

Statistical Analysis on the Variation of the Nutrient Content of the Soil in Nanniwan, Yan'an

Jianglong Shen^{1,2,3,4,5}, Na Lei^{1,2,3,4,5}

¹ Shaanxi Provincial Land Engineering Construction Group Co.,Ltd., Xi'an 710075, China

² Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Natural Resources, Xi'an 710021, China

³ Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co.,Ltd., Xi'an 710021, China

⁴ Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xi'an 710075, China

⁵ Land Engineering Technology Innovation Center, Ministry of Natural Resources Xi'an 710075, China

Abstract

Nanniwan Town, Yan'an City is located in the loess plateau area. Due to the wide distribution of terraces and the implementation of gully control and land reclamation projects, there are a lot of soil in this area. The soil can not only block the soil and divide the fields, but also take into account the preservation of water, soil and fertilizer, which is conducive to farming and irrigation. Farmers often use scrubbing to improve the nutrients of farmland soil, and studying the distribution of nutrients in the soil and its change characteristics are of great significance to improve soil quality and farmland quality. In this paper, by collecting soil samples of different time ranges, different orientations and different heights, using descriptive statistics to analyze the change characteristics of soil nutrient content in the soil, the results show that the soil nutrient content of the soil is significantly affected by time, orientation, and height. Multivariate correlation analysis and canonical correlation analysis are used to analyze the correlation between soil physical and chemical properties and soil nutrient elements. The results show that pH and electrical conductivity are highly negatively correlated, total nitrogen and organic activated carbon are highly positively correlated, available phosphorus and electrical conductivity There is a strong positive correlation.

Keywords

Nutrient Content; Terrace Wall; Descriptive Statistics; Multivariate Correlation Analysis.

1. Introduction

Soil is the foundation of crop growth and provides essential material conditions such as water and nutrients for healthy crop growth. The level of soil quality not only affects the growth and yield of crops, but also affects and restricts the sustainable development of agriculture. To obtain stable crop yields and maintain a virtuous cycle of agro-ecological environment, it is necessary to understand the relationship between soil quality and the environment to maintain and improve soil quality[1-3]. In the Loess Plateau area, especially the Nanniwan area, local farmers increase soil fertility through a method called "washing". Nian refers to the vertical surface of the horizontal terrace along the contour line. When the soil is fully exposed to the direct action of sunlight, wind, and water, nutrients will be enriched in the surface layer. Farmers collect potash and nitrogen fertilizer by "washing nian". This shows that the soil has

strong nutrient enrichment and self-repair capabilities, and reveals that the restoration of soil quality is of great significance to food security.

2. Materials and Methods

2.1. Overview of the Study Area

The study area is located in Nanniwan Town, Baota District, Yan'an City. It has a warm temperate zone and semi-humid continental monsoon climate. It is a hilly and gully area. The soil is loessial and paddy soil. The forest and grass coverage rate is 83%, the annual average temperature is 8.1°C, and the annual average rainfall is 565mm.

2.2. Sample Collection and Determination

Collect the soil surface soil of different years (1-5 years, 5-10 years, more than 10 years) in the study area; collect soil and soil under different land use methods (grassland, farmland, woodland, etc.); choose different slope directions (Shadow slope, sunny slope) the top soil is collected from the soil. All collected soils are mixed soil samples, which are mixed and fully mixed into sample bags from 3 sampling points. Measure the pH, conductivity, total nitrogen, available phosphorus, available potassium, active organic carbon and other indicators of the sample respectively. The pH is measured with a glass electrode method and a pH meter. The water-soil ratio is 2.5:1; the conductivity is measured with a conductivity meter produced by Shanghai Lemag, and the water-soil ratio is 5:1; the total nitrogen is analyzed and measured with a Kjeldahl nitrogen analyzer; effective Phosphorus was extracted with 0.5mol•L⁻¹ NaHCO₃—molybdenum-antimony anti-spectrophotometer and measured with ultraviolet-visible spectrophotometer; quick-acting potassium was mixed with soil with 1 mol•L⁻¹ CH₃COONH₄ as extractant (water-soil ratio was 10 :1), measured with a flame photometer; active organic carbon was measured with a German TOC/TN analyzer (MultiC/N 3100).

2.3. Data Analysis

According to the test results of soil samples obtained by field sampling, R software programming is used to perform descriptive statistical analysis on the samples. And use multiple linear correlation analysis and canonical correlation analysis to solve the correlation between various indicators and between the physical and chemical properties of soil and soil nutrients.

3. Results and Analysis

3.1. Distribution Characteristics of Soil Nutrients in Different Age Intervals

Figure 1 The abscissa is the age of soil formation (unit/year), and the ordinate is the effective phosphorus content (unit mg/kg), total nitrogen content (unit g/kg), and available potassium content from left to right. (Unit mg/kg), organic activated carbon element content (unit mg/kg). It can be seen that not all the elements in the soil show a trend of increasing element content with the increase of time. Among them, total nitrogen and organic activated carbon increase with the increase of soil formation time, and with the passage of time, the growth rate continues to accelerate. On the other hand, the content of available phosphorus and available potassium both showed a trend of first decreasing and then increasing. This result is different from previous studies on soil nutrients[4].

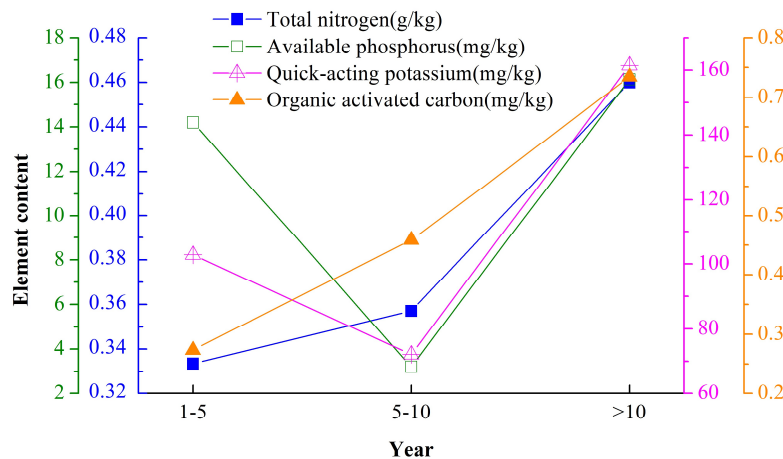


Figure 1. Variation characteristics of soil element content in different years

The abscissa of Figure 2 is the age of soil formation (unit/year), and the ordinate is pH and conductivity from left to right. It can be seen that with the increase of soil age, pH showed a trend of first increasing and then decreasing. The soil conductivity is opposite to pH, showing a trend of first decreasing and then increasing. From this, it is determined that there is a negative correlation between pH and conductivity, and the strength of the relationship will be measured by subsequent correlation analysis.

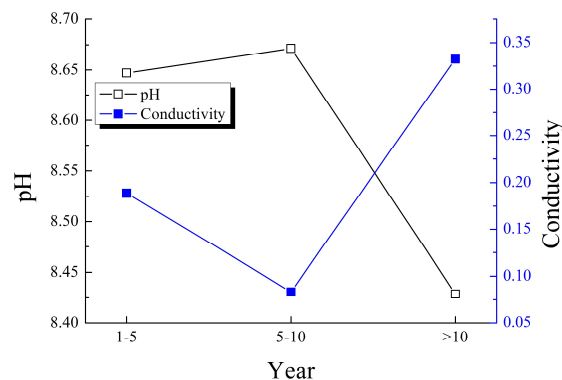


Figure 2. Differences in soil chemical properties of different ages

3.2. Distribution Characteristics of Soil Nutrients in Different Slope Directions

Figure 3 depicts the distribution characteristics of the total nitrogen, available phosphorus, available potassium, and active organic carbon content of the soil in the soil under different slope conditions within five years.

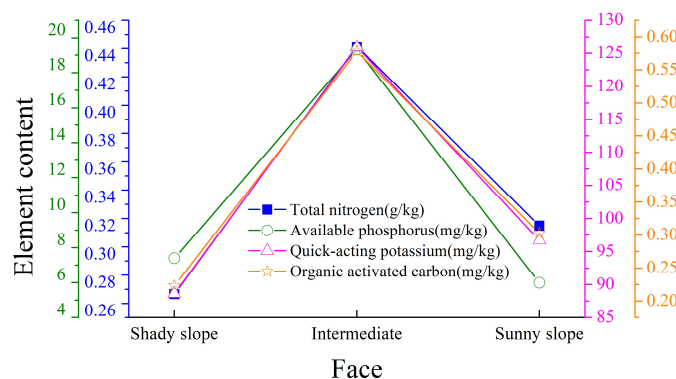


Figure 3. Content characteristics of soil element changes in different slope directions

It can be seen that the content of elements in the soil shows a consistent trend, and the content of various elements in the semi-sun slope is the highest. The content of available phosphorus showed that the shade slope was greater than that of the sunny slope, and the content of total nitrogen, available potassium, and active organic carbon showed that the sunny slope was greater than that of the shade slope. It shows that light is beneficial to promote the enrichment of total nitrogen, available potassium, and active organic carbon, while the change of available phosphorus content is the opposite, and light has a side effect on the increase of available phosphorus content.

Figure 4 depicts the distribution characteristics of soil pH and electrical conductivity under different orientation conditions. It is found that the gradient of soil pH value is: sunny slope>shadow slope>semi-sun slope, and the result of soil conductivity is shady slope>half sunny slope>sunny slope.

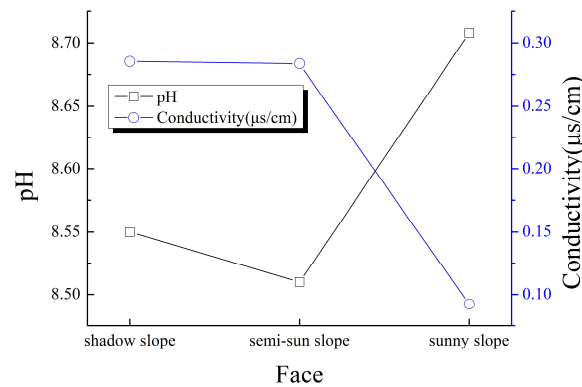


Figure 4. Differences in soil chemical properties in different slope directions

3.3. Multiple Correlation Analysis

By analyzing the correlation between different factors, we can find the key influences and driving factors in the change of soil nutrient content. First of all, for PH, electrical conductivity, effective phosphorus content (unit mg/kg), total nitrogen content (unit g/kg), quick-acting potassium content (unit mg/kg), organic activated carbon content (unit mg/kg)) Perform data standardization processing:

$$x_{ij} = \frac{x'_{ij} - \bar{x}_i}{\sqrt{S_i}} \quad \bar{x}_i = \frac{1}{n} \sum_{j=1}^n x'_{ij} \quad s_i = \frac{1}{n} \sum_{j=1}^n (x'_{ij} - \bar{x}_i)^2 \quad (1)$$

Pearson's correlation coefficient is used to measure the correlation between indicators:

$$r = \frac{1}{n-1} \sum_{i=1}^n \left(\frac{x_i - \bar{x}}{s_x} \right) \left(\frac{y_i - \bar{y}}{s_y} \right) \quad (2)$$

As shown in Figure 5, the range of the coordinate axis is -1 to 1, and the color transitions from dark blue to light blue and then from light red to dark red, indicating that the change in correlation has changed from strong negative correlation to weak negative correlation to irrelevant. The process from weak positive correlation to strong positive correlation. The size of the circle area in the upper triangular matrix also describes the strength of the correlation. It is found that there is a strong negative correlation between pH and conductivity, with a

correlation coefficient of -0.83; pH has a strong negative correlation with available phosphorus, with a correlation coefficient of -0.55; total nitrogen has a strong positive correlation with organic activated carbon, the correlation coefficient is 0.84; conductivity and available phosphorus. In the strong positive correlation, the correlation coefficient is 0.54.

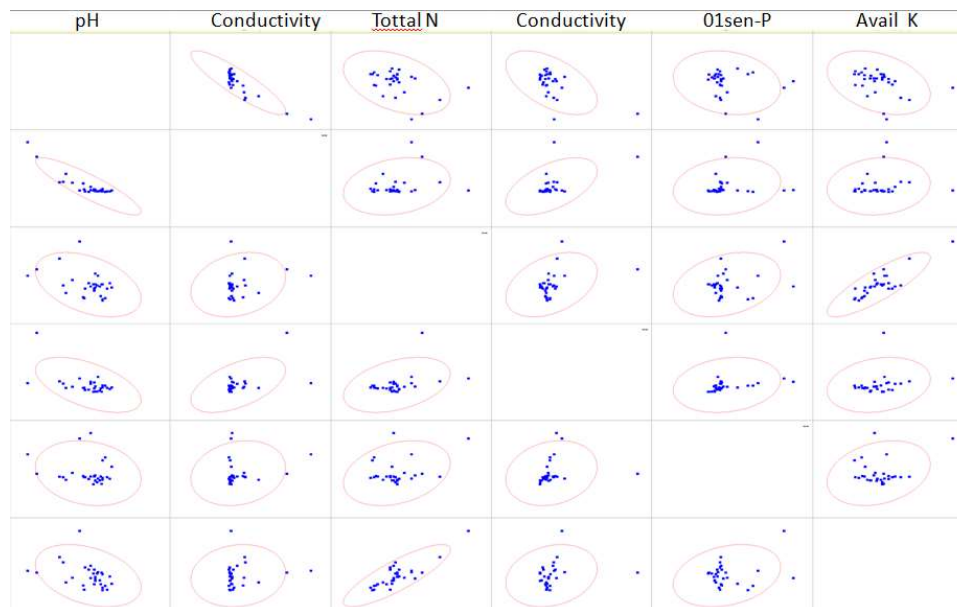


Figure 5. Multivariate correlation analysis of soil variables

4. Discussion

At this stage, the contradiction between man and land is a major constraint to my country's social development. The state has set a red line for 1.8 billion mu of arable land to determine the quantitative value of my country's arable land. However, the quality of the red line arable land has not been clearly regulated, resulting in low quality of some arable land. It is difficult to meet the needs of production and life, which further leads to the large-scale application of chemical fertilizers and pesticides, which causes great damage to the cultivated land itself, and even irreversible damage. A large number of domestic experts and scholars have focused on soil quality improvement, soil remediation and other related soil research, and have achieved corresponding results. Available potassium is mainly affected by soil-forming parent materials, climate and other factors. The soil-forming parent materials at sampling sites are basically the same, and are mainly affected by climatic factors. The impact of climate on soil potassium is mainly characterized by the impact of precipitation and temperature on exchangeable potassium in soil; Through the analysis of the influence of temperature on soil potassium, it is shown that as the temperature increases, the activity of potassium in the soil increases [5]; The average annual precipitation and annual temperature increase. Soil organic matter content and climate are the main natural factors that affect soil total nitrogen content. The accumulation and mineralization of soil organic matter is directly related to the transformation and storage of soil nitrogen, and has a significant positive correlation with soil total nitrogen content; precipitation and temperature directly affect The intensity of soil nitrogen leaching and denitrification affects the mineralization of soil organic matter, which in turn affects the soil nitrogen content [6]. Soil moisture, humidity, temperature, seasons, land use methods, land management measures and other factors all have an impact on soil active organic carbon. At present, most domestic research on soil quality restoration is focused on time scale. Soil quality restoration is mainly the normalization of soil nutrient content, and there are many natural factors that affect soil nutrient content, such as light, moisture, freezing and thawing, vegetation,

etc. And the existence of interaction, coupled with the influence of human factors, makes the research content more complicated [7]. This study conducted a preliminary analysis of the nutrient content in the soil according to the difference in time and aspect, and analyzed the correlation between soil nutrients, hoping to provide a reference for subsequent further research.

5. Conclusion

By analyzing the distribution characteristics of soil nutrients in the soil under different formation years and different orientations, as well as the correlation analysis of different elements and chemical properties in the soil, the following conclusions are drawn:

- (1) The content of nutrients in the soils of different formation years showed significant differences. Unlike previous studies, not all nutrients increase over time. Different from total nitrogen and organic activated carbon, the content of available phosphorus and quick-acting potassium is the lowest in the interval of 5-10 years, and the content greater than 10 years is the highest.
- (2) There are huge differences in the nutrient content in the soil of different slope directions, and the soil on the semi-sun slope has the highest nutrient content in the soil, indicating that the suitable temperature and light conditions on the semi-sun slope contribute to the improvement of nutrients. Generate and accumulate.
- (3) The chemical properties of soil and nutrients can influence each other. There is a strong negative correlation between pH and conductivity. Organic activated carbon has a strong correlation with total nitrogen, and available phosphorus has a strong correlation with electrical conductivity.

Acknowledgments

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