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Impact Analysis of Different Mixtures of Compost and Polymer on Soil Physical Properties and the Growth and Yield of Wheat (Triticum aestivum)

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Abstract

Polymer and compost amendment is a general approach to improve soil properties and promote crop productivity. This study was carried out to assess the effect of polymer and compost amendments on the growth parameters of wheat (Triticum aestivum) and soil properties. The experiment was carried at the Agricultural Research Station/College of Agriculture and Marshes/University of Thi-Qar using a Randomized Complete Block Design with three replicates. The results show that the addition of polymers and compost significantly improved soil properties such as bulk density, total porosity, and moisture content and also increasedthe dry weight of the plant, spike weight, number of spikes, spike length, plant height, number of tillers, leaf area. These results illustrate that polymers and compost should be incorporated in agriculture for higher production.

Keywords: Polymer , compost , soil physical proprieties , wheat .

I. Introduction

Wheat (Triticumaestivum L.) is a staple food crop grown in diverse climatic conditions worldwide (AbdElgalil et al., 2016). Food security is a global issue that requires comprehensive solutions, including enhancing crop productivity. As the most important cereal crop globally, wheat plays a pivotal role in human diet and nutrition, providing substantial amounts of calories and proteins compared to other crops.

In Iraq, wheat is a crucial crop, with 80% of grains cultivated in the winter as a secondary crop in irrigated agriculture. However, its productivity does not exceed 1.5 million tons/hectare. Notably, Iraq was classified in 2019 as a water-scarce country, with approximately 98% of its freshwater resources sourced externally, primarily from Turkey and Iran. Therefore, effective measures are necessary to improve water use efficiency and increase productivity (Omara et al., 2022).

On the other hand, the intensive use of chemical fertilizers has boosted crop production without considering negative impacts on the physical and chemical properties of the soil, leading to structural degradation and increased erosion. Excessive use of inorganic fertilizers has exacerbated soil degradation issues, resulting in reduced fertility, depletion of organic matter, increased acidity, and problems of salinity and erosion that hinder crop growth and agricultural development.

The solutions are rooted in the application of inorganic materials as substitutes plant nutrients to enhance soil quality enhancement. Additionally, the use of raw organic material is a sustainable agricultural practice and helps restore soil fertility and addresses some aspects of environmental degradation.

The ideal effect of adding compost and polymers on improving soil characterization and in turn crop yield, particularly wheat production in southern Iraq was highlighted in various studies. Research shows that, by adding

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polymers in compost, it is possible to increase the availability of water for crops during the development phase in soils affected by salinity (Wodajo, 2015). In contrast, moderate application of organic fertilizer such as compost improves the physical and chemical properties of the soil which improves yields (Zemichael& Dechassa, 2018).

Furthermore, studies have revealed that the effects of using compost on soil quality and crop productivity can persist this long after the first dose (Lord &Sakrabani, 2019), highlighting the importance of such agricultural practices. Moreover, they enhance soil stability and moisture capacity, leading to better planting results (Wang et al., 2023). Nonetheless, it is also important to bear in mind its risk of heavy metal build-up attained in the soil (Ding et al., 2020). Polymers and polymeric materials are essential for agriculture and are used for greenhouse, soil enrichment, plant growth regulation, environmental treatment, mulching, and water retention applications. Additionally they improve soil properties and function as polymer materials (Krasnopeeva et al., 2022) since they retain ions and salts and even water.. Increased crop yields, superior soil aggregation, and enhanced germination and growth are reported with synthetic biopolymers and super absorbent organic fertilizers.

Indigenous crops respond positively to these treatments, reducing seedling mortality. Significant biopolymers include gum arabic, chitosan, carboxymethyl cellulose, and starch, known for their high cation exchange capacity (CEC) and moisture retention, which benefit crop growth (Stachowiaket al., 2022).

Based on the above, it can be said that the use of compost and polymers represents a promising solution for improving soil properties and increasing crop productivity in southern Iraq, necessitating further research to identify the best agricultural practices suitable for local conditions.

II. Methods and Materials

An agricultural experiment was conducted in pots in the plant nursery of the Field Crops Department at the College of Agriculture and Marshlands, University of Thi-Qar. The objective was to study the addition of different mixing levels of polymer and compost based on dry soil weight, with three replicates for each treatment, focusing on some physical properties of the soil and growth indicators of wheat. A completely randomized design (C.R.D) was used to determine the best addition level that contributed to improving soil and plant characteristics. The pots were planted with wheat seeds on October 20, 2024, and after the experiment concluded on April 20, 2025, soil and plant samples were taken from each pot for laboratory analyses of physical soil properties and growth indicators of the cultivated plants.

Table 1: some soil physical proprietiesof experiment.

Soil Depth cm	Sand %	Clay %	Silt %	Soil Texture	Bulk density g cm^{-3}	Total Porosity %	Moisture content %
0-15	44.21	30.19	25.59	Clay Loam	1. 29	51.32	18.45
15-30	38	36.23	25.77	Clay Loam	1.31	50.57	20.36

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Experimental Treatments:

Polymer: There are four levels of addition (0, 0.04, 0.08 0.12, and 0.16) % of dry soil weight

Compost: 4% on a dry soil weight basis

Studied Traits:

Physical Properties of Soil:

1- **Bulk Density (g cm^{-3}):** The bulk density was evaluated according to the equation described by Black et al. (1965).
2- **Total Porosity** (%) : refers to the porosity calculated based on the method and formula provided by Black et al. (1965):
3- **Moisture Content (%):** The bulk density was determined using the core method in which the core sampler was used to take soil samples of equal weight and volume. Wet weight for each sample was noted and was later dried at 105°C in an electric oven until constant weight was achieved. The moisture content was determined based on the following equation, as described by Black et al., (1965).

Growth Indicators and Wheat Yield:

1- **Plant Height(cm):** Measurement from the base of the stem to the topmost point (a measuring tape can be used for this).
2- **Leaf Area (cm^2):** It was calculated by taking random plants for each plot treatment. The leaf area during flowering stage, maximum leaf area occurs at end of flowering stage as per equation which is described by Thomas, 1975.

   Leaf area = Length of the leaf × Maximum width × 0.95

3- **Number of Tillers**: The number of tillers per plant was recorded.
4- **Spike Length (cm)**: using a tape measure, from spike base to spike tip.
5- **Number of Spikes**: Counted the total spikes on each plant.
6- **Spike weight(g)**: Weigh was scoring of a single spike using sensitive scale.
7- **Plant Dry Weight(g)**: The plant was dried in an oven set at 105 °C until a constant weight was achieved and then weighed.

Experimental Design

The pot experiment data of studied properties were statistically analyzed by completely randomized design (CRD) statistical base on experimental treatments. All experimental data were statistically analyzed with Gen Stat statistical software and treatment means were compared by LSD test at 0.05 significance level.

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III. Results

Soil physical properties :

1- Bulk Density (gm cm^{-3}):

The values in the table 2 suggest that the bulk density was positively and significantly influenced by adding amendments to the soil. Results indicated that, with the addition of compost and polymer, bulk density significantly decreased. In addition, the lowest bulk density recorded by (T4) at 1.194 g cm^{-3} and the control treatment without amendments(T0) had the highest bulk density at 1.253 g cm^{-3}.

2- Total Porosity (%):

The table 2 shows the total fermented porosity of the soils treated with different amendment addition treatments. In addition, the mixed treatment(T4) had the highest total porosity of 54.93% among the other addition treatments (Table 2). In contrast, the control treatment, which received no amendments (T0), exhibited the lowest total porosity, at 52.70%.

3- Moisture Content(%) :

The table 2 demonstrates a considerable effect of the amendment addition treatments on the soil moisture. Results show increased moisture content of the different addition treatments with the mixed treatment (T4) having the highest moisture content at 28.14%. In contrast, the control treatment without amendments had the lowest moisture content 22.82 % among the samples.

Table 2: indicates the effect of adding a mixture of compost and polymer to the soil on certain physical properties of the soil.

Treatment (T)	Bulk Density (g cm^{-3})	Porosity (%)	Moisture Content (%)
T0	1.253	52.70	22.82
T1	1.228	53.65	24.46
T2	1.214	54.18	25.62
T3	1.203	54.60	26.32
T4	1.194	54.93	28.14
RLSD	0.00994	0.3752	1.016

Growth Indicators and Wheat Yield:

1- Plant Height(cm):

The data given in Table 3, indicates a significant increase in plant height after addition of compost and polymer in the soil. The results revealed that the tallest plant height of 78 cm recorded was achieved by treating T4 which was mixed treatment and the lowest height of 49.33 cm also recorded was by the treatment control without amendments.

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2- Leaf Area (cm^2):

As shown in Table 3, leaf area was significantly improved with the addition of compost and polymer to the soil. Notably, the mixed treatment (T4) accumulated the highest leaf area68.05 cm^2 and control treatment without any amendments (T0) had the lowest leaf area 30.59 cm^2.

3- Number of Tillers:

As indicated in Table 3, the application of compost and polymer to the soil outside the pot had a more positive impact on number of tillers. The number of tillers was highest in the (T4)which is mixed treatment 10.33 and the lowest 5.33 in control where no amendments were made.

4- Spike Length (cm):

Based on the data presented in Table 3, it is obvious that the addition of compost and polymer into the soil greatly promotes spike length. Notably, the mixed treatment (T4) recorded a spike length of 13.33 cm, whereas the control treatment without amendments yielded the smallest spike length at 8.17 cm.

5- Number of Spikes:

Table 3 shows that the application of compost and polymer to soil markedly increases the number of spikes. More specifically, the mixed treatment (T4) notched the most spikes 11 cm, and the control treatment (no amendments at all) had the least 7.33 cm.

6- Spike Weight (g)

As illustrated in Table 3, spike weight was significantly higher than in control plots regularly treated with compost and polymer. Significantly, the T4 mixed treatment had the highest spike weight of 9.79 g, whereas the control treatment without any amendment had the lowest spike weight of 4.41 g.

7- Dry Weight (g):

As presented in Table 3, the application of compost and polymer to the soil increased dry weight significantly. Among the treatments, the T4 mixed treatment exhibited the highest dry weight of 22.73 g while the control treatment, which did not have any amendments, recorded the lowest dry weight of 14.32 g.

Table 3: The effect of adding compost and polymer to the soil on the growth indicators and yield of wheat.

Treatments T	Plant Height cm	Leaf Area cm^2	Number of Tillers	Spike Length cm	Number of Spikes	Spike Weight g	Dry Weight g
T0	49.33	30.59	5.33	8.17	7.33	4.41	14.32
T1	65.50	38.93	6.33	9.33	8.33	5.68	15.32
T2	72.67	57.00	7.33	11.00	8	6.53	16.70
T3	76.00	56.94	8	12.33	10	7.41	18.91
T4	78.00	68.05	10.33	13.33	11	9.79	22.73
RLSD	5.918	3.907	1.243	1.024	1.558	0.883	1.24

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IV. Discussions

A great deal of attention has focused on soil amendments, especially compost and polymer modifiers that improve soil physical (bulk density, porosity, moisture content) properties. Polymers assist in stabilizing soil according to (Wagiealla Abdalla Mohamed, 2004), suggesting the need to improve soil properties for specific usage. The addition of organic amendments has been proven to reduce bulk density and improve soil structure (C. Pagán-Roig et al., 2016, Yang et al., 2018), which leads to facilitating for the water infiltration and root penetration. In addition, these amendments improve the organic matter and microbial activity, critical for soil health. Moreover, Kraut-Cohen et al., (2023) confirm are that compost and polymer amendments can decrease bulk density and increase moisture retention and overall soil quality. These solutions can help replace both synthetic fertilizers, which come from extractive processing of rock mined for nutrients, as well as other green approaches, they argue. So, soil amendments significantly increase soil porosity and soil-moisture dynamics, thus, promoting agricultural productivity and soil health.

Several factors contribute to the improvement in soil moisture content when compost and polymer amendments are added. Study by (Ekebafe et al., 2018) reported that hydrolyzed starch copolymers increase moisture levels by improving nutrient retention and keeping moisture where water is scarce. In addition to soil porosity, which is another important aspect. (Eba et al., 2018) a combination of manure and straw mulch converts the soil into a larger water storage tank, increasing soil porosity and, thus, moisture capacity. Furthermore, less evaporation helps with moisture, too. Organic mulches can efficient at reducing the evaporation rates as a result, soil moisture is preserved which makes water more available (Zhang et al., 2023). Moreover, (Wang et al., 2023) further scored the importance of organic polymer modifiers to better soil water retention and stability.

Several interlinked factors contribute to the enhancement in wheat growth and yield observed with compost and polymer amendments of the soil. First and foremost, these amendments are improving soil properties tremendously. The compost polymer symbiosis enhances soil structure, porosity, and reduces bulk density. Its aid has a better structure in terms of its ability to retain water essential to give moisture to the roots of the plant. The soil amendments not only improve soil properties but also provide enhanced nutrient allosteric load and plant health (Aboelsoud et al., 2020, and Ghanem et al., 2022) Compost contains organic matter, essential nutrients, and also improves the soil structure. Soil fertility is also enhanced and important elements such as nitrogen, phosphorus and potassium are made available for wheat plants. Thus, the plants can absorb the nutrients necessary for its optimal growth, (Tian et al., 2021, and Gil-Ortiz et al., 2020). Also, compost encourages the growth of beneficial microbes in the soil. These microorganisms play a vital role in decomposition of organic matter liberating nutrients, which subsequently ensure these nutrients are made available for the plants, (Ghanem et al., 2020). Furthermore, it is the role of polymers to retain the water. This minimizes the evaporation of the soil and allows the wheat to have moisture for a longer time. It is beneficial in arid and semiarid regions where deficit of moisture act as barriers for growth of vegetation (Aboelsoud et al., 2020) and through improving soil properties which aids in reducing the external thrust on the plants. This is akin to a phosphorescent effect enrichment empowers the wheat plants to adapt better to stressors such as drought, and thus allows for sustained growth and productivity. Polymers also help in holding the nutrients in the soil, reducing the leaching damage. Compost is a slow-release form of nutrients essential for the Plants, which are released at a slower and steady rate, thus resulting in sustained and higher yields (Tian et al., 2021 and Yang et al., 2022).

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V. References

Abdalla Mohamed, ShihabWagiealla, "Stabilization of Desert Sand Using Water-Borne Polymers" (2004). Theses. 437.https://scholarworks.uaeu.ac.ae/all_theses/437

AbdElgalil, M. A., Harb, O. M., Abo-Elhamd, A. E. R. S., Ibrahim, M. M., & Hassan, A. A.(2016).The Integration of Microbial Inoculation and Organic Fertilization to Improve the Productivity of Wheat (Triticumaestivum L.) in New Land. *Journal of Advanced Laboratory Research in Biology*, *7*(3), 66-75.

Aboelsoud, H. M., & Ahmed, A. A. (2020). Effect of biochar, vermicompost and polymer on wheat and maize productivity in sandy soils under drought stress. *Environment, biodiversity and soil security*, *4*(2020), 85-102.

Black, C. A. (1965). Methods of soil analysis. Physical and Mineralogical. Part 1. Am.Soc. of Agron., Madison , Wisconsin. U S A.1572 p.

Ekebafe, L. O., Ogbeifun, D. E., Okieimen, F. E., &Ekebafe, O. M. (2018). Assessment of the Effect of Hydrolysed Starch Graft Copolymers Application on Soil Nutrient (Phosphorus and Nitrogen) Retention. *Materials Science: Materials Review*, *2*(1).

Ghanem, O. M., & El-Kharbotly, A. A. (2020). Improving Wheat Growth and Yield through Application of Compost and Plant Growth Promoting Rhizobacteria under Deficit Irrigation in a Sandy Soil. *Journal of Soil and Water Sciences*, *5*(1), 21-30.

Ghanem, O. M., & El-Kharbotly, A. A. (2020). Improving Wheat Growth and Yield through Application of Compost and Plant Growth Promoting Rhizobacteria under Deficit Irrigation in a Sandy Soil. *Journal of Soil and Water Sciences*, *5*(1), 21-30.

Gil-Ortiz, R., Naranjo, M. Á., Ruiz-Navarro, A., Caballero-Molada, M., Atares, S., García, C., & Vicente, O. (2020). New eco-friendly polymeric-coated urea fertilizers enhanced crop yield in wheat. *Agronomy*, *10*(3), 438.

Krasnopeeva, E. L., Panova, G. G., &Yakimansky, A. V. (2022). Agricultural applications of superabsorbent polymer hydrogels. *International Journal of Molecular Sciences*, *23*(23), 15134.

Kraut-Cohen, J., Zolti, A., Rotbart, N., Bar-Tal, A., Laor, Y., Medina, S., ... &Minz, D. (2023). Short-and long-term effects of continuous compost amendment on soil microbiome community. *Computational and Structural Biotechnology Journal*, *21*, 3280-3292.

Lord, R., &Sakrabani, R. (2019). Ten-year legacy of organic carbon in non-agricultural (brownfield) soils restored using green waste compost exceeds 4 per mille per annum: Benefits and trade-offs of a circular economy approach. *Science of the Total Environment*, *686*, 1057-1068.

Omara, A. E. D., Hafez, E. M., Osman, H. S., Rashwan, E., El-Said, M. A., Alharbi, K., ... &Gowayed, S. M. (2022). Collaborative impact of compost and beneficial rhizobacteria on soil properties, physiological attributes, and productivity of wheat subjected to deficit irrigation in salt affected soil. *Plants*, *11*(7), 877.

Pagán-Roig, I. C., Chong, J. A., Dumas, J. A., & de Jensen, C. E. (2016). Repeated short-term organic amendments effects on physical and biological properties of a San Antón soil. *J. Agric. Univ. Puerto Rico*, *100*(2), 123-140.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 1 (2025) PP 352-359

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

Stachowiak, T., Postawa, P., Malińska, K., Dróżdż, D., &Pudełko, A. (2022). Comparison of Physical and Thermal Properties of Mulching Films Made of Different Polymeric Materials. *Materials*, *15*(21), 7610.

Thomas , H. 1975. The growth response to weather of simulator vegetative swards of a single genotype of Loliumperenne. J. Agric. Sci. Camb. 84 : 333-343.

Tian, X., Wang, K., Fan, H., Wang, J., & Wang, L. (2021). Effects of polymer materials on the transformation and utilization of soil nitrogen and yield of wheat under drip irrigation. *Soil Use and Management*, *37*(4), 712-722.

Wang, L., Yao, Y., Li, J., Liu, K., & Wu, F. (2023). A state-of-the-art review of organic polymer modifiers for slope eco-engineering. *Polymers*, *15*(13), 2878.

Wodajo, D. (2015). Effects of compost application rates and mulch thickness on tomato (Solanumlycopersicum l.) yield, quality and soil physicochemical properties under salt affected soil of Dugda District of Oromia Region (Doctoral dissertation, Jimma University).

Yang, Y., Wu, J., Du, Y. L., Gao, C., Tang, D. W., & van der Ploeg, M. (2022). Effect on soil properties and crop yields to long-term application of superabsorbent polymer and manure. *Frontiers in Environmental Science*, *10*, 859434.

Yang, Y., Wu, J., Zhao, S., Han, Q., Pan, X., He, F., & Chen, C. (2018). Assessment of the responses of soil pore properties to combined soil structure amendments using X-ray computed tomography. *Scientific reports*, *8*(1), 695.doi: 10.1038/s41598-017-18997-1

Zemichael, B., &Dechassa, N. (2018). Effect of mineral fertilizer, farmyard manure, and compost on yield of bread wheat and selected soil chemical properties in Enderta District, Tigray Regional State, Northern Ethiopia. *East African Journal of Sciences*, *12*(1), 29-40.

Zhang, P., Xiao, M., Zhang, Z., Dai, Y., Liu, G., &Senge, M. (2023). Hydrological characteristics of different organic materials mulches. *Scientific Reports*, *13*(1), 771.