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Coal Mining influences on the Soil Water content in Mao Wusu Sand Land

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Abstract. The soil water content in a region is closely related to plant growth. The coal Mining has a strong influence on the soil in Mao Wusu sand land. This study investigated the relationship between the soil water content and the collapse Degree Land of Coal Mining. Samples of the collapse land were analyzed for the soil water content in different slope locations in summer. The soil moisture changes are basically same in different slope location regardless whether it is in subsidence area or not when no rain occurs within two weeks in summer, and soil water content is relatively low in slope button, and a relative high in the other slope location, the water content in the control area and subsidence area follows from high to low by: 0a> 3a> 2a> 1a. The soil water content of the control region each layer is significantly higher than that of the subsidence region.The soil volumetric water content of the sample land on both sides of the subsidence cracks is less than that in the control land in the experimental period. The water content of relative subsidence side is higher than in the exposed side, and the water content is shown the law of the control area>light >light-exposed>medium>medium-exposed>heavy>heavy-exposed.

Introduction

The water content,also known as soil moisture[1-3], is the soil moisture quantity of soil[4,5]. Generally, it refers to the amount of water released from the soil in drying method under temperature between 105 ~ 110℃[6,7]. Soil moisture is an important component of soil and the foundation for the analysis of soil moisture condition and dynamic changes[8-11].On the one hand, it plays an important role in the process of transformation. On the other hand, it is also the necessary material needed for plant growth. At the same time, it also influences the transfer speed and distance of soil nutrient toward the roots of plants, and then the effectiveness of soil nutrient. It is the active media that influences the structure formation and stability of soil.The soil water content is affected by meteoric water, soil vaporation, plant absorption, plant transpiration and soil character. For lean soil, a kind of bare sandy ecological system due to the strong activity of sand soil, its biological activity is very weak, especially in the semi-arid and arid areas. Among the restricting factors of sand, moisture distribution and water quantity are the most important elements, and the moisture distribution and balance of sand soil are the foundations of the development and utilization of sand soil areas.

Research method

The research region is located in Shanxi, Shaanxi, Inner Mongolia provinces at the junction of Erdos coal basin in northeastern Erdos Plateau, located in the southeast edge of Mu Us Sandland Dongsheng coalfield Bulianta coal mine, belongs to the administrative of Yijinhuoluo Banner, Erdos City(109 ° 45 ' E - 110° 40', 38 ° 50 ' - 39° 50' N), from the Yijinhuoluo Banner 18km.

The experiment was carried out from March to October in 2010. In order to minimize soil properties spatial heterogeneity, the sampling region was chosen from the similar parent material, soil forming conditions of biological, climate and topography. The chosen four sand dunes are the same parent material formation and similar to underlying surface conditions (Extension of sand dunes from

the east to the west, with an average altitude about 1190m, the average height of 3.0m to3.5m dunes, slope is approximately the same, the windward slope angle of about 11° to 14 °, the leeward slope angle of about 30° to 34 °, the same plant species, vegetation coverage of about 30 per cent). The first dune underground mining (not collapsed recorded as 0a); second collapsed in windward slope on May, 2009, Lee did not collapsed (denoted as 1a); third in windward slope collapsed on April, 2008, Lee did not collapsed (denoted as 2a); fourth collapsed in windward slope on September, 2007, the leeward slope did not collapsed (denoted as 3a).

Changes in soil water content in subsiding land

In different subsiding slope location soil water content had great change. Figure.1 shows the soil moisture changes are basically same in different slope location regardless whether it is in subsidence area or not when no rain occurs within two weeks in summer, and water content is relatively low in slope button, and a relative high in the other slope location, the water content in the control area and subsidence area follows from high to low by: 0a> 3a> 2a> 1a. The 0a, 1a, 2a, and 3a follows by 0.14%, 0.07%, 0.08% and 0.05%, the control area is larger than the subsidence area. Because of no rain when air temperature is high in summer, soil evaporation is more vigorous, as against a higher soil water content, with a corresponding greater evaporation, resulting in the increased amplitude; while the vertical fissure in the subsidence area develops, soil evaporation is strong, the water lost is fast, soil water content is low, evaporation reduces, soil moisture deficit is severe, the evaporation is reduced by the soil moisture restrictions, so the amplitude is smaller. The variance test shows that, in addition to slope button ($p = 0.02$), there is no significant difference between the outside control area and the other subsided land in the other different slope location ($P > 0.05$).

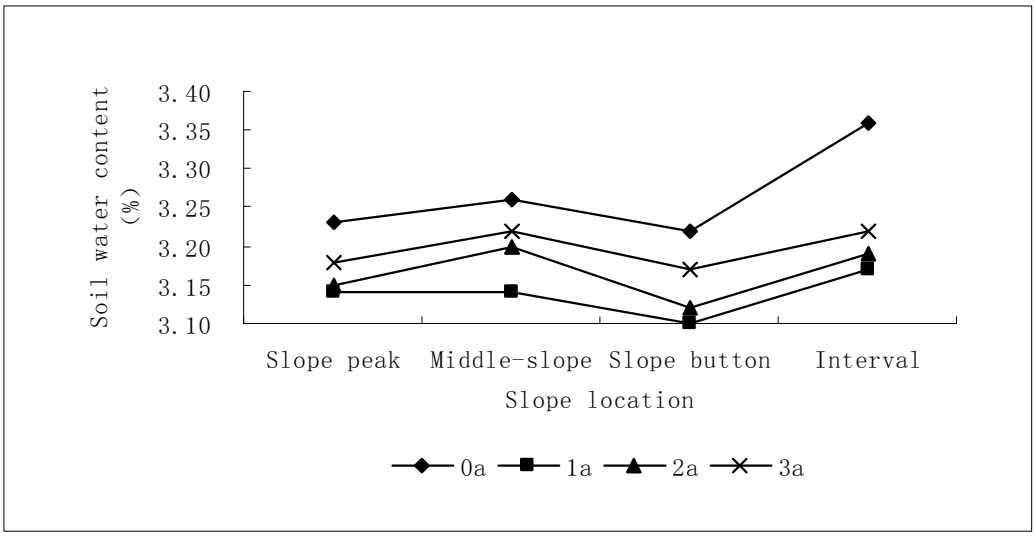

Figure.1.Changes in soil water content in different slope location in no rainfall summer.

The results of Figure 2 show that the change is basically the same in different slope location in the subsidence area after summer rainfall, the change scopes of 0a, 1a, 2a and 3a are respectively in the order of 5.93% ~ 8.25%, 5.76% ~ 7.23%, 4.72% ~ 7.73% and 5.82% ~ 7.16%. The changes of water content between 0a and 2a are large, and there are few changes in varying degrees between the control area and the subsidence area in different slope location. Analysis of variance results show that there is no significant difference in water content between slope peak, middle-slope and interval in the control area and the corresponding location of the subsidence area after rainfall ($P > 0.1$); but the difference is significant at their button($P < 0.01$). This is mainly because soil moisture is replenished by heavy rain, and it mitigates soil water deficit in varying degrees, and reduces the difference between the control area and the subsidence area.

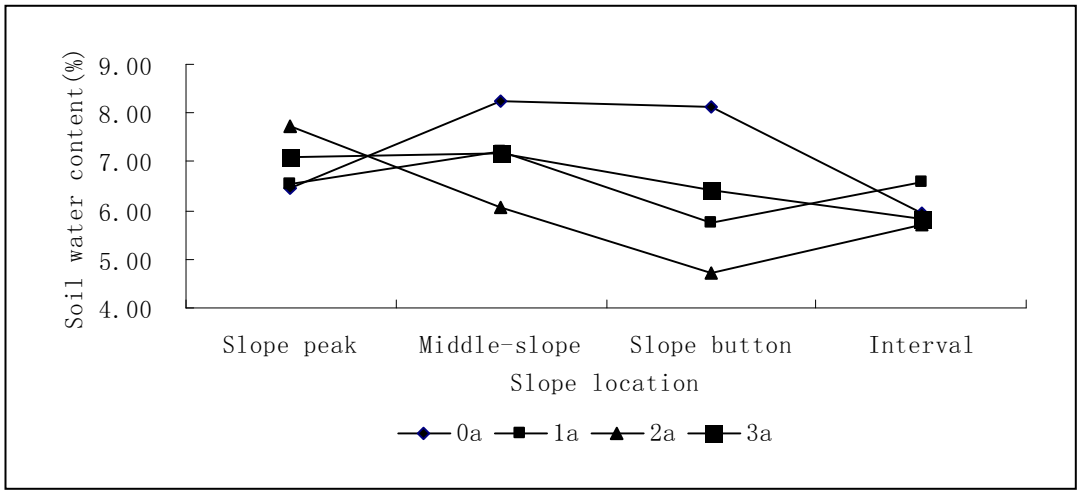

Figure.2.Changes in soil water content in different slope location in rainfall summer

Soil water content had apparent change in a vertical direction in different subsiding land. During the rainy season in summer, the soil changes frequently and is affected by precipitation. Soil moisture level in summer is higher than in spring because of the rainfall recharge. The moisture of Mao Wusu Sand Land is mainly affected by precipitation. The over 20cm precipitation may be wet sand below 60cm, and the infiltration of water-saturated content is quick, it can make the whole land section maintain a high water content, and more rainwater supply for the soil layer.

Table.1 Soil water content in different depth in summer after raining （%）

Susidence time	5cm	15cm	25cm	35cm	45cm	55cm	65cm	75cm	85cm	95cm
0a	7.85	9.08	9.60	10.50	9.86	10.10	8.00	5.84	5.06	4.58
1a	7.40	7.26	8.94	7.16	6.42	7.90	6.42	6.56	6.40	6.48
2a	6.48	6.22	7.56	8.60	6.08	6.58	6.28	5.50	5.51	4.73
3a	6.85	6.54	7.88	9.27	8.88	5.4	6.31	5.55	5.75	4.88

The results of table.1 show that a day after heavy rainfall in summer, the control area is higher than the subsidence within 0 ~ 65cm; the subsidence area is higher than the control area within 65 ~ 100cm, and the water content of 1a is the highest, the control area and the other subsidence area reduces in varying degrees. The moisture changes of 2a and 3a in different depth are complex due to the disturbance of soil layers in varying degrees, but affected by the strong mining-induced interference, the 1a's moisture change is very small with in different depth, and it is almost a straight line.

The main reason is that the soil develops a greater amount of vertical cracks with the subsidence, the internal or external water vapor of the soil can directly spread from the homogeneous, coarse straight cracks into the atmosphere or into the soil, and the speed of the moisture diffusion and penetration is much faster than through the curved soil pore clearly. Due to the cracks of the sample plots 1a, 2a, and 3a are higher growth after a large rainfall, the upper soil evaporation increases, the water-holding capacity of the soil reduces. The soil seepage water transforms into the cracks stream, makes the water infiltration speed of the sample plots 1a, 2a, and 3a be faster than the sample plot 0a, so the soil water content of sample plots 1a, 2a, and 3a is higher than the sample plot 0a within the 65 ~ 100cm; while the average soil water content of the sample plots 1a, 2a, and 3a is lower than the sample plot 0a within the 0 ~ 65cm. At the same time variance test shows that the differences between the 2a, 3a, and 0a are not significant, and due to the soil water content differences before the rain, the difference between 1a and 0a is more significant, this reduces the difference between the control area and the subsidence area together with rainfall in a certain extent.

Table.2 Soil water content in different depth after rainfall 15 days in summer （%）

Susidence time	5cm	15cm	25cm	35cm	45cm	55cm	65cm	75cm	85cm	95cm
0a	4.26	6.62	6.96	7.22	7.30	7.54	6.10	5.52	6.28	6.25
1a	3.98	5.50	5.02	5.04	6.22	6.42	6.76	6.66	7.10	6.92
2a	4.48	4.76	5.90	4.64	5.12	6.54	6.50	6.46	6.44	5.95
3a	4.15	4.87	6.39	4.71	5.54	6.89	6.43	6.14	6.59	5.66

The results were shown in table.2 that after rainfall15 days in summer, when the soil moisture suffered from the evaporation and seepage, the soil water content within 0 ~ 50cm is all lower than the initial stage of rainfall, the change between the control area and the subsidence area is more complicated compared with the early stage of rainfall within 50 ~ 100cm affected by the infiltration. The change between the control area and the subsidence area is not significant on the soil surface at 5cm. There is about 5cm thick layer of dry sand, the water content of the control area is still higher than the subsidence area within 5 ~ 65cm, the water content of 0a is lower than 1a within 65 ~ 100cm, but higher than 2a and 3a. In other words, the soil water content has rising and falling in varying degrees within 15 ~ 100cm regardless whether in the control area or in the subsidence area, but the total trend is that the water content of the control area first rises and then decreases in different depth; the change of water content in the subsidence area is more complex in different depth, but it shows in general the feature of the water content, lower is higher than the upper. The main reason is the high temperature in summer and the strong evaporation. Due to the quick evaporation and infiltration, dry sand layer is formed after the surface water rapid evaporation, so that the capillary in soil is cut off, so that the lower water cannot rise through the capillary, the formed layer of dry sand shields the water evaporation in lower sand.

For the control area, this shielding effect makes the soil hoard the water in atmosphere precipitation and condensation constantly, and transports slow down in non-saturation, and stores in the sand layer in the form of poised capillary water. For the subsidence area, the evaporation and infiltration are much larger than the control area because of the cracks, particularly the layer within 10 ~ 35cm, the soil moisture change is the most dramatic, while dry sand layer plays a certain shielding role, but the impact of cracks is greater, the soil water content of 1a, 2a, and 3a decreases by 78.09%, 28.14% and 23.32% in this15 days, and the soil moisture increases in the layer within 35 ~ 65cm. The water content in the subsidence area is higher than the control area within 65 ~ 100cm. Tensile force is generated because of the subsidence, produces a large number of cracks (joints), so that the soil pores are larger. The study of Feng Jie et shows that when there are large pores in the soil, the water and solute in the soil reach the deep depth of the soil or groundwater quickly passes most of the soil matrix, and through the large pores. A large number tests of laboratory and field show that the large pore flow is a common existent phenomenon in the soil (Rui et al.2010; Chen 2010). Therefore, the subsidence make pores larger, the water conductivity rises, the moisture migration accelerates, and the moisture in the deep soil increases. At the same time, due to deep the soil, the evaporation is significantly reduced compared to the upper.

Changes in soil water content under different strewn at random with time

In order to analyze the difference of soil water content between both sides of the different strewn crack, it is necessary to select the water content of the mild, moderate and severe strewn field in middle-slope in the 1 year subsidence area. To facilitate the analysis, the relative subsidence side and the exposed side of cracks are classified as "light" and "light-exposed","middle" and "middle-exposed" ,"heavy" and "heavy-exposed" in table 3. Experimental time is from March 25th to April 15th, 2011, the water content of all sorts of volumetric is sampled once every 3 days. The experimental area is blizzard in March 2nd to 4th, 2011 before the experimental period, the snowfall is 13.4 ~ 21.4mm. Uneven distribution of snow appears again from the night on 18th to the day on 19th, and snowfall further increases. During the experiment period, the snow melted and the soil environment is relatively moist during the experiment.

Table.3 In accordance with the scattered height to classify

Collapse degree	Control area	Light degree	Middle degree	*Heavey degree*
the scattered height（cm）	0	0～20	20～40	*40～60*

Table.3 and Figures 3, 4 and 5 show that the soil volumetric water content of the sample land on both sides of the subsidence cracks is less than that in the control land in the experimental period. The soil volumetric water content declines as the subsidence increases, the change degree of the soil volumetric water content increases, the water content of relative subsidence side is higher than in the exposed side, and the water content shows the law of the control area > light >light-exposed>medium>medium-exposed>heavy>heavy-exposed. It also shows that different layers of the soil profile and the water content change of soil layer are complex within 0 ~ 15cm, the change law of the subsidence area and control area is not obvious, the water content of the subsidence area and the control area fluctuate. The change ranges of light, light-exposed, middle, middle-exposed, heavy and heavy-exposed within15 ~ 95cm in the control area are in the order of 5.18% ~ 5.44%, 5.06% ~ 5.48%, 4.84% ~ 5.30%, 4.18% ~ 5.43%, 4.18% ~ 5.32%, 3.88% ~ 5.33% and 3.48 % ~ 5.04%, respectively. The average change of the control area is less than in the subsidence area. A variance analysis is done for the data of the stratified volumetric water content in both sides of the subsidence cracks in different subsidence degree with the software SPSS11.0, and according to the subsidence side, subsidence degree, stratification and determination date. The results show that the soil moisture distribution of subsidence area is significantly different ($P < 0.0001$), and is respectively as follow subsidence side ($P < 0.0001$), the relative degree of subsidence ($P < 0.0001$) and stratification ($P < 0.0001$). The influence of determination date is not significant, which can be considered as duplicate. The soil surface is mainly affected by the melting snow in varying degrees in the experimental area. The following surface is mainly affected by the result of the long-term comprehensive nature change difference. The difference between the both sides of the same crack (the subsidence side), and the relative exposed side is mainly due to the result of coal mining subsidence.

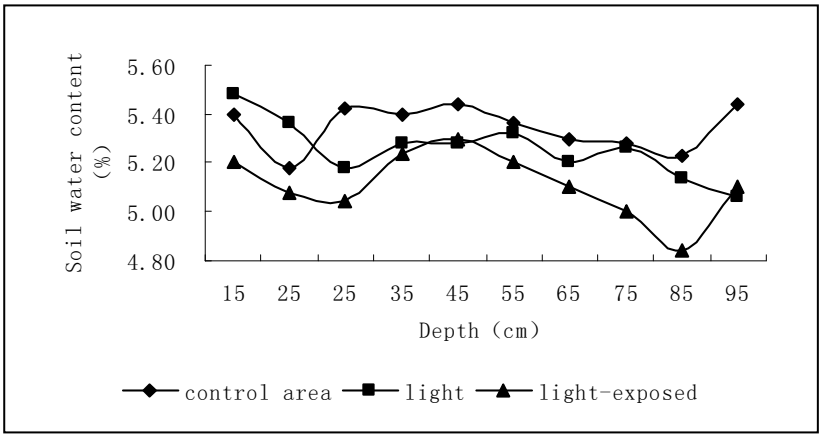

Figure.3.Changes in sandy soil water content of two sides of fissure in light subsidence area

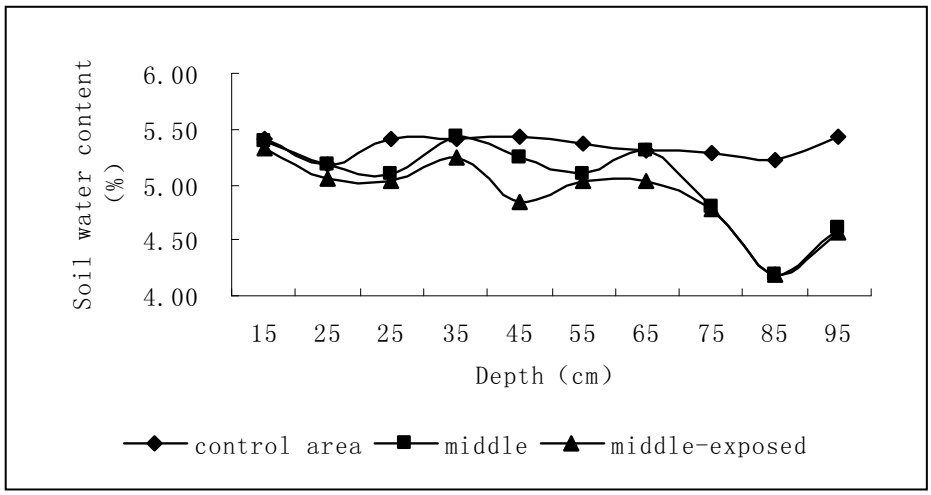

Figure.4.Changes in sandy soil water content of two sides of fissure in middle subsidence area

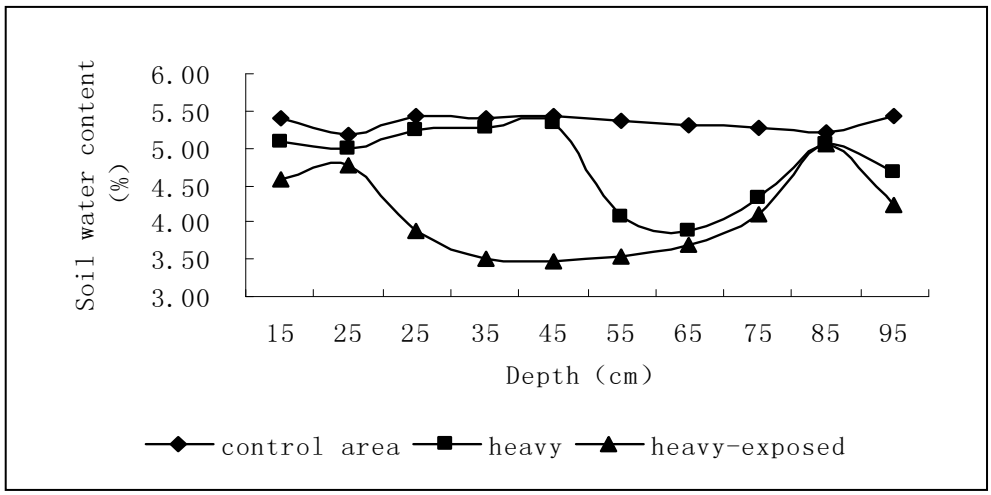

Figure.5.Changes in sandy soil water content of two sides of fissure in serious subsidence area

Conclusion

The soil moisture changes are basically same in different slope location regardless whether it is in subsidence area or not when no rain occurs within two weeks in summer, and soil water content is relatively low in slope button, and a relative high in the other slope location, the water content in the control area and subsidence area follows from high to low by: 0a> 3a> 2a> 1a.

The soil volumetric water content of the sample land on both sides of the subsidence cracks is less than that in the control land in the experimental period. The water content of relative subsidence side is higher than in the exposed side, and the water content shows the law of the control area > light >light-exposed>medium>medium-exposed>heavy>heavy-exposed.

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