The effect of Magnesium in the nature of the mineral Composition and its effect in the chemical Equilibrium forms of Potassium in the soil

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Abstract

Studying the effect of adding magnesium in the dispersion of clay and its effect in the chemical equilibrium forms of potassium. A laboratory experiment was carried out on two types of soils, the first is clay S_1 and the second silt clay S_2. The soil was incubated with magnesium at two concentrations: 25 and 100 mmol $Mg^{2+}.L^{-1}$. The results of the X-ray diffraction analysis showed that there was a change In the diffraction intensity of clay minerals and to the two concentrations, The X-ray diffraction analysis results also showed that the predominance of minerals in the two soils was Smectite > Kao. = Mica > Chl. In the first, the second was Smectite > Mica > Kao. > Chl. the results also showed that adding magnesium to the soil contributed to an increase in soluble and exchangeable potassium by 5.517, 28.276, 12.215, and 48.188% and a decrease in non-exchangeable potassium by 11.421 and 28.274% compared to the comparison treatment Mg_0 and for the two concentrations of 25 and 100 mmol Mg^{2+}. L^{-1}, respectively, for clay soil, while in silt clay soil, the values of soluble and exchangeable increased by 15.789, 55.263, 20.800, and 37.200%, and non-exchangeable potassium decreased by 12.466 and 20.000% for the two concentrations of 25 and 100 mmol $Mg^{2+}.L^{-1}$, respectively, compared to the comparison treatment Mg_0.

Keywords: X-ray diffraction; forms of equilibrium; Clay minerals

Introduction

Potassium is one of the basic elements in soil The percentage of potassium in soil is estimated at about 0.4 - 3.0 % of the general total of the elements, depending on the type of potassium-bearing minerals the intensity of soil formation processes and the degree weathering. The potassium content of the earth's crust is estimated at about 23 gm K^+. kg^{-1} soil(12). It is one of the eight most common elements in the earth's crust. It is considered one of the components of rocks and minerals and is widely distributed in the components of soil. However, it is not found in the form of the potassium ion K^+ in the components of the earth's crust. Rather, it is found combined with other ions and other mineral forms. The most important minerals that carry this element are potassium feldspar and mica, as they the soil of dry regions has a high content of these minerals compared to other regions, which is attributed to the difference in mineral composition in those regions, which originate from sedimentary (2 and 3). Potassium is also one of the necessary nutrients in plants and has received the attention of many researchers and those interested in soil chemistry, fertility, nutrition, physiology, and plant biochemistry. The prevailing belief in Iraq was that Iraqi soils contain a high reserve of it, so it was neglected to include potassium in the fertilizer recommendation. As a result of intensive agriculture, the increasing diversity of agricultural crops in the country, and the lack of fertilization with potassium, the need to add it arose (10 and 23) As a result, potassium fertilizers were used in relatively high quantities and on a large scale, and it became necessary to know the status and fate of the potassium added to the soil and the extent of the crops' response to it. Is it possible for the added potassium, which may be subject to fixation in the soil, to be released again, how quickly is it released and what are the influencing factors In the speed of its release, one of the most important factors affecting the readiness of potassium is the quantity and quality of the clay mineral (11 and 6). Many studies were conducted in Iraq to verify the effect of this on the fixing process, and the results showed that 28-76% of the added potassium is subject to fixing. Many attempts have been made to reduce this process by adding organic matter or following other methods in the process of adding this element, such as spraying on the leaves (14 and 9). The chemical behavior of any element affects the effectiveness and behavior of some other elements, either directly through the process of competition for the surface of the complex exchange and displacement, or indirectly through influencing other soil properties (1). A difference may occur in the nature of the mineral composition in the soil as a result of the influence of the behavior of some elements in it. For example, increasing the concentration of magnesium may lead to the formation of what is known as the phenomenon of chlorination(27). Most studies conducted by a number of researchers indicate that magnesium is one of the elements that has the ability to disperse soil particles, and that the main reason for this specific effect is due to the large size of its hydrosphere compared to calcium and the small size of the real ion, reaching (0.078 nm), while

Calcium (nm 0.106), in addition to its role in influencing the ion exchange process, as it carries a dual charge (24 and 19). Also, the possibility of fixing it in the soil is very small due to the high temperature of its circulation and the large aqueous layer with high affinity for the ion. A wide space is occupied between the layers of silica minerals, which makes them exchange easily, and this is due to the large water layer of the ion, which causes swelling of the clay minerals . To understand the chemical behavior of magnesium and its role in soil dispersion and its reflection on the equilibrium forms of potassium in the soil.

Materials and Methods

A laboratory experiment was carried out on two soils of different textures (clay from Diyala Governorate and silt clay from Najaf Governorate).After the soil was brought from the field, it was dried and ground with a sieve with holes diameter of 2 mm. Chemical and physical analyzes of the soil were also carried out according to what was stated in (15, 25, and 22). Clay minerals were also diagnosed using X-ray diffraction, and samples were examined according to what was stated in Jackson (21) by X-ray diffraction. ray diffraction using a Philips , Its characteristics are shown in Table 1. The soil was incubated in small plastic containers weighing 1 kg of soil per container, and in three replicates, magnesium was added at three concentrations (100, 25, 0) mmol $Mg^{2+}.L^{-1}$ for it in the formula of $MgSO_4$ and with three replicates, so that the total of the units became 18 to calculate the amount of potassium that can be released in its various forms (soluble, exchangeable, and non-exchangeable) after 120 days of treating it with magnesium. A mineral examination was also conducted for it before and after treatment with magnesium at the end of the incubation period of 120 days.

Table 1. Some chemical and physical properties of soil

Traits	Measurement value	value (S_1)	value (S_2)
ECe	$dS.M^{-1}$	3.54	3.80
pH	------	8.19	7.82
Ca^{2+}		10.90	9.88
Mg^{2+}		4.75	6.65
Na^{+}		1.50	4.60
K^{+}		2.60	0.34
Cl^{-}	$mmol.L^{-1}$	8.08	7.30
HCO_3^{-}		4.10	5.00
SO_4^{2-}		11.61	12.85
CO_3^{2-}		NiL	NiL
CEC	$Cmol.Kg^{-1}$	39.00	35.00

Organic matter	gm.Kg^{-1} Soil	7.35	7.12
Total Carbonate		352.5	265.8
Active Carbonate		200	175
Clay		558.10	423.00
Silt		245.40	462.00
Sand		196.50	115.00
Texture		Clay	Silt Clay
Solube K^+	Cmol.Kg^{-1} Soil	0.260	0.032
Exchangeable K^+		0.76	0.27
Unexchangeable K^+		1.97	1.46
Mineral K^+		42.24	30.98
Total K^+		45.23	32.75

Results and Discussion

The X-ray diffraction analysis of soil S_1 before and after saturation with magnesium at concentration of 25 and 100 mmol $Mg^{2+}.L^{-1}$

The examination results in Figure (1) for the Diyala/Muqdadiya soil clay textured model before saturating the soil with magnesium ions showed the presence of diffraction of 14.40 A° within the air-dry magnesium saturation treatment which The saturation treatment with ethylene glycol led to an expansion of the basal distance of the mentioned diffraction to reach 16.99 A°, and then this distance decreases again, reaching 10.05 A° within the two treatments saturated with potassium and heated to two temperatures of 350 C° and 550 C°, thus confirming the presence of smectite minerals in the sample examined and as the results of Figure (1) showed, the increase in diffraction intensity is 10.05 A° at the expense of the diffraction intensity of 14.40 A° Within the treatment of saturation with potassium and heated to temperature 350 C° it is confirmed that the smectite minerals in the examined sample are inherited from the mica minerals. As the results showed, the continued presence of diffraction 14.40 A° in all treatments confirms the presence of the mineral chlorite in the examined sample. As for the mica minerals, they were diagnosed by the presence of diffraction 10.05 A° in all treatments, while the kaolinite mineral was diagnosed by the presence of diffraction 7.20 A° in the treatments saturated with magnesium and air-dried, saturated with ethylene glycol, and saturated with potassium and heated to a temperature of 350 C°, then The aforementioned diffraction disappears during the treatment of saturation with potassium and heated to a temperature of 550 C°,this is consistent with what he found (4 and 13).The test results are shown in Figure (2) of the Diyala / Muqdadiya soil clay model after saturating the soil with magnesium ion at a concentration of 25 mmol $Mg^{2+}.L^{-1}$. The saturation treatment had a limited effect on the d-spacing basicity of both the mica and smectite minerals in the model at Comparing it to the basal distance recorded for those minerals the soil clays before the by magnesium ion saturation process and recording a basal distance of 10.16 and 14.49 A°, respectively. The saturation treatment also led to an expansion of the diffraction sizes of these minerals, especially within the two air-dry magnesium saturation treatments and the ethylene glycol saturation treatment. Likewise, the results showed that the chlorite mineral was not affected by the saturation process with magnesium ion (25 mmol $Mg^{2+}.L^{-1}$). The reason is that the chlorite mineral It is a 2:1:1 clay mineral, and as a result of it containing an internal hydroxide layer within the crystalline structure, the mineral will not respond to the saturation treatment and remains maintaining its basic distance of 14.49 A° in all treatments. While the results are it appears in Figure (3) that both the mica and smectite minerals responded to the saturation process with magnesium ion (100 mmol $Mg^{2+}.L^{-1}$) through the widening of their diffraction area . As The response of mica minerals to the saturation process higher compared to smectite minerals in the model these results were consistent with what was obtained by (26). The study (7) also showed that the lack of a significant response of smectite minerals to the process of saturation with magnesium ions and thus the swelling of their inner layers is mainly due to the conditions surrounding those minerals. They showed that the mineral montmorillonite in calcic soils, which is called Ca-Mantmorillonite, Therefore the exchange of magnesium on the metal surface does not directly affect the process of dispersal of metal particles and swelling but rather works to contribute to dissolving the calcium carbonate and then increasing the electrolyte concentration of the soil solution which is sufficient to prevent the dispersion and swelling of the separated clay particles. In another study by the same researchers (8), they showed that the lack of a significant response of smectite minerals to the by magnesium saturation process compared to mica minerals is due mainly to the charge density of Smectite, they showed that smectite minerals possess a high external charge density Their response to by magnesium saturation is less than those metals that have low charge densities. In the current study the smectite minerals, as is the case in all Iraqi soils, are inherited from the mica minerals and are characterized by a high external charge density, which we mentioned in the mineral description within the paragraph (Mineral Description), so the response of these minerals in the examined model was lower compared to the response of the mica minerals.

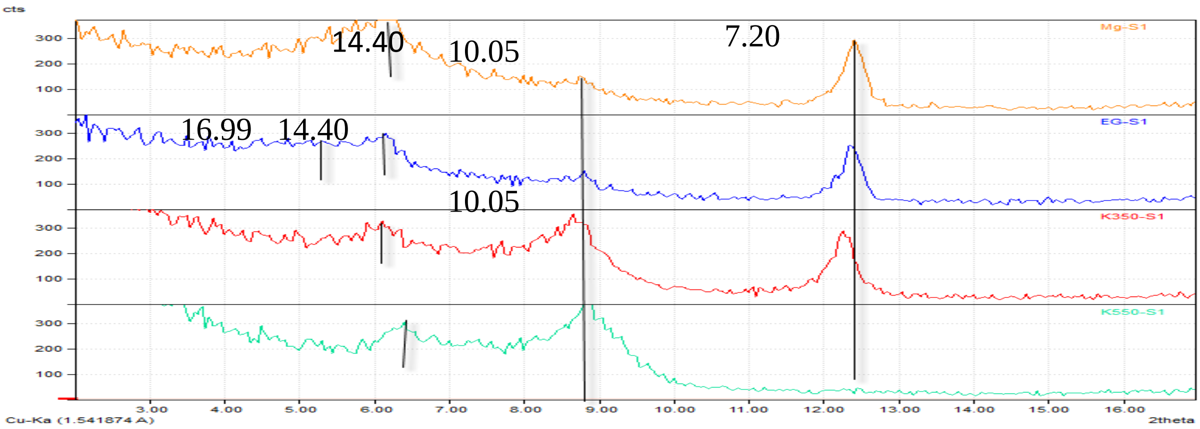

Figure 1. X-ray diffraction analysis of clay particles in study soil S_1 before saturation with magnesium

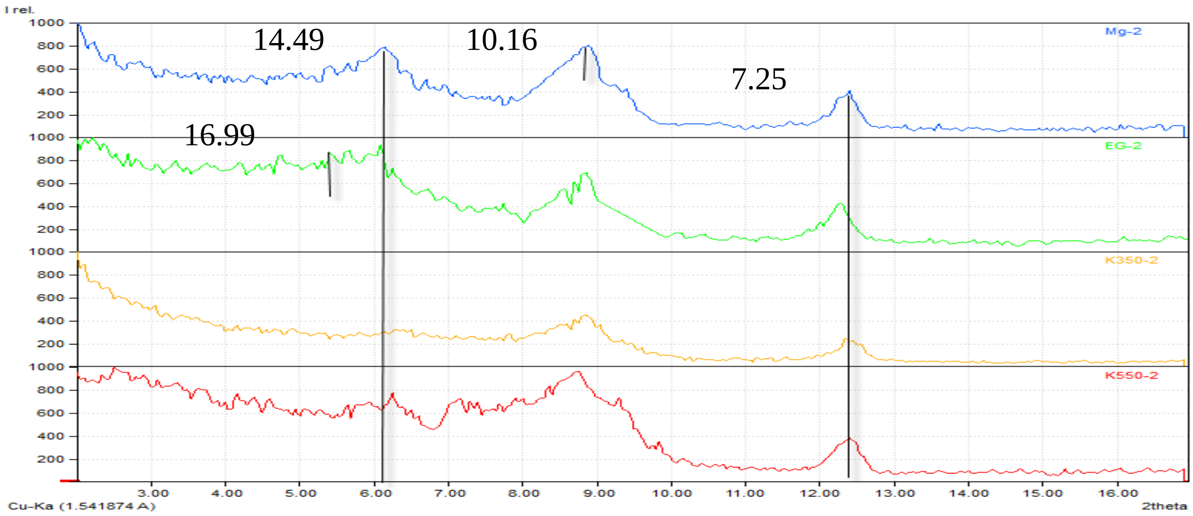

Figure 2. X-ray diffraction analysis of clay particles in study soil S_1 after saturation with magnesium at a concentration of 25 mmol $Mg^{2+}.L^{-1}$

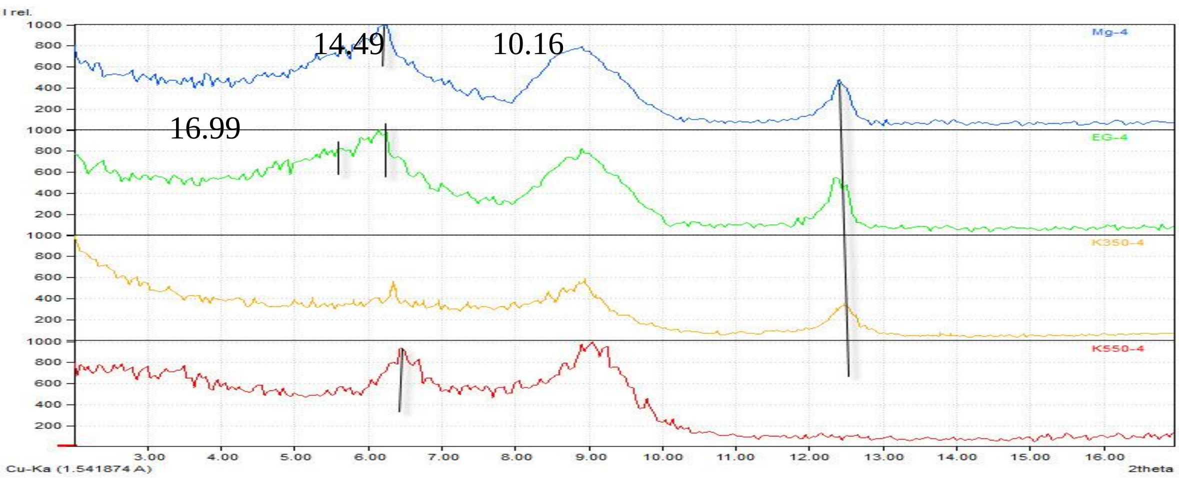

Figure 3. X-ray diffraction analysis of clay particles in study soil S_1 after saturation with magnesium at a concentration of 100 mmol $Mg^{2+}.L^{-1}$

The X-ray diffraction analysis of soil S_2 before and after saturation with magnesium at concentration of 25 and 100 mmol $Mg^{2+}.L^{-1}$

The results in Figure (4) of the X-Ray examination showed the presence of diffraction 14.40 A° within the magnesium-saturated and air-dried treatment and the continued presence of the mentioned diffraction by the same basal distance within all treatments, confirms the presence of the true heat-resistant chlorite mineral in the examined sample. The results also showed the appearance of diffraction was 14.40 A° within the and air-dried magnesium saturation treatment the saturation treatment with ethylene glycol led to an expansion of its basal distance to reach 16.06 A° and then that basal distance decreased again to 10.05 A° within the two potassium saturation treatments and heated to temperatures of 350 and 550 C° It confirms the presence of smectite minerals in the examined sample. Just as the results showed the appearance of a diffraction of 10.05 A° in all treatments, which shows the presence of mica minerals in the model, it was also possible to diagnose the mineral kaolinite through the appearance of a diffraction of 7.0 A° in the treatments saturated by magnesium , dried in the air, saturated with ethylene glycol, and saturated with potassium and heated to a temperature of 350 C°, and the disappearance of the mentioned diffraction under the treatment of saturation with potassium and heated to a temperature of 550 C°, this is consistent with what he found (12 and 5).The results shown in Figure (5) examine the model after saturation with magnesium at a concentration of 25 mmol Mg^{2+}. L^{-1} indicates that the basal distance d-spacing for the diffraction of the smectite, mica, and kaolinite minerals will not be greatly affected, As if its breadth is limited, recording a basal distance of 14.49, 10.16, and 7.08 A°. for each of the smectite, mica, and kaolinite minerals, respectively (Figure 5), which reflects The effect of these minerals with the saturation treatment was limited. The results of Figure (6) Concerning For the the Kufa soil clay model /Qazwinia after saturating the model with magnesium ion at a concentration of 100 mmol $Mg^{2+}.L^{-1}$ It led to a change in both the basal distance and the diffraction size for both smectite and mica minerals in the examined model, recording a basal distance It was estimated at 14.93 and 10.16 A° for each of the smectite and mica minerals, respectively, as the diffraction sizes of these minerals appeared wider compared to the treatments before saturation or saturation at a concentration of 25 mmol $Mg^{2+}.L^{-1}$ magnesium, which reflects the increased penetration of the magnesium ion into the inner layers of those metals and thus an increase in the openness of those layers which in turn affected the expansion of the diffraction area of those metals these results were consistent with what was found by (16) when they showed that the diffraction of metals Smectite and mica expand and become shorter due to the saturation of their inner layers with magnesium ions, and shared this opinion (20) when studying some Iraqi soils in the Kurdistan region. According to our belief, increasing the concentrations of magnesium ions within the soil solution will work to penetrate the inner layers of those minerals, which leads to the expansion of those layers and thus works to open them as a result of the properties that the magnesium ion has that qualify it to do so, which was mentioned by (28) as they showed that the effect of magnesium ion in the process of dispersing clay minerals does not depend only on the type of clay mineral, but also depends on the high concentrations of magnesium ion in the soil solution as the magnesium ion is characterized by its small ionic diameter compared to the diameter of the calcium ion which works to increase the hydration shell of the magnesium, which leads to an increase in the negativity of the hydration enthalpy of the magnesium, which works to increase the binding strength between the magnesium ion with the water molecules surrounding it, which works to increase the ability of the magnesium ions to penetrate the inner layers of clay minerals and increase their swelling and this effect was more evident In mica minerals and smectite minerals, which were originally inherited from mica minerals (18) and (26).

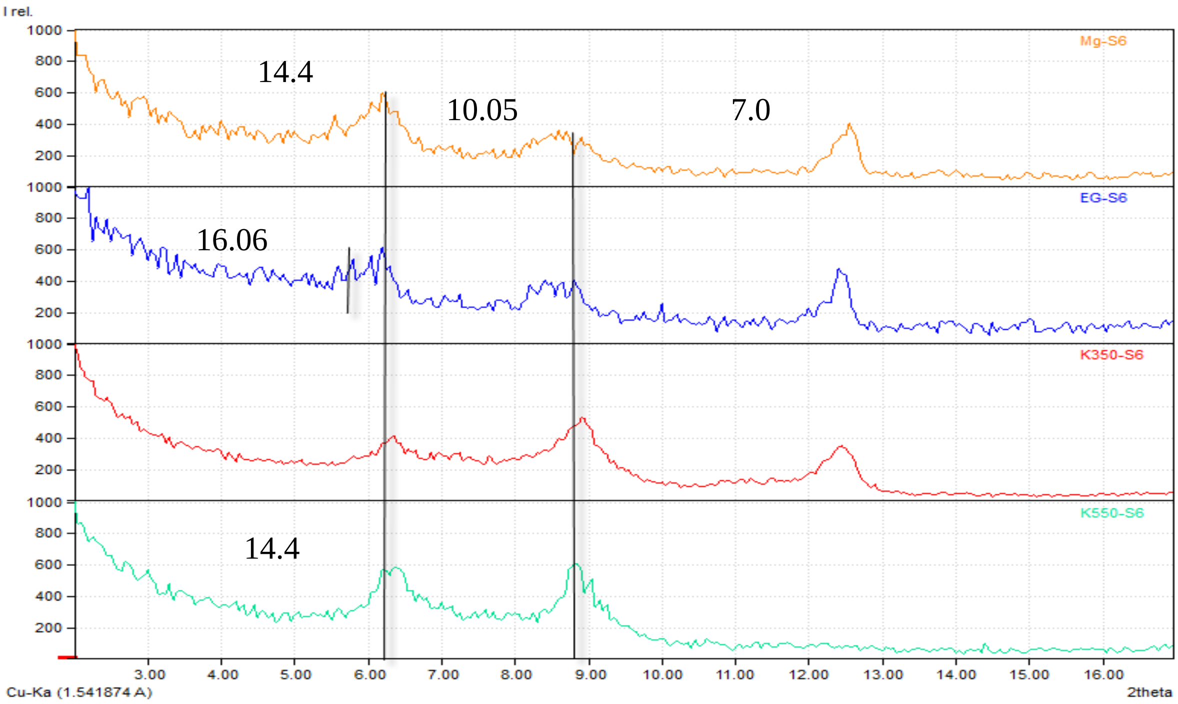

Figure 4. X-ray diffraction analysis of clay particles in study soil S_2 before saturation with magnesium

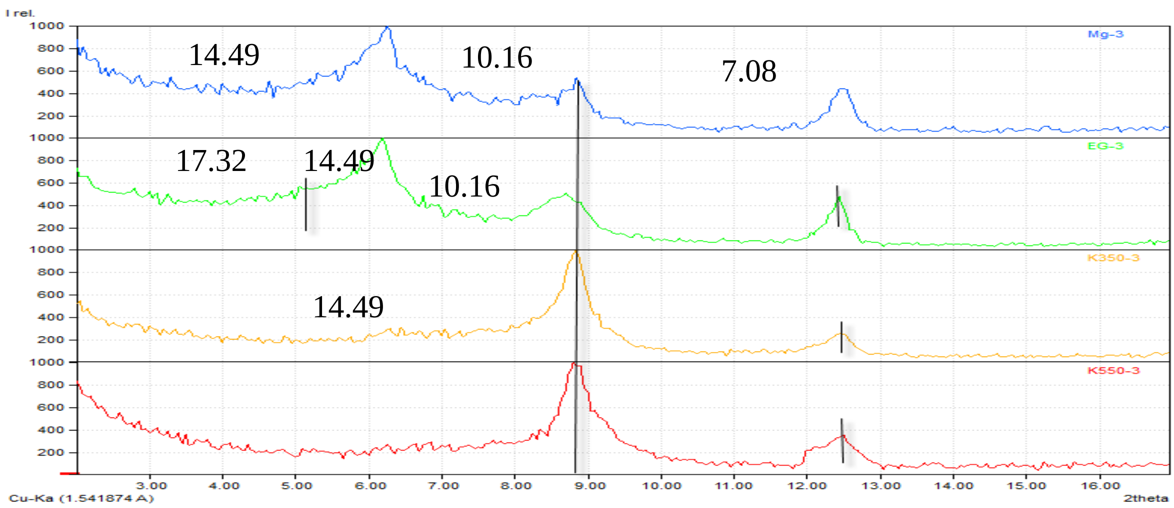

Figure 5. X-ray diffraction analysis of clay particles in study soil S_2 after saturation with magnesium at a concentration of 25 mmol $Mg^{2+}.L^{-1}$

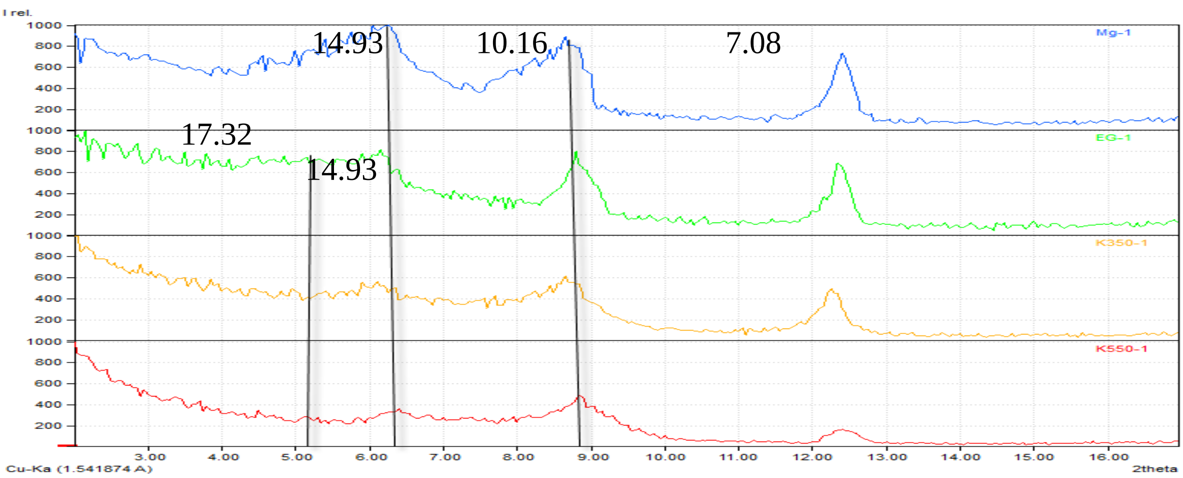

Figure 6. X-ray diffraction analysis of clay particles in study soil S_2 after saturation with magnesium at a concentration of 100 mmol $Mg^{2+}.L^{-1}$

The effect of added magnesium levels and incubation period in the Soluble potassium concentration values

The results shown in Figure (7) showed the effect of increasing the concentrations of added magnesium and the incubation period to the soil in increasing the values of the Soluble potassium concentration liberated from the soil. It is clear from the results that the Soluble potassium concentration values for soil (S_1) reached (0.29, 0.306, and 0.372) Centimole K^+ $Kg.^{-1}$ Soil at concentrations of 0, 25, and 100 mmol Mg^{2+}. L^{-1}, respectively. The results also showed an increase in the concentration of potassium at concentrations of 25 and 100 mmol Mg^{2+}. L^{-1} by 5.517 and 28.276%, respectively, compared to the concentration of 0 mmol

Mg^{2+}. L^{-1} during the incubation period of 120 days in a row. The highest value in the percentage of potassium release was at the period of 120 days compared to the time of 0 days of incubation, The results shown in Figure (7) also showed that the Soluble potassium concentration values for soil S_2 reached (0.038, 0.044, and 0.059) Centimole K^+ .$Kg.^{-1}$ Soil at concentrations of 0, 25, and 100 mmol Mg^{2+}. L^{-1}, respectively. The results also showed an increase in the concentration of Soluble potassium at concentration 25 and 100 mmol Mg^{2+}. L^{-1} by 15.789 and 55.263%, respectively, compared to the concentration of 0 mmol Mg^{2+}. L^{-1} during the incubation period of 120 days in a row, was The highest value in the potassium release rate at the period of 120 days compared to the period of 0 days of incubation. It is noted from the results that the concentration values of Soluble potassium increase with increasing concentrations of added magnesium and the incubation period, This is due to the role of magnesium and its binary valence in the displacement of monovalent potassium from the surface of soil particles and reducing its fixation in the soil by affecting the layers of minerals, and this is confirmed by the results of mineral analysis for the two soils (S_1 and S_2) it was observed that there was a change in the nature of the clay minerals with the addition of magnesium at concentration of 25 and 100 mmol Mg^{2+}. L^{-1}, this is consistent with what he found (17).

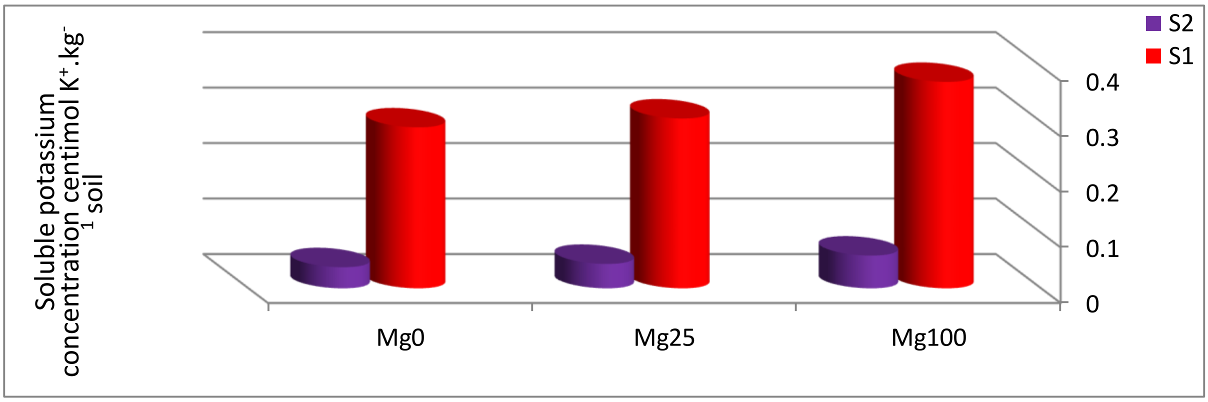

Figure 7. shows the effect of magnesium concentration and incubation period in Soluble potassium values for soil (S_1 and S_2) Centimol K^+.Kg^{-1} Soil

The effect of added magnesium levels and incubation period in the exchangeable potassium concentration values

The results shown in Figure (8) showed the effect of increasing the added magnesium concentrations and the soil incubation period in increasing the potassium concentration values released from the soil. It is evident from the results that the exchangeable potassium concentration values for S_1 soil reached (0.755, 0.836, and 1.104) Centimole K^+ .$Kg.^{-1}$ Soil at concentrations of 0, 25, and 100 mmol Mg^{2+}. L^{-1}, respectively. The results also show an increase in the exchangeable potassium concentration at concentrations of 25 and 100 mmol Mg^{2+}.

L^{-1}, by 12.215 and 48.188%, respectively, compared to the concentration of 0 mmol Mg^{2+}. L^{-1} during the incubation period of 120 days in a row. was The highest value in the potassium release rate at the period of 120 days compared to the period of 0 days of incubation, The results shown in Figure (8) also showed that the exchangeable potassium concentration values for S_2 soil reached (0.268, 0.302, and 0.343) Centimole K^+ $.Kg.^{-1}$ Soil at concentrations of 0, 25, and 100 mmol Mg^{2+}. L^{-1}, respectively. The results also show an increase in the exchangeable potassium concentration at concentration of 25 and 100 mmol Mg^{2+}. L^{-1}, by 20.800 and 37.200%, respectively, compared to the concentration of 0 mmol Mg^{2+}. L^{-1} during the incubation period of 120 days in a row. was The highest value in the potassium release rate at the period of 120 days compared to the period of 0 days of incubation. It is noted from the results that the values of the exchangeable potassium concentration increase with increasing concentrations of added magnesium and the incubation period of the soil, At the concentration of Mg_0 distilled water did not affect the release of exchangeable potassium, which is linked to a high binding force with soil particles. This correlation gradually decreased with the increase in the concentration of magnesium in the equilibrium medium due to the charge the divalent magnesium ion which contributes to the displacement of monovalent potassium.

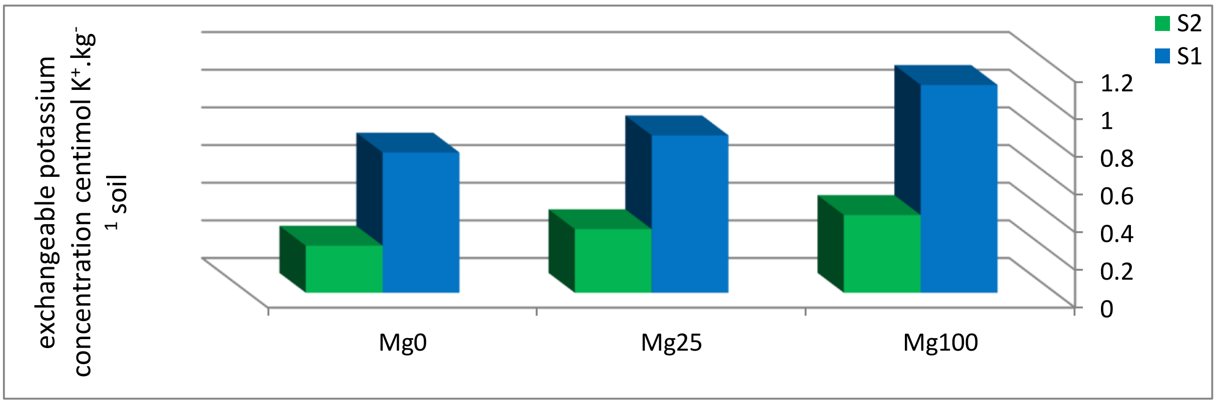

Figure 8. shows the effect of magnesium concentration and incubation period in exchangeable potassium values for soil (S_1 and S_2) Centimol $K^+.Kg^{-1}$ Soil

The effect of added magnesium levels and incubation period in the non-exchangeable potassium concentration values

The results shown in Figure (9) showed the effect of increasing the concentrations of added magnesium and the incubation period to soil in increasing the values of the concentration of potassium released from the soil. It is clear from the results that the values of the non-exchanged potassium concentration for soil S_1 reached 1.745 and 1.413 Centimole K^+ $.Kg.^{-1}$ Soil. At concentrations of 25 and 100 mmol Mg^{2+}. L^{-1}, respectively. The results also show a decrease in the concentration of non-exchanged potassium at concentrations of 25 and 100 mmol

Mg^{2+}. L^{-1}, by 11.421 and 28.274%, respectively, compared to the concentration of 0 mmol Mg^{2+}. L^{-1} during the incubation period of 120 days in a row, and the highest value in the percentage of non-exchanged potassium was at the time of 0 days compared to the period of 120 days of incubation The results shown in Figure (9) also showed that the values of non-exchangeable potassium concentration to soil S_2 reached (1.278 and 1.168) Centimole K^+ .$Kg.^{-1}$ Soil at concentrations of 25 and 100 mmol Mg^{2+}. L^{-1}, respectively. The results also show a decrease in the concentration of non-exchanged potassium at concentrations of 25 and 100 mmol Mg^{2+}. L^{-1}, by 12.466 and 20.000 %, respectively, compared to the concentration of 0 mmol Mg^{2+}. L^{-1} during the incubation period of 120 days in a row. The highest value in the percentage of non-exchanged potassium at 0 days compared to the period of 120 days of incubation, It is noted from the results that the values of the non-exchanged potassium concentration decrease with increasing concentrations of magnesium added and the incubation period to the soil through The effect of magnesium in dispersing the layers of minerals and releasing a portion of the potassium fixed between those layers, and this was confirmed by the results of the mineral analysis of the soils (S_1 and S_2) in showing the role of magnesium in changing the diffraction intensity of clay minerals in the soil, and this was clear at the concentration of 25 and 100 mmol Mg^{2+}. L^{-1}.

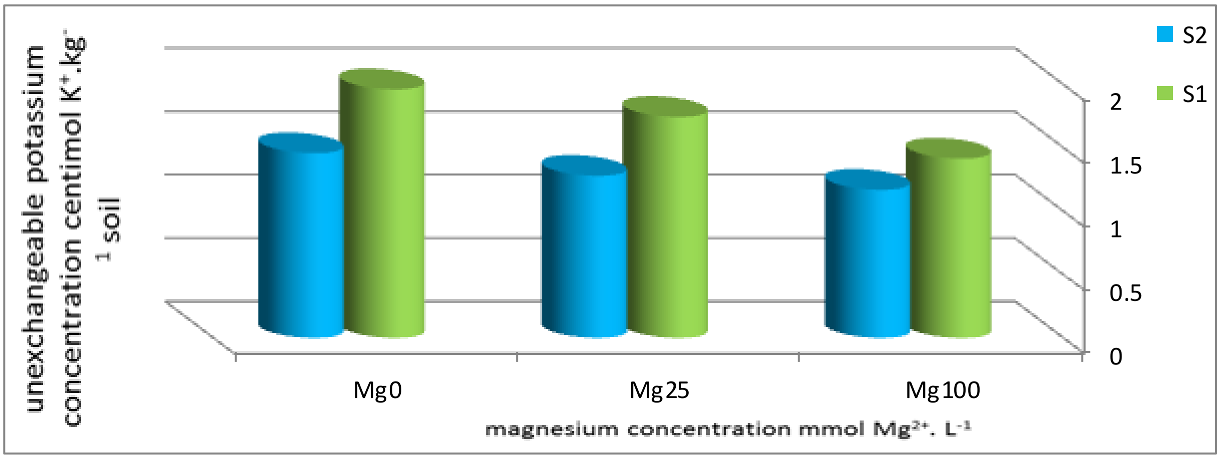

Figure 9. shows the effect of magnesium concentration and incubation period in non-exchangeable potassium values for soil (S_1 and S_2) Centimol K^+.Kg^{-1} Soil

Conclusion

Based on the results obtained, it is clear that magnesium has a significant effect on the forms of chemical equilibrium of potassium in the soil by changing the X-ray diffraction of clay metal This phenomenon, in which the layers of minerals diverge, can be used to release part of the non-exchanged potassium and turn it into a ready-made composition that the plant can benefit from.

Conflict of Interest

There is no conflict of interests regarding the publication of this research.

References

1-Al-Hassoun, N. H., Al-Hayani A. S. J. Z., and Muhammad A. J. Al-Obaidi 2019. Copper adsorption in two soils of different textures. Iraqi Journal of Agricultural Sciences, 50 (2): 638-645.

2-Al-Hazzaa, S. H. 2018. Types of clay minerals in the shale units of the Kayista and Ura Formations of northern Iraq: their use in interpreting the depositional environment, Journal of Ethno-Agricultural Sciences, 49 (4): 601-610.

3-Al-Jaff, B. O., and Essa, S. K. 2020. The effect of vegetation on mica mineral changes in the rhizosphere. Journal of Ethno-Agricultural Sciences, 51 (1): 493-499.

4- Al-Khalil, S. M.A., and Essa, S. K. 2020. Effect of sedimentation sources on the nature occurrence and distribution of the feldspar in some soil of alluvial plain Iraq. Plant Archives, 20 (2), 818-822.

5- Al-Khalil, S. M.A., and Essa, S. K. 2021. Effect of sedimentary source on the Properties of Sphericity and Roundness of feldspar minerals in some soils of the Alluvial Plain. Indian Journal of Ecology, 48 (1), 315-318.

6- Al-Obaidi, S. M. J., and Hassan A. A. R. 2021. Evaluation of the combination of bacterial biofertilizer and vermicompost on the readiness of K, P, N and some growth standards of the bean plant (*Phaseolus vulgaris* L.). Iraqi Journal of Agricultural Sciences, 52 (4): 960- 970.

7-Al-perovitch, N., I. Shainberg., and R . Keren . 1981. Specific effect of magnesium on the hydraulic conductivity of Sodic soils. J. Soil sci. 32, 543-554.

8- Al-perovitch, N., I. Shainberg., and R . Keren 1985. Effect of clay mineralogy and Al and Fe oxides on the hydraulic conductivity of Clay –Sand mixtures: clays and clay Minerals 33,443-450.

9-Al-qrawi, H. S. Y. 2018. The effect of organic and mineral fertilizers on the readiness of potassium in the soil and the yield of chickpeas (*Cicer arietinum* L.). Iraqi Journal of Agricultural Sciences, 49 (2): 295-

10- **Al-Rawi, M. M. A. and Al-Jumaili, M. A. H. 2018.** The effect of spraying potassium and zinc in the growth and yield of pods and okra seeds. Iraqi Journal of Agricultural Sciences, 49 (6): 1041-1048.

11-**Al -Shamary, S .H. K., Al Maamouri, A.D.S. and Dwenee, S. J. H . 2022.** Effects of climatic variation on weathering intensity for the mineral composition in some Iraqi soils:Caspian Journal of Environmental Sciences, Vol. 20 No. 5 pp. 991-1001 DOI: 10.22124/ CJES.2022.6053 .

12- **Al-Shamare, A. H.D. and Essa, S. K. 2020.** The effect of sedimentation sources on the exchange properties of the clay particles of some soils in wasit and maysan governorates, Plant Archives 20 (2), 566-573

13- **Al Taee, Z.A.H., and Al Maamouri, A. D.S. 2020 .**Study of the mineral compostion of some Iraqi Soils and its effect on zinc dsorption: Plant Archives Vol. 20 No. 1, pp. 769-776**.**

14- **Asaad, S. A. K. and Qahtan J. A. R. 2017.** An evaluation study of some methods for extracting ready soil potassium and its relationship to potassium absorbed from the barley crop. Iraqi Journal of Agricultural Sciences, 48 (6): 1697-1704.

15-**Black , C.A. ED. 1965.** Methods of soil analysis.part 2 chemical and microbiological properties .Am.Inc Madison. Wisconsin , USA. Soc. Agron.

16-**Chavez-Garcia, M.l., dE.pabb-Galan., and S. Ramirez 2006.**Synthes of intercalated Al-hydroxy- montmorillonite- J. Of the Mexican chemical society: 50,36-41.

17-**El-fahdawi, W. A.T., Ahmed, F. W. and Cheyed, S. H. 2020.** Effect of Agricultural Sulfur on Availability of NPK in Soil, growth and yield of corn (*Zea mays* L.). Indian Journal of Ecology, 47 (12), 200-205.

18-**Emerson .W . W., and Chi, C . L 1977.** Exchangeable calcium , Magnesium and Sodium and the dispersion of illite in Water .II.Dispexsion of illites in water. Aust.j.Soil Res.15:255-262.

19- **Oudah,B.M., and Al-Kellabi, H.G.A. 2023**. The Effet of some Irrigation Methods and Moisture Depletion percent in the growth and productivity of Corn. Kufa Journal for Agricultural Sciences. 15 (1), 124-134

20-**Goran, A. H. 2023.** study the lmpact of chloritization phenomenon on exchange properties of some Soils of Kurdistan Region Ms.c thesis. College of Agricuture Engineering Sciences- univexsity of Salahaddin-Erbil.

21- **Jackson, M. L. 1979.** Soil chemical analysis. Advanced Course. 2nd Ed. Printed by the author. Univ. of Wisconsin, Madison, Wisconsin.

22- **Jackson, M. L. 1958.** Soil chemical analysis. Printice-Hall int. Englewood cliffs.

23-**Mahmood, Y. A., Mohammed, I. Q ., Ahmed F. W. and K. A. Wheib 2020.** Effect of organic, mineral fertilizers and foliar application of humic acid on growth and yield of corn (*Zea mays* L.). Indian Journal of Ecology. 47 Special Issue (10): 39-44.

24-**Nafawa, S. M. 2017.** Study of the minerals controlling the solubility of calcium, magnesium, and iron and their relationship to soil management by adopting dissolution plans, Iraqi Journal of Agricultural Sciences, 48 (6): 1715- 1726

25- **Richards, A. 1954.** Diagnosis and improvement of saline and alkali soils . Agriculture Hand book No:60. USDA. Washington of tomato. Italian Journal of Agronomy.7(8): 50-57.

26- **Rahman, W. A., and D.L. Rowell 1979.** The influence of magnesium in saline and sodic Soils: A specific effect or a Problem of cation exchange ? European Journal of Soil Science. 30(3): 535-546.

27- **Zhang, X.C., and L.D. Norton 2002.** Effect of exchangeable Mg on saturated hydrautic conductivity , disaggreyation and Clay dispersion of disturbed Soils. J.of Hydrology, vol.260,lssue,1-4:pp.194-205.

28- **Watifi, A. S. S. 2012.** Effect of montmorillonite metal transformations to chlorite in physicochemical properties of some Iraqi soils. PhD thesis. University of Baghdad. Faculty of Agriculture.