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Soil Systematic Classification Research in Dong District of Panzhihua City

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--ABSTRACT--
Aims: As Panzhihua City has not yet been studied on soil taxonomy, this research will make up for this gap and enable people to understand Panzhihua soil and its composition comprehensively, systematically and in detail. Soil taxonomy is an effective way for people to understand soil. Scientific taxonomy can simplify the study of soil, and a recognized taxonomy can provide communication language between scientists. Soil taxonomy classifies soils by studying the differences in various aspects of soil. The analysis of soil nutrient components plays an important role. Soil nutrient components include acidity, alkalinity, organic matter, ammonium nitrogen, available phosphorus, available potassium and other related contents. Methods: In this research, the soil nutrient components were measured by TPY-6A soil nutrient analyzer, and the data were processed by Sigmaplot, SPSS, ArcGIS and other software. Results: The results of soil system classification map and soil nutrient content map of Panzhihua Dong District were obtained. Conclusions: The results show that the difference of water content in Dong District of Panzhihua is large and the distribution of precipitation is not uniform; most of the soils in Dong District of Panzhihua City are neutral soils; organic matter and available phosphorus are in the middle level, while the content of ammonium nitrogen is low; available potassium is different in different areas.
KEYWORDS;- soil system classification, soil water content, soil pH value, soil organic matter, soil ammonium nitrogen, soil available phosphorus, soil available potassium

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I. INTRODUCTION

1.1 Background of this research

Classification is a tool for inventing, naming and categorizing in order to understand the relationship between the elements and themselves. The purpose of classification is to establish an orderly system by distinguishing and recognizing[1]. Classification must be updated periodically with the change of knowledge. Soil classification integrates soil knowledge, forms a communication language for scientists, and provides technology transfer tools for soil users[2].

Soil classification is the foundation of soil science. The historical process of soil classification is from genetics classification to morphology classification and diagnostics classification. At present, it is developing towards automatic numerical classification[3]. One of its important signs is the gradual establishment, perfection, standardization and quantification of classification indicators[4]. Classification should be based on certain numerical data, and through proper data processing, we can get a logical value evaluation of the systematic relationship among the individual classifications, which should be the numerical classification[5].

1.2 The significance and purpose of this research

There are many kinds of soil types with different characteristics in nature, which are formed by different soil-forming processes under different environmental conditions, and they are related to each other to a certain extent[6]. Soil classification is a scientific distinction of soil types based on the characteristics of various soils and their occurrence relations. Soil classification is also a scientific summary and summary of all kinds of knowledge about soil, which can be easily understood and remembered by people as a basic means of agricultural production and ecological and environmental factors[7]. It has been fully applied in production practice. In short, the goal of soil classification is to systematize soil knowledge for production. Therefore, soil classification is not only a major marker of the level of soil science development, but also one of the main bridges between soil science and production practice[8].

Any scientific classification is extremely important, because timely classification and collation, the characteristics of objects are easier to remember, their links are easier to understand, and it is easier to study other special attributes[9]. Soil classification is the mark of soil science degree, the basis of soil survey mapping and capital evaluation, the basis of random implementation of agricultural technology and improvement of soil status, and the premise of global soil information exchange[10]. A complete soil classification system can reflect the fertility level and utilization value of soil in agriculture, which is an important theoretical basis of soil geography[11]. The purpose of soil classification is to guide land use and soil management. Different soil types play an important role in soil quality evaluation, so soil classification data is selected as an evaluation index[12]. Therefore, it is very important to investigate different types of soils, implement soil testing and formula fertilization, maintain the balance of supply and demand of soil fertility, improve the quality of existing land, greatly increase the understanding of soil, and develop relevant research on soil. Soil is mainly composed of four substances, namely minerals, organic matter, water and air[13].

1.3 Research objective

In summary, the study took different types of soils in different areas of Dong District as objects, classified various soils, and determined their water content, pH, organic matter, ammonium nitrogen, available phosphorus and available potassium content. The results were summarized and analyzed, and the soils in Dong District were systematically classified and improved by agricultural measures according to the nutrient content of different soils.

II. MATERIALS AND METHODS

2.1 General situation of administration and natural conditions in the research Area

The Dong District is the main urban area of Panzhihua City. It is the political, economic, cultural, financial and commercial center of the whole city. It is located on the hillside platform on both sides of the east section of Jinsha River in Panzhihua City. It is between 26° 32′ ~26° 39′ in the north latitude and 101° 39′ ~101° 49′ . From the east of the administrative region, the junction of Jinsha River Avenue and Jinsha River goes down 850 meters; from the west to the top of Yunpan Mountain and Liangfengao, they are bounded by Renhe District and Xi District respectively; from the south to Bashi Road in the middle of Dahe River; from the north to Daheishan, Laoyanshan, Renhe District and Yanbian County. The area of the jurisdiction is 166 square kilometers, of which 179 hectares are cultivated land, accounting for 1.08% of the total area of the jurisdiction[14].

The Dong District belongs to the three-dimensional climate based on the subtropical zone, with significant vertical difference. The winter half year is controlled by the tropical continental air mass, and the weather is clear and dry. The summer half year is affected by the tropical monsoon, and the rainfall is abundant. June to October is the rainy season, November to May next year is the dry season, more than 90% of the precipitation concentrated in the rainy season. The average annual temperature of the region is 20.9 ℃. The average temperature and total heat are higher in the whole city. The hottest month usually occurs from May to June, and the coldest month occurs in December or January. The daily temperature difference between January and February is the largest in the whole year. The monthly average is about 13℃, and the maximum daily temperature difference can be more than 20℃. The annual sunshine duration is about 2640 hours, the annual average sunny day is about 240 days, rainy day is about 60 days, cloudy day is about 65 days, the annual average total solar radiation is about 632,100 joules/square centimeters, forming a unique high temperature area in the same latitude area[15].

The Dong District has a dry climate with annual rainfall of about 800 mm, annual evaporation of 2400 mm and annual average relative humidity of 59%. The annual average pressure is 878.00 millibars, the lowest in June and the highest in November. The difference between height and height is about 9 millibars. The southeasterly winds prevail in summer and winter. The annual maximum wind speed is 18.30 m/s, the annual average wind speed is 2 m/s in summer and 1.10 m/s in winter. The annual average gale days are 12.20 days, the annual quiet wind frequency is 46%, the first ten days of February to May are the monsoon season, the wind speed in autumn is the smallest, the gale days are the least, and the quiet wind frequency is the highest. The annual frost-free period is over 300 days, and there is almost no winter below 1400 meters above sea level, and the summer lasts for about half a year. The average frost days in China are 14.20 days, the initial frost period is in mid-December, the final frost period is in February, and the frost-free period is 287.60-308.10 days on average.

The land area is large and the resources of farmland are insufficient. The city is generally divided into 95 forests with four fields and one water, and the nature of the pastoral hills is the most spectacular. From the point of view of land resources, forestry and pasture land are the main areas in the city, and the farmland is very little. It only distributes on the rivers and valleys of Jinsha River and its tributaries, Anning River, Sanyuan River, Dahe River, Baguan River, and a part of the mountain plain. The area of farmland is reported to be 470,000 mu, of which 254,000 mu is farmland, and 215,000 are farmland. The total area of cultivated land is

737.8 million mu (net area), accounting for 6.63% of the total area. The remaining 93.37% of the total area is forest, animal husbandry and other land. The per capita land of the city is 1347 mu, which is lower than the national level of 15 mu.

2.2 Research contents

2.2.1 Soil pH

Soil acidity and alkalinity is one of the important chemical properties of soil, which is related to the distribution of soil microbial flora and its activities, and then to the decomposition of organic matter and the transformation of nutrient elements such as nitrogen and sulfur; to the forms and validity of calcium, magnesium, phosphoric acid and iron, manganese, zinc, copper, molybdenum and boron in soil; to all kinds of plants, soil acidity and alkalinity are inevitable. If we break the law of adaptation, growth will be hindered. Therefore, although soil acidity and alkalinity are not fertility factors, it directly affects soil fertility, and has close relationship with suitable crops and types of fertilizer. Soil pH is closely related to the analytical methods and results of many other projects, which is also a basis for reviewing the results of other projects.

Soil acidity and alkalinity changes are directly affected by natural environmental conditions such as biological climate, topography, parent material and agricultural measures such as fertilization and irrigation. Therefore, the acidity and alkalinity of different regions and different types of soils are also different. The topography and climate of this city are complex, the vertical change of soil types and regional differences are obvious, and the change range of soil acidity and alkalinity is large. In the dry-hot valley of Jinsha River, due to the lack of dry heat and rain, large evaporation and alkaline irrigation water quality, the effect of soil double salt base is relatively common, and the soil pH value is relatively high. The new alluvial vegetable field has a pH of 7.0-8.0, with individual as high as 9.0; the dry laterite in this area has a pH of 6.5-8.4, showing a neutral to slightly alkaline reaction. In Miyi and Yanbian valleys, the rainfall is relatively increased, the humidity is increased, the leaching effect is strengthened, the soil pH value is lower, and the lateritic red soil pH is the lowest, generally about 5.5-6.0; the newly accumulated soil in the valley is generally neutral. The pH of a few paddy fields in Renhe and Yanbian valleys is as high as 8.0 due to the influence of parent material or the water quality of nearby rock crevices.

In addition to the above-mentioned regional changes, the vertical changes of soil acidity and alkalinity with elevation are also very significant: the pH of red soil (below 1700 meters above sea level) is about 5.3-6.8, showing acidic-slightly acidic reaction; the pH of brown red soil (1700-2200 meters above sea level), yellow brown soil (2200-2700 meters) is about 4.5-6.5, showing acidic-strong acidic reaction; the pH of brown soil and dark brown soil is about 4.6-5.9, showing acidic-strong acidic reaction; Mountain shrub meadow soil is generally acidic and neutral in individual sections of carbonate mother rocks. From red soil to dark brown soil, with the increase of altitude, rainfall increased, leaching increased, and soil acidity also increased. In addition, the pH value of natural soil is affected to some extent by the amount and composition of organic matter provided by surface vegetation.

2.2.2 Soil organic matter

Soil organic matter is an important component of soil. It includes products of different decomposition and synthesis stages of soil microorganisms and animal and plant residues, mainly humic acids. The content of organic matter varies greatly in different soils, with the highest being over 30%, and the lowest being less than 0.50%. The cultivated soil is generally less than 5.0%. Although the content of organic matter is small, it has a significant impact on the physical and chemical properties of soil, biological properties and soil fertility. First, soil organic matter contains all kinds of nutrients needed by plants and microorganisms, and is a stable and long-term nutrient source. More than 95% of soil nitrogen belongs to organic nitrogen, so organic matter is the main source of soil nitrogen. Soil organic matter also contains organic phosphorus. In some paddy soils in southern China, organic phosphorus accounts for about 20-50% of total soil phosphorus. This part of organic phosphorus can be converted into available phosphorus that can be used by plants. On the one hand, organic acids produced in the decomposition process of soil organic matter can promote soil mineral weathering and release nutrients; on the other hand, they can form complexes with some trace elements to improve the effectiveness of elements.

The second is to enhance the fertilizer conservation capacity of Shilou. Soil humus has both positive and negative charges, mainly negative charges, so the ions it adsorbs are cations, which can make K^+, NH^+, Ca^{2+}, Mg^{2+}, and other nutrients adsorbed and reduce loss. The ability of humus colloids to preserve nutrients is several to tens of times greater than mineral colloids. Therefore, for sandy soil with very weak fertility, increasing organic fertilizer to improve its humus content not only increases soil nutrients, improves the physical properties of sandy soil, but also improves its fertility conservation ability.

Because the soil humus is soft, porous and has the necessary cohesive force, but the cohesive force is smaller than the mineral colloid. Therefore, it can not only make the unstructured sandy soil form aggregate distribution, but also make the cohesive soil become soft and no longer caked, thus improving the permeability, water storage, aeration and tillage of the soil. Soil organic matter can obviously deepen the color of soil, help heat absorption and warming, and promote early and rapid growth of crops in spring. For low-yielding fields, increasing organic matter content can improve soil fertility and soil fertility. For high-yielding fields, organic matter needs to be continuously supplemented because of the decomposition of organic matter.

2.2.3 Soil nitrogen

Nitrogen is one of the indispensable elements for plant growth and development. Plants mainly absorb and utilize ammonia from soil, so the nitrogen status of soil directly affects the growth and yield of crops.

Soil nitrogen generally exists in two forms: organic ammonia, including various complex organic nitrides and water-soluble simple organic nitrides. Organic nitrogen is the main source of soil nitrogen. The other is inorganic nitrogen, mainly ammonium nitrogen and nitrate nitrogen, which can be directly absorbed and utilized by plants. It plays an important role in plant nitrogen nutrition. Organic nitrogen and inorganic matter can be converted to each other, so they are often in dynamic equilibrium.

Soil nitrogen content is one of the main indicators of soil fertility. Total nitrogen can reflect the total storage and existing state of nitrogen in soil. Under certain conditions, it is positively correlated with crop yield. Therefore, understanding soil total nitrogen can not only be used as a reference for fertilization, but also be used to judge the level of soil fertility. Nitrogen is also a component of the vitamin and energy system in plants.

2.2.4 Soil phosphorus

Phosphorus is one of the indispensable nutrient elements in crop growth. It plays an important role in promoting nutrient absorption and increasing seed weight. Phosphorus plays an important role in plant nutrition. Most of the organic compounds in plants are composed of phosphorus. Phosphorus is also a component element of many important compounds such as nucleic acids, proteins and enzymes in plants.

There are obvious differences in phosphorus status among different types of soils: dry red soil has the lowest total phosphorus content, followed by lateritic red soil, purple paddy rice, yellow brown soil and red limestone soil, which is rich in total phosphorus content, reaching 0.14-0.17%. Total phosphorus content in natural soils increases from low to high altitudes, which is basically consistent with the variation of organic matter content.

2.2.5 Soil potassium

Potassium in soil can promote the growth of plant stems and leaves, make the stem strong, not easy to lodge, enhance disease resistance, etc.. The average content of total potassium is 1.71%, of which the first grade land whose content of pure potassium is more than 2.5% only accounts for 5.08% of the total cultivated land area; the second and sixth grades account for 16.219%, 40.85%, 26.67%, 6.92% and 4.27% of the cultivated land respectively; the soil with rich content above the third grade accounts for 62% of the total cultivated land, and the soil below the third grade only accounts for 38%. The average content is lower than that in the interior of Sichuan Province, which is due to the fact that the city is located in the red soil area and the high degree of soil weathering, but compared with other red soil areas in the south, it is also one of the areas with high potassium content. The regional distribution of total potassium in this city is not uniform. The average potassium contents of Miyi, Renhe and Yanbian are 1.93%, 1.62% and 1.44% respectively, showing certain regional differences.

Water-soluble potassium is the only available potassium in soil, and exchangeable potassium is the available potassium that plants can absorb and utilize directly. According to the national unified classification standard, the percentage of available potassium in farmland of grade 1 to 6 was 14.29%, 7.87%, 22.05%, 31.92%, 19.41% and 4.46%, respectively. The average potassium content of cultivated land is about 120 ppm. Among them, the area with potassium content less than 100 ppm accounts for more than half, and the area lacking potassium content less than 50 ppm accounts for more than 20%. The situation of soil potassium supply in the whole city is at a moderately low level.

For water-soluble available potassium in soil, it is mainly released by decomposition of potassium-bearing minerals. Soil total potassium should be correlated with available potassium, but because of the mobility of potassium ions, potassium in soil solution is easily lost with water besides being absorbed by plants and absorbed by colloids. Therefore, there is no correlation between available potassium and total potassium, but there is a certain correlation between available potassium and clay content.

According to statistics, the average content of available potassium in dry land soil below 1800 meters in this city is 76, 147, 158 and 205 ppm in light soil, middle soil, heavy soil and clay, respectively, which tends to increase with the increase of physical clay. The content of soil available potassium in mountain area is higher than that in valley area, which is related to the content of soil organic matter.

In addition, the content of available potassium in soil is also related to agricultural utilization: available potassium in dryland soil is generally higher than that in paddy soil, the average value of available potassium in

Dryland is l98ppm, the average value of available potassium in paddy soil is only 102 ppm, 96% higher than that in paddy field; available potassium in vegetable land is higher than that in grain land, generally about 50% higher.

Understanding the change and distribution of available potassium in soil is helpful to the rational application of potassium fertilizer.

2.3 Sampling method

Field sampling of soil in Dong District was carried out in different areas according to their administrative divisions.

Mixed soil sampling method was used. In each administrative division, three representative sampling points are selected to collect soil samples and mix them to form a representative mixed soil sample, which represents the soil profile of the region.

2.4 Measuring items and methods

The samples were fully mixed before the determination.

A certain amount of soil sample is weighed and placed in a ventilated place for natural air-drying. After air-drying, the soil moisture content is calculated by weighing for the second time. The air-dried soils were ground, and the ground soils were screened with 100 meshes to prepare for the subsequent determination of nutrients.

The determination of nutrients (pH, organic matter, ammonium nitrogen, available phosphorus, available potassium) was carried out by TPY-6A soil tester.

2.5 Technology roadmap

The technology roadmap is shown in Figure 2-1.

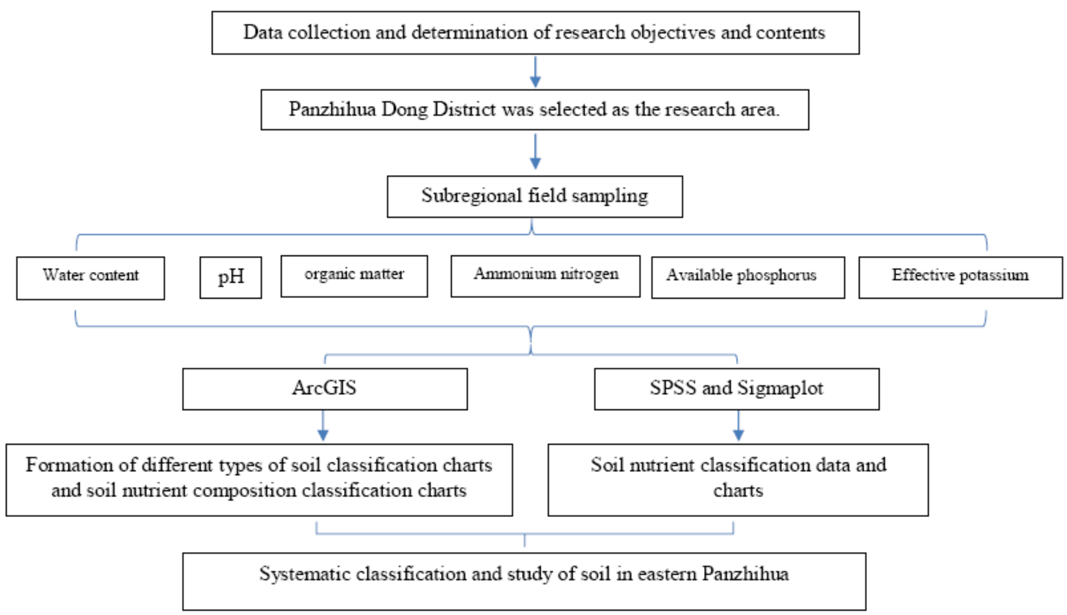


Figure 2-1 Technology Roadmap

2.5 Data processing

The original data is processed by excel.

The sorted data are input into SPSS for data processing, and one-way ANOVA is used to calculate the average value and standard deviation to find the same subset for labeling.

According to the results, the single factor classification map was drawn in Sigma plot. Different lowercase letters were used to indicate the significant difference of soil samples at $P < 0.05$ level. The nutrient composition map of the Dong District was drawn by ArcGIS.

III. RESULTS AND DISCUSSIONS

3.1 Data aggregation

The table of soil nutrient composition in Panzhihua Dong District is shown in Table 3-1.

Table 3-1 Nutritional Composition Table of Soil in Dong District

Number	Sampling sites	Soil type	Water content（%）	pH	Organic matter（%）
1	Yingjiang	Brown soil	15.52±0.91c	6.49±0.05a	1.7±0.1ab
2	Panzhihua Park	Yellow brown soil	13.24±4.23c	7.09±0.02b	1.71±0.08ab
3	Airport Road	Stone-bone soil	1.49±0.09ab	7.35±0.04b	1.88±0.15ab
4	Airport Road	Lateritic red soil	0.08±0.03a	7.75±0.07c	1.59±0.07a
5	Baoanying Airport	Forest mossy soil	3.97±0.21ab	7.73±0.02c	1.84±0.01ab
6	Ashuda	Yellow soil	1.57±0.17ab	7.3±0.05b	1.59±0.09a
7	Xiao Panzhihua	Black sand soil	0.73±0.07ab	6.39±0.05a	2±0.12ab
8	Nongnongping	Red soil	5.44±1.87b	7.75±0.09c	2.06±0.09b
9	Dadukou	Dark brown soil	4.68±0.57ab	6.67±0.19a	1.94±0.08ab
10	Xiangyangcun	Black sandy soil	0.07±0.02a	6.66±0.12a	1.93±0.22ab
11	Wudaohe Zhujiabaobao	Mine sample	0.03±0.01a	6.62±0.08a	1.64±0.14a
Number	Sampling sites	Soil type	Ammonium nitrogen（mg/Kg）	Available phosphorus（mg/Kg）	Effective potassium（mg/Kg）
1	Yingjiang	Brown soil	7.47±1.32a	30.6±1.3e	211±8.29f
2	Panzhihua Park	Yellow brown soil	26.53±2.64c	17.93±4.81d	44.67±2.05c
3	Airport Road	Stone-bone soil	16.53±0.66b	11.47±0.82bc	145±4.32e
4	Airport Road	Lateritic red soil	7.07±1.15a	14.53±1.39cd	11.67±2.36a
5	Baoanying Airport	Forest mossy soil	9.4±1.41a	13.8±0.85cd	12.67±2.05a
6	Ashuda	Yellow soil	9.8±1.23a	8.67±0.52abc	14.33±0.94a
7	Xiao Panzhihua	Black sand soil	17.53±1.84b	5.47±0.5a	282.67±4.5g
8	Nongnongping	Red soil	8.13±0.38a	13.47±0.9cd	69.33±3.3d
9	Dadukou	Dark brown soil	7.87±0.38a	4.27±0.5a	29.33±2.36b
10	Xiangyangcun	Black sandy soil	22.47±0.47c	6.93±0.34ab	34.33±2.36bc
11	Wudaohe Zhujiabaobao	Mine sample	5.47±0.66a	3.67±0.29a	43.33±5.19bc

Note: Average±standard deviation (n=3). Different lower-case letters in the same column showed significant differences at the level of $P < 0.05$.

3.2 Schematic map of soil system classification in Dong District

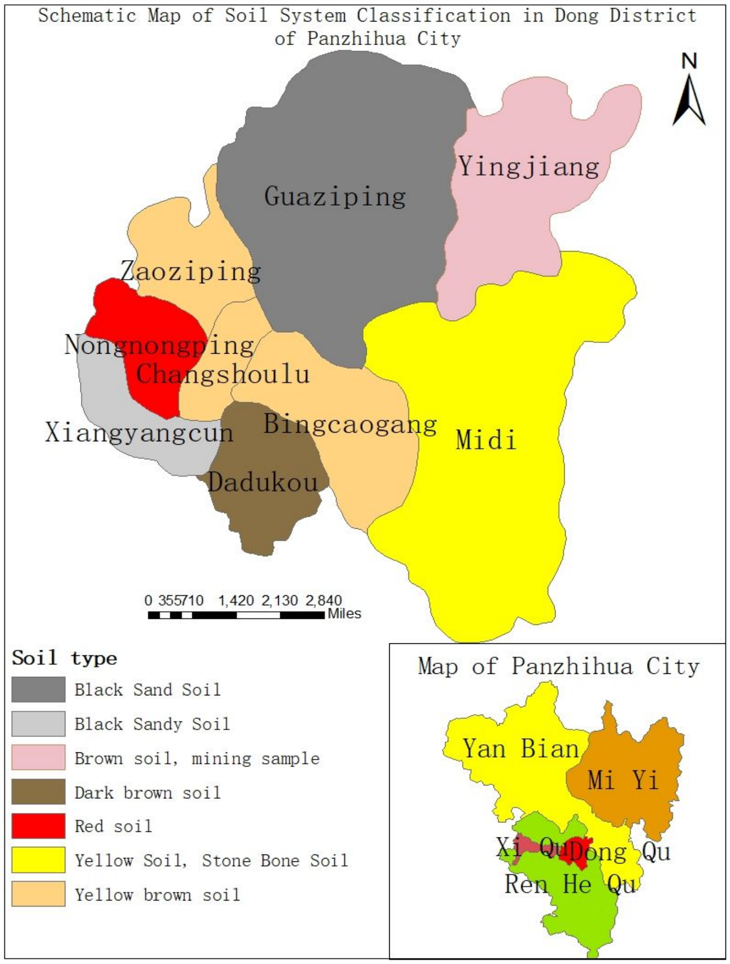


Figure 3-1 Schematic map of Soil Taxonomy in Dong District of Panzhihua City

In this research, 11 different types of soil samples were collected in Panzhihua Dong District. According to the street distribution of Panzhihua Dong District, the soil system classification map of Panzhihua Dong District was drawn. See Figure 3-1, and the soil of Panzhihua Dong District was systematically classified. Details of soil classification in the Dong District of Panzhihua are shown in Table 3-2.

Table 3-2 Soil Classification Table of Township in Dong District

Town name	Soil type
YinJiang	Brown Soil, Mine Sample
Bincaogang	Yellow brown soil
Changshoulu	Yellow brown soil
Zaozhiping	Yellow brown soil
Midi	Yellow Soil, Forest Bryophytic Soil, Stone Bone Soil and Laterite Red Soil
Guaziping	Black Sand Soil
Nongnongping	Red soil
Dadukou	Dark brown soil
Xiangyangcun	Black Sandy Soil

Two kinds of soils were collected in Yinjiang Town, so mixed soil sample parameters were used to represent the soil parameters of Yinjiang Town and a variety of soils were collected in Midiqiao Street. Therefore, mixed soil sample parameters were used to represent the soil parameters of Midiqiao Street to draw the soil system classification map and nutrient content map.

3.3 Nutrient Content Map of Soil System in Dong District of Panzhihua City

Soil nutrient maps and single factor analysis maps of nutrient components were drawn by Sigmaplot, SPSS, ArcGIS and other software. Different lowercase letters in the maps showed significant differences at the level of $P < 0.05$.

3.3.1 Analysis of Soil Water Content

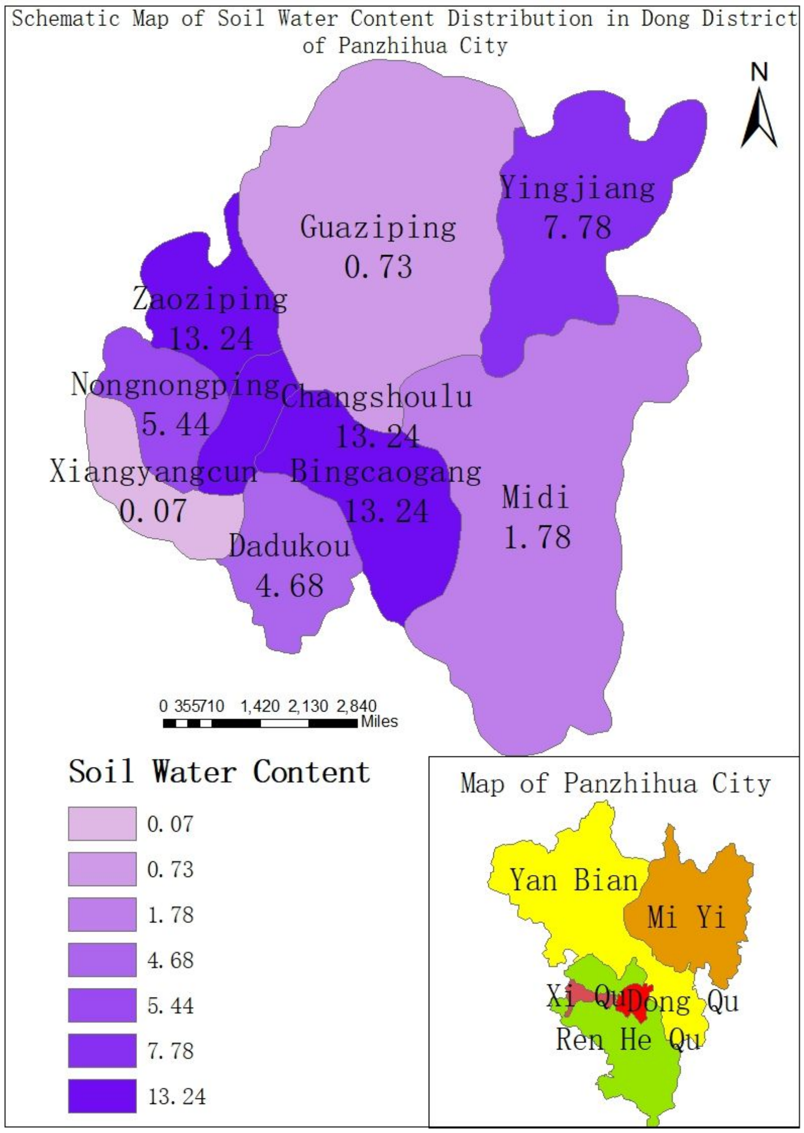


Figure 3-2 Schematic map of Soil Water Content (%) Distribution in Dong District of Panzhihua City

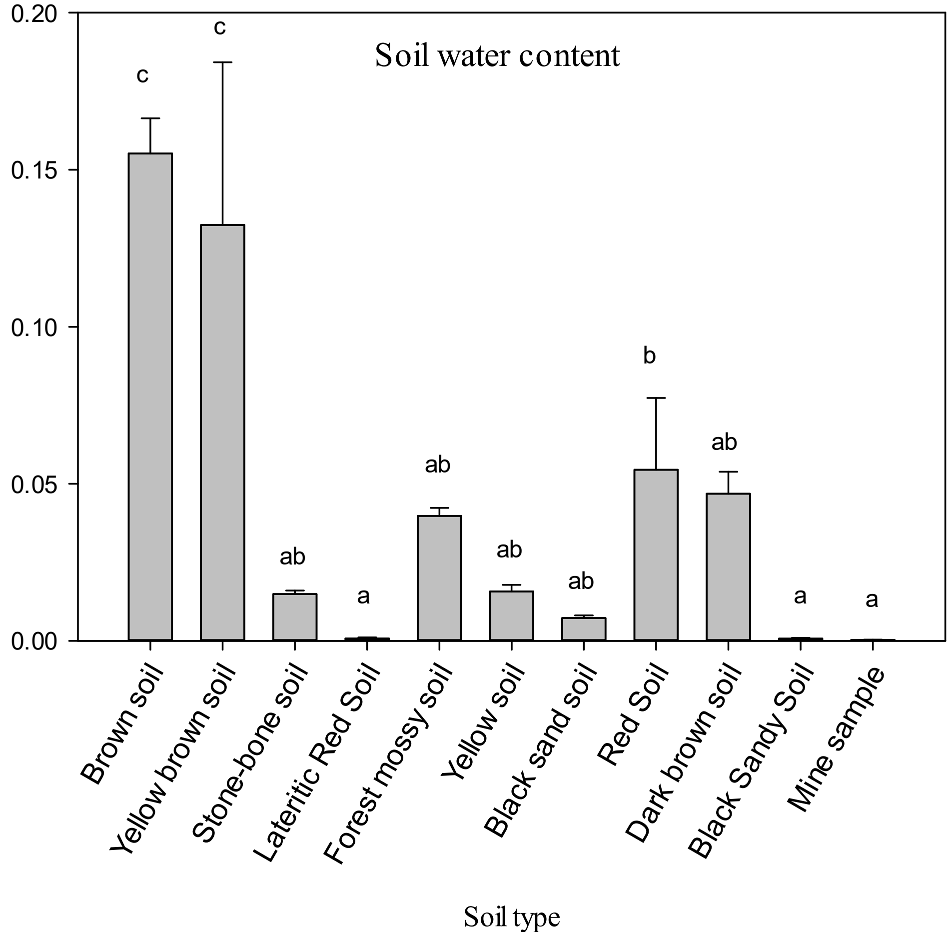


Figure 3-3 Soil water content one way ANOVA analysis graph

Table 3-4 Soil water content (%) classification

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

From the analysis of Figure 3-3, it can be seen that the soils in the Dong District can be roughly divided into four distinct types according to their water content. Among them, lateritic red soil, black sandy soil and mining soil belong to category a, and their water content is low; while stone bone soil, forest moss soil, yellow soil, black sandy soil and dark brown soil belong to category ab. The water content of red soil belongs to type b, which is much higher than that of type a, and the water content of different soil samples fluctuates greatly. The water content of brown soil and yellow-brown soil belongs to type C is much more varied than that of other soils, which may be due to the high air humidity or the rainfall.

Combining Figure 3-2 with Table 3-4, it can be found that the soil with high water content in the Dong District of Panzhihua City is located in Zaoziping Street, Changshou Road Street, Bingcaogang Street and Yinjiang Town. Considering only soil types, it can be found that only the water content of brown soil is higher than 15% in 11 different types of soils, while the water content of most other soils is less than 15%. 5%, even the soil moisture content is less than 1%.

Although Panzhihua City has abundant rainfall, the rainfall period is too concentrated to maintain the moisture content of most soil for a long time. The annual average sunny day is about 240 days, rainy day is about 60 days, cloudy day is about 65 days, and the annual average total solar radiation is about 632100 JW/sq cm, forming a unique high temperature area.

3.3.2 Soil acidity and alkalinity analysis

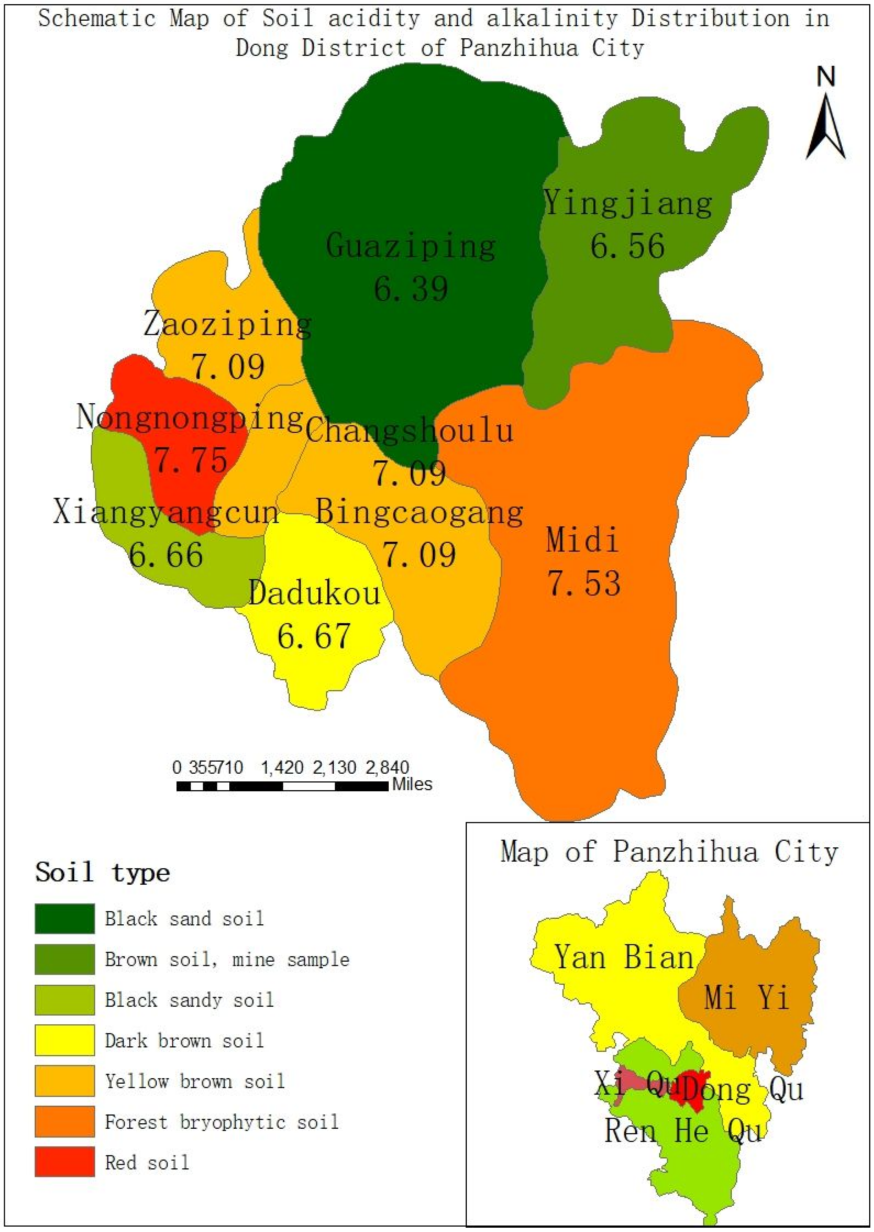


Figure 3-4 Schematic Map of Soil acidity and alkalinity Distribution in Dong District of Panzhihua City

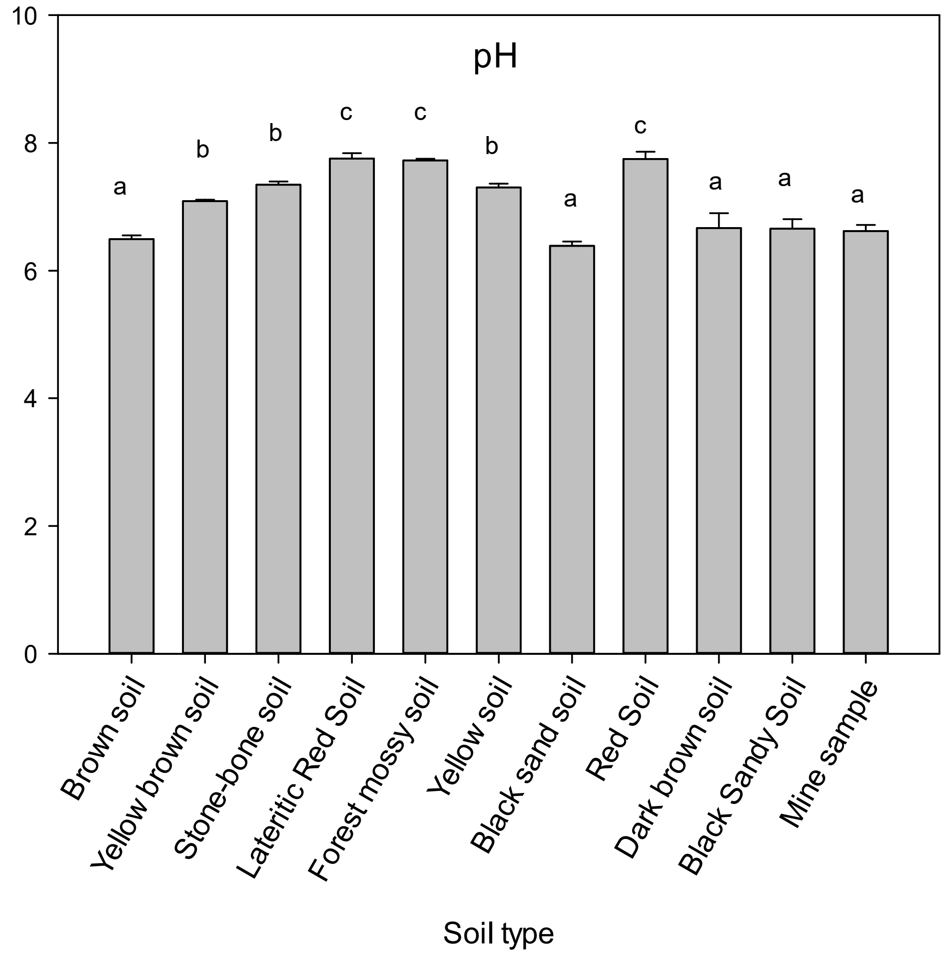


Figure 3-5 Soil pH one way ANOVA analysis graph

Table 3-5 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 the analysis of Figure 3-5, it can be seen that the soils in the Dong District of Panzhihua can be roughly divided into three distinct types according to their acidity and alkalinity. Among them, brown soil, black sand soil, dark brown soil, black sand soil and mine samples belong to category a, while yellow brown soil, stone-bone soil and yellow soil belong to category b, while lateritic red soil, forest moss soil and red soil belong to category C.

Combining Figure 3-4 and Table 3-5, it is found that the soil pH of Midi Street in Panzhihua Dong District is 7.53, and that of Nonglongping Street is 7.75, which belongs to weak alkalinity. The other street pH values are between 6.5 and 7.5, which belong to neutral soil.

Most of the soils in the Dong District of Panzhihua belong to neutral soils.

Neutral soil is more conducive to the growth of most plants. For the weak alkaline soil in the Dong District of Panzhihua, the following measures can be taken to control its pH to make it more suitable for plant growth.

Adding a small amount of aluminium sulfate, ferrous sulfate, sulfur powder, humic acid fertilizer, etc. Pouring some diluted water of ferrous sulfate or aluminium sulfate can increase the acidity of the soil. Humic acid fertilizer can adjust the acidity and alkalinity of soil because it contains more humic acid.

Sulfur powder has a slow but lasting effect; phosphorus fertilizer should be supplemented when aluminium sulfate is applied; ferrous sulfate has a quick effect, but its action time is not long, so it needs to be applied regularly.

3.3.3 Analysis of Soil Organic Matter

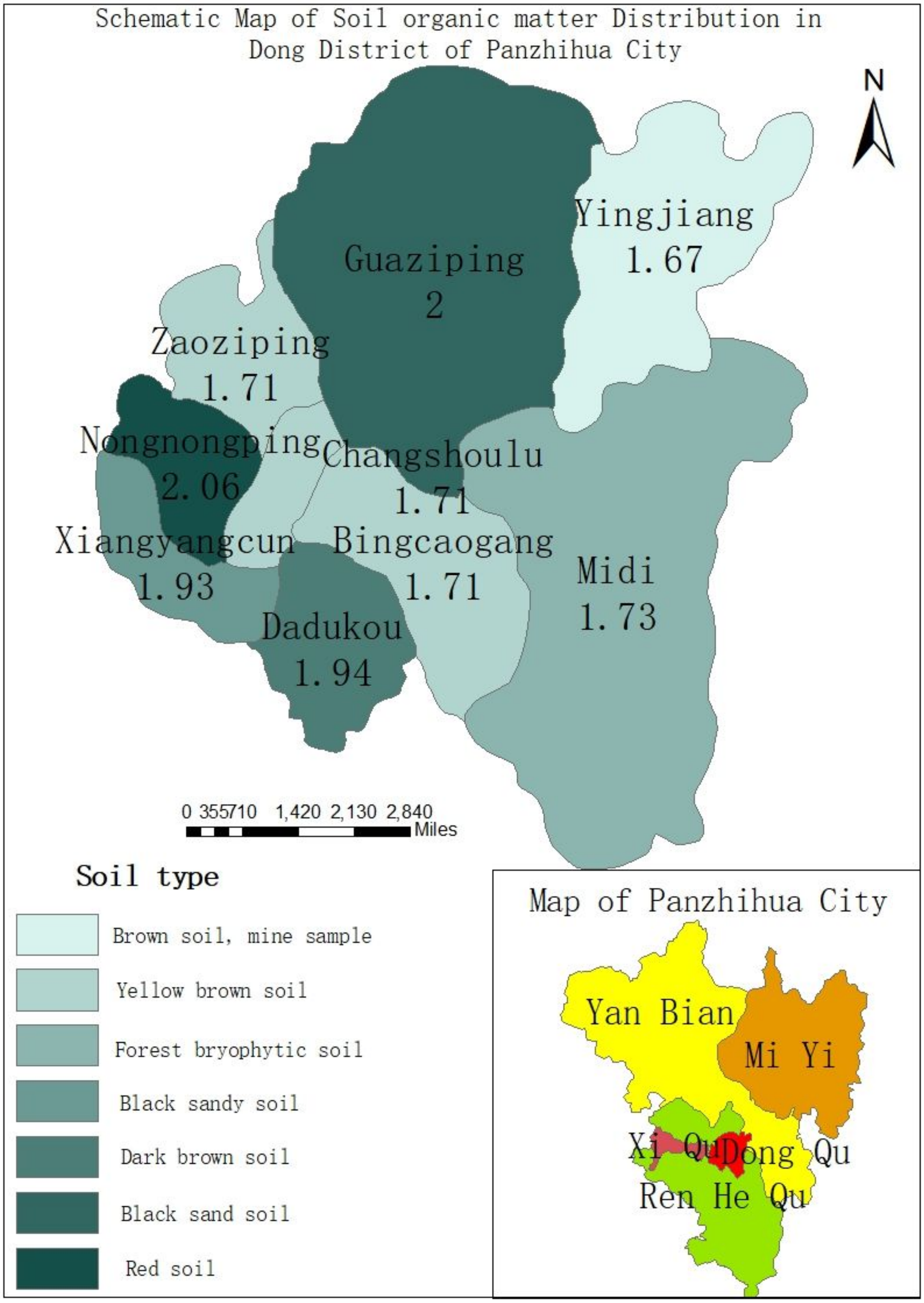


Figure 3-6 Schematic Map of Soil organic matter (%) Distribution in Dong District of Panzhihua City

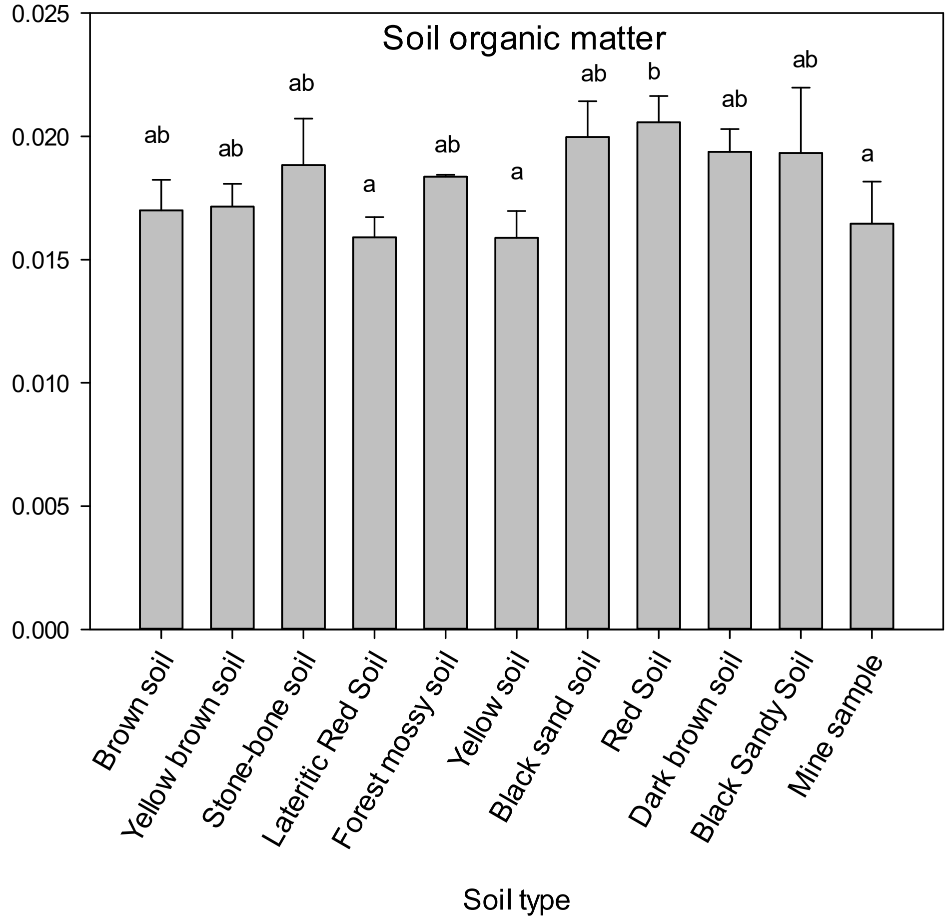


Figure 3-7 Soil organic matter one way ANOVA analysis graph

Table 3-6 Soil organic matter (%) grade

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

From the analysis of Figure 3-7, it can be seen that the soils in Dong District of Panzhihua City can be roughly divided into three distinct types according to the content of organic matter, among which lateritic red soil, yellow soil and mine samples belong to category A and their organic matter content is relatively low, while brown soil, yellow brown soil, stone bone soil, forest moss soil, black sandy soil, dark brown soil and black sandy soil belong to category a. The content of organic matter in the red soil belongs to C, and the content of organic matter in the red soil is the highest.

Combining Figure 3-6 and Table 3-6, it is found that the content of soil organic matter in the Dong District of Panzhihua City mostly belongs to 1%~2%, which belongs to the middle-lower level, while that in the LANGPING street is 2.06%, which belongs to the middle-upper level. On the whole, it seems that the content of soil organic matter in the Dong District of Panzhihua City belongs to the middle-lower level.

Soil organic matter is supplemented by adjusting soil organic matter in Dong District. One of the ways is crop rhizome and root exudates and aboveground debris, mainly through crop rotation and cultivation; the other is to use organic materials to fertilize the soil. This is the most significant way to fertilize, called "fertilization". Organic fertilization of soil. In order to improve soil organic fertility, it is necessary to apply organic materials scientifically. When the main nutrient supply is nutrient supply, organic materials such as green manure, human manure and urine, which are easy to decompose in a short time and small in C/N ratio, should be composted or combined with nitrogen fertilizer for organic materials which are not easy to decompose and large in C/N ratio, and straw, manure and other organic materials with large C/N ratio and high humification coefficient should be selected for the main purpose of improving soil structure and improving basic fertility. Organic materials are not suitable for composting.

3.3.4 Analysis of Ammonium Nitrogen

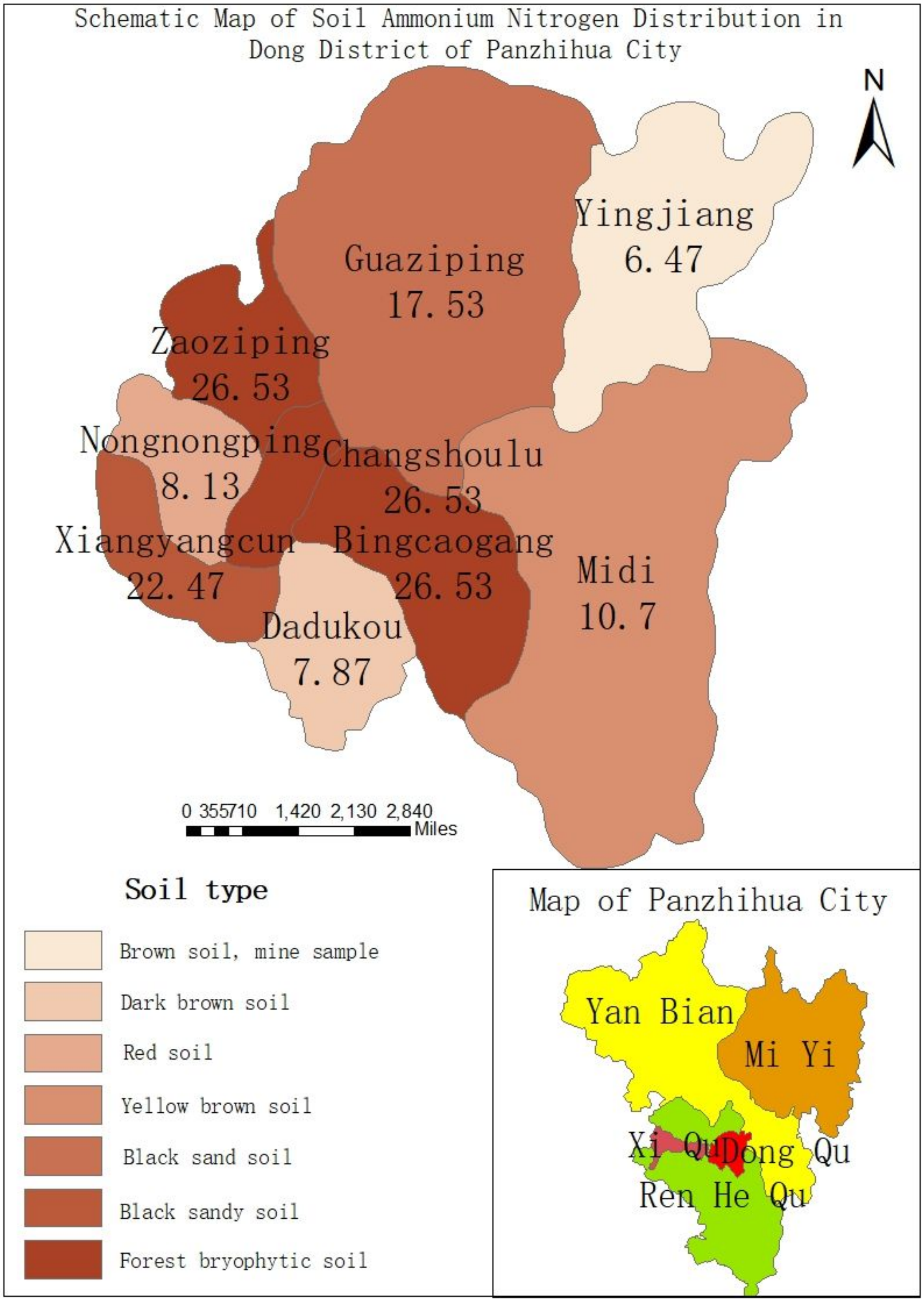


Figure 3-8 Schematic Map of Soil Ammonium Nitrogen (mg/Kg) Distribution in Dong District of Panzhihua City

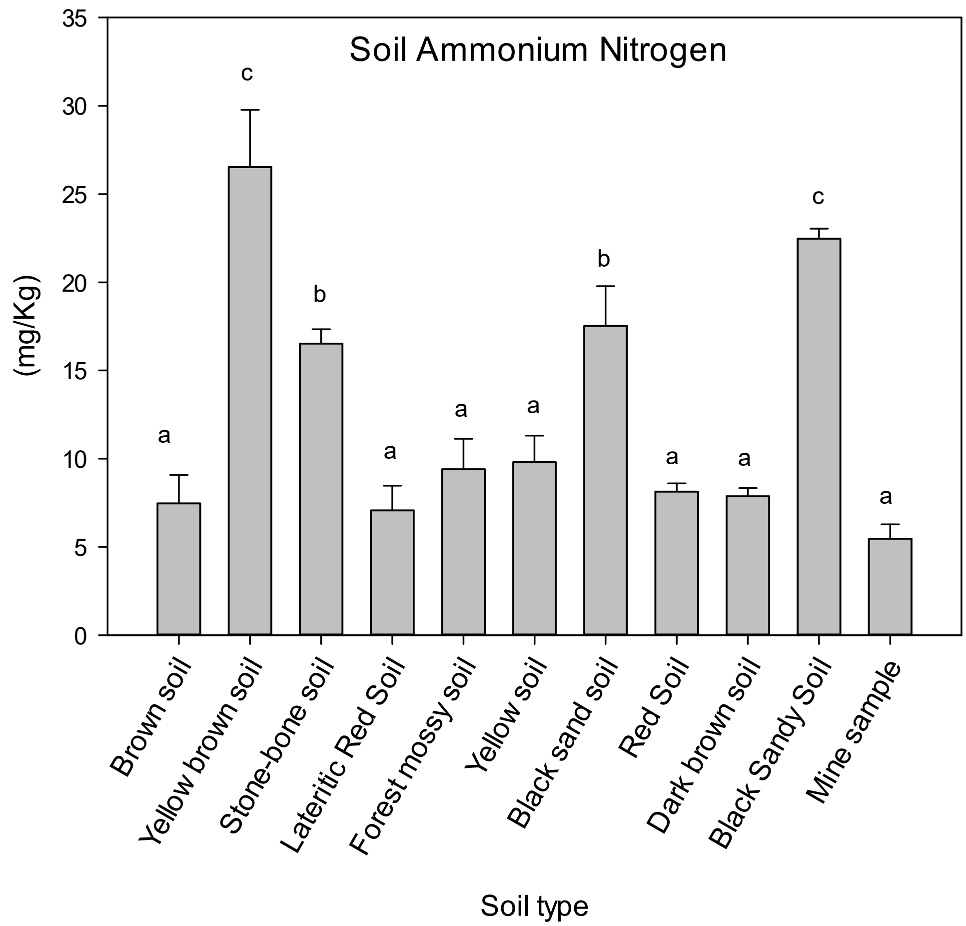


Figure 3-9 Soil Ammonium Nitrogen one way ANOVA analysis graph

Table 3-7 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 the analysis of Figure 3-9, it can be seen that the soil in the Dong District of Panzhihua can be roughly divided into three distinct types according to the content of ammonium nitrogen: brown soil, lateritic red soil, forest bryophyte soil, yellow soil, red soil, dark brown soil and mine samples belong to category a, and the content of ammonium nitrogen is lower; while black sand soil and stone soil belong to category b; while yellow brown soil, yellow brown soil, yellow soil, yellow soil, red soil, red soil, dark brown soil and Black sandy soil belongs to category C.

Combining Figure 3-8 and Table 3-7, it is found that the highest content of soil ammonium nitrogen in the Dong District of Panzhihua City is 26.53 mg/kg, which is less than 30 mg/kg. On the whole, the content of soil ammonium nitrogen in the Dong District of Panzhihua City is relatively low. Appropriate measures can be taken to improve the content of soil ammonium nitrogen. Therefore, green manure should be actively developed, organic manure and nitrogen fertilizer should be increased, but not. Only when crop nitrogen requirements are met can high yield be obtained.

Nowadays, nitrogen fertilizer can be divided into three types: ammonium nitrogen fertilizer, nitrate nitrogen fertilizer and nitrate and ammonium nitrogen fertilizer.

Ammonium nitrogen is forbidden to be used in greenhouse vegetables. When ammonium nitrogen volatilizes, it will cause damage to crops, but nitrate nitrogen will not. However, nitrate nitrogen should not be used in paddy fields, because nitrate nitrogen is very soluble in water, resulting in great loss. So nitrate nitrogen is more suitable for arid land, and nitrate nitrogen can also play a role in winter when the temperature is low.

In Panzhihua City, where the temperature is higher and most of the soil moisture content is lower, it is more appropriate to apply nitrate nitrogen fertilizer.

3.3.5 Analysis of Available Phosphorus

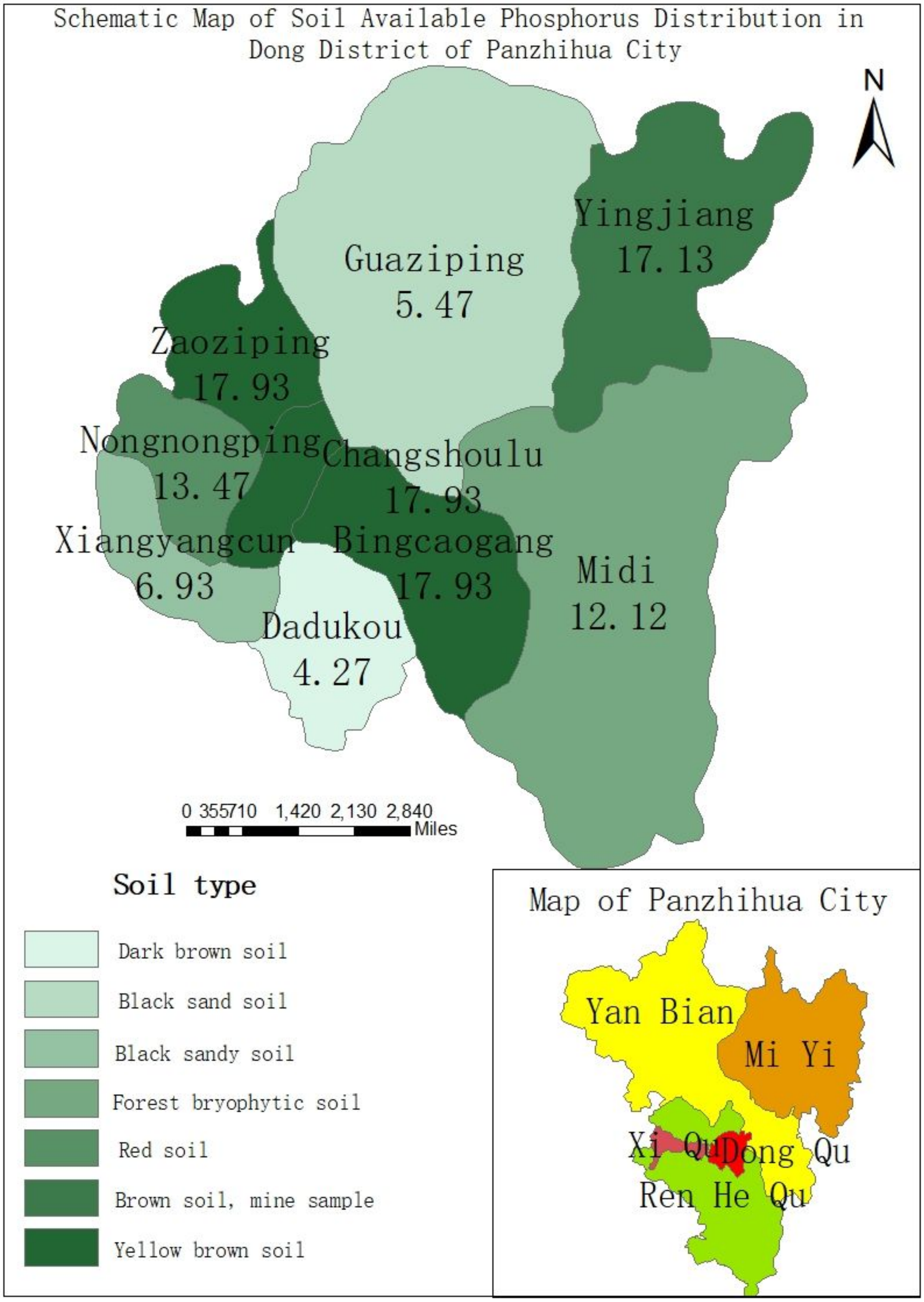


Figure 3-10 Schematic Map of Soil Available Phosphorus (mg/Kg) Distribution in Dong District of Panzhihua City

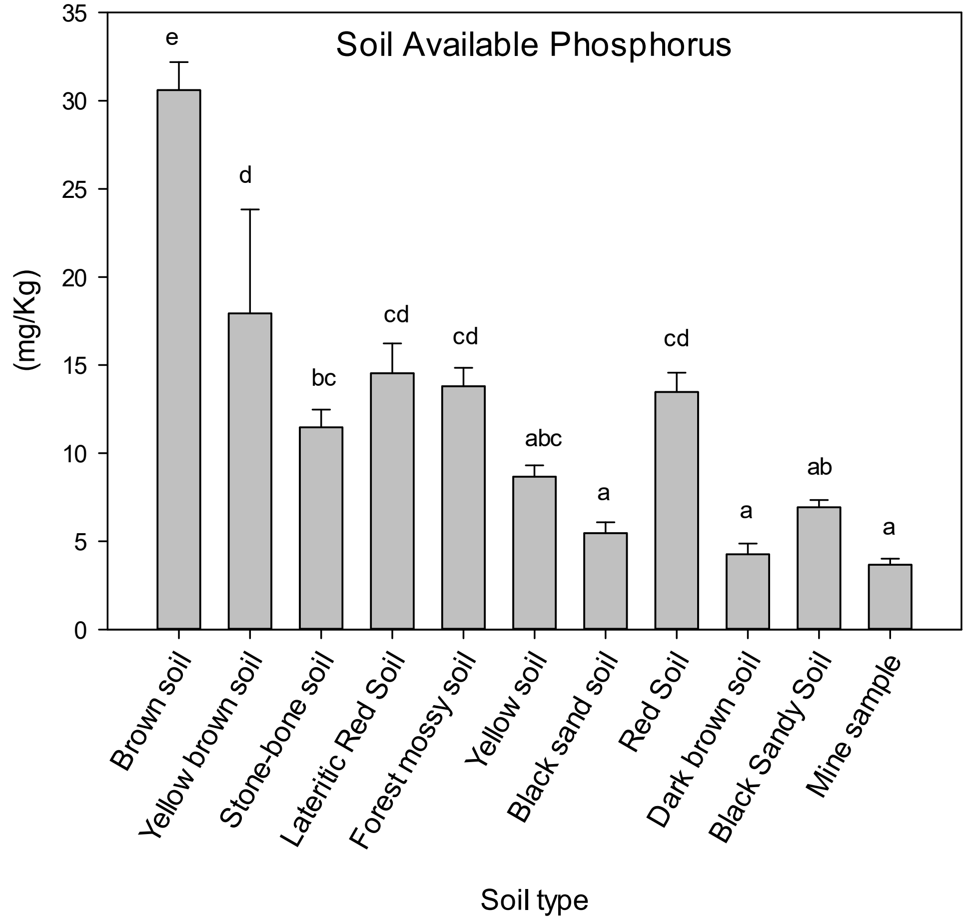


Figure 3-11 Soil Available Phosphorus one way ANOVA analysis graph

Table 3-8 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	20~39	10~19	5~9	3~4	＜3

From the analysis of Figure 3-11, it can be seen that the soils in Dong District can be roughly divided into seven distinct types according to the content of available phosphorus. Among them, black sandy soil, dark brown soil and mine samples belong to category a; black sandy soil belongs to category ab; stone-bone soil belongs to category bc; yellow soil belongs to category abc; red soil, forest moss soil and red soil belong to category CD brown; Soils belong to category D; yellow brown soils belong to category D.

Combined with Figure 3-10 and Table 3-8, it was found that the soil available phosphorus content of Dadukou Street in Panzhihua Dong District was 4.27mg/Kg, lacking of available phosphorus; the soil available phosphorus content of Guaziping Street was 5.47 mg/Kg, and that of Xiangyang Village Street was 6.93 mg/Kg, belonging to the middle and lower levels; while the soil available phosphorus content of other streets was between 10 and 19, belonging to the middle and lower levels. In general, the content of available phosphorus in the Dong District of Panzhihua belongs to the upper and middle level.

For general soil, the content of available phosphorus should be in the range of 10-20 mg/Kg, but the content of available phosphorus in soil samples collected in the Dong District of Panzhihua City is less than 10%, which is not conducive to plant growth.

Vegetation can improve the content of available phosphorus in soil, improve soil structure and microbial activity, activate phosphorus elements in soil, promote the relationship between carbon and nitrogen cycle, and increase available phosphorus in soil. It is worth advocating [16].

3.3.6 Analysis of Effective Potassium

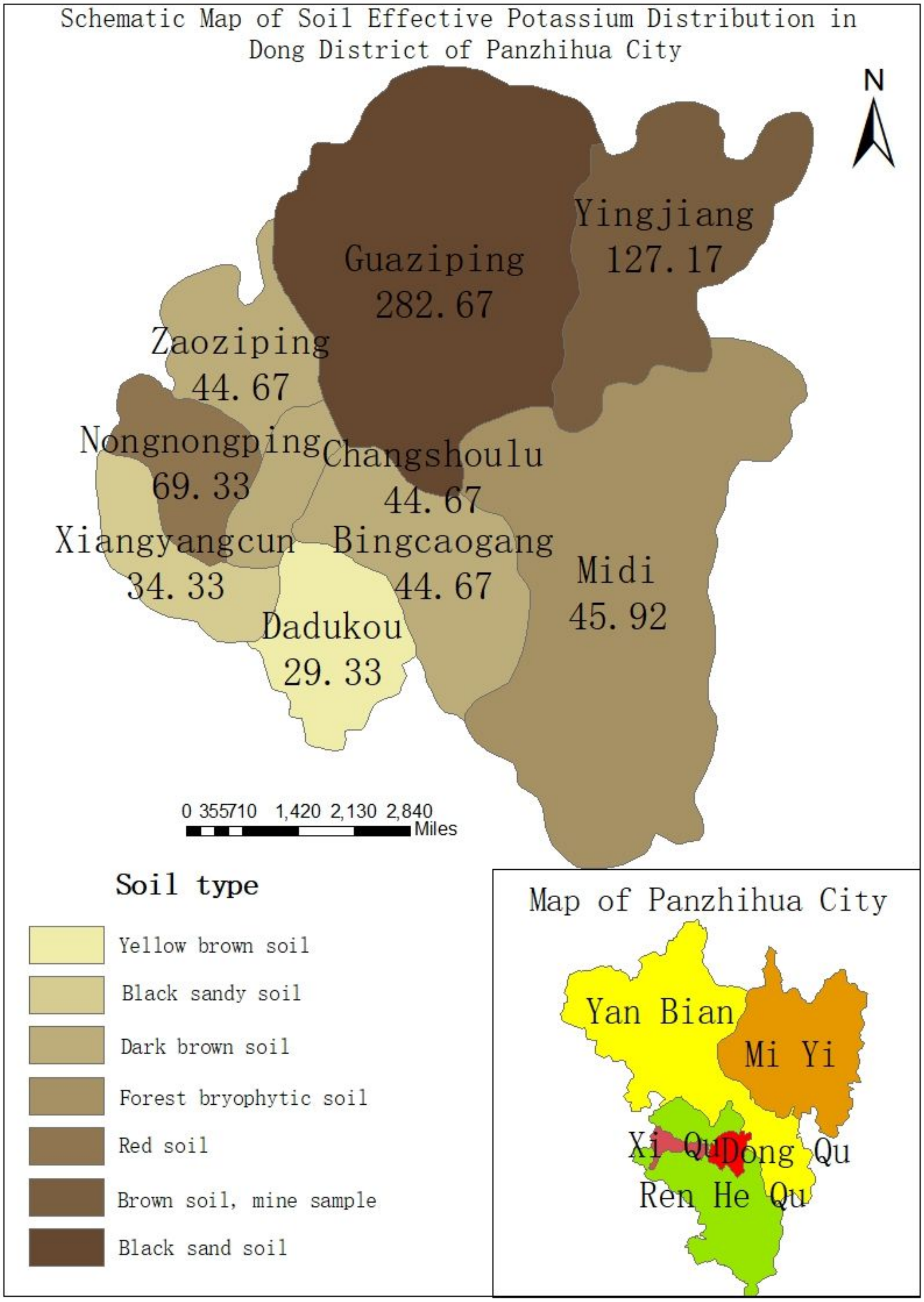


Figure 3-12 Schematic Map of Soil Effective Potassium (mg/Kg) Distribution in Dong District of Panzhihua City

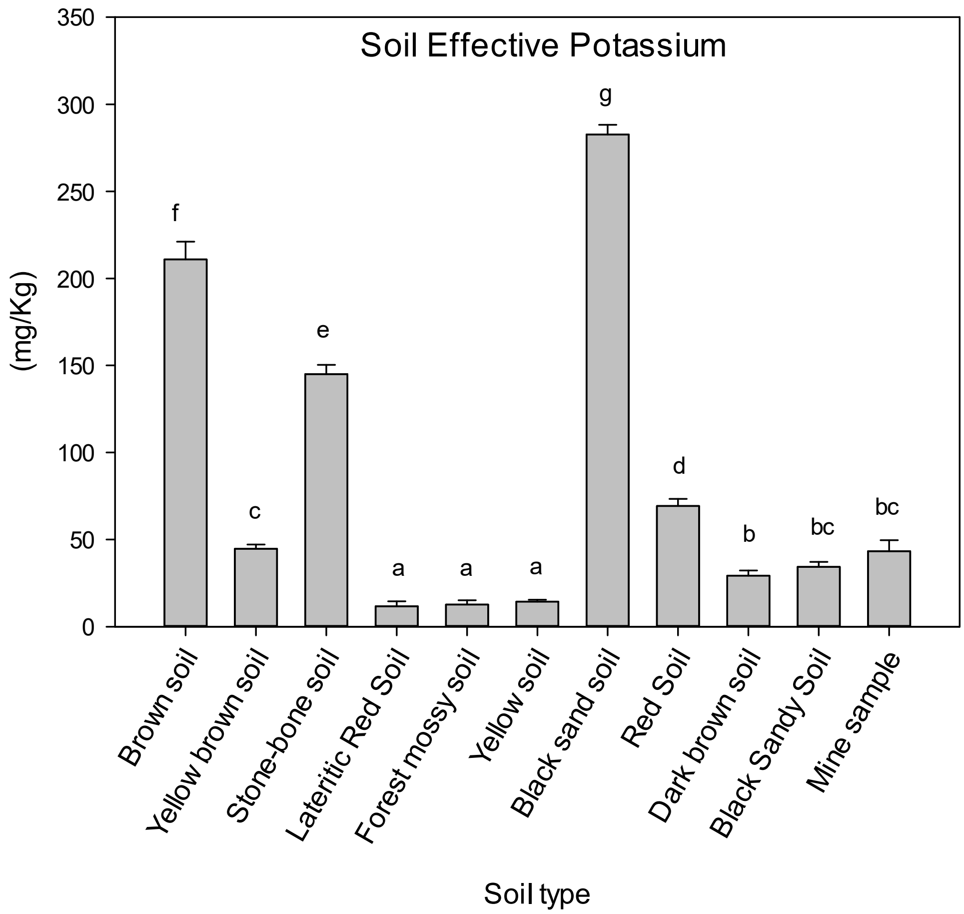


Figure 3-13 Soil Effective Potassium one way ANOVA analysis graph

Table 3-9 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	150~149	100~149	50~99	30~49	＜30

From the analysis of Figure 3-13, it can be seen that the soils in Dong District can be roughly divided into eight distinct types according to the content of available phosphorus, among which lateritic red soil, forest mossy soil and yellow soil belong to category a; dark brown soil belongs to category b; black sandy soil and mine samples belong to category B c; yellow brown soil belongs to category c; red soil belongs to category d; stone-bone soil belongs to category E. Brown soil belongs to f and black sand soil belongs to g.

Combining Figure 3-12 and Table 3-9, it is found that the soil available potassium content in Dadukou Street is less than 30 mg/kg, and the soil available potassium content in Xiangyangcun Street, Zaoziping Street, Changshou Road Street, Bingcaogang Street and Midiqiao Street is between 30 mg/kg and 40 mg/kg, and the soil available potassium content in Nongping Street is 69.3. The soil available potassium content in Yinjiang Town was 127.17 mg/Kg, belonging to the upper and middle level, and the soil available potassium content in Guaziping Street was 282.67 mg/Kg, which was very rich.

In summary, the content of available potassium in soil varies greatly. The crops sensitive to potassium and potassium fertilizer can be solved by increasing organic fertilizer and plant ash.

When the content of potassium in soil is low, the soil has a high sensitivity to potassium fertilizer. Therefore, potassium fertilizer can not be used in a large number of soils with low content of potassium, but its sensitivity to potassium fertilizer will be reduced to a certain extent when the content of potassium increases. Potassium fertilizer should also be used to maintain the dynamic balance of potassium when the content of potassium in soil is appropriate.

3.4 Analysis of Soil Fertility

Radar maps are drawn by using organic matter content, ammonium nitrogen content, available phosphorus content, available potassium content and water content in soil nutrients. Due to the different ranges of data, the following transformations can not be directly quoted from the data:

The range of water content (%) is 0-20. All data multiplied by 1.5 range becomes 0-30.

The range of organic matter content (%) is 0-3. All data multiplied by 10 ranges change to 0-30.

The range of ammonium nitrogen content (mg/Kg) is 0-29, which need not be changed.

The range of available phosphorus content (mg/Kg) is 0-33, which need not be changed.

Available potassium content (mg/Kg) ranged from 0 to 290. All data divided by 10 ranges changed to 0-29.

Table 3-10 Soil Fertility Data Table

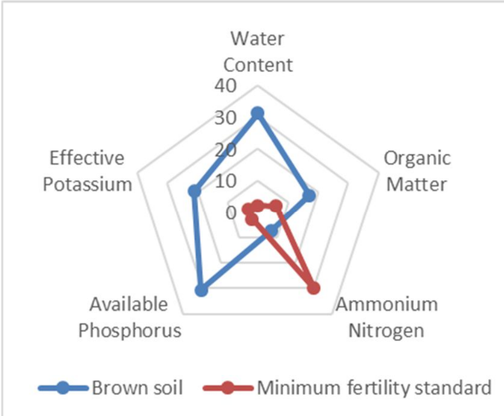
	Soil sample 1	Soil sample 2	Soil sample 3	Average
Brown soil	9.51	8.9	8.52	8.98±0.41h
Yellow brown soil	6.68	6.72	7.28	6.89±0.27g
Stone-bone soil	3.76	3.22	3.58	3.52±0.22f
Lateritic red soil	0.99	1.32	1.02	1.11±0.15ab
Forest mossy soil	1.86	2.4	1.96	2.07±0.23d
Yellow soil	1.27	1.53	1.39	1.4±0.11bc
Black sand soil	2.85	3.56	2.94	3.12±0.32ef
Red soil	3.44	2.58	2.5	2.84±0.43e
Dark brown soil	1.71	1.78	1.58	1.69±0.08cd
Black sandy soil	2.89	2.62	3.29	2.93±0.28e
Mine sample	0.48	0.63	0.71	0.61±0.1a

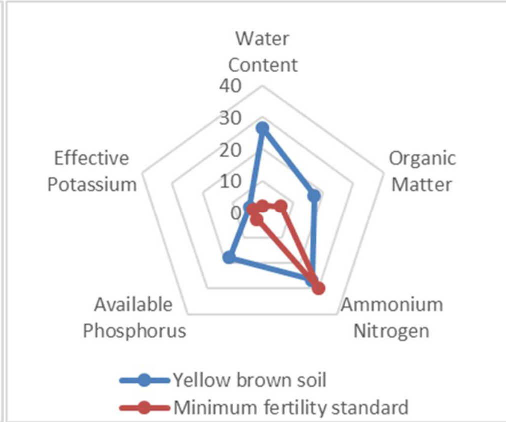
Note: The data in the fertility data table are drawn from the data of water content, organic matter, ammonium nitrogen, available phosphorus and available potassium of the sample after changing the range. The calculated data are drawn from the radar plot calculation area, and table 3-10 is obtained from the one-way ANOVA of the calculated data.

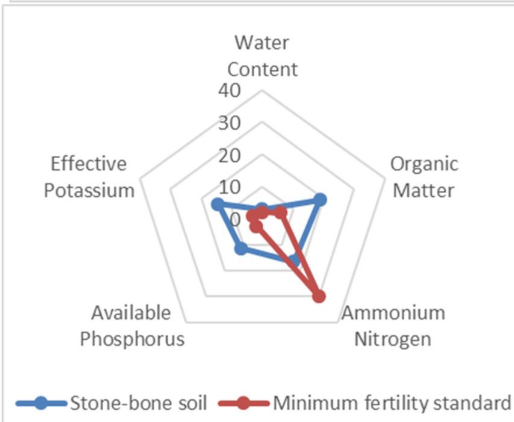
Radar maps of soil fertility are drawn from the average nutrient content of different types of soils as shown in Fig. 3-14 and Fig. 3-15.

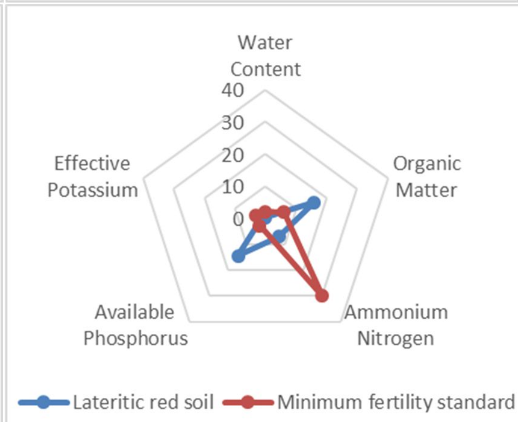
From the data table of soil fertility in Table 3-10 and the radar maps of soil fertility in Figures 3-14 and 3-15, it can be seen that there is a big fertility gap among 11 different soils collected in the Dong District of Panzhihua, among which the high fertility of brown soil and yellow-brown soil is suitable for planting crops.

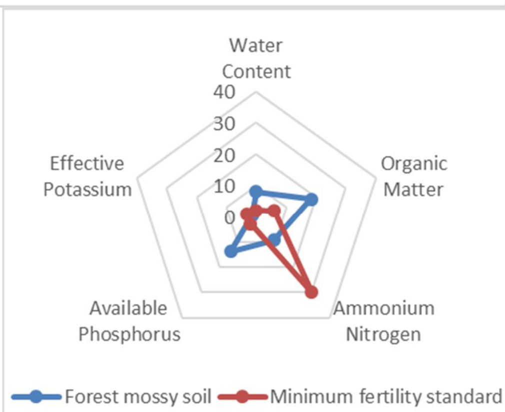
Compared with Figure 3-1, most of the soil with high fertility was found in Zaoziping Street, Nonglongping Street, Bingcaogang Street and Midi Street.

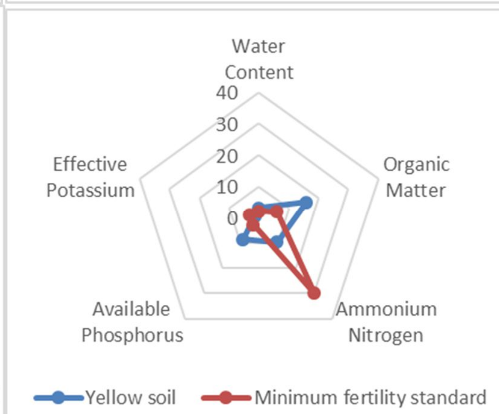

Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Brown soil
Minimum fertility standard

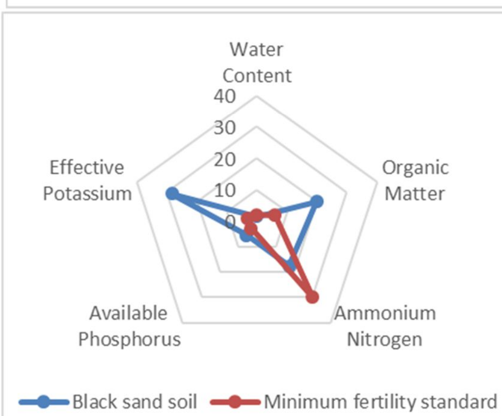

Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Yellow brown soil
Minimum fertility standard

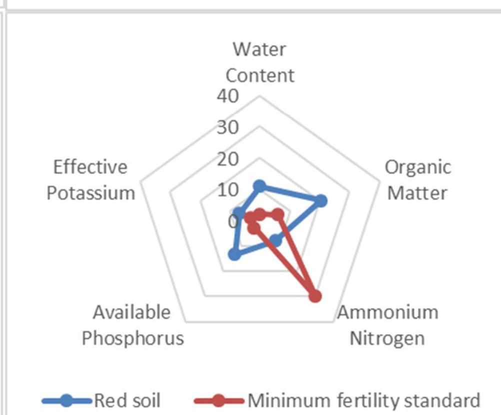

Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Stone-bone soil
Minimum fertility standard


Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Lateritic red soil
Minimum fertility standard


Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Forest mossy soil
Minimum fertility standard


Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Yellow soil
Minimum fertility standard


Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Black sand soil
Minimum fertility standard


Water Content
40
30
20
10
0
Organic Matter
Ammonium Nitrogen
Available Phosphorus
Effective Potassium
Red soil
Minimum fertility standard

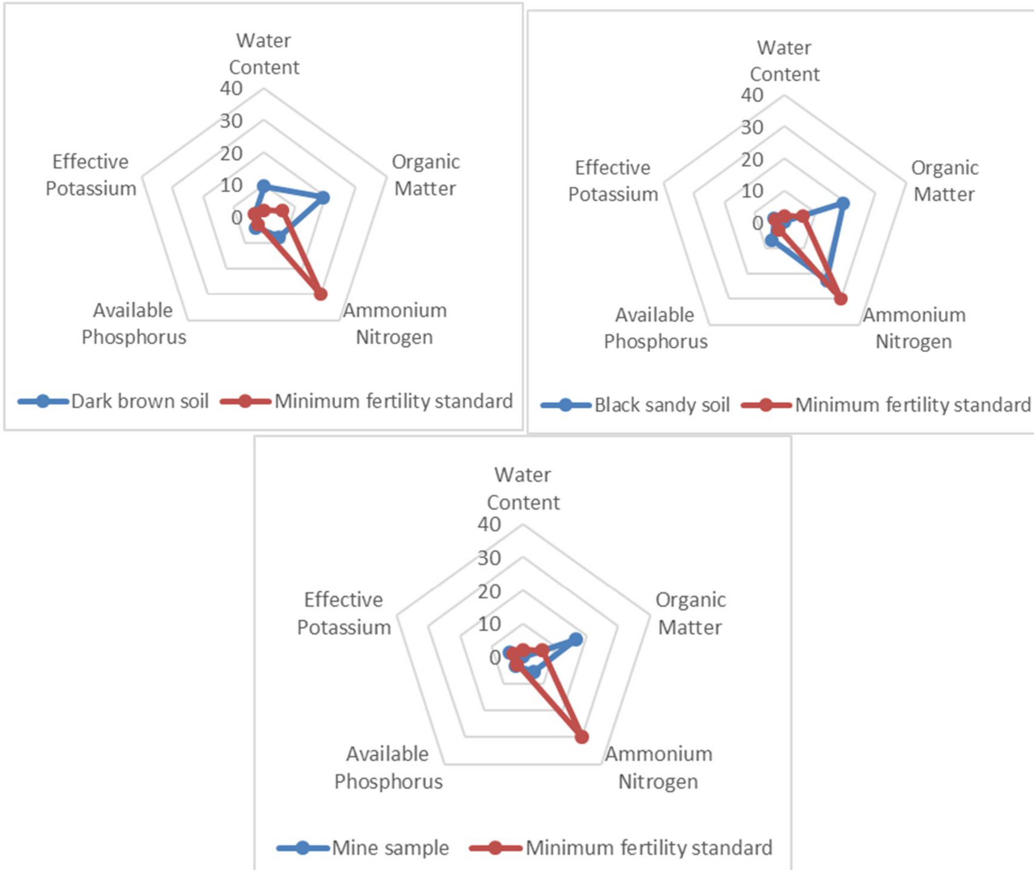


Figure 3-14 Soil Fertility Radar Map

IV. CONCLUSIONS

Through data analysis, the following conclusions can be drawn in this research:

(1) The water content in the Dong District of Panzhihua is quite different, and the distribution of precipitation is not uniform. Most of the soil water content in Panzhihua is at a low level due to the hot weather.

(2) Most of the soils in the Dong District of Panzhihua City are neutral soils, and there is no acidic or alkaline soil which has little effect on the availability of soil nutrients and will not affect the activities of most soil microorganisms, thus providing a good environment for crop growth.

(3) The soil organic matter content in the Dong District of Panzhihua belongs to the medium level, which has little effect on crops.

(4) The content of ammonium nitrogen in the soil in the Dong District of Panzhihua is relatively low. Appropriate measures should be taken to increase the content of ammonium nitrogen in the soil so as to provide better living conditions for crop growth.

(5) The content of available phosphorus in the Dong District of Panzhihua is mostly in the upper and middle levels, which is stable compared with other nutrient components.

(6) The content of available potassium varies greatly in the Dong District of Panzhihua, and the distribution of available potassium is too concentrated. There are extremely deficient available potassium and abundant available potassium. Detailed measures should be taken as soon as possible to improve the content of available potassium in the soil which is extremely deficient in available potassium, such as using potassium fertilizer according to the amount of available potassium fertilizer. Reducing the use of potassium fertilizer and excessive available potassium have adverse effects on crop growth.

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