Plant Archives Volume 20 No. 2, 2020 pp. 5681-5685 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF FERTILIZERS TYPE ON THE PERCENTAGE OF TOTAL CARBONATE MINERALS IN THE RHIZOSPHERE OF *ZEA MAYS* L.

Raid shaalan Jarallah* and Maha Hussein Hashem

Department of Soil Sciences and Water Resources, College of Agriculture, University of Al-Qadisiyah, Iraq.

Abstract

This study was conducted in plastic pots to study the effect of organic fertilizer, mineral fertilizer and humic acid on the presence of carbonate minerals in the rhizosphere and bulk soils during the period of plant growth (40, 70 and 100) days after planting for the maize plant. The experiment was designed according to the Complete Randomized Design (C.R.D). The experimental treatments included mineral fertilization (250) kg.N.h^{-1} for the yellow corn, symbolized by the symbol (M) and organic fertilization (poultry waste) at level (10) tons.h^{-1} and symbolized by the symbol (O). Humic acid was applied at the level (450) kg.h^{-1} symbolized by the symbol (H). Yellow corn seeds (*Zea mays* L.), an American variety (DKC 6120) were planted in plastic pots on the 13th of July 2018. The results present that fertilizer type (mineral, organic and humic acid) plays a big role in the percentage of total carbonate minerals. After the 40-day of planting date in, mineral fertilization was the most effective in reducing the percentage of carbonate minerals compared to other treatments into the rhizosphere area. Its value is statistically greater than the comparison treatment, while the organic matter and humic acid had a role in increasing these minerals. After 70-day of the planting date, the percentage of carbonate minerals with the treatment of humic acid decreased significantly as compared to the treatment of mineral fertilization and the MO and HO treatments. There were no significant differences with the organic fertilization treatment. After 100-day of the planting date in the maize rhizosphere, it is found that the lowest values of the percentage of carbonate minerals were with thetreatment of organic fertilization and with significant differences than the treatments for mineral fertilization and humic acid. The lowest values were with the MO treatment. The results also showed that the percentage of total carbonate minerals decreased as the increase in plant growth times and the highest values were in bulk soil.

Key words: total carbonate, rhizosphere, maize, fertilizer, humic acid.

Introduction

Carbonate minerals are among the most important basic components of the soil and one of the most important carbon salts common, especially in the soils of arid and semi-arid regions, Al-Zubaidi, (1989); Hussein M. Khaeim *et al*., (2019). Most studies conducted on these minerals in the soil indicate that their percentages range between (5-35)% and their percentages may become more than (40)%, which is the case in some areas of southern Iraq, AL-Kaysi, (1983); Khaeim, H.M. *et al*., (2019). Shahwan *et al*., (2002) mentioned that carbonate minerals are an important component of the Earth's crust, accounting for about (4)% of the Earth's crust weight. Al-Hadidi, (2000) found that carbonate mineral content was 59-313g.Kg^{-1} in some soils from northern Iraq.

Calcareous soils consist of limestone origin materials such as limestone, dolomite, calcite, basalt, Balbaa, (1999); Khaeim, H.M., (2013). It also consists of the secondary deposits due to the combination of carbonate and bicarbonate with the calcium and magnesium ions dissolved in the soil solution. They accumulate carbonates in large quantities, especially in arid and semi-arid regions where rainfall does not be more than 400mm a year, accompanied by high temperatures leading to insufficient washing and transportation of calcium and magnesium carbonate salts from the soil provider to the lower layers, Bashour *et al*., (2007); Baker D. Aljawasim, *et al*., (2020). It is easy to identify this type of soil through its extreme variation with the application of dilute hydraulic acid to it, SSSA, (1997); Jeber, B.A. *et al*., (2019). Al-Mahamid, (1984) concluded that there are differences in morphological soil from one location to another and perpendicularly within one site when studying the inheritance of some sedimentary soils and their development in central Iraq, where it was found that the high carbonate mineral content reached 4.33%. Balba

***Author for correspondence :** E-mail: raid.jarallah@qu.edu.iq

(1995); Duiker *et al*., (2003) indicated that the stability of soil masses is greatly affected by the soil content of organic matter, clay particles and the ratio of carbonate minerals in dry areas.

The results of a study conducted by Al-Husayni, (2005) on some dried Al-Hamar swamp soils in southern Iraq showed that the soil of the study area is a newly developed soil, with a high content of carbonate minerals and a noticeable increase in its content of organic matter in the surface horizons. Al-Ani, (2006) found that there is a uniformity in the vertical distribution of carbonate minerals and the prospects for all studied soil, given that the sedimentary origin material is rich in carbonate minerals. The aim of this study was to study the type of fertilization and their interactions in the percentage of total carbonate minerals in the yellow corn rhizosphere, Alawsy *et al*., (2018).

Methods and Materials

This study was conducted in the canopy of the Department of Soil Science and Water Resources/ College of the Agriculture/ University of Qadisiyah. The soil was brought from the extension station of Nuriya, which was airly dried, milled and sifted through a sieve with a diameter of 4mm. The amount of 20kg dry soil was placed in each pot and prepared for planting. Seeds of yellow corn (*Zea mays* L.), the American (DKC 6120) species were planted in these pots. Five seeds were placed in each pot and after 15 days of planting, the seedlings were rugged out to a single plant in each pot. Fertilizers were applied to the pots before planting. Potassium sulfate fertilizer was applied (50% K_2O) at a level of 100 kg.K_2O.h^{-1} and triple super phosphate fertilizer at a level of 200 kg.h^{-1}. Urea fertilizer 46% N at a level of 250 kg.N.h Fife was applied to the plantstwice after 15 days of planting and the second 30 days after the first application. Sesamia cailica, the corn stalk borer, was controlled using the granular (diazinon) pesticide, 10% effective material, given to the growing peaks of plants 20 days after germination. The process of hoeing and weeding was done manually in order to get rid of bush plants growing with the plant whenever required. Irrigation was done when the water reached 50% of the field capacity and according to the plant's need. The following treatments were taken to conduct the mineral analyzes: control treatment (C), organic fertilization (O), humic acid (H), mineral fertilization (M), organic, mineral and humic acid fertilization (MHO).

A sample of the soil was taken before planting, dried aerially and crushed with a plastic hammer and passed through a sieve with a diameter of 2mm (s) and some physical and chemical properties were estimated by the methods mentioned in Jackson, (1958); Black, (1965) and Page and others, (1982) as shown in table 1. The total carbonates of rhizosphere and of bulk soil were estimated during plant growth periods after (40, 70 and 100) days after planting using 1M of HCl and 0.5M of NaOH as reported in Page *et al*., (1982); Hussein M. Khaeim, *et al.,* (2020).

The results were analyzed statistically by using the Statistical Analysis System-SAS, (2012) to study the effect of different factors (fertilization and treatment) according to the Complete Randomized Design (CRD), Khaeim, H.M. *et al*., (2019). The significant differences between the averages were compared with the Least Significant Difference (LSD).

Table 1: The chemical and physical properties of the soil prior to planting.

Trait		Value	Unit	Reference
Reaction Degree (pH) (1:1)		7.6	-	Page *et al*., (2982)
Electrical Conductivity (EC) (1:1)		3.42	DesiSmens.M^{-1}	
Cation exchange capacity (CEC)		23.73	Cml.charge. kg^{-1}.soil	Savant, (1994)
Carbonate minerals		230	g.kg^{-1}	Page *et al*., (2982)
Organic matter		11.37		Black, (1965)
Cationic dissolved ions	Ca^{2+}	25.45	Cml.charge.L^{-1}	Page *et al*., (2982)
	Mg^{2+}	13.44		
	Na^{1+}	40.58		Jackson, (1958)
Negative dissolved ions	SO_4^{2-}	17.95		Black, (1965)
	HCO_3^{1-}	16.8		Jackson, (1958)
	CO_3^{-2}	Nill		
	Cl^-	41.56		Jackson, (1958)
Available Nitrogen	$N-NH_4^+$	22.18	Mg. kg^{-1}	Black, (1965)
	$N-NO_3^-$	19.33		
Available phosphorous		16.30	Mcg.m^{-1}	Page *et al*., (2982)
Available potassium		164.40		Black, (1965)
Bulk Density		1.36		
Soil Separators	Sand	270	g.kg^{-1}	
	Loam	540		
	clay	190		
Texture type		Silt Loam		

Results and Discussion

Total carbonates after the first planting period

Table 2 present the percentage of the total carbonates of the rhizosphere and bulk soils after 40 days of planting.

Table 2: Percentage of total calcium carbonate after 40 days of planting the planting date.

Treatment	Soil Type	
	Rhizosphere soil	Bulk soil
Control	21.33	25.66
M	22.66	26.66
O	29.33	30.33
H	33.00	34.33
MO	32.00	33.66
MH	35.33	36.00
HO	28.00	37.00
MHO	31.33	36.33
* (P<0.05).	6.063*	

Table 3: Percentage of total calcium carbonate after 70 days of planting.

Treatment	Soil Type	
	Rhizosphere soil	Bulk soil
Control	20.66	28.00
M	25.66	31.66
O	19.66	21.66
H	18.66	27.33
MO	31.00	33.00
MH	24.33	30.00
HO	32.33	34.33
MHO	23.66	26.33
* (P<0.05).	*6.181	

The results showed that there were significant differences with the level of 5% in all treatments except for mineral fertilizing treatment of rhizosphere and the two treatments of mineral fertilization and organic fertilization in bulk soil. This may due to the weak absorption of chemical fertilizers because of the small size of the plant in this period and the lack of decomposition of organic fertilizers. It may return to the high porous capacity of the soil.

It is noted that the highest percentage of total carbonates outside the rhizosphere is with the HO treatment amounted to 37.00 compared to the control treatment that achieved the lowest total carbonate ratio in this period 25.66 in bulk soil. This is due to the fact that the application of organic waste to the soil plays an effective role in increasing soil fertility and providing nutrients, as well as improving the chemical and physical properties of the interchanging space in the interchangeable space. This causes a decrease in the voltage that the plant's roots spend, thereby reducing the CO_2 released, which leads to an increase in carbonates as a result of their sedimentation, as well as what the organic compounds supply of calcium ions, which are determined with carbonates and increase their deposits.

In the soil of the rhizosphere, it was the lowest in the control treatment that gave 21.33 and the highest percentage of total carbonate in the treatment of MH, which was given 35.33. This is due to the increase in nitrogen availability as a result of mineral fertilization and consequently, a decrease in the effort exerted by plant roots and thus reduced respiration, as well as from which the organic compounds supply calcium ions that combine with carbonates and increase their deposits.

Temperature plays also a big role in the formation of these minerals as a result of high temperatures. Temperatures above 50°C lead to the formation of calcite, Gabrielli *et al*., (1999); Al-Baldawy *et al*., (2019) and Karoui *et al*., (2008). It is also noticed that the percentage of total carbonate of the rhizosphere has decreased in all the treatments compared with the bulk soil treatments.

Total carbonates after the second planting period (70 days)

Table 3 shows the effect of the application of the mineral fertilizer, the organic fertilizer and the humic acid and their overlaps on the percentage of total carbonates of both of the rhizosphere bulk soils after 70 days of the planting date. There was no significant difference at the level of 5% for all treatments in the soil of the rhizosphere, except for the MO and HO treatments, which increased significantly and their values were 31.00% and 32.33%, respectively. In the bulk soil, they increased significantly with the (HO) treatment the value of 34.33% and with the treatment of (O) decreased significantly 21.66%.

The highest total concentration of carbonate in bulk soil was with the treatment of (HO), which was given 34.33%. In comparison with the (O) treatment, which gave the lowest percentage of total carbonate in the soil 21.66%. This is due to the fact that the application of organic waste to the soil is a modification of the release of catalysts from amino acids, Daweny, (2003). This leads to a decrease in its value as a result of dissolving, as well as a decrease in the effort at the roots of the plant and consequently a decrease in the CO_2 released, which leads to an increase in carbonates as a result of what the organic compounds supply of calcium ions that unite with carbonates and increase their sedimentation. In the rhizosphere, the highest percentage of total carbonates was at the treatment of (HO), which amounted to 32.33 and the lowest percentage of the total carbonates was in the treatment of (H) that valued 18.66. This is due to the fact that the application of organic waste to the soil reduces soil pH and thus increases the solubility of carbonates, Narrator, (1985). A decrease in the overall carbonate percentage was observed with all treatments in and outside the rhizosphere in this period (flowering stage).

Table 4: Percentage of total calcium carbonate after 100 days of planting.

Treatment	Soil Type	
	Rhizosphere soil	Bulk soil
Control	27.00	32.33
M	28.00	34.33
O	19.33	25.33
H	26.00	30.33
MO	16.00	21.00
MH	18.00	23.33
HO	24.66	29.00
MHO	27.00	29.66
* (P<0.05).	*6.828	

Total carbonates after the third planting period (100 days)

Table 4 shows the effect of the application of mineral fertilizer, organic fertilizer and humic acid and their overlap on the percentage of total carbonates of the soil of the rhizosphere and the bulk soil after 100 days of the planting of the maize plant. The results showed that there were no significant differences at the level of significance of 5% with all treatments in the soil of the rhizosphere except for the (MO and MH) treatments that valued 16.00 and 18.00% respectively, which decreased as compared the comparison treatment. There were no significant differences in the soil outside the rhizosphere in all treatments except for the O, MO and MH coefficients, whose values decreased from the comparison treatment and their values reached 25.33, 21.00 and 23.33 respectively. In the bulk soil, the treatment of (M) achieved the highest percentage of total carbonate 34.33%.

Treatments of (MO) resulted in the lowest percentage of total carbonate, which amounted to 21.00%. This is due to the fact that the application of organic wastes to the soil increases the number and activity of microorganisms. It also works to add nutrients to the soil continuously, which rebalances the nutrients. It also provides nutrients and reduce their loss through washing

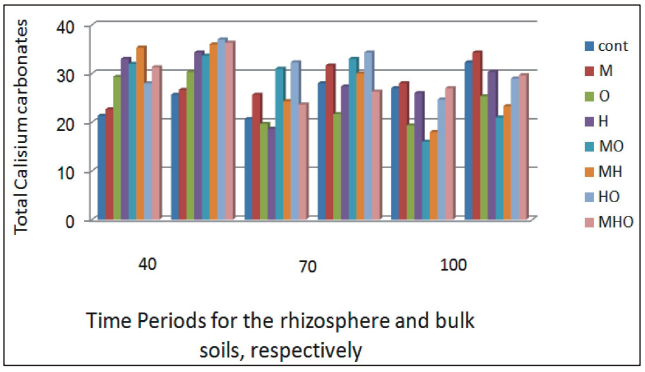

Fig. 1: Percentage of total calcium carbonate for maize during growth periods.

by adsorption, Allen and Zink surfaces, (1998), or creating chelating compounds from organic acids resulting from the decomposition of organic matter. In addition to releasing organic acids, carbon dioxide gas reduces the pH of the soil, which affects the dissolution of minerals and makes their mineral elements more readily available, as well as its ability to hold ions by humus colloids due to its high surface area, Hartman, (2002).

In the soil of the rhizosphere, the highest percentage of total carbonates was with the treatment of M 28.00% and the lowest with the treatment of MO 16.00%, due to the same reason. The percentage of total carbonates continues to decrease at this time period for the soil of the rhizosphere compared to bulk soil.

Based on the results, the percentage of calcium carbonate generally decreased as the growth periods goes forward and the highest values were recorded in bulk soil (Fig. 1).

References

Al-Ani, Amal Mohamed Saleh (2006). Applications of numerical classification in the classification of some river soils chains in the Iraqi sedimentary plain. Ph.D. thesis - College of Agriculture - University of Baghdad.

Alawsy, W.S.A., L.A.S. Alabadi and H.M. Khaeim (2018). Effect of sewage water irrigation on growth performance, biomass and nutrient accumulation in maize and barley. *International Journal of Agricultural and Statistical Sciences*, **14(2):** 519-524.

Al-Baldawy, M.S.M., H. Ahed Abd Ali and H.M. Khaeim (2019). Antifungal Inhibitory Activity of *Thymus Vulgaris* L. And Artemisia Herba-alba Powder and its Constituent Phytochemicals Against Aspergillus Ochraceus and Fusarium Graminearum growth. *Plant Archives*, **19(1):** 801-804.

Al-Hadidi, Abdel-Qader Abish Plumber (2000). Evaluation of the water quality of some springs and their effect on the soil chemical properties in Nineveh Governorate. Master Thesis - College of Agriculture and Forestry - University of Mosul.

Al-Hussaini, Iyad Kazem Ali (2005). Study the characteristics of some dried marshes soils in southern Iraq. Master Thesis - College of Agriculture - University of Baghdad.

Ali, Noureddine Shawky (2012). Fertilizer technologies and their uses. Ministry of Higher Education and Scientific Research - College of Agriculture - University of Baghdad.

AL-Kaysi, S.C. (1983). Physical and chemical characterization of carbonate minerals in Iraqi soils. Ph.D. Thesis, Dept. of Soil Sci. Newcastle Upon Tyne, U.K.

Al-Mahamid, Abd al-Halim Ali (1984). A study of the inheritance and development of some sedimentary soils in central Iraq. Master Thesis - College of Agriculture - University of Baghdad.

Al-Zubaidi, Ahmed Haider (1989). Soil salinity (theoretical and applied foundations), College of Agriculture, Baghdad University, Bayt Al-Hikma Press.

Baker D. Aljawasim, Hussein M. Khaeim and Mustafa A. Manshood (2020). Assessment of arbuscular mycorrhizal fungi (*Glomus* spp.) as potential biocontrol agents against damping-off disease Rhizoctonia solani on cucumber. *Journal of Crop Protection*, **9(1):** 141-147.

Balba', Abdel Moneim (1999). Reclamation and Improvement of Land. Modern Knowledge Library, Alexandria.

Balba, A. (1995). Management of problem soils in an arid ecosystem. Lewis Publishers. New York.

Bashour, I. and H.A. Sayegh (2007). Methods of analysis for soils of arid and semiarid regions. Food and Agriculture Organization of the United Nations, Rome.

Black, C.A. (1965). Methods of soil Analysis. AM. Soc. Agron. No.9 Part 1. Madison, Wisconsin. The USA. 374-390.

Doeny, Sadiq Jaafar Hassan (2003). The role of organic matter and water quality in the dynamics and distribution of salts in saline-affected soils. Master thesis. Department of Soil Sciences - College of the Agriculture / University of Baghdad.

Duiker, S.W., F.E. Rhoton, J. Torrent, N.E. Smeck and R. Lal (2003). Iron (hydroxide) crystallinity effects on soil aggregation. *Soil Sci. Soc. Am. J.*, **67:** 606-611.

Gabrielli G. Maurin, G. Poindessous and R. Rosset (1999). Nucleation and growth of calcium carbonate by an electrochemical scaling process, J. Cryst., Growth of 200. 236-250.

H. Karoui, A. Korchef, M.M. Tlili, H. Mosrati, O. Gil, R. Mosrati and M. Ben Amor (20080. Effects of Mg+2, Ca+2 and SO_4 2 ions on precipitation kinetics and microstructure of aragonite, *Ann. Chim. Sci. Mater*., **33:** 123-134.

Hartman, G. E. (2002). Mythos and dogmas of biocontrol changes in perceptions derived from research on Trichoderma harzianum. *Plant Disease*. **84(4):** 377- 393.

Hussein M. Khaeim, Bushra A. Jeber, Baker D. Aljawasim, Salwan Abdel Muaen Al-khaikani and Ali Ahmed Mohsen (2020). Tillers Patterns of Bread Wheat and Grain Yield Productivity Under Abiotic Stress. *Plant Archives*, **20(2):** 2020. e-ISSN:2581-6063 (online), ISSN:0972-5210.

Hussein M. Khaeim, Bushra A. Jeber and Mahmood A. Ali. (2019). Winter Wheat Genotypes Response to Different Water Quality. *International Journal of Agricultural and Statistical Sciences*. **15(2):** ISSN:0973-1930. eISSN-09763392.

Jackson, M.L. (1958). Soil chemical analysis. prentice-Hall. Inc. Engelwood. Cliffs, N.J.

Jeber, B.A. and H.M. Khaeim (2019). Effect of Foliar Application of Amino Acids, Organic Acids and Naphthalene Acetic Acid on Growth and Yield Traits of Wheat. *Plant Archives*, **19(2):** 824-826.

Khaeim, H.M. (2013). Mass selection with an optical sorter for head scab resistance in soft red winter wheat.

Khaeim, H.M., A. Clark, T. Pearson and D. Van Sanford (2019). Methods of Assessing Fusarium Damage to Wheat Kernels. *Al-Qadisiyah Journal For Agriculture Sciences (QJAS),* (P-ISSN: 2077-5822, E-ISSN: 2617-1479), **9(2):** 297-308.

Khaeim, H.M., A. Clark, T. Pearson and D. Van Sanford (2019). Determining The Effect of Mass Selection for FHB Resistance in Soft Red Winter Wheat Using an Image-Based Optical Sorter. *Al-Qadisiyah Journal For Agriculture Sciences,* (QJAS)(P-ISSN: 2077-5822, E-ISSN: 2617-1479), **9(2):** 278-296.

Khaeim, H.M., A. Clark, T. Pearson and D. Van Sanford (2019). Comparing Genetic Variation within Red Winter Wheat Populations with and without Image-Based Optical Sorter Selection. *Al-Qadisiyah Journal For Agriculture Sciences,* (QJAS)(P-ISSN: 2077-5822, E-ISSN: 2617-1479), **9(2):** 266-277.

Narrator Jamal Zahmal (1985). The effect of adding some soil reforms on some properties of calcareous, gypsum soils and millet plant growth using watering water of different quality. *Agricultural Research and Water Resources Journal*, **4:** 1- 20.

Page, A.L., R.H. Miller and D.R. Keeny (Eds) (1982). Methods of soil analysis. Part 2. 2nd edition. Chemical and Microbiological Properties. Am.Sco. of Agr, s.s.s.Am.inc., Madison, Wisconson, USA.

SAS (2012). Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. The USA.

Shahwan, T.A.C. Attain, H.N. Erten and A. Zarasiz (2002). Uptake of Ba2+ ions by natural bentonite and $CaCO_3$ A radiotracer, EDXRF and PXRD study, *J. of Radioanalytical and Nuclear Chemistry*, **254:** 563-568.

SSSA. 1997. Glossary of soil science terms. Soil sci. Soc. Am., Madison, Wisconsin, USA.

Zink, T.A. and M.F. Allen (1998). The effects of organic amendment on the restoration of a disturbed coastal sage scrub habitat. *Restoration Ecol*. **6(1):** 52-58.