33, 7.38, and 7.47 respectively. This variation is attributed to differences in the organic matter composition of each manure type, its degree of decomposition, and content of active organic compounds and organic acids.

The pH reductions are mainly due to microbial decomposition of organic matter, releasing organic acids and acidic ions such as H^{+} and Al^{3+}. Microorganisms associated with vermicompost also help shift the soil environment toward moderate acidity. (Brady & Weil 2002) noted that adding organic matter often lowers pH, especially in alkaline soils or those with low microbial activity.

The results showed that differences among treatments were not statistically significant according to the Least Significant Difference (L.S.D) test, the overall trend clearly showed a pH decrease with increasing vermicompost application rates, especially with the more rapidly decomposing sheep vermicompost. The low coefficient of variation (CV) values indicate data homogeneity and high accuracy.

Given the relatively non-aggregated soil properties studied, the pronounced treatment effects are likely related to the physical and chemical characteristics of the added organic matter, such as degree of decomposition, particle size, and moisture content. These organic amendments' effects are expected to change over time as decomposition continues, highlighting the importance of long-term studies to assess sustainability.

Based on the above, extraction horse manure is considered an effective method to improve soil reaction by reducing alkalinity, which enhances nutrient availability to plants. These results are particularly important for alkaline soils common in dry and semi-arid environments, where pH adjustment is crucial for better nutrient uptake. However, further long-term studies across various soil types are recommended to ensure the stability and sustainability of this effect.

These findings are consistent with those of (Atiyeh *et al*., 2001), who reported that increasing vermicompost application rates led to reduced soil pH. Similarly, (Maheshwarapa *et al*., 1999) found that higher vermicompost content in soil reduces pH due to the production of ammonium ions (NH_4^+), carbon dioxide (CO_2), and organic acids during microbial decomposition, which stimulates microbial activity and further acid compound release. (Albanell *et al*., 1988) suggested that this pH reduction may also be related to decreased soil buffering capacitya typical characteristic of the soils used in this study as noted by (Neilsen *et al*., 1995).

Furthermore, vermicompost fertilization may also raise soil pH by supplying basic cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), and potassium (K^+), which react with hydrogen ions (H^+) in the soil solution, thus reducing acidity and increasing pH. Fulvic and humic acids derived from organic matter decomposition form alkaline humate complexes by binding with these basic cations, further enhancing soil alkalinity. Additionally, organic matter in vermicompost complexes aluminum via low molecular weight organic acids like fulvic acid, which reduces aluminum's acidic effects and limits H^+ release in the soil solution (Mazur *et al*., 1983; Cruz *et al*, 2012; Hue *et al*., 1986).

The optimal soil pH range is generally between 6 and 7 (Hartel, 2005). Numerous studies (Khaleel *et al*., 1981; Atiyeh *et al*., 2001) have shown that organic amendments lower soil pH due to organic acid formation and CO_2 generated by root and microbial activity, leading to carbonic acid (H_2CO_3) formation (Brady & Weil, 2001). Continuous and intensive use of vermicompost and organic fertilizers effectively lowers soil pH (Chand *et al*., 2011; Kumar *et al*., 2011).

The organic matter plays a major role in lowering root zone pH by releasing hydrogen ions, organic acids, and CO_2 during decomposition (Al-Shater *et al*., 2017). Microbial decomposition of organic matter produces various acidic compounds, contributing to pH reduction (Al-Issa, 2007). These results align with (Sandoval *et al*., 2014) and (Atiyeh *et al*., 2002), who confirmed vermicompost as an effective means of reducing soil acidity due to ammonium, CO_2, and organic acid production during microbial metabolism, increasing H^+ concentration through ionization of the organic roots present in vermicompost.

2-2. Effect of Different Types of Vermicompost on the Electrical Conductivity (EC) of Soil Extract:

Electrical conductivity (EC) reflects the concentration of soluble inorganic salts in the soil. By measuring the EC of a solution, the total amount of dissolved salts can be estimated. EC measurement is one of the methods used to estimate the total soluble salts in soil, as the concentration of dissolved salts in the aqueous extract is directly proportional to its electrical conductivity. The EC value is considered a very important indicator because it reflects the salinity level of the fertilizer and the amount of ions present, thus indicating the potential phytotoxicity that could affect plant growth (Gao *et al*., 2010). The EC value depends on the rate of organic matter decomposition, which leads to ion accumulation (Chan *et al*., 2016).

Table (7) shows the effect of vermicompost treatments on the electrical conductivity of the soil extract.

	2025-2024				2024-2023			
Average	**Horse manure vermicompost**	**Cow manure vermicompost**	**Sheep manure vermicompost**	**Average**	**Horse manure vermicompost**	**Cow manure vermicompost**	**Sheep manure vermicompost**	Type / quantity t ha^{-1}
0.64	**0.64^{a}**	**0.64^{a}**	**0.64^{a}**	**0.86 a**	**0.86^{ab}**	**0.86^{ab}**	**0.86^{ab}**	**Check**
0.64	**0.629^{a}**	**0.63^{a}**	0.655^{ab}	**0.87 ab**	**0.846^{ab}**	**0.85^{ab}**	0.9^{b}	**0.3**
0.65	**0.625^{a}**	**0.629^{a}**	0.707^{bc}	**0.89 ab**	**0.842^{ab}**	**0.847^{ab}**	0.97^{c}	**0.6**
0.67	**0.614^{a}**	**0.626^{a}**	0.758^{c}	**0.90 bc**	**0.833^{a}**	**0.84^{ab}**	1.04^{d}	**0.9**
0.69	**0.601^{a}**	**0.616^{a}**	0.85^{d}	**0.94 c**	**0.81^{a}**	**0.817^{a}**	1.18^{e}	**1.2**
	0.62^{a}	**0.63^{a}**	**0.72^{b}**		**0.84^{a}**	**0.84^{a}**	**0.99^{b}**	**Average**
A= 0.03069 B= 0.03962 A × B =0.06863				**A= 0.03035 B= 0.03918 A × B =0.06787**				**L.S.D 0.05**
R 0.8 R*Units 6.2				R 0. 5 R*Units 4.6				**CV%**

Note: Within each column or row, values followed by the same letter are not significantly different at the 0.05 probability level ($P \leq 0.05$).

The effect of adding different types of vermicompost (from sheep, cows, and horses) at increasing rates (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) on the electrical conductivity (EC) of soil extract during two consecutive growing seasons (2023–2024 and 2024–2025). The results show significant differences between treatments depending on the type of vermicompost and its application rate. Some treatments contributed to raising EC values compared to the check, while other increases were limited or not statistically significant depending on the type of fertilizer and the application rate Table (7).

In the first season, the lowest EC value was recorded in the check treatment (0.86 dS/m), whereas the addition of vermicompost caused a gradual increase in EC values with increasing amounts. This increase was most pronounced when using sheep vermicompost, where the highest value was recorded at 1.2 t ha^{-1} of this type (1.18 dS/m), representing a 37.2% increase compared to the check. In contrast, the EC value for the same rate of cow vermicompost was 0.817 dS/m, and for horse vermicompost 0.810 dS/m. Looking at the averages, sheep vermicompost showed the greatest effect in increasing EC (0.99 dS/m), followed by cow and horse vermicompost (0.84 dS/m each), with statistically significant differences between the types.

In the second season, recorded values were generally lower, with the check treatment showing an EC of 0.64 dS/m. The same upward trend was observed with increasing vermicompost rates, where 1.2 t ha^{-1} of sheep vermicompost yielded the highest value (0.85 dS/m), a 32.8% increase over the check. The values for cow and horse vermicompost at the same rate were 0.616 and 0.601 dS/m, respectively. The overall average effect by type showed that sheep vermicompost resulted in the highest EC value (0.72 dS/m), followed by cow vermicompost (0.63 dS/m), then horse vermicompost (0.62 dS/m), indicating the greater efficacy of sheep vermicompost in influencing soil extract salinity.

These increases in EC values can be explained by the higher content of soluble cations such as K^+, Ca^{2+}, Mg^{2+}, and Na^+ in vermicompost especially from sheep along with anions like Cl^- and SO_4^{2-}, which lead to the accumulation of soluble salts in the soil solution. (Brady & Weil 2002) noted that organic amendments contribute to raising EC due to their soluble nutrient elements, particularly when applied at high rates or in soils with low buffering capacity.

Although some differences between treatments were not statistically significant according to the L.S.D test, the overall trend clearly demonstrates the pronounced impact of vermicompost particularly the sheep-derived type in enhancing electrical conductivity, especially at higher application rates. This observation is further supported by the low coefficient of variation (CV), reflecting consistent results and precise measurements.

These results highlight the need to balance the benefits of improved soil fertility via organic fertilization with the risks of salt accumulation, especially in dry and semi-arid environments that suffer from poor drainage. Therefore, periodic monitoring of EC values is recommended when using large amounts of vermicompost, particularly those rich in soluble elements.

(Chand *et al*.,2011) and (Kumar *et al*., 2011) also indicated that repeated vermicompost applications can raise soil EC due to the release of soluble elements during organic matter decomposition. (Hartel ,2005) emphasized the importance of keeping EC within appropriate limits to maintain ionic balance in the root zone and avoid negative impacts on nutrient uptake.

The vermicompost especially sheep-derived vermicompost is an important factor in improving soil fertility but requires cautious use, particularly in soils with poor aeration and drainage and when applied in large quantities. Additional studies are recommended to evaluate the cumulative long-term effects of vermicompost on the physical and chemical properties of soil.

The relative decrease in the magnitude of increases observed at times may be due to improvements in total soil porosity. Atiyeh *et al*. (2001) found that vermicompost derived from pig manure increased EC, attributing this to the nature of raw materials and the concentration of ions in the vermicompost.

The results may also be related to organic acid production during organic matter decomposition, which lowers soil pH and EC (Kansotia *et al*., 2015). EC decreases might also result from salt leaching due to improved permeability (Srikanth *et al*., 2000). These findings align with those of (Mahmoud & Ibrahim 2012) and (Sandoval *et al*., 2014).

2-3. Effect of Different Types of Vermicompost on Organic Carbon in the Studied Soil (%)

The addition of vermicompost (worm compost) is considered one of the sustainable agricultural practices for improving soil fertility, as it contributes to increasing organic carbon content - a key indicator of soil quality. The effectiveness of vermicompost varies depending on its source (such as sheep, cow, or horse manure) and application rate.

Table (8) shows the effect of vermicompost treatments on the organic carbon content in the soil %.

	2025-2024		**2024-2023**	

Average	Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost	Average	Horse manure vermicompost	Cow manure vermicompost	Sheep manure vermicompost	Type / quantity t ha^{-1}
0.55 e	0.55^{j}	0.55^{j}	0.55^{j}	0.44 e	0.44^{i}	0.44^{i}	0.44^{i}	Check
0.64 d	0.58^{i}	0.606^{h}	0.72^{e}	0.49 d	0.46^{h}	0.47^{gh}	0.54^{d}	0.3
0.75 c	0.65^{g}	0.68^{f}	0.92^{c}	0.56 c	0.48^{fg}	0.49^{ef}	0.70^{c}	0.6
0.81 b	0.71^{e}	0.72^{e}	1.003^{b}	0.59 b	0.493^{ef}	0.5^{e}	0.79^{b}	0.9
0.87 a	0.75^{d}	0.77^{d}	1.09^{a}	0.61 a	0.5^{e}	0.503^{e}	0.84^{a}	1.2
	0.65^{c}	0.66^{b}	0.86^{a}		0.47^{c}	0.48^{b}	0.66^{a}	Average
A= 0.009 B= 0.01162 A × B =0.02012				A= 0.00601 B= 0.00776 A × B =0.01344				L.S.D 0.05
R 0.5 R*Units 1.7				R 0.4 R*Units 1.5				CV%

Note: Within each column or row, values followed by the same letter are not significantly different at the 0.05 probability level ($P \leq 0.05$).

The effect of applying different types of vermicompost (derived from sheep, cow, and horse manure) in increasing amounts (0.3, 0.6, 0.9, and 1.2 t ha^{-1}) on the organic carbon content in the soil over two consecutive growing seasons. The results showed clear increases in organic carbon concentration compared to the check treatment, with statistically significant differences related to the type and quantity of vermicompost applied Table (8).

In the first season, the check treatment recorded the lowest average organic carbon content (0.44%), while the fertilized treatments showed a gradual increase proportional to the applied vermicompost rate, reaching the highest value of 0.839% in the treatment of 1.2 t ha^{-1} of sheep vermicompost a 90.6% increase compared to the check. This treatment exhibited significant differences compared to others, especially when using sheep vermicompost. In the second season, this increasing trend continued, with organic carbon content rising from 0.55% in the check to 1.086% in the 1.2 t ha^{-1} sheep vermicompost treatment, representing a 97.45% increase.

Regarding the effect of vermicompost type, sheep vermicompost outperformed others in raising the average organic carbon during both seasons (0.66% and 0.86%), surpassing cow vermicompost (0.48% and 0.66%) and horse vermicompost (0.47% and 0.65%). This indicates the high efficacy of sheep vermicompost in enhancing organic carbon, likely due to its higher content of decomposable organic matter and greater proportion of stable carbon.

Statistical analyses revealed significant differences in most treatments, confirming the positive impact of vermicompost type and dosage on increasing soil organic carbon. These findings align with studies by (Aira *et al*., 2002) and (Karmegam & Daniel 2009), which showed that vermicompost use promotes organic carbon accumulation by stimulating microbial activity and decomposing complex organic compounds. (Lal .2004) also emphasized that higher organic carbon content is a vital indicator of improved soil fertility and biological activity.

The improvement in organic carbon is attributed to vermicompost's content of active organic compounds such as humic and fulvic acids, and polysaccharides, which serve as primary energy sources for beneficial soil microbes. These compounds contribute to stabilizing soil aggregate structure, enhancing cation exchange capacity, and improving nutrient uptake efficiency, thus positively affecting soil chemical and physical properties.

The superiority of sheep vermicompost in increasing organic carbon can be explained by its rich composition of partially undecomposed organic matter like fibers and plant residues that decompose gradually, providing a sustainable long-term carbon source.

These results suggest that applying vermicompost, whether in moderate or high amounts, effectively improves soil organic carbon and reduces soil pH, as supported by (Chand *et al*., 2011) and (Kumar *et al*., 2011), who highlighted the pivotal role of organic fertilizers in modifying pH and increasing organic carbon. Other studies, including (Manivannan *et al*., 2009) and (Kansotia *et al*., 2015), also found that adding organic residues and fertilizers enhances soil organic carbon content.

The results consistent with results of (Sigaye *et al*., 2020), (Sandoval *et al*., 2014), which demonstrated that vermicompost application significantly increases soil organic carbon. (Arancon *et al*., 2006) found that soil treated with sheep manure-based vermicompost showed a marked increase in organic carbon compared to other vermicompost types.

Correlation analysis between soil chemical properties showed a strong positive and significant correlation between organic matter content and increased electrical conductivity (EC) (r = 0.8), and a significant negative correlation between organic matter and decreasing soil pH (r = -0.883). A perfect positive correlation was found between organic matter and organic carbon content, reflecting the close relationship between these indicators as key determinants for improving soil quality when using vermicompost.

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تأثير أنواع مختلفة من الفيرمي كمبوست في بعض الخصائص الفيزيائية والكيميائية في تربة محافظة الحسكة

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الملخص

هدفت هذه الدراسة إلى تقييم تأثير أنواع مختلفة من الفيرمي كمبوست (مستخلص من مخلفات الأغنام، الأبقار، والخيول) وبمعدلات تطبيق متزايدة (0.3، 0.6، 0.9، و1.2) طن/ه في بعض الخصائص الفيزيائية والكيميائية لتربة محافظة الحسكة. أظهرت النتائج أن فيرمي كمبوست الخيول كان الأكثر فاعلية في تحسين الخصائص الفيزيائية للتربة، حيث ساهم بشكل ملحوظ في تقليل الكثافة الظاهرية وزيادة المسامية وسعة الاحتفاظ بالماء (السعة الحقلية)، إذ سجلت المعاملة التي استخدمت 1.2 كغ/دونم من فيرمي كمبوست الخيول أعلى زيادة في هذه الخصائص. أما من الناحية الكيميائية، فقد تفوق فيرمي كمبوست الأغنام في تحسين خصائص التربة، من خلال تقليل درجة الحموضة والملوحة، مما يعزز خصوبة التربة وجودة بيئتها الكيميائية. وتعزى التحسينات الفيزيائية، لا سيما في سعة الاحتفاظ بالماء، إلى زيادة المادة العضوية التي تعمل على تحسين هيكل التربة وتوزيع المسام الدقيقة، مما يعزز كفاءة استخدام الماء من قبل النباتات وقدرتها على تحمل الإجهاد المائي.

الكلمات المفتاحية:

فيرمي كمبوست، سعة الاحتفاظ بالماء، الكثافة الظاهرية، المسامية، المادة العضوية.