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The role of decomposed organic fertilizer inoculated with fungi and bacteria in enhancing wheat growth.

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ABSTRACT

To reduce the addition of chemical fertilizer to agricultural soils, this research has been conducted to assess the impact of three types pre-decomposed organic manures (chicken, sheep, and alfalfa green manure) on productivity of wheat plant (*Triticum aestivum* L.). after composting process of selected manures, the pot experiment was conducted to study the effect of inoculated and decomposed manures at three rates (0.5%,1%,2% w/w) on wheat growth. Essential growth parameters such as number of seeds and spikes, weight and protein of seeds, length of shoot and root, Concentration of N, P and K in wheat plant under the effect of local manures were studied. The results show that chicken manure at rate of 2% had the greatest result in weight and number (25.96g ,683.33) of seeds also protein percent (16.72) compare to other treatments, while sheep manure at rate of 2% recorded high result in number of spikes parameter. Number, weight of seeds and root length gets low result (101.00cm ,3.84cm ,25.73cm) with adding 0.5% alfalfa green manure. Also, Number of spikes, seed protein and shoot length gets low result (2.93 ,12.69 ,81.40) with 0.5%sheep manure. The growth parameter of length of shoot and root reveled maximum (101.06cm, 50.06cm) with chicken manure2% and minimum (81.40cm, 25.73cm) with sheep manure0.5% and alfalfa green manure0.5% respectively. Macro nutrients of N and K gets high value (3.89%, 2.90%) in chicken treatments2% respectively and P gets high amount (0.90%) in alfalfa green manure2%. Lowest result of N, P and K (2.24%, 0.14%, 2.23%) recorded at 0.5% rate in alfalfa green manure and chicken manure respectively. The study tells that decomposed chicken manure2% generally have great effect on growth and yield of wheat plant compare to other manures and rates.

***Keywords*:** Organic manure; composting process; wheat; growth parameters; yield.

INTRODUCTION

One of the most strategic crops in the world is wheat. Its great nutritional value has led to its global cultivation. There are numerous ways to consume wheat grain in various industries and commercial items. An endless supply of resources, such as nutrients and water, is necessary for crop growth to be at its best yield and quality. Since ancient times, organic matter has been utilized to enhance soil health and provide plant nutrients. Tons of organic matter have been added to the soil at different stages of decomposition and in different forms to increase crop output [1]. Because organic farmers are prohibited from using synthetic fertilizer formulas, organic produce has comparatively better nutrient levels. Crops farmed by organic farmers are only indirectly fed. Rather than providing plants with easily dissolved and absorbed powders and solutions containing nitrogen, phosphorus, and potassium, they fertilize their crops by incorporating organic elements into the soil through manures, compost, and cover crops. In addition to gently releasing nitrogen, phosphorous, and potassium in a manner that the plants can use, the bacteria also release a variety of additional nutrients in ratios that are challenging to duplicate with synthetic fertilizers. The impact of organic materials and other leftovers on plant behavior extends beyond the availability of nutrients; they also affect the physical, chemical, and biological properties of soil, affecting how plants develop. Another crucial practice that has an unfavorable effect on the environment is organic fertilization. Long-term use of chemical fertilizers at very high rates reduces the stability of soil organic matter and the potential activity of microflora and causes soil and water pollution. By adding beneficial levels of organic matter to soils, organic manures especially solid manures act as soil conditioners and structural enhancers. The biological activity of soils can be enhanced, along with their ability to retain water, withstand droughts, and maintain their structural integrity. Where frequent manure applications are performed, these gains are most likely to be realized [2].

Organic residue release nutrients very slowly in soil [3]. Decomposition of organic matter and nutrients depends on several factors, the primary one being soil microbial activity. Even though the decomposition of organic matter has been the subject

of in-depth research and sophisticated studies, more has to be done to understand the role of microorganisms and the variables that control the decomposition of organic matter into stable SOM, such as the quality of organic matter and climate. The soil ecosystem contains a variety of microorganisms with different capacities to break down the organic matter (carbon) portion, including lipids, cellulose, lignin, hemicelluloses, and chitin [4]. This study was designed to assess the effect of pre-decomposed organic matter (chicken, sheep and alfalfa green manure on the growth, yield, and nutrient concentration of wheat plants.

Materials and methods

2.1. Soil Sample and Organic Residues Collections.

Rhizospheric soil samples from Ainkawa (Erbil directorate of agriculture research) Erbil governorate - Kurdistan region-Iraq were taken in November 2022, collected at a depth of 3-30 cm. The soils were air- dried, sieved through 4mm for pot experiment and sub soil samples were sieved through a 2mm sieve for measuring some physical and chemical properties of the soil samples. Three types of organic residues (chicken, sheep, and Alfalfa green manure) were collected from Grdarasha farms, they were dried and grind to powder, and sieved using 2 mm sieve.

2.2. Soil and Organic manures analysis.

The samples were undergoing some physical and chemical analysis included: soil texture, field capacity, EC, pH, and soil organic matter content as shown in table (1). particle size distribution was performed by hydrometer method as described by [5]. Field capacity have been estimated according to the model prepared by [6]. Electrical conductivity, Soil pH and Organic matter were measured for the soil saturated extract as described in [7].

For calculating C:N ratio in manures and soil, organic carbon and total nitrogen were determined. Organic carbon for manures were determined by titrimetric method according to [24]. Amount of total nitrogen in manures were determined by the kjeldahl method as described in [25]. The (C: N) ratio for chicken, sheep and alfalfa were (9:1), (13: 1), (8: 1) respectively. Ec and pH value for chicken, sheep and alfalfa was (10.5, 9.6, 6.2) dSm^{-1} and (7.5, 7.8, 6.7).

Table 1: Some chemical and physical properties of the soil used in pot experiment.

Some Chemical and physical properties		Values
pH		7.94
Ec dsm^{-1}		0.298
Organic matter %		1.548%
Soil organic carbon		0.980%
Soil texture		SiC
Particle size distribution %	Sand	8.8%
	Silt	61.3%
	Clay	29.9%
water content %	Saturation percentage	56.12
	F.C	28.41
	W. P	17.47

2.3. Total counting of Bacteria and Fungi.

The Soil sample, which used as inoculum for manures inoculation, was subjected for microbiology analysis. Both soil Bacteria and Fungi numbers were estimated by determination of viable plate count according to [23]. After preparation of serial dilution, soil suspensions were cultivated on nutrient agar plates, then all plates were put in an incubator for one day at 28°C. to determine bacterial cell counts. While for Fungal population count soil suspensions were cultured on SDA (Sabouraud Dextrose Agar) then plates were put into an incubator for 7 days at 25°C. The numbers of bacterial and fungal colonies were counted are 97.619 g soil $*10^6$ and 4.571 g soil $*10^6$.

2.4. Composting experiment

Ten kilograms of each studied manure (Chicken, sheep and alfalfa green manure) were inoculated with 500ml of soil suspension ($14*10^8$ cell/ml), individually [26]. The inoculated manures were incubated for three months (August, September and October), 2022 at room temperature. After composting process, the composted manures were reached to suitable form for pot experiment.

2.5. Pot experiment

The pot experiment was carried out at Ainkawa research center in Erbil. The location was defined according to GPS reading of Latitude (N 36° 14. 720)- Longitude (E 43° 59. 692) and Elevation 418.7 m during (November, 2022 to May, 2023). To study the effect of decomposed chicken, alfalfa green and sheep manure and their combination on growth, yield of wheat plant, the Completely Randomized Design CRD was used with 3 replicates.

The pots (26 cm in diameter) containing equal amounts of homogeneous soil (8kg). The prepared composted manures were added at different rats (0.5%,1% and 2% w/w) to pots for preparing treatments with three replications. Controls pots were

prepared without the addition of decomposed manures. Then, wheat seeds (15 seeds/ pot) were sown during November, 2022. After germination, the seedling emerged 20 days after planting, they were thinned down to 10 seedlings per pot. All pot treatments were irrigated depending on rainwater for plant growth. After harvesting the Data were recorded.

2.6. Measurements at maturity stage

All ten plants at full maturity were randomly selected representative samples from each experimental pot to increase the quantity of seeds and spikes, the weight and protein of the seeds, and the length of the wheat plant's shoot and root. In each experimental unit's spikes were chosen at random, crushed by hand, and the amount of seeds produced by each plant was then determined. After being harvested, the seeds were cleaned, sieved, and threshed to remove any contaminants before being weighed. Plant height was measured before harvesting stages and after harvesting, the roots were removed from the shoots and measured in cm.

Chemical analysis of wheat plants done to determine essential macro nutrients. Total nitrogen in the plant was estimated according to the macro Kjeldhal method described by [7]. Total phosphorus was spectrophotometrically estimated and total potassium by using Flame photometer according to [7].

2.7. Statistical analysis

The data was illustrated as mean (X + S.E) and statistical analysis was carried out using available software (SPSS version 26.0). Data analysis was made using one-way analysis of variance (ANOVA). The comparisons between groups were done using Duncan test was considered as statistically significant as mentioned by [8].

3. Results and Discussion:

3.1. Effects of three studied decomposed manure on wheat growth

The results of wheat yield in table (2) illustrate that Chicken manure at rate 2% recorded the highest values of number and weight of seeds (683.33, 25.96g) compare to sheep and alfalfa green manure. Generally, all treatments with 2% composted manures gets good result comparing to 1% and 0.5% rates of treated samples. For the same above parameters, Alfalfa green manure recorded lowest result in all three rates of added manures compare to sheep manure and Chicken manure.

In this regard, [9] found that applying compost and chicken manure enhanced the total dry biomass output by wheat. Wheat output increased due to improved nitrogen absorption, consistent decomposition of farmyard waste, and nutrient release during crop growth [10].

Number of spikes in the studied plant had high result in sheep manure and alfalfa green manure at rate of 2%, while Chicken manure 0.5% gets low result (2.73) in all treated samples with manures.

Plant development benefits from the use of organic fertilizers. Sheep dung is advised for developing organic barley since it produces results comparable to conventional fertilizers [11]. Compared to the unmodified control, manure increased wheat production and growth; however, the effect varied depending on the treatment rate. The high manure production rate led to more spikes and a comparable grain output [12].

Protein percent in seeds of study wheat plant was recorded the highest value (16.72%) in 2% Chicken manure and lowest (12.69%) in 0.5% sheep manure differing in all other rates and types of organic manures.

Utilizing organic fertilizers in agriculture increases the yield of farmed plants because they are rich in food components. Crop yields are impacted by mineral nutrient levels [13]. Application of farmyard manure over control resulted in a considerable increase in protein production in wheat grain [14].

In measuring length of shoot and root of wheat plant, effect of chicken manure is clearly noticed and gets maximum (101.06 cm, 50.06 cm) especially in 2% rate. Control samples, which the amount of added manure was 0% showed minimum number (79.86 cm, 21.66 cm) in both shoot and root length parameter compare to other rates of treated samples with organic manures.

The highest plant height was obtained using the chicken manure treatment; this means that the chicken manure enhanced the response and the growth of wheat plants. The enhanced effects of organic manure, which enhanced the physo-chemical and biological qualities of soil, may cause the increases in plant growth. This might improve the availability of nutrients and soil exchange capability, which would encourage plant development. These findings are comparable to those of [15,16]. A plant with healthy roots is better able to absorb water and vital nutrients from the soil, which increases output. Plant nutrient absorption and water stress are increasing due to growing plant roots, both in quantity and size, or the depletion zone of diseased roots, which may be the primary factors promoting plant growth [17].

Table 2: Effect of Chicken manure, Sheep manure and Alfalfa green manure in three different rates on some Wheat yield parameters.

	Treated soil with manures	Chicken manure	sheep manure	Alfalfa green manure
Number of seeds/plants	0% manure (control)	262.33^{f}		
	0.5% manure	198.33^{g}	103.33^{h}	101.00^{h}
	1%manure	424.00^{d}	321.66^{e}	294.66^{f}
	2%manure	683.33^{a}	475.33^{c}	617.33^{b}
Weight of	0% manure (control)	9.17^{ef}		

seed(gm)/plant	0.5% manure	7.53^{f}	3.92^{g}	3.84^{g}
	1%manure	17.02^{c}	12.40^{d}	9.70^{e}
	2%manure	25.96^{a}	18.30^{c}	21.53^{b}
	0% manure (control)	3.26^{abc}		
Number of spikes/plants	0.5% manure	2.73^{c}	2.93^{bc}	3.26^{abc}
	1%manure	3.26^{abc}	3.53^{a}	3.33^{ab}
	2%manure	3.66^{a}	3.73^{a}	3.73^{a}
	0% manure (control)	14.10^{d}		
Protein of seed %	0.5% manure	13.49^{e}	12.69^{f}	14.93^{c}
	1%manure	15.73^{b}	14.74^{c}	15.81^{b}
	2%manure	16.72^{a}	15.77^{b}	15.97^{b}
	0% manure (control)	79.86^{e}		
length of shoot (cm)	0.5% manure	91.80^{b}	81.40d^{e}	83.80^{cd}
	1%manure	94.33^{b}	82.80^{cde}	85.26^{c}
	2%manure	101.06^{a}	85.26^{c}	93.00^{b}
	0% manure (control)	21.66^{d}		
length of root (cm)	0.5% manure	41.20^{b}	31.60^{c}	25.73^{d}
	1%manure	48.53^{a}	37.06^{b}	31.20^{c}
	2%manure	50.06^{a}	40.80^{b}	38.00^{b}

3.2. Effects of decomposed Chicken, Sheep, and Alfalfa green manure on N, P and K uptake in Wheat plant.

Data regarding to macronutrients of N, P and K in wheat leaves Application of prepared treated soil samples with organic manures resulted in a considerable increase in results when compared to control treatment, as seen in table (3). This might result from raising soil fertility to boost the population of these microbes and quicken specific microbial activities occurring in the soil's rhizosphere. The highest total nitrogen (3.89%) was recorded in 2% chicken and sheep manure treatments. Samples which treated with 0.5% alfalfa green manure have least effective (2.24%) on total nitrogen in leaves wheat.

These results are in agreement with those obtained by [18,19] who found that organic fertilizer with bio-fertilizers caused significant increase in nitrogen content and uptake of wheat plant. In addition to, the release of N from the decomposed chicken manure. Further, it may be due to the availability of these nutrients in soil or higher initial content of these nutrients in the chicken manure and their uptake by wheat plants. These findings concur with those of [18,19], who discovered that the combination of organic fertilizer and biofertilizer significantly increased the nitrogen content and uptake by wheat plants. Additionally, it can result from the release of mineral-bound insoluble nitrogen caused by the action of organic acids generated during decomposition [20].

The highest and lowest result in Phosphorous amount in wheat leaf was recorded in 2% alfalfa green manure treatments and 0.5%chicken manure by (0.90%) and (0.14%) respectively.

The favorable effects of organic manure, which enhanced the physo-chemical and biological qualities of soil, may be the cause of the increases in P-content. Thus, it might boost soil exchange capacity, making some nutrients more available in the soil, which would then encourage P-uptake. According to [19], the combination of organic fertilizer and biofertilizer significantly increased the N P and K content and the wheat plant's uptake. The promotive effects of the bio-fertilization specially the effective microorganism's mixture with the chicken manure; may be attributed to the production of growth promotive substance from rihzospheric microorganisms such as IAA and GA3 which regulates various aspects of plant growth and development [21]. It is worth mentioning that the response of P-uptake by wheat plants was more pronounced to the organic material, might be described to increasing the volume of soil explored by the roots [2].

Chicken manure treatments of 2% had the capability to get the greatest amount (2.90%) in potassium per cent as compared to other treatments and the control sample.

Several works reported increased K-content and K-uptake in plants by adding organic materials. According to [16, 22], applying organic manures (swine, cattle, or chicken manure, or a combination of them) to rice plants greatly enhanced the N, P, and K contents of the plants. The general improvements in rice's nutrient uptake in manured pots, they said, suggested that manure mineralization immediately after application produced a larger pool of nutrients that were available to plants.

Table 3: Effect of Chicken manure, Sheep manure and Alfalfa green manure in three different rates on NPK amount of wheat plant.

	Treated soil with Manures	Chicken manure	sheep manure	Alfalfa green manure
N% in Leaf	0% manure (control)	2.20^{e}		
	0.5% manure	2.73^{d}	2.83^{cd}	2.24^{e}
	1%manure	3.25^{bc}	3.38^{b}	3.13bcd
	2%manure	3.89^{a}	3.89^{a}	3.47ab
P% in Leaf	0% manure (control)	0.10g		

	0.5% manure	0.14^{g}	0.20^{f}	0.22^{f}
	1%manure	0.24^{f}	0.31^{e}	0.44^{d}
	2%manure	0.72^{b}	0.57^{c}	0.90^{a}
	0% manure (control)	2.09e		
K% in Leaf	0.5% manure	2.23^{de}	2.39^{cd}	2.30^{d}
	1%manure	2.53^{bc}	2.60^{a}	2.54^{bc}
	2%manure	2.90^{a}	2.81^{b}	2.80^{a}

Conclusion:

All studied growth parameters such as number of seeds and spikes, weight and protein of seeds, length of shoot and root, amount of nitrogen, phosphorous and potassium by wheat plants increased gradually from 0.5%,1%and 2% when were added regardless the organic type. Application of chicken manure is more effective than another organic manures in all studied cases of wheat plant growth except number of spikes which sheep manure recorded high result in very little difference with chicken manure. The highest plant height and root length was obtained by using the chicken manure treatment; this means that the chicken manure enhanced the response and the growth of wheat plants. Positive results in N, P and K amount observed in treated samples of manures while, the lowest results recorded in control samples which no organic manures added. The obtained results indicated that chicken manure gave the positive result followed by sheep manure while alfalfa green manure gave the lowest. The amounts of various organic manures had observed to increase crop yield.

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دور السماد العضوي المتحلل والملقح بالفطريات والبكتريا في تعزيز نمو القمح.

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الخلاصة

للحد من إضافة الأسمدة الكيماوية إلى التربة الزراعية، أجري هذا البحث لتقييم تأثير ثلاثة أنواع من السماد العضوي المتحلل (روث الدجاج، الأغنام، والبرسيم الأخضر) على إنتاجية نبات القمح ***(Triticum aestivum* L.)** بعد عملية تسميد السماد المختار أجريت تجربة وعاء لدراسة تأثير السماد الملقح والمتحلل بثلاثة معدلات (0.5%، 1%، 2%) في نمو الحنطة. تمت دراسة عوامل النمو الأساسية مثل عدد البذور والسنابل، وزن البذور وبروتينها، طول المجموع الخضري والجذري، كمية **NPK** في نبات القمح تحت تأثير السماد المحلي. أظهرت النتائج أن روث الدجاج بنسبة 2% كان له أعلى نتيجة في وزن وعدد البذور (25.96غرام،683.33) ونسبة بروتين (16.72) مقارنة بالمعاملات الأخرى، في حين سجل سماد الأغنام بنسبة 2% نتيجة عالية في عدد البذور. عدد ووزن البذور وطول الجذر حصل على نتيجة منخفضة (101.00سم،3.84سم،25.73سم) مع إضافة 0.5% سماد البرسيم الأخضر كما أن عدد السنابل وبروتين البذور وطول البراعم كانت نتيجتها منخفضة (2.93، 12.69، 81.40) بنسبة 0.5٪ بسماد الأغنام. وأظهرت معامل نمو طول الساق والجذر كأقصى حد (101.06 سم، 50.06 سم) باستخدام سماد الدجاج بنسبة 2٪ وأدنى حد (81.40 سم، 25.73 سم) مع سماد الأغنام 0.5٪ وسماد البرسيم الأخضر 0.5٪ على التوالي. كما حصلت العناصر الغذائية الكبرى من النيتروجين والبوتاسيوم على قيمة عالية (3.89٪، 2.90٪) في معاملات الدجاج بنسبة 2٪ على التوالي ويحصل الفسفور على كمية عالية (0.90٪) من سماد البرسيم الأخضر بنسبة 2٪. كأقل نتيجة لـ ***NPK*** (2.24٪، 0.14٪، 2.23٪) وسجلت بمعدل 0.5٪ من سماد البرسيم الأخضر وسماد الدجاج على التوالي. أظهرت الدراسة أن سماد الدجاج المتحلل بنسبة 2٪ له تأثير كبير بشكل عام على نمو وإنتاجية نبات القمح مقارنة بالأسمدة والمعدلات الأخرى.

الكلمات المفتاحية: سماد عضوي، عملية التسميد، قمح، عوامل نمو، أُثْمَر.