

Soil Systematic Classification Research of Hongge Town and Other Areas in Yanbian County of Panzhihua City

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ABSTRACT

Because there is no systematic study on soil classification in yanbian county, panzhihua city. Therefore, this study will fill this gap. Secondly, the main purpose of this study is to provide a basis for the systematic classification of mountainous soil in yanbian county and the development and utilization of soil resources.

In this study, the soil types of eight towns under the jurisdiction of yanbian county were taken as the research object. According to the "soil systematic classification and retrieval in China" (the third edition), the data of moisture content, pH, organic matter, ammonium nitrogen, available phosphorus and available potassium were determined through field investigation and soil indoor physical and chemical properties analysis. SPSS was used to make the correlation analysis of soil, and Sigmaplot was used to make the intuitive difference comparison between the same elements of different soils. Finally, the soil classification map and soil nutrient content distribution map were drawn by ArcGIS. The following results are obtained:

(1) the soil system classification map of yanbian county and the distribution map of various contents in yanbian county were made.

(2) correlation analysis of different soils was made, and a relatively intuitive conclusion was drawn in the table.

(3) comparative charts of different soil fertility were made to facilitate the analysis of different soil fertility.

Conclusion: by analyzing the data of water content, it is found that the soil in most areas is short of water, and a few towns can reach the normal level. Analysis of organic matter data found that half were below average and some were above average. Analysis of pH data showed that the soil in this area was alkaline. The analysis of ammonium nitrogen data shows that the whole area of yanbian county is short of nitrogen. The analysis of available phosphorus data shows that most areas in yanbian county are abundant in phosphorus, while a few areas are deficient. The analysis of available potassium data shows that yanbian county as a whole is in the state of potassium surplus.

KEYWORDS: yanbian county; soil system classification; soil physical and chemical property

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I. INTRODUCTION

The change of soil classification is the symbol of scientific progress, the cornerstone of soil mapping, one of the bases of popularizing agricultural technology according to local conditions, and the medium of soil information exchange at home and abroad. Compared with the traditional geographic classification, the system classification is based on diagnostic layer and diagnostic features, and is characterized by quantification, which overcomes the ambiguity between different attributions and soils in the same soil classification (Xiong, 2016). Moreover, the classification information can be input into the computer, establish a query system, and carry out self-classification and testing (Xiong, 2013). At the same time, it is also convenient for land scientists to carry out international exchanges and cooperation. Soil taxonomy improves the troubles caused by traditional classification in daily application, which makes it difficult to solve the problem of Soil Taxonomy itself (Cabrera, 2015). Soil taxonomy has become a new direction of development.

1.1 Significance of Soil Classification

Soil classification is a necessary process of soil development. Soil classification has laid a foundation for the development of soil science (Xiong, 2015). On the one hand, soil classification reflects the direction of soil evolution, so that we can see the difference intuitively, and it also represents the improvement of the soil classification level; from the practical significance, soil classification can observe the characteristics of soil intuitively, so as to improve the local soil, so as to achieve economic utilization and development (Madejón,

2014). To protect the environment, a sound soil classification system can reflect the fertility level and the value of utilization of the plot, provide a basis for soil resource management, so as to manage the soil conveniently and efficiently, and achieve the purpose of soil classification (Xiong, 2012).

1.2 Characteristics of Soil Systematic Classification

Soil taxonomy is guided by the theory of soil genesis. According to the actual situation of soil, a soil retrieval system is developed. Every soil can be found, and can only be found in one place, without duplication or overlap, which avoids the shortcoming of inaccurate classification of soil types. In China's soil taxonomy, there are very clear indicators to distinguish soil grade, subspecies, Tu nationality and even soil sequence, which is conducive to the quantification, informatization and modernization of soil classification (Xiong, 2012). Soil classification is scientifically classified according to its own characteristics, which avoids the ambiguity of boundary caused by soil classification (Zhang, 2012). Soil classification has a complete retrieval system. According to some basic properties of soil and profile description of soil, diagnostic horizons and diagnostic characteristics are determined according to "Chinese Soil Systematic Classification and Retrieval", and then advanced classification (subcategory) is carried out (Xiong, 2017). Then, according to the characteristics of soil itself, the same kind of soil is divided into "Chinese soil system". The classification of grassroots taxa was carried out by using the criteria of Tu nationality classification and soil classification. In this way, each soil can find its corresponding location in the search system, with accurate and clear indicators, and on the basis of evidence, realize the quantification and standardization of soil classification, and cooperate with the international soil classification work. It meets the requirements of soil science research, communication and practical utilization. Soil types are classified according to diagnostic faults and diagnostic characteristics, reflecting the law of soil occurrence, and the principle of soil occurrence can further enrich the theory of soil classification. Historians and others have studied the diagnostic and diagnostic characteristics of cross-reference between soil geographic classification and Soil Taxonomy in China. Based on diagnostic layer and diagnostic characteristics, a pedigree-based soil classification method was established.

II. MATERIALS AND METHODS

2.1 Geographical Administration and Regionalization

Yanbian County is situated in the west of Liangshan area, southeast of Qinghai-Tibet Plateau, on the West Bank of the lower reaches of Yalong River, with a longitude of 100 degrees 42.102'03 to the East and a latitude of 27 degrees 6.28'16 to the north. The eastern part is Meiye County, Liangshan Yi Huili County, the southern part is the suburb of Panzhihua, the western part is Ninglang Yi Autonomous County, and the northern part is Yanyuan County of Liangshan Yi Autonomous Prefecture. Yanbian County belongs to Panzhihua City, Sichuan Province. It is located in the southwestern corner of Sichuan Province and is a key county for poverty alleviation and development at the provincial level. Yanbian County is 3269.453 square kilometers. It has four towns, 12 townships, 164 villages, 826 villagers'groups and 7 residents' committees. As shown in Table 2-1.

Subordinate towns			
Tongzilin	Hongge	Yumen	Yongxing
Yiming	Xinjiu	Heai	Hongguo
Huiming	Qinghe	Wenquan	Geshala
Ganyu	Gonghe	Guosheng	Hongbao

Tongzilin Town: Located in the south of Yanbian County, it is the economic center of Yanbian County. It is the representative town of Yanbian County and reaches the city center 20 km. Chengdu-Kunming Railway and 214 Provincial Highway Lines run through the whole territory. There are Tongzilin Railway Station and two other railway stations. In the east, Xinjiu Township and Xinmin Township are connected, in the south, Jinsha River and Jinjiang Town in Renhe District are separated by rivers, in the west, Yalong River and Yinjiang Town in the east, in the north, Anning River and Miyi County in the top 100 counties in the whole country are

connected by water in three directions, and in the last place, there are several major rivers (Jinsha River, Yalong River and Anning River) in the territory. River). The terrain inclines from north to south.

Tongzilin Town Sampling Point:



Figure 2-1 Tongziling

Hongge Town: It is located in the southeast of Yanbian County. It lies on Aixiang in the east, on the south, on Yushu Township in Huili County, across the river from Renhe District in the west, and on the north, on Yimin Township and Xinjiu Township. The highest altitude is 2400 meters and the lowest is 1200 meters. From north to south, the terrain gradually decreases. The annual average temperature is between 20 and 21 degrees Celsius. The precipitation reaches 800 mm. The sun is abundant and the heat is abundant. The town covers an area of 160.23 square kilometers. It has jurisdiction over four administrative villages, 21 villagers'groups and a community neighborhood committee, with a total population of more than 20,000.

Hongge Town Sampling Point:



Figure 2-2 Hongge Town

Yumen Town: Located in Panzhihua "Baili Eco-corridor" ring line, it is also an important post station in "Gesara" sunshine eco-tourism circle. It has abundant tourism resources. Its characteristics are: integrating history and culture with modern human landscape. There are not only Neolithic Diqiang people's sarcophagus tombs for exhibition, but also legends of "five cattle trapped in ponds", "fishing turtles", "rhinoceros looking at

the moon". After the formation of Ertan Reservoir Area, the island scenery in the water area of 25 square kilometers in the town, lakes and mountains are ideal places for urban people to spend their holidays and leisure.

Sampling Point of Yumen Town:



Figure 2-3 Yumen Town

Yimin Township: located 5 kilometers southeast of Hongge Town, Yanbian County, 30 kilometers away from the county town, 28 kilometers away from the center of Panzhihua City-Bingcaogang, respectively, bordering Hongge Town, Xinmin Township and Xinjiu Township. The lowest elevation of the whole town is 1160 meters, the highest elevation is 1428 meters. It belongs to the Dry-hot Valley climate of the subtropical plateau type, with the lowest annual temperature of 4 degrees Celsius and the highest atmosphere. Temperature 39 degrees Celsius, annual average temperature 20 degrees Celsius, annual rainfall 700 mm, ravines vertical and horizontal, a comb-shaped distribution, farmland scattered in gentle hillsides or slope top. Wool sandy soil and loam soil are the main soil types. It covers an area of 23.4 square kilometers, with cultivated land area of 46.69 million square meters, of which 233.45 million square meters are reclaimed. Fruit, pigs, vegetables and labor export are the four pillar industries in the whole township. More than 7 million yuan was invested in adding a new pump station intake to ensure that the water intake is as usual in the rainy season.

Sampling Points in Yimin Township:



Figure 2-4 Yiming

Xinjiuxiang: Located in the east of Panzhihua, southeast of Yanbian County, it is adjacent to Xiaolang Township and Xiaoheiqing Township in Huili County in the east, Hexiang, Hongge Town in the south, Xinmin Township and Tongzilin Township (Town) in the county, and Yuankou Town in Miyi County in the north, with an area of 119 square kilometers. Seven administrative villages, 46 agricultural cooperatives, a total population of 10594 people, including 2749 farmers, 10334 agricultural population, 260 non-agricultural population, a total area of 9780 mu of arable land, including 6439 mu of farmland, 3341 mu of land. In 2001, the total income of industry and agriculture in the whole town was 109.267 million yuan, of which 86.8 million yuan was industrial income. Agricultural income was 21.467 million yuan, per capita net income was 1930 yuan, and township financial revenue was 26.66 million yuan. The countryside is rich in products, rich in vanadium-titanium magnetite resources, and abundant resources in the south subtropical zone: suitable for agriculture, fertile soil, abundant agricultural production, convenient transportation and communication, and adequate power supply; it is a place with good resource advantages, potential and specialty, as well as a place with relaxed environment, suitable for development and investment ideas. Where it works fast.

Xinjiu Sampling Point



Figure 2-5 Xinjiu

Ganyu Township: located in the eastern part of Yanbian County. Geya Longjiang in the East is opposite to Tuanjie Township in Miyi County, Lima Township in the south, Yumen Town in the West and Longsheng Township in the north. It covers an area of 71.2 square kilometers (10,6800 mu). It has jurisdiction over 3 villages, 15 villager groups (cooperatives), 337 households and 1315 people. There are 759 rural labors, accounting for 57% of the total population. The statutory area of cultivated land reported in the township is 995 mu, and the per capita agricultural area is 0.76 mu, which is lower than the average level of the county. The lowest altitude of the whole town is 1200 meters, the highest altitude is 2300 meters, the township government is located at 1350 meters above sea level, the annual precipitation is about 300 mm, the annual average temperature is about 19 C, and the relative humidity of the air is about 60%. There are many kinds of vegetation in the border area, and the forest coverage rate is as high as 62%.

Sampling Points in Ganyu:



Figure 2-6 Ganyu Township

Hongguo Yi Nationality Township: Hongguo Yi Nationality Township is located in the middle of Yanbian County, Panzhihua City. The world-famous dam hub project of Ertan Hydropower Station is within the territory. The coast of Ertan Lake is the core area of Ertan Scenic Spot and Ertan Forest Park. It has abundant products and beautiful scenery. It is adjacent to Tongzilin Town, Yumen Town and Chuyu Township, Tongde Town and Deshi Town of Miyi County. The township government is now stationed in Hongguoji Town, 40 kilometers away from Yanbian County Town and 75 kilometers away from Panzhihua City. It is a mixed ethnic township of Han, Yi and Lisu nationalities. The whole town covers an area of 245.73 square kilometers. By the end of 2010, the population of the whole town was 13,140, and the minority population was 5,213, accounting for 39.7%. It has 11 villages, 1 neighborhood committee, 46 villagers'groups and 3 residents' groups.

Sampling Points in Hongguo Yi Nationality Township:



Figure 2-7 Hongguo Yi Township

Heai: Heai, also known as Aizang Township, is a township-level administrative unit under the jurisdiction of Yanbian County, Sichuan Province. Located in the west of Mianning County, 80 kilometers away from the county town, it has 96 square kilometers of high mountains and cliffs. It has jurisdiction over 27 villagers'groups in 6 villages. There are 3115 people of Tibetan, Han and Yi nationalities. The township government is stationed

at an altitude of 2,000 meters. It mainly produces corn, potato, silkworm mulberry, pepper and walnuts. It has one central school and five small villages. Township Central Hospital

Sampling Points in Heai:



Figure 2-8 Heai

2.2 Soil sampling

2.2.1 Soil Sources

The soil samples collected in this experiment belong to the jurisdiction area of Yanbian County and its subordinate towns, which are embodied in (agricultural land, mountain area, industrial land, forest soil, etc.).

2.2.2 Soil Samples Collection Method

Specific methods and steps for soil sampling:

1. Distribution: First, according to the type of soil and the distribution of agricultural products and other plants, secondly, according to the high, medium and low levels of soil fertility. Generally, in a township (different areas can be determined according to the situation), a soil layer is adopted. The main farming soils in each township generally collect three mixed agrochemical soil samples. Sampling points are arranged by five-point method, and uniformity and randomness should be achieved as far as possible. The soil bottom map is used to determine the sampling area and sampling point, and the general location is marked on the map. Finally, the survey sampling route and its scheme are determined.

2. Sampling location and depth: According to the thickness of the tillage layer, the sampling depth is determined. The general sampling depth is 0-30 cm.

3. Season and time of sampling: The location and time of soil sample collection should be as consistent as possible with the soil area represented by the soil sample during the last soil census, so as to compare the changes of soil nutrients before and after. The collection time of soil samples is the same as that of the last soil survey. If the last sampling time is uncertain, it is suggested that the collection should be unified before winter sowing and fertilization after autumn harvest, so as to ensure that soil properties will not change significantly.

4. Sampling method and quantity: Soil samples are collected by multi-point mixed soil sampling method. Each mixed soil sample consists of five samples. The distribution range of sample points is not more than 1 mu. The depth and weight of soil taken at each point should be roughly the same, and the proportion of soil samples taken at each level should be as same as possible. The sampler should be vertical to the ground, and buried to the specified depth and level. Stainless steel iron catalpa and other items were used for sampling. Do not touch air and water during sample processing and storage to prevent soil properties from changing. Each mixed sample usually takes about 2 kg. If too many samples are collected, the redundant soil can be separated by "quartering method".

5. Sample Number: Sampling Record, Soil Number, Sampling Place, Soil Name, Sampling Depth, Sampling Date, Sampling Leader, etc..

2.2.3 Soil sample treatment

In January 2019, eight typical soil samples were collected. Firstly, we took the soil samples back to the laboratory, packed them in fresh-keeping bags, weighed their initial weight, and used the data for subsequent use. Then we opened the fresh-keeping bags, made the samples air-dried naturally, and took out the stones in the

soil. Leaves, and other impurities, and finally the air-dried soil samples for follow-up treatment, the air-dried soil samples with 100 mesh screening, through 100 mesh screening soil samples roughly screened out 500 grams, and then put into fresh-keeping bags for reserve. (Determination of soil moisture content before soil treatment).

2.2.4 Technology roadmap

Firstly, we selected Yanbian County of Panzhihua City as our research object. Through field investigation, we sampled Yanbian County and its eight subordinate townships. Secondly, soil samples were brought back to the laboratory for processing. After nutrient analysis and determination, the final research results were obtained. The overall technical roadmap is as follows:

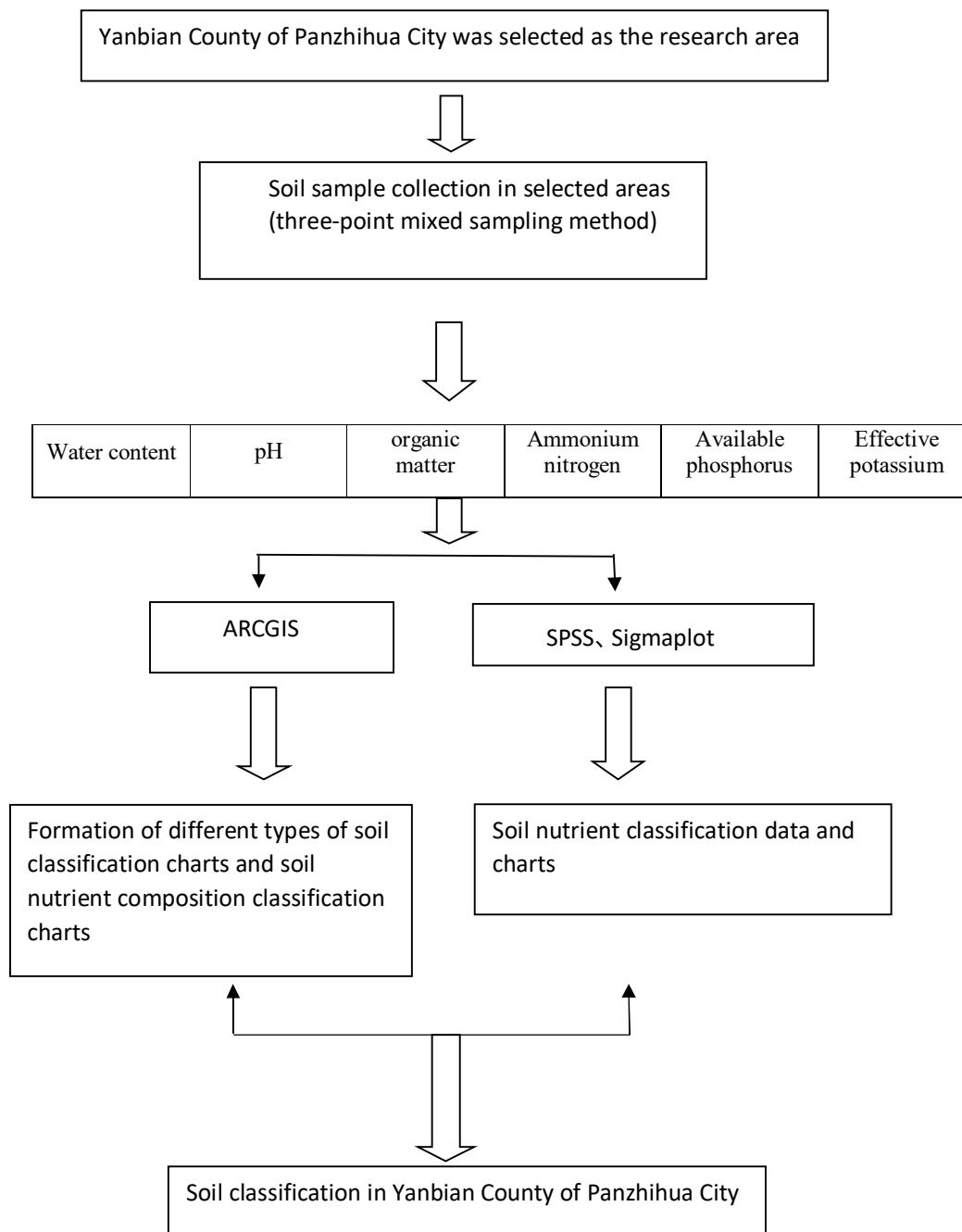


Figure 2-9 Technology roadmap

2.3 Testing items

2.3.1 Physical Properties of Soil

Water content: The water content of the soil represents the percentage of the water content of the soil to the soil quality, usually expressed as a percentage.

2.3.2 Chemical Properties of Soil

Soil acidity and alkalinity: Soil acidity and alkalinity represent whether the soil is acidic or alkaline. The growth and development of plants with different acidity and alkalinity have different effects. Moreover, different plants have different adaptations to soil acidity and alkalinity.

Organic Matter: Soil organic matter refers to the substances derived from life in the soil, the secretions of life in the growth and development of the soil and the organic fertilizer used.

Ammonium nitrogen: A form of natural nitrogen that exists in the form of ammonium ions (NH_4^+) and circulates in soil, plants, fertilizers and the atmosphere. It can be transformed into other forms of nitrogen under certain conditions. Because of its high solubility and fast absorption by plants, it is widely used in fertilizer industry.

Available phosphorus: Phosphorus that is easily absorbed and utilized by plants in soil. Apart from phosphate ions in soil solution, some soluble inorganic phosphorus compounds and adsorbed phosphorus in soil belong to available phosphorus. Soil available phosphorus is the most effective part of soil available phosphorus storage for crops, and it is also an important index to evaluate the level of soil phosphorus supply.

Available potassium: potassium that can be directly absorbed and utilized by plants in soil, including potassium in aqueous solution and exchangeable potassium adsorbed on soil colloids, is the main source of plant potassium and one of the important indicators of soil supply.

2.4 Determination method

Reference to Instructions for Soil Nutrient Tester tpy-6A

2.5 Data Statistical Tools

The final data and results of this experiment were processed by Excel, SPSS, Sigmaplot, ArcGIS and other software. Through Excel, we can save and process the data we got for further analysis. Secondly, we use SPSS to do one-way ANOVA of soil. By observing the difference between them, we use Sigmaplot to make a more intuitive comparison of the differences among the same elements in different soils. Finally, through ArcGIS, we can draw the difference between the same elements in different soils. Draw the soil system classification map and soil nutrient content distribution map, complete our design requirements.

III. RESULTS AND DISCUSSIONS

3.1 Soil Systematic Classification Map

From Figure 3-1, we can see that among the eight towns sampled, the soil types of Yumen Township belong to red soil, the soil types of Chanyu Township belong to brown red soil, the soil types of Hongguo Township belong to light red soil, the soil types of Tongzilin Township belong to deep brown soil, the soil types of Yimin Township belong to yellow soil, and the soil types of Xinjiuxiang. The soil types of Hongge Town belong to brown soil, and those of Aixiang belong to brown red soil.

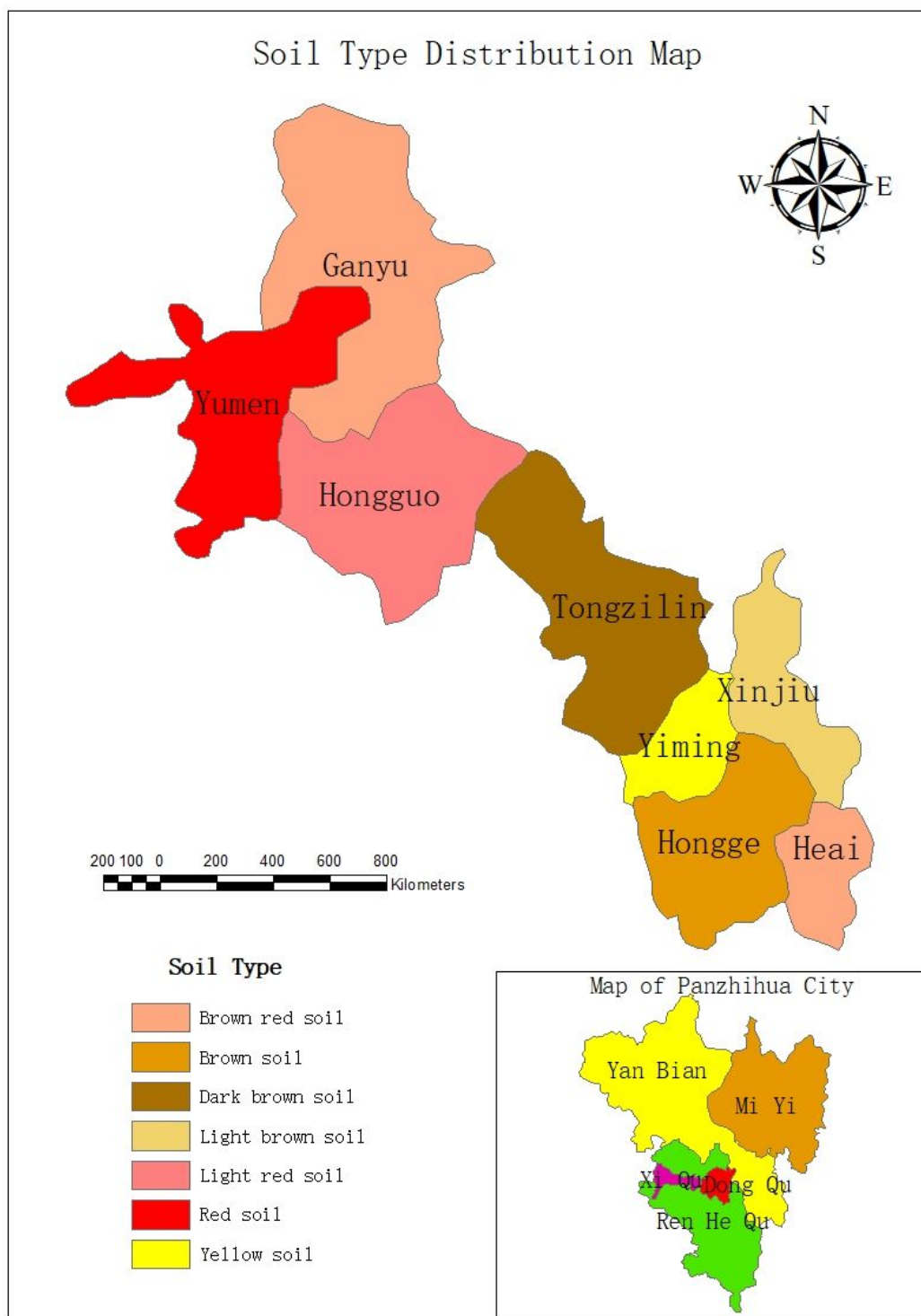


Figure 3-1 Soil Type Distribution Map

3.2 Analysis of Nutrient Content in Soil

3.2.1 Soil Nutrient Data

Table 3-1 Soil Nutrient Content

Township name	Soil types	Water content (%)	pH	Organic matter (%)
Heai	Brown red soil	1.74±0.23 a	7.55±0.13 b	6.74±0.89 d
Hongge	Brown soil	17.27±5.48 ab	7.15±0.05 a	5.22±0.29 cd
Yiming	Yellow soil	4.84±0.22 ab	7.82±0.20 c	2.33±0.93 ab
Xinjiu	Light brown soil	3.71±0.23 ab	8.16±0.04 d	1.34±0.21 a
Tongzhilin	Dark brown soil	4.81±0.17 ab	7.86±0.07 c	3.91±1.53 bc
Hongguo	Light red soil	7.27±0.11 b	7.73±0.07 bc	3.83±0.21 bc
Ganyu	Brown red soil 2	1.13±0.20 a	7.62±0.05 bc	6.58±0.64 d
Yumen	Red soil	2.12±0.49 ab	7.78±0.06 bc	3.51±0.46 abc

Township name	Soil types	Ammonium nitrogen (mg/kg)	Available phosphorus (mg/kg)	Effective potassium (mg/kg)
Heai	Brown red soil	18.87±1.96 a	9.43±0.21 ab	172.33±14.64 b
Hongge	Brown soil	15.33±1.86 a	35.20±4.70 e	346.33±15.01 c
Yiming	Yellow soil	16.00±4.00 a	18.13±0.50 c	26.33±2.31 a
Xinjiu	Light brown soil	9.33±2.31 a	7.40±0.20 a	14.00±0.00 a
Tongzhilin	Dark brown soil	17.33±2.31 a	12.47±0.31 ab	141.33±11.24 b
Hongguo	Light red soil	30.67±6.11 b	34.87±20 e	331.67±67.04 c
Ganyu	Brown red soil 2	16.00±0.00 a	28.53±0.46 d	122.67±35.80 b
Yumen	Red soil	16.67±6.43 a	12.80±0.40 b	158.33±17.24 b

Note: Average ± standard deviation (n=3). Different letters in the same column showed significant difference at the level of $p<0.05$.

3.2.2 Water Content Distribution

According to the measured data, after software processing, make the following chart:

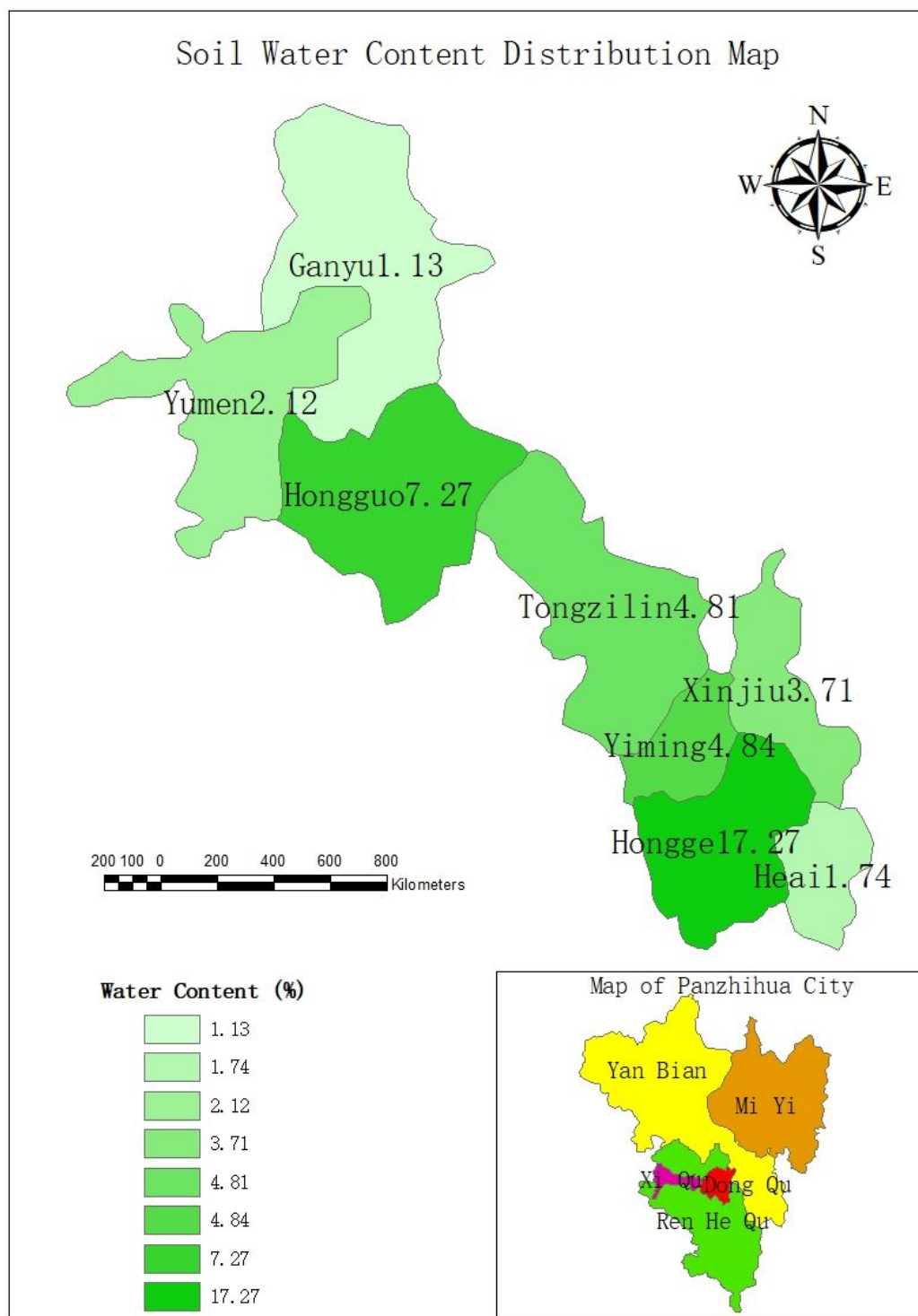


Figure 3-2 Soil Water Content Distribution Map

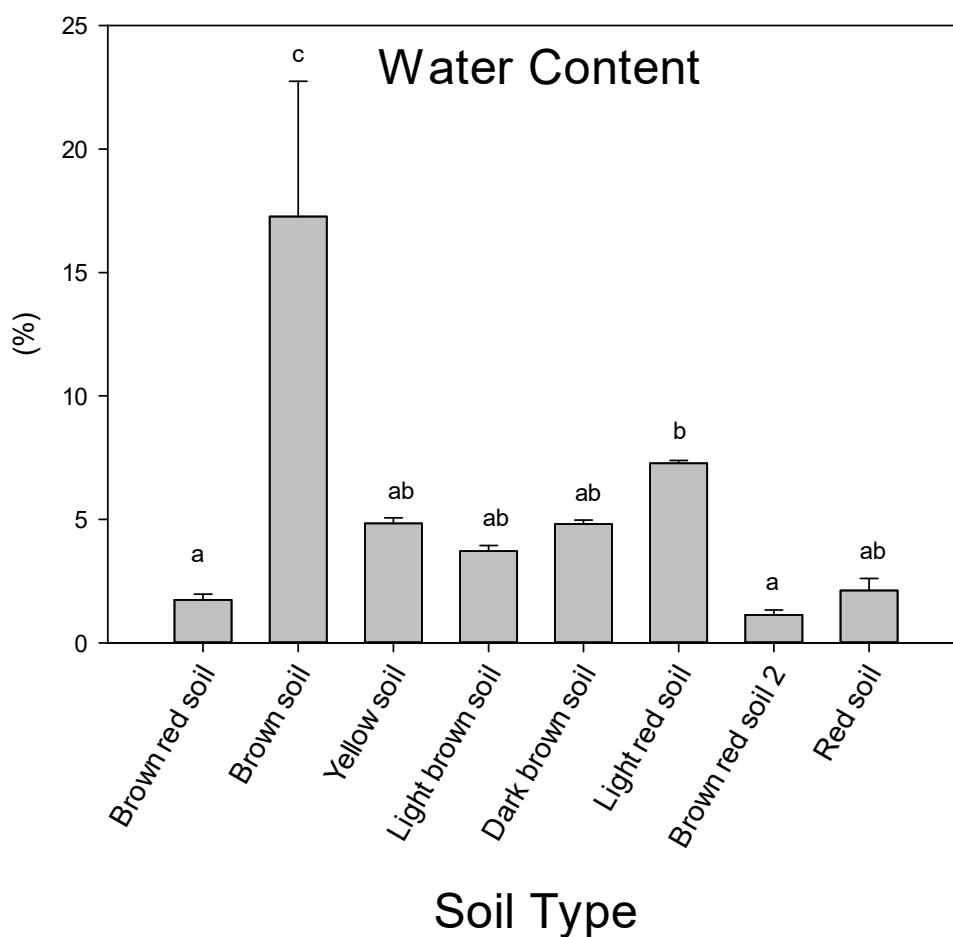


Figure 3-3 Soil water content one way ANOVA analysis graph

Table 3-2 Soil water content (%) classification

Water content (%)	<1	1-5	5-10	10-15	>15
Grade	Extremely low	Low	Normal	High	Higher

From Figure 3-2 and Table 3-2, it can be seen that the soil moisture content in Yumen Town, Yinyu Town, Aixiang Town, Tongzilin Town, Yimin Town and Xinjiu Township are all low, while that in Hongguo Township is normal, while the soil moisture content in Hongge Town is high, which may be related to the time of soil collection, but as a whole, the soil in Yanbian County is short of water.- 3. It can also be seen that most soils are at the same level in soil correlation. The extremely high Hongge Town is divided into another level, which may be due to the lack of water resources development and the low utilization rate of water resources.

To solve these problems, we can improve water content by covering water saving: plastic film mulching and straw mulching can prevent water loss. Chemical water-saving can also improve soil water content: the use of water-retaining agents, drought-resistant agents, and anti-transpiration inhibitors. The application of organic fertilizer can increase soil water content and improve soil structure.

It can also be achieved by improving water use efficiency: therefore, increasing production, reducing irrigation, reducing evaporation and transpiration during class, reducing surface runoff and reducing underground leakage are all ways to increase water use efficiency.

3.2.3 pH Distribution

By analyzing and processing the original data of pH, the following group diagrams are obtained:

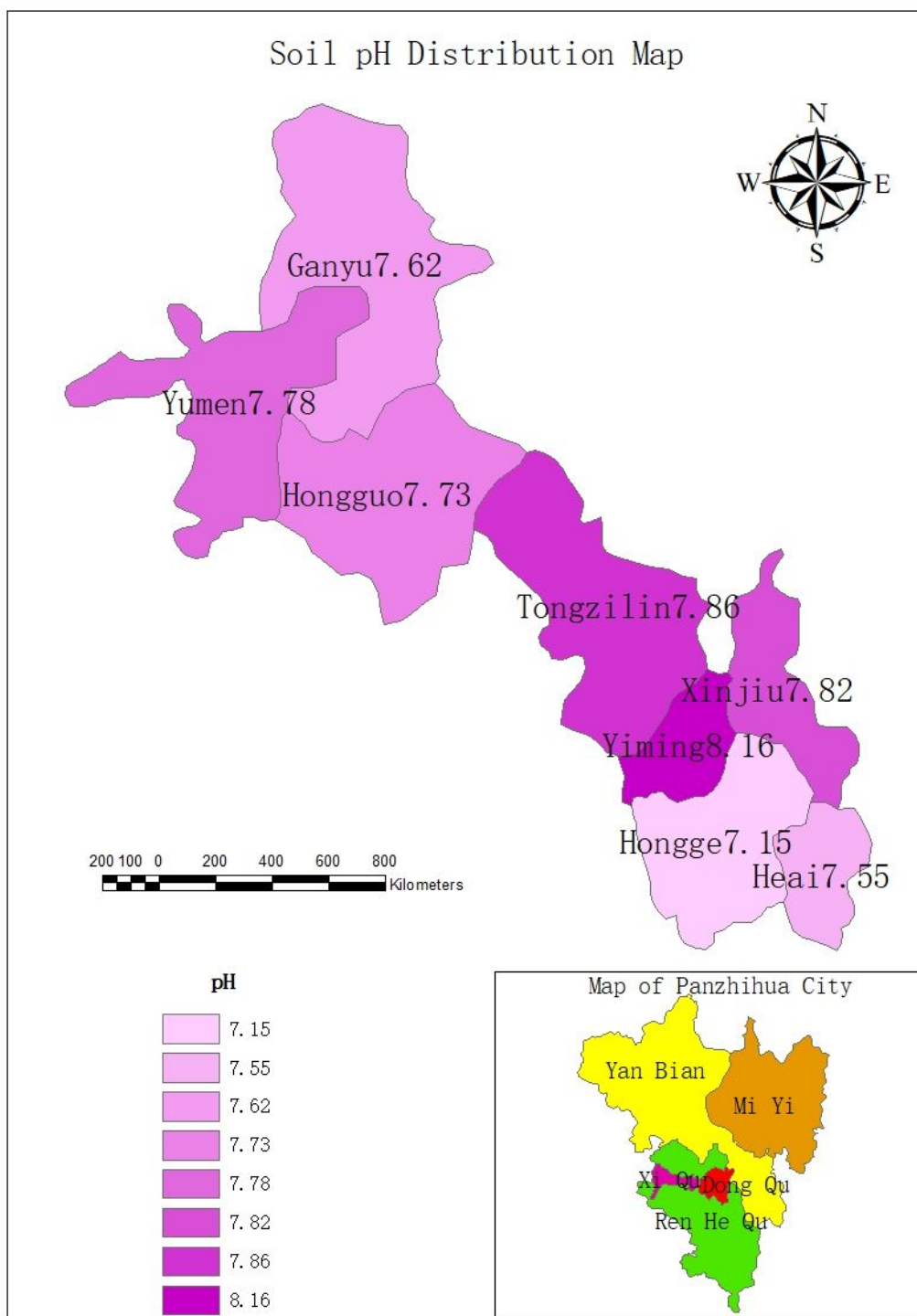


Figure 3-4 Soil pH Distribution Map

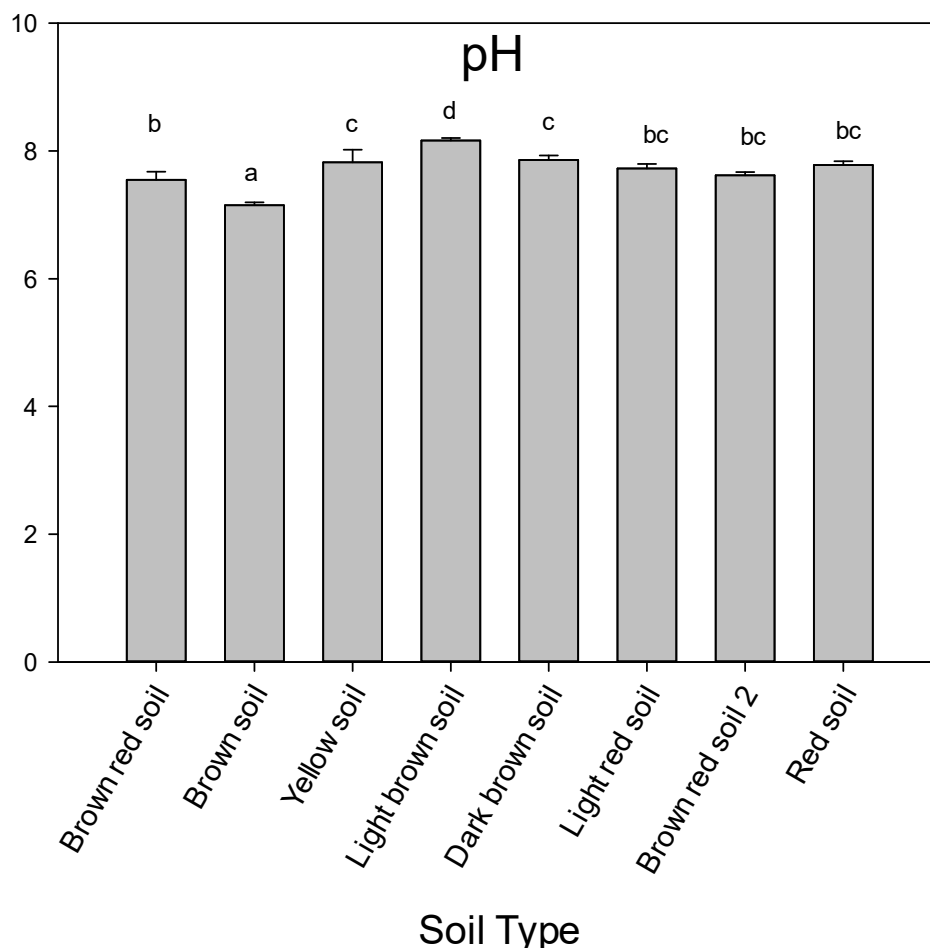


Figure 3-5 Soil pH one way ANOVA analysis graph

Table 3.2 Soil pH grade

Grade	strong acid	acid	weak acid	neutral	Weak alkali	alkali	Strong alkali
pH value	<4.5	4.5~5.5	5.5~6.5	6.5~7.5	7.5~8.5	8.5~9.0	>9.0

From Figure 3-3 and Table 3-3, we can see that the pH of Hongge Town is between 7.0 and 7.5, which belongs to weak alkali soil, while the pH of the remaining seven townships is between 7.5 and 8.5, which belongs to alkaline soil. On the whole, the soil of Yanbian County belongs to alkaline soil. This may be because Yanbian County belongs to the type of mountain soil and mountain soil samples are unavoidable. That is rock, because of rock weathering, most of the lime-type materials enter the soil, resulting in the increase of soil alkalinity, and because of the decrease of soil moisture content, the self-regulation of acidity and alkalinity can not reach the normal level, resulting in the overall high alkalinity of the soil. In terms of soil correlation, Yanbian County soil can be divided into four different standards, including Hongge Town, Xinjiuxiang Township, Yinyu Township, Tongzilin Township and Yimin Township. Finally, Yumen Town, Hongguo Town and Aixiang are classified into one group. However, they have the same subset in the same subset, which indicates that they have some similarities but not the same in the acidity and alkalinity of the land.

Improvement measures to reduce pH: (1) Apply more calcium fertilizer (such as calcium superphosphate, calcium nitrate, etc.) and acidic fertilizer (such as ammonium nitrate, etc.) in saline-alkaline soil with appropriate organic fertilizer. Organic fertilizer can not only increase the content of soil organic matter, but also improve the physical and chemical properties of the soil, and enhance the soil to achieve water conservation effect. (2) Planting green manure. Green manure can increase coverage, reduce water evaporation and inhibit salt. At the same time, green manure is also an important source of organic fertilizer. (3) Reasonable cultivation. Reasonable tillage and timely loosening of soil can improve soil aeration, change the state of soil compaction, reduce evaporation and inhibit salt return.

3.2.4 Distribution of Organic Matter

By analyzing and processing the original data of organic matter, the following maps are obtained:

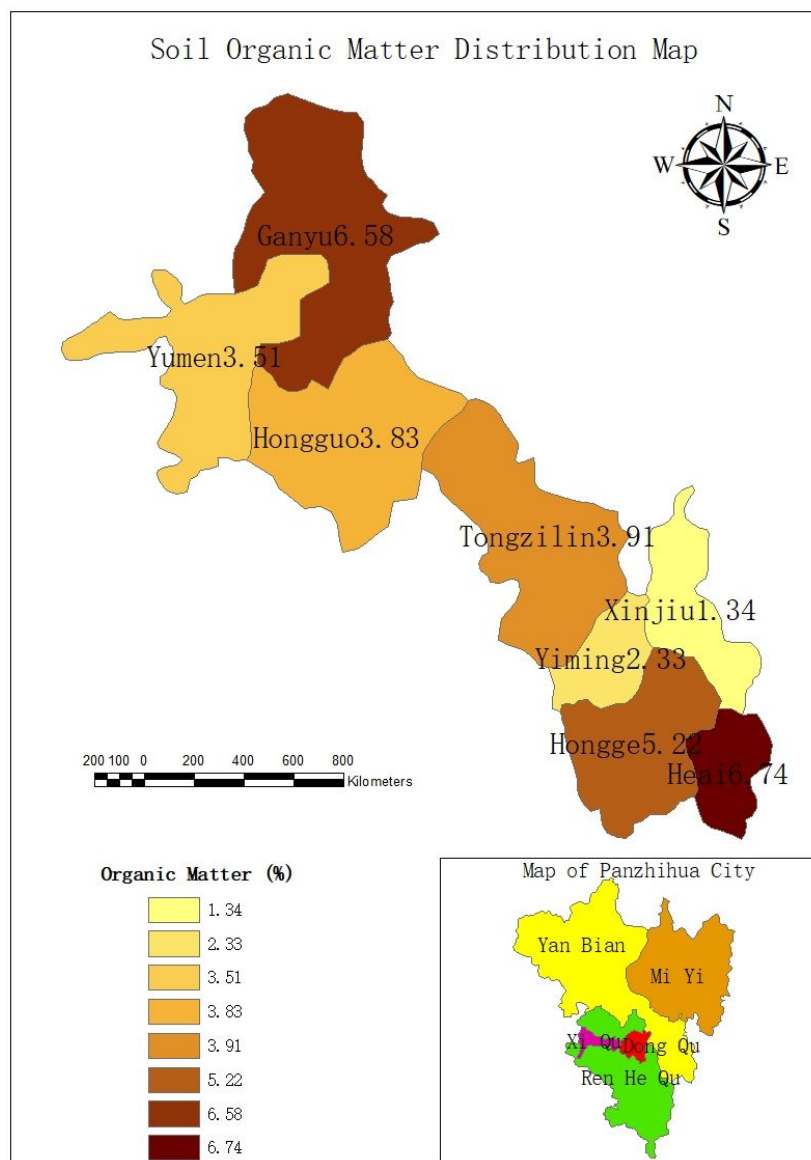


Figure 3-6 Soil Organic Matter Distribution Map

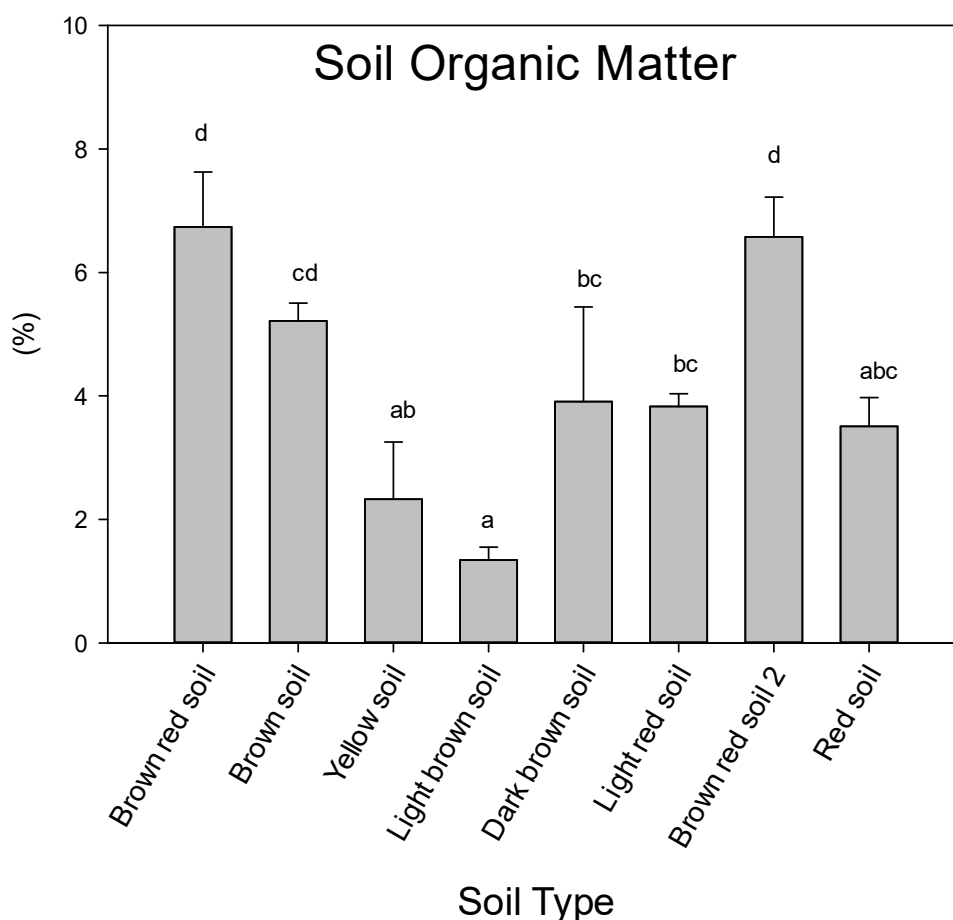


Figure 3-7 Soil organic matter one way ANOVA analysis graph

Table 3-4 Soil organic matter (%) grade

Grade	1 (Extremel y abundant)	2 (Rich)	3 (Middle- higher)	4 (Middle- lower)	5 (Lack)	6 (Extremel y deficient)
Soil organic matter	>4	3~4	2~3	1~2	0.6~1	<0.6

According to Figure 3-6 and Table 3-4, the organic matter level in Xinjiuxiang is relatively low, belonging to the fourth level, Yimin Township belongs to the third level, Tongzilin Town, Hongguo Town and Yumen Town are higher, at the second level, and finally, Aixiang, Hongge Town and Yinyu Township are the highest, at the first level. It can be seen from this that Yanbian County is rich in organic matter in the soil as a whole. The main factor affecting the organic matter level is the biological activities, because it belongs to the mountainous area, rich vegetation and strong biodiversity, which makes the overall organic matter level in Yanbian County higher than the normal level. From Figure 3-7, we can see the correlation of soil. In the aspect of organic matter, the soil in Yanbian County can be divided into five criteria, among which, Echinochloa Township, Aixiang Township and Xinjiu Township are at an independent level. The other townships have similarities with the three towns mentioned above. Of course, they also have certain correlation with each other.

In view of the fourth level of organic matter content in Xinjiuxiang, the following measures can be taken: (1) Increasing the total biological yield. On the premise of increasing yield, the content of soil organic matter will be increased, because the yield of aboveground part will increase, and the root system of underground part will also increase accordingly, which will lead to more active and flourishing underground organisms, and eventually increase the number of animal and plant residues. (2) Soil is mixed with plant ash, straw and so on, because they are rich in organic matter, which not only protects the environment, but also improves the soil level. (3) Increasing the amount of organic fertilizer and concentrating on the soil lacking organic matter are fertilization, mixed fertilization and rational fertilization, so as to improve the content of soil organic matter.

3.2.5 Distribution of Ammonium Nitrogen

By analyzing and processing the raw data of ammonium nitrogen, the following group diagrams are obtained:

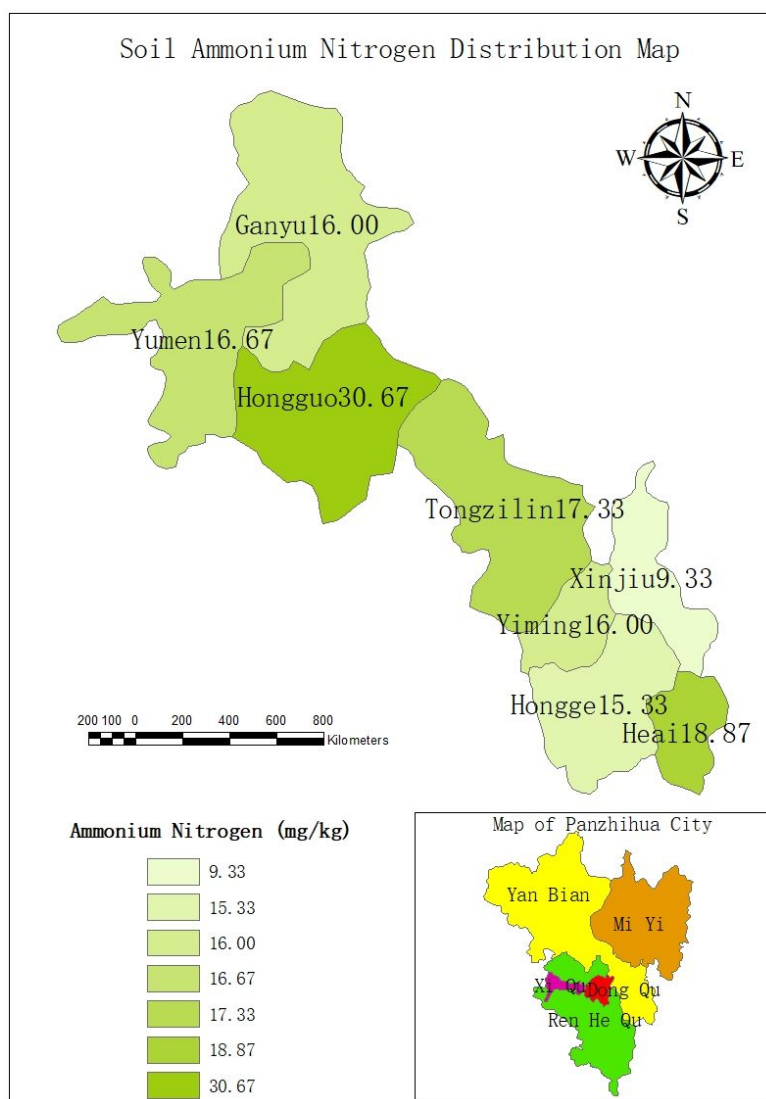


Figure 3-8 Soil Ammonium Nitrogen Distribution Map

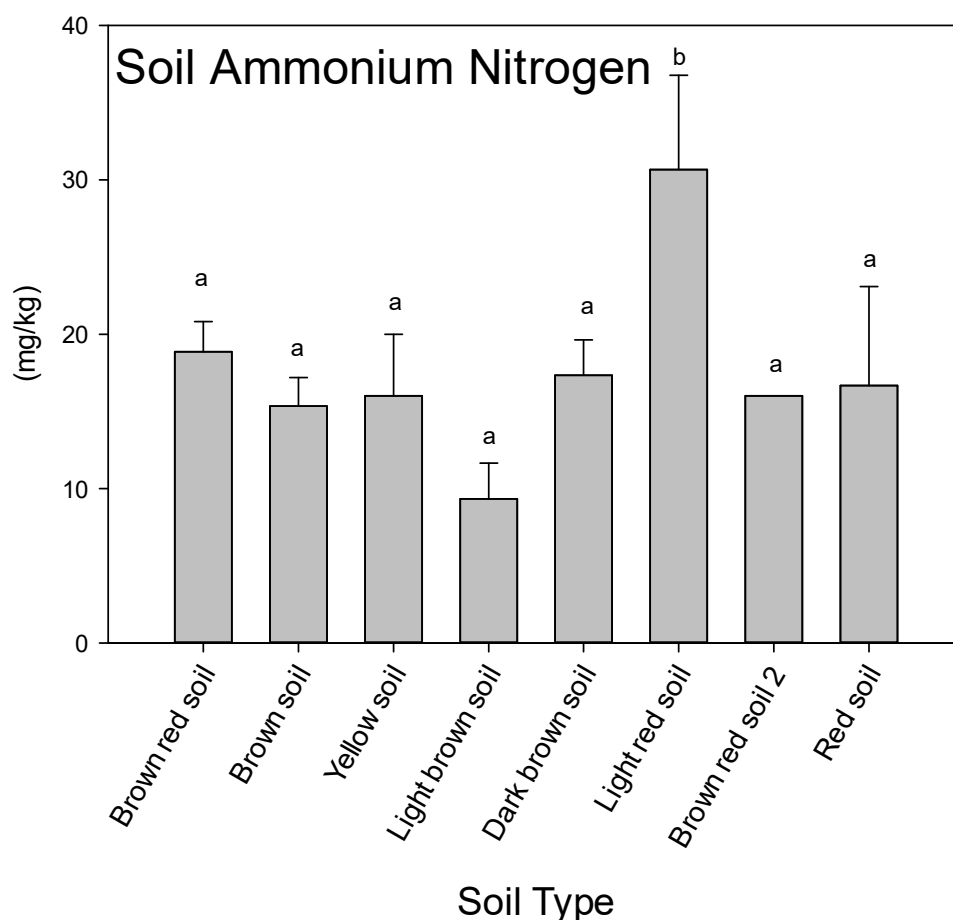


Figure 3-9 Soil Ammonium Nitrogen one way ANOVA analysis graph

Table 3-5 Soil Ammonium Nitrogen (mg/kg) grade

Grade	1 (Extremely abundant)	2 (Rich)	3 (Middle-higher)	4 (Middle-lower)	5 (Lack)	6 (Extremely deficient)
Concentration	>150	120~150	90~119	60~89	30~59	<30

From Figure 3-8, Figure 3-9 and Table 3-5, we can see that except Kaihongguo Township, soil nitrogen content in other seven towns is extremely deficient. Among them, Yingyu Township, Yumen Town, Tongzilin Town, Xinjiu Township, Hongge Town, Aixiang and Yimin Township are at the same level in this aspect of soil nitrogen content. In Figure 10, we can see that the results of correlation analysis of the above seven townships are all a, representing that these soils belong to the same subset. Secondly, the soil nitrogen content of Hongguo Township is higher than that of other townships, but as a whole, we can find that the soil ammonium nitrogen content of Yanbian County is higher than that of other townships. According to the standard of soil nutrient content, it is far from qualified. Therefore, there is a need for targeted improvements in this regard.

Some methods to increase nitrogen content: (1) Applying ammonium nitrogen fertilizer and deep application in 8-15 cm of soil are the most suitable, covering soil, increasing the adsorption of ammonium ions in soil, reducing the volatilization of nitrogen nutrients, and improving the utilization rate of nitrogen fertilizer; (2) mixing with other fertilizers, the release of nitrogen fertilizer is relatively slow. Establishing suitable nutrient

supply conditions is an important measure to increase the yield of nitrogen fertilizer. (3) Because ammonium ion is acidic, it will neutralize with alkaline soil and lead to nitrogen volatilization, so improving soil acidity and alkalinity can also achieve the goal.

3.2.6 Distribution of Available Phosphorus

By analyzing and processing the raw data of available phosphorus, the following group charts are obtained:

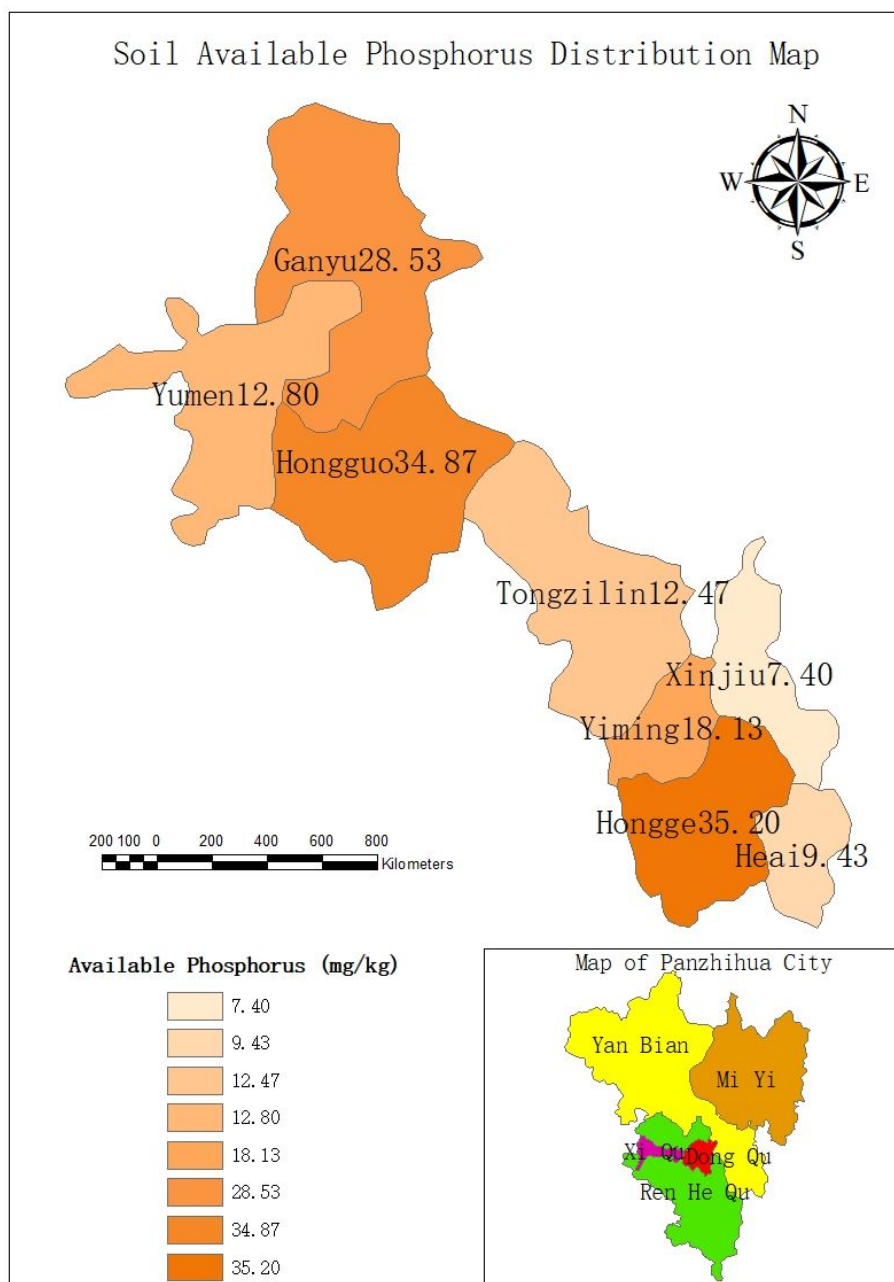


Figure 3-10 Soil Available Phosphorus Distribution Map

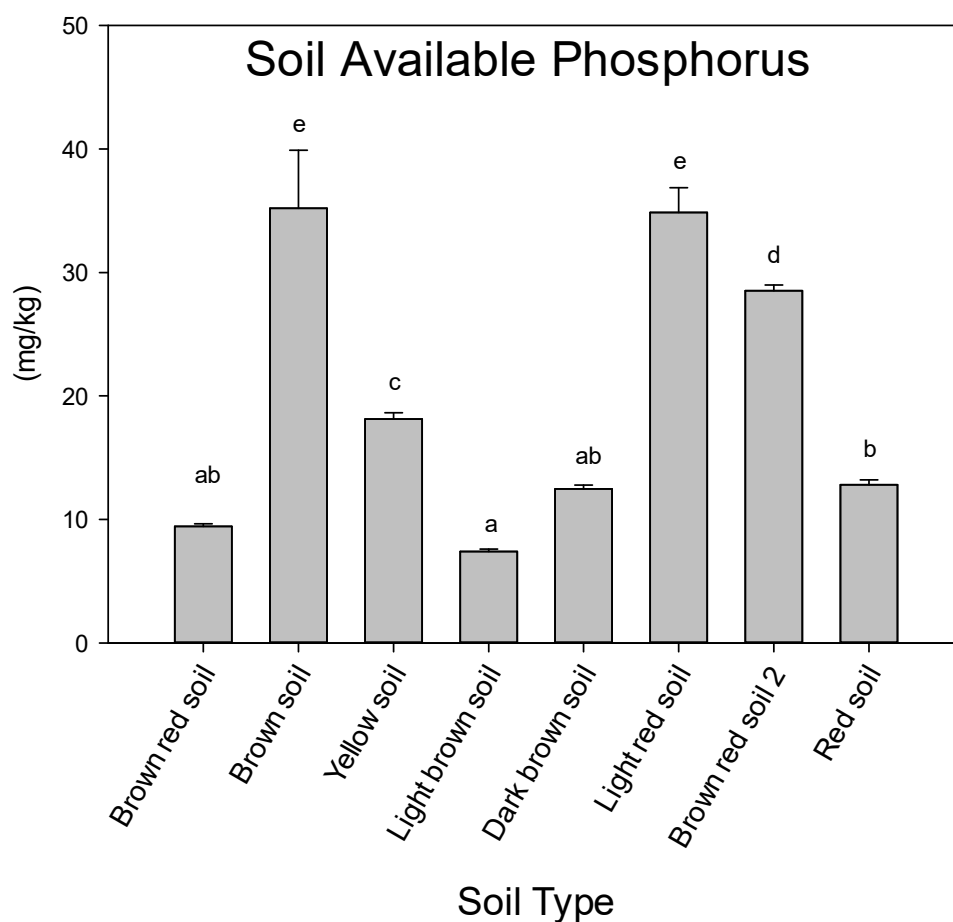


Figure 3-11 Soil Available Phosphorus one way ANOVA analysis graph

Table 3-6 Soil Available Phosphorus (mg/kg) grade

Grade	1 (Extremely abundant)	2 (Rich)	3 (Middle-higher)	4 (Middle-lower)	5 (Lack)	6 (Extremely deficient)
Concentration	>40	20~40	10~20	5~10	3~5	<3

According to Figure 3-10 and Table 3-6, the phosphorus content of Xinjiuxiang and Aixiang is lower in the standard of available phosphorus grade. Tongzilin Town and Yumen Town belong to the general level, Chanyu Township, Yimin Township belong to the higher level, Hongge Town and Hongguo Township belong to the high level. Overall, most of Yanbian County belongs to phosphorus-rich areas. From the analysis of soil correlation, Figure 3-11 shows that Tongzilin Town and Chanyu Township are at the same level, Yimin Township, Xinjiu Township, Chanyu Township and Yumen Town are at different levels, Hongguo Township and Hongge Town are at the same level, but Xinjiu Township is at the same level. The soil acidity and alkalinity in Jiuxiang are similar to those in Tongzilin Town and Chanyu Township.

In view of phosphorus deficiency and low phosphorus areas, we can make the following improvements:

1. Phosphorus-deficient soils are generally alkaline soils. Alkaline soils are not really phosphorus-free, but generally phosphorus in soils is soluble phosphates such as sodium hydrogen phosphate and sodium dihydrogen phosphate. In alkaline soils, these phosphates exist in insoluble substances such as calcium phosphate, which cannot be dissolved in soil solution, and can not be vegetated. Body absorption, that is, the formation of soil phosphorus deficiency phenomenon, so the first treatment method is to improve the acidity and alkalinity of the soil.

2. The commonly used method is to apply phosphate fertilizer to the soil, such as phosphate rock powder, bone powder, phosphate rock dihydrogen potassium. Secondly, plant ash in daily life is also a convenient and efficient substance to improve the phosphorus content of the soil.

3.2.7 Distribution of Effective Potassium

Through the analysis and processing of the effective potassium original data, the following groups of maps are obtained:

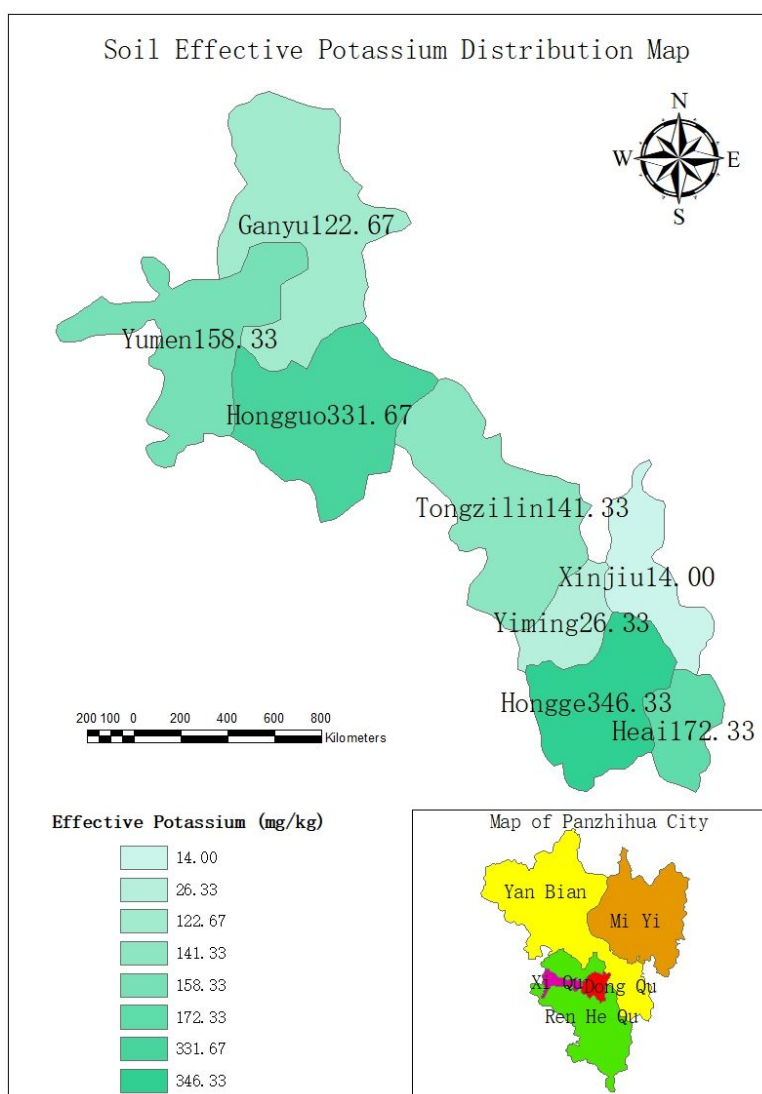


Figure 3-12 Soil Effective Potassium Distribution Map

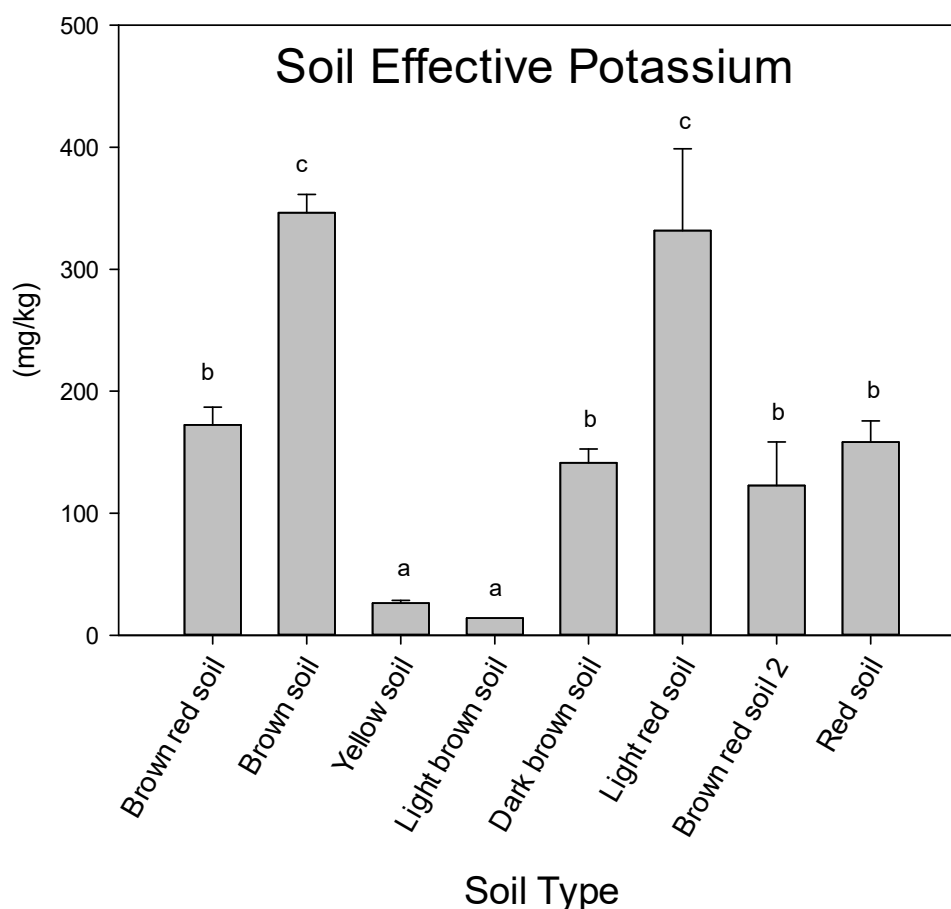


Figure 3-13 Soil Effective Potassium one way ANOVA analysis graph

Table 3-7 Soil Effective Potassium (mg/kg) grade

Grade	1 (Extremely abundant)	2 (Rich)	3 (Middle-higher)	4 (Middle-lower)	5 (Lack)	6 (Extremely deficient)
Concentration	>200	150~200	100~150	50~100	30~50	<30

Through Figure 3-13, Figure 3-14, Table 3-7, we can see that the potassium content in Xinjiuxiang and Yimin Township is very high in the available potassium level. On the whole, the soil in Yanbian County is rich in potassium. This is because the mineral type of soil is very effective in fixing potassium, and the level of soil organic matter content will also be affected. Fixation of Sound Potassium. Therefore, the potassium content in a few areas is insufficient and can be targeted. From Table 3-7, we can see that there is no difference in soil correlation between Yimin Township and Xinjiu Township. They belong to the same kind. Yumen Town, Tongzilin Town, Aixiang Town and Chanyu Township are also the same subset. The last two high-potassium soils are divided into another subset. In terms of potassium, Yanbian County soil is composed of three types.

In view of the two townships lacking potassium, the measures to increase the high content of potassium are as follows: applying different kinds of potassium fertilizer, potassium chloride and potassium sulfate are commonly used as some kinds of potassium fertilizer. In addition, in recent years, a multi-element potassium

fertilizer has been introduced, which contains not only potassium, magnesium and sulfur, but also iron, zinc, calcium, silicon and boron, i.e. magnesium sulfate potassium fertilizer. Making the best use of organic fertilizers, our country lacks potassium fertilizer resources, and a large number of potassium fertilizers need to be imported, so we should take local materials and increase the sources of potassium fertilizer, such as straw returning to the field, grass ash returning to the field and so on. In addition, the characteristics of soil surplus in high potassium area can be used to transfer soil to low potassium soil for soil improvement.

3.3 Comparison of Soil Fertility

Through the analysis and processing of the original data, the following charts are obtained.

Table 3-8 Fertility Data

Township name	Soil types	Soil sample 1	Soil sample 2	Soil sample 3	Average±S.D.
Heai	Brown red soil	408.98	514.74	534.70	566.68±55.17b
Hongge	Brown soil	2277.90	2229.45	2694.85	2176.60±208.91a
Yiming	Yellow soil	401.91	447.86	289.80	210.01±6.38bc
Xinjiu	Light brown soil	83.61	122.96	86.00	69.42±18.01c
Tongzhilin	Dark brown soil	558.86	479.53	522.74	544.01±32.43b
Hongguo	Light red soil	2356.50	2729.43	2363.68	2432.71±174.13a
Ganyu	Brown red soil 2	787.02	999.69	879.17	722.38±87.08b
Yumen	Red soil	400.97	632.81	437.59	527.06±101.77b

Note: The above data reflect the area of the shaded part of the radar image.

The related data are analyzed and processed, and the following charts are obtained:

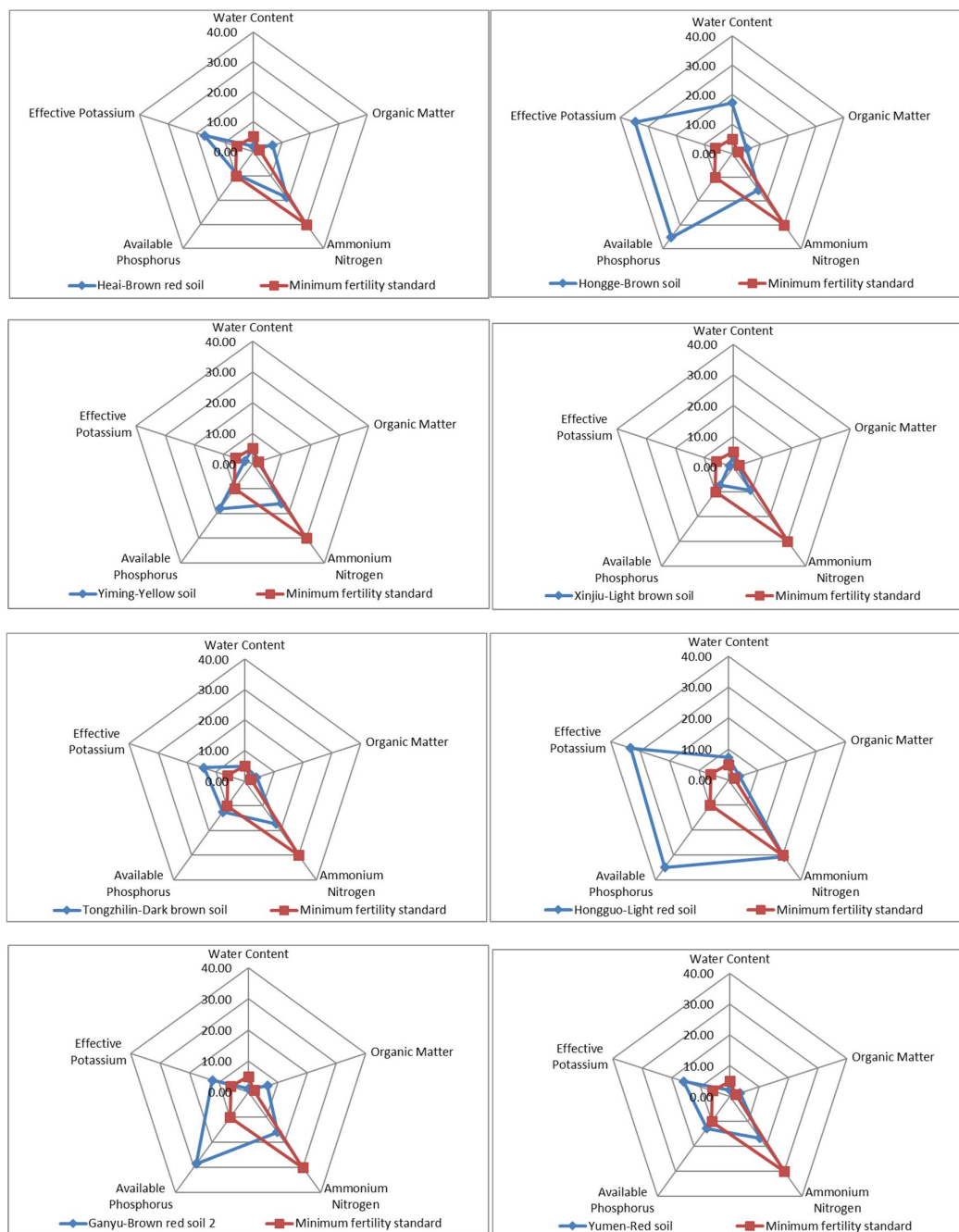


Figure 3-14 Soil Rader Map

Note (The Effective Potassium content in the above figure has been condensed to 1/10).

From the above radar charts and table 8, it can be seen that the soil fertility of Hongguo Township and Hongge Township is more prominent. That is to say, the land nutrition is relatively rich, but the soil fertility of Yimin Township and Xinjiu Township is relatively poor. All kinds of nutrients are not prominent and belong to the poor soil level. In the view of the other four townships, the soil fertility is relatively one. Generally, some nutrients are above or below the average level. On the whole, the soil fertility in most areas of Yanbian County is on the high side. As can be seen from the above chart, the key factors affecting soil fertility are effective potassium and available phosphorus.

Table 3-10 Principal component analysis table

Variable loadings on the first two principal components (PC1 and PC2) for soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Yanbian County.

Variable	PC1	PC2
Water	<u>-0.690</u>	-0.660
Organic Matter	-0.565	<u>0.688</u>
pH	<u>0.857</u>	-0.046
N	<u>-0.521</u>	0.361
P	<u>-0.839</u>	-0.136
K	<u>-0.912</u>	-0.052
Variance explained (%)	55.6	17.7

Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Yanbian County.

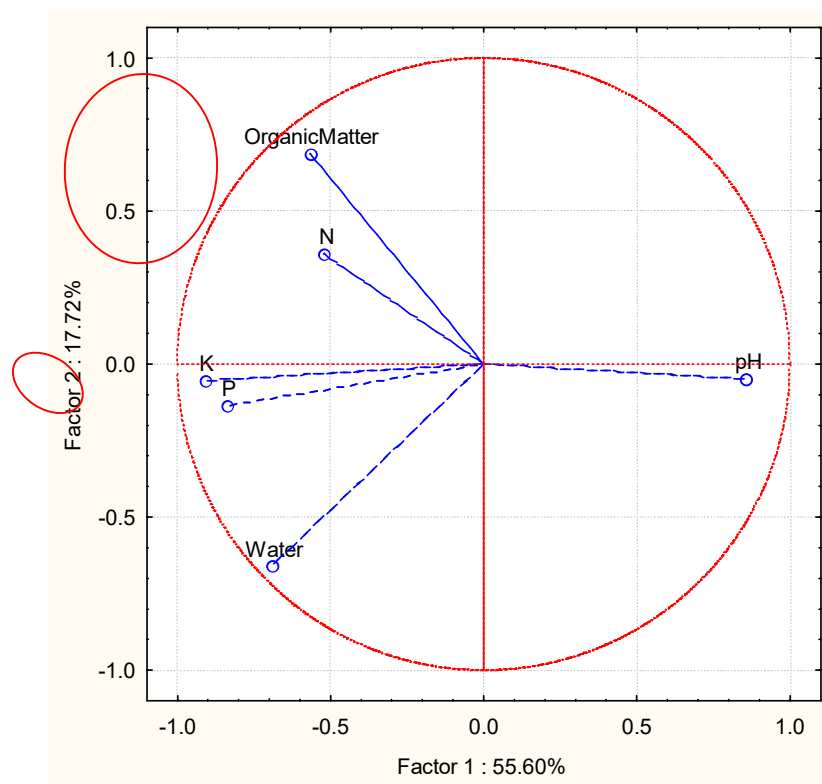


Figure 3-15 Principal component analysis (a)

Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Yanbian County, based on ordination of the plots of the different soil types by the first two principal components (PC). 1=Brown red soil in Heai; 2=Brown soil in Hongge; 3=Yellow soil in Yiming; 4=Light brown soil in Xinjiu; 5=Dark brown soil in Tongzhilin; 6=Light red

soil in Hongguo; 7=Brown red soil 2 in Ganyu; 8=Red soil in Yumen. The number 1, 2, 3 for example 7-1, 7-2, 7-3, are three sample reduplicate for each soil type.

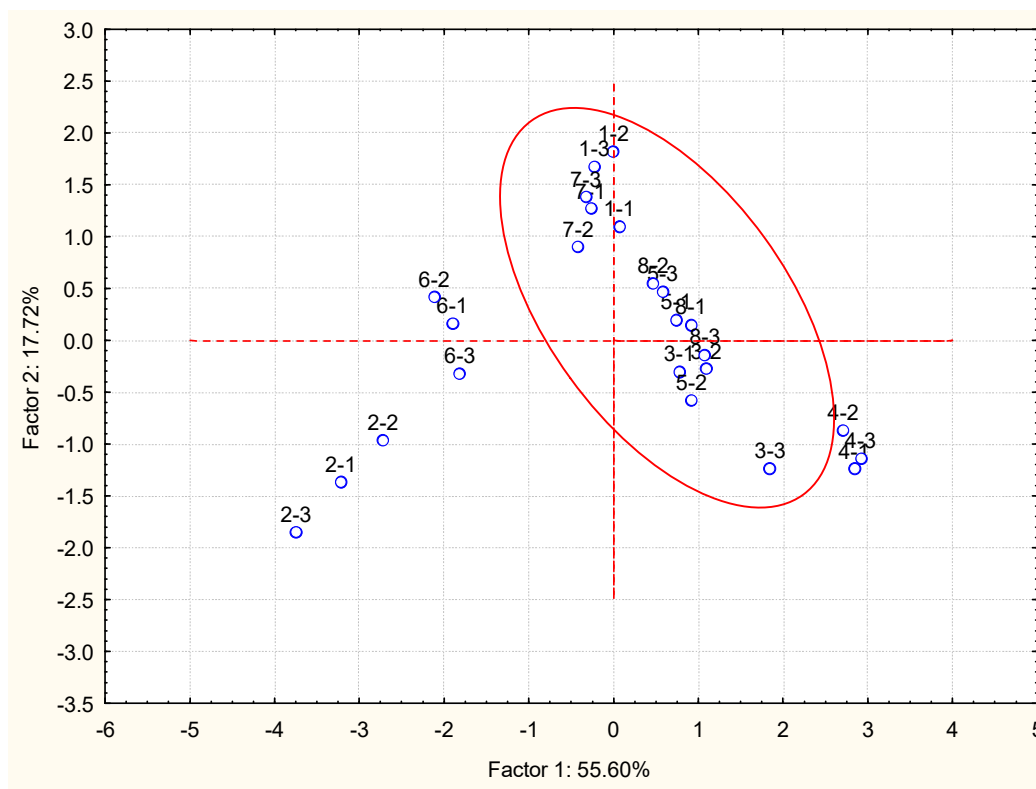


Figure 3-16 Principal component analysis (b)

Principal component analysis (PCA) allows simplification of data complexity by reducing the number of variable orthogonal factors, thus facilitating the visualization of meaningful correlations.

The PCA results of Yanbian County soil Table showed that the first two components accounted for 73.3% of the total variance.

The first component (PC1, 55.6%) was mainly positively associated with the parameters water (variable loadings: -0.715), organic matter (variable loadings: 0.740), pH (variable loadings: 0.776), P (variable loadings: 0.878) and K (variable loadings: 0.182). The second component (PC2, 26.4%) was mainly positively associated with N (variable loadings: 0.869).

Figure shows the parameters distribution map: organic matter and pH associated together, demonstrated they have close correlation. Infers that improve organic matter concentration can increase pH values in the soil.

Figure shows the parameters distribution map: organic matter and K associated together, N and P associated together, demonstrated they have close correlation. Infers that improve organic matter concentration can increase K content in the soil.

Figure shows the soil types distribution map: soil types 1, 2, 3, 5, 6, 7, are greater soil fertility types associated together; soil types 4 and 8 are poorer soil fertility types. Which has a clear demarcation of soil fertility.

IV. CONCLUSIONS

In this experiment, eight townships in Yanbian County of Panzhihua City were taken as research objects. The soil moisture content, pH, organic matter, ammonium nitrogen, available phosphorus and available potassium in the soil were analyzed by tpy-6a soil nutrient rapid measuring instrument. The following conclusions were drawn:

(1) Analyzing the data of soil water content, it is found that most areas are short of water and a few towns can reach normal level. In view of this result, we can consider opening water storage pools, constructing ditches and using greenhouse planting to realize the efficient utilization of water resources and the improvement of soil water content.

(2) Analyzing the soil organic matter data, we found that half of the areas had lower organic matter level and some were higher than the average level. For the high level, only need to maintain is enough. The simple method is to mix with plant ash. For the low level areas, organic fertilizer is needed on this basis.

(3) The analysis of soil pH data shows that the soil in this area is alkaline, alkaline soil is not conducive to the growth and development of some plants, and will affect the retention of phosphorus elements in the soil. Therefore, it is necessary to improve it as a neutral soil, which can be improved through agricultural improvement, improve water conservancy facilities, or apply fertilizers, phosphogypsum, or inhibit. Salts and other chemicals reduce soil pH.

(4) Analysis of soil ammonium nitrogen data shows that the whole area of Yanbian County is deficient in nitrogen. Nitrogen is an essential element for plant growth, and measures need to be taken.

(5) The analysis of available phosphorus data shows that most areas of Yanbian County are rich in phosphorus and a few areas are lack of phosphorus. Another way to improve this index is to adjust the soil acidity and alkalinity. Secondly, we should pay attention to the addition of phosphorus fertilizer to make rational use of it.

(6) The analysis of available potassium data shows that Yanbian County is in a state of potassium surplus as a whole. In view of the lack of potassium, the measures of returning plant ash to the field can be implemented. At the same time, attention should be paid to the mixed application of nitrogen fertilizer and phosphorus fertilizer, while other areas need to be maintained without improvement.

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