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The Effect of Sawdust Extract Injection on the Physical Characteristics of Compacted Soil

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ABSTRACT
Compacted and Undisturbed soil samples were collected, from a field in the west of Baghdad. soil samples were wetted according to the capillary property. sawdust extract was injected into soil cylinders in form of a solution to get soil moisture to limits of field capacity, and with three treatments, control and equivalent of 5% of organic matter into the soil as once at first wetting and drying cycle, and third treatment was an application same amount on seven cycles. Distribution size of the aerobically dried soil aggregates, dry sieve for the second half of the sample, using a set of sieves 9.5, 4, 2, 1, 0.5, and 0.25 mm. Bulk and soil bulk density was estimated, the clay flocculation index CFI, and the soil penetration; results can be summarized as follows: Soil aggregates greater than 9.5 were not affected by the application of extract only in aggregates with a size of 4-9.5 mm, while the wetting and drying cycles significantly affected the percent of large soil aggregates (greater than 9.5 mm and those with a size of 4-9.5 mm), at the same time, the interaction effect of in these two volumetric ranges was more significant than the effect of fraction factors; A decrease in the bulk density and soil penetration is indicated by the application of sawdust extract compared to the control treatment; on the other hand, values of two indicators decreased in most of the seventh wetting and drying cycles. Samples treated with the full amount appear under an electron microscope with greater and more granularity and smooth edges compared to the division of quantity on wetting and drying cycles, which in turn appear better.

Keywords: Bulk density, clay dispersion, clay aggregation, soil penetration.

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INTRODUCTION

Soil structure is defined as the regularity and arrangement of the initial soil particles (sand, silt, and clay). These are linked together, forming specific geometric shapes and arrangements. Soil aggregation is a complex process, with the interaction treatment of many biological and abiotic factors, as well as processes that affect soil properties, such as mineral composition, soil texture, bioactivity, and environmental activities, and soil management treatments such as plowing (Bronick and Lal, 2005). Li *et al.* (2010) mentioned that organic matter contents, including polysaccharides, humic and fulvic acids, are of great importance in soil aggregates stability, rather than compounds and nutrients that make up the organic matter in general. Organic matter also increases soil biota activity, whose secretory activities contribute to structure soil stability, and improving physical properties (Tayel and Abd EL-Hady, 2009). Fageria *et al.* (2005) explained that frequency and type of plowing affect soil organic matter content, so in ecosystems there is a deterioration in soil structure, as a result of repeated plowing, causing a decrease in soil organic matter content. Oguike and Mbagwu (2009) found that the weighted main diameter (MWD) as a stability index of large soil aggregate was higher in bush fallow lands than in meadowlands, and that the lowest MWD was on plowed lands, while values ASC, DR, and clay flocculation index (CFI) are evidence of better micro-aggregates stability in meadow soils than other lands, and that DR was highest in plowed soils and that the dispersion percentage was highest in cassava farmlands.

Park *et al.* (2007) study showed that aggregate stability was significantly decreased when they exposed soil aggregates to two and three wetting and drying cycles and when carbon glucose was not added compared to the absence of wetted cycles and non-application of carbon glucose, as well as carbon glucose application of to maintain soil aggregates stability for five wetting cycles when wetting cycles were compared with each other. The response of aggregates stability and sizes distribution of their to sodic were influenced by clay minerals, content and type of wetted of samples, and soils containing kaolinite were less effective in stabilizing their aggregates. Ruiz-Vera and Wu (2006) subjected soil aggregates to conditions of non-sodic and slow wetting, they observed that shrinkage, swelling, and dispersion were major factors affecting soil stability of containing smectite and soils containing vermiculite. Soil clay content compared to kaolinite soils aggregation forming factors such as wetting and drying cycles (WDC) distribute carbon differently in different aggregations depending on the aggregation site, its size, or both (Urbanek *et al.* (2011). carbon sequence due to compost applications for eighteen years increased carbon stability in the fine soil aggregate and the clay fraction. + Silt, in contrast, soil carbon increased by increasing NPK fertilization, but less consistently in large soil aggregations and the clay + silt portion (Yu *et al.*, 2012)

The aggregation of organic matter in soil aggregates plays a major role in the organic matter stability that supported by the variation in the patterns of sizes distribution of these aggregates compared to the stability patterns of soil organic carbon, suggesting that the adsorption of organic matter on the surfaces of the mineral part is the main mechanism for stabilizing the organic matter that dominates the storage and organic carbon stability (Yang *et al.* 2020). Guo *et al.* 2019 showed that MWD increases with increasing soil depth and that fertilization, especially farmyard manure, has improved the stability of soil aggregates with fast wetting and mechanical fracturing at surface depth 0-15 cm, and the correlation between MWD with fast wetting and mechanical cracking at the same depth, organic carbon molecules increased, total organic carbon and carbohydrates dissolved in hot water and pH, and the interference with iron oxides and amorphous aluminum oxides enhanced aggregates stability against degradation. Therefore, this study aims to evaluate the effect of sawdust extract injection on soil physical properties of compacted soils.

MATERIALS AND METHODS

Sawdust was collected from a carpentry factory in Baghdad. The collected amount was placed in a pile, and an anaerobic decomposition process was carried out. Sawdust was placed on top of polyethylene pieces, then nitrogen was applied under 2% (urea 46% N), and phosphorus (P 0.5%), in the form of fertilizer Triple superphosphate (20% P) Al-Hadithi, (1997). The mulch pile is constantly moistened by spraying water and turned every 4 to 5 days while covering with polyethylene until a degree of decomposition is reached which made the original material cannot be diagnosed, as well as the decrease in the pile reaction temperature, from 65 °C to 45 °C, using the thermometer to change follow daily of temperature, as a guide to reach the end of the reaction, after which the decomposed sawdust was brushed and left to air drying. Compacted and undisturbed soil samples were collected from a field at west Baghdad city that soil did not use to two years using PVC cylinders, with a thick wall in diameter of 10 cm and 10 cm in height, one end of the cylinder was sharply drilled to facilitate penetration of the soil, the cylinders were lowered into the soil with a hydraulic press, after which the soil was dug around the cylinder not to touch the soil cylinder, and the soil sample was cut with a knife from the bottom of the cylinder, then the cylinders were packed after being lifted from the field in a walled box Then the spaces between the box wall and the cylinders were also filled with the foam material, to avoid being shattered while moved, and then it was transported to the laboratory for treatment and analysis.

Soil samples were moistened by capillary propriety. Cylinders were placed on a fine column of sand of 0.5 mm size and 10 cm above the water surface. The water column was fixed using a Mariot Bottle. The hydration process continued until the soil sample reached the saturation point (approximately 16 hours), after which the samples were left to drain water until the field capacity limits. The first treatment was incubated, which was not treated with the sawdust extract. In the other two treatments, the entire amount of sawdust extract (SE) was applied to the second treatment and in the third treatment the same amount of sawdust extract was applied to the second treatment and divided into the seven wetting and drying cycles (WDC), the two treatments were injected, the second and third, according to the amount of solution required to be applied to the soil from the extract, after the moisture of the cylinders of both treatments reached less than the field capacity, this amount is sufficient to get field capacity limits again. The amount of SE was injected with gravity at a height of 1 m, and four syringes, 5 cm apart from the other, forming a square in the center of the container. With an amount equivalent to the amount of organic matter that the organic soils are supposed to contain, that is, the application was made equivalent to 5% of the supposed organic matter; the soils were injected with many cylinders of the same quantities of extract, which covers all wetting and drying cycles as well as their repetitions (Alnuaymy and Alalusi, 2016), this containers also incubated.

All samples were incubated for five days at 22 ° C. (Smucker *et al.*, 2007). The cylinders were placed on the ground horizontally after being removed from the incubator to be air-dried for three days, then the samples were re-wetted for the cylinders that would remain in the subsequent cycles until the saturation point at 16 hours again. As for the treated containers on which the analysis will be conducted, a cylinder of soil is cut from opposite sides, into two halves with a longitudinal inclination by melting the plastic container with a heated knife to redness, then the mold is divided into two parts by hand, one of the two parts was taken for analysis. The soil was passed through a sieve with a diameter of 2 mm, and its natural moisture (after air drying), then sieved and dried the air-sieved soil at a laboratory at room temperature and prepared for analysis except for distribution size aggregate, Table 1 shows some soil properties. The bulk density was estimated by wrapping a pool of soil with paraffin wax according to the method mentioned by [Black 1965]. The actual soil density of the soil was estimated using a pycnometer [Black 1965], while soil texture was estimated by an absorbent method as shown in Gee and Bauder (1986). The CDI clay dispersion index and CFI clay forth index were estimated after removing the binder and using a hydrometer and based on Stoke's law and from the equations below.

$$CDI = \frac{\%\,clay\ (w)}{\%clay\ (g)} \times 100 \qquad \text{............1}$$

$$CFI = \frac{\%\,clay\ (g) - \%\,clay\ (w)}{\%clay\ (g)} \times 100 \qquad \text{..............2}$$

Where clay (w) is the percentage of clay upon sedimentation with distilled water only, and clay (g) the percentage of clay upon dispersion.

pH was estimated [Richards.1954] using a pH-meter, and the electrical conductivity was estimated [Richards.1954] using an Ec-meter. At the same time, gypsum was estimated by sedimentation with acetone, while the organic matter was estimated by wet digestion method, as reported in [Richards, 1954]. Total nitrogen in the soil was estimated by the Kjeldahl apparatus method according to [Richards, 1954] as illustrated [Bremer 1960].

Water saturation degree at moisture tension 0 kPa, as well as soil moisture at the field capacity limits (33 kPa) and the wilting point (1500 kPa) were estimated using pressure vessels according to the method (Rawlin *et al.*2013). The pocket penetrometer (CL700) has a cylindrical stem and a flat end with a diameter of 0.00672 m and a penetration depth of 0.01 m from the soil surface (Donald, 1965).

The aggregates size distribution of the air-dried was estimated, dry sieve for the second half of the sample, using a set of sieves 9.5, 4, 2, 1, 0.5 and 0.25 mm, then weighed amount of soil retained on each sieve, then estimate distribution size of soil, as weight ratios to simulate the main weighted diameter index commonly used in assessing soil aggregates stability.

Table 1: physical and chemical properties of the study soil.

Character	Value	Measure unit	Character	Water stress	Value	Measure unit
pH	7.34	ds m^{-1}	Soil Moisture	0	49.0	%
Ca	254	g kg^{-1} soil		33	28.4	%
gypsum	2.099	g kg^{-1} soil		1500	14.2	%
M.O.	0.71	g kg^{-1} soil		Sand	385	g kg^{-1} soil
Bulk density	1.73	$Meq.m^{-3}$	Soil Texture	Silt	468	g kg^{-1} soil
				Clay	147	g kg^{-1} soil
			Silty clay loam			

RESULTS AND DISCUSSION

Volumetric distribution of soil clusters

Figure 1 shows that the two methods of injection of whole and fractionated SE did not significantly affect soil aggregates size larger than 9.5 mm, and this may be due to dissolving some bonds due to the acid effect of the extract, as the extract consists of fulvic and humic acids. At the same time, it is noticed that WDC increased the percentage of soil aggregates (POSA) greater than 9.5 mm in the third, fourth and fifth cycles significantly, with increases of 36.7, 25.9, and 27.9%.

The interaction of two factors increased in soil aggregates greater than 9.5 mm significant in the fourth wetting and drying (WD)cycles and for the two methods of complete and fractional injection, with an increase of 66.8% and 25.5 for the two methods, respectively. Also, there is a significant increase in the injection of the SE in the sixth cycle with the fractional addition, with an increase of about 28.3%, And in the seventh cycle when adding the entire amount with an increase of 38.5%, and the remaining increases in the POSA greater than 9.5 mm were not significant, at the same time a significant decrease in the POSA greater than 9.5 is observed in the fifth WDC, with a decrease of 31.9%, and the rest of the declines were not statistically significant

Micro-organisms activity has led to this increase as a result of the accumulation of multiple products of this activity, in addition to the high percentage of clay (Table 1), and the quality of the minerals forming this separation, such as the minerals of montmorillonite and illite expanded (Al-Bayati and Al-Rawi 2000), which allows the reformation of soil aggregates, as well as to Increase the clay flocculation index (CFI) and decrease the clay dispersion index (CDI) Fig. 8 and 9. While the destructive factors due to contraction and expansion in the last two cycles were stronger than the building factors, especially since the microorganisms of the soil must have changed their types and numbers over time, the effectiveness of microorganisms and stabilization of organic carbon in large soil aggregates and vice versa in small soil aggregations (Bimüller *et al*. 2016).

It was also noticed from the figure that the size of soil aggregates within the range greater than 9.5 mm has increased significantly in the third and fifth cycle, and this may be due to the quality of the minerals that make up that soil. It is also evident from Figure 1 that the full application method was significantly higher as compared to fractionation and vice versa in the second Fifth, the reason for this behavior is not understood. Perhaps the amount of extract added in these sessions is still small so that it was affected by the same factors that affected the soil under the control treatment sawdust.

It is noticed from Figure 2 that the WDC increased the weight percentage of soil aggregates (WPOSA) with a diameter of 4-9.5 mm significantly by increasing the WDC except for the third and fourth cycles. This is a result of the increase in the growth of microorganisms over time, which made the aggregation factors greater than the Crushing factors, while the application method did not affect the POSA with a size of 4-9.5 mm.

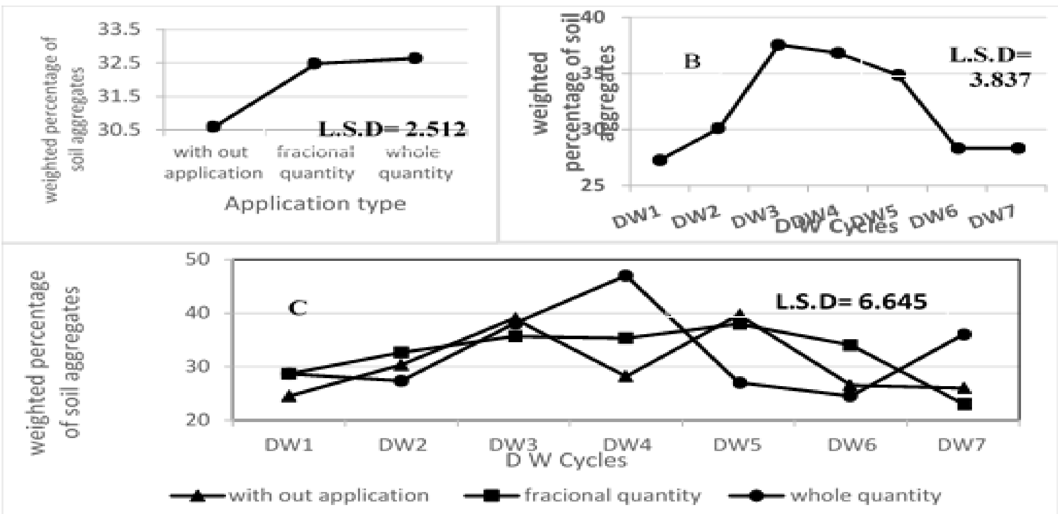

Figure 1. Effect of SE injection on the size distribution of larger soil aggregates of 9.5 mm. A type of addition, B WDC, C interaction

The WDC increased the WPOSA with a diameter of 4-9.5 mm significantly by increasing the WDC significantly, except for the third and fourth cycles. This is a result of an increase in the growth of microorganisms over time, which made the aggregation factors greater than the destructive factors. The application method did not affect WPOSA with a size of 4-9.5 mm.

The same figure shows that there was no significant effect on the WPOSA sizes with a diameter of 4-9.5 mm when fractionally adding SE with WDC interaction except for the sixth cycle in aggregates percentage with 19.3. when full addition, it is noticed that the WPOSA with a diameter of 4-9.5 mm did not change in the first cycle and decreased in the second to the fourth cycle, as the decrease in this cycle was significant, while it increased in the rest cycle, and significantly at the sixth cycle by a percentage an increase of 14%, compared to not adding SE, When comparing SE addition fractionally and complete form, it is noted that the WPOSA for the same range of sieving, it decreased significantly in the fourth cycle when adding full quantity compared to fractional by 25%, noting that the values of the whole injection were less than the values of the other two methods. Except for the fifth and sixth cycles, while it increased by 29.2% for the same addition methods in the sixth drying and moisturizing cycle, changes were not significant for the rest of the cycles. WDC increased the WPOSA with a diameter of 4-9.5 mm significantly by increasing the WDC significantly, except for the third and fourth cycles. The addition method did not affect the WPOSA with a size of 4-9.5 mm.

Figure 3 shows the injection SE and WDC effect on the aggregates sizes distribution of soil with a size of 2-4 mm. WPOSA is shown to have decreased in general for the two methods of application compared to control treatment when the two factors interacted, but the decrease was not significant except in the fourth WDC, and not significant to the WDC and adding SE. The two methods of application and WDC had no significant effect in changing the WPOSA for the sieving range of 2-4 mm.

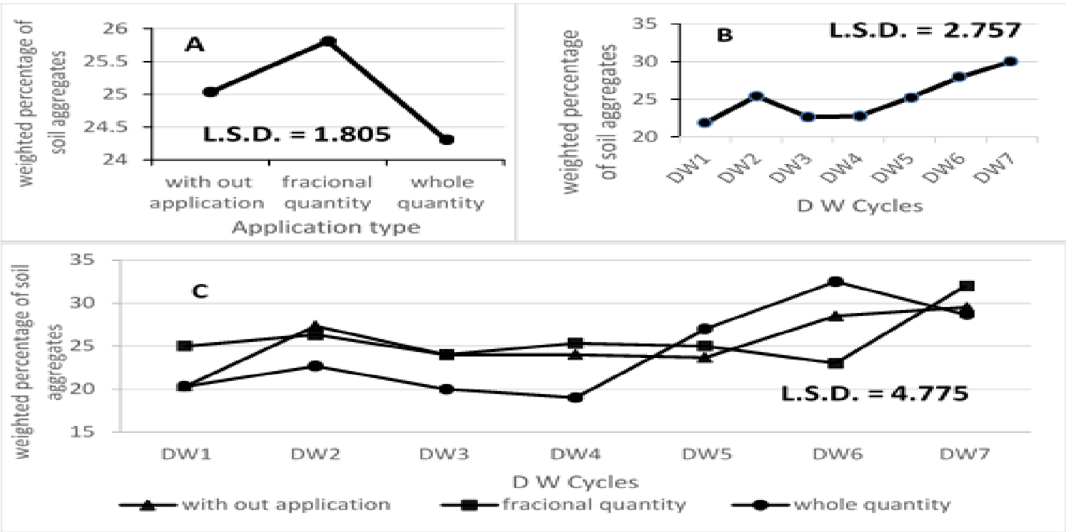

Figure 2. Effect of SE injection on the size distribution of 4-9.5 mm soil aggregates. A type of addition, B WDC, C interaction

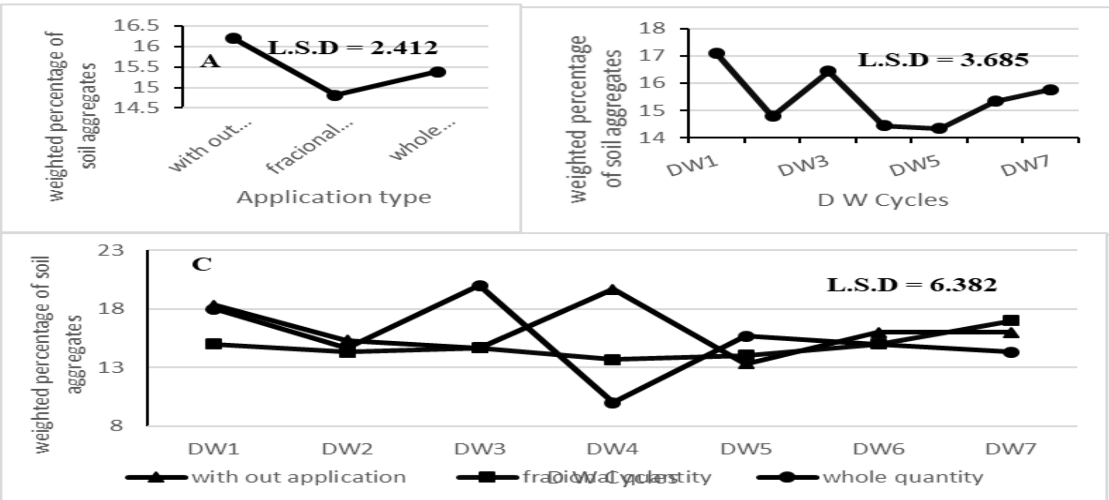

Figure 3. Effect of SE injection on the size distribution of soil aggregates 2-4 mm. A type of addition, B WDC, C interaction

Figure 4 shows that there is no significant effect when the application methods interact with the WDC in the WPOSA within aggregates size between 1-2 mm, except that this percentage decreases significantly when applying the full amount of SE from the sixth WD cycle, also, WPOSA within the sieving range 1-2 mm was not affected by of WDC, nor by the two methods of application compared to non-application, noting that the sixth WD cycle increased the WPOSA significantly, and the reason for this is due to the shattering soil aggregates larger than 9.5 mm after the fourth cycle, as increasing them in the fourth cycle reduced the percentage of aggregates within the range 1-2 mm.

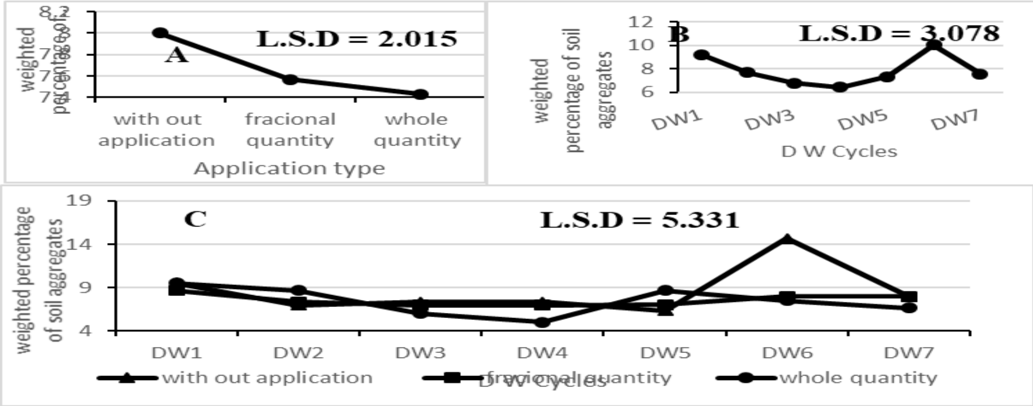

Figure 4. Effect of SE injection on the size distribution of soil aggregates of 1-2 mm. A type of addition, B WDC, C interaction

Figure 5 revealed that the WPOSA with a size of 0.5-1 mm was also not affected by the application of SE and WDC significantly, except that it decreased significantly in the sixth WD cycle, with a decrease of 49% and 46% for the two application methods. The WDC did not significantly affect the POSA. However, the difference between its decrease in the WDC from the second to the fifth and its height in the sixth was significant, that is, the remodeling of soil aggregates in this size and with the sixth WDC is a result of the destruction of the same aggregates The diameter is 9.5 mm, which was increased in the fourth cycle, by the inevitable change of chemical formulas for fulvic and humic acids by the time aging of the organic matter (Nuzzo *et al*. 2013).

WPOSA with a size of 0.25-0.5 mm, as well as those of less than 0.25 mm shown in Figures 6 and 7, behaved like the WPOSA in size 0.5-1 mm. In any case, the WPOSA formed approximately 10% or less than that. In most cases, this will be explained later in Figures 8, 9, and 10.

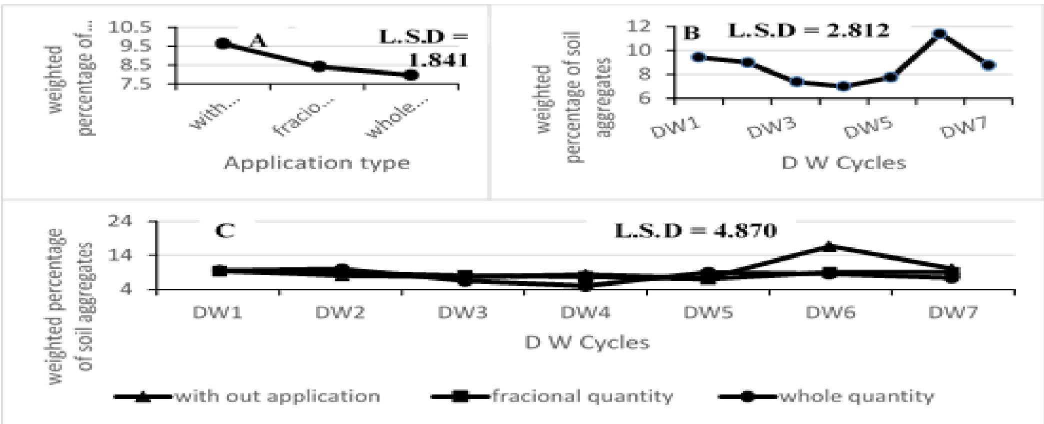

Figure 5. Effect of SE injection on the size distribution of soil aggregates of 0.5-1 mm. A type of addition, B WDC, C interaction

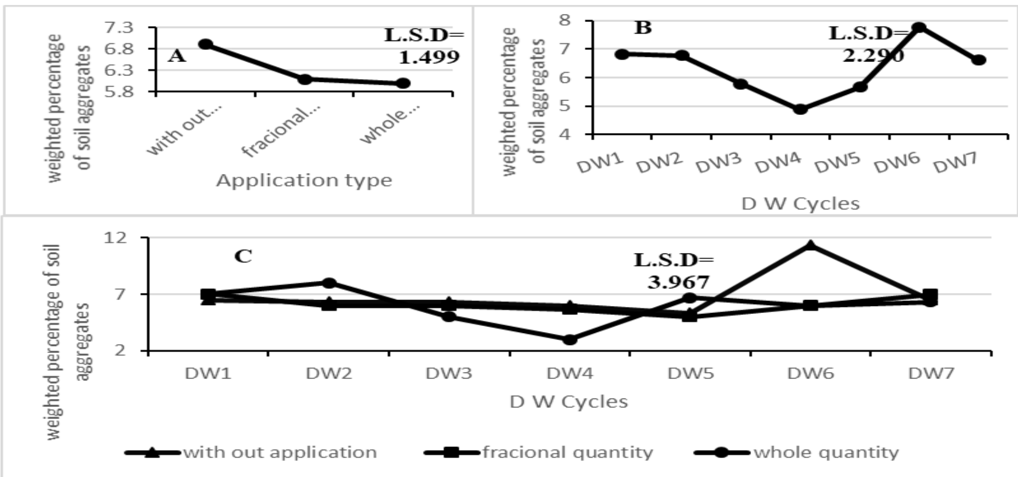

Figure 6. Effect of SE injection on the size distribution of soil aggregates of 0.5-0.25 mm A type of addition, B WDC, C interaction

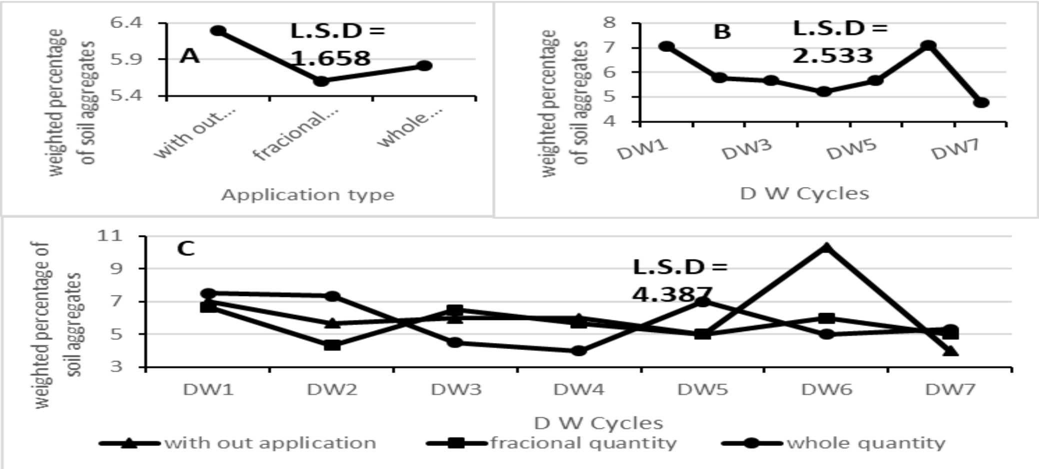

Figure 7. Effect of SE injection on the size distribution of soil aggregates less than 0.25 mm. A type of addition, B WDC, C interaction

Some Soil aggregation stability index:

F|igure 8 revealed that there is an increase in the values of the clay flocculation index (CFI), when the soil was injected with SE for fractionation treatments and the full quantity compared to not injecting SE, and the percentage of increase was 4.62% and 5.93%, respectively. An increase in the CFI values is also observed, with an increase of 5.72% and 8.64%, respectively, and this is due to the formation of humic-clay complexes, which keep the soil from breaking down, and the carboxylic groups in organic matter with multi-charged cations form bridges of organic complexes. Minerals - clay. As well as the humic anions between the positively charged faces of the clay (Imbufe *et al*. 2005, Al-Nuaymy and Al-Hadithi 2014), or perhaps the effect of such complexes on the electric double layer on the one hand and the other hand also affects the electrical charge of the surfaces of the clay particles and the particles of the organic matter itself.

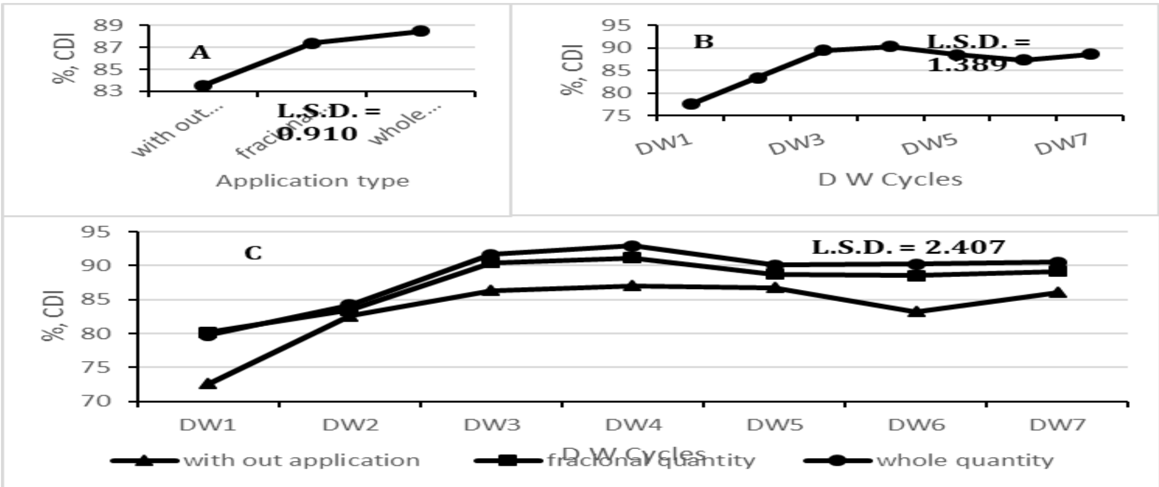

Figure 8. Effect SE injection and WDC in CFI A type of addition, B WDC, C interaction

WDC increased the CFI by increasing the WDC also significantly, with an increase of 7.6, 15.4, 16.6, 14.2, 12.7, and 14.2% in the cycles after the first WD cycle respectively, due to the relative rise of the clay separator In the study soil (Table 1) and to the clay minerals that make up the study soil, such as the minerals of montmorillonite and expanded illite (Al-Bayati and Al-Rawi, 2000), noting that the fourth cycle has increased CFI more than the rest of the cycles and that this may be due to the increased accumulation of compounds the biological processes developing on the extract leading to the influence of building agents and bridging. Also, the negative charge on the clay particles increases with the increase in the degree of soil interaction, which leads to controlling the dispersion of the clay and increasing its clotting, and that the largest groupings are formed in soils with a degree of interaction and concentration of high carbonate Bronick and Lal (2005), and that Table 1 shows that pH and carbonate concentration of soil the study agrees with that. Likewise, the collection of organic matter in soil aggregates varies according to the patterns of distribution of the size of these aggregates compared to the stability patterns of soil organic carbon, and that adsorption of organic matter on the surfaces of the mineral part will stabilize the organic matter that controls the storage and stability of soil organic carbon (Yang *et al*. . The effect of the interaction treatment between the method of applying SE and the WDC was consistent and enhanced the effect of the two separate factors.

Figure 9 showed the effect of SE and the WDC in the clay dispersion index (CDI), as it is evident that the index decreased significantly for the two methods of application compared to no application, on the one hand, and the CDI also decreased significantly in the cycles that follow the first WD cycle. CDI is at its lowest levels at the first and second cycles, that this is a result of the mechanical breakdown of the WDC, as well as the amount of difference in the expansion of the parts of the large masses more than the small ones, which leads to their breakage and since the treatment of soil with SE has increased the proportion of large aggregates. Thus, the clay will be intertwined with those large parts (Al-Muhammadi 2019), and from a comparison of Figures 8 and 9, we conclude that the CFI has a high impact, which reduces the effect of the CDI

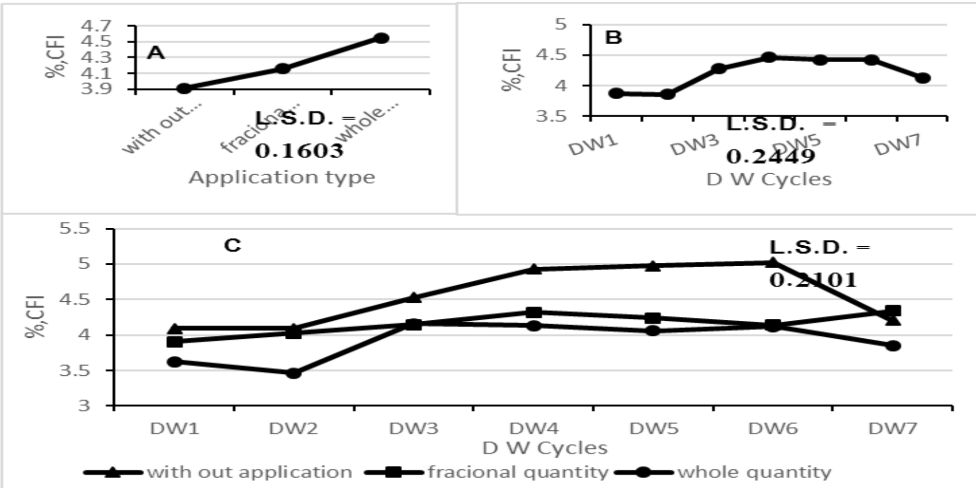

Figure 9. Effect of SE injection and WDC in CDI. A type of addition, B WDC, C interaction

Soil Bulk density

It is noticed from Fig. 10 that there is a significant decrease in the soil bulk density when injecting the soil with SE, for the two fractionation treatments and the entire added amount significantly compared to non-injection, with a decrease of 3.05% and 8.29%, respectively. The figure also shows that the third and seventh wetting cycles affected the apparent soil density, with a significant decrease of 11.7 and 6.3% compared to the first cycle. The interaction treatment between the two factors shows the addition of the extract in the second and fourth cycles in a fractional manner affected the soil bulk density significantly, as the soil bulk density decreased by between 5.5 and 5.7%, but the injection of the full amount of the extract reduced the soil bulk density significantly, by a percentage of 9.4, 8.5 13.3, 5.9 and 6.3% for all WDC except for the sixth cycle. It is also noticed from the figure a significant decrease in the value of bulk density in the third cycle compared to the other cycles. This is due to the increase in the large soil aggregates in Figures 1, 2, and 3, which led to an increase in the interstitial pores, as is also evident in Figures 12, 13, and 14, as a result of the growth of fungi groups and the increase in the biomass of micro-organisms, as well as the increase in the percentage of organic matter as a result of the death of living organisms developing on soil organic matter extract and low organic matter density, the bulk density of which is low compared to the mineral fraction, (Al-Nuaymy and Alousi 2016) and the overall soil porosity profile (Celik *et al.*, 2004, Salih at al, 2005 and Mosaddeghi *et al.*, 2009). As well as the formation of communities of microorganisms, and the growth of mycelium as a result of incubation (Al-Nuaymy and Alousi 2016).

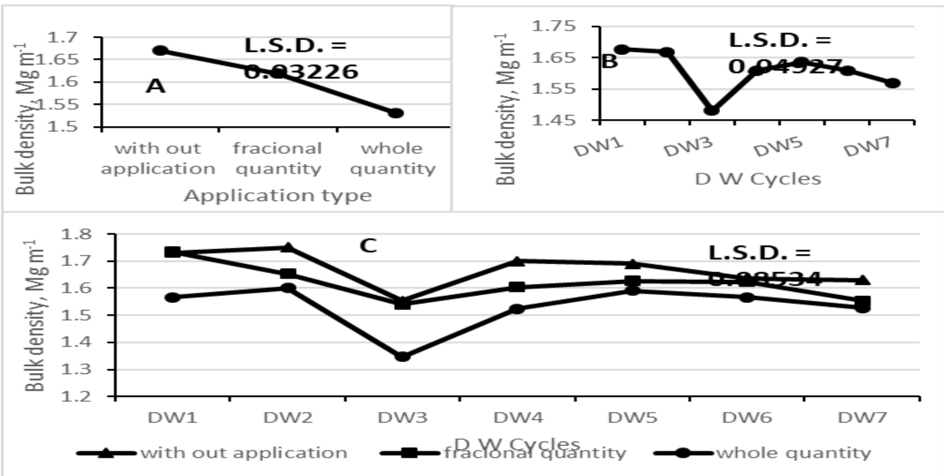

Figure 10. Effect of SE injection into the soil on soil bulk density. A type of addition, B WDC, C interaction

Soil penetration

Figure 11 shows a significant decrease in soil penetration when treating the soil with SE, for fractionation treatments and the full amount compared to the comparison treatment, which decreased significantly by 37% and 58%, respectively, compared to non-injected soil, while the WDC affected the fourth cycle Only significantly, as soil penetration decreased by 28% compared to the first cycle. It was also evident that the interaction treatment has increased the penetration resistance of the soil in the third, fifth, and seventh moistening cycles significantly when the soil was not injected with sawdust extract. While the soil penetration resistance decreased significantly at the fractional injection for all sessions compared to the first cycle except for the second cycle, with decreases of 54.8, 47, 45.1, 49.4, and 54.2% from the third to the seventh cycle, respectively, while the soil penetration resistance decreased when the extract was injected. It was significantly when full injection for all the WDC, with decreases of 49.4, 64.5, 52.9, 52.2, 69.9, and 68.6% from the second to the seventh cycle, respectively, compared to the first cycle. The reason for the decrease is because the organic matter helped to keep the soil in the form of stable and large aggregates, Figures 1, 2, and 3.

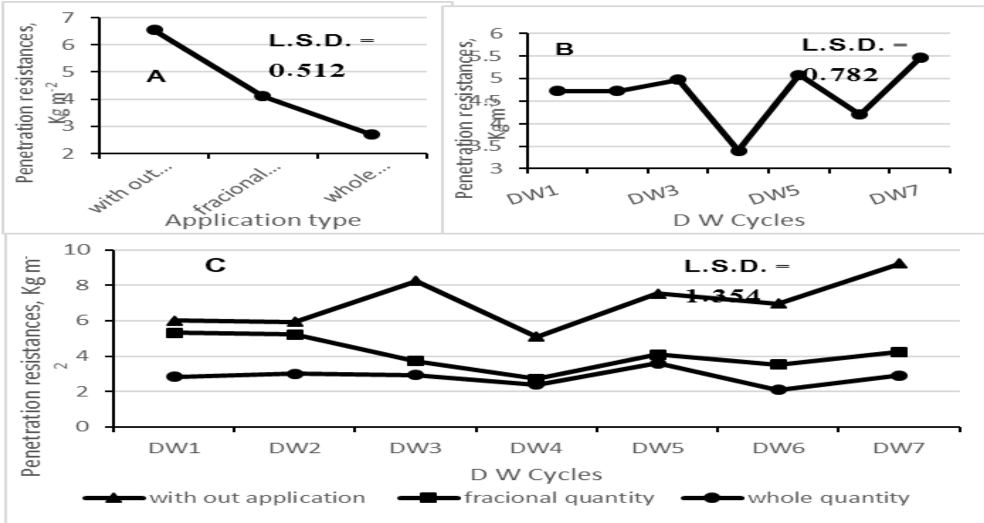

Figure 11. Effect of SE injection, WDC on soil penetration. A type of addition, B WDC, C interaction

As well as improving its apparent density, Figure 10, it also improved its mechanical properties and through its presence among the soil particles (Al-Naymy and Al-Alousi, 2016), as well as the dynamic ones (Al-Nuaymy and Al-Hadithi 2014) Also, the biology of the soil growing on the extract has mechanical properties that are more flexible than the mineral composition itself, which reduces its resistance to penetration., is confirmed by Figures 12, 13 and 14.

Figure 12 displays images of soil aggregates taken with an electron scanner (SE|M), and it appears from image C for uninjected soil and the first WD cycle, that most of the image area is a solid mass, with sharp edges, compared to image A, which is for soil injected with the full amount of extract, if cavities are noticed It is clear, at the same time that the solid part is more granular and indicates large aggregates similar to a cluster, and this image is in line with Figure 1, while in image B it is noticed that it is more granular than the other two images and shows slit cavities, unlike image A in which the pores appear larger. Their aggregates are smaller but fused, and Figure 11 is in line with both Figures 2 and 8.

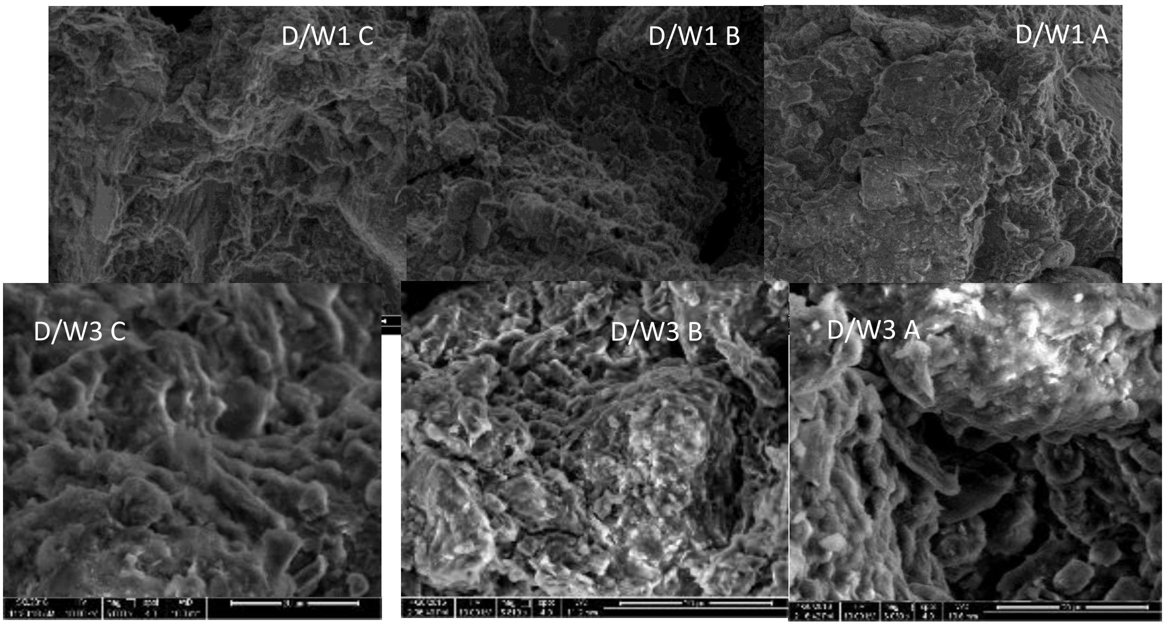

Figure 13. SEM Images of the third WD cycle، A full quantity injection, B partial injection and C without injection of SE

In figure 13, it is noticed that the uninjected soil at the third WD cycle still has sharp edges and small pores, unlike the fully injected soil, which shows clear granularity, clear and continuous pores, and varies in size and shape of the particles. Its pores are much less than those injected with the full amount, at the same time it has more pores than the non-injected SE, compared to the group of images in the first cycle. The clarity of graininess is observed in both injection methods compared to non-injection, in application to the fact that the sharp corners of uninjected soil appear to be less in the third cycle is in the first cycle, that this is due to the mechanical erosion of the mineral substance on the one hand, and the biological activity of the original organic matter in the soil, as it is present in all its solid, soft and coarse parts, as well as its solutions formed as a result of hydration, while in the case of injection the liquid substance increased by analogy with the original solid organic matter in the soil, this led to an evolution in enzymatic activity at the expense of the mass activities of microorganisms (Li *et al*. 2013).

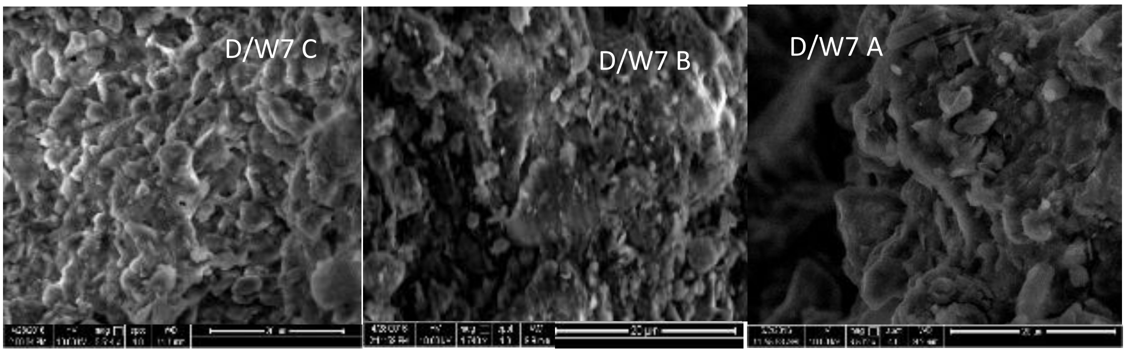

Figure 14. SEM Images of 7th W/D cycle، A Whole quantity injection, B partial injection and C without injection of soil sawdust extract

Figure 14 displays the SEM of injected and uninjected soil grains with SE in the seventh WD cycle, and it is noticed from the figure that applying the full amount collected the largest number of grains in one large aggregate and another smaller, with a relatively large void, and usually such spaces are as a result of the accumulation of large-sized granules on each other, and their corners are not sharp and grainy, while the application of the amount is fragmented on the WDC, so that the granules appear more agglomerated and the granules of their clusters are more numerous and smaller in size, and the pores in them appear in a smaller size in application to the full application as well as their granules less granularity and showing a more bridging shape and with somewhat sharp angles, when the soil is not injected with the extract, the pores are not clear, and their clusters are compact and the angles formed by the soil grains are sharp and in sheets, compared to the third and first cycle, it is noticed that no soil injection was the most granular of the above two cycles, respectively. This is due, as mentioned previously, to the mechanical erosion of the mineral matter, as well as to the biological activity of the original organic matter in the soil, as it is present in all its solid parts. Fine and coarse ones, as well as their solutions formed as a result of hydration, led to an improvement in enzymatic activity forming larger chemical complexes (Li *et al*. 2013).

REFERENCES

1. Al Hadithi A. A.1997. Role of added humic acids in concentrations and release of some micronutrients in calcareous soils. Ph.D. thesis college of agriculture university of Baghdad.
2. Al-Bayati, A. H., and M. K. Al-Rawi, 2000. The mineralogical formation of Anbar Governorate Soils 2- Diagnosis of silt and clay minerals. Al-Rafidain Agriculture Journal. 32 (1): 10-18.
3. Al-Mahamde, M. S. H. 2019. Effect of The Addition of the Sawdust Extract On the Sustainability of the Soil Aggregate and Some Soil Hydraulic Properties. MS. The Thesis, College of Agriculture at the University of Anbar.
4. Alnuaymy, W. S. S., and A. M. Alalusi. 2016. Effect of injected organic matter extract in soil on some soil physical properties. Anbar Journal of Agricultural Sciences.14(2):1-14.
5. Alnuaymy, W. S.S. 2013. Evaluation of aggregates stability and itś relation to some soil contents for Euphrates higher basin soils at Anbar province. Ph.D. thesis. College of Agriculture- University of Anbar.
6. Bimüller, C., O. Kreyling, A. Kölbl, M. V. Lützow and I. Kögel-Knabner, 2016. Carbon and nitrogen mineralization in hierarchically structured aggregates of different size. Soil and Tillage Research. 160:23-33. https://dx.doi.org/10.1016/j.still.2015.12.011
7. Blake, G.R. 1965. Bulk density. In C.A. Blak *et al*. (eds) Methods of Soil Analysis, Part 1. Agron. 9:374-390. ASA, Madison, WI.USA
8. Bouyocos, G.J. 1962. Hydrometer method improves for making particle- size analysis of soil. Agron. J. 53: 464 – 465. https://doi.org/10.2134/agronj1962.00021962005400050028x
9. Bronick C.J. and R. Lal, 2005. Soil structure and management: a review. Geoderma.124: 3 –22. https://doi.org/10.1016/j.geoderma.2004.03.005
10. Celik, I. O., and S. Kilic, 2004. Effects of compost, mycorrhiza, manure, and fertilizer on some physical properties of as chromoxeret soil. Soil Till Res., 78: 59-67. http://dx.doi.org/10.1016/j.still.2004.02.012
11. Donald, T. D. 1965. Penetrometer. In Black, C. A., D. D. Evans, L. E., Ensminger, J. L. White, and F. E. Clark (eds.). Methods of Soil Analysis. Part 1. Agronomy 9. Am. Soc. of. Agron. Madison, Wisconsin U. S. A. PP.472-484.

12. Fageria, N. K., V. C. Baligar, and B. A. Bailey, 2005. Role of cover crops in improving soil and row crop productivity. Communications Soil Sci. Pl. A. 36: 2733-2757. http://dx.doi.org/10.1080/00103620500303939
13. Gee, G.W., and J.W. Bauder. 1986. Particle size analysis. A. Klute (ed.), Methods of Soil Analysis. Part 1. Physical and Mineralogical Methods. 2nd Edition, 9(1):383-411, American Society of Agronomy, Madison, WI.
14. Guo, Z., L. Zhang, W. Yang, L. Hua, and C. Cai .2019. Aggregate Stability under Long-Term Fertilization Practices: The Case of Eroded Ultisols of South-Central China. Sustainability J. 11:1-17. Sustainability 2019, 11, 1169; https://doi.org/10.3390/su11041169 .
15. Imbufe A.U., A. F. Patti, D. Burrow, A. Surapaneni, W. R. Jackson, A. D. Milner. 2005. Effects of potassium humate on aggregate stability of two soils from Victoria, Australia. Geoderma 125: 321–330. 10.1016/j.geoderma.2004.09.006
16. Li, H., Y. W. Chun, F. T. Wen. Q. H. Hong, F. C. Chong, and K. W. Ming, 2010. Distribution of organic matter in aggregate of eroded Ultisols, Central China. Soil Till. Res.,108: 59-67.
17. Li, Y., W. Tan, L.K. Koopal, M. Wang, F. Liu, W. Norde, 2013. Influence of soil humic and fulvic acid on the activity and stability of lysozyme and urease. Environ Sci Technol. 47(10):5050-5056. https://doi.org/10.1021/es3053027 .
18. Mossadeghi, M. R., A. A. Mahboubi, and A. Safadoust, 2009. Short-term effects of tillage and manure on some soil physical properties and Maize root growth in a Sandy loam soil in western Iran. Soil Till Res. 104: 173-179. http://dx.doi.org/10.1016/j.still.2008.10.011.
19. Nuzzo A., A. Sánchez, B. Fontaine, A. Piccolo, 2013. Conformational changes of dissolved humic and fulvic superstructures with progressive iron complexation. Journal of Geochemical Exploration 129: 1–5.
20. Oguike P.C. and J.S.C. Mbagwu. 2009. Variations in some physical properties and organic matter content of soils of coastal plain sand under different land-use types. World Agric. Sci. 5 (1): 63-69.
21. Park E., W. J. Sul, and A. J.M. Smucker. 2007. Glucose additions to aggregates subjected to drying/wetting cycles promote carbon sequestration and aggregate stability. Soil Biology & Biochemistry 39: 2758–2768.
22. Rawlins, B. G., J. Wragg, and R. M. Lark, 2013. Application of a novel method for soil aggregate stability measurement by laser granulometry with sonication. European Journal of Soil Science. 64 (1), P: 92-103.
23. Richards, L. A., 1954. Diagnosis and Improvement of saline and alkali soils. U. S. Dept. Agric. Handbook No. 60.
24. Richards, L. A.1954. Diagnosis and Improvement of saline and alkali soils. U.S.Dept. Agric. Handbook No. 60.
25. Ruiz-Vera V. M. and L.Wu. 2006. Influence of sodicity, clay mineralogy, pre-wetting rate, and their interaction on aggregate stability. Soil Sci. Soc. Am. J. 70:1825–1833.
26. Salih, A.A.T., A.S. Atte, and A.N. Al-Ani. 2005. Influence of ground corn cobs and incubation on some physical properties of sandy loam soil. The Iraqi journal of agricultural sciences.36(4)1-8.
27. Smucker A. J. M., Eun-Jin P., W. J. Sula, 2007 b. Glucose additions to aggregates subjected to drying/wetting cycles promote carbon sequestration and aggregate stability Soil Biology & Biochemistry 39(11) 2758–2768. DOI: 10.1016/j.soilbio.2007.06.007
28. Tayel M.Y., A.A. El Gendy, and M. Abd El-Hady and, 2009. Effect of Irrigation Systems on: 1- some soil physical characteristics. J. Applied Sci. Res., 5(5):573-578.
29. Urbanek, E., A. J.M. Smucker, and R. Horn. 2011. Total and fresh organic carbon distribution in aggregate size classes and single aggregate regions using natural $^{13}C/^{12}C$ tracer. Geoderma 164: 164–171. doi:10.1016/j.geoderma.2011.05.020
30. Yang, S., B. Jansen, S. Absalah, R. L. vanHall, K. Kalbitz, and E. L. H. Cammeraat. 2020. Lithology- and climate-controlled soil aggregate size distribution and organic carbon stability in the Peruvian Andes. SOIL, 6, 1–15. https://doi.org/10.5194/soil-6-1-2020 .
31. Yu H., W. Ding, J. Luo, R. Geng, A. Ghani, and Z. Cai. 2012. Effects of long-term compost and fertilizer application on stability of aggregate associated organic carbon in an intensively cultivated sandy loam soil. Biol Fertil Soils. 48:325–336. https://doi.org/10.1007/s00374-011-0629-2 .