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EFFECT OF ORGANIC WASTE FERTILIZERS ON THE SOIL STRUCTURE

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SUMMARY

In investigating the effect of adding different sources of organic waste fertilizers on soil structure, the selection of two locations in Wasit Province, Iraq, with different soils succeeded. The first location had sandy loam, and the second had clay. The soil distribution in plastic pots ensued, with three sources of organic waste added (cow, sheep, and poultry). The application of five amounts of each source included 0, 5, 10, 15, and 20 t/ha with three replicates. The study confirmed the characteristics of the weighted rate and the stability of the soil groups. After completing the experiment, the study found that sheep waste was the most effective source in the stability of the soil groups. It has recorded 05.28% when treating the control at 0 t/ha, while it became 54.48% at the level of 20 t/ha. Moreover, the weight was 37.0 mm in the control treatment; it became 95.0 mm at the level of 20 t/ha. The lower effect was the waste from cows, while the waste of poultry had fewer effects in both trials.

Keywords: Organic waste, fertilizers, soil structure, cows, sheep, and poultry wastes

Key findings: Given the heterotic effects, the hybrids had better mean performance for the evaluated traits than their parental lines and testers. The parental genotypes, IR58025A, BRRI1A lines, and the BUdhan2R tester emerged as appropriate for hybridization. IR58025A × BUdhan2R and BRRI1A × BUdhan2R were also the best crosses due to higher grain yield, heterosis, and combining abilities. These parents and hybrid combinations could proceed to be deployed in an aromatic rice hybridization program.

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INTRODUCTION

Soil building is the most important physical concept that has a great effect on the balance between air and water in the soil. Therefore, the focus is on improving soil structure by natural and artificial methods to reach the balance. Although the construction of the soil is one of its dynamic properties, it increases the matter in reaching the desired condition. Thus, the primary role of managing and improving soil characteristics lies in providing the suitable physical environment for the growth of plants. One must consider the role of organic matter, as it is one of the basic soil components, together with the mineral part, called the solid phase of the soil. The organic fertilizer ratio and its components differ in varied soils. This depends on the environment, different climatic factors, and agricultural operations (Lekfeldt *et al.*, 2017; Hundi *et al.,* 2025).

The organic fertilizers in the soil are an accumulation of dead plants and various plant and animal parts that are partially or completely decomposed (Al Hasnawi et al., 2020; Shepherd *et al.*, 2002). The critical role of organic fertilizer in the soil comes from the products of its decomposition. Hence, the addition of animal organic matter on it and plants are in an active state of decomposition due to being attacked by soil organisms (Al-Silmawy *et al.,* 2025; Hamid, 2025). Furthermore, it becomes one of the auxiliary components that are choices continuously renewed by adding organic waste to maintain soil properties in an appropriate condition. It works on efficient agricultural production by improving fertility traits by supplying plants with the necessary nutrients for their growth and enhancing their physical properties, such as density, conductivity, and porosity (Rezig *et al.,* 2013). Moreover, improving the chemical trails transpires, such as the exchange capacity of positive ions and the organic content of the soil (Chew *et al.,* 2019; Zhu *et al.,* 2021).

The organic waste added to the soil from different sources also plays an influential role in determining the physical properties of the soil. These fertilizers are directly affecting the improvement of soil building. Likewise, they increase the stability of soil assemblies through their work in collecting soil buckets. It also leads to an increase in the ability of the soil to retain water. It works as a storehouse of necessary nutrients for plant nutrition and preservation, saving the soil surface from erosion by forming groups through the soil bonds together. Thus, it hinders fragmentation and erosion with water or wind (Lima *et al.,* 2009; Suleiman *et al.,* 2018).

Adding different levels of poultry waste increased the stability of the aggregates, as it was 75% when without the waste (Chen *et al.,* 2003; Assefa and Tadesse, 2019). However, adding 6.7 t/ha, the stability became 78% until it reached 84% when adding 4.30 t/ha more. The stability of the aggregates increases with the rise in the level of organic fertilizer. Abedi *et al.'s* (2010) findings indicated the stability of soil aggregates rises with the increase in soil levels, including corn; this boost in stability increased with the rise of the soil content of clay.

Li *et al.* (2021) have used two types of soil, one of which is clay and the other is sandy loam. It was notable that the stability of the soil aggregates increased more in clay soils than in sandy loam. The agglomerations containing a percentage of sand are stable and subject to degradation by natural processes, such as drying cycles, thawing, and freezing (Hossain *et al*., 2017; Assefa and Tadesse, 2019). Auler *et al.'s* (2020) findings have shown that the constancy of aggregates rose with the increase of the clay content. The presence of calcium and magnesium ions in the soil, particularly calcium, acts as a binding agent between clay and organic matter, forming stable aggregates. This confirms that no stable clusters exist in sandy or silty soils due to the absence of colloids acting as binders; confirmation came from studies by Diacono and Montemurro (2015). Assefa and Tadesse (2019) reported an increase in the weighted rate using cows' waste for three levels (0/5/12 t/ha). The weighted ratios recorded were 243.0, 733.0, and 926.0, respectively. Zhu *et al.* (2021) found that adding 25 tons of cow waste to a clay loam soil led to an escalation in the weighted rate, as it increased from 26.0 to 37.0 mm. Therefore, this study aimed to investigate the effect of adding animal waste (sheep, poultry, and cow waste) on the stability of soil aggregates and the weighted rate for different soils.

MATERIALS AND METHODS

The experiment occurred during period November 1, 2021 to May 1, 2022 at the two locations in Wasit Province, Iraq. Plastic pots were used as containers for samples to study the effect of adding organic waste on some physical and chemical properties of different soils. The first soil was clayey, and the second was sandy. Afterward, soil grinding took place before sifting with a sieve with holes of 4-mm diameter. Then, taking more samples from them succeeded in sifting with a sieve with holes of 2 mm. Some analysis performed included physical and chemical properties (Table 1).

After measuring the amount of waste needed for each pot, mixing it continued with the soil to be used in the experiment. Then, the calculated waste quantities sustained soil filling in plastic pots with a soil volume of 5 kg added to the calculated amount of waste after placing 1 kg of gravel at the bottom of the pot as a filter. Subsequently, the pots received wheat crop sowing (Al-Rashid variety), with 10 seeds planted in each pot. After three weeks, reducing them to five plants occurred. The randomly completed block design with three replicates was the layout used in this experiment. Each replicate included 30 experimental units. The first factor was the source of the added organic waste, including poultry, cow, and sheep waste (Table 2). The second factor was the level added to each source. It was 0, 5, 10, 15, and 20 tons/ha. The third factor was soil texture (clay or sandy loam). Afterward, the stability of the soil aggregates and diameter rate entailed measuring. Stability of soil aggregates measurement used the following methods: The percentage of stability of soil aggregates measured used a sieve with holes of 250 μ, according to Hillel (1980).

$$AS\% = \frac{\text{Residual weight in sieve} - \text{sand weight}}{\text{Total weight} - \text{sand weight}} \times 100$$

Table 1. Physical and chemical properties of the soil.

Traits	Units	Soil type	
		Clay	Sandy loam
Ec	Des.m^{-1}	2.34	1.38
pH		7.72	7.31
Sand	g/kg^{-1}	170	650
Clay		230	200
Silt		600	180
Mixture		C	S.L
Exchange capacity	centmol.kg^{-1}	20.33	11.27
Calcium carbonate	%	27.24	25.77
Phosphorus	mg/kg^{-1}	20.95	14.73
Nitrogen		19.85	2.10
Organic matter	g/kg^{-1}	4.5	1.6
Bulk density	μg m^{-3}	1.33	1.71
True density		2.65	2.65
Water conductivity		0.72	11.50
Mean weight diameter		0.51	0.25
Constant soil aggregates		46.95	9.16
Soil porosity		49.80	35.11

Table 2. Organic waste with the traits.

Trails	Unit	Waste type		
		Cow	Poultry	Sheep
Ec	Des.M^{-1}	20.3	11.65	22.32
pH		6.68	6.74	7.53
Phosphate	g/kg^{-1}	7.31	6.98	7.83
Nitrogen		13.98	16.42	12.8
Potassium		7.2	21.82	15.34
Carbon		243.1	213.8	258.5
Organic matter		439.4	460.9	493.5
C/N ratio		17.38	13.02	20.19
CEC	centmol.kg^{-1}	110	103	96

Average weight diameter

Soil samples taken underwent sieving with their buckets confined between the two sieve holes at 4 and 9 mm. Then, taking 25 g of samples succeeded in placing them on a set of sieves (0.25, 0.5, 1.0, 2.36, and 4.57 mm). The sieving process applied used a Yoder device (Kemper 1965) for 6 minutes at a speed of 30 C/min. The contents of each sieve incurred transferring to a moisture jar before drying in the oven at a temperature of 105 °C. The study recorded the soil weight on each sieve, then calculated the average of MWD according to the equation of Youker McGuiness (1956):

$$M.W.D. = \sum XiWi$$

Where M.W.D. = the mean weight diameter, Wi = mass as a percentage of total weight, and Xi = diameter rate.

RESULTS AND DISCUSSION

The results indicated significant differences appeared in the stability of the soil aggregates (Table 3, Figures 1 and 2). The clay soils recorded the highest rate, which was 62.87%, compared with the sandy loam soil, which was 16.00%. The sheep waste resulted in the topmost rate of 39.34% versus the cow and poultry wastes that recorded 39.11% and 38.75%, respectively. The level of 20 t/ha provided the maximum percentage of 48.14%, while the control treatment was 28.05%. The levels of 5, 10, and 15 t/ha have recorded 35.42%, 40.24%, and 43.65%, respectively.

For the combination between the coefficients in the stability of the soil aggregates, the mix between clay soil and sheep waste had the highest percentage (63.33%), while the combination between sandy loam soil and poultry waste gave the lowest (15.15%). However, the combination of clay and a level of 20 t/ha provided the highest rate (75.33%), compared with the combination of sandy soil and control treatment, which gave 9.17%.

The combination of sheep waste and a level of 20 t/ha has recorded the highest percentage of 48.55%, compared with the combination of cow waste and the control treatment without organic matter, which gave 28.03%. The results shown on the table have indicated that a combination of treatments significantly affected soil stability. The research recorded that the mix between clay soil and sheep waste at the level of 20 t/ha gave the supreme rate (75.57%), compared with the combination between mixed sandy loam soil and cow waste and the control treatment without organic. The latter recorded 9.16%.

For the effect of mean weight diameter, a significant effect of the soil type, fertilizer source, added levels, and the interaction between them occurred on the mean weight diameter (Table 4, Figures 3 and 4). The clay soil resulted in the highest mean weight diameter, which reached 0.48 mm, compared with the sandy loam soil, which gave an average of 0.49 mm. When comparing the added fertilizer levels, the level of 20 t/ha has

Table 3. Effect of organic wastes on soil stability.

Soil type	Organic sources	Levels of organic waste ton/ha					Soil × waste
		0	5	10	15	20	
Clay	Poultry	46.55	57.70	64.20	68.00	74.40	62.17
	Sheep	46.50	59.20	65.29	69.20	75.47	63.13
	Cow	46.40	59.00	65.20	68.00	75.40	62.80
Sandy loam	Poultry	9.10	12.10	15.21	18.40	20.45	15.05
	Sheep	9.12	12.20	15.65	19.00	21.33	15.45
	Cow	9.10	11.90	15.40	18.40	20.70	15.10
$LSD_{0.05}$		2.98					5.77
The soil effect							
Soil	Clay	46.48	58.63	64.89	68.40	75.09	62.69
	Sandy loam	9.10	12.06	15.41	18.60	21.82	15.19
$LSD_{0.05}$		0.77					
The waste effect							
Waste	Poultry	28.02	35.00	39.40	43.26	47.54	38.75
	Sheep	28.02	35.60	40.30	43.15	48.45	39.43
	Cow	28.00	35.20	40.20	43.40	48.14	39.12
$LSD_{0.05}$		3.60					0.94
The level effect		28.05	35.42	40.24	43.65	48.14	
$LSD_{0.05}$		1.22					

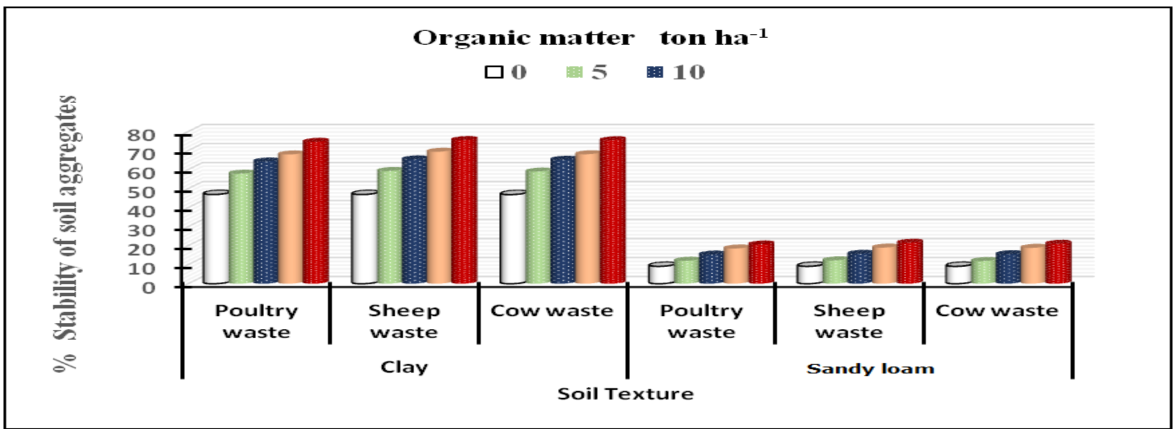

Figure 1. Effect of added organic waste sources and levels on the stability of soil aggregates.

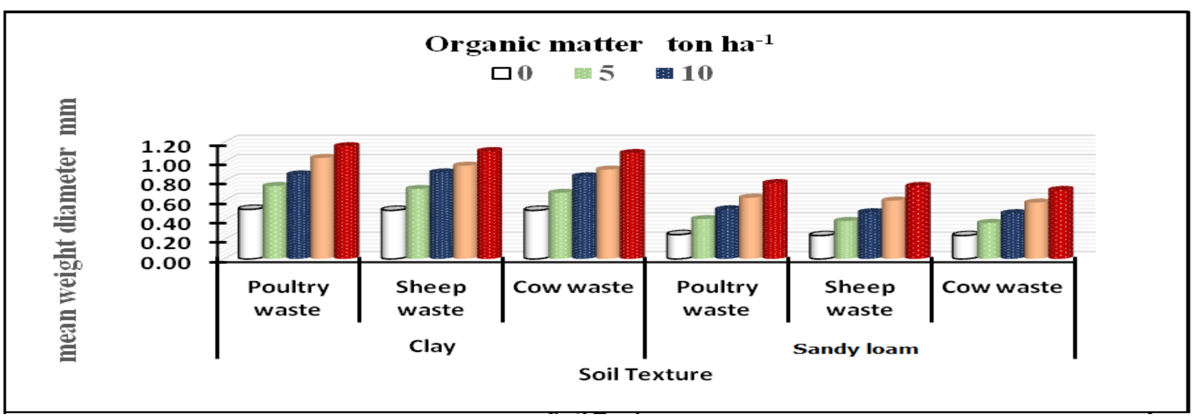

Figure 2. Effect of added organic residue sources and levels on mean weight diameter.

Table 4. Effect of organic wastes on the mean weight diameter.

Soil type	Organic sources	Levels of organic waste ton/ha					Soil × waste
		0	5	10	15	20	
Clay	Poultry	0.51	0.75	0.87	1.04	1.16	0.87
	Sheep	0.50	0.72	0.89	0.96	0.11	0.84
	Cow	0.50	0.68	0.85	0.92	1.09	0.81
Sandy loam	Poultry	0.25	0.41	0.51	0.63	0.78	0.52
	Sheep	0.24	0.39	0.48	0.60	0.75	0.49
	Cow	0.24	0.37	0.47	0.58	0.71	0.47
$LSD_{0.05}$		0.13					0.15
The soil effect							
Soil	Clay	0.50	0.72	0.87	0.97	1.12	0.84
	Sandy loam	0.24	0.39	0.49	0.60	0.75	0.49
$LSD_{0.05}$		0.07					
The waste effect							
Waste	Poultry	0.38	0.58	0.69	0.83	0.97	0.69
	Sheep	0.37	0.55	0.68	0.78	0.93	0.66
	Cow	0.37	0.52	0.66	0.75	0.90	0.64
$LSD_{0.05}$		0.23					0.04
The level effect		0.37	0.55	0.68	0.79	0.93	
$LSD_{0.05}$		0.05					

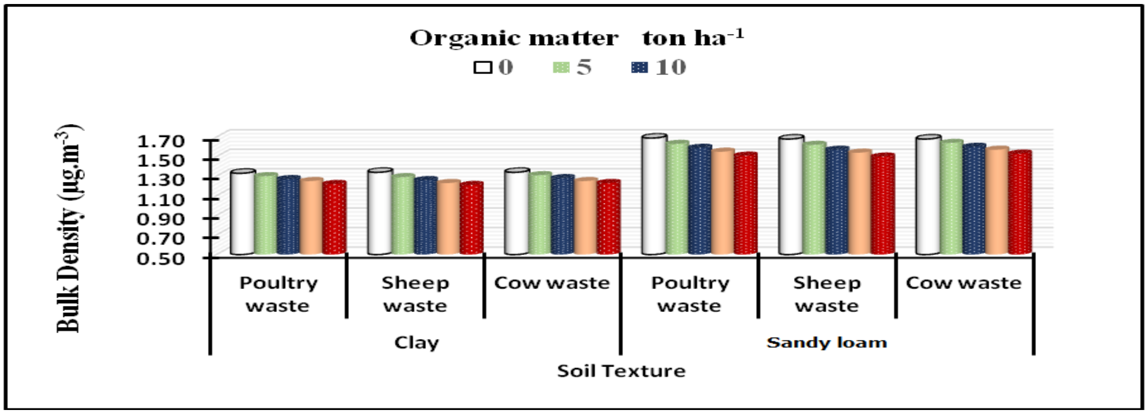

Figure 3. Effect of added organic residue sources and levels on soil bulk density.

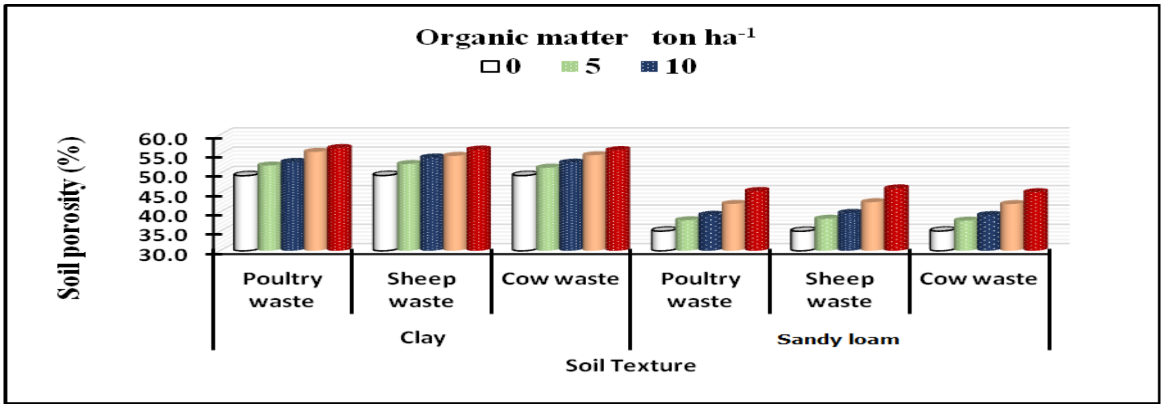

Figure 4. Effect of added organic residue sources and levels on soil porosity.

given the maximum average of 0.93 mm, compared with the other levels (5, 10, and 20 t/ha), having averages of 0.55, 0.68, and 0.79 mm, respectively. Meanwhile, the control treatment without organic waste exhibited the lowest rate (0.37 mm). The mean weight diameter has increased with the increase in organic waste level for all sources, but this increase was uneven with sheep waste, which gave the topmost rate of 0.69 mm compared with the cow waste, recording 0.66 mm. The poultry waste recorded 0.47 mm.

The results also showed an effective combination between the treatments and the soil type. The combination of clay soil and sheep waste gave the highest rate (0.87 mm) compared with the combination of sandy loam soil and poultry waste, which disclosed the average of 0.47 mm. Meanwhile, the combination of clay soil and a level of 20 t/ha recorded the highest rate of 1.12 mm compared with the combination of sandy loam soil and the control treatment without organic waste, which gave an average of 0.24 mm. The combination of the sheep waste with the level of 20 t/ha provided the maximum rate (0.97 mm) versus the combination of the waste of both poultry and sheep with the control treatment without organic matter. These displayed the lowest average (0.37 mm). The results from the same table have shown a remarkable combination between treatments on the mean weight diameter. The combination of clay soil and sheep waste and the level of organic waste (20 t/ha) emerged with the highest rate of 1.16 mm. When compared with the combination of sandy loam soil with the waste of both poultry and cow and the control treatment without organic waste, they appeared with the lowest average of 0.24 mm.

The findings revealed substantial differences between the types of soils (Tables 3 and 4, Figures 1 to 4). The stability of the aggregates and the mean weight diameter in clay soils was higher than in sandy loam soils. This is due to an increase in the percentage of clay soils compared with sandy loam soils. As the increase in the clay separation raises the stability of soil agglomerations to boost the surface area, the presence of clay leads to the linking of soil buckets (Abedi *et al.,* 2010; Li *et al.,* 2021; Akol *et al.,* 2024).

The soils, wherein clays with a specific surface area and a high exchange capacity prevail, are susceptible to absorbing wear materials. Likewise, they increase the stability of aggregates to a greater degree than soils with a low clay content (Rezig *et al.,* 2013; Hassan *et al.,* 2020). The soil made of sand has a steady stability and is subject to shattering by natural processes. Soil leads to an increase in soil saturation to retain water, which provides suitable conditions to increase the effectiveness of microorganisms that decompose organic matter and increase the stability of soil aggregates (Lima *et al.,* 2009).

The reason for the increase in the stability of soil agglomerations and the mean weight diameter when adding organic waste refers to the role of organic matter in forming sludge materials when decomposed by microbial activity. The release of organic acids that help increase the stability of aggregations and the soil content of organic matter has an effect on increasing the concentrations of some organic compounds, such as fulvic acid and sugars. Polysaccharides play an important role along with ions with multiple charges. Ca^2 and M together contribute to increasing the continuity of the agglomerations and then enhancing the mean weight diameter (Assefa *et al.,* 2019). Similarly, the role of organic matter in wrapping the soil buckets lessens the speed of its hydration (Diacono and Montemurro, 2015; Hamid *et al.,* 2025).

Furthermore, significant differences existed between the sources of the organic material used. The sheep waste formed the highest increase in the stability of the aggregates and the mean weight diameter versus the cow waste, which was higher than the poultry waste. The duration of the water has a pure effect in the first case due to the decomposition of the binding materials themselves from the pulp of the long sap of organisms. The second case requires a longer period to decompose, and then its effect lasts for a longer period because it contains a high percentage of polysaccharides resulting from the decomposition of waste and scum organisms. This plays a major role in increasing the stability of major and minor soil aggregates (Auler *et al.,* 2020; Mahmoud *et al.,* 2025).

CONCLUSIONS

The study concludes significant differences occurred between the types of soils. The stability of the aggregates and the mean weight diameter in clay soils was higher than in sandy loam soils. This is due to an increase in the percentage of clay soils compared to sandy loam soils, as the rise in the clay separation raises the stability of soil agglomerations to boost the surface area. Consequently, the presence of clay leads to the linking of soil buckets.

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