Characteristics of soil stability and carbon sequestration under water storage and drainage model

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Abstract. This research was conducted to investigate the influence of saline alkali soil on soil physical properties, stability and organic carbon storage under water storage and drainage, and to provide scientific basis for improving soil quality in Fuping County of Shaanxi Province, China. Saline alkali soil model test was conducted and the process was assessed with two different methods: i) traditional drainage and ecological water storage, measure and analyze 0-30 cm soil bulk density, porosity, field water capacity, mean mass diameter (MWD), geological mean diameter (GMD), stability of water stable aggregate (WASR), aggregate destruction rate (PAD), fractal dimension (D) and; ii) organic carbon storage, comprehensively analyze the relationship between stability index and soil organic carbon. The results show that: (1) compared with traditional drainage treatment, water treatment may effectively reduce the soil bulk density by 1.3%-4.2%, and improve soil porosity and field capacity at the same time; (2) under dry and wet screen treatment, soil stability, the water storing treatment is higher than the drainage treatment. Performance trend of soil MWD and GMD increases with the increase of soil depth. The stability of soil water stable aggregates increased 14.5%-53.4%. The average aggregate destruction rate was 3.2% lower than that of the drainage treatment and the difference is obvious (P< 0.05). (3) Soil organic carbon content and organic carbon storage in 0-30 cm soil layer could be increased effectively by water storage. Both of them were 13.4%-27.9% and 9.9%-18.8% higher than the drainage treatment. (4) There is a negative correlation among average aggregate destruction rate, fractal dimension and soil organic carbon storage. The correlation coefficient is, respectively, R^2=0.86 and R^2=0.94, and the difference is obvious (P<0.05). To sum up, the water storage treatment can effectively improve the soil quality, improve soil stability and soil organic carbon storage, which can be a good control of saline alkali soil.

1. Introduction
In agricultural production, saline soil is a low yield soil, which is an obstacle to the construction of high and stable yield fields [1-3]. In particular, the threat of soil secondary salinization is highly extended in modern irrigated areas because of human activities [4-6]. Soil quality degradation may further cause groundwater pollution [7, 8], posing high health risks to residents and ecological diversity [9-11]. The comprehensive treatment of saline alkali land includes many methods, such as physical improvement, water conservancy, chemical and biological improvement. Water improvement, namely the model of “Fresh water salt and Drainage of salt”, is mainly used in China. The practice of
“drainage” increases the slat in the area. The traditional saline alkali land treatment technology incurs high operating cost, but also causes a waste of water resources and pollutes the downstream water to some extent [12-16].

The evaluation of soil quality generally includes a comprehensive analysis of soil bulk density, porosity and stability and carbon storage [17]. Soil structure controls soil stability. Aggregate is the basic unit of soil structure [18, 19]. The basic characteristic of soil is one of the key indicators determining the process and effect of soil separation, handling, compaction and compaction in soil eroding process, and an important evaluation index of soil safety, soil quality and health [20]. The stability of soil aggregates can be divided into mechanical stability, water stability and biological stability [21]. Generally, the stability index is used to characterize the soil structure. And it is related to the movement of water and the growth of crop root and the carrier of organics [22]. For the present stage, under the development of the saline alkali soil, different treatment methods affect the soil aggregation stability and water stability of soil aggregate distribution, and then affect the improvement and restoration of land quality. Soil aggregate stability is usually characterized by average diameter of soil water stable aggregates, geometric mean diameter and percentage of soil aggregates with diameter > 0.25 mm. Greater value indicates better aggregate stability [23]. Several researches mainly focused on the different cultivation patterns on soil aggregate and the impact on the carbon and land consolidation after a variety of land use mode studying the distribution characteristics of soil aggregate stability [24-28], but for a different approach to governance and saline-alkali soil on the stability of few reports research remains to be further strengthened.

Halogen Beach between Fuping County and Pucheng County in Shaanxi Province, China is affected by severe saline alkali soil. Lubotan soil, a typical soil type in the Halogen Beach, is mainly composed of moderately and severely salinized soil. Han et al. who proposed the traditional Saline alkali land treatment give priority to the water storage and establishing and perfecting irrigation and drainage system [29], storage fresh water on saline alkali land for leaching, washing salinity by irrigation, draining the saline water. They proposed a new model of “changing drainage to storage, water and land harmony, and harmonious ecology” for Saline alkali land treatment under water storage and drainage conditions. The research will set up simulation test in the Fuping experimental base of Shaanxi province, China to analyze the changes in soil physical characteristics and stability and organic content under different treatment modes. Comprehensive system research will be conducted on each treatment and conduct correlation analysis between the soil stability indicator and organic carbon, and provide scientific basis for the economic development and utilization of saline-alkali soil and improving the stability.

2. Materials and methods

2.1. Site description

The test is set up in Fuping experimental base (109°11′N, 34°42′E, 492 m above sea level), which is located in Chuyuan Village, Ducun Town, Fuping County, Weinan City, Shaanxi Province. This area belongs to the warm temperate semi humid climate zone. Annual rainfall is 473 mm on average and the rainfall in July-September covers 49% of the rainfall throughout the year. Annual evaporation is 1 000~1 300 mm and the frost free period is 225 d. Annual mean temperature is 13.4 ℃. The highest temperature in summer is 41.8 ℃ and the lowest temperature in winter is -22 ℃. The total amount of annual light radiation is 123.9~127.8 kca cm².

2.2. Experimental design

The experiment was conducted in May 2010. In order to simulate the land condition in the experimental area of Halogen Beach, the test device is customized and the size is 23.0 m×1.5 m×2.0 m (length×width×height). It is made of cement brick and concrete structure. The test device includes two parts, namely water storage (water drainage) and test soil. One end stores water with water tank (drain water) and the middle section is soil tank. The water and soil are blocked with Geotextile to
prevent the inlet of soil into the water surface. In order to ensure the test results, the interface of each device will conduct waterproof treatment. The experimental treatment is designed for two kinds of water storage and drainage. Water treatment is to put quantitative water in the ditch and take use of the dominant effect of “water-soil” dispersion effect to control the shift of soil salt; the drainage treatment takes use of broad irrigation and convection effect between water-soil to drain water and leach salt. The water quantity used in the water storage and drainage is the same. The salt shifting and changing under each treatment are shown in figure 1.

![Diagram](image.png)

**Figure 1.** The soil salinity transport under water storage and water drainage treatments.

The test soil samples were selected from saline alkali soil in Halogen Beach. Halogen beach undisturbed soil was taken every 30-40 cm. the soil passes rolling, crushing, drying, sieving and fills in self-made test soil trough. According to the detection data of development soil in test zone of Northwest Agriculture and Forestry University Testing Center in 2010, soil analysis showed: Average content of soil organic matter is 0.7%; Total salt content is 0.8% on average; pH value is 9.3 on average; average content of Cl\(^-\), HCO\(_3\)^- and SO\(_4^{2-}\) are 0.4%, 0.1% and 0.1%, respectively.

### 2.3. Measurement items and methods

#### 2.3.1. Determination of physical index of soil.
After the winter wheat is harvest, take the standard ring shear with height 5cm and diameter of 5.04 cm to collect the soil sample in each test plot for the determination of soil capacity and porosity. According to the diagonal sampling method, 4 sampling points were set up. The sampling depth and interval are respectively 30 cm and 10 m. Each plot takes a total of 24 bulk density samples. The average value determined with drying method refers to the soil capacity of each soil layer.
After the spring corn is harvested, 4 sampling points are set up according to the diagonal sampling method. The sampling depth and interval are respectively 30 cm and 10 cm. The undisturbed sample collected from each soil layer is used to determine relevant index of soil aggregate. There is not backfill and damage back to the laboratory. After natural drying, the stone and sundries existing in soil sample are removed. Dry sieving method is used to measure the mechanical stability of soil and wet sieving method is used to determine the water stability of soil [30].

2.3.2. Determination of chemical index of soil. Soil samples were collected immediately after winter wheat harvest. The soil depth of each plot was 0-30 cm and the sampling interval is 10 cm. The diagonal line method is used and 4 sampling points are set. Four repeated samples at the sample depth form one mixed sample and are naturally dried in the laboratory to remove gravel and plant roots, stubble and other debris and pass through 0.25 mm sieve. Potassium dichromate (K$_2$Cr$_2$O$_7$) by oxidation external heating method (GB7857-1997) is used to determine the soil organic carbon and calculate the reserve of organic carbon [31].

2.4. Data calculation
Soil bulk density, porosity, field capacity can be calculated as follows:

$$P = \frac{(DS - W)}{V}$$  \hspace{1cm} (1)

Where $P$ is soil bulk density (g/cm$^3$); $DS$ is total weight of drying soil and cutting ring (g); $W$ is the quality of cutting ring (g); $V$ is the volume of cutting ring (cm$^3$)

$$SD = (1 - P/SP) \times 100$$  \hspace{1cm} (2)

Where $SD$ is the soil porosity (%); $SP$ is specific gravity of soil (2.65 g/cm$^3$)

$$W_S = \frac{(M_d - DS)}{(DS - W)} \times 100$$  \hspace{1cm} (3)

Where $W_S$ is field capacity (%); $M_d$ is total weight of soil and ring cutter after water control (g).

To calculate the soil aggregate stability index, the equations derived by Yang et al were used [32].

$$W_n = \frac{W_{dn}}{W_{wn}} \times 100\%$$  \hspace{1cm} (4)

$$R_{0.25} = \sum_{n=1}^{i} (W_{n})$$  \hspace{1cm} (5)

$$MWD = \sum_{n=1}^{i} (X_n \times W_n)$$  \hspace{1cm} (6)

$$GMD = \sum_{n=1}^{i} \left( \frac{X_n}{MWD} \times W_n \right)$$  \hspace{1cm} (7)

$$WSAR = WSA / MSA \times 100\%$$  \hspace{1cm} (8)

$$PAD = (DR_{0.25} - WR_{0.25}) / DR_{0.25} \times 100\%$$  \hspace{1cm} (9)

$$\frac{M(r < X_{max})}{M_r} = \left( \frac{X_{n}}{X_{max}} \right)^{3-D}$$  \hspace{1cm} (10)

Where $R_{0.25}$ is the content of aggregate with diameter > 0.25 mm (%); WMD is mean weight diameter.
of aggregate (mm); GMD is the graphical mean diameter of aggregate (mm); \( X_n \) is the mean diameter of aggregate in certain scope; \( W_n \) is the proportion of n level aggregate mass (%); dry sieving \( (W_{dn}) \) and wet sieving method \( (W_{dn}) \) may calculate them. \( M(r<X_n) \) is the weight of aggregate with grain size less than \( X_n \) (g); \( M_t \) is total weight of aggregate (g); \( X_{max} \) is the maximum particle size of aggregate (mm); \( D \) is aggregate fractal dimension.

Organic carbon storage is calculated with the following equation by Liang et al [26].

\[
SOC_{\text{(storage in depth)}} = 2 \times P \times C
\]

Where: \( SOC_{\text{(storage in depth)}} \) is the unit area of soil carbon reserve in equal depth (t hm\(^{-2}\)); \( P \) is the capacity of soil (t/hm\(^2\)); \( C \) is the content of soil organic in 0-10, 10-20 and 20-30 cm layer (g kg\(^{-1}\)).

2.5. Data analysis
The test data were analyzed by using SPSS (PASW Statistics 16.0) and factor analysis of variance were performed. EXCEL 2007 and Sigmaplo12.5 were used to organize and map these data.

3. Results and analysis

3.1. Analysis on soil physical characteristics of water storage and drainage mode

**Figure 2.** Comparison of soil bulk density, soil porosity and field water capacity at 0-30 cm soil layer of under different treatments. Letters indicate significant differences among different treatments at \( p < 0.05 \) levels.

Different treatments had significant effects on soil bulk density, soil water holding capacity and soil porosity (figure 2). Soil water holding capacity and porosity were negatively correlated with soil bulk density. If the unit weight is larger, the soil will be denser, thus field capacity and porosity will be decreased. In 0-30cm soil layer, the soil bulk density increased with the increase of soil depth. There is
significant difference between water storage and drainage, so is the soil layers \((P<0.05)\). In 0-30 cm soil layer, the soil capacity of water storage treatment is 1.3%-4.2% lower than the drainage treatment. As for the field capacity, the water storage and drainage treatment perform consistently, and decrease with the increase of soil depth. The field capacity of water storage treatment is superior to the water drainage treatment. The average field capacity under storage treatment is 3.1% higher than the water drainage treatment. The trend of soil porosity under different treatments was consistent with field capacity and decreases with the increase of soil layer. The water storage treatment is 3.1%, 4.7% and 1.5% higher than drainage treatment in soil porosity. Upon the comprehensive analysis of soil bulk density, field capacity and soil porosity under two treatment modes, water storage can effectively improve the soil porosity, increase soil aeration and water permeability, and is beneficial to maintain soil bulk density at a low level; drainage treatment could increase the soil bulk density and promote the soil hardening.

### 3.2. Analysis on characteristics of soil aggregates in water storage and drainage model

#### 3.2.1. Analysis of soil aggregate size

From the perspective of WMD, WMD and GMD under dry sieving of each treatment method are far higher than WMD and GMD under wet sieving (table 1) mainly because most of the soil aggregates in the experiment were non water stable aggregates. The performance tendency of WMD and GMD of soil under dry sieving method and wet sieving method is similar. The water storage treatment is higher than the drainage treatment and MWD and GMD of soil increases with the soil depth.

| Method       | Index | Treatment | Soil layer (cm) |     |     |     |
|--------------|-------|-----------|-----------------|-----|-----|-----|
|              |       |           | 0-10            | 10-20| 20-30|
| Wet sieving  | WMD   | Storage   | 5.65±0.25ab     | 5.50±0.03ab | 6.38±0.23a |
|              |       | Drainage  | 4.80±1.03b      | 5.04±0.23ab | 5.90±0.24ab |
|              | GMD   | Storage   | 4.07±0.37abc    | 4.01±0.04abc | 5.35±0.36a |
|              |       | Drainage  | 2.77±0.81c      | 3.24±0.29bc | 4.50±0.30ab |
| Water sieving| WMD   | Storage   | 0.217±0.01b     | 0.224±0.02b | 0.222±0.01a |
|              |       | Drainage  | 0.184±0.03b     | 0.207±0.12b | 0.216±0.04b |
|              | GMD   | Storage   | 0.140±0.00b     | 0.154±0.01ab | 0.182±0.01a |
|              |       | Drainage  | 0.139±0.00b     | 0.148±0.02b | 0.153±0.01ab |

Note: MWD: mean weight diameter, GMD: mean geometric diameter. values followed by the different letters are significantly different at \(P<0.05\), the data: mean±standard deviation. The same below.

The difference of WMD and GMD of two treatment methods under dry sieving is obvious \((P<0.05)\). The average weight diameter of soil layers under water storage treatment was higher than that under drainage treatment. In 0-30 cm soil layer under water storage treatment, WMD increases by 8.1%-17.7% than drainage treatment; the increase amplitude of GMD is 18.9%-46.6%. The difference of two treatment methods under the wet sieving treatment is not obvious as the dry sieving treatment. The effect of water storage treatment in improving soil structure is superior to the drainage treatment. Under wet sieving, WMD is 17.8% higher than the drainage treatment in 0-10 cm soil layer under water storage treatment. The improvement effect is the most obvious compared with other soils. It is mainly because the salt is leached after broad irrigation, thus causing serious compaction on soil surface. The soil moisture can be effectively increased by the water storage treatment, and the soil
water stability is effectively improved. In 0-10 cm and 10-20 cm soil layer, the water storage treatment increases GMD by 1.1% and 4.3% than the drainage treatment. There is significant difference between two treatment methods (\(P<0.05\)). WMD and GMD are the common indexes reflecting the size and distribution of soil aggregate.

### 3.2.2. Soil aggregate stability analysis

Under the treatment methods, the trend of WSAR and PAD is shown in figure 3. WSAR decreases with the increase of soil depth and PAD increases with the increase of soil depth. In 0-10, 10-20 and 20-30 cm soil layer, WSAR under water storage treatment is 30.2%, 53.4% and 14.5% higher than that under water drainage treatment; PAD decreases by 30.2%, 53.4% and 14.5% respectively. Upon comprehensive analysis WSAR under water storage treatment is 33.9% higher than that in water drainage treatment, and PAD is 3.2% lower than the water drainage treatment. The difference between two treatment methods is obvious (\(P<0.05\)). Compared with water drainage treatment, water storage treatment may effectively improve soil stability, and has a positive effect on increasing soil aggregate structure and improving inter aggregate cementation.

![Figure 3. WSAR and destruction rate of aggregate (%)](image)

**Table 2. Fractal dimension of soil aggregates under different pattern at 0-30 cm soil layer.**

| Treatment | Soil layer (cm) | Fractal dimension (wet sieving) | Fractal dimension (water sieving) |
|-----------|-----------------|---------------------------------|-----------------------------------|
| Storage   | 0-10            | 1.97±0.01ab                     | 2.93±0.21c                       |
|           | 10-20           | 1.90±0.03ab                     | 2.95±0.11bc                      |
|           | 20-30           | 1.65±0.06b                      | 2.96±0.05ab                      |
| Drainage  | 0-10            | 2.15±0.09a                      | 2.94±0.07bc                      |
|           | 10-20           | 2.04±0.05a                      | 2.97±0.04b                       |
|           | 20-30           | 1.84±0.04ab                     | 2.98±0.01a                       |

### 3.2.3. Fractal dimension analysis

The fractal dimension of soil is the parameter reflecting the geometry of soil structure. The fractal dimension of soil aggregate size distribution reflects the effect of soil water stable aggregates and water stable aggregates on soil structure and stability, namely the smaller the fractal dimension, the better the structure and stability of soil [33]. Equation (10) is used to conduct fitting calculation on the dry sieving and wet sieving data of aggregate to obtain fractal dimension value. The fractural dimension of aggregate of sectional soil in 0-40 cm soil under different treatment methods is shown in table 2. In 0-30 cm soil layer, the fractal dimension of soil aggregate of each treatment in dry sieving method decreases with the increase in soil depth and the performance tendency is consistent. The fractal dimension of soil aggregate is 1.65-2.15 and the difference of two
treatment methods is obvious ($P<0.05$). In the soil stability, the water storage treatment is 7.0%-11.8% higher than the water drainage treatment; in 0-30 cm soil, the average stability under water storage treatment is increased by 9.1% than water drainage treatment. In 0-30 cm soil layer, the fractal dimension of soil aggregate with wet sieving method is opposite to the dry sieving method, namely each treatment increases with the increase of soil depth. The fractal dimension of soil aggregate is 2.93-2.98.

3.3. Effects of organic carbon and organic carbon storage

The difference of organic carbon and organic carbon storage of different layers of soil under water storage and drainage treatment methods is shown in table 3. The tendency of organic carbon and organic carbon storage is the same, and show negative relationship with the soil depth. It decreases with the increase of soil depth. The organic carbon and organic carbon storage in water storage treatment are higher than the water drainage treatment. In 0-30 cm soil layer, the organic carbon content under water storage treatment is 13.4%-27.9% higher than the water drainage treatment; the organic carbon storage is 9.9%-18.8% higher than the water drainage treatment. In 0-30 cm soil layer, organic carbon and organic carbon storage under water storage treatment are 18.9% and 15.8% higher than the water drainage treatment and the difference is obvious ($P<0.05$). The research results show that on the premise of other treatment measures are consistent, water storage and drainage treatment is helpful to improve the soil organic carbon content and carbon storage, and has a positive effect on the stability of soil.

Table 3. Soil organic carbon soil organic carbon storage under different pattern at 0-30 cm soil layer.

| Treatments | Soil layer (cm) | Soil organic carbon (g kg$^{-1}$) | Soil organic carbon storage (t hm$^{-2}$) |
|------------|----------------|---------------------------------|-------------------------------------|
| Storage    | 0-10           | 6.08±0.35a                      | 16.87±0.50a                        |
|            | 10-20          | 5.05±0.36bc                     | 15.45±0.67a                        |
|            | 20-30          | 4.90±0.50bc                     | 14.10±0.61a                        |
| Drainage   | 0-10           | 5.36±0.05ab                     | 15.33±0.40a                        |
|            | 10-20          | 4.28±0.30bc                     | 12.86±0.82b                        |
|            | 20-30          | 3.83±0.20c                      | 11.87±0.14b                        |

3.4. Relationship between organic carbon storage and soil stability index

![Graph](image1)

![Graph](image2)

**Figure 4.** Comparison of soil fractal dimension and soil PAD and soil organic carbon storage under different treatments.
The relationship between average organic carbon and average fractal dimension in 0-30 cm soil layer in water storage and drainage treatment is shown in figure 4. There is negative relationship between organic carbon reserve and fractal dimension, namely when the fractal dimension is larger, the reserve of organic carbon will be smaller and it is not conducive to the improvement of soil stability. Under water storage and drainage treatment, we conduct fitness analysis on the PAD (X) and soil organic carbon storage (Y) in 0-30 cm layer. The regression equation Y=-0.43x+53.22 (R²=0.86) and the difference is obvious (P<0.05); the regression equation exists between x and Y, namely Y=-91.58x+285 (R²=0.94). The research results indicate organic carbon reserve, fractal dimension and PAD are important indicators reflecting the soil stability. There is high correlation among three factors. It may be directly regarded as the scientific basis of soil stability evaluation.

4. Discussion

4.1. Influence on the physical characteristics of soil

Soil bulk density, field capacity and porosity are one of the important indicators evaluating the soil quality [34, 35]. At present, the research on saline alkali land mainly focuses on the selection of salt tolerant varieties, the choice of irrigation methods and the design of saline alkali land treatment project. After cyclic salt and its engineering application, the spatial distribution of salt in the vertical direction can be changed, and the pressure can be gradually reduced. However, there are few reports on the changes of soil physical characteristics [36, 37]. Compared with drainage treatment, water storage treatment can effectively reduce soil salinity, effectively maintain soil compaction and soil bulk density in a suitable range. Straw returning treatment has obvious effect on improving the soil structure [38]. Water treatment can effectively improve the soil bulk density, increase soil water and improve the soil pore distribution. Combined with straw returning, reasonable distribution of solid, gas and liquid accelerated the decomposition of straw, and improved soil structure to some extent. Under water drainage treatment, the irrigation increased soil compaction and structural damage, and it is easy to form soil runoff channel, increase nutrient loss and reduce water use. The results showed that the water treatment significantly improved the soil quality.

4.2. Influence on the aggregate characteristics of soil

Previous studies have shown that there is a significant positive correlation between the fractal dimension of soil and the content of soil aggregates [39]. The storage and drainage treatment combined with straw returning could affect the transformation and redistribution of small aggregates and large aggregates, and then affect the stability and erosion resistance of soil structure. Many scholars have shown that there is a significant negative correlation between the fractal dimension of soil and large aggregates, namely the fractal dimension decreases with the increase of the content of large aggregates [40, 41]. The research shows that under dry sieving and wet sieving, WMD and GMD under water storage treatment are superior to the drainage treatment, and increase with the increase of soil. WSAR and PAD may better reflect the soil structure stability. If WSAR value is higher, it indicates the soil structure will be more stable; if PAD value is higher, it indicates the soil structure is not stable and the degradation degree increases. In 0-30 cm soil layer, WSAR under water storage treatment is more obvious than the water drainage (P<0.05), and the increase amplitude is 32.7%; soil PAD of water storage treatment is obviously lower than the water drainage treatment. It is beneficial to the improvement of soil structure and soil degradation. D is a new comprehensive index which evaluates the soil structure distribution. The index may not only express the size and distribution of soil particle, but also reflect the evenness degree of soil texture. The value is higher, indicating the texture is thinner and the soil penetration ability is weaker; the value is smaller, indicating the soil structure is better and the through ability is better. The research indicates in 0-30 cm soil and with dry sieving method, the fractal distribution of soil aggregate of water storage and drainage treatment decreases with the increase of soil depth and the performance tendency is consistent. D of soil aggregate is 1.65-2.15; with wet sieving method, D of soil is 2.93-2.98. It is opposite to the results
obtained with dry sieving method, namely it increases with the soil depth.

4.3. Influence on organic carbon and organic carbon storage of soil

Application of various nutrient elements and other elements in soil contributes to the formation of small aggregates and its stability. The balanced application of fertilizer and good water retention are beneficial to the growth of plants and the formation of aggregates. Studies have shown that the chemical alkaline solution has a destructive effect on the large aggregates, which can disperse the particles, which is not conducive to the maintenance and improvement of the stability of the aggregates [42-44]. This is the same as the results of this study. Water storage can effectively reduce the soil salt content, and has obvious effect on improving the stability of soil. Water retention is beneficial to the decomposition and transformation of organic matter such as straw, which is beneficial to the increase of organic carbon and organic carbon in soil [45]. Straw returning to the field, the addition of plant residues effectively improved the organic matter status of the aggregates, and played a positive role in promoting the formation and stability of aggregates. The results showed that soil organic carbon content and storage were higher than that of water drainage treatment. Six thinks that large aggregates are formed around fresh plant residues, and the quantity of micro-aggregate will increase after the relieving the new and old micro-aggregate which are enclosed by macro aggregate [46]. After No tillage coverage, Soil organic matter input increased, soil organic carbon content increased, more new large aggregates will increase, while the micro aggregates decreased accordingly. The results show that SOC is closely related to soil aggregates, that is, the higher the soil stability, the higher the soil organic carbon content, the larger the fractal dimension of soil aggregates. Correlation coefficient of soil organic carbon storage is $R^2=0.94$. The studies have shown that the correlation coefficient between soil aggregate destruction rate and organic matter content is 0.89. The higher the soil organic matter content, the lower the aggregate destruction rate. The results of this study are consistent with the results that the soil organic matter content is negatively correlated with the aggregate destruction rate, and the relevant coefficient is $R^2=0.84$.

5. Conclusions

This study investigated the characteristics of soil stability and carbon sequestration under water storage and drainage. The following conclusions can be summarized:

- Water storage treatment may effectively improve the soil capacity, porosity and field capacity in 0-30cm soil and the improvement effect is better than the water drainage treatment.
- Water storage treatment is superior to water drainage treatment in mean mass diameter and geological mean diameter in 0-30 cm soil. It tends to increase with the increase of soil and stability of water stable aggregate, aggregate destruction rate and fractal dimension better reflect the soil stability. WASR of water storage treatment is 32.7% higher than water drainage treatment. It may effectively improve the soil stability.
- Water storage treatment may effectively improve the organic carbon and organic carbon storage of soil layer. There is negative relationship among organic carbon storage, PAD and D. the coefficient of correlation is $R^2=0.84$ and $R^2=0.94$.

To sum up, the water treatment is conducive to improving the soil quality in saline-alkali soil and. The effect on the improvement in soil stability is superior to the water drainage treatment. The stability of the soil in the deep soil of saline alkali soil needs to be further studied.

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