

# Study on Soil Nutrient Characteristics of Different Cover Soil Thicknesses on Bare Rocky Ground

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**Abstract.** In order to study the relationship between different soil cover thickness and soil organic matter and total nitrogen in floodplain after land consolidation, spatial distribution characteristics of six soil cover thicknesses and soil carbon and nitrogen in the field plot experiment from 2015 to 2017. The results showed that soil organic matter and total nitrogen content decreased with soil depth under different thickness of soil cover, soil depth had a negative correlation with soil organic matter and total nitrogen content, and soil nutrient had apparent surface aggregation. When soil thickness was 50-60cm (C50, C60), soil organic matter and total nitrogen content were the highest among all soil depths, indicating that soil organic matter is one of the key ecological factors affecting soil total nitrogen. Therefore, for land reclamation of floodplain, the soil thickness of 50-60cm is the best, with good fertilizer-holding effect.

## 1. Introduction

Bare rocky and gravel land is an important reserve resource for cultivated land and is widely distributed throughout the country. The only area within Shaanxi Province that can be exploited is 350,000 mu, which is mainly distributed in Guanzhong, southern Shaanxi, and other regions where light and water resources are abundant [1-3]. However, the bare rock and gravel land is mainly composed of gravel and gravel. The coarse gravel on the surface is exposed. The land is barren and the crops cannot grow at all. It is in a state of ridiculous state for a long time, and it is extremely difficult to rectify and exploit. The Shaanxi Provincial Land Engineering Construction Group, through land engineering technology, provided land and soil coverage to reconstruct the bare rock and gravel land into agricultural land. The project was demonstrated and a number of innovative results were obtained [4-5]. However, technical problems such as improving the quality of land and improving the stability of the tillage layer still plague the work of uncovering bare rock and gravel land. At present, there are many researches on soil cover and soil physical and chemical properties in the field of pollution or industrial and mining wastes at home and abroad [6-7]. However, the study on the nutrient characteristics of soils with different soil cover thickness for bare rock and gravel land types is rarely reported. In this paper, the distribution characteristics and dynamic changes of soil organic matter and total nitrogen under different cover soil thickness in the treatment of bare rock and gravel land in the



old river are studied to reveal the spatial distribution of soil carbon and nitrogen under different soil cover thickness in bare rock and gravel land remediation. It not only provides technical support and theoretical basis for the improvement of soil fertility and land remediation of such lands, but also has important significance for the rational utilization of soil resources and sustainable development.

## 2. Materials and Method

### 2.1. Test site overview

The experiment was set up in Ducun Town, Fuping County, Weinan City. The area is a semi-arid continental climate, with very uneven distribution of rainfall during the year, mostly concentrated in July-September, accounting for 49% of the annual rainfall and relatively dry in other seasons. The dry and wet seasons are distinct, and the dry season is longer than the wet season. In particular, it is windy and rainy in spring and has a large amount of evaporation. The annual evaporation is 1000 to 1300 mm, which is 2.0 to 2.3 times the rainfall. Evaporation was the largest in June, at 189.5mm, and the lowest in December was 44.9mm. The frost-free period is 225 days, the annual average temperature is 13.4°C, the summer maximum temperature is 41.8°C, and the minimum winter temperature is -22.0 to -10.0°C. The conditions in this area basically satisfy the growth of crops such as wheat, corn, and cotton.

### 2.2. Test methods

Set up a 1:100 scale physical model test device, including four parts of simulated river channel, irrigation channel, test field and observation channel. The test device will be set up with 6 test plots, ie 6 treatments, each test plot with an area of 2.0 m×4 m. 48 m<sup>2</sup>. According to site conditions, taking into account the uniformity of light and micro-topography, six test plots were placed from east to west in a “1” shape, and the thickness of cover loess was set to 30 cm, 40 cm, 50 cm, 60 cm, 80 cm and 100 cm, respectively. The conditions were as follows: 170cm, 160cm, 150cm, 140cm, 120cm, 100cm gravel (80%) and sandy soil (20%) were filled below the soil.

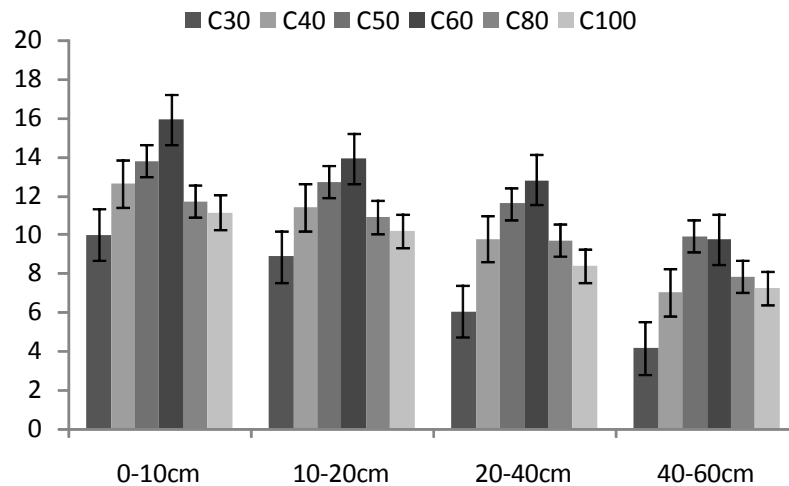
Soil samples were collected after wheat harvest for three consecutive years from 2015 to 2017. Each plot was selected by 5 points on the diagonal, and samples were taken every 10cm. Soil samples were taken from soil layers in the soil thickness of each treatment, 3 repeatedly, after being naturally air-dried, used for the determination of soil organic matter and total nitrogen.

## 3. Results and Analysis

### 3.1. Distribution of organic matter under different soil thicknesses

Soil organic matter content is closely related to the level of soil fertility, which plays a significant role in soil fertility [6]. The variation of soil organic matter content with different soil thickness in the soil treatment of bare rocky gravel land is shown in Figure 1. The content of soil organic matter in different soil cover thicknesses decreased gradually with increasing soil depth. The organic matter content of 0-20 cm topsoil was the highest, which was 4.63 times higher than the organic matter content of 40-60 cm soil layers. Different soil-covering thickness C30, C40, C50, C60, C80, C100 the content of organic matter in 0-20 cm soil layers accounted for 64%, 60%, 55%, 57%, 56%, and 58% of the total soil organic matter content from 0 to 60 cm. The content of organic matter in different soil thickness in 0~40cm soil layer was C60 (42.76 g•kg<sup>-1</sup>)>C50 (38.2 g•kg<sup>-1</sup>)>C40 (33.9 g•kg<sup>-1</sup>)>C80 (32.38 g•kg<sup>-1</sup>)>C100 (29.79 g•kg<sup>-1</sup>)>C30 (25.29 g•kg<sup>-1</sup>). Soil organic matter content in different soil layers with the thickness of 50cm~60cm is the highest, and it is in the 0~40cm soil layer. The content of organic matter with a thickness of 60 cm (C60) and 50 cm (C50) in the middle soil was 1.69 and 1.51 times that of organic matter with a thickness of 30 cm (C30). The average organic matter content of the 60cm (C60) and 50cm (C50) soils for the native soils accounted for 39%, 38%, and 41% of the organic matter content in the soil layers of 0~10cm, 10~20cm, and 20~40cm, respectively. The content

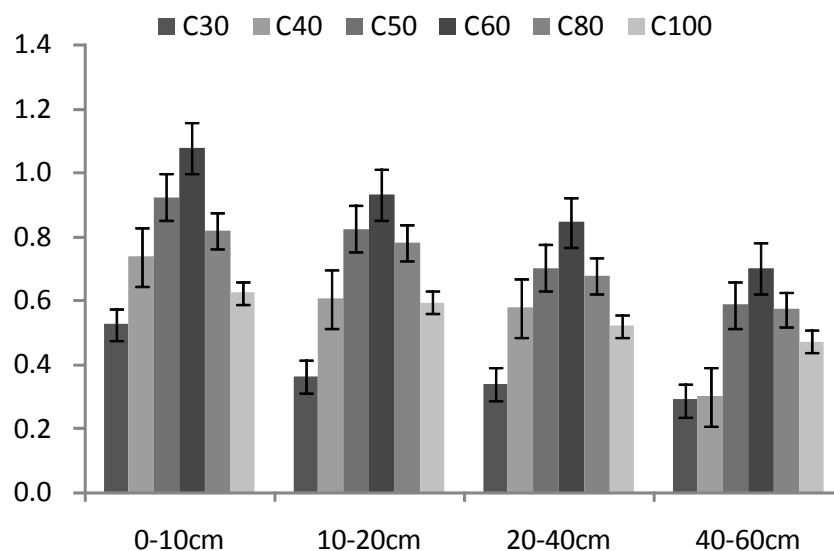
of soil organic matter in the soil layer with a thickness of 50 cm to 60 cm (C50, C60) was higher than other types of soil cover.



**Figure 1.** Changes of organic matter in different layers of different soil thickness.

### 3.2. Characteristics of total nitrogen under different soil cover thickness

With different cover soil thickness, the soil total nitrogen content varies with soil depth (Figure 2). Soil total nitrogen content with 30cm (C30) and 40cm (C40) soil thickness decreased significantly with the increase of soil thickness. The total nitrogen content of the soil with 50cm (C50) and 60cm (C60) thickness also increased with soil depth. However, the degree of total nitrogen in the soil with thickness of 30cm (C30) and 40cm (C40) is more evenly distributed in the 0-40cm soil layer. The total nitrogen content of topsoil with different thickness of 0~20 cm was the highest, and the total nitrogen content of different soil thicknesses C30, C40, C50, C60, C80, and C100 in the 0~20 cm soil layer accounted for 0~60 cm. The total nitrogen content is 62%, 61%, 57%, 56%, 56%, 55%.



**Figure 2.** Distribution characteristics of total nitrogen in different soil thicknesses

The soil total nitrogen content of different soil thickness was significantly different. The total nitrogen content of 60 cm (C60) was significantly higher than that of other soil samples. The total soil

nitrogen content in different soil thicknesses was significantly different. The total nitrogen content in the 60cm (C60) thickness is obviously higher than that in other cover soils. The total nitrogen content in the shallow topsoil of 0~10cm is as high as 1.079 g/kg, and the thickness is 30cm. (C30), 40cm (C40), 100cm (C100) 2.05 times, 1.46 times and 0.68 times, 10-40cm soil organic matter content is also 0.933 ~ 0.847 g/kg; Secondly, the customer soil thickness is 50cm (C50) The content of total nitrogen in the surface soil was relatively large, and the contents of organic matter in the layers of 0~10cm, 10~20cm, and 20~40cm were 0.924, 0.825, and 0.703 g/kg. The average total nitrogen content of 0 ~ 40 cm soil layers with different thickness of the soil is C60 ( 0.953 g•kg<sup>-1</sup> ) > C50 ( 0.817 g•kg<sup>-1</sup> ) > C80 ( 0.760 g•kg<sup>-1</sup> ) > C40 ( 0.625 g•kg<sup>-1</sup> ) > C100 ( 0.581 g•kg<sup>-1</sup> ) > C30 ( 0.404 g•kg<sup>-1</sup> ). The average total nitrogen content of the 60cm (C60) and 50cm (C50) soils with the native soil thickness is 42%, 25%, and 26% of the total nitrogen content of the soil thicknesses of 0~10cm, 10~20cm, and 20~40cm respectively. The soil total nitrogen content in different soil layers with a soil cover thickness of 50 cm to 60 cm (C50, C60) is higher than that of other soil cover types.

#### 4. Discussion and Conclusion

This study shows that the soil organic matter and total nitrogen contents gradually decrease with increasing soil depth under different soil cover thicknesses. The depth of soil layer negatively correlates with the soil organic matter and total nitrogen content, which indicates the obvious surface aggregation, the soil organic matter and total nitrogen is mainly distributed in 0-40cm soil layer. This is mainly due to the fact that the main planting types of the experimental plots in this study were corn and wheat, both of which were shallow rooted plants. The thickness of the 30 cm soil layer was the trophic area where the roots grew, and the fixed area below 30 cm was the fixed area for plant root growth. Accumulation of litters in soil litters above 0-40 cm, with the decomposition of root exudates, releases nutrients to the soil. At the same time, acid substances are generated in the decomposition process to accelerate decomposition and changes of soil minerals, and plants absorb soil nutrients through biological microcirculation is enriched in the topsoil, so nutrient content is high. The conclusions of this study are similar to those of Yuan Ziru et al. [8] on the relationship between soil organic matter and total nitrogen distribution in different grassland types in the Qilian Mountains. Similar conclusions have been reached with Lei Jianrong et al. [9] on the relationship between soil organic matter and total nitrogen in hilly regions of central Sichuan.

In summary, when the thickness of the customer soil layer is 50-60cm (C50, C60), the soil organic matter and total nitrogen content are the highest in all soil depths compared to other types of soil cover thickness, therefore, the thickness of the soil cover 50-60cm is the best, and this conclusion is similar to the effect of Han Jichang et al. [4-5] on the effect of different soil cover thickness on soil physical and chemical properties of naked rock and gravel soil and winter wheat yield. In this study, the relationship between soil thickness, soil organic matter and total nitrogen in bare rocky gravel land after land reclamation was studied. It is necessary to further understand the mutual relationship between soil carbon pool, nitrogen pool, and land cover thickness after land consolidation for bare rocks and gravel lands. As for the relationship between them, it is still necessary to explore and study the mechanism.

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#### References

- [1] Song X Y, Wang J H, Xue X Z, Assessment of the influence of soil nitrogen supplies and variable fertilization on winter wheat growth condition using airborne hyperspectral image. Transactions of the Chinese Society of Agricultural Engineering. 20 (2004): 45 - 49.
- [2] Sparling G P, Wheeler D, Vesely E T, What is soil organic matter worth [J]. Journal of Environmental Quality, 35 (2006): 548-557.

- [3] Xiao Guo-ju, Zhang Qiang, Wang Jing, Impact of global climate change on agro-ecosystem: A review, *Chinese Journal of Applied Ecology*. 18 (2007): 1877 ~ 1884.
- [4] Han Ji-chang, Li Juan, Zhang Yang, Effects of different depth of soil thickness on soil physiochemical properties and winter wheat yield on barren gravel land for land reclamation, *Journal of Anhui Agri.Sci.* 41 (2013): 5312 - 5314, 5341.
- [5] Li Juan, Zhang Yang, HAN Ji-chang, Effects of different depth of soil thickness on soil chemical properties and spring maize yield on barren gravel land for land reclamation, *Journal of Anhui Agri. Sci.* 41 (2013): 2037 - 2039, 2060.
- [6] Shi Yan, Wei Dongbin, Yu Zhenwen, Effects of soil thickness on nitrogen distribution and utilization and yield in dry land wheat, *Acta Pedologica Sinica*. 38 (2001): 128 - 130.
- [7] Zhu Bo, Kuang Fuhong, Gao Meirong, Effects of Soil Thickness on Productivity of Sloping Cropland of Purple Soil, *Journal of Mountain Science*. 27 (2009): 735 - 739.
- [8] Yuan Zirui, Ren Ling, Chen Jiangang, Relationship between soil organic matter and total nitrogen in different types of grassland on Qilian Mountain, *Grassland and Turf*. 36 (2016): 12 - 16.
- [9] Lei Jianrong, Mo Taixiang, Li Xiaodong, Relationships between soil organic matter and total nitrogen in central Hilly Area of Sichuan, *Southwest China Journal of Agricultural Sciences*. 26 (2013): 663 - 666.