Effect of potassium and organic fertilizers on some physical and chemical soil properties and vegetative growth of maize (*Zea mays* L.)

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Abstract: Adding potassium and organic fertilizers increases the vitality of agricultural soil. The research was carried out in Deir Ezzor Governorate during the two agricultural seasons 2022 and 2023 with the aim of studying the effect of adding potassium and organic fertilizers and their interaction on some soil properties and vegetative growth of maize (Ghouta 82 variety). A factorial experiment was conducted according to a randomized complete block design (RCBD) with three replications. The experiment included two factors: The first factor included four levels of potassium fertilizer (K_0, K_1, K_2, K_3) (0, 100, 150, 200) kg K ha^{-1} respectively and the second was organic fertilizer (OM_0, OM_1, OM_2, OM_3) (0, 15, 20, 25) tons ha^{-1}. The results showed: There were no significant differences in bulk density at all levels of potassium fertilizer, while the total porosity of the soil increased for the first and second seasons, and the electrical conductivity also increased for both seasons, and the increase was significant at K_3 of potassium fertilizer compared to the other treatments and the control. While the degree of soil interaction decreased at K_3 for both seasons. Adding organic fertilizer to both seasons led to a significant decrease at OM_3 in the values of bulk density, degree of soil interaction, and electrical conductivity compared to the rest of the treatments and the control, while there was a significant increase in porosity for both seasons. As for the K_3 and OM_3 interference, the values of both the bulk density and the degree of soil interaction decreased, and the porosity values increased compared to the rest of the interactions and the control for the first and second seasons. While the electrical conductivity decreased when OM_3 of organic fertilizer was mixed with K_0 of potassium fertilizer. The results also show the positive effect of potassium and organic fertilizers separately on the studied plant characteristics (number of leaves, the dry weight of the vegetative part of plants). As for the combined effect of both fertilizers, the best results were when K_3 and K_2 of potassium fertilizer were mixed with OM_3 of organic fertilizer, as it increased (number of leaves, the dry weight of the vegetative part of plants).

Keywords: Potassium fertilizer, Oganic fertilize, Soil properties, Maiz, Vgetative growth.

Citation: Al-Sheikh, M. A., O. A. Abdulrazzak, and T. H. Al-Khalifa. 2025. Effect of potassium and organic fertilizers on some physical and chemical soil properties and vegetative growth of maize (*Zea mays* L.). Agricultural Engineering International: CIGR Journal, 27(3): 17-27.

1 Introduction

Cultivation of maize (*Zea mays* L.) is widespread throughout the world. It is one of the important crops belonging to the *Poaceae* family and comes in third place in importance after wheat and rice (Zaidan et al., 2019). It is considered one of the primary sources of energy and protein for half of the world's population (Ahmed et al., 2020). The importance of this crop is

Received date: 2024-07-14 **Accepted date:** 2025-06-07

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due to its multiple uses in human nutrition and as a fodder crop for animals, as well as the oil content of the grains, which reaches (4%-10%). It has the ability to be productive and adapt to climatic conditions. (Mandić et al., 2016). The lack of nutrients in the soil negatively affects the production of maize, which requires treating this deficiency by adding fertilizers to achieve the required production and cover the plant's nutritional needs (Aljoubory and Al-Yasari, 2023).

The optimal use of fertilizers aims to avoid environmental pollution resulting from high fertilizer payments, or resulting from incorrect fertilization. The main goal of studying fertilizers and their effect on the soil is to set specific limits for the necessity of fertilization and the optimal fertilizer quantity (Hussain et al., 2006). Providing the ideal level of nutrients in the soil plays an important role in obtaining the highest production in agriculture, and potassium is one of the most important macronutrients that the plant needs during its life and plays an important role in improving the properties of the soil and plant nutrition (Ali et al., 2014).

Potassium acts as an important element in transporting carbohydrates from areas of their formation to other areas of the plant. It also maintains the structure of proteins and the permeability of membranes, increases root growth and resistance to diseases, improves the quality of fruits, and helps the plant withstand soil salinity, drought, and frost resistance (McGrath et al., 2014). The amount of potassium that a plant needs varies depending on the type, variety, growth stage, and quality of grains or fruits produced (Ali et al., 2014). In a study conducted by Nurliawati and Faqih (2024) on maize plants by adding K20 potassium fertilizer, the study showed that the highest level achieved the best results with regard to the number of leaves, the weight of the corn cob with husks, and the height of the plant, compared to the other levels and to the control. Ibrahim et al. (2023) also confirmed that adding potassium fertilizer led to an increase in (plant height, cob, number of cob, number of cob rows, stalk weight, and whole plant weight) of maize.

One of the important fertilizers that contribute to raising soil fertility is organic fertilizers, which have a role in reducing environmental pollution caused by mineral fertilizers. Organic fertilizers also work to improve the physical and chemical properties of the soil and fertility. Organic fertilizers can be of high value, inexpensive, and a source of various plant nutrients. One of the alternative methods for using chemical fertilizers, which causes increased vegetative growth and increased productivity of the maize crop, is the use of organic fertilizers (Gao et al., 2020). Organic nutrients contain important elements for the plant that have a role in the formation of organic acids, which are considered the basis for the formation of proteins. It also regulates osmotic pressure and increases plant resistance to stress conditions (Ameen et al., 2019).

Organic fertilizers affect the physical properties of the soil, as the root environment improves, which reflects positively on plant growth, and these properties determine the suitability of the soil for producing cultivated plants (Iqbal et al., 2012). These properties are controlling factors in the soil that affect oxygen provision, water movement through it, root penetration, as well as the biological and chemical behavior of nutrients in the soil and plants (Gul et al., 2011). Adding organic fertilizers improves physical soil properties such as porosity, permeability, movement of air and water in the soil, penetration and spread of roots, and retention of soil heat and moisture, which reflects positively on plant growth (Keshavarz et al., 2012).

The use of organic fertilizers is important for improving the chemical properties of the soil and its fertility, and contributes, along with mineral fertilizers, to increasing crop productivity (Al-Khafage and Al-Sham, 2021). Mahdy (2011) noted that the electrical conductivity of the soil decreased to more than 50%, and in return, the electrical conductivity of the washing solution increased when municipal fertilizer was added to the soil. He attributed the reason for this to the role of these wastes in reducing the bulk density of the soil and increasing its porosity, which improved the conditions for washing salts. Sodium and low soil salinity. The integrated use of organic and mineral fertilizers leads to increased soil fertility and crop productivity, which results from increased availability of nutrients in the soil and their absorption by plants (Satyanarayana et al., 2002).

In a study conducted by Mahmood et al. (2017) to determine the effect of organic and mineral fertilizers on maize, and their effect on the physical and chemical properties of the soil, the results showed an increase in growth indicators and grain yield of maize when adding chemical fertilizers with organic fertilizers, and the soil content of organic matter and nitrogen increased., phosphorus, and potassium at the end of the experiment compared to chemical fertilization alone. In an experiment conducted by Admas et al. (2015) on maize plants using organic and inorganic fertilizers, the results showed an increase in (plant grain yield, plant hength, number of grains cob^{-1}, weight of the cob, weight of 1000 grains).

In view of the economic importance of the maize crop, its good yield, and its response to the addition of mineral fertilizers, especially potassium, which plays a major role in increasing the productivity of this crop, which is one of the fertilizers that the soil needs continuously, because it suffers from the fixation of potassium despite its large availability, it is necessary to add potassium fertilizers in a rational manner in line with the needs of the soil and plants. Given the low percentage of organic matter in soils of dry and semi-arid climates for many reasons, raising the organic matter content of soil is extremely important. Increasing the vitality of agricultural soil by adding the necessary organic matter is an important way to improve the physical and chemical properties of the soil. Therefore, the study aimed to:

(1) Study the effect of adding potassium fertilizer and organic fertilizer, each separately, on the physical and chemical properties of the soil and the vegetative growth of corn, and determine its optimal concentration.

(2) Study the interaction effect of potassium fertilizer and organic fertilizer on the physical and chemical properties of soil and vegetative growth of corn, and determine its optimal concentration.

2 Materials and methods

2.1 Research materials

2.1.1 Place where the research was carried out

The research was carried out in the Al- Agawat area in Deir Ezzor Governorate during the 2022 and 2023 seasons.

2.1.2 Plant material

The maize plant, Ghouta variety (82), was used, obtained from the Seed Multiplication Center in Deir Ezzor.

2.1.3 Fertilizers used

Four levels of potassium fertilizer were added (K_0, K_1, K_2, K_3) (0, 100, 150, 200) kg K ha^{-1} in the form of potassium sulfate K_2SO_4 (50% K_2O), which was added to the soil before planting, and mixed with soil.

Organic fertilizers (fermented sheep waste) were added at four levels (OM_0, OM_1, OM_2, OM_3) (0, 15, 20, 25) tons ha^{-1}. The organic fertilizer was mixed with the surface layer of the soil before planting for each experimental unit.

2.2 Working methods

2.2.1 Preparing soil for agriculture

The land was plowed, smoothed, and divided into three sectors. Each sector is divided into 16 experimental units. Each experimental unit contained three lines (each line was 3 m long and the distance between one line and the other was 70 cm). A distance of 1 m was left between the experimental units, and 2 m between untis. The area of the experimental plot was 6.3 m^2, i.e. with dimensions of (3 × 2.1) m^2, then the experiment was planted with the maize crop at a depth of 5 cm and a distance of 25 cm between the holes. Planting took place on 21/6/2022, 23/6/2023, and three seeds were placed in one hole, and they were reduced to one plant after germination.

2.2.2 Fertilizers added

Phosphate fertilizers, 170 kg of superphosphate fertilizer, 46% phosphorus, were added per hectare before planting, and nitrogen fertilizers were added in two batches in the form of 46% urea fertilizer at a rate of 120 kg N ha^{-1}. The first batch was added before planting at a rate of 60 kg N ha^{-1}, while the second batch was added at a rate of 60 kg N ha^{-1} at the beginning of the male inflorescence formation stage, according to the recommendations of the Ministry of Agriculture based on soil analysis.

2.2.3 Soil-related indicators before planting

The research was conducted on a private farm in Deir Ezzor province, where soil samples representing the research site were taken. After drying and cleaning the soil samples from root residues, they were ground and sieved using a sieve with a diameter of (2) mm. Physical and chemical analyses were performed, including mechanical analysis to determine soil texture (%) using the Hydrometer method, bulk density of the soil (g cm^{-3}) using the density cylinder method, porosity, electrical conductivity (ECe) in deciSiemens.meter^{-1} using an Electrical conductivity device, soil pH using a pH-meter, organic matter using the wet oxidation method, mineral nitrogen using the (Kjeldahl) method, available phosphorus using the Olsen method, and available potassium using a Flame photometer. Tables 1 and 2 illustrate the soil and organic fertilizer analyses.

Table 1 Physical and chemical properties of research soil before planting

Parameters		Value	Unit
pH_{KCl}		7.9	-
ECe		0.63	dS m^{-1}
Organic matter		0.76	%
Mineral nitrogen	N	4.6	mg kg^{-1}
Available phosphorus	P	6.9	mg kg^{-1}
Dissolved potassium	K	12	mg kg^{-1}
Mutual potassium	K	205	mg kg^{-1}
	Sand	24.8	
Soil separates	Silt	35.52	
	Clay	39.68	
Soil texture		Clay silt	
Soil Real Density		2.63	g cm^{-3}
Bulk density		1.57	g cm^{-3}
Porosity		40.53	%

Table 2 Characteristics of the organic fertilizer used in the research

Parameters	Value
Organic materials	51.6
Organic carbon	%30
pH	7.25
EC	dS m^{-1} 12.92
C/N	17.44
Total N	%1.72
P%	%0.96
K%	1.43%

3 Studied attributes and characteristics

Bulk density of soil (g cm^{-3}): using the density cylinder method.

Total porosity of soil: It was calculated from the bulk density and Soil Real Density of the soil.

Degree of soil reaction pH: In the paste extract saturated with (pH-meter).

Electrical conductivity: In the paste extract using an electrical conductivity device.

Number of leaves per plant: It was calculated from the soil surface to the last leaf of the plant, then the average was calculated for five plants.

The dry weight of the vegetative part of yellow corn plants: The plants were cut at the level of the soil surface, and left to dry in the sun for 24 hours. They were then dried in an electric oven at a temperature of 70°C, and when the weight remained constant, the dry weight of the plants was calculated.

4 Experiment design and statistical analysis

In designing the experiment, the method of factorial experiments was used according to a randomized complete block design (RCBD) with three replicates and a rate of (36) plants per replicate, to study the effect of both the first factor, potassium fertilizer rates, and the second factor, organic fertilizer rates, and their interaction, and thus required the implementation of the experiment. 48 experimental plots, the results were analyzed statistically using the ANOVA method by calculating the value of the least significant difference (LSD) at the level (5%) for field results and the level (1%) for laboratory results using the statistical program GenStat 12 th.

5 Results and discussion

5.1 Bulk density of soil

We conclude from the data presented in Table 3 for the two seasons, and with regard to bulk density, that there are no significant differences between all potassium fertilization treatments and the control. The bulk density value at K_3 of potassium fertilizer was lower (1.43, 1.38 g cm^{-3}) for the two seasons, respectively, and the reason is attributed to an increase in the root mass, the addition of potassium fertilizer led to an increase in the root mass, which in turn led to a decrease in bulk density. This result is consistent with (Marbong and Swaroop, 2018).

As for the organic fertilization treatment for the first season, it was noted that as the level of organic fertilizer increased, the bulk density decreased. The decrease was significant at OM_3 compared to the rest of the treatments, as it reached (1.37 g cm^{-3}), while the highest value for bulk density was in the control (1.54 g cm^{-3}). The results of the second season also show a decrease in the apparent density at OM_3 and OM_2, and there were no significant differences between them as it decreased to (1.33, 1.35 g.cm^{-3}). The reason for the decrease in the value of the apparent density with the increase in the added organic matter is due to the role of organic matter in improving soil structure and redistributing the pores in it, and this result is consistent with (Sarboukh et al., 2020).

Regarding the combined effect of adding potassium and organic fertilizers, high levels of potassium fertilizer with high levels of organic fertilizer achieved a noticeable decrease in bulk density compared to the interaction of the remaining levels with each other. It reached the lowest value when K_3 overlapped with OM_3 and was (1.35, 1.30 g cm^{-3}), while in the control it was (1.55, 1.53 g cm^{-3}) for the first and second seasons, respectively.

Table 3 Impact of using potassium and organic fertilizer on the bulk density of the soil (g cm^{-3}) after harvest

Potassium fertilizer kg ha^{-1}	The first season					The second season				
	Organic fertilizer tons ha^{-1}				Average (K)	Organic fertilizer tons ha^{-1}				Average (K)
	OM_0	OM_1	OM_2	OM_3		OM_0	OM_1	OM_2	OM_3	
K_0	1.55	1.47	1.43	1.39	1.46a	1.53	1.44	1.38	1.35	1.42a
K_1	1.55	1.47	1.42	1.38	1.45a	1.52	1.43	1.36	1.34	1.41a
K_2	1.54	1.46	1.40	1.37	1.44a	1.50	1.43	1.35	1.33	1.40a
K_3	1.53	1.44	1.39	1.35	1.43a	1.49	1.40	1.33	1.30	1.38a
Average (OM)	1.54a	1.46b	1.41c	1.37d	1.44	1.51a	1.42b	1.35c	1.33c	1.40
LSD1%K			0.012					0.026		
LSD1% OM			0.018					0.020		
LSD1% K×OM			0.015					0.017		

Note: (LSD) at (5%) level for field results and (1%) level for laboratory results.

5.2 Total porosity of soil

The results of the statistical analysis in Table 4 regarding porosity in the first season indicate that there was a significant increase in the value of porosity at K_3, which reached (45.51%), followed by K_2, which was (44.96%), while the value at K_1

decreased to (44.52%), which was not between There are no significant differences in the treatment of the control. As for the second season, K_3 achieved the highest value (46.85%), followed by K_2 and K_1, between which there were no significant differences (46.06%-45.78%), while the value decreased significantly in the control (45.39%), and this is explained by the porosity being completely dependent on the value Bulk density, where the relationship between them is always inverse, i.e. increasing the value of bulk density reduces porosity in the soil, and this result is consistent with (Günal et al., 2018).

The results of the first season also indicate an increase in the value of porosity with increasing fertilizer levels. The highest value was at OM_3, reaching (47.25%), and the lowest value was at the control (41.66%). While porosity in the second season achieved its highest value at OM_3 and OM_2 without any significant differences, and were respectively (48.45%-47.77%), followed by OM_1, followed by the control, which achieved the lowest value (42.51%). This is explained by the presence of organic matter in the soil, which allows the collecting of fine soil particles with organic parts to form larger earth masses, they reserve pores with larger diameters between them. The result is consistent with (Mohamad and Khoury, 2023),

As for the combined effect of both potassium and organic fertilizers, the highest significant value for porosity was reached when K_3 was mixed with OM_3. It reached (48.07%, 49.49%) for the first and second seasons, respectively, while it was in control (41.44%, 41.97%) for the two seasons, respectively.

Table 4 Impact of using potassium and organic fertilizer on the total porosity of the soil (%) After harvest

Potassium fertilizer kg ha^{-1}	The first season					The second season				
	Organic fertilizer tons ha^{-1}				Average (K)	Organic fertilizer tons ha^{-1}				Average (K)
	OM_0	OM_1	OM_2	OM_3		OM_0	OM_1	OM_2	OM_3	
K_0	41.44	44.06	45.35	46.64	44.37c	41.97	44.95	46.88	47.79	45.39c
K_1	41.39	44	45.71	46.98	44.52c	42.16	45.23	47.61	48.12	45.78b
K_2	41.75	44.33	46.46	47.32	44.96b	42.83	45.08	47.95	48.40	46.06b
K_3	42.08	45.08	46.82	48.07	45.51a	43.10	46.17	48.64	49.49	46.85a
Average (OM)	41.66d	44.36c	46.08b	47.25a	44.84	42.51c	45.35b	47.77a	48.45a	46.02
LSD1%K			0.36					0.30		
LSD1% OM			1.04					1.42		
LSD1% K×OM			0.68					0.81		

Note: (LSD) at (5%) level for field results and (1%) level for laboratory results.

5.3 Degree of soil reaction pH

It is noted from Table 5 that the soil pH at K_3 of potassium fertilizer decreased significantly compared to the rest of the treatments, as it decreased to (7.60, 7.57) for the first and second seasons, respectively, while the highest value was in the control for both seasons, respectively (7.78, 7.76). The results also show that with an increase in the rate of adding potassium sulfate, there is a decrease in the pH of the soil because it contains sulfur, which works to increase the number of microorganisms, especially of the type Thiobacillus Thioparus, which leads to the release of hydrogen ions, which leads to a decrease in the pH of the soil. This is consistent with the findings of Aliwi and Al-Shamaa (2008). This capacity keeps the soil pH from falling or rising.

The results of the two seasons with regard to the organic fertilization treatments also indicate a decrease in the soil pH to (7.58, 7.55) at OM_3, with significant differences with the rest of the treatments and with the control, whose values reached (7.80, 7.78) for two seasons in a row. We also notice an increasing decrease in the soil pH with increasing rates of organic fertilizer. This is explained by the fact that organic acids such as: humic, fulvic, and humin resulting from the decomposition of organic matter work to reduce the degree of soil interaction, and this is consistent with (AL-Makhlof et al., 2022).

As for the combined effect of adding potassium and organic fertilizers, K_3 with OM_3 achieved a significant decrease in the value of the soil reaction degree, which amounted to (7.48, 7.44), while the value in the control was (7.89, 7.87) for both seasons, respectively.

Table 5 Impact of using potassium and organic fertilizer on the degree of soil pH reaction after harvest

Potassium fertilizer kg ha^{-1}	The first season					The second season				
	Organic fertilizer tons ha^{-1}				Average (K)	Organic fertilizer tons ha^{-1}				Average (K)
	OM_0	OM_1	OM_2	OM_3		OM_0	OM_1	OM_2	OM_3	
K_0	7.89	7.80	7.75	7.68	7.78a	7.87	7.79	7.73	7.65	7.76a
K_1	7.82	7.74	7.68	7.61	7.71b	7.80	7.72	7.64	7.60	7.69b
K_2	7.78	7.70	7.63	7.55	7.66c	7.75	7.67	7.62	7.52	7.64c
K_3	7.73	7.65	7.56	7.48	7.60d	7.71	7.62	7.51	7.44	7.57d
Average (OM)	7.80a	7.72b	7.65c	7.58d	7.69	7.78a	7.70b	7.62c	7.55d	7.66
LSD1%K	0.04					0.038				
LSD1% OM	0.05					0.062				
LSD1% K×OM	0.07					0.066				

Note: (LSD) at (5%) level for field results and (1%) level for laboratory results.

5.4 Electrical conductivity

We conclude from the data presented in Table 6 regarding the first season that there was an increase in electrical conductivity values with increasing potassium levels, and its highest value reached (0.70) dS m^{-1} at K_3 compared with the rest of the levels and with the control in which the electrical conductivity value reached (0.56) dS m^{-1}, As for K_2 and K_1, there were no significant differences between them (0.62, 0.60) dS m^{-1}, As for the second season, we notice a significant increase in the value of electrical conductivity at K_3, reaching (0.75) dS m^{-1}, compared to the rest of the treatments and the control, among which there were no significant differences. This is attributed to the oxidation of sulfur and the formation of sulfuric acid, which led to a lowering of the temperature. Soil interaction and increased dissolution of some compounds and minerals, and the release of some exchanged ions as a result of their replacement by hydrogen ions, led which led to an increase in electrical conductivity in the soil solution. This is consistent with what was confirmed by (Al-Magrebi, 2015)

As for adding organic fertilizer, the electrical conductivity decreased at high levels, and it reached its lowest value at OM_3, which amounted to (0.51, 0.51) dS m^{-1}. This decrease was significant compared with the rest of the treatments, and with the control, whose value reached (0.75, 0.80) dS m^{-1} for the first and second seasons, respectively, This decrease is due to the fact that organic compounds absorb cations on their surfaces, and microorganisms consume a significant amount of mineral elements to build their cells, which leads to a decrease in the concentration of some dissolved elements in the soil solution and thus a decrease in the electrical conductivity of the saturated soil paste extract, and this is consistent with (Hussein and Abdul Razzaq, 2024)

The results of the two seasons also show that the interaction of potassium and organic fertilizers affected the electrical conductivity. When high values of organic fertilizer were mixed with low values of potassium fertilizer, there was a noticeable decrease in electrical conductivity values, and the lowest value was when OM_3 was mixed with K_0. It decreased to (0.46, 0.41) dS m^{-1} for the first and second seasons, respectively.

5.5 Number of leaves per plant

It is noted from Table 7 that the plants treated with potassium fertilization at K_3 were significantly superior to the other treatments in terms of the number of leaves for the first and second seasons, reaching (14.74, 15.08 leaf per plant), while the number of leaves decreased significantly in the control to 13.49, 14.19 leaf per plant). Another additional reason, increase number of leaves by increasing K concentrations is attributed to the role of potassium in reducing the water potential of the roots and improving their ability to absorb water and nutrients, which leads to improved growth and cell division and an increase in their size and expansion. This leads to increased growth, such as plant height and number. Leaves (Wang et al., 2024).

As for the organic fertilization treatments, OM_3 recorded a significant superiority in the number of leaves over the rest of the treatments and over the control for both seasons. The number of leaves reached (15.07, 15.41 leaf per plant), respectively, while the value was lower in the control treatment (13.29, 13.64 leaf per plant) for the first and second season respectively. This is because organic fertilizer contains a good percentage of nitrogen, phosphorus, and potassium, as these elements work to increase the characteristics of vegetative growth by increasing the formation of proteins, nucleic acids, and protoplasmic construction through the formation of DNA and RNA necessary for cell division, in addition to their role in carbon assimilation, respiration, and providing the necessary energy. To form new cells, which increases plant growth and the number of leaves. These results are consistent with Asfaw (2022).

The results also indicate a positive effect of the interaction of potassium fertilization and organic fertilization treatments on the number of leaves. The highest value for the first and second seasons was reached at K_3 and its interaction with OM_3, and it was (15.69, 15.71 leaf per plant). There were no significant differences between it and the interaction of the potassium fertilization treatment at K_2 with OM_3. While the value in the control (12.77 and 13.16 leaf per plant) decreased significantly for the first and second seasons, respectively, with a significant difference compared to all treatments.

Table 6 Impact of using organic fertilizer and potassium on electrical conductivity (ECe, desmens m^{-1}) after harvest

Potassium fertilizer kg ha^{-1}	The first season					The second season				
	Organic fertilizer tons ha^{-1}				Average (K)	Organic fertilizer tons ha^{-1}				Average (K)
	OM_0	OM_1	OM_2	OM_3		OM_0	OM_1	OM_2	OM_3	
K_0	0.68	0.59	0.51	0.46	0.56c	0.71	0.56	0.48	0.41	0.54b
K_1	0.72	0.60	0.55	0.49	0.60b	0.77	0.59	0.53	0.48	0.59b
K_2	0.79	0.64	0.58	0.54	0.62b	0.83	0.66	0.62	0.56	0.66b
K_3	0.84	0.76	0.65	0.56	0.70a	0.91	0.78	0.73	0.61	0.75a
Average (OM)	0.75a	0.64b	0.57c	0.51d	0.62	0.80a	0.64b	0.59c	0.51d	0.63
LSD1%K			0.03					0.084		
LSD1% OM			0.04					0.042		
LSD1% K×OM			0.04					0.051		

Note: (LSD) at (5%) level for field results and (1%) level for laboratory results.

Table 7 Impact of using potassium and organic fertilizer on the number of leaves (leaf plant^{-1})

Potassium fertilizer kg ha^{-1}	The first season					The second season				
	Organic fertilizer tons ha^{-1}				Average (K)	Organic fertilizer tons ha^{-1}				Average (K)
	OM_0	OM_1	OM_2	OM_3		OM_0	OM_1	OM_2	OM_3	
K_0	12.77	13.02	13.95	14.25	13.49d	13.16	13.86	14.67	15.10	14.19c
K_1	12.95	13.62	14.07	14.81	13.86c	13.32	14.15	14.86	15.19	14.38c
K_2	13.46	13.88	14.63	15.54	14.37b	13.57	14.68	15.07	15.66	14.74b
K_3	14.01	14.37	14.92	15.69	14.74a	14.51	14.91	15.22	15.71	15.08a
Average (OM)	d13.29	c13.72	b14.39	a15.07	14.12	13.64d	14.4c	14.95b	15.41a	14.60
LSD1%K			0.31					0.26		
LSD5% OM			0.42					0.30		
LSD5% K×OM			0.34					0.27		

Note: (LSD) at (5%) level for field results and (1%) level for laboratory results.

5.6 The dry weight of the vegetative part of plants

We conclude from the data presented in Table 8 for the first and second seasons that there was a significant increase in the dry weight of the shoots at K_3, which reached (318.11, 325.09 g) compared with the other levels and with the control (280.89, 290.1 g). The increase in the dry weight of the vegetative group when the potassium concentration increases is explained by the role that potassium plays inside the cells from the beginning of cell division until the end of plant growth. Potassium also works to control the closing and opening of pores associated with the accumulation of carbohydrates in guard cells. It also accelerates the production of proteins, and thus the accumulation of these manufactured materials causes an increase in vegetative growth and thus an increase in the dry weight of the plant. This is what was confirmed by Kazem et al. (2024).

The results of the two seasons also indicate an increase in dry weight with high rates of organic fertilizer. The highest dry weight value was reached at OM_3, It reached for both seasons (325.38, 329.47 g) While it decreased significantly in the control (276.80, 286.79 g). The reason for the increase in dry matter when increasing the levels of organic fertilizers is due to the role played by these fertilizers in improving the chemical, physical and biological properties of the soil, which works to increase the availability of the elements present in the soil that the plant benefits from, in addition to what these fertilizers contain of important nutritional elements that they add to the soil. These fertilizers also help to increase the plant's absorption of these elements necessary for the manufacture of proteins and carbohydrates and the construction of new cells that lead to increased plant growth and thus an increase in the dry weight of the vegetative group. These results are consistent with (Iqbal et al., 2015).

As for the combined effect of adding potassium and organic fertilizers, the interaction of K_3 with OM_3 achieved the highest dry weight value, which was (334.19, 337.04 g) for the first and second seasons, respectively, and there were no significant differences between it and K_2 and its interaction with OM_3 (332.36, 334.93 g), while The lowest value of the dry weight was in the control, which was (248.13 and 254.20 g). The results also show that there is an increase in the dry weight of the plant accompanying an increase in the rates of the two fertilizers if they are added together and for both seasons.

Table 8 Impact of using organic fertilizer and potassium on dry weight of the vegetative part of yellow corn plants (g)

Potassium fertilizer kg ha^{-1}	The first season					The second season				
	Organic fertilizer tons ha^{-1}				Average (K)	Organic fertilizer tons ha^{-1}				Average (K)
	OM_0	OM_1	OM_2	OM_3		OM_0	OM_1	OM_2	OM_3	
K_0	248.13	274.36	289.68	311.41	280.89d	254.20	287.60	300.14	318.46	290.1d
K_1	267.76	288.23	299.92	323.57	294.87c	282.54	298.37	316.08	327.46	306.11c
K_2	283.52	298.18	314.46	332.36	307.13b	296.98	314.72	323.04	334.93	317.41b
K_3	307.81	310.26	320.18	334.19	318.11a	313.46	321.62	328.27	337.04	325.09a
Average (OM)	276.80d	292.75c	306.06b	325.38a	300.25	286.79d	305.57c	316.88b	329.47a	309.68
LSD5%K			9.12					5.14		
LSD1% OM			15.46					8.26		
LSD5% K×OM			7.32					5.67		

Note: (LSD) at (5%) level for field results and (1%) level for laboratory results.

6 Conclusion

The experiment showed the positive role of adding potassium and organic fertilizer in improving the studied soil characteristics (bulk density, total soil porosity, degree of soil interaction, electrical conductivity), as well as improving the studied plant characteristics (number of leaves, dry weight of shoots). K_3 of potassium fertilizer achieved the best results as well as OM_3 of organic fertilizer separately.

The interaction between potassium and organic fertilization treatments led to a significant superiority in the studied soil indicators (bulk density, total soil porosity, degree of soil interaction, and electrical conductivity), at the K_3 level with OM_3. The interaction between K_2 and K_3 potassium fertilization treatment and OM_3 organic fertilization gave the best results for the studied plant traits (number of leaves, the dry weight of the vegetative part of plants).

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