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The effect of fertilizers on the percentage of total carbonate minerals on the sunflower (*Helianthus annuus L.*)

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Abstract
This study was carried out 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 after (30, 60, and 90) days from planting the sunflower plants. The experiment was designed according to the Complete Randomized Design (C.R.D). The treatments included mineral fertilization (160) kg.N.h^{-1}, symbolized by (M) and organic fertilization (poultry waste) at the level (10) tons.h^{-1}, symbolized as (O). Humic acid was applied at the level (450) kg.h^{-1}, symbolized by the symbol (H) a local variety of sunflower seeds (*Helianthus annuus L*) planned in pots on July, 13th, 2018. The present that the fertilizing type (mineral, organic and humic acid) plays a big role in the percentage of total carbonate minerals. The percentage of carbonate minerals in the soil of rhizosphere statistically decreased with the organic fertilization treatment as compared to the treatments of mineral fertilization and humic acid at the 30-day period of planting. The highest statistical decrease occurred with the treatment MHO (24.33) as compared to the comparison treatment. After (90) day period, into the sunflower rhizosphere, the values were lower than the treatment for O and MH, with significant differences compared to the treatment of mineral fertilization and non-significant from the treatment of humic acid. The percentage of total carbonate minerals decreases with time as plant growth continued and the highest values were recorded in bulk soils.

Keywords: total carbonate, rhizosphere, sunflower, fertilization, humic acid

Introduction
Most carbonate minerals in Iraqi soil are dispersed in separate minutes within the soil material and the remainder of these minerals are in the form of binder or encapsulated materials for other soil separations and that the ratio of their presence varies from one soil to another, AL-Kaysi (1983) [5]. Jar Allah (2000) [17] found in a study on the sediments of the Tigris and Euphrates rivers that the percentage of carbonate minerals in the seasons of the study soils took the following order for the deposits of the Euphrates River: Silt > coarse clay > sand > soft clay. As for the sediments of the Tigris River, they were arranged as Sand > silt > coarse clay > soft clay. The percentage of carbonate minerals in the clay separator with a soft and coarse particle represents the effective carbonates. Examining the soft sections of the sand separators for both deposits, it was found that the carbonate minerals were present in the form of separated materials or linked to the soil separations. Carbon chains were distinguished by being white mixed with red or black color.
Carbonate minerals affect the chemical behavior of many of the necessary elements in the soil, and that is either directly through the process of adsorption and sedimentation of these elements on their surfaces such as phosphorus, iron, and zinc, Nifaah (2002) And Al-Taey (2017) [8], Al-Mashhadani, (2008) [6] or indirectly through the effect of these minerals on chemical soil properties such as the degree of soil reaction (pH) and the cation exchange capacitance (CEC). Calcium carbonate is characterized by its complexity, its interactions with the soil system, and its chemical and geochemical reactions with other soil phases, Abril *et al*. (2003) [1]; and Rezaei *et al*. (2004) [25]. The presence of calcium carbonate in the soil in a certain percentage helps to increase soil granulation and improve its construction, and the compounds containing calcium are among the best materials for the reclamation of acidic soils and basic soils, Dib (1993) and Baker D. Aljawasim *et al* (2020) [9]. The distribution and amount of carbonate minerals affect soil fertility. Increased calcium carbonate in the soil usually leads to many problems related to the availability of nutrients, Jeber, B. A., *et al* (2019) [14].
The amount of carbonate minerals affects the soil, and its chemical and physical nature (size of carbonate minutes and type of mineral), Hamid (2009) [27] and Khaeim, H. M. (2019) [19]. Carbonate also greatly affects the chemical properties of soil in calcareous soils. Such as nutrient availability and phosphorous fixation due to chemical fixation that reserved from (70 – 90) % of phosphorous fertilizers applied to the soil, Havlin *et al*. (2007) [15] and Hussein M. K *et al* (2019) [14].
Fertility and the resultant harvest efficiency because of supplement irregularity in the soil, which has been perceived as a standout amongst the most imperative factors that limit crop yield. Along these lines, the utilization of chemical fertilizer may not keep pace with time in support of soil well-being for maintaining the efficiency (AL-Juthery *et al*, 2018; AL-Taey and AL-Musawi, 2019) [4, 7].
Based on the above mentioned, the aim of the research is to study the effect of fertilization on the percentage of total carbonate minerals on the rhizosphere sunflower plant.

Methods and Materials
This study was done in the canopy of the Department of Soil Science and Water Resources at the College of Agriculture, University of Al-Qadisiyah. The soil was brought from the extension station in Noria. The soil was airly dried, grinded and sifted through a (4) mm diameter sieve. **(**20) Kg dry soil

was placed in each pot and prepared for planting. A local variety of sunflower seeds (*Helianthus annuus L*) planned on the 13th of July 2018 in plastic pots. 5 seeds were planted in each pot, and after (15) days, the seedlings were rugged out to a single plant per each. Fertilizers were applied heading to planting, potassium sulfate fertilizer (K_2O) was applied at a level (80) kgK_2O^{-1}, and triple superphosphate fertilizer was applied at a level (80) $kg.h^{-1}$. Urea fertilizer (46) % N was applied at a level (160) $kg.N.h^{-1}$ twice, after (15) days of planting and after (30) days after the first application

The process of hoeing and weeding were done manually to get rid of bush plants growing with the plant whenever required. Irrigation was carried out when the water reached (50) % of the field capacity and according to the plant's need for humiliation. A sample of soil was taken before planting, dried, and pulverized with a plastic mallet and passed through a sieve with a diameter of (2) mm.

Some physical and chemical properties were estimated by the methods mentioned in Jackson (1958) [16], Black (1965) [10] and Page and others (1982) [24] and presented in Table (1). The total carbonates of the rhizosphere and bulk soils were estimated during plant growth periods after (30, 60 and 90) days after planting using (1) M of HCl and (0.5) M of NaOH as mentioned in Page *et al* (1982).

The results were analyzed statistically by using the Statistical Analysis System (SAS) (2012) to study the effect of the different treatments (fertilization and treatment) according to a Complete Randomized Design (CRD), Khaeim, H. M. *et al* (2019) [20]. The significant differences between the means were compared with the Least Significant Difference (LSD) test.

Table 1: Some 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) [24]
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) [24]
Organic matter		11.37		Black, (1965) [10]
Cationic dissolved ions	Ca^{2+}	25.45	Cml.charge.L^{-1}	Page *et al*., (2982) [24]
	Mg^{2+}	13.44		
	Na^{1+}	40.58		Jackson, (1958) [16]
Negative dissolved ions	SO_4^{2-}	17.95		Black, (1965) [10]
	HCO_3^{1-}	16.8		Jackson, (1958) [16]
	CO_3^{-2}	Nill		
	Cl^-	41.56		Jackson, (1958) [16]
Available Nitrogen	$N-NH_4^+$	22.18	Mg. kg^{-1}	Black, (1965) [10]
	$N-NO_3^-$	19.33		
Available phosphorous		16.30	Mcg.m^{-1}	Page *et al*., (2982) [24]
Available potassium		164.40		Black, (1965) [10]
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 30 days of planting

Table (2) present the percentage of the total carbonate of the soil into the rhizosphere and in bulk soils after (30) days of planting the sunflower seeds. The results present that there were non-significant differences at the level significance of (5) % for all treatments in and around the rhizosphere. This may due to the small size of the sunflower root group system and in this period, the plant still young. It can be observed that the highest percentage of total carbonates outside the rhizosphere is the application of the (HO) treatment (37.66) % and the lowest with the (MO) treatment (29.33) %.

The highest percentage of total carbonates into the rhizosphere recorded with the (M) treatment (31.33) % and the lowest under the (MHO) treatment, (24.33) %.

Therefore, the effect was not from the roots of the plant, but rather because of the applied organic compounds and acidic ions that lead to decrease the carbonate values. The organic matter is a source for the supply of plants and microorganisms with a number of nutrients necessary for its growth in Addition to improving some soil properties such as regulating the movement of water, air and gas exchange, increased soil susceptibility to water retention, increased cation exchange capacitance of positive ions, and soil pH reduction, Alhadithy (2002). It is also noticed that the percentage of total carbonate of the rhizosphere decreased under all of the treatments compared to the treatments of bulk soil.

Table 2: Percentage of total calcium carbonate after the (30) days of planting

Treatment	Soil Type	
	Rhizosphere soil	**Bulk soil**
Control	30.33	33.00
M	31.33	36.00
O	28.00	32.00
H	30.00	35.00
MO	28.66	29.33
MH	26.00	34.00
HO	30.33	37.66
MHO	24.33	30.00
) *P<0.05.(	8.715 *	

Total carbonates after 60 days of planting

Table (3) presents the effect of the application of mineral fertilizer, organic fertilizer, and humic acid and their overlap on the percentage of total carbonates of the rhizosphere and bulk soils after (60) days of planting. The results showed that there were significant differences at the level of significance of (5) % under treatments of O MH and HO (28.33, 28.00 and 31.33) in the soil of the rhizosphere, while there were non-significant differences under the rest of the treatments. In the bulk soil, all the parameters were not significant except with the M treatment whose value decreased as compared to the comparison treatment (20.66)%, whereas the MH and HO treatments increased their value over the comparison treatment (34.33 and 34.00) %, respectively.

The highest percentage of total carbonate in bulk soil was under the MH treatment (34.33) % and the lowest in the M treatment (20.66) %. This is due to the calcium ions' of organic compounds that combine with carbonates and increase their sedimentation, Gabrielli *et al*. (1999) [11] and Karoui *et al*. (2008) [13].

The highest percentage of total carbonates into the rhizosphere obtained under the HO treatment (31.33) % and the lowest one obtained under the M (17.00) %. This is due to the application of chemical fertilizer, which increases the growth of the plant and thus increases its vital activities and its inspiration that leads to increased the rate of CO_2 release and organic acids, which leads to an increase in the dissolution of carbonates. It was also noted that the percentage of total carbonates for all treatments in the rhizosphere is less than in bulk soil this period of growth (flowering stage) except for organic fertilization.

Table 3: Percentage of total calcium carbonate after (60) days of planting

Treatment	Soil Type	
	Rhizosphere soil	Bulk soil
Control	21.33	27.66
M	17.00	20.66
O	28.00	23.66
H	23.33	25.00
MO	24.33	29.00
MH	28.33	34.33
HO	31.33	34.00
MHO	22.66	27.00
) *P<0.05.(	6.073 *	

Total carbonates after 90 days of planting

Table (4) shows the effect of the application of mineral fertilizer, organic fertilizer, and humic acid and their interaction on the percentage of total carbonates of the rhizosphere and bulk soils after (90) days of cultivation. The results present that there were no significant differences at the level of significance of (5) % for all studied treatments and for the rhizosphere and bulk soils, which indicates a decrease in the effectiveness of plant roots in this period of plant growth stages. In bulk soils, treatment M resulted in the highest percentage of total carbonates (33.00), while the lowest was under the treatment of MH (19.66) %. In the soil of the rhizosphere, the highest percentage of total carbonates obtained under in the M treatment (27.33) %, and the lowest under the MH treatment (16.66) %. The percentage of total carbonates continues to decrease during this time period in both of the rhizosphere and bulk soils.

Table 4: Percentage of total calcium carbonate after (90) days of planting

Treatment	Soil Type	
	Rhizosphere soil	Bulk soil
Control	23.00	28.33
M	27.33	33.00
O	20.33	24.66
H	25.33	29.00
MO	26.33	30.00
MH	16.66	19.66
HO	17.33	21.66
MHO	18.66	22.66
) *P<0.05.(	6.832 *	

Based on the results, the percentage of calcium carbonate generally decreased as increasing growth periods and its highest values were in the soil outside the rhizosphere, Figure (1).

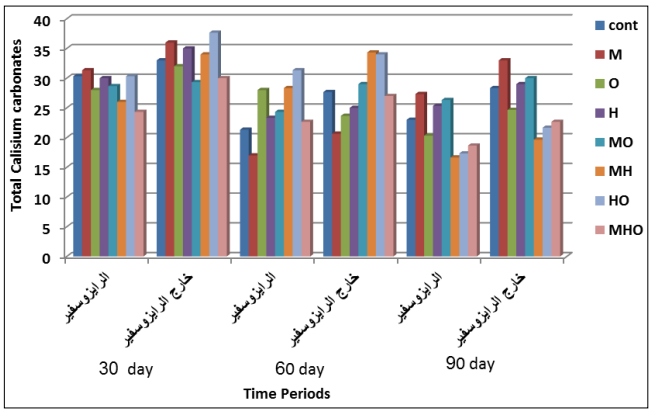

Fig 1: Percentage of total calcium carbonate for sunflower during growth periods

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