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Overview of Soil Swellability in Major Geographical Areas of Shaanxi Province

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Abstract

There are various soil types in Shaanxi Province. The main soil types are chestnut soil, black soil, brown soil, cinnamon soil, yellow brown soil, yellow cinnamon soil, aeolian sandy soil, loess soil, lime calcium soil, paddy soil, fluvo-aquic soil, new fill soil, swamp soil and saline soil, etc. The most typical aeolian soil is mainly distributed in the aeolian sand area north of the Great Wall on the northern Shaanxi Plateau. Loess soil is mainly distributed in the loess area of the northern Shaanxi Plateau. The soil is the main agricultural production soil in Guanzhong area. Yellow brown soil is the main agricultural production soil in southern Shaanxi. Due to the large number of soil types in Shaanxi, the longitude span is large, the climate difference between southern and northern Shaanxi is large, and the parent materials and processes of different types of soil are different, so the incentives for regional ecological and environmental problems are also different. Soil erosion resistance is the key point of ecological protection and prevention of soil erosion, and soil swelling characteristics are the key indicators affecting soil erosion resistance characteristics. There are significant differences in soil swelling characteristics in different regions, and the key factors affecting this difference are soil genesis and texture. Proving the swelling properties of soil types in different regions is conducive to reducing the occurrence of soil erosion and geological disasters in the region. If appropriate human intervention is carried out, the local soil environment can be effectively improved and the process of local ecological security can be promoted.

Keywords

Swellability; Soil types; Soil texture.

1. INTRODUCTION

There are a variety of soil types in Shaanxi Province, with 22 soil classes, 49 subclasses, 134 soil genera and 403 soil species. The main soil types are chestnut calcium soil, black kiln soil, brown soil, brown soil, yellow brown soil, yellow brown soil, wind and sand soil, yellow sheep soil, gray calcium soil, rice soil, tide soil, new accumulation soil, swamp soil and salt soil. The most typical geographic soil distribution is as follows: sandy soils are mainly distributed in the sandy areas north of the Great Wall in the northern Shaanxi Plateau. Loess soils are mainly

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distributed in the loess area of the northern Shaanxi plateau. Small mound soils are the main agricultural production soils in the Guanzhong region. Rice soil is the main agricultural production soil in southern Shaanxi. Xinjian soil is distributed on both sides of rivers and is found throughout the province. Swampy soils are mainly distributed in areas with low-lying terrain and frequent exposure of groundwater. Saline soils are mainly distributed in the low depressions on both sides of the rivers in Guanzhong, and are more concentrated in Halpo Tan in Pucheng County and Dingbian County. Because of the large number of soil types in Shaanxi, the longitude span, the climate difference between southern and northern Shaanxi, and the differences in soil-forming matrices and processes between different types of soils, the causes of regional ecological and environmental problems are not the same.

2. HAZARDS OF EXPANSIVE SOILS

Soils are often in a state of alternating wet and dry under natural precipitation and evaporation conditions. Soils expand when wet and contract when dry [1, 2], especially for expansive soils, the expansion and contraction processes and the harmful effects they produce are more pronounced. Soils contain clay-grained minerals such as montmorillonite and illite, which are very sensitive to changes in water content. Evaporation, rainfall, and transient changes in water content and level can cause swelling and shrinking of the soil [3]. In the process of water absorption, the soil humidity increases, the volume expands and forms expansion pressure, and in the process of dehydration, the soil will undergo axial and radial shrinkage, and its shrinkage strain gradually increases, which will eventually lead to cracks in the soil, and as the water content decreases, the area, length and density of cracks show an increasing trend [4], which are significantly harmful to both slope engineering and greening engineering. In slope engineering, when water is absorbed by the slope, the soil expands and softens, and the strength decreases; when water is lost, the soil contracts and cracks are subsequently produced. The repeated expansion and contraction lead to the loosening of the soil body of the swelling soil and the formation of many irregular fissures in it, thus creating conditions for further weathering of the soil surface [5]; in the event of rainfall infiltration, it is very likely to lead to geological disasters such as landslides [6]. In greening projects, cracks generated by soil shrinkage may damage crop roots, thus affecting their distribution and water absorption and causing mechanical tearing [7]; on the other hand, soil shrinkage cracks will lead to changes in soil water movement and solute migration characteristics, and even generate preferential flow, causing ecological problems such as nutrient loss and groundwater pollution [8].

Wet swelling and dry shrinkage is one of the most basic properties of soil. Farmland with severe soil swelling and shrinkage is prone to drought and flooding, causing massive nutrient loss and more obvious damage to crop physiology, which is one of the important attribute barriers limiting the improvement of the basic ground strength of regional farmland [1-6]. Soil swelling and shrinkage is a complex process that is influenced by a variety of other soil factors. Soil swelling and shrinking properties are strongly related to clay mineral type and content, cation exchange capacity (CEC), and other factors [1,3,7]. Montmorillonite is more likely to cause soil swelling and shrinkage compared to illite and kaolinite [3]. Soil swelling and shrinkage were positively correlated with clay content and CEC when the soil clay mineral species were similar [1-2,8]. Soil swelling and shrinkage are also strongly related to organic matter, but the mechanism of mutual influence is more complex. Some studies suggest that soil shrinkage intensity is positively correlated with organic matter content, but others suggest that soil water retention capacity is higher at higher soil organic matter content, and soil structure is stable and less prone to shrinkage behavior [9-13]. Soil erosion resistance is a key point for ecological environmental protection and prevention of soil erosion, and soil swelling characteristics are key indicators affecting soil erosion resistance characteristics.

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3. OVERVIEW OF SOIL SWELLABILITY IN DIFFERENT REGIONS OF SHAANXI PROVINCE

Windsand soils are mainly distributed in the windsand area north of the Great Wall in the northern Shanxi Plateau. Wind-sand soils are soils developed in sandy parent material. Its main feature is that the mineral part of the soil is almost entirely composed of fine sand particles (0.25~0.05 mm in diameter); the profile level differentiation is not obvious, only A layer (drench layer) and C layer (parent material layer) lacking B layer (precipitation layer), wind erosion is serious, and the soil is in the juvenile stage. Due to its own soil texture, its swelling is not strong. Loess soil is mainly distributed in the loess area of the northern Shanxi plateau. Loess soil is a kind of young soil formed by direct cultivation of loess parent material. It is named because the soil is loose, soft and light in color. The substance is a soil primitive soil. Its main characteristics are, the development of the profile is not obvious, only A layer and C layer, and there is no obvious boundary between the two; soil erosion is serious. It is widely distributed in the areas with serious soil erosion on the Loess Plateau in China, and more in northern Shaanxi. A large number of studies have shown that loess has wet sinkability, when it is wetted by water under certain pressure, the soil structure will be rapidly destroyed, producing large additional subsidence, and the strength will be rapidly reduced. Small mound soils are the main agricultural production soils in the Guanzhong area. It is a soil formed under human influence with a layer of man-made manure pile bedding ≥ 50cm thick. "Small mound" means that the soil is like a building, formed by two layers of human mounding, the upper layer is the soil and manure mounding layer, and the lower layer is the original loess. According to the cause of small mound soil, most of the soil is formed by artificially taking strong pile bedding layer superimposed, so the soil is not strong expansion.

Yellow-brown loam is mainly distributed in Shangluo area in southern Shaanxi, with brown or reddish-brown B layer in the profile, i.e., a clayed layer containing more clay particles, and iron-manganese nodules in the soil. Swampy soil is developed in low-lying soils where water accumulates for a long time and grows moisture-loving plants. Its surface layer accumulates a large amount of organic matter or peat with low decomposition, the soil is slightly acidic to acidic reaction, the bottom layer has low-valent iron and manganese presence, so this soil type has very obvious swelling.

4. CONCLUSION

Soil types in Shaanxi Province are diverse, and the swelling characteristics of soils vary significantly from region to region, and the key factors affecting this difference are soil genesis and texture. It is found that the soil swelling is due to the large amount of active clay minerals, such as montmorillonite and illite, especially montmorillonite, which has a large specific surface area and has a great suction force on water at low water content. The amount of montmorillonite content in the soil directly determines the size of the swelling and shrinking properties of the soil. From the microstructural aspect, the spatial association state of these mineral components also affects its swelling and shrinking properties. It has been shown that surface-face connected stromatolites are a common structural form of swelling soils, and this structure has a greater ability to swell and shrink with water loss than agglomerate structures. The migration of water is the key external factor controlling the swelling and shrinking characteristics of the soil. This is because only the presence of gradients in the soil that may produce water migration and the pathways for water migration can cause expansion or contraction of the soil.

To find out the swelling properties of different regional soil types is beneficial to reduce the occurrence of soil erosion and geological disasters in the region, and if appropriate human

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intervention is made, it can effectively improve the local soil environment and promote the process of local ecological security.

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