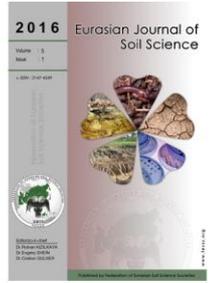




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## The effect of zeolite and some plant residues on soil organic carbon changes in density and soluble fractions: Incubation study

Milad Mirzaei Aminiyan\*, Ali Akbar Safari Sinemani, Mohsen Sheklabadi

Soil Science Department, College of Agriculture, Bu-Ali Sina University, Hamedan, Iran

### Abstract

Organic carbon (OC) fractions play an important role in soil and many ecosystem processes. This study focuses on changing of OC in different fractions in a soil treated with different levels of zeolite and plant residue that incubated for 90 days. The results showed that the amounts of light fraction (LF) and heavy fraction (HF) increased with increasing the percentage of zeolite and plant residues in the soil. The highest amounts of LF (22.7 g LF. Kg<sup>-1</sup>Soil) and HF (26.7 g. Kg<sup>-1</sup>Soil) were found when 30% zeolite, 5% wheat and alfalfa straws was added to the soil respectively. Accordingly, wheat straw and alfalfa straw were effective for increasing the LF and HF respectively. However they declined with decreasing the OC from the 1<sup>st</sup> day of experiment until the 90<sup>th</sup> day of experiment. Soluble OC in hot (2.80 g. Kg<sup>-1</sup>Soil) and cool (2.25 g. Kg<sup>-1</sup>Soil) water fractions increased with the addition of 30% zeolite and 5% plant residues particularly alfalfa straw in comparison with control. Although they increased after 30 days of starting incubation but, then they decreased in the continuation of the experiment. In fact, OC contents in density and soluble fractions increased with application and addition of 30% zeolite and 5% plant residues into the soil; however they decreased after 30 days of incubation with decreasing the OC. The findings of this research revealed the application of zeolite and plant residues improved carbon pools in density and soluble fractions and carbon sequestration increase by increasing the OC contents in soil.

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### Introduction

It has been recognized in recent decades that the quantity of carbon stored in soils is important on a global scale. Therefore, land management practices affecting the soil organic carbon (SOC) content may have a global impact, if they are applied over large areas (Bronick and Lal, 2005). Global warming concerns have led to a surge of interest in evaluating the effect of management practices on carbon sequestration in soils (Adesodun and Odejimi, 2010). This interest is justified because soils as a sink for atmospheric CO<sub>2</sub> play a key role in the global carbon budget as well as in the global carbon cycle (Eshel et al., 2007). Soils are the third largest active carbon pool after the hydrosphere and the lithosphere. The role of soils as either a source or a sink for greenhouse gases, in general, and that of CO<sub>2</sub>, in particular, has been a focus of recent studies (Bhattacharyya et al., 2009; Majumder et al., 2008).

Since the largest terrestrial pool of carbon is located in the soils (Bhattacharyya et al., 2009), factors that affect its retention and release also influence its exchange between soil and atmosphere (Borkowska and Stępniewska, 2011). Storage of SOC in agricultural systems is a balance between carbon additions from non-

\* Corresponding author.

Soil Science Department, College of Agriculture, Bu-Ali Sina University, Hamedan, 65178-33131 Iran

Tel.: +989132929758

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E-mail address: [miladmir67@yahoo.com](mailto:miladmir67@yahoo.com)

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harvested portions of crops (Wu et al., 2008), organic sources (Thelen et al., 2010), and carbon losses, primarily through organic matter decomposition and release of respired CO<sub>2</sub> to the atmosphere (Bird et al., 2002). For centuries, organic matter has been applied to agricultural soils as a means of supplying the crops with nutrients and maintaining the required SOC content with benefits to soil structure (Balashov et al., 2010). Organic substances improve soil aggregation, reduce soil compaction and surface sealing, increase carbon sequestration and nutrient availability, and enhance infiltration rate and water holding capacity (Olu et al., 2009).

### Density fractionation

Changes total organic carbon (TOC) in soil with changes in land use and management can be partly explained by the way carbon (C) is allocated in different fractions of soil organic matter (SOM) (Tan et al., 2007). These fractions exhibit different rates of biochemical and microbial degradation (Stevenson, 1994) as well as different accessibility and interactions (Sollins et al., 1999). The dynamics of SOC are usually described by dividing SOM into two or more fractions. Physical fractionation of SOM is useful for distinguishing specific carbon pools responsive to management, identifying the physical control of SOM (Cambardella and Elliott, 1993; Collins et al., 1997), and characterizing the relationship between SOM and size distribution of aggregates (Feller et al., 1996).

Density fractionation is a laboratory procedure that physically separates soil into light and heavy fractions (Wander and Traina 1996; Sollins et al. 1999). The procedure is useful for assessing labile pools of SOM that are more sensitive to cropping practice than is the total SOC pool in temperate soils (Janzen et al., 1992). Among liquids for density fractionation, sodium polytungstate (SPT) solution of 1.85 g .mL<sup>-1</sup> is often used (Magid et al., 1996; Six et al., 1998, 2002). Light fraction is commonly referred to a plant-like and less stable fraction with high organic carbon (OC) concentration (Golchin et al., 1994; Gregorich et al., 1996). Heavy fraction is a more stable and high-density organo-mineral fraction having lower C concentrations (Golchin et al., 1995a, b).

Light fraction of SOM is not only sensitive to changes in management practices (Cambardella and Elliott, 1992; Bremer et al., 1994), but also correlates well with the rate of N mineralization (Hassink 1995; Barrios et al., 1996). By incubating bulk soil and density fractions, Alvarez and Alvarez (2000) observed that light fraction was the driving factor in soil respiration. Light fraction supposedly represents an intermediate pool between undecomposed residues and humified SOM (Gregorich and Janzen, 1996). In contrast, the heavy fraction contains more processed SOM (Hassink 1995; Wander and Traina, 1996) and can be a major sink for C storage in soil because it has a little mineralizable carbon (Barrios et al., 1996; Whalen et al., 2000), although it is demonstrated by poor relationships with soil respiration (Alvarez and Alvarez, 2000). Meanwhile, the importance of light fraction (including free and occluded organic C within aggregates) is widely recognized for its role in formation and stability of soil structure, especially in stabilization of soil macroaggregates (>250 μm) (Miller and Jastrow, 1990; Kay 1998). Janzen et al (1992) reported that light fraction of surface soil (0–7.5 cm) accounted for 2–17% of SOC, depending largely on cropping systems. However, there are few direct data quantifying these two fractions and their contributions to total SOC storage as related to changes in land use and tillage practices.

### Water soluble organic carbon

Soluble organic matter in soils plays an important role in many ecosystem processes. For example, the size of this pool of organic matter and its availability as a substrate are critical to nutrient fluxes in agricultural systems. The amount and biodegradation of soluble organic matter in soil also have implication for different parts of the ecosystem, from the atmosphere (e.g., Production of greenhouse gases) to the hydrosphere (e.g., Water quality) (Gregorich et al., 2003). Plant residue and humus are the most significant sources of soluble organic carbon in soil (Kalbitz et al., 2000). In studies using <sup>13</sup>C natural abundance technique to identify the source of carbon in labile organic matter fractions, Gregorich et al. (2000) observed that carbon isotope signature of water-soluble carbon was similar to that of humus, whereas for the microbial biomass carbon, it was similar to recent maize residue. They hypothesized that, although the water-soluble carbon pool was small, it had a high turnover and was in equilibrium with soil humus.

Results of Boyer and Groffman (1996) suggested that, the difference in water-soluble and biodegradable C between agricultural soils and forest soils (values were higher in agricultural soils) was due to increases in soluble humic materials in agricultural soils. Therefore, humus is likely the major source of water-soluble C

because of the relatively large amount of humus present in soil relative to that contributed by the microbial biomass or recently deposited plant residues. Soluble organic matter is an important substrate for microorganisms (Marschner and Bredow, 2002) and is quickly depleted during incubation. Laboratory studies (Boissier and Fontvieille, 1993; Nelson et al., 1994; Boyer and Groffman, 1996) have shown that microorganisms can decompose different amounts of the water-soluble organic matter fraction. These studies, which ranged in duration from hours to months, indicated that 10–40% of the water-soluble organic carbon was decomposable under laboratory conditions. Boyer and Groffman (1996) reported that land use and soil depth had significant effects on the proportion of soluble organic C that was readily biodegradable C (i.e., Labile C). In order to fully understand the dynamics of soluble organic C, it is useful to have some knowledge of the biological nature of soluble organic N. But in contrast to soluble organic C, little work has been done to characterize soluble organic N.

The quantity and the biological nature of dissolved organic matter are affected by the extraction procedure used. Extraction procedures involving higher temperatures extract a greater amount of soluble organic matter than extractions carried out at the room temperature. High temperature is known to hydrolyze organic structures, lyse cells, and dissociate organic materials from inorganic colloids (Nelson et al., 1994). Davidson et al (1987) found strong correlations between organic C extracted with hot water and mineralizable C, but noted that the extent to which heterotrophs could decompose the extracted C was uncertain. Non-microbial pools contribute to the hot water-extractable C (Sparling et al., 1998), and this material may represent a pool of organic matter involved in the formation of stable aggregates (Haynes and Swift, 1990).

During last years, great strides have been made in a number of research topics such as characterizing the spatial and temporal variations in the concentration and flux of dissolved organic carbon (DOC) reviewed by Kalbitz et al (2000) and Aitkenhead-Peterson et al (2003), quantifying its role in soil chemistry and pedogenesis (e.g., Kaiser and Zech, 1998; Jansen et al., 2003; Cances et al., 2003), describing the chemical composition of DOM (Guggenberger and Zech, 1994; Kaiser et al., 2001; Strobel et al., 2001), and quantifying the availability of DOC to soil microflora (Zsolnay and Gorlitz, 1994; Yano et al., 2000; Kalbitz et al., 2003; Marschner and Kalbitz, 2003). The main objectives of this study were to determine water soluble and density fractions of organic carbon in soils treated by different percentage of zeolite and some plant residues and incubation them in field capacity for 90 days.

## Material and Methods

### Study area

This study was conducted in Hamedan province, western part of Iran. This area is located between longitudes 47° 42' and 48° 45' E and latitudes 33° 28' and 34° 29' N. The climate of the region is semiarid with a mean annual precipitation of 300 mm and a mean annual temperature of 10 °C. Agriculture is an industry and principal land use in Hamadan. The soil of this area was classified as Typic Haplocalcids (Aminiyan et al., 2015).

### Sampling, treatment and analysis of soil

The methods used for soil sampling, treatment and analysis were reported in Aminiyan et al (2015). The treated and moistened soils were incubated in lab condition (20-25 °C) for 90 days. After 1, 5, 10, 20, 30, 45, 60, 75 and 90 days of incubation, a portion of each soil was taken for the study of in density (light and heavy) and soluble (hot water and cool water) organic carbon fractions.

### Density fractionation

About 10 g dried sample was transferred to a 20 ml graduated centrifuge tube, and 50 ml of NaI solution ( $d = 1.3 \text{ g cm}^{-3}$ ) was added. Suspensions were immediately centrifuged at 3000rpm for 10 min. The supernatant containing the light fraction (LF) was decanted onto Whatman no. 50 filters (2.7-µm retention) and vacuum-filtered. The heavy fraction (HF) residue was re-suspended twice in fresh NaI solution and the LFs were combined. Light and heavy fractions were then washed four times into pre weighed tins with deionized water, afterwards dried at 55°C for 24 h in the oven, and weighed (Strickland and Sollins, 1987). Then organic carbon content in heavy fraction was determined by Walkley and Black (1934) method.

## Soluble water organic carbon fractions

The soluble water organic carbon in the whole soil and the three aggregate fractions were extracted using cold water followed by hot water. Soluble organic matter in cold water was extracted from soils by adding 150 ml of distilled/deionized water to a tube containing 15g of air-dried whole soil or aggregate fraction. The soil water suspension was shaken for 30 min and centrifuged at 4500 rpm for 20 min. The supernatant solutions were decanted and passed through a 0.45- $\mu\text{m}$  cellulose nitrate filter. The weight of extraction tubes with remaining wet soil was recorded in order to calculate the amount of cold water extract remaining. Hot water-soluble organic matter was extracted from these soils by adding water to the wet soil remaining in each tube to return the water volume to 150 ml, then by placing the tubes in a water bath at 80 °C for 16 h. After this period of time, the samples were centrifuged, decanted, and filtered as above. Filtered solutions were stored in a refrigerator (4°C) prior to incubation (Gregorich et al., 2003). Then organic carbon content in heavy fraction was determined by Walkley and Black, (1934) method.

## Statistical data analysis

The experiment was a completely randomized factorial design with three replicates. The factors applied were alfalfa straw (0 and 5%), wheat straw (0 and 5%), Zeolite (0, 10 and 30%) and incubation time (1, 5, 10, 20, 30, 45, 60, 75 and 90 days). All statistical analyses were performed in the SAS Ver.9.2 statistical framework (SAS Institute, 2008); to obtain the main differences between the treatments, the Duncan's ( $\alpha = 0.01$ ) test was applied.

## Results and Discussion

### Some of soil, plant residues and zeolite properties

Table 1 shows the sand, silt and clay contents were 69, 19 and 12%, respectively in the soil corresponding to a loamy sand texture. The soil was not saline (EC 1.1 dS.  $\text{m}^{-1}$ ); equivalent calcium carbonate ( $\text{CaCO}_3$ ) and pH values were 1.79% and 7.2 respectively, with low cation exchange capacity (CEC 4.80  $\text{Cmol c Kg}^{-1}$ ), organic matter (OC 3.41  $\text{g Kg}^{-1}$ ). Table 2 presents some properties of applied plant residues. Alfalfa and wheat straw had neutral pH (6 and 7.97), high OC (511 and 532  $\text{g Kg}^{-1}$ ) values and C/N (23.30 and 90.75) and C/P (85.20 and 123.50) ratios respectively. Table 3 reveals some of applied zeolite properties.

Table 1. Some of chemical and physical properties of applied soil.

EC (dS. $\text{m}^{-1}$ )	pH	CEC ( $\text{Cmol c Kg soil}^{-1}$ )	Total organic C ( $\text{g Kg}^{-1}$ )	CCE*	Sand %	Clay %	Silt %
1.10	7.20	4.80	3.41	1.79	69	12	19

\* Carbonate Calcium Equivalent

Table 2. Some properties of applied plant residues in this study.

	pH	EC ( $\text{dS m}^{-1}$ )	Total Organic C ( $\text{g Kg}^{-1}$ )	Total Nitrogen ( $\text{g Kg}^{-1}$ )	Total Phosphorous ( $\text{g Kg}^{-1}$ )	C/N	C/P
Alfalfa straw	6.00	9.50	511	22	5.98	23.30	85.20
Wheat straw	7.97	4.30	532	7	4.31	90.75	123.50

Table 3. Some properties of applied Zeolite

EC (dS. $\text{m}^{-1}$ )	pH	Organic C ( $\text{g Kg}^{-1}$ )	CEC ( $\text{Cmol c Kg soil}^{-1}$ )
0.98	7.20	0.93	169.30

### The effect of zeolite and plant residues on OC in density fractions

Table 4 shows the analysis of variance of the effects of applied zeolite, plant residues, incubation time, and their interaction on light fraction (LF), heavy fraction (HF), Soluble OC in Cool water and hot water fractions in soil. Also this table shows that the significant ( $p < 0.01$ ) effects of application of zeolite, alfalfa and wheat straws, their interaction and incubation time on LF and HF, Soluble OC in Cool water and hot water fractions in soil. Although, the interactions between zeolite and incubation time, plant residues and incubation time and zeolite, plant residues and incubation time did not have significant effects on mentioned organic carbon fractions in the soil.

Table 4. Analysis of variance (mean square) of the effects of zeolite, plant residues application, incubation time and their interaction on light (LF) and heavy fraction (HF), Soluble OC in Cool water and hot water fractions in soil.

Source	DF	Organic Carbon (gr/Kg soil)			
		LF (g LF. Kg <sup>-1</sup> Soil)	OC in HF (g .Kg <sup>-1</sup> Soil)	Soluble OC in Cool water (g .Kg <sup>-1</sup> Soil)	Soluble OC in Hot water (g .Kg <sup>-1</sup> Soil)
Zeolite	2	524.45 **	1144.33 **	1.54 **	1.43 **
Plant Residues	3	54 **	201.44 **	0.19 **	0.80 **
Time	8	65.45 **	353.87 **	5.00 **	11.59 **
Zeolite*Time	16	60.48 ns	1.97 ns	1.66 ns	3.67 ns
Plant Residues*Time	24	19.59 ns	0.98 ns	1.16 ns	2.72 ns
Zeolite* Plant Residues	6	111.15 **	3.90 **	0.34 **	0.49 **
Zeolite*Plant Residues*Time	48	16.32 ns	0.54 ns	0.41 ns	0.92 ns
Error	216	6.02	0.5	0.1	0.1

\*\* ) Mean square of the treatment is significant at the 0.01 level.

ns) Mean square of the treatment is not significant.

Table 5 reveals the OC content in LF and HF increased by the addition of zeolite and plant residues ( $p < 0.01$ ). LF value in 30% zeolite plus 5% wheat straw (Z30W5) treatment was greater than the other treatments; as its value 6.38 (g LF Kg<sup>-1</sup>Soil) was greater than control, because C:N ratio in wheat straw was higher than alfalfa straw thus subsequently wheat straw had lower stage of biodegradation by microorganisms in soil. This fraction of organic carbon decreased from the 1<sup>th</sup> day (20.61 g LF Kg<sup>-1</sup>Soil) to the 90<sup>th</sup> day (16.99 g LF Kg<sup>-1</sup>Soil) during soil incubation (Figure 1).

Table 5. Light fraction and heavy fraction content in all of treatment.

Treatment	LF (g LF. Kg <sup>-1</sup> Soil)	OC in HF (g .Kg <sup>-1</sup> Soil)
Control	16.32±1.30* f	17.60±3.00 f
Z0A5	17.08±1.27 f	20.50±3.01 de
Z0W5	18.04±1.28 e	19.70±3.02 ef
Z10PR0	18.36±1.29 e	21.90±3.04 cd
Z10A5	18.85±1.30 de	25.80±3.02 ab
Z10W5	19.52±1.26 d	24.60±3.03 bc
Z30PR0	20.48±1.30 c	24.10±3.01 bc
Z30A5	21.60±1.29 b	26.70±3.04 a
Z30W5	22.70±1.28 a	25.40±3.03 ab

\*. Mean ± Standard deviation

The same letter are not significantly different at  $p < 0.01$  using Duncan's LSD.

Note: Z0A5 (0% zeolite+5% alfalfa straw), Z0W5 (0% zeolite+5% wheat straw), Z10PR0 (10% zeolite+0% Plant Residue), Z10A5 (10% zeolite+5% alfalfa straw), Z10W5 (10% zeolite+5% wheat straw), Z30PR0 (30% zeolite+0% Plant Residue), Z30A5 (30% zeolite+5% alfalfa straw), Z30W5 (30% zeolite+5% wheat straw).

The heavy fraction value in Z30A5 treatment was significantly increased (9.1 g C/Kg soil) in comparison with the control treatment (Table 5). Also this table investigates that Z30A5 treatment increased heavy fraction (approximately 1 g Kg<sup>-1</sup>Soil) and (6.2 g Kg<sup>-1</sup>Soil) in comparison with the Z10A5 and Z0A5 treatments respectively. Actually, it is known that the alfalfa straw was more efficiency due to increasing organic carbon in heavy fraction than wheat straw in all of the treatments with the similarity percentage of zeolite (Table 5).

Soil organic carbon (SOC) in the light fraction plays an important role in retaining of cellulase molecule from washing out and nutrition of soil microorganisms and subsequently humus production. Thus soil organic matter quality is an important factor in its disintegration rate (Schmidt et al., 2002; Beheshti et al., 2012). According to the Figure 2, OC in heavy fraction had a distinct downward trend from the 1<sup>st</sup> day (27 g Kg<sup>-1</sup>Soil) until the 90<sup>th</sup> day (18.4 g Kg<sup>-1</sup>Soil). The recent research on organic carbon decay dynamics showed that LF and HF were decreased during of soil incubation (Hassink et al., 1995; Creamer et al., 2012). This is consistent with the finding of Rovira and Vallejo's studies (2003) who also found that LF and HF contents were declined in during of soil incubation period.

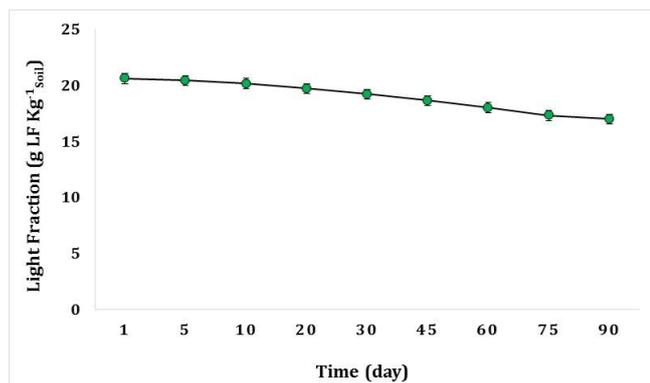


Figure 1. Light fraction changes with the passage of time

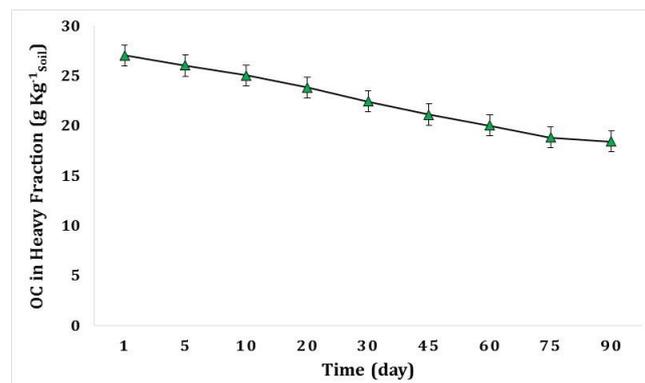


Figure 2. Organic carbon changes in heavy fraction with the passage of time.

### The effect of zeolite and plant residues on water soluble organic carbon fractions

As shown in Table 6, soluble organic carbon contents in hot water and cool water increased by the addition of zeolite and plant residues especially alfalfa straw. The results showed that soluble OC in hot water in Z30A5 treatment was 0.46 (g Kg<sup>-1</sup>Soil), 0.18 (g Kg<sup>-1</sup>Soil) and 0.3 (g Kg<sup>-1</sup>Soil) greater than control, Z10A5 and Z0A5 treatments respectively (Table 6). Studying on the chemical composition of dissolved organic carbon (DOC) suggested that, most DOM is an end product of microbial metabolism (Guggenberger and Zech, 1994); however short-term experimental manipulations of organic matter sources showed that fresh litter also contributes significantly to the production of DOC (Park et al., 2002). These two views are not necessarily mutually exclusive, but they do point out the considerable difficulty in determining the influence of substrate (litter, soil organic matter), microbial community composition (Muller et al., 1999), and abiotic factors such as temperature and water flux on DOC production and flux (Brooks et al., 1999). Aminiyan et al (2015) reported that the addition of 30% zeolite with 5% alfalfa straw to the soil redounded increasing OC in different aggregate particle size classes.

Table 6. Soluble organic carbon in Hot and Cool water content in all of treatments.

Treatment	Soluble OC in Cool water (g .Kg <sup>-1</sup> Soil)	Soluble OC in Hot water (g .Kg <sup>-1</sup> Soil)
Control	1.93±0.348* b	2.34±0.552 e
Z0A5	2.01±0.353 ab	2.50±0.546 de
Z0W5	1.94±0.357 b	2.42±0.561 de
Z10PR0	1.97±0.352 ab	2.44±0.454 cd
Z10A5	2.10±0.355 ab	2.62±0.461 ab
Z10W5	2.04±0.357 ab	2.52±0.477 ab
Z30PR0	2.15±0.360 ab	2.58±0.480 ab
Z30A5	2.25±0.358 a	2.80±0.491 a
Z30W5	2.19±0.349 ab	2.68±0.473 ab

\*. Mean ± Standard deviation

The same letter are not significantly different at  $p < 0.01$  using Duncan's LSD.

Note: Z0A5 (0% zeolite+5% alfalfa straw), Z0W5 (0% zeolite+5% wheat straw), Z10PR0 (10% zeolite+0% Plant Residue), Z10A5 (10% zeolite+5% alfalfa straw), Z10W5 (10% zeolite+5% wheat straw), Z30PR0 (30% zeolite+0% Plant Residue), Z30A5 (30% zeolite+5% alfalfa straw), Z30W5 (30% zeolite+5% wheat straw).

According to the Table 6, the same results were achieved similar the results of hot water to cool water, accordingly soluble OC in cool water increased with the greater percentage of zeolite and plant residues particularly alfalfa straw. Soluble OC in cool water content was 0.32 (g Kg<sup>-1</sup>Soil) and 0.26 (g Kg<sup>-1</sup>Soil) greater than the control in Z30A5 and Z30W5 treatments respectively. Thus Z30A5 treatment more effective to increasing soluble OC in cool water than Z30W5 treatment. Soluble OC content in hot water was greater than soluble OC content in cool water (Table 6), because hot water had greater ability to extract of lysis microbial cells and extractable soluble organic matter may be adsorbed to clay or complexed with other organic material produced by plants or decomposing organic matter than cool water (Guggenberger and Zech, 1994;

Muller et al., 1999). The plant residues with lower C:N ratio are a readily decomposable substrate for microorganisms and they have additional soluble OC content than plant residues with higher C:N ratio (Gregorich et al., 2003). Also these researchers found that the quantity of biodegradable soluble organic matter was related to the extraction procedure and the quantity of organic matter present in the soil.

Figure 3 indicates that, soluble OC in both hot water and cool water increased with over time from 1<sup>st</sup> day until the 30<sup>th</sup> day of incubation period but then decreased by the end of the experiment. Accordingly, the soluble OC in cool water increased from 2 (g Kg<sup>-1</sup>Soil) in the 1<sup>st</sup> day to 2.63 (g Kg<sup>-1</sup>Soil) in the 30<sup>th</sup> day and then it decreased by the end of experiment 1.68 (g Kg<sup>-1</sup>Soil). As shown in Figure 3, Soluble OC in hot water value increased from 2.41 (g. Kg<sup>-1</sup>Soil) in the 1<sup>th</sup> day to 3.37 (g Kg<sup>-1</sup>Soil) in the 30<sup>th</sup> day and finally it decreased by the 90<sup>th</sup> day 1.95 (g Kg<sup>-1</sup>Soil). Since soluble organic carbon was increased with the development and promoting plant residues biodegradation in the initial 30 days and when the growth and development of microbial communities were increased with the passage of time and subsequently soluble organic carbon decreased with the passage of time. Kalbitz et al (2003) observed that soluble OC increased with the passage of time, but in another study soluble OC decreased by over the time (Gregorich et al., 2003). Alfalfa straw had greater Soluble organic carbon than wheat straw, thus its degradation rate and OC content decreasing was done by higher rate in this fraction (Swanston et al., 2002; Preston and Schmidt, 2006). It is known in recent reviews that the organic matter quality is particularly important for SOC stabilization (Amelung et al., 2008; Schmidt et al., 2011).

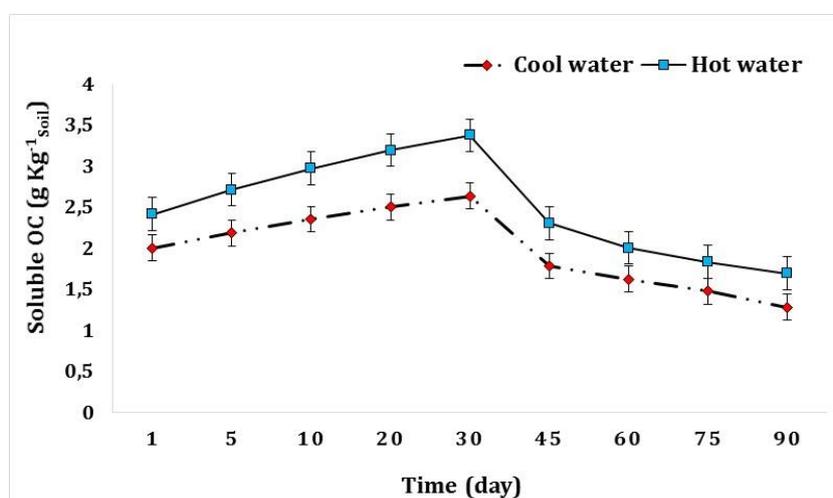


Figure 3. Soluble OC changes in hot and cool water with the passage of time

## Conclusion

The results of this study showed that, light fraction, heavy fraction and water soluble organic carbon were increased by addition of greater percentage of zeolite and plant residues into the soil. The results of this study showed that light fraction was greater in Z30W5 treatment than the other treatments. But OC in heavy fraction, Soluble organic carbon in hot water and cool water were maximum in (Z30A5) than the other treatments. LF and HF decreased with the passage of time from the 1<sup>st</sup> day until the 90<sup>th</sup> day. Soluble organic carbon in hot water and cool water increased from 1<sup>st</sup> day until the 30<sup>th</sup> day and then they decreased by the end of the experiment. In fact, organic carbon content increased by application and addition of zeolite and plant residues into the soil, but these pools decreased with the passage of time. Finally it can be said that the application of zeolite and plant residues improve carbon sequestration process in soil.

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