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Impact of organic fertilizer quality on the phenotypic characteristics of Corn crop and soil properties

Impacto de la calidad del abono orgánico en las características fenotípicas del cultivo de maíz y en las propiedades del suelo

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Abstract

The purpose of this study is to know the effect of organic fertilizers on the growth and productivity of yellow corn and the properties of saline soil. The experiment was carried out on the farm of Sayeed Habib Al-Khatib in the city of Numaniyah, 45 km west of the city of Kut, during the 2024 agricultural season. To study 3 types of organic waste: cows, F1, sheep F2, and poultry F3, then a mixture of them, (F1+F2), (F1+F3), (F2+F3), to know the effect of these fertilizers on the growth and production of Maize plants and soil properties. The land was plowed, ground, and mixed, Then the waste was then added to the soil with the surface layer 2 t.ha^{-1}, Then the corn grains were planted and irrigation began until the end of the experiment. Agricultural operations and crop service were carried out according to the recommendations followed in the region. Soil, plant and yield measurements were taken at the end of the growing season. The research results showed that the level (F 2 + F3) of organic Fertilizer from sheep waste mixed with poultry waste resulted in a significant increase in plant height, root length, Ear length, leaf area, weight of 500 grains, yield, and biological yield compared to other levels of fertilizer and organic matter in the soil, while the pH and EC of the soil did not give a significant difference. This experiment demonstrated the positive effect of poultry waste and mixture of poultry and sheep manure in growth and corn production. Additional to this mixture of poultry and sheep manure influence soil properties by decreasing electrical conductivity and increasing organic matter.

Key Words: *Corn, Poultry, Fertilizer, Organic Waste, Al-Khatib*

Resumen

El objetivo de este estudio es conocer el efecto de los abonos orgánicos sobre el crecimiento y la productividad del maíz amarillo y las propiedades del suelo salino. El experimento se llevó a cabo en la granja de Sayeed Habib Al-Khatib en la ciudad de Numaniyah a 45 km al oeste de la ciudad de Kut durante la temporada agrícola de 2024. Para estudiar 3 tipos de residuos orgánicos: vacas, F1, ovejas F2, y aves de corral F3, a continuación, una mezcla de ellos, (F1 + F2), (F1 + F3), (F2 + F3), para conocer el efecto de estos fertilizantes en el crecimiento y la producción de plantas de maíz y las propiedades del suelo. La tierra se aró, se trituró y se mezcló, después se añadieron los residuos al suelo con la capa superficial 2 t.ha^{-1}, a continuación se plantaron los granos de maíz y se empezó a regar hasta el final del experimento. Las operaciones agrícolas y el servicio a los cultivos se realizaron de acuerdo con las recomendaciones seguidas en la región. Al final del período vegetativo se realizaron mediciones del suelo, la planta y el rendimiento. Los resultados de la investigación mostraron que el nivel (F 2 + F3) de fertilizante orgánico procedente de residuos ovinos mezclado con residuos avícolas produjo un aumento significativo de la altura de la planta, la longitud de la raíz, la longitud de la espiga, la superficie foliar, el peso de 500 granos, el rendimiento y el rendimiento biológico en comparación con otros niveles de fertilizante y materia orgánica en el suelo, mientras que el pH y la EC del suelo no dieron una diferencia significativa. Este experimento demostró el efecto positivo de los residuos avícolas y de la mezcla de gallinaza y estiércol ovino en el crecimiento y la producción de maíz. Además, la mezcla de gallinaza y estiércol de oveja influye en las propiedades del suelo al disminuir la conductividad eléctrica y aumentar la materia orgánica.

Palabras clave: *Maíz, Aves de Corral, Fertilizantes, Desechos orgánicos, Al-Khatib*

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1. Introduction

Organic matter is a mixture of materials resulting from the decomposition process, whether from plant or animal waste for a long time. Organic matter contains many nutrients necessary for plant growth, including carbon, nitrogen, hydrogen, sulfur, and phosphorus.

The process of decomposition of organic matter begins when appropriate conditions are available, such as heat, humidity, ventilation, and acidity. Its original composition disappears, and the remaining material becomes brown to black in color and is relatively resistant to decomposition. It is called humus, which is considered a storehouse of nutrients that are gradually released in a way suitable for plant use.

It is of fundamental importance in the carbon cycle. Nitrogen, sulfur, phosphorus, and most metal ions (Lobus & Kulikovskiy, 2023). The addition of organic residues due to a reduction in electrical conductivity, dissolved sodium concentration, dissolved chlorine concentration, and apparent density (Brempong & Addo-Danso, 2022). Organic fertilizers with low C:N ratios can be applied to supply both macro and micronutrients to the soil. Aside nutrient supply, they can improve soil structure, texture, water holding capacity and nutrient holding capacity (Brempong & Addo-Danso, 2022).

Compost treatment provides an environmentally sustainable approach to managing soil salinity, addressing the impact of saline irrigation, improving soil organic matter, enhancing water and nutrient availability to plants, and increasing plant growth and carbon sequestration potential (Suvendran et al., 2024).

Farmers should be empowered through education and awareness on organic fertilization, nitrogen fixation in plants, and sustainable input use techniques (Jaja & Barber, 2017). Organic agriculture enhances the quality of food crops and soil quality. It is a system known as organic farming, as it maintains soil efficiency (Rahman-Saleh & Rahem-Bader, 2022).

AL-Sadoon & AL-Ubaidi (2014) showed that the use of organic fertilizer on yellow corn crops at the level of 100 kg.ha^{-1}, it showed a significant increase in all the studied traits: plant height, leaf area, number of seeds per stalk, number of rows per stalk, and grain yield of the plant. Asfaw (2022) sheep manure produced 3.9 t.ha^{-1} of maize and a small yield of 2.8 t.ha^{-1} of maize was recorded in the control management.

The influence of cattle manure on leaf area remained significant under different application levels; maximum leaf area index 403.04 cm^2 was recorded at 20 t.ha^{-1} (Eleduma et al., 2020). Organic substitution (partial substitution of chemical fertilizer with organic fertilizer) is an effective approach to address soil degradation caused by excessive application of chemical fertilizers, particularly in saline areas (Cheng et al., 2023).

The research aims to determine the response of the yellow corn crop to organic fertilizers during the growth stages, and to study the effect of organic fertilizers on soil salinity and the degree of their interaction. Organic fertilizers can improve soil physical properties such as structure and aggregation, water holding capacity and drainage and chemical properties such as nutrient holding capacity

2. Method and materials

The experiment was carried out in 2023 at Al-Khatib Farm , located in Al-Numaniyah District, at a longitude of 45.5° and a latitude of 32.3°. It is bordered to the south by Wasit Governorate, 50 km away, and to the north by Baghdad Governorate, 160 km away. It is bordered to the east by Diyala Governorate, 70 km away, and to the west by Babil Governorate, 60 km away.

The climate of the city of Numaniyah, where the experiment was carried out, is suitable for agriculture. In the summer, the temperature reaches 44 degrees Celsius, while in winter it reaches zero or below. Also, Numaniyah is characterized by a lack of rain, not exceeding 50 mm**.**

The land was prepared for cultivation by plowing with two perpendicular plows, leveling it, leveling it, and dividing it into experimental units of one hectare.

Before planting, laboratory analysis of the experimental soil was conducted by taking soil samples randomly from different locations in the study area at the layer (0-20) cm. Laboratory analysis of the irrigation water used was also conducted, and to determine the amount of nutrients of nitrogen, phosphorus and potassium in the added organic fertilizers, laboratory analysis was also conducted. Tables 1, 2 and 3 show this.

To use in the experiment 3 types of organic waste: cows, sheep, and poultry, then a mixture of cow and sheep waste, a through increased cation exchange capacity and increased ability to resist changes in soil pH. Improvement in soil physical and chemical properties can improve plant growth (Gezahegn, 2021) and yield mixture of cow and poultry waste, and a mixture of poultry and sheep waste, in an amount of 2 t. ha^{-1}. for each of them, in addition to the comparison sample F0, were given the following symbols, respectively, F1,F2,F3, (F1+F2), (F1+F3), (F2+F3), to know the effect of these fertilizers on the growth and production of Maize plants and soil properties.

Organic fertilizers were mixed with the soil in an amount of 2 t. Hectare and the mineral fertilization process were carried out by adding 200 kg.ha^{-1} in two batches, and compound fertilizer 17:17 was added at a rate of 300 kg.ha^{-1} and urea fertilizer were added 200 kg.ha^{-1}. Planting was done on 7/20/2023 so that the distance between one hole and another was 30 cm. By placing 3 seeds in each hole, then thinning and patching operations were carried out.

200 kg of urea was added 40 days after planting, and the growth of the plants was observed, field observations were recorded, and finally the harvest took place on 6 November, 2023.

Table 1. Some physical and chemical characteristics of the soil used in the study

Adjective			Value
pH			7.70
EC dSm^{-1}			2.40
		Ca^{++}	6.67
		Mg^{++}	3.89
Irrigation water	HC Mmol.L^{-1}	Na^{+}	4.41
	6.5	K^{+}	2.35
		Cl^{-}	3.24
The dissolved ions Mmol.L^{-1}		$SO4^{--}$	6.26
		HCO_3^{-}	5.23
Soil separators g.kg^{-1}		Sand	186
		silt	612
		clay	203

Table 3. Organic fertilizer analysis before planting

Type of organic waste	Nitrogen %	Phosphorus %	Potassium %	EC dS.m^{-1}	pH
Cows	3.52	1.89	3.72	14.5	5.7
sheep	2.25	1.77	2.90	12.1	6.5
Poultry	2.90	1.66	2.56	15.4	6.7

The experiment was arranged according to a completely randomized block design within split panels, with three repetitions for each treatment.

Statistical analysis

The data were statistically analyzed using the SPSS program, using randomized completely block design(RCBD),with three replications for each treatment, and the means were compared at a significant difference of 0.05 according to Duncan's method Table 4. ANOVA analysis showed that there was a significant difference at the 5 % significance level for the coefficients.

Table 2. Mineral composition, pH and electrical (EC) conductivity of irrigation water before planting

Irrigation water	HCO^{-3} Mmol.L^{-1}	SO^{-4} Mmol.L^{-1}	Cl^{-} Mmol.L^{-1}	Na^{+} Mmol.L^{-1}	Mg^{++} Mmol.L^{-1}	Ca^{++} Mmol.L^{-1}	pH	EC dS.m^{-1}
	6.5	3.6	4.7	5.3	3.7	4.2	7.6	1.9

Table 4. Statistical analysis.

		Sum of Squares	df	Mean Square	F	Sig.
Plant height	Between Groups	20556.000	6	3426.000	877.390	.000
	Within Groups	54.667	14	3.905		
	Total	20610.667	20			
Root height	Between Groups	1769.143	6	294.857	119.077	.000
	Within Groups	34.667	14	2.476		
	Total	1803.810	20			
Ear length	Between Groups	608.571	6	101.429	44.375	.000
	Within Groups	32.000	14	2.286		
	Total	640.571	20			
Leaf area	Between Groups	16552696.286	6	2758782.714	37.769	.000
	Within Groups	1022606.667	14	73043.333		
	Total	17575302.952	20			
500 grain weight	Between Groups	9743.905	6	1623.984	93.435	.000
	Within Groups	243.333	14	17.381		
	Total	9987.238	20			
Grain yield	Between Groups	138.600	6	23.100	32.818	.000
	Within Groups	9.854	14	.704		
	Total	148.454	20			
Biological yield	Between Groups	976.571	6	162.762	39.287	.000
	Within Groups	58.000	14	4.143		
	Total	1034.571	20			
O.M	Between Groups	11.641	6	1.940	43.138	.000
	Within Groups	.630	14	.045		
	Total	12.271	20			
PH	Between Groups	9.060	6	1.510	39.148	.000
	Within Groups	.540	14	.039		
	Total	9.600	20			
EC	Between Groups	4.183	6	.697	54.222	.000
	Within Groups	.180	14	.013		
	Totals	4.363	20			

3. Results and Discussion

Plant height and root length (cm)

The effect of the mixture of poultry manure with sheep waste was significant in plant height 161 cm and root length 54.3 cm compared to the organic fertilizer treatments used in the experiment. This is consistent with what was concluded (Khalifah et al., 2017) that the fertilization treatment with a mixture (poultry and sheep waste) gives the highest average in plant height and root length due to the role of organic fertilizers in the availability of nutrients, especially nitrogen, and its importance in increasing cell size and the speed of their division, which caused an increase in plant and root height.

The high percentage of organic acids in poultry waste reduces the degree of soil reaction and increases the phosphorus and potassium elements that are important for plant growth (Kireycheva et al., 2021).

Leaf area (cm^2)

The experiment showed that the organic fertilizer mixture of poultry and sheep waste increased the area of corn leaves 6859.3 cm^2 due to the increase in potassium, which plays an effective role in delaying the aging of plant leaves this is consistent with what was concluded (Hu et al., 2016) because potassium plays a role in controlling cell growth, wood formation, water content and movement in wood and bark, and the transport of nutrients and metabolites (Sardans & Peñuelas, 2021).

Weight 500 grains

Fertilization treatments differed significantly among themselves, as the treatment (sheep and poultry waste mixture) gave a significant difference in the average weight of 500 seeds 165.3 g (table 5), which led to an increase in seed weight, which led to an increase in seed weight (Cihangir & Oktem, 2019).

Yield and biological yield (t. Ha^{-1})

A significant difference was found in the effect of different organic fertilizers on the yield and biological yield of corn crop when treating fertilizers with poultry manure mixed with sheep manure. The yield was calculated to be 12 t. ha^{-1} and the biological yield was 36.3 t. ha^{-1} (table 5).

The results showed that adding the goat and poultry manure significant increase in availability of few soil nutrients, yield and fruit's quality. Goat manure is preferable to cattle manure for use in vegetable gardens because it is less likely to suffer detrimental effects from prolonged exposure to gaseous losses and leaching by rain. Soil treated with goat dung increased in carbon and nitrogen content, and plants grew taller, wider, and had more leaves than those grown in soil with no fertilizer (Ramadevi et al., 2023). Among the three organic fertilizers, chicken manure was highest in total N, P and exchangeable Ca, cow dung was highest in exchangeable K (Abukari, et al., 2024)

The electrical conductivity

Electrical conductivity decreased when using the fertilizer treatment (mixing poultry waste and sheep waste) and was 2.7 $dS.m^{-1}$ (Table 5).

This result is consistent with what (Mahdy, 2011) reached, that adding organic waste to saline soil improved the conditions of salt and sodium leaching by 50 %, which caused a reduction in the electrical conductivity of the soil (EC)

The addition of organic matter at the level of a mixture of sheep and poultry waste led to a significant increase in all the characteristics studied of the corn plant, this is consistent with what was reached by Hossain et al., (2017).

4. Conclusions

According to the results obtained from this study, we conclude as follows**.**

1- In the growth and production of corn, poultry waste was better than sheep waste, followed by cow waste.

2- The organic fertilizer treatment of poultry and sheep manure mixture (F2+F3) resulted in a significant decrease in electrical conductivity compared to other fertilizer treatments, and an increase in organic matter in the soil.

3- The addition of organic matter at the level of a mixture of sheep and poultry waste led to a significant increase in all the studied characteristics of the corn plant.

Table 5. Effect of organic fertilizer quality on the phenotypic characteristics of Maize and soil salinity and pH

Fertilizers 2t.h^{-1}	Plant height cm	Root height cm	Ear length cm	Leaf area cm^2	500 grains weight g	grain yield t.ha^{-1}	Biological yield t.ha^{-1}	O.M %	pH	EC $dS.m^{-1}$
F0	64	25	12	4314	101	4	15	1.0	5.4	3.1
F1	99	32	15.6	4856	116.3	5.6	20	1.3	7.0	3.5
F2	109	36	18.6	5363	130	7.4	23.6	1.9	7.5*	3.5
F3	120	41.3	22	5910	142	9	27	2.4	6.9	4.1*
(F1+F2)	133.3	44.3	23.6	6230	148	9	28	2.6	6.5	3.9
(F1+F3)	156	47.6	25	6760	160	10.6	32.6	2.9	6.3	3.7
(F2+F3)	161*	54.3*	29*	6859.3*	165.3*	12*	36.6*	3.1*	5.9	2.7

* significant differences at a probability $p < 0.05$

Recommendations

We recommend using organic fertilizers, especially a mixture of sheep and poultry waste, because of their beneficial effect on plants and soil.

We also recommend washing the soil to get rid of the salts contained in the organic fertilizer.

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