

The Effect of Adding Poultry Manure and (Dap) Fertilizer on Some Soil Physical and Chemical Properties, Growth and Yield of Potato Plant (*Solanum Tuberosum* L.)

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Abstract

A field experiment was conducted in one of the private farms in Kutha, district in Babylon governorate- Iraq for the autumn season 2018 in a loamy soil. The current study aims to investigate the effect of poultry waste with three levels (0,10,20 t.ha⁻¹) and dap fertilizer in three levels (0, 200 ,400 kg.ha⁻¹) in some soil physical and chemical properties. Besides, the growth and yield of potato plant var. safrane. Using the randomized complete block design(RCBD) with three replicates. The results showed that adding poultry waste to the soil had a significant effect on soil physical and chemical properties, while the chemical fertilizer did not affect these properties. On the other hand, the interaction between the two factors showed a significant effect on these properties and the vegetative, productive characteristics of the plant. Thus, the interaction of the level (20 t.ha⁻¹) of Poultry waste with (400 kg.ha⁻¹) of Dap fertilizer achieved the highest mean weight diameter MWD (1.34 mm), moisture content (19, 20%), lowest average bulk density (1.28 Mg.m⁻³), electrical conductivity (2.93 ds.m⁻¹) and the ph (7.4). It also gave the highest average for the number of branches (3.88 branches . plant⁻¹), the leaf area (59.68 dm².plant⁻¹), the yield of one plant (0.598 kg.plant⁻¹). In addition to the total yield (24.48 t.ha⁻¹) compared to (0.53 mm) (14.50%), (1.41 Mg.m⁻³), (3.44 ds.m⁻¹), (7.60), (2.80 branches . plant⁻¹), (47.13 dm².plant⁻¹) and (0.417 kg.plant⁻¹) and (18.25 t.ha⁻¹), respectively, in the comparison treatment.

Keywords: Poultry Manure, Dap, Potato, *Solanum Tuberosum* L.

Introduction

The excessive use of chemical fertilizers leads to an increase in the percentage of salts in the soil and exacerbation of environmental pollution problems. Therefore, it has become necessary to search for environmentally clean and cheap alternatives that help in improving the physical and chemical properties of the soil such as organic fertilizers (13). Organic agriculture is a means for the natural balance of the environment of humans, plants, animals, and soil. Thus, it is considered an agricultural system that avoids or excludes contamination of the environmental components of soil and water with mineral residues. Besides, increases vital activity that serves plants, humans, animals, and soil. Accordingly, the addition of organic fertilizers improves the physical, chemical, and biological properties of the soil in a way that gives a yield called an organic product that does not contain any

contaminated trace of mineral residues of fertilizers, herbicides, vaccines, or growth regulators (6). Poultry manure is a good organic fertilizer that contains a high percentage of NBK and the elements that the plant needs according to soil fertility and the soil's ability to retain water and nutrients, unlike chemical fertilizers (8). Moreover, (9) found that the addition of poultry manure had a significant effect on some soil physical and chemical properties, as the bulk density decreased and the soil moisture content increased in addition to improving the growth and yield of millet. Potato (*solanum tuberosum* L.) is one of the most important food crops of the world and holds the fourth position in production next to wheat, rice and maize (7). (1) stated that the potato are one of the most common and important vegetable crops in the world and carrying different health benefits that make them all the more essential as a staple dietary item for much of the world population. (4) recorded with the 50% addition of chemical fertilizer NPK to 50% of the poultry residues, obtained a significant increase in the total yield of the chard yield.

Materials and methods of work

The experiment was carried out in one of the private fields in the Euphrates region - Kutha district - Babylon governorate for the autumn season 2018. Soil samples were collected from different locations from the field experiment to determine some of the soil's physical and chemical properties as shown in Table (1). Then, the soil services operation was conducted, using the randomized complete block design RCBD was used with three replicates. The study field was divided into experimental units, each experimental unit includes six furrows, the distance between one furrow and another 0.75 m with a length of 6 m and leaving a distance of 1 m between the experimental units and between the sectors to prevent the transfer of fertilizers. Poultry manure and Diammonium Phosphate (Dap) fertilizer were added to their experimental units. Poultry manure, as well as Dap fertilizer, were mixed well with the soil, then the experiment was irrigated using a small electric pump equally for all treatments. After 5 days of irrigation, potato tubers (var. safrane) were planted, and the distance between one tuber and another was 0.25 m, and the number of tubers per treatment is 140 tubers. The study included the effect of two factors with three replicates, the first factor is poultry waste with three levels (0,10,20 t.ha⁻¹), the second factor is dap fertilizer with three levels (0,200,400 kg.ha⁻¹). Finally, the results were analyzed according to the analysis of variance, and the averages were compared using Duncan's New Multiple Range Test at a probability level of 0.05 (3).

Table (1) Some physical and chemical properties of the experiment soil

Property		Value	Unit
Soil separators	Sand	402	g.kg ⁻¹
	Silt	393	g.kg ⁻¹
	Clay	205	g.kg ⁻¹
Texture			Loamy

Electrical conductivity	3.55	ds.m ⁻¹
Bulk density	1.45	Mg.m ⁻³
Organic matter	8.4	g.kg ⁻¹
Ph	7.4	-----
Total Nitrogen	0.245	g.kg ⁻¹
Available Nitrogen	0.081	g.kg ⁻¹
Available Phosphorous	10	mg.kg ⁻¹
Available Potassium	250	mg.kg ⁻¹

Results and discussion

- **The effect of poultry manure and dap fertilizer on some soil physical and chemical properties**

It is evident from the results of Table (2) that adding poultry waste to the soil has a significant effect on the soil's physical and chemical properties. As a result, the level 20 t.ha⁻¹ achieved the best results by achieving the highest MWD (1.32 mm), moisture content (19.00%), the lowest average bulk density (1.29 Mg.m⁻³). Further, EC (2.93 ds.m⁻¹) and pH (7.40) compared to (0.54 mm), (13.67%), (1.44 Mg.m⁻³), (3.29 ds.m⁻¹) and (7.60), respectively, in the comparison treatment. The positive effect of these properties is due to the addition of organic matter to the soil represented by poultry waste, which increases the soil capacity to water retention due to the bonds between water and the negative charges carried by the organic matter and thus increases the soil moisture content. However, the presence of organic matter is considered one of the factors that help in the formation of soil structure. In addition, it is considered one of the best bonding materials between soil particles and grains, especially after the decomposition of organic matter (9). This may be due to the significant effect of decomposition of added organic waste and its role in improving soil structure. Also, forming the stability of soil groups through its function as binders for soil particles because it contains active groups such as hydroxyl and carboxylic groups and others that work to increase the stability of soil aggregates. Likewise, the decomposition of organic residues produces sticky gel substances that binding the soil particles between them. These results present a good agreement with (11) findings, which observed that the addition of poultry waste increased the moisture content and decreased the soil bulk density. Moreover, it agrees with (10) study, which found significant differences with the adding of organic wastes in the weight diameter values. Where as, no significant differences were observed between the treatments in all the studied traits for the dap fertilizer addition. The interaction between the two factors (levels of poultry waste and levels of dap fertilizer) had a significant effect on soil properties. The interaction of the level 20 t.ha⁻¹ of poultry waste with 400 kg.ha⁻¹ of dap fertilizer achieved the highest MWD (1.34 mm), moisture content (19.20%). As well as, lowest average bulk density (1.28 kg.m⁻³), EC (2.92ds.m⁻¹) and pH (7.40) compared to (0.53 mm), (4.50%), and (1.41 kg.m⁻³), (3.44 ds.m⁻¹) and (7.60), respectively, in the comparison treatment thus, it did not differ significantly from the two interaction treatments of level 20 t.ha⁻¹ of poultry waste with 200 kg.ha⁻¹ with or

without dap fertilizer in these properties. Finally, (12) found that the addition of poultry manure with chemical fertilizer has increased the soil content of nutrients such as N, p, and ZN. Along with, the readiness of these elements also increased, and the yield of wheat and the percentage of organic matter in the soil increased, which also agreed with the study results.

Table (2) The effect of poultry waste and dap fertilizer, and their interaction on some physical and chemical properties of the soil

Poultry waste t.ha ⁻¹	DAP fertilizer Kg.ha ⁻¹	MWD (mm)	Bulk density Kg.m ⁻³	Moisture content (%)	EC ds.m ⁻¹	pH
0	0	0.53 c	1.41 ab	14.50 cd	3.44 a	7.60 ab
	200	0.55 c	1.44 a	13.50 d	3.46 a	7.65 a
	400	0.54 c	1.47 a	13.00 d	3.48 a	7.55 abc
10	0	0.72 b	1.39 abc	16.10 bc	3.35 a	7.50 bcd
	200	0.80 b	1.38 abc	16.50 bc	3.37 a	7.44 cd
	400	0.85 b	1.38 abc	16.60 b	3.38 a	7.41 d
20	0	1.30 a	1.29 c	19.00 a	3.06 b	7.40 d
	200	1.33 a	1.30 bc	18.80 a	3.04 b	7.41 d
	400	1.34 a	1.28 c	19.20 a	2.92 b	7.40 d
Effect of DAP fertilizer	DAP fertilizer levels Kg.ha ⁻¹	MWD (mm)	Bulk density Kg.m ⁻³	Moisture content (%)	EC ds.m ⁻¹	pH
	0	0.85 a	1.36 a	16.53 a	3.28 a	7.50 a
	200	0.85 a	1.37 a	16.17 a	3.29 a	7.50 a
	400	0.89 a	1.38 a	16.27 a	3.26 a	7.45 a
Effect of poultry waste t.ha ⁻¹	Poultry waste t.ha ⁻¹	MWD (mm)	Bulk density Kg.m ⁻³	Moisture content (%)	EC ds.m ⁻¹	pH
	0	0.54 c	1.44 a	13.67 c	3.46 a	7.60 b
	10	0.79 b	1.38 a	16.40 b	3.37 a	7.45 a
	20	1.32 a	1.29 c	19.00 a	3.07 b	7.40 a

- **The effect of poultry waste and dap fertilizer on some vegetative and productive characteristics**

The results in Table (3) indicated that the addition of poultry waste to the soil had a significant effect on some vegetative and productive characteristics of the potato plant. Consequently, the level 20 t.ha⁻¹ of poultry waste gave the highest rate of the number of branches (3.73 branch/plant) and leaf area (56.98 dm².plant⁻¹) and the

yield of one plant ($563 \text{ kg}\cdot\text{plant}^{-1}$). Besides, the total yield ($22.76 \text{ t}\cdot\text{ha}^{-1}$), and thus, exceeded the levels of 10 and 0 $\text{t}\cdot\text{ha}^{-1}$ in these characteristics, except for the yield per plant, it did not differ significantly from the level of 10 $\text{t}\cdot\text{ha}^{-1}$. However, the non-addition treatment of poultry waste recorded the lowest rate for these characteristics, which amounted to ($3.25 \text{ branch}\cdot\text{plant}^{-1}$), leaf area ($50.06 \text{ dm}^2\cdot\text{plant}^{-1}$), yield per plant ($485 \text{ g}\cdot\text{plant}^{-1}$), and the total yield ($19.43 \text{ t}\cdot\text{ha}^{-1}$) respectively. These results can be explained because the addition of poultry manure has prepared the soil with the basic elements NBK. As well as, other necessary secondary elements for plant growth and this has an effect on increasing soil fertility and improving its physical and chemical properties as shown in Table 2, and thus reflected on the growth and production of the crop. These results are consistent with the findings of (9) that the addition of poultry manure has a significant effect on some physical and chemical properties of soil and the growth, yield of millet plant. Dap fertilizer had a significant effect on these characteristics, as the level of $400 \text{ kg}\cdot\text{ha}^{-1}$ achieved the highest average of the number of branches ($3.75 \text{ branches/plant}$), leaf area ($56.18 \text{ dm}^2\cdot\text{plant}^{-1}$), yield per plant ($556 \text{ kg}\cdot\text{plant}^{-1}$), and the total yield ($22.83 \text{ t}\cdot\text{ha}^{-1}$). Thus, it exceeded the levels 10 and 0 $\text{t}\cdot\text{ha}^{-1}$ in the number of branches per plant and the total yield, but it did not differ significantly from the level of $200 \text{ kg}\cdot\text{ha}^{-1}$ in the leaf area and yield per plant. The non-addition treatment of the Dap fertilizer gave the lowest rate for these characteristics, amounted to ($3.26 \text{ branch/plant}$), leaf area ($49.89 \text{ dm}^2\cdot\text{plant}^{-1}$), yield per plant ($489 \text{ g}\cdot\text{plant}^{-1}$), and the total yield ($19.55 \text{ t}\cdot\text{ha}^{-1}$) respectively. The increase in these values may be attributed to the fact that the dap fertilizer contains a good percentage of nitrogen, which contributed to the vegetative growth of the potato plant, as well as the presence of phosphorus in a high percentage in it. The dap fertilizer also contributed to the increase in energy and vital activities, building the plant body and increasing production. These results are consistent with what was obtained by (5), where the highest production was in organic waste treatment with NBK fertilizer ($400 \text{ kg}\cdot\text{ha}^{-1}$) with the comparison treatment. Moreover, these results also agreed with (2) findings during the adding of ($600 \text{ kg}\cdot\text{ha}^{-1}$) in monoculture, as the highest yield of potato plants was ($44 \text{ t}\cdot\text{ha}^{-1}$) with poultry manure, compared with the comparison treatment without fertilization that gave ($16 \text{ t}\cdot\text{ha}^{-1}$). The interaction between the two factors (poultry waste and dap fertilizer) had a significant effect on these characteristics. Generally, the interaction of the level $20 \text{ t}\cdot\text{ha}^{-1}$ of poultry waste with $400 \text{ kg}\cdot\text{ha}^{-1}$ of dap fertilizer achieved the highest rate of the number of branches ($3.88 \text{ branches/plant}$), leaf area ($59.68 \text{ dm}^2\cdot\text{plant}^{-1}$), yield per plant ($592 \text{ kg}\cdot\text{ha}^{-1}$) and the total yield ($24.48 \text{ t}\cdot\text{ha}^{-1}$). Therefore, it exceeded all interaction treatments except for the interaction of level $20 \text{ t}\cdot\text{ha}^{-1}$ of poultry waste with $200 \text{ kg}\cdot\text{ha}^{-1}$, which did not differ significantly from him in these characteristics. The comparison treatment recorded the lowest rate for these characteristics,. The reason for the improvement of these traits is due to the combined effect of poultry waste and dap fertilizer. These results are consistent with what (4) found.

Table (3) The effect of poultry waste and dap fertilizer, and their interaction on some plant growth and yield traits for potato, var. safrane

Poultry waste t.ha ⁻¹	DAP fertilizer Kg.ha ⁻¹	Number of branches (Branch/plant)	Leaf area (dm ² .plant ⁻¹)	Yield per plant (g.plant ⁻¹)	Total yield (ton.ha ⁻¹)
0	0	2.80 e	47.13 d	0.417 d	18.25 d
	200	3.32 d	50.84 cd	0.503 c	19.42 cd
	400	3.64 abc	52.22 bc	0.534 bc	20.63 bcd
10	0	3.47 cd	49.73 d	0.509 c	19.86 cd
	200	3.51 bcd	54.05 bc	0.559 ab	21.57 bc
	400	3.72 abc	56.63 ab	0.561 ab	23.37 ab
20	0	3.52 bcd	52.80 bc	0.541 bc	20.55 bcd
	200	3.79 ab	58.20 a	0.576 ab	23.25 ab
	400	3.88 a	59.68 a	0.592 a	24.48 a
Effect of DAP fertilizer	DAP fertilizer levels Kg.ha ⁻¹	Number of branches (Branch/plant)	Leaf area (dm ² .plant ⁻¹)	Yield per plant (g.plant ⁻¹)	Total yield (ton.ha ⁻¹)
	0	3.26 c	49.89 b	0.489 b	19.55 c
	200	3.54 b	54.36ab	0.539ab	21.41 b
	400	3.75 a	56.18 a	0.556 a	22.83 a
Effect of poultry waste t.ha ⁻¹	Poultry waste t.ha ⁻¹	Number of branches (Branch/plant)	Leaf area (dm ² .plant ⁻¹)	Yield per plant (g.plant ⁻¹)	Total yield (ton.ha ⁻¹)
	0	3.25 c	50.06 c	0.485 b	19.43 c
	10	3.57 b	53.47 b	0.536ab	21.60 b
	20	3.73 a	56.89 a	0.563 a	22.76 a

Conclusion

It can be concluded from this experiment that both poultry waste and dap fertilizer are useful when they are added to the soil and they give good results in improving growth and production for the potato crop var. safrane. Besides that, the best treatment was the interaction of the level 20t.ha⁻¹ of poultry waste with 400 kg.ha⁻¹ of dap fertilizer, which gave the best results.

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