Altitude and Soil Factors Gray Relational Analysis in The Dry - hot Valleys of Jinsha River

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Abstract. This paper analyzed the relationship between altitude and soil factors in dry - hot valley, based on gray relational grade analysis method for quantitative analysis, and Cluster analysis of the associated degree. The results showed that: altitude most closely with the available nitrogen, followed by potassium, organic matter; most unclosely is the bulk density. The close degree of relational grade between soil factors and altitude can be broadly divided into three categories.

Introduction

Soil as an important part of terrestrial ecosystem , is core area of material cycle, energy conversion and transmission of information [1].Soil not only provide a survival habitat for animals and microbes, but also provides essential nutrition and water for plant, is the main place of various material and energy conversion[2]. The quality of soil conditions is directly related to the merits of its grown species. In affecting crop growth factor, the altitude is one of important factor. This is because changes in altitude often results in the amount of sun light, light intensity, air humidity, rainfall, temperature difference between day and night and the effective accumulated temperature and other ecological factors changed significantly [3-7].Altitude is close relation with various meteorological factors, even plays a decisive role in part of meteorological factors[8-9].With altitude increased, the average climate temperature continues to decreased, precipitation and sunshine hours increase, frost and ⩾10 ℃ accumulated temperature has continued to decreased[7], and then will have a significant influences to plant growth. Meteorological index showing a regular changes with changing altitude.

Dry - hot valley is a unique type of geography after transection southwest of deep mountain, is a sub-type of arid valley, the region's arid climate, water and heat extremely uneven. Over the years, because of copper smelting and modern reclamation of steep slopes in history and the irrational exploitation of natural resources, leading to the ecological functions of the area significant degradation under natural and human factors affecting, has become one of China's ecological environment is fragile region [10-12].For a long time, vegetation, soil properties under different elevation were studied intensively, it has achieved abundant research results [13-16].Despite a lot of researches, but use of gray correlation method to research altitude and soil factors in dry-hot valley has not been common reports.

Therefore, this paper use gray system theory comprehensive analysis of the relationship between altitude and soil physical and chemical properties, in order to provide evidence to the future management of soil, soil fertility directed cultivation.

Study Area and Methods

Study area

Select the study area in the east of southern Ningxia county of Jinsha River valley. The geographical position for the north latitude26° 54'-27° 09', east longitude 102° 54'- 103° 02′ ,⩾10 ℃ annual accumulated temperature is7000～8000℃, annual sunshine hours is 2179～2736 h, belong to multi-zone sunshine; annual precipitation is between600～800mm, annual evaporation is 3~6 times

than annual precipitation; distinct of dry and wet season. Evaporation dry season is 20 times higher than the precipitation, the serious lack of soil moisture, both relative water capacity and effective water guarantee rate is very low, soil types based mainly on weak anti-evaporation of dry red, and brown soil, red soil, purple soil, etc. The main vegetation types based mainly on dry-hot valley shrubs and savanna [17].

Sample collection

Based on the field investigation, according to the altitude from 705m to1585m, selected typical grassland 7 blocks and Yunnan pine 1 block as research object[17],basic characteristics of sample plot see table 1. Each altitude choose three plots, each plot choose seven samples according to S type, digging depth of 0-20cm soil samples, spare after uniform mixing. After removing visible animal and plant residues and stones, soil samples was air-dried, sieved storage for analyzing measurements of soil indicators.

Table1 Basic characteristics of sample plot

Land type	Terrain	Aspect	Slope [°]	Altitude [m]	Soil type	Total coverage [%]
Grassland	Windward slope	ES17°	35	705	Dry red soil	70
Grassland	Windward slope	NE6.5°	28	805	Dry red soil	20
Grassland	Windward slope	ES11°	26	920	Dry red soil	20
Grassland	Windward slope	ES	26	1005	Dry red soil	20
Grassland	Windward slope	ES16°	30	1235	Dry red soil	20
Grassland	Windward slope	WN33°	30	1400	Dry red soil	30
Grassland	Windward slope	ES16°	26	1500	Dry red soil	20
Pine forest	Windward slope	ES14°	40	1585	Dry red soil	80

Determination of soil index

Soil bulk density using cutting ring method; TOC using outside heating method of potassium dichromate oxidation, TN using Semimicro-Kjeldahl Method, PH using pH meter, TP using melted sodium carbonate-the molybdenum stibium anti method, AP using Olsen method, AK using Ammonium acetate extraction - flame photometric[18].

Data Processing

（1）Set the reference number series

According to grey system theory, altitude and soil properties metric as a gray system(altitude as reference number series, soil indicators as the comparison number of columns), each trait indicators seen as grey system's a factor, according to Deng Julong's [19] method to compute the correlation of various factors

（2）Dimensionless of soil performances

Because each trait factors (raw data) is difference about dimension, uncomparable. Raw data need to make indexes being dimensionless, obtained data initial image.

（3）Absolute deviation calculation of soil properties index

（4）Soil properties index correlation coefficients is calculated, which, the value of x is 0.5.

（5）Calculation of the related degree.

Results and Analysis

Initial value processing of soil factors and altitude original data

Initial value processing were obtained in experiments on soil factors raw data, the results shown in Table 2.

Table 2 Initial value processing of soil factors and altitude original data

Altitude	Organic matter	TN	TP	AN	AP	AK	Bulk density
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.14	1.05	0.79	0.80	0.95	0.73	1.14	0.98
1.30	1.72	1.29	1.53	1.30	1.24	1.33	0.92
1.43	1.86	1.92	1.42	1.94	1.49	1.48	0.93
1.75	2.84	2.52	1.31	1.68	1.55	1.46	0.88
1.99	2.38	2.09	1.49	1.59	1.46	1.25	0.94
2.13	2.27	1.62	1.53	1.99	1.27	1.29	0.95
2.25	2.10	1.62	1.23	2.31	1.26	1.33	0.86

Related degree analysis of altitude and soil physical and chemical characteristics

Based on the gray theory, grey correlation analysis is mainly reflected in the closeness of the relationship between comparison sequence and the reference sequence which is system traits. It has been obtained by analysis that with the related degree of biggest, the more close of comparison sequence and the reference sequence, more intimate the relationship.

In the research, using 《Grey Modeling Software (Seventh Edition)》,grey correlation calculation is obtained between soil factors and altitude, the results shown in Table 5.

Table 3 Grey correlation between soil factors and altitude

Incidence matrix	Organic matter	TN	TP	AN	AP	AK	Bulk density
Altitude	0.73	0.71	0.69	0.83	0.71	0.75	0.57

As can be seen from table 5，altitude have close relationship with AN, the correlation degree is 0.83；followed by potassium, organic matter; most unclosely is the bulk density, the correlation degree is 0.57, 0.26 correlation degree distance with AN.

Clustering analysis of grey relational grade

Correlation degree clustering analysis on these results is given by altitude and 7 factors, from the result of the clustering analysis (Fig 1), according to close degree between altitude and each factor, 7 factors can be roughly divided into three categories: the first group includes TN、AP、TP、organic matter、AK; the second group include AN; the third group is bulk density.

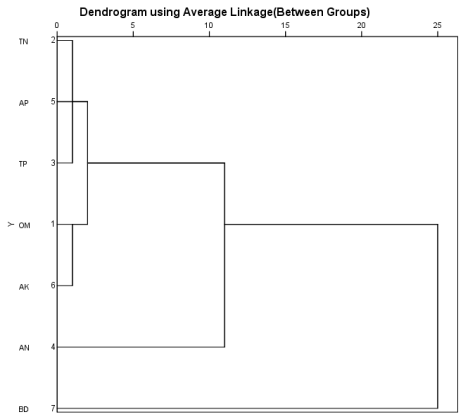

Fig 1 Ward clustering analysis of different factors

Conclusion

In this study, did not use correlation analysis, regression analysis, because these methods need a lot of sample. This article applying gray relation method, analyzes gray correlation between different soil factors and altitude. This method have hasrelatively high application value, simple and practicable, is a simple and effective practical method.

The results showed that: altitude most closely with the available nitrogen, followed by potassium, organic matter; most unclosely is the bulk density. The close degree of relational grade between soil factors and altitude can be broadly divided into three categories.

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