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Soil Systematic Classification Research of Panlian Town and Other Areas in Miyi County of Panzhihua City

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----------ABSTRACT----------
Soil is the basis of human survival. Scientific classification of soil system and rational use of soil are of great significance to the development of agriculture. Miyi County is a large agricultural county with agriculture, forestry, animal husbandry and fishery as its primary industry. The total planting area of crops is 25 657 hectares. There is no study on Soil Taxonomy in Panxi National Strategic Resources Innovation and Development Pilot Area. Therefore, the study of Soil Taxonomy in Miyi County of Panzhihua City will make up for this gap. Based on the school-level scientific research project, this paper studies the soil taxonomy of Panlian Town, Miyi County, Panzhihua City.

In this experiment, TYP-6A soil nutrient analyzer was used to measure the soil acidity and alkalinity (pH), water content, organic matter, ammonium nitrogen, available phosphorus, available potassium and other nutrients in representative plots of Miyi County. The samples and data were analyzed and compared by Sigmaplot, ARCGIS and SPSS software, and the soil system classification map of Panlian Town, Miyi County, Panzhihua City was obtained. The nutrient content map of soil system and the main nutrient content of representative soil were obtained.

Through scientific and reasonable sampling, experiment and analysis, it is concluded that the organic matter, water content and acidity and alkalinity in the representative plots of Miyi County are all suitable for crop growth, and the contents of a large number of elements, such as ammonium nitrogen, available phosphorus and effective potassium, are relatively low and need to be improved. Overall, it meets the basic requirements of crop growth.

KEYWORDS: Systematic Classification, Soil Composition Water Content, Miyi County

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I. INTRODUCTION

1.1 Background of this research

Soil is the natural resource on which human beings live, and it plays the most active part in the earth's surface system. Soil variability is very high, and it is easy to be affected by various external factors, which are also very complex physical, chemical and biological changes, so it is very difficult to make a scientific and reasonable soil classification (Xiong, 2016; Xiong et al., 2013; Cabrera et al., 2015).

Soil classification represents today's scientific level of soil, provides effective technical support for related land work, and provides a basis for people to protect the environment and use and manage land resources (Xiong et al., 2015).

Soil classification in China has been improved in several aspects and is more referential than before. Nowadays, soil classification in China has clear boundaries and quantitative indicators, and complete automatic retrieval. It has a specific connection with the international classification and has its own characteristics (Madejón et al., 2014; Xiong, 2012).

Compared with other countries, China has a large population and insufficient arable land reserve resources. Soil fertility plays an important role in improving crop yield. Exploring and understanding soil types, using and managing land resources scientifically and effectively, providing information for decision makers and providing technical support for farmers' rational production are major research topics in current soil survey and hot issues in scientific and technological research in the direction of soil classification (Xiong et al., 2012; Zhang et al., 2012; Xiong, 2017).

1.2 Research meaning

Soil is the basis of human survival. Scientific classification of soil system and rational use of soil are of great significance to the development of agriculture. Therefore, soil classification is undoubtedly one of the most important basic studies in soil science. Miyi County is a large agricultural county with agriculture, forestry, animal husbandry and fishery as its primary industry, with a total planting area of 25,657 hectares. There is no study on Soil Taxonomy in Panxi National Strategic Resources Innovation and Development Pilot Area. Therefore, the study of Soil Taxonomy in Miyi County of Panzhihua City will make up for this gap. Based on the school-level scientific research project, this paper studies the soil taxonomy of Panlian Town, Miyi County, Panzhihua City. The scientific, reasonable and rigorous classification of soil system can provide the basis for the study of Panxi area and provide decision-makers with reference.

Land is limited, and all walks of life also have certain requirements for land area, location, etc. Therefore, the importance of land for non-agricultural production is self-evident.

Agricultural production requires more land than other industries. In agricultural production, land is not only the object of labor, but also the best and most important means of labor. Without land, there would be no agricultural production. Agricultural production needs land in a large area, otherwise it is impossible to produce enough agricultural products to meet human needs. This is because, no matter how high the quality of land and the level of cultivation, the productivity of land per unit area is always limited. In the narrow sense, agriculture has very strict requirements for soil, climate, landform, hydrology and other conditions. The varieties, quality and quantity of agricultural production vary greatly from place to place and from quality to quality. Therefore, only certain conditions of land can be suitable for agricultural production. We need to know what kind of soil conditions are suitable for planting what kind of crops, those plants can adapt to different soils, so the classification of soil is very helpful for better use of soil, also for crop selection and crop yield.

It can be seen that nature provides a variety of available land resources for human beings and provides conditions for human activities such as habitation, reproduction, life and production. The development of social productive forces will not reduce the importance of land issues, on the contrary, land has become a major global issue affecting human sustainable development.

Miyi County has not carried out a special soil taxonomy study before, the conclusion of this experiment just filled the gap, providing technical support for the rational development and use of soil and the development of planting technology in Miyi County. To provide technical support for the development direction and decision-making of Miyi County.

II. MATERIALS AND METHODS

2.1 Geographical Location and Administrative Division of the Research Area

Miyi County is located in the southwest of Sichuan Province, in the lower reaches of the Anning River, with latitudes ranging from 26°42′ to 27°10′ in the north and 101°44′ to 102°15′. Miyi County is on the back of Panzhihua, Huili County of Liangshan Prefecture to the east, Yanbian County to the South and Yalong River to the west. Miyi County covers a vast area of 52.2 kilometers from east to west, 73.2 kilometers from north to South and 2153 square kilometers in area. In Miyi County, there are 26 famous ethnic groups and 220,000 people. Among them, the Han nationality is the main population, and the Yi nationality is the secondary population. Miyi County is 80 kilometers away from Panzhihua City. There are mountains, ravines, valleys and basins in the county area. The address is generally high in the north and low in the south.

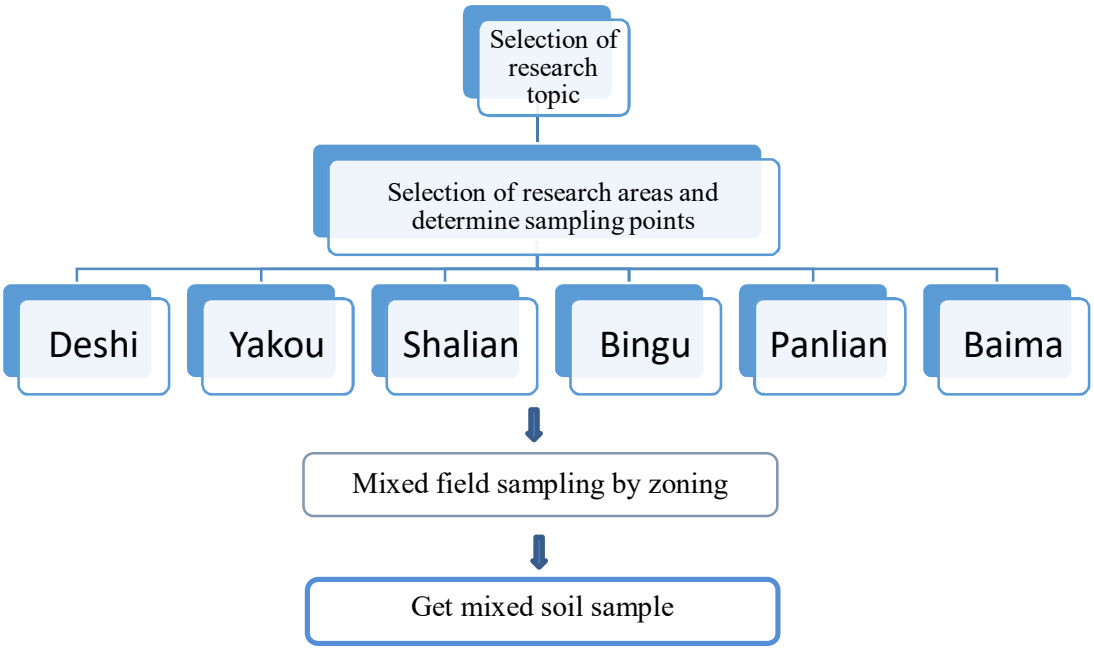
At the end of 2015, Miyi County is divided into seven towns, namely, Panlian Town, Binggu Town, Salian Town, Yakou Town, Deshi Town, Baima Town and Puwei Town. There are five townships, namely, Caochang Township, Malong Yi Township, Baipo Yi Township, Wanqiu Yi Township and Xinshan Lisu Township. There are 12 township-level governments. Miyi County is rich in natural resources, abundant rainwater, mostly night rain, sunny day and long frost-free period throughout the year. It is a well-known land of fish and rice, and a healthy place. Most of the soil types in Miyi County are brown soil, red soil, yellow soil and sandy soil. The soil is rich in potassium and lacks nitrogen and phosphorus.

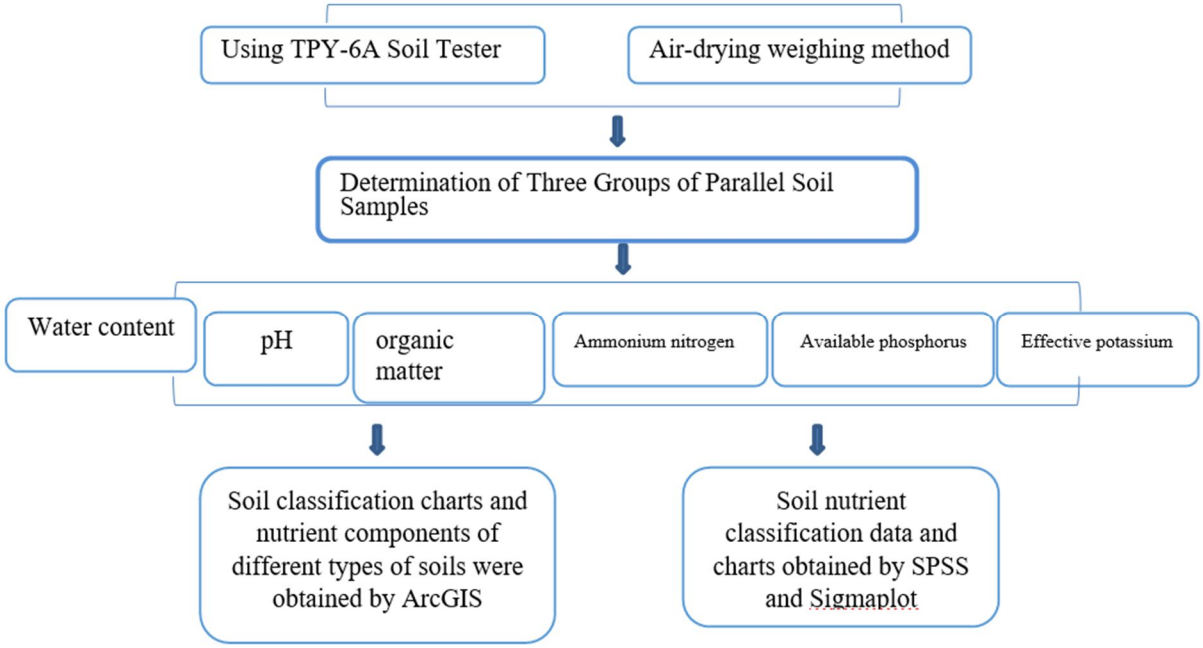
Figure 2-1 Map of Panzhihua City

2.2 Sample collection

According to the administrative situation of Miyi County, 18 soil samples were laid out in this experiment. Soil samples were collected at the same time to reflect the real nutrient status and the measured substance content of the sampling plots, while avoiding the rainy season. Soil samples were collected from 0-20 cm tillage layer. According to the shape of the field, three-point method is used to take three soil samples from the same sampling unit to form a mixed pattern. After air-drying, grinding, sieving, mixing, soil properties were analyzed and determined. Soil water content, ammonium nitrogen, available phosphorus, effective potassium, soil organic matter, soil acidity and alkalinity were determined.

2.3 Technology roadmap





2.4 Data treatment

The original data is summarized and calculated by excel.

The sorted data are processed by SPSS software, and the results are analyzed by one-way ANOVA. The average value and standard deviation are calculated, and the same subset of the data is calculated and labeled.

According to the results, the single factor classification map was drawn by inputting data in Sigmaplot, and the nutritional composition map of representative plots in Miyi County was drawn by ArcGIS.

The results of Sigmaplot and ArcGIS are compared and combined to get the one way ANOVA analysis results.

III. RESULTS AND DISCUSSIONS

3.1 Sampling results

Miyi County has twelve townships and administrative regions. Six representative townships (Deshi Town, Yakou Town, Salian Town, Binggu Town, Panlian Town, Baima Town) were selected for field sampling. Sampling methods such as 2.1 are introduced. Sampling is completed in one day. There is no rain in the area before and after sampling. Through on-site investigation and interviews with surrounding personnel, agricultural land without artificial landfill and fertilization in recent years was selected for sampling. The results of sampling point selection are shown in Fig. 3-1.

Deshi-Dark brown soil

Yakou-Yellow brown soil

Shalian-red soil

Bingu-Light brown soil

Panlian-Dark brown soil 2

Baima-Brown soil

Figure 3-1 Sampling results

After a day's sampling, the soft soil contains more rhizomes and seeds. The difference of soil water content is large, and the difference of color is small or big dependent on different towns. Miyi County is located in a mountainous area, sampling time is in the daytime, because the sampling site is affected by topography, part of the sampling points is in the shade, part of the sampling points is in direct sunlight.

Based on the soil color of representative plots, the soil was divided into six categories. The names of towns and villages in representative plots and soil color were used as soil names. The naming results were shown in Fig. 3-1.

3.2 One way ANOVA analysis

Table 3-1 Nutritional Composition of Soil in Miyi County -1

Soil types	Water content（%）	pH	Organic matter（%）
Deshi-Dark brown soil	5.78±0.51a	8.14±0.1a	3.47±0.07b
Yakou-Yellow brown soil	8.94±0.17b	7.88±0.72a	2.65±0.14a
Shalian-Red soil	11.71±0.9c	6.96±0.64a	2.42±0.23a
Bingu-Light brown soil	10.15±0.17bc	6.32±0.09a	2.20±0.23a
Panlian-Dark brown soil 2	4.57±0.23a	7.96±0.78a	2.67±0.14a
Baima-Brown soil	11.26±0.68c	8.27±0.02a	3.45±0.17b

Table 3-1 Nutritional Composition of Soil in Miyi County-2

Soil types	Ammonium nitrogen (mg/kg)	Available phosphorus (mg/kg)	Effective potassium (mg/kg)
Deshi-Dark brown soil	15±0.82a	22.13±1.42c	53±11.58b

Yakou-Yellow brown soil	15±1.41a	17.52±0.25b	188±12.36d
Shalian-Red soil	23±1.41a	7.75±0.23a	19±22.45a
Bingu-Light brown soil	34±3.56b	15.79±0.37b	84±2.94c
Panlian-Dark brown soil 2	44±1.63c	20.66±0.41c	66±2.45bc
Baima-Brown soil	21±4.55a	16.63±0.46b	11.2±0.68c

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

3.2 Soil taxonomy

3.2.1 Soil taxonomy

According to the soil color collected, the classification of the soil samples collected in Miyi County in the administrative area is shown in Figure 3-2. Different soil colours are marked on the map of Miyi County in ARCGIS, and figure 3-2 is obtained.

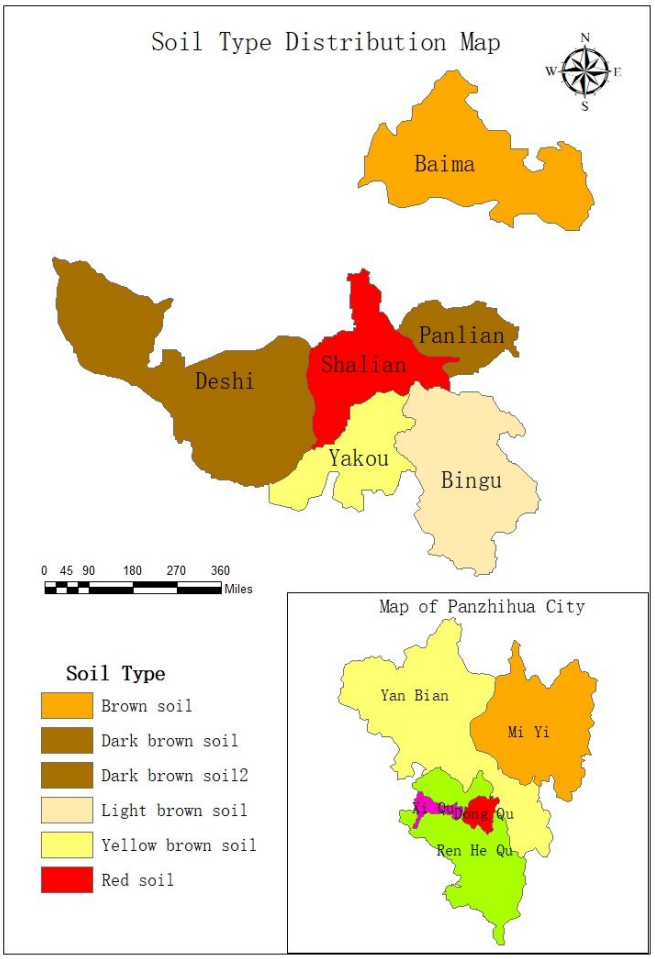


Figure 3-2 Soil Type Distribution Map

From Figure 3-2, it can be seen that the dark brown soils in Deshi Town and Panlian Town are darker, the soils in Salian Town are redder, the soils in Baima Town and Salian Town are lighter, and then in Bingu Town and Yakou Town.

3.2.2 Distribution and comparison of soil water content

The water content of each representative block in Miyi County is measured by air-drying method, and the average value of the data is obtained after processing by spreadsheet. The water content of each representative block is labeled on the map of Miyi County by ARCGIS software, and the water content distribution map is obtained as shown in Figure 3-3.

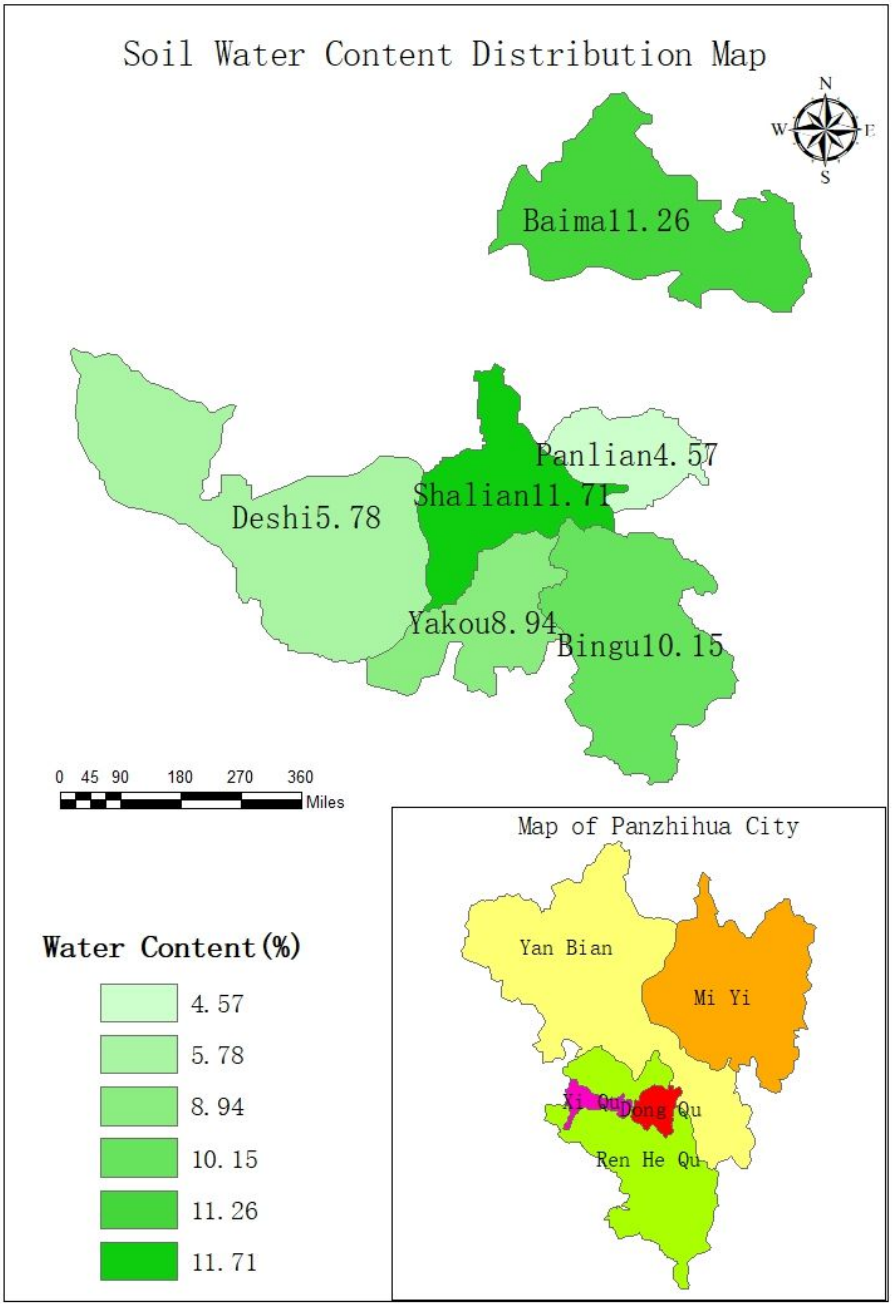


Figure 3-3 Soil Water Content Distribution Map

The average value of water content obtained is processed by Sigmaplot software to form a columnar map and mark the same subset of SPSS with the top of the column. The columnar maps of water content of representative soils in Miyi County are shown in Fig. 3-4.

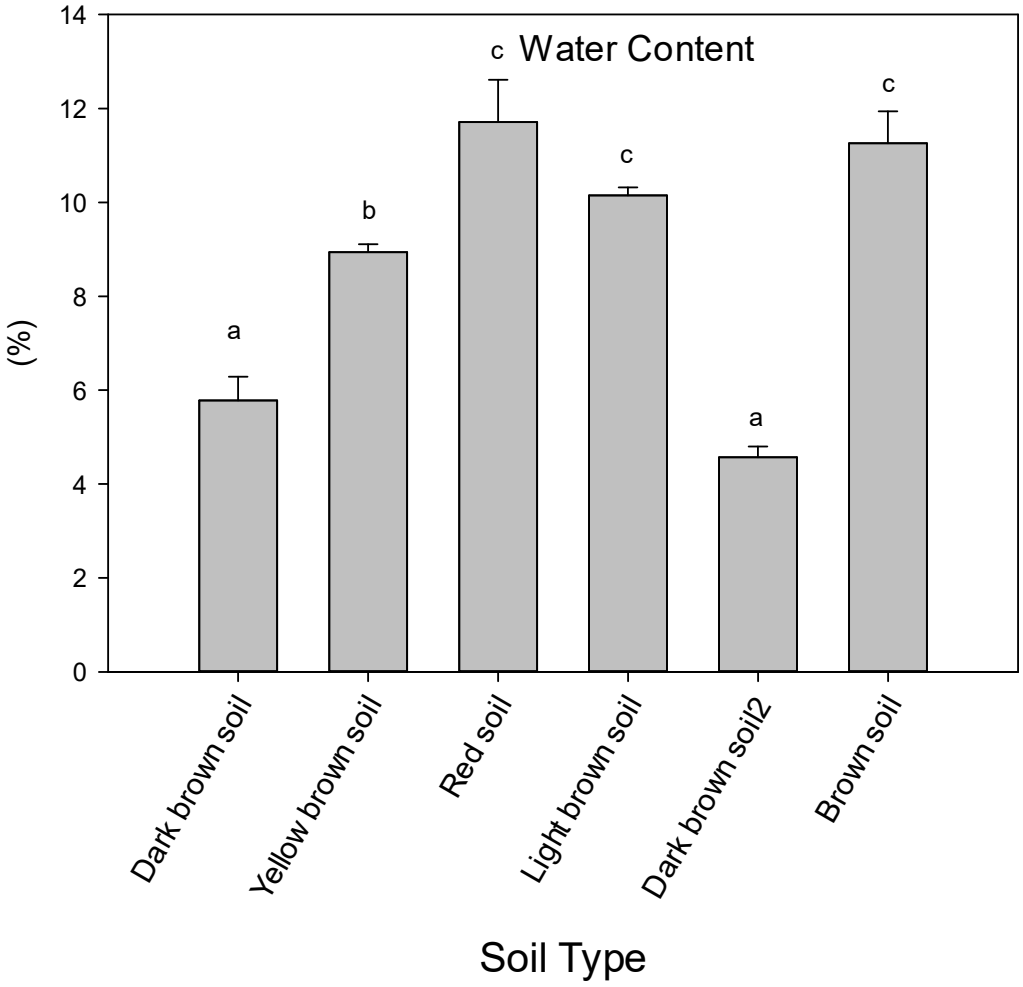


Figure 3-4 Soil water content one way ANOVA analysis graph

The water content distribution of soil types in the representative plots of Miyi County is shown in Fig. 5 and Fig. 6. From Fig. 5 and Fig. 6, it can be seen that in the representative plots of Miyi County, the water content of deep brown soil in Panlian Town and Deshi Town is lower, 4.57% and 5.78%, with darker color and lower water content. The following are Salian Town, Yakou Town, Binggu Town and Baima Town. The highest water content of red soil in Baima Town is 11.26%. In the area of soil moisture content, Deshi Town and Panlian Town have high water content and dark brown color, while the light brown soil of Binggu Town and Baima Town have higher water content of red soil of Salian Town. There is a big difference between the two.

Soil water content (%) classification table

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

In summary, the water content of representative plots in Miyi County of Panzhihua City ranges from 4.57% to 11.26%, and the higher soil water content is suitable for crop growth.

3.3.3 Distribution of Soil Acidity and Alkalinity

In 3.2, we have already distinguished the representative soil of Miyi County from the soil acidity and alkalinity. Here, the average soil acidity and alkalinity obtained by SPSS software is substituted into ARCGIS to get the distribution map of soil acidity and alkalinity in Miyi County. At the same time, the column of soil acidity and alkalinity of various types is obtained by Sigmaplot software.

The distribution of soil acidity and alkalinity is shown in Fig. 3-5, and the acidity and alkalinity histograms of different types of soils are shown in Fig. 3-6.

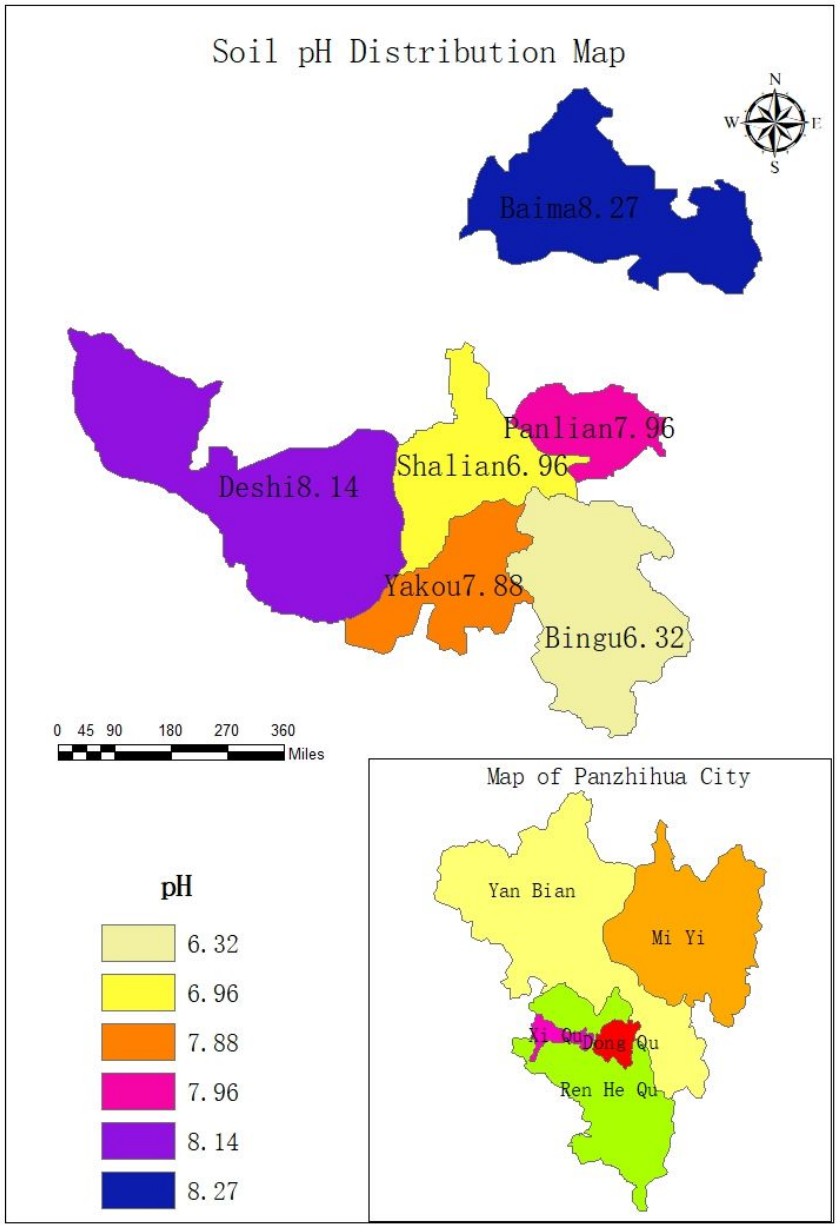


Figure 3-5 Soil pH Distribution Map

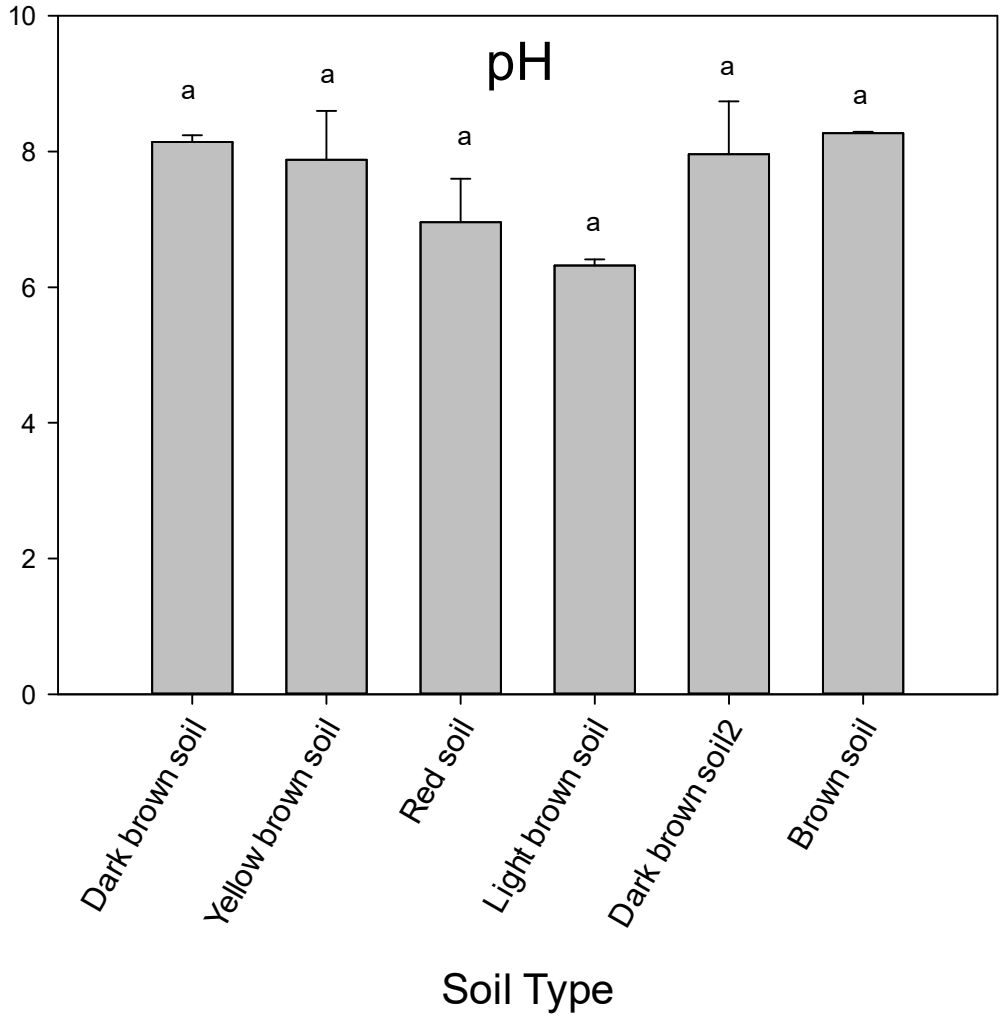


Figure 3-6 Soil pH one way ANOVA analysis graph

Soil pH grade table

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 figs. 3-5 and 3-6, we can see that the shallow brown soils in Pinggu Town are weak acidic. The yellow brown soils in Yakou Town, Deshi Town, and the brown soils in Baima Town, Panlian Town are weak alkaline. Compared with Table 2-1, we can see that the shallow brown soils in Pinggu Town are acidic in the most representative plots of Miyi County, and the shallow brown soils in Baima Town are acidic in pH=6.32. The most alkaline pH of brown soil is 8.27. Among them, the red soil Ph=6.96 in Salian town is neutral, while the yellow brown soil pH in Yakou town is 7.88 in Panlian town, and the deep brown soil pH=7.96 in Deshizhen is also alkaline.

In summary, the representative plots in Miyi County of Panzhihua City are generally distributed in weak acidity, weak alkalinity and neutrality, which are suitable for most crops. Baimazhen brown soil with higher alkalinity can enhance the affinity of the plot by fertilizing the soil, and can properly apply mature manure,

some peat and sawdust. Organic fertilizers can also be applied to edible acid fertilizers such as lead sulfate or ferrous sulfate or ammonium sulfate to neutralize the alkalinity of the soil.

3.2.4 Distribution of Soil Organic Matter

In principle, using the average data obtained previously, the distribution of organic matter in the representative land area of Miyi County was first marked by ARCGIS software, and the distribution map of soil organic matter in the representative area of Miyi County was obtained by using different colors and classifications as shown in Figure 3-7. In Sigmaplot software, the average organic matter content of each block was substituted with the soil type as the transverse axis and the soil organic matter content as the longitudinal axis to obtain the column comparison map of various types of soil organic matter as shown in Fig. 3-8.

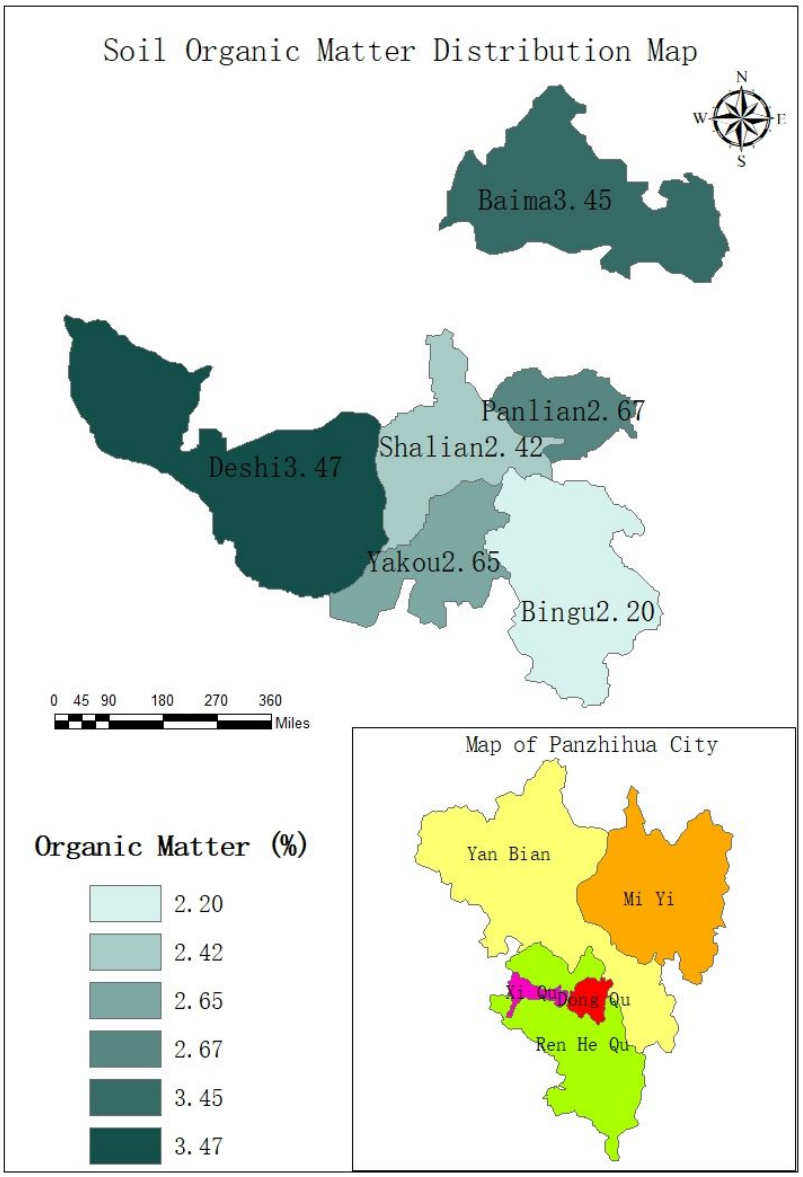


Figure 3-7 Soil Organic Matter Distribution Map

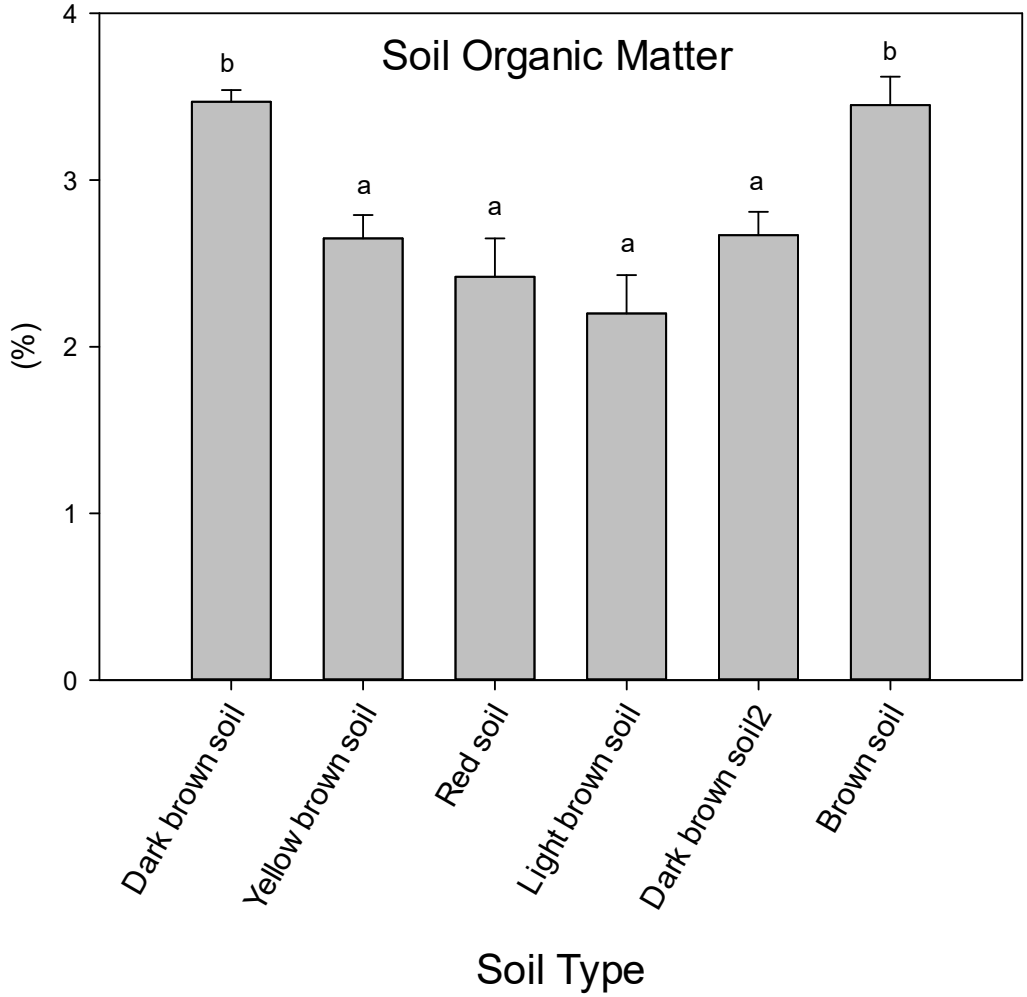


Figure 3-8 Soil organic matter one way ANOVA analysis graph

Soil organic matter grade table

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

According to Table 2-1 of Figure 3-7 and Figure 3-8, the most abundant organic matter content in Deshi Town is 3.74%, which belongs to 2 (abundant) level. The content of organic matter in the brown soil of Baima Town is 3.45%, which belongs to 2 (rich) grade. The organic matter content of deep brown soil 2 in Panlian Town is relatively less than 2.67% and belongs to 3 (middle and upper) grade. The organic matter content of yellow brown soil in Yakou town is 2.65%, which belongs to 3 (middle and upper) grade. The content of organic matter in red soil of Salian Town is 2.42%, which belongs to 3 (middle and upper) grade. The organic matter content of the shallow brown soil in Binggu Town was the lowest, which was 2.20% of the total organic matter in the shallow brown soil. In summary, the organic matter content in the representative blocks of Miyi County is generally rich. Among them, Deshi Town's deep brown soil and Baima Town's brown soil have reached 2 grades, and the rest of the fast organic matter content is more uniform than 2%.

The organic matter distribution in representative plots of Miyi County is relatively uniform and suitable for plant growth. It originates from the relatively large vegetation coverage, the development of aquaculture and the rational use of land in Miyi County.

3.3.5 Distribution of Soil Ammonium Nitrogen

In the same principle, the distribution of ammonium nitrogen in the representative area of Miyi County was marked by ARCGIS software based on the average data obtained previously. The distribution map of soil ammonium nitrogen in the representative area of Miyi County was obtained by using different colors and classifications as shown in Figure 3-9. In Sigmaplot software, the average organic matter content of each block was substituted with the soil type as the horizontal axis, and the soil ammonium nitrogen content as the vertical axis to obtain the column comparison map of organic matter of all kinds of soils as shown in Fig. 3-10. Based on the two maps, the content of ammonium nitrogen in the representative block of Miyi County is distinguished and the conclusion is drawn.

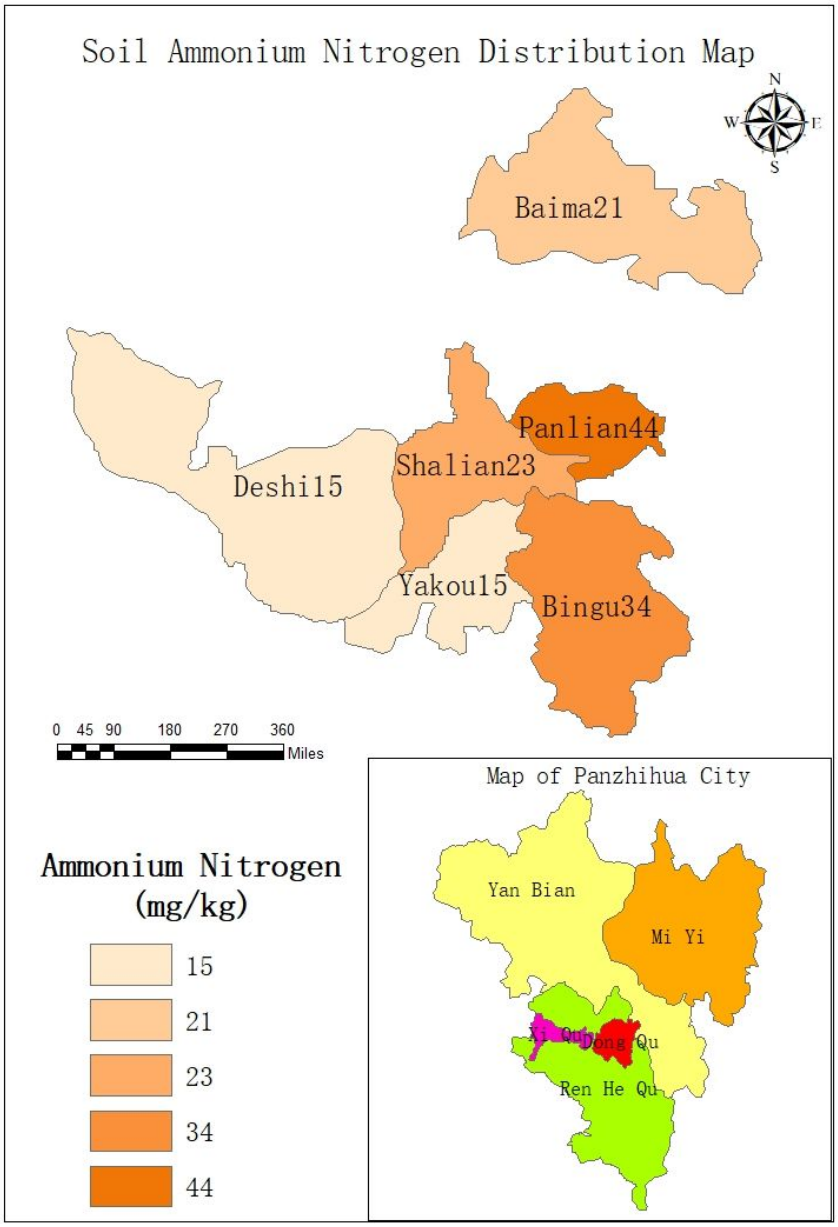


Figure 3-9 Soil Ammonium Nitrogen Distribution Map

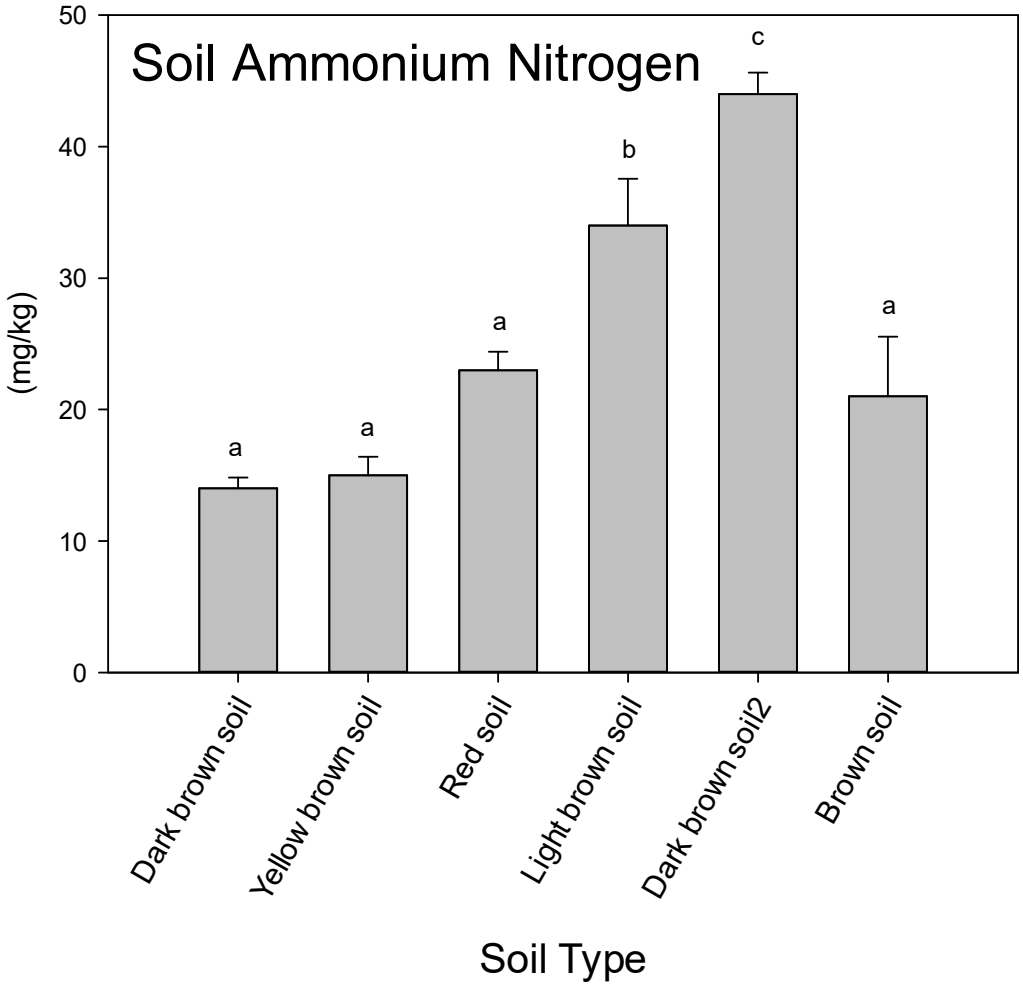


Figure 3-10 Soil Ammonium Nitrogen one way ANOVA analysis graph

Soil Ammonium Nitrogen (mg/Kg) grade Table

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

According to Table 2-1 of the comparison between Figure 3-9 and Figure 3-10, it can be seen that the lowest ammonium nitrogen content of the deep brown soil in Deshi Town, the representative block of Miyi County, is 14.00 (mg/kg), which belongs to the 6 (extremely scarce) level. The content of ammonium nitrogen in yellow brown soil in Yakou Town was 15.00 (mg/kg), which was also very low and belonged to 6 (extremely scarce) grade. The content of ammonium nitrogen in deep brown soil in Panlian town was 20.00 (mg/kg), which belonged to 6 (extremely deficient) grade. The content of ammonium nitrogen in the brown soil of Baima Town (21mg/kg) was only 1 mg more than that of the deep brown soil of Panlian Town. The content of ammonium nitrogen in red soil of Salian town is 23 (mg/kg), which belongs to 6 (extremely scarce) grade. The content of ammonium nitrogen in shallow brown soil in Binggu Town was the highest, but only 34 (mg/kg) belonged to 5 (deficiency) grade.

In summary, it can be seen that the content of ammonium nitrogen in the representative terrain of Miyi County is generally extremely deficient. The best and fastest way to improve is to apply appropriate ammonium

nitrogen fertilizer. Ammonium bicarbonate is commonly used as ammonium bicarbonate, or ammonium bicarbonate in some places. Appropriate increase of humidity and temperature is beneficial to the decomposition of ammonium bicarbonate in soil to increase the content of ammonium nitrogen. Ammonium sulfate can also be added to paddy fields with good drainage to supplement soil ammonium nitrogen.

3.2.6 Distribution of Soil Available Phosphorus

Similarly, using the average data obtained previously, the distribution of soil available phosphorus content in the representative area of Miyi County was marked by ARCGIS software, and the distribution map of soil available phosphorus in the representative area of Miyi County was obtained by using different colors and classifications as shown in Figure 3-11. In Sigmaplot software, the average organic matter content of each block was substituted with the soil type as the transverse axis and the available phosphorus content as the longitudinal axis to obtain the column comparison map of organic matter of all kinds of soils as shown in Fig. 3-12. Based on the two maps, the content of available phosphorus in representative plots of Miyi County was distinguished and the conclusion was drawn.

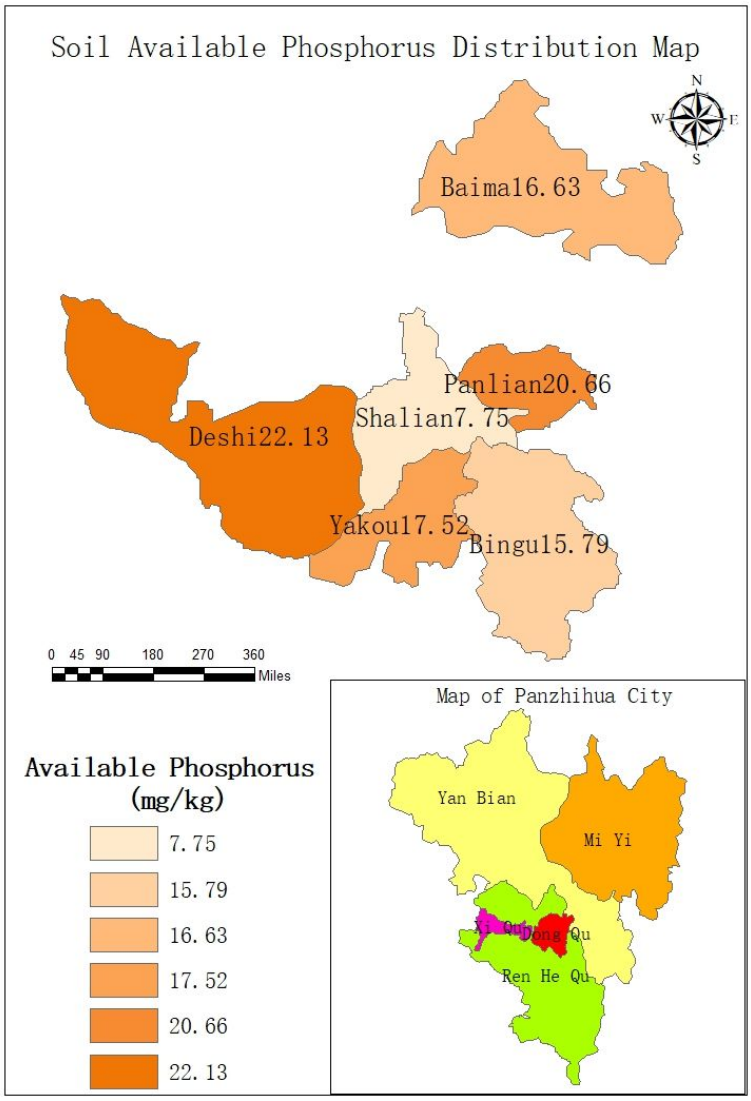


Figure 3-11 Soil Available Phosphorus Distribution Map

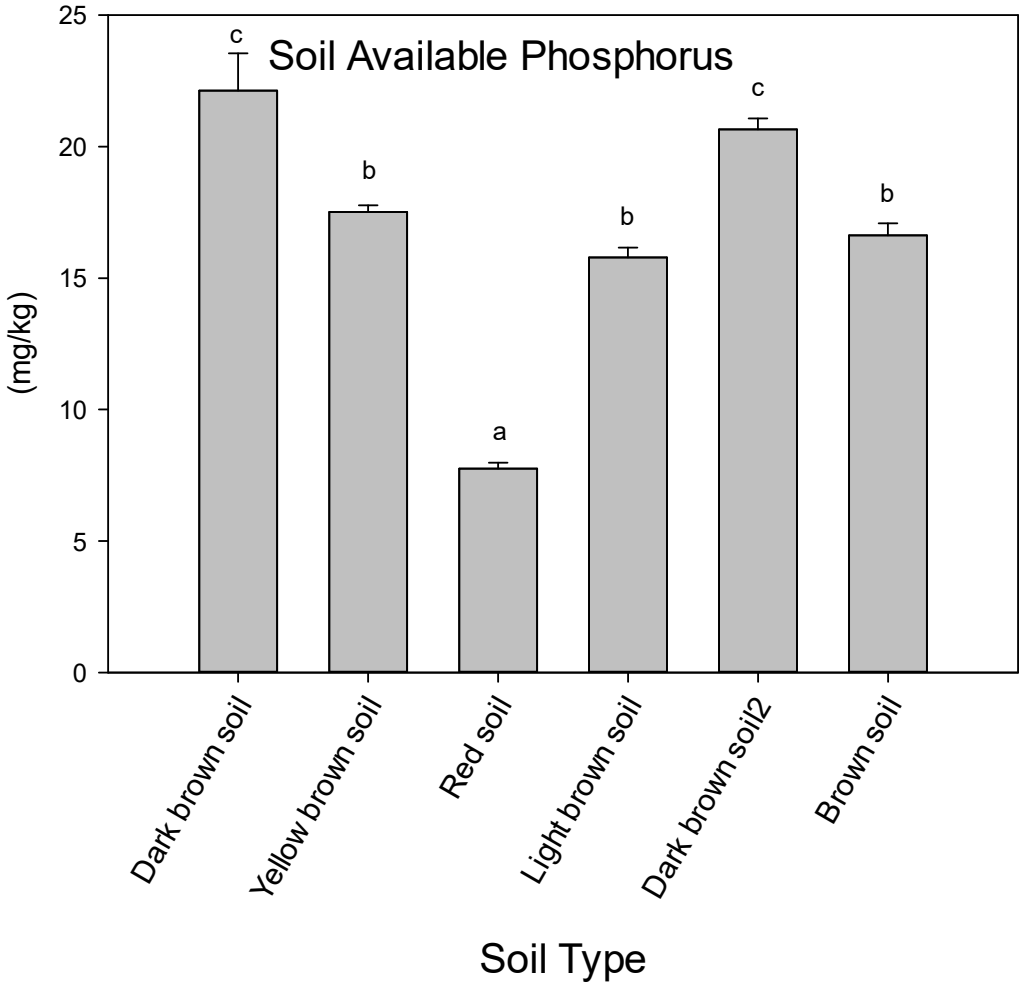


Figure 3-12 Soil Available Phosphorus one way ANOVA analysis graph

Soil Available Phosphorus (mg/Kg) grade Table

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

From the comparison table 2-1 of figs. 3-11 and 3-12, it can be seen that the lowest phosphorus content is 2.67 (mg/kg) of available phosphorus content in deep brown soil 2 of Panlian Town, which belongs to the sixth (extremely deficient) level. The available phosphorus content of red soil in Salian Town is 7.75 (mg/kg), which belongs to the fourth (middle and lower) grade. The available phosphorus content of the shallow brown soil in Binggu Town was 15.79 (mg/kg), which belonged to 3 (upper and middle) grades. The available phosphorus content of yellow brown soil in Yakou town is 16.63 (mg/kg), which belongs to 3 (upper and middle) grades. The available phosphorus content of the brown soil in Baima Town was 17.52 (mg/kg), which belonged to the third (middle and upper) grade. The available phosphorus content of Deshizhen deep brown soil is 22.13 (mg/kg), which belongs to 2 (rich) level.

Among the representative plots in Miyi County, the available phosphorus content in Deshi Town is richer than that in other plots, while that in Panlian Town and Deshi Town is dark brown in color, but the available phosphorus content in Deshi Town is extremely deficient. The available phosphorus content of the shallow

brown soil in Binggu Town and the yellow brown soil in Baima Town in Yakou Town is on the upper side, while the available phosphorus content of the red soil in Salian Town is slightly lower.

In summary, the content of available phosphorus in the representative plots of Miyi County in Panzhihua City is high or low. Among them, the content of available phosphorus in deep brown soil of Panlian town and red soil of Salian town is lower than the basic value required by crops. Soil acidity and alkalinity can affect the content of available phosphorus in soil. In article 3.3.3, we know that the pH of deep brown soil in Panlian town and red soil in Salian town are both greater than 7, which is not conducive to the formation of available phosphorus. Therefore, natural organic acids can be added to the soil to improve the acidity and alkalinity of the soil. In addition, natural phosphate fertilizers such as seabird dung, bone meal and fish bone meal can be added, and chemical phosphate fertilizers such as calcium superphosphate and calcium magnesium phosphate can also be added.

3.2.7 Distribution of Soil Effective Potassium

The principle is the same. The content of potassium is marked by ARCGIS software on the way of the region, distinguished by different colors, and then compared by using Sigmaplot to draw a bar chart. The resulting figures are shown in Figs. 3-13 and 3-14.

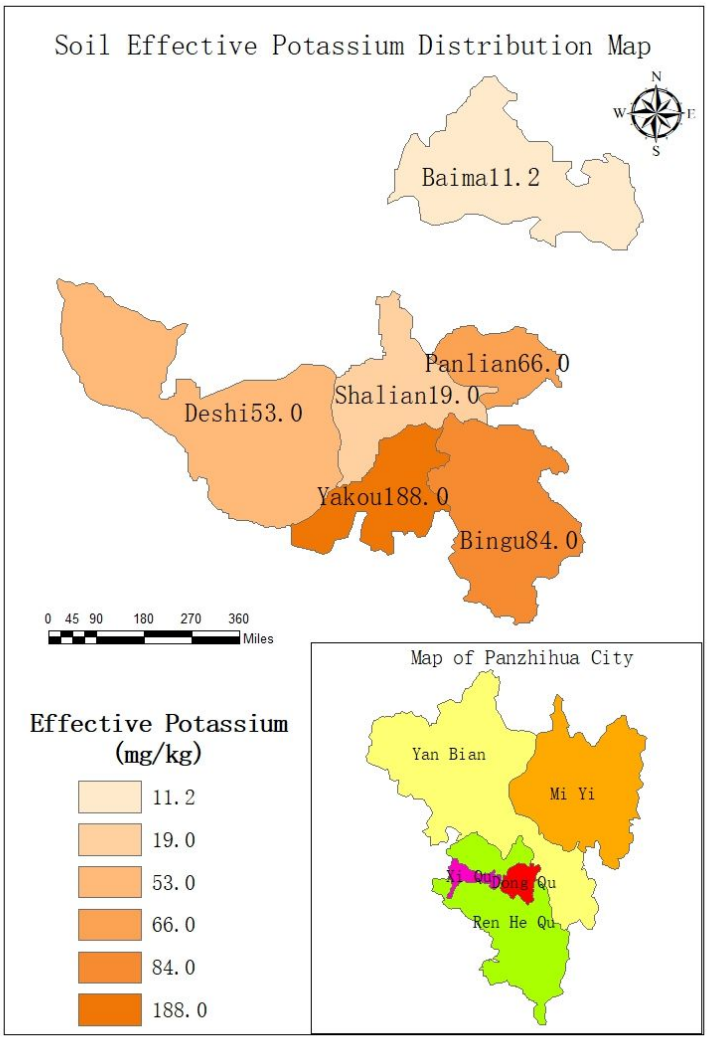


Figure 3-13 Soil Effective Potassium Distribution Map

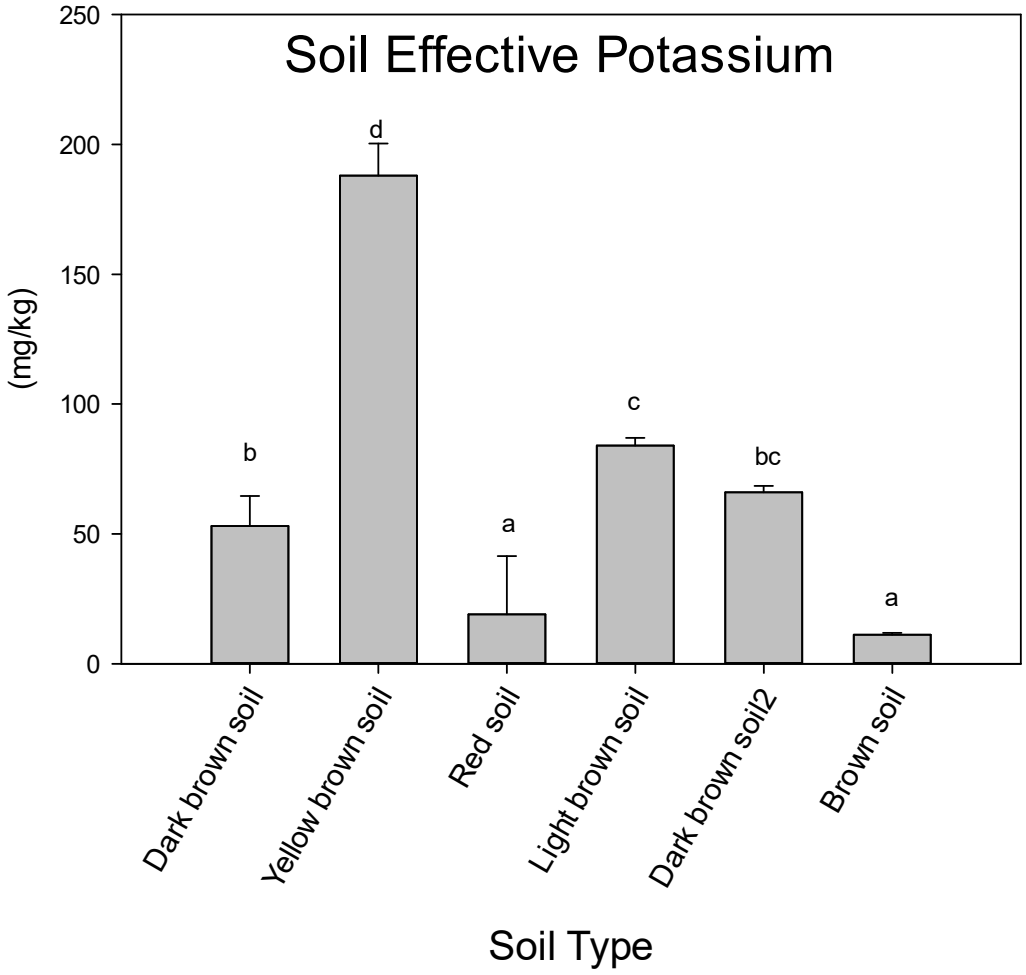


Figure 3-14 Soil Effective Potassium one way ANOVA analysis graph

Soil Effective Potassium (mg/Kg) grade Table

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

From the comparison table 2-1 of figs. 3-13 and 3-14, it can be seen that the lowest K content of red soil in Salian Town is 19.00 (mg/kg), which belongs to 6 (extremely scarce) levels. The content of available potassium in the brown soil of Baima Town was 46.00 (mg/kg), which belonged to 5 (deficiency) level. The available potassium content of Deshizhen deep brown soil is 53.00 (mg/kg), which belongs to 4 (middle and lower) grades. The content of available potassium in deep brown soil of Panlian Town was 67.00 (mg/kg), which belonged to 4 (middle and lower) grades. The available potassium content of shallow brown soil in Binggu Town was 84.00 (mg/kg), which belonged to 4 (middle and lower) grades. The highest available potassium content of yellow brown soil in Yakou town is 188.00 (mg/kg), which belongs to 2 (rich) level.

In summary, the available potassium content of yellow brown soil in Yakou Town is relatively rich in the representative plots of Miyi County, while that of deep brown soil in Panlian Town, Deshi Town, and shallow

brown soil in 2C Valley Town are general, while that of red soil in Baima Town, Salian Town, is very deficient. The distribution of available potassium in different types of plots is quite uneven.

In this case, potassium chloride, potassium sulfate, potassium dihydrogen phosphate, kiln ash potassium, potassium nitrate and other potassium fertilizers can be applied in the soil. When applying potassium fertilizer, attention should be paid to applying potassium fertilizer according to the nature of the plot, and appropriate selection of potassium fertilizer should be made according to the farming, fertilizer price and irrigation conditions planted under soil conditions.

3.3 Analysis of Soil Fertility

Radar maps were drawn by Excel using organic matter content, ammonium nitrogen content, available phosphorus content, available potassium content and water content in soil nutrients. Soil acidity and alkalinity are not directly proportional or quasi-proportional to soil fertility level, so soil acidity and alkalinity are not analyzed here. Due to the different data ranges, the data can not be directly referenced to transform as follows:

The range of organic matter content (%) is 0-4. All data multiplied by 50 ranges are 0-200.

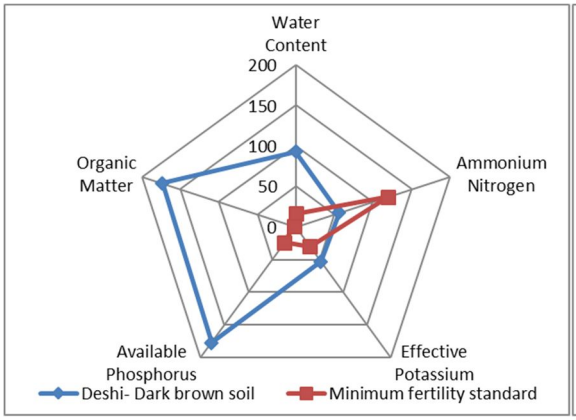
Ammonium nitrogen content (mg/Kg) ranges from 0 to 50. All data multiplied by 4 ranges become 0 to 200.

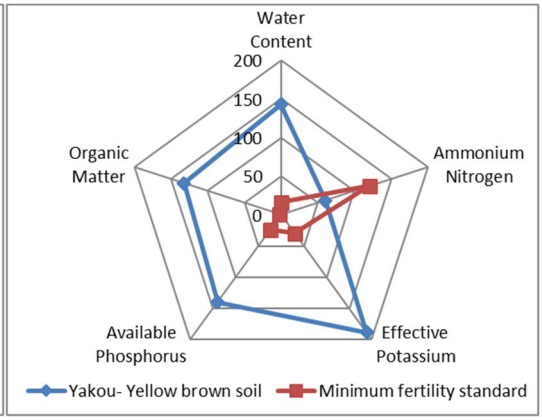
The range of available phosphorus content (mg/Kg) is 0-23. All data multiplied by 8 ranges are 0-200.

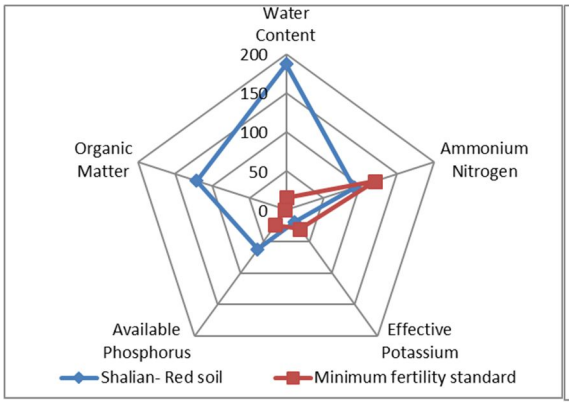
The range of available potassium content (mg/Kg) is 0-200, which need not be changed.

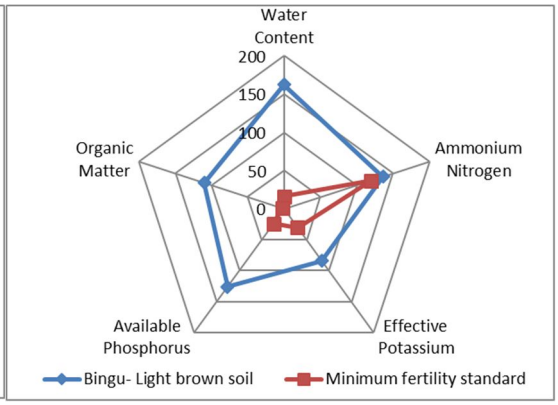
Water content (%) ranges from 0 to 12. All data multiplied by 16 ranges become 0 to 200.

Radar plots are drawn from the changed data to calculate the radar plot area as a data representation of soil fertility.









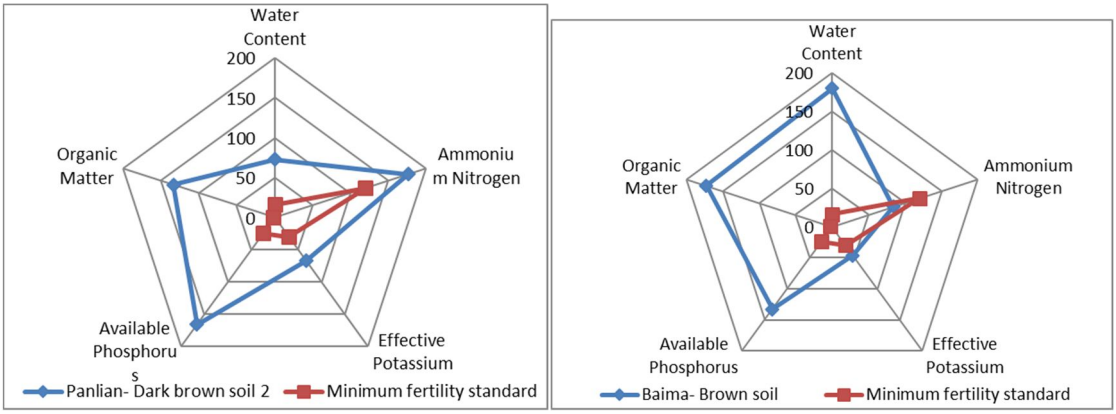


Figure 3-15 Soil Fertility Radar Graph

Figure 3-15 is constructed from the average water content of available phosphorus, available potassium and ammonium nitrogen in various soils.

Based on the above principle, the original data of three soil samples in each plot are analyzed by radar plot according to the changed range, and the area of each soil sample is calculated one by one. The area obtained is analyzed by one-way ANOVA with SPSS software, and the average value and standard deviation are calculated to obtain the same subset. Calculate labeling. This result is supported by the soil fertility level from a Ning point of view, and is a supplement to Figure 3-15. The results are shown in Table 3-1.

Table 3-1 Soil Fertility Data Table

Region	Soil sample1	Soil sample 2	Soil sample 3	Average±S.D.
Deshi-Dark brown soil	264.67	234.62	233.06	244.12±14.55ab
Yakou-Yellow brown soil	447.70	397.60	417.81	421.04±20.58d
Shalian-Red soil	206.87	222.81	200.52	210.07±9.38b
Bingu-Light brown soil	370.55	318.52	370.62	353.23±24.54c
Panlian-Dark brown soil 2	373.35	367.77	372.26	371.13±2.41bc
Baima-Brown soil	343.04	359.78	312.58	338.47±19.54b

(Note: Mean±Standard deviation of soil sample (n=3), the same column of different lower-case letters indicates significant difference at the level of $P < 0.05$.)

From Figure 3-15 and Table 3-1, it can be seen that there is a certain difference in fertility values among the representative plots in Miyi County, and there are more or less individual nutrient values in each plot. The comprehensive fertility value of yellow brown soil in Yakou Town was the highest, followed by that of deep brown soil in Panlian Town. The comprehensive fertility values of shallow brown soils in Binggu town and brown soils in Baima town were moderate, and the worst were red soils in Salian town and deep brown soils in Deshi town. The average area of comprehensive fertility values was less than 300.

The red soil fertility in Salian town is the lowest. The main reason for this result is that the content of available phosphorus and potassium in the red soil in Salian town is the lowest in the representative plots, and the content of organic matter is also low. It is suggested that natural organic acids can be added to the soil properly to improve the acidity and alkalinity of the soil. In addition, natural phosphate fertilizers such as seabird dung, bone meal and fish bone meal can be added, and chemical phosphate fertilizers such as calcium superphosphate and calcium magnesium phosphate can also be added. In order to supplement the available phosphorus deficiency in the soil of the plot. Potassium fertilizers such as potassium chloride, potassium sulfate, potassium dihydrogen phosphate, kiln ash potassium and potassium nitrate should also be applied to the soil. In

order to supplement the shortage of available potassium in the soil of this plot. The soil was improved by the above methods.

The fertility value of Deshizhen deep brown soil is also very low. The main reason for this result is that the content of ammonium nitrogen and water content (%) of Deshizhen deep brown soil are very low. It is suggested to increase wastewater irrigation and apply appropriate ammonium nitrogen fertilizer.

Pearson's correlation

Table 3-2 Pearson's correlation coefficients for relationships among soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Miyi County.

Variable	Water	Organic Matter	pH	N	P	K
Water	1	-0.236	-0.311	-0.333	-0.793**	-0.108
Organic Matter		1	0.627**	-0.439	0.468	-0.202
pH			1	-0.271	0.470*	0.074
N				1	0.074	-0.224
P					1	0.281
K						1

*Significant at P<0.05 (n=18); **Significant at P<0.01 (n=18).

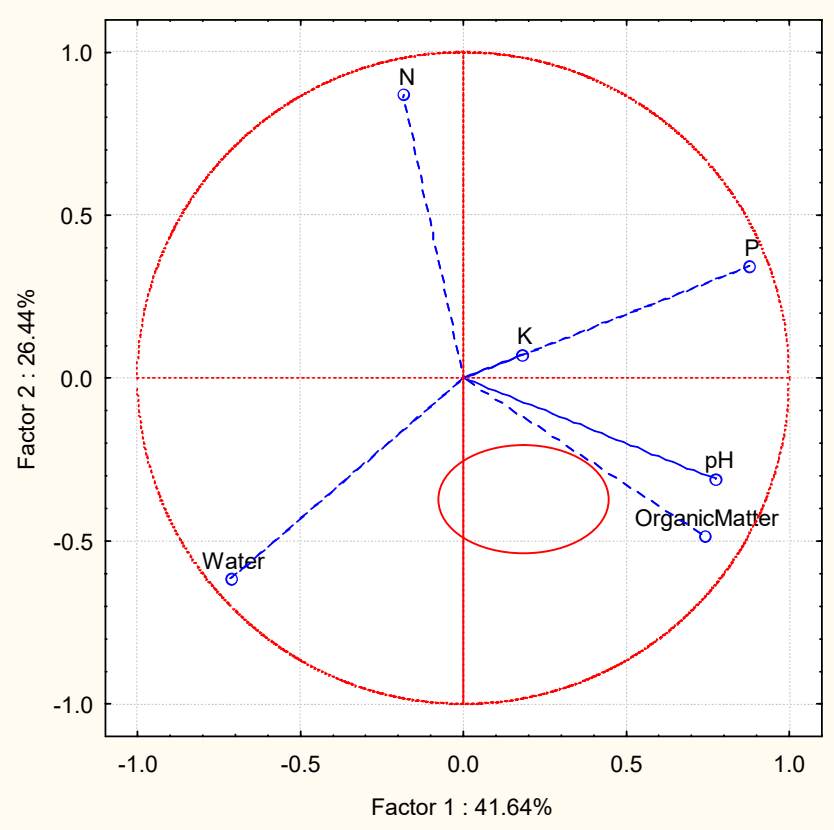
As the table 3-2 shown, significant negative correlations of water with P -0.793 (P<0.01), significant positive correlations of organic matter with pH 0.627 (P<0.01) and pH with P 0.470 (P<0.05) were observed. This means lower water content can increase P concentration; higher organic matter content can increase pH values; higher pH values can increase P contents.

Principal component analysis

Table 3-3 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 Miyi County.

Variable	PC1	PC2
Water	**-0.715**	-0.615
Organic Matter	**0.740**	-0.484
pH	**0.776**	-0.307
N	-0.183	**0.869**
P	**0.878**	0.344
K	**0.182**	0.073
Variance explained (%)	41.6	26.4

Figure 3-16 Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Miyi County.



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 Miyi County soil Table 3-3 showed that the first two components accounted for 68% of the total variance. The first component (PC1, 41.6%) 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 3-16 shows the parameters distribution map: organic matterand pH associated together, demonstrated they have close correlation. Infers that improve organic matter concentration can increase pH values in the soil.

IV. CONCLUSIONS

Through the study and analysis of Soil Taxonomy of representative plots in Miyi County, Panzhihua City, the following conclusions are drawn:

1. The color of soil is closely related to the composition of soil. It is reasonable to classify the soil by color first when the composition of soil is not clear before the study.

2. Most of the representative soil in Miyi County is brown, which belongs to the typical soil in southwestern Sichuan.

3. The representative soil of Miyi County is generally rich in exchange rate, which is suitable for the growth of crops, especially rice and other crops.

4. The organic matter content in the representative terrain of Miyi County is generally rich. Among them, Deshi Town's deep brown soil and Baima Town's brown soil have reached 2 grades, and the rest of the fast organic matter content is more uniform than 2%. It is suitable for the growth of most crops.

5. The contents of ammonia nitrogen, available phosphorus and available potassium in representative plots of Miyi County are generally not high, or even urgent, and need fertilization and improvement.

6. There is a certain difference in fertility value among the representative plots in Miyi County, and there are many and few in single nutrient value of each plot. Among them, Yakou Town has the largest comprehensive fertility value, followed by Panlian Town. The comprehensive fertility values of shallow brown soil in Binggu Town and brown soil in Baima Town were moderate, while the worst were the red soil in Salian Town and the deep brown soil in Deshi Town. However, the overall fertility also belonged to the medium level, which met the basic requirements of crop growth.

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Additional Information

Competing Interests statement

The author Jian Xiong declare that there is no competing interests.

Conflicts of Interest

The authors declare no confilicts of interest.

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Data Availability Statement

Data available on request from the authors
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Xiong Jian