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The Influence of Different Land Use Manners on Soil Aggregate Characteristics of Consolidation and Returning to Field in Hollow Village of Hilly Area

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Abstract The research aimed to explore the influence of different land use manners on soil aggregate, and provide scientific basis for improving soil stability and production performance of consolidation and returning to field in hollow village of hilly area. After consolidation and returning to field in hollow village of hilly area of Chengcheng County, Shaanxi, 5 kinds of land use manners were set for 1-year plantation test, and they were corn (C treatment), wheat (W treatment), vegetable (V treatment), medicinal material (M treatment) and control (no plantation: CK treatment). Soil aggregate distribution, mean mass diameter (*WMD*), geometric mean diameter (*GMD*), aggregate failure rate (PAD), unstable aggregate number (ELT) and fractal dimension (D) at 0 – 40 cm of soil layer were measured and analyzed by dry and wet sieving methods. The results showed that (i) soil aggregate number and size at 0 – 40 cm of soil layer by each treatment were all significantly better than CK treatment, and >0.25 mm of aggregate content by dry sieving method ($DR_{0.25}$) and >0.25 mm of aggregate content by wet sieving method ($WR_{0.25}$) at 0 – 40 cm of soil layer in each treatment showed declining trend with soil layer depth increased; (ii) MWD and GMD sequences of each treatment at 0 – 40 cm of soil layer by dry and wet sieving methods were both W treatment > C treatment > M treatment > V treatment > CK treatment, and C treatment was conducive to increasing large aggregate content of surface soil, while W treatment was conducive to increasing large aggregate content of lower soil; (iii) the analysis by wet sieving method showed that PAD and ELT at 0 – 40 cm of soil layer in each treatment both showed similar "Z" shape trend, and each treatment was significantly lower than CK; (iv) D sequence at 0 – 40 cm of soil layer in each treatment was C treatment < W treatment < M treatment < V treatment < CK treatment. D showed good linear relationship with >0.25 mm of aggregate content at 0 – 40 cm of soil layer by dry and wet sieving methods, and they were respectively $R^2 = 0.74$ and $R^2 = 0.67$. Corn and wheat plantation after consolidation and returning to field in hollow village was conducive to improving large aggregate content at 0 – 40 cm of soil layer, increasing the stability of soil layer and improving soil structure.

Key words Hollow village, Soil aggregate, Average mass diameter, Geometric mean diameter, Fractal dimension

1 Introduction

China is a big country with a large population, and agriculture is the foundation of national economy in China, and land is the foundation of the foundation, so the contradiction between man and land is particularly prominent[1–2]. With non-agricultural transfer and employment of rural population increase, rural housing demand continuously grows. Under the situation of lacking rural construction planning and strict land management, rural hollowing phenomenon that new house construction expands out of the village and is idle in the village is formed, causing serious destruction and waste of land resource[3–4]. It has strategic significance for easing contradiction between man and land in China and increasing farmland to impel consolidation and returning to the field of hollow village[5]. Soil aggregate is the most basic unit of constituting soil structure, which directly affects soil quality and production performance[6–9]. Different particle size distribution has different nutrient retention and supply effects, which decides water and fertility conservation characteristics of soil[10]. The index is also one of important evaluation indexes for soil degradation[11–14]. At present, the researches on the consolidation of hollow village mainly concentrate in its space form and consolidation model, which also confirms the significance and future important role of hollow village consolidation. But there are fewer researches on how to promote soil stability, soil quality and crop production performance after consolidation of hollow village[15–17]. Besides increasing farmland area, it should value the improvement of soil quality, which is the win-win measure of effective land consolidation. In this paper, consolidation and returning to the field of hollow village in hilly area of Chengcheng County, Shaanxi was taken as an example. Soil stability difference under different land use manners was studied, which could provide scientific basis for improving soil quality of returning to the field in hollow village of hilly area.

2 Materials and methods

2.1 General situation of research area The test was set in Caidai Village, Siqian Town, Chengcheng County, Shaanxi (35°19′ N, 110°05′ E, H 900 m), which is in northeast Weibei Plateau. Annual average air temperature, average rainfall and av-

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erage evaporation capacity are respectively 12.0 ℃, 680 mm and 1832.8 mm. Seasonal distribution of local rainfall is uneven, and rainfall mainly concentrates in July – September. It belongs to continental monsoon climate, and annual average air temperature is 12 ℃, with clear season. It is warm and dry in spring, and diurnal temperature difference is larger. The terrain is high in north and low in south, Chengcheng County is divided into "three beams and one tableland" by four rivers, which belongs to typical hilly region. Basic physical and chemical properties of soil before the experiment were shown as Table 1.

Table 1 The basic chemical properties of soil before the experiment

Soil layer//cm	Soil bulk density//g/cm	Soil organic matter//g/kg	Total N content//g/kg	Available P content//mg/kg	Available K content//mg/kg	Soil texture
0 – 20	1.25 ab	3.74 a	1.32 a	3.45 a	58.3 a	Powder soil
20 – 40	1.34 b	2.81 b	0.93 ab	2.02 b	42.2 a	Powder soil
40 – 60	1.60 a	1.34 c	0.58 c	1.82 b	37.1 b	Powder soil

Note: Different small letters in the same column meant significant difference among treatments at 0.05 levels, respectively.

2.2 Land reclamation manner Land consolidation project of hollow village indicates arranging abandoned and vacant homestead by using the engineering means of land consolidation. It is generally composed of land leveling project, farmland water conservancy project, field road project and farmland shelterbelt project. Among them, land leveling project is the focus, which mainly indicates pushing old soil walls and houses of hollow village, filling back soil, eliminating gravel, and plowing surface soil in the courtyard of hollow village, and plowing depth is about 35 cm. Then soil fertilization treatment is conducted, such as fertilizing organic fertilizer and straw returning to the field.

2.3 Test scheme Consolidation of hollow village in Caidai Village, Siqian Town, Chengcheng County, Shaanxi was conducted in March of 2014, and finished in middle dekad of April. Soil sample at 0 – 40 cm of soil layer was collected, and sampling interval was 10 cm. 2 kg of undisturbed soil sample at each soil layer was collected, and there were three repeats. Consolidation region was divided into 4 plantation zones from east to west, and corn (C), wheat(W), vegetable (V) and medicinal material (*Scutellaria baicalensis*: M) plantation tests were conducted, and each district area was 667 m^2. The same amount of fertilizer was used in early stage of plantation, and fertilization amounts were as below: P_2O_5 120 kg/hm^2, N 75 kg/hm^2, K_2O 90 kg/hm^2, and fertilization was not conducted in test research period. On April 20, 2015 (one year after reclamation), according to diagonal method, 5 sampling sites were set in each district, and soil sample was collected for characteristic research of soil aggregate.

2.4 Determination items and methods

2.4.1 Determinations of soil aggregate number and size. (i) Sampling method. After the collected undisturbed soil sample was dried naturally, coarse roots and small stones were removed, and large clod was stripped into 1 cm^3 according to natural rift. Then the dried soil sample was classified, and each soil sample was respectively screened by 5 and 2 mm of sieves, and they were divided into three levels: >5, 5 – 2 and <2 mm. Then 200 g of mixed soil sample was weighed according to the proportions of three-level soil samples in the undisturbed soil (WT). (ii) Measurement methods. Grain size distribution and stability of soil aggregate were measured by dry and wet sieving methods[18]. (a) Dry sieving method: 200 g of soil sample was respectively put on the top of 5, 2, 1, 0.5 and 0.25 mm of set sieve. The box was set on the bottom, and screen cover was on the top. After vibrated for 2 min at the maximum movement frequency of 200 times/min by oscillating sieving machine, the sieves were taken from the upper part in turn, thereby obtaining >5, 5 – 2, 2 – 1, 1 – 0.5, 0.5 – 0.25 and <0.25 mm of mechanical stable aggregate (*MSA*). They were respectively collected, and mass W_{di} was weighed. (b) Wet sieving method: 200 g of soil sample was set on the top of 5, 2, 1, 0.5 and 0.25 mm of set sieve. Water surface height in the bucket was adjusted, making aggregate in the uppermost sieve just submerged below the water surface when the sieve moves to the highest position. After the measured soil sample was soaked for 10 min under water surface, it was vibrated for 5 min at the velocity of 30 times/min. Then water stable aggregate in each layer of sieve was washed in aluminum box, and mass W_{Wi} was weighed after drying.

2.4.2 Data calculation. Based on each grain size of aggregate data, > 0.25 mm of aggregate $R_{0.25}$, *MWD*, *GWD*, *PAD* and *ELT* were calculated.

$$W_i = \frac{W_{di} \text{ or } W_{wi}}{200} \times 100\% \quad (1)$$

$$R_{0.25} = \sum_{i=1}^{n} (W_i) \quad (2)$$

$$MWD = \sum_{i=1}^{n} (\overline{W_i} \times W_i) \quad (3)$$

$$GWD = \sum_{i=1}^{n} (\overline{W_i} \times W_i) \quad (4)$$

where $R_{0.25}$ is the content of >0.25 mm of aggregate; *MWD* is mean weight diameter of aggregate (mm); *GMD* is geometric mean diameter of aggregate (mm); X_i is average diameter of aggregate in any level range (mm); W_i is the proportion of *i* grain level of aggregate mass, which could be calculated by dry sieving method (W_{di}) and wet sieving method (W_{wi}).

$$WSAR = WSA/MSA \times 100\% \quad (5)$$

$$PAD = (DR_{0.25} - WR_{0.25})/DR_{0.25} \times 100\% \quad (6)$$

$$E_{LT} = (W_T - WSA\&MSA)/W_T \times 100\% \quad (7)$$

where *WSAR* is stability of water stable aggregate; *WSA* is the mass of >0.25 mm of water stable aggregate (g); *MSA* is the mass of >0.25 mm of MSA (g); *PAD* is destruction rate of aggregate (%); $DR_{0.25}$ is the content of >0.25 mm of *MSA* (%); $WR_{0.25}$ is the content of >0.25 mm of water stable aggregate (%); E_{LT} is unstable aggregate index (%); W_T is total weight of the tested soil.

D is calculated by the formula deduced by Yang Peiling *et al.*[19]:

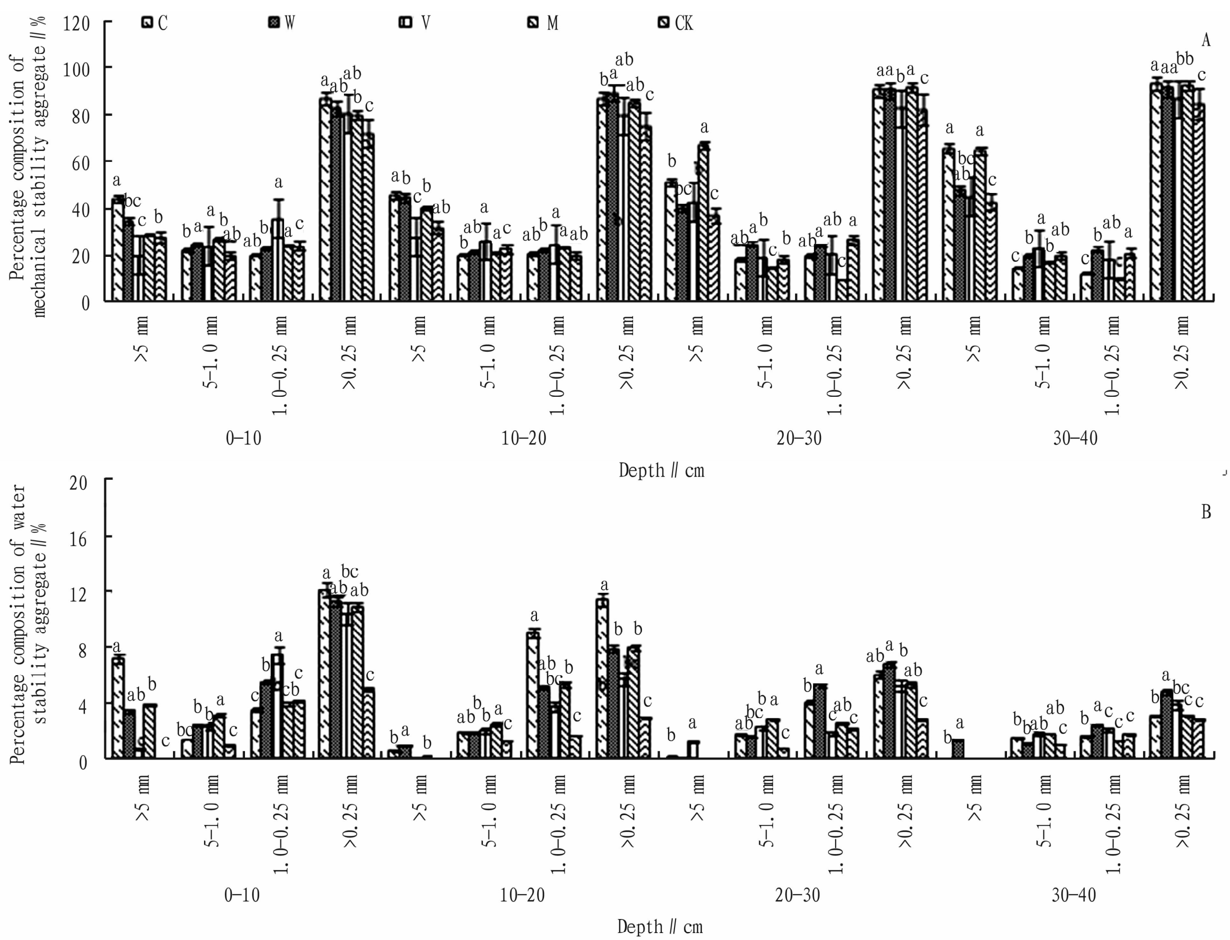
$$\frac{M(r < \overline{X}_i)}{M_i} = \left(\frac{\overline{X}_i}{M_{max}}\right)^{3-D} \quad (8)$$

where X_i is average diameter of one grain size of aggregate (mm); $M(r < X_i)$ is the weight of aggregate with the particle size smaller than X_i (g); M_t is total weight of aggregate (g); X_{max} is the maximum particle size of aggregate (mm).

2.5 Data analysis Microsoft Excel 2010 was used to process the data and chart, and SPSS (PASW Statistics 18) statistical analysis software was used for statistical analysis of data, and Duncan SSR was used for multiple comparisons.

3 Results and analyses

3.1 The influence of use manner on number of soil aggregate MSA with dispersive mechanical resistance was obtained by dry sieving method, and these MSAs contained non water stable aggregates and water stable aggregates; water stable aggregate with dispersive hydraulic resistance was obtained by wet sieving method[20-21]. The proportions of aggregates with different particle sizes were measured by dry and wet sieving methods, and the proportions of > 5, 5 - 1, 1 - 0.25 and > 0.25 mm of aggregates were obtained (Fig. 1). In April of 2015, the content of > 0.25 mm of aggregate ($DR_{0.25}$) obtained by dry sieving method was 72.2% - 93.1%. Seen from whole analysis, $DR_{0.25}$ content by each treatment at 0 - 40 cm of soil layer was significantly higher than CK, with the increase amplitude of 0.7% - 20.2%; average $DR_{0.25}$ sequence by each treatment was C treatment > M treatment > W treatment > V treatment, and there was no significant difference among various treatments. $DR_{0.25}$ content by each treatment showed increasing trend with soil layer deepened. The content of > 0.25 mm of aggregate ($WR_{0.25}$) obtained by wet sieving method was far lower than that by dry sieving method, between 3.1% and 12.3%. It illustrated that soil aggregate was mainly dominated by mechanical stable aggregate after land consolidation and development. The analysis showed that $WR_{0.25}$ content in each treatment showed the decreasing trend with soil layer increased, and there was significant difference between other treatments and CK ($P < 0.05$), with declining amplitude of 43.6% - 74.8%. Average $WR_{0.25}$ sequence in various treatments was W treatment > C treatment > M treatment > V treatment > CK treatment. At 0 - 20 cm of soil layer, $WR_{0.25}$ content under C treatment had significant difference from other treatments ($P < 0.05$). At 20 - 40 cm of soil layer, $WR_{0.25}$ content under W treatment had significant difference from other treatments ($P < 0.05$). It illustrated that corn had significant effect on soil aggregate of surface layer, while wheat had significant effect on soil aggregate of deeper layer.



Note: (D/W)$R_{0.25}$ denotes aggregates of diameter > 0.25 mm (dry/wet sieving); different small letters denote significant difference among treatments at 0.05 levels, respectively.

Fig. 1 Soil aggregate size fraction content by dry (A) and wet (B) sieving methods at 0 - 40 cm depth under different land utility patterns

3.2 The influence of land use manner on soil aggregate size Seen from average weight diameter of aggregate, *DWMD* and *DGMD* of aggregate in each treatment by dry sieving method were far higher than *WMWD* and *WGMD* of water stability aggregate by wet sieving method (Table 2). It was because that most of aggregates in test soil were non water stability aggregate. Both *MWD* and *GMD* sequences in each treatment by dry and wet sieving methods showed as W treatment > C treatment > M treatment > V treatment > CK treatment, and there was significant difference between other treatments and CK treatment ($P<0.05$). One-year plantation test showed that *MWD* values under C treatment, W treatment, V treatment and M treatment at 0 – 40 cm of soil layer by dry sieving method significantly increased by 38.0%, 34.9%, 2.8% and 19.0% than CK; soil *GMD* values were improved by 77.5%, 76.2%, 7.4% and 39.4%. At 0 – 10, 10 – 20, 20 – 30 and 30 – 40 cm of soil layers, each treatment had significant difference from CK treatment ($P<0.05$). Moreover, *MWD* and *GMD* values in each treatment increased with soil layer deepened. *MWD* and *GMD* values in each treatment at 0 – 40 cm of soil layer by wet sieving method showed contrary trends with that by dry sieving method, that is to say, they showed declining trend with soil layer deepened. At 0 – 10 cm of soil layer, *MWD* and *GMD* values in C treatment were the maximum. At 20 – 40 cm of soil layer, *MWD* and *GMD* values in W treatment were the maximum, followed by C treatment. At 0 – 40 cm of soil layer, *MWD* values in C treatment, W treatment, V treatment and M treatment significantly increased than CK, with the increase amplitude of 56.2% – 106.2%; soil *GMD* increase amplitude was between 5.1% and 16.8%.

Table 2 ***MWD*** **and GMD of dry and wet sieving methods under different land utility patterns**

Method	Index//mm	Treatment	Depth//cm				AVG
			0 – 10	10 – 20	20 – 30	30 – 40	
Dry sieving	*MWD*	C	4.15 a	4.13 a	4.54 b	5.38 a	4.55 a
		W	3.03 c	3.78 b	5.41a	5.53 a	4.44 a
		V	2.39 e	2.96 d	3.90 c	4.17 b	3.35 c
		M	3.43 b	3.82 ab	4.27 b	4.09 b	3.90 b
		CK	2.78 d	3.14 c	3.45 d	3.78 c	3.29 c
	GWD	C	2.20 a	2.08 a	2.51 b	3.45a	2.56 a
		W	1.31 b	1.76 b	3.54 a	3.60 a	2.55 a
		V	1.02 b	1.26 c	1.78 c	2.14 b	1.55 b
		M	1.54 b	2.05 a	2.32 b	2.13 b	2.01 a
		CK	1.03 b	1.25 c	1.47 d	2.02 b	1.44 c
Water sieving	*MWD*	C	0.71 a	0.24 b	0.20 b	0.17 b	0.33 a
		W	0.46 a	0.34 a	0.26 a	0.193 a	0.31 a
		V	0.33 b	0.27 ab	0.196 ab	0.191 b	0.25 a
		M	0.51 a	0.22 ab	0.21 cd	0.18 b	0.28 a
		CK	0.165 c	0.163 c	0.16 b	0.15 d	0.16 b
	GWD	C	0.18 a	0.173 a	0.14 a	0.143a	0.16 a
		W	0.18 a	0.15 a	0.14 ab	0.145 a	0.15 a
		V	0.159 a	0.155 a	0.14 ab	0.12 a	0.144 b
		M	0.17 a	0.15 a	0.14 ab	0.13 a	0.15 a
		CK	0.14 a	0.137 a	0.138 b	0.132 a	0.137 c

Note: Different small letters in the same column meant significant difference among treatments at 0.05 levels, respectively.

3.3 The influence of land utilization manner on the stability of soil aggregate After planting different crops for one year, changing trends of *WSAR*, *PAD* and E_{LT} of soil under different treatments at 0 – 40 cm of soil layer were shown as Fig. 2. *WSAR* under each treatment decreased with soil depth increased, while *PAD* and E_{LT} increased with soil depth increased. At 0 – 40 cm of soil layer, *WSAR* means under C treatment, W treatment, V treatment and M treatment had significant difference from CK ($P<0.05$), which respectively increased by 111.1%, 101.4%, 65.4% and 80.5%; at 0 – 20 cm of soil layer, *WSAR* value by C treatment was the maximum, and there was significant difference from other treatments, and stability was improved by 87.6% – 151.8%; at 20 – 40 cm of soil layer, *WASR* sequence by each treatment was W treatment > C treatment > M treatment > V treatment > CK treatment. At 0 – 40 cm of soil layer, *PAD* and E_{LT} by C treatment, W treatment, V treatment and M treatment had significant difference from CK ($P<0.05$), and *PAD* means under various treatments were respectively 90.6%, 91.1%, 92.2%, 91.9% and 95.6%, while E_{LT} means were respectively 91.8%, 92.3%, 93.7%, 93.1% and 96.6%. By analyzing the relationship between three soil stability indexes and $WR_{0.25}$, it was clear that $WR_{0.25}$ showed significant correlation with the three indexes ($P<0.05$). That is to say, the higher the $WR_{0.25}$, the stronger the soil aggregate stability, the more stable the soil structure. Crop plantation had the best improvement on soil structure.

3.4 The influence of utilization manner on fractal characteristics of soil aggregate Soil fractal dimension is the parameter of reflecting geometry shape of soil structure[22 – 24]. Based on the formula (8), fitting calculation of dry and wet sieving data of aggregate was conducted, thereby counting *D* value. Fig. 3 was distribution chart of fractal dimension of soil aggregate under 5 kinds of treatments at 0 – 40 cm of soil layer. At 0 – 40 cm of soil layer, fractal dimension of soil aggregate by dry sieving method under each treatment decreased with soil layer depth increased, which had consistent trend. Fractal dimension of soil aggregate was between 2.05 and 2.56, and D mean sequence by each treatment was C treatment < W treatment < M treatment < V treatment < CK treatment. Moreover, each treatment had significant difference from CK ($P < 0.05$), and stability was improved by 2.5% – 10.7%. Fig.3b displayed fractal dimension of water stability aggregate. Comprehensive analysis showed that fractal dimension of soil aggregate by wet sieving at 0 – 40 cm of soil layer showed contrary trend with that by dry sieving method. That is to say, fractal dimension in each treatment increased with soil depth increased, which showed "Z" shape trend. At 0 – 40 cm of soil layer, fractal dimension in C treatment was the smallest (2.96), and there was significant difference from other treatments ($P < 0.05$), followed by W treatment (2.97), and fractal dimension in CK treatment was the highest (2.98).

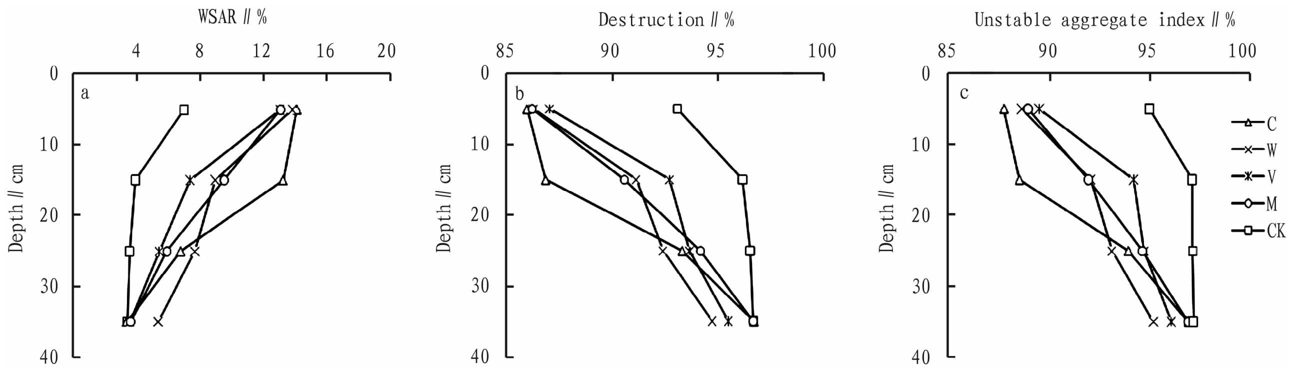
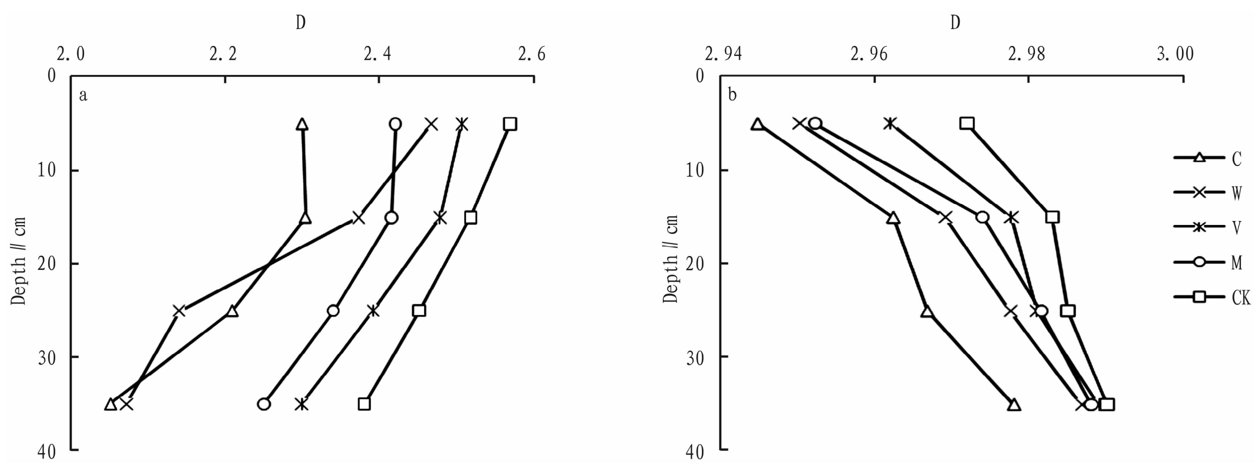


Fig.2 *WSAR* (a), destruction rate of aggregate (b) and unstable index of aggregate (E_{LT}, c) under different land utility patterns



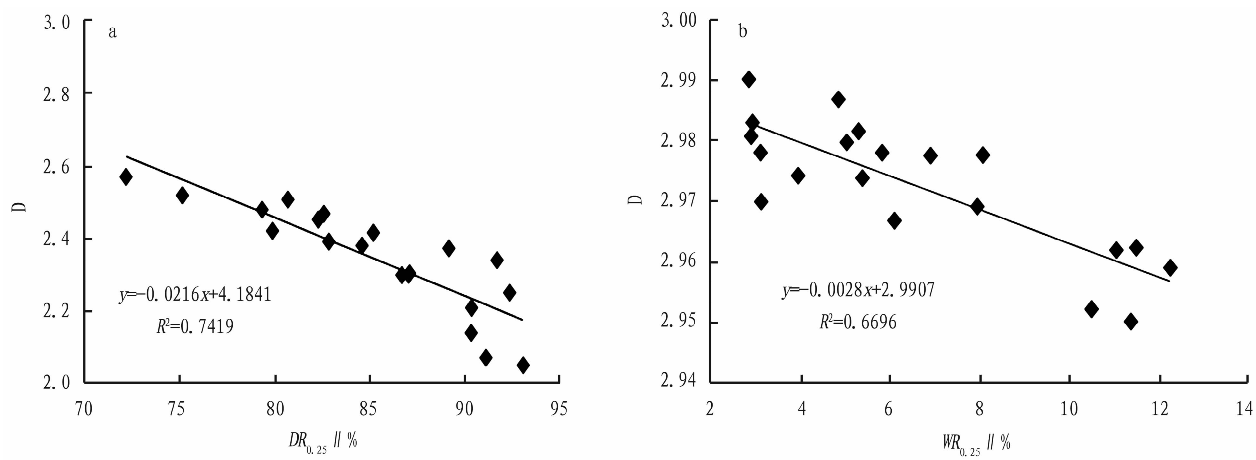
Note: a. Dry sieving; b. Water sieving.

Fig.3 Fractal dimension of soil aggregates under different land utility patterns

3.5 The relationships between fractal dimension and $DR_{0.25}$, $WR_{0.25}$ The relationships between fractal dimension and $DR_{0.25}$, $WR_{0.25}$ at 0 – 10, 10 – 20, 20 – 30 and 30 – 40 cm of soil layer by C treatment, W treatment, M treatment, V treatment and CK treatment were comprehensively analyzed. It was found that they showed significantly negative correlation with separate fractal dimension ($P < 0.05$). That is to say, fractal dimension of soil decreased with $DR_{0.25}$ and $WR_{0.25}$ increased, and $DR_{0.25}$ and $WR_{0.25}$ increase was conducive to declining viscosity degree of soil and improving soil structure. Fractal dimension of soil by dry sieving method (y) showed good linear relationship with $DR_{0.25}$ (x), and $R^2 = 0.74$; fractal dimension of soil by wet sieving method (y) and soil $WR_{0.25}$ (x) also had better linear relationship, and $R^2 = 0.67$. The higher the content of > 0.25 mm of soil stability aggregate, the more stable the soil structure, the better the soil corrosion resistance. Correspondingly, large fractal dimension showed higher fractal dimension of soil aggregate, complex soil structure and higher soil development stage.

4 Discussion

4.1 The influence of land use manner on number of soil aggregate Soil aggregate is basic unit and material basis of soil structure composition, and the index directly affects soil quality and crop production performance[25–26]. By declining soil compaction, straw returning to the field could improve soil structure[27]. The researches in recent years show that aggregate composition and number of soil developed from the same parent material change greatly due to different utilization manners, and land use manner has larger impact on aggregate formation[28]. Soil aggregate number and size at 0 – 40 cm of soil layer by each treatment were significantly better than CK treatment, and average $DR_{0.25}$ sequence of each treatment was C treatment > M treatment > W treatment > V treatment; $WR_{0.25}$ sequence was W treatment > C treatment > M treatment > V treatment > CK treatment. Maybe it is because that root system effects of corn and wheat are stronger. $DR_{0.25}$ and $WR_{0.25}$ of each treatment showed contrary trend with soil layer depth increased, which was consistent with research result of Zhang Peng *et al.* It is because that the influence of human and external interference on deep soil is smaller, thereby effectively declining mineralization rate of soil organic carbon. That is to say, test soil was dominated by mechanical stability aggregate[29].



Note: a. Dry sieving; b. Water sieving.

Fig. 4 Correlation of fractal dimension and >0.25 mm of soil aggregate content

4.2 The influence of land use manner on soil aggregate size and distribution *MWD* and *GMD* of soil aggregate could better reflect grain level distribution characteristics of aggregate under each treatment[30]. *MWD* and *GMD* are often taken as the indexes of soil aggregate condition, and their larger values show higher soil agglomeration degree and stronger aggregate stability[31 – 32]. The research showed that *MWD* and *GMD* sequences by dry and wet sieving methods were all W treatment > C treatment > M treatment > V treatment > CK treatment, and there was significant difference between other treatments and CK ($P < 0.05$). *MWD* and *GMD* at 0 – 40 cm of soil layer by dry sieving method increased with soil layer deepened, while *MWD* and *GMD* showed declining trend with soil layer deepened by wet sieving method, and the tested soil was dominated by mechanical stability aggregate. C treatment was conducive to increasing large aggregate content of surface soil, while W treatment was conducive to increasing large aggregate content of lower soil, which was mainly caused by different root system characteristics of crop.

4.3 The influence of land use manner on stability of soil aggregate *WSAR*, *PAD* and E_{LT} could better reflect stability of soil structure[33]. Higher *WSAR* illustrates that soil structure is stable; higher *PAD* and E_{LT} illustrate that soil structure is unstable, and degradation degree increases. The research showed that *WSAR* means under C treatment, W treatment, V treatment and M treatment at 0 – 40 cm of soil layer had significant difference from CK ($P < 0.05$), with increase magnitude of 65.4% – 111.1%; *PAD* and E_{LT} values of each treatment were significantly lower than CK. As a new comprehensive index of evaluating soil structure distribution, fractal dimension could not only express soil particle size and distribution, but also reflect even degree of soil texture. The higher the value, the more fine the texture, the weaker the soil permeability; the smaller the value, the better the soil structure, the better the soil permeability[34]. The research showed that fractal dimension of soil aggregate at 0 – 40 cm of soil layer decreased with soil depth increased, and they had consistent trend, and fractal dimension of soil aggregate was between 2.05 and 2.56. *D* value under each treatment by dry sieving method decreased with soil depth increased, while wet sieving method showed "Z" shape trend, which was similar to research result of Li Han *et al.* Fractal dimension of soil(y) and soil $R_{0.25}$ (x) had good linear relationship, and the correlation coefficients by dry and wet sieving methods were respectively $R^2 = 0.74$ and $R^2 = 0.67$.

5 Conclusions

(i) >0.25 mm of aggregate content, *MWD* and *GMD* were analyzed, and the results showed that crop plantation was conducive to improving soil stability after consolidation and returning to the field in hollow village of hilly area, increasing the content of large aggregate in soil, and effectively improving soil structure. (ii) Comprehensive factor analysis showed that corn and wheat plantation after consolidation and returning to the field in hollow village of hilly area could significantly improve soil stability than vegetable and medicinal material. In summary, corn and wheat had better improvement effect on soil structure. Corn could improve soil stability of surface layer, while wheat could obviously improve soil stability of deep layer. In future test, it should increase wheat – corn rotation and related tillage treatment, and analyze and screen the best plantation model and tillage measure of improving whole stability of soil tillage layer.

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