Effects of the biofertilizers and organic fertilizers on certain chemical properties of soil and plants.

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Abstract

The Sustainable Development aims mandate the adoption of sustainable agricultural approaches, for which sound environmental management practices are essential. This is because the use of fertilizers increases environmental pollution, deteriorates soil quality, and contributes to a lack of biodiversity. Several goals relate to the protection of natural resources, the environment, change. Sustainable Development Goals (SDGs) 2, 6, and 13 are related to soil health and environmental sustainability.This study focuses on the role of vermicompost as a natural, environmentally friendly organic fertilizer and biofertilizer, and aims to contribute to improving soil properties and plant physiological characteristics. . Experiments were conducted to examine the effects of interacting and adding vermicompost and biofertilizer on plant leaf pH, organic matter percentage, and NPK concentration. Results showed that a 30-gram vermicompost treatment per well demonstrated superior soil pH, soil organic matter, and plant NPK concentration (2.03% and 6.47%, respectively). The Glomus mosseae treatment showed better soil pH, soil organic matter, plant phosphorus and potassium concentrations (6.86%, 1.92%, 0.37% and 4.75%, respectively), while the *Azotobacter chroococcum* treatment showed better soil nitrogen concentration in plants, reaching 3.63%. The 30g vermicompost and biofertilizer interaction treatment had a positive effect on all the studied characteristics.

Keywords: Worm compost , Bacteria ,Fungi, sustainable agricultural, Nitrogen, Phosphorus, Potassium ,plant,

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Introduction

Sustainable development is a comprehensive approach that encompasses all sectors and meets the needs of the present without compromising the ability of future generations to meet their own needs. Many countries are facing numerous environmental crises and accidents that adversely affect life on Earth. Among the practices that have the greatest environmental impact, the agricultural sector relies on the use of mineral fertilizers and the associated emissions that harm the environment. One of the most important mechanisms for sustainable agricultural development is the use of biofertilizers and organic vermicompost[2].

The agricultural sector requires a variety of inputs to produce high-quality, mass-produced animal and plant products. , which increases nutrients in plants, improves productivity, and can increase yields by more than 35%. It also increases plant compound and nutrient content compared to mineral fertilizers, contributing to reduced chemical fertilizer costs [3]. One study investigated the effects of biofertilizers and inorganic fertilizers on plant growth and yield. The experiment used biofertilizers (plant growth-promoting bacteria and mycorrhizal fungi) and inorganic fertilizers (NPK). Compared to inorganic fertilizers, biofertilization increased all plant growth parameters, as well as soil biomass, organic acids, and plant hormones [17]. An experiment was conducted to investigate the effects of biofertilizers containing *Azotobacter chroococcum* and the fungus *G. mossae* applied alone, in combination, and in interaction with inorganic fertilizers on potato growth and yield. The results showed that biofertilizers containing only Azotobacter, mycorrhizal fungi, and inorganic fertilizer significantly improved several indicators, including plant growth (e.g., plant height, number of aboveground stems, dry weight of vegetative parts), potato yield, and its quantitative characteristics (average tuber weight, yield per plant, total potato yield) and qualitative characteristics (dry matter, starch, and protein content) [2]. study also showed that biofertilizers containing only Azotobacter, mycorrhizal fungi, and inorganic fertilizer significantly improved several indicators of potato growth and yield. isolated and identified several species belonging to the genus Azotobacter, tested their nitrogen fixation abilities, selected the most efficient ones, and added them to maize plants as primary pollen. All plant growth parameters were significantly improved. The objective of this study was to clarify the role of PGPR bacteria in protecting pumpkin plants from drought damage [14]. Experimental treatments consisted of a control treatment with *Azotobacter chroococcum* bacteria and no

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inoculation. Another factor was the irrigation system applied at three field volume levels. Results showed that co-inoculation with the bacteria was effective in improving plant physiological characteristics and significantly reduced the detrimental effects of water stress. Protein and soluble sugar levels were observed to be highest in plants treated under severe drought stress [5,11].

Material and Methods

A field experiment was conducted at the Agricultural Research and Experiment Station of the Projects Department of the Ministry of Agriculture, Wasit Province. . After soil preparation, tillage, and leveling, treatment and experimental plots were sprayed. Each experimental plot consisted of three rows, each 3 m long and 0.5 m wide. Tubers were planted in a completely randomized block design with 30 cm spacing between tubers.

Organic Fertilizer

We used vermicompost containing locally sourced organic fertilizer. We prepared rectangular pots measuring 25cm x 100cm with holes in the bottom to allow for drainage.

We added food waste and vegetables, including lettuce, basil, broad bean skins, watercress skins, eggs, and cardboard. The experiment lasted for 100 days. After the experiment, we removed the earthworms and used only the vermicompost.

Sample digestion

he plants were dried in an oven at 60°C for 48 hours to stabilize their weight. The samples were then crushed and sieved through a 4 mm sieve. 0.3 g of plant material was collected and placed in a plant sample digestion tank. 2 ml of sulfuric acid and 2 ml of perchloric acid were added and fermented for 1 day. The mixture was then heated on a hot plate for 1 hour, until the black color changed to transparent. The mixture was transferred to a 50 ml volumetric flask and filled with distilled water.

2.3ExperimentalProcedure

factor (1) Biovaccine (Microbiology)

B : without B1: Azotobacter Bacteria B 2: (Glomos mosseae)

Factor (2) (Worm compost)

W0: without W1: 25 gm W2: 40 gm

Statistical analysis

The results were statistically analyzed using the analysis of variance method and using the Genstat program, and the means were compared according to the least significant difference (LSD) test at a probability level of 0.05 .

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Results and Discussion

soil pH

Statistical analysis revealed that the addition of organic vermicompost significantly reduced soil pH after planting, reaching 6.59 in the W2 treatment compared to 6,73 in the W0 treatment. Application of *Glomos mosseae* biofertilizer to plants resulted in a decrease in soil pH, reaching 6.37 in B2 treatment, followed by 6.61 in B1 treatment and 7.14 in B0 treatment. Interaction of biofertilizer with organic vermicompost resulted in the lowest pH in B2 W2 treatment, reaching 6.23 in B2 W2 treatment compared to 7.1 in B0 W0 treatment.

Table 1. Field soil characteristics before planting the experiment

Character		Value	Character		Value
pH		7.12	EC (1:1)	dS m^{-1}	2,12
Soluble Nutrients m.mole L^{-1}	Ca^{+2}	6.57	Available nutrients mg kg^{-1}	N	12.27
	Mg^{+2}	2.85		P	7.19
	Na^{+}	5.64		K	121.00
	SO_4^{-2}	0.94		CO_3^{-2}	Nill
	K^{+}	6.86	Analysis particle	HCO_3^{-}	0.98
	CL^{-}	2.43			
				Texture	Clay loam

Total bacteria 15 x 10^{7} CFU

Total fungi 7 x 10^{4} CFU

Table 2. Vermicompost properties

OM%	K%	P%	N%	C%	Moisture	EC dsm^{-}	pH

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					content %	1	
40.54	1.09	1.33	1.89	23.20	33.23	0.78	7.33

Table 3. Effect of organic fertilizer and biofertilizer on soil pH value

(B)	(W) W0	W1	W2	Mean (B)
B0	7.10	7.20	7.12	7.14
B1	6.76	6.64	6.43	6.61
B2	6.34	6.56	6.23	6.37
L.S.D B*W	0.11			L.S.D B = 0.03
Mean (W)	6.73	6.8	6.59	L.S.D w = 0.04

The positive effect of combining vermicompost and mineral fertilizer is achieved by providing substances that regulate plant growth, such as hormones and growth regulators. When NPK fertilizer and vermicompost are added, plant growth characteristics are enhanced due to the abundance of nutrients and their role in physiological processes within the plant and in cell division. Furthermore, vermicompost not only provides nutrients but also improves the physical condition of the soil and develops a balanced nutrient environment for both the roots and the plant system[2,13]. This enzyme cleaves the ester bond connecting phosphate to organic carbon, releasing phosphorus. Filamentous fungi are important cellular factories, playing a key role in the production of various enzymes and metabolic products. Among these products, fungi overproduce organic acids of industrial importance. Organic acids such as citric acid, lactic acid, and ethaconic acid are abundantly accumulated in fungi, leading to commercialization of their production [12,15].

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Soil Organic Matter

Table 3 shows that the addition of vermicompost had a positive effect on the soil organic matter content. The results showed that W2 (1.92%) was significantly higher than W1 (1.49%) and W0 (1.44%). Rhizosphere B2 was also significantly higher than B1 (2.03%) by 1.56%. Furthermore, under the dual action of vermicompost and biofertilizer, W2B2 treatment had the highest organic matter content at 2.61%, compared to 0.93% in W0B0 treatment.

Table 4: role of earthworm-based organic fertilizers in soil organic matter content

(B)	**(W)**			**Mean (B)**
	W0	**W1**	**W2**	
B0	**0.93**	**1.28**	**1.47**	**1.22**
B1	**1.46**	**1.54**	**1.69**	**1.56**
B2	**1.86**	**1.64**	**2.61**	**2.03**
L.S.D B*W	**0.08**	**L.S.D B = 0.04**		
Mean (W)	**1.41**	**1.49**	**1.92**	**L.S.Dw=0.05**

The role of vermicompost, carbon-to-nitrogen ratio, and composition of fertilizer derived from imported earthworms adapted for organic fertilizer production were investigated, along with their genetic characteristics and productivity. Results showed that vermicompost improved the quality, nutrients, and organic matter content, which was reflected in the degree of decomposition and decomposition products. Earthworms neutralize alkaline and acidic soils, creating a neutral environment. The pH of earthworm decomposition products and waste (including soil) is close to 7. In addition, the earthworm's digestive system, through which soil and organic matter pass, contains acids that neutralize acidity. The increased availability of nutrients in the soil is due to the organic acids produced by the decomposition of vermicompost. [1,5]

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Nitrogen concentration in plant leaves

Table

5 The presence of vermicompost resulted in a 2.84% increase in nitrogen concentration in the plant in treatment W2 and a 3.63% increase in treatment W1. The microbial treatment was superior to treatment B1 (2.83%), while B2 (2.98%) resulted in a decrease in plant nitrogen. The interaction of vermicompost, bacteria, and fungi led to an increase in leaf nitrogen, with treatment W1B1 showing a 4.12% higher increase than treatment W0B0 (0.99%).

Table5: vermicompost and biofertilizers on plant nitrogen concentrations

(B)	**(W)**		
	W0	**W1**	**W2**
B0	**0.99**	**3.12**	**2.10**
B1	**2.17**	**3.57**	**3.20**
B2	**2.26**	**4.12**	**3.37**
L.S.D $_{B*W}$	**0.11**		
Mean (W)	**1.81**	**3.63**	**2.84**

In biofertilizer treatment, we observe an increase in nitrogen content. This is because the formulation contains numerous bacteria that stimulate plant growth, in addition to mycorrhizal fungi. Nitrogen-fixing bacteria fix nitrogen, thus increasing its availability in the soil. This is due to the activity of the nitrogenase enzyme, which is linked to a high density of nitrogen-fixing bacteria. Consequently, the increased nitrogen fixation rate enhances their competitiveness, vital functions, and ability to occupy a large root area under field conditions. Gibberellins are produced by bacteria during their stationary phase, in conjunction with root secretion of polysaccharides and the presence of an optimal nitrogen concentration. The resulting gibberellins increase root hair density, contributing to higher nitrogen fixation rates, as they are free, non-symbiotic nitrogen fixers. Therefore, we observe higher available nitrogen values in the experimental soils treated with biofertilizer[1].

Vermicompost is considered one of the most beneficial organic wastes for soil and plants. In an experiment, researchers observed that adding vermicompost to field soil at various levels improved the soil's physical, fertility, and biological properties. It enhanced the biological activity of soil microorganisms, soil structure,

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and water retention capacity, as well as increasing plant yield and quality characteristics. The effect of mineral fertilizers is also positive, as it increases the availability of readily absorbable nutrients for the root system, thus boosting plant activity and vitality throughout its life cycle, ultimately leading to better production. [8].

Phosphorus concentration in plant leaves

results in Table 6 show that earthworm organic fertilizer had a significant effect on leaf phosphorus concentrations. by 0.37% and treatment W1 was superior by 0.25%. *Glomos mosseae* B2 treatment also outperformed the plants in leaf phosphorus concentration, reaching 0.31% compared to 0.22% in the control treatment B0. The overall evaluation of the vermicompost-biofertilizer interaction showed that treatment W2B2 was superior by 0.42% and treatment W1B2 was superior by 0.38%.

Table 7 Role of earthworm-mediated organic fertilizer and biofertilizer on leaf phosphorus concentration %

(B)	**(W)**			**Mean (B)**
	W0	**W1**	**W2**	
B0	**0.10**	**0.21**	**0.33**	**0.22**
B1	**0.26**	**0.23**	**0.38**	**0.29**
B2	**0.21**	**0.30**	**0.42**	**0.31**
L.S.D $_{B*W}$	**0.007**			**L.S.D $_B$ = 0.07**
Mean (W)	**0.19**	**0.25**	**0.37**	**L.S.D$_B$=0.08**

Compost increases the organic carbon and nitrogen content in soil. This is partly due to the low carbon-to-nitrogen ratio in vermicompost, which means more organic matter is decomposed and more nutrients are provided to plants. Improving soil fertility and chemistry promotes plant growth and enhances plant and enzyme activity [3]. Fungi produce low-molecular-weight organic acids, which promote the weathering of phosphorus-containing clay minerals. They form positively charged compounds with iron, magnesium, and calcium, which bind and precipitate phosphate, increasing the concentration of clay minerals. *Glomos mosseae* also has the ability to absorb phosphorus by extending its

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mycelium into areas inaccessible to microorganisms. This process extracts nutrients from the roots, making them readily available for plant absorption [9,8]. This is consistent with other reports. Similarly, the increase in leaf phosphorus concentration was attributed to the positive effect of double-inoculating *Glomos mosseae* with vermicompost, a nutrient-rich organic matter, which positively impacts the supply of nutrients to phosphate-decomposing microorganisms, contributing to their growth and reproduction. The increase in phosphatase activity in soil after biofertilizer application is likely due to increased microbial activity. Biofertilizers significantly increase the activity of various enzymes, thereby improving soil bioenergetics and enzymatic activity [6].

Potassium content of plants

Table 8 show that organic fertilizer significantly affected potassium in plant leaves, with an increase of 4.26% in the W2 treatment compared to 2.94% in the W0 treatment. The statistical analysis also showed a superiority of the *Glomos mosseae* B2 treatment, with an increase of 4.01% significantly higher than the 3.72% increase in the *Azotobacter chroococcum* B1 treatment. There was a positive correlation between vermicompost and *Glomos mosseae*, with an increase of 4.75% in the W2B2 treatment compared to 1.83% in the control and W0B0 treatments.

Table 8 Effects of bacteria, fungi, and vermicompost on potassium concentration in plant leaves

(B)	(W)	Mean (B)		
	W0	W1	W2	
B0	1.83	2.34	3.71	2.62
B1	3.32	3.54	4.32	3.72
B2	3.68	3.60	4.75	4.01
L.S.D B*W	0.23	L.S.D B = 0.12		
Mean (W)	2.94	3.16	4.26	L.S.DB=0.13

Vermicompost enriches the soil with humus, improving its physical properties by increasing its water absorption and retention capacity. It also enhances the biological activity of soil microorganisms, resulting in higher-quality produce. The increased nutrient concentration in leaves is likely due to the important roles of the nutrients in vermicompost in the plant's vital and physiological processes. This translates to increased

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plant efficiency and its ability to absorb essential nutrients for growth, leading to higher levels of these elements in the leaves. Adding vermicompost may help the plant achieve optimal nutritional status, resulting in increased efficiency in nutrient absorption and accumulation in the leaves. The decomposition of vermicompost releases nutrients into the soil solution in the root zone, where they are absorbed by the plant. Furthermore, it produces organic acids and natural chelates that can contribute to increased nutrient availability[10].

Conclusion

1

. Vermcompost at a 40 g treatment outperformed the 25 g treatment in all plant

growth parameters and soil properties.

2 .The addition of Azotobacter bacteria and mycorrhizae significantly improved the studied parameters and properties.

3. Microorganisms have the potential to be used as highly efficient biofertilizers,

reducing pollution from chemical fertilizers and promoting clean and sustainable

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