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Soil Systematic Classification Research of Renhe Town and Other Areas in Renhe District of Panzhihua City

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ABSTRACT
Soil is an important basic natural resource in human production and life. Studying the micro-structure of soil, understanding various types of soil and grasping its specific data are of great guiding significance and reference value for the growth and development of plants and crops. Therefore, the systematic classification of soil is particularly important. There is no study on Soil Taxonomy in Renhe District of Panzhihua City, so this study will make up for this gap.The soil samples of 8 towns and townships in Renhe District of Panzhihua City were collected and analyzed. The main nutrient components were soil water content, soil ammonium nitrogen, soil available phosphorus, soil effective potassium, soil organic matter and soil pH value. The characteristics of soil were obtained through data analysis, and the soil types in the study area were also analyzed. Types were named and classified. Complete the task of land resources survey in Renhe District, clarify the types and distribution of soil in Renhe District, and enrich the content of soil science. The nutrient contents of various soils were analyzed by laboratory tests, which provided scientific basis for soil classification.Through the analysis of experimental data, it is found that the soil water content in Renhe District is low, the soil is weak alkaline, the content of organic matter is generally high, the content of ammonium nitrogen is low, the content of available phosphorus is generally high, and the content of effective potassium is relatively low.
KEYWORDS: soil type, soil pH value, soil organic matter, soil ammonium nitrogen, soil available phosphorus, soil effective potassium

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I. INTRODUCTION

Soil is the natural resource on which human beings depend. It has its own law of occurrence and development. Soil is a complex and huge group system composed of numerous individuals (single soil body). Many commonalities and differences among individuals make it possible for soil classification (Xiong, 2016; Xiong et al., 2013; Cabrera et al., 2015). Soil classification is the symbol of the level of soil science, the basis of soil survey and mapping, and the medium of academic exchange of soil at home and abroad. Soil is the most basic means of production in agricultural activities. Scientific soil classification is of great significance for the development and sustainable utilization of agricultural soil in accordance with local conditions (Xiong et al., 2015; Madejón et al., 2014; Xiong, 2012).

1.1 The purpose and significance of the research

Complete the task of land resources survey in Renhe District. To clarify the types and distribution of soil in Renhe District and enrich the content of soil science. The nutrient contents of various soils were analyzed by laboratory tests, and the basis for improving soil classification and guiding agricultural production was provided.

1.2 Main research contents

Soil sample types in Renhe District of Panzhihua City were classified and named. At the same time, the distribution characteristics of nitrogen, phosphorus and potassium in soil and the content of organic matter were completed. The task of land resources survey in Renhe District was completed. Soil types and distribution in Renhe District were clarified, and the contents of soil science research were improved. The nutrient content of various soils was determined to provide scientific basis for soil taxonomy.

Based on the collected data and preliminary preparatory work, the distribution characteristics of nitrogen, phosphorus and potassium and the content of organic matter in soil were preliminarily explored in eight areas (Dahe Zhonglu, Renhe Town, Jinjiang Town, Datian Town, Pingdi Town, Futian Town, Tongde Town and Bude Town) of the study area. Soil water content, soil pH value, ammonium nitrogen, available phosphorus, effective potassium and organic matter content in different regions were systematically classified by ARCGIS software. Finally, it provides guidance for agricultural measures to improve and fertilize soil.

At the same time, the land resources survey task of Renhe District was completed. To clarify the types and distribution of soil in Renhe District and enrich the content of soil science. The physical and chemical properties of various soils were analyzed by laboratory tests, which provided scientific basis for soil classification. This research includes field investigation of soil types in different regions, classification and nomenclature. Soil classification maps of different types in different regions were drawn by ARCGIS software. The nutrient index of soil was analyzed and determined in laboratory, which could provide guidance for improving and fertilizing soil by agricultural measures. Finally, SPSS and Sigmaplot are used to analyze the chart data.

II. MATERIALS AND METHODS

2.1 Overview of the research area

Renhe District administers 1 sub-district (Dahe Zhonglu sub-district office), 8 townships (Renhe Town, Tongde Town, Datian Town, Pingdi Town, Futian Town, Jinjiang Town (already managed by Panzhihua Municipal Government), Qianjin Town, Bude Town), 6 townships (Zhongfa Town, Taiping Town, Wuben Town, Zhongba Township, Ala Yi Township, Dalongtan Yi Township) (Xiong et al., 2012; Zhang et al., 2012; Xiong, 2017;Zhang et al., 2016: Vladimír and Gerhard, 2015; Yang et al., 2011).

2.2 Sampling Method and Technical Route of Soil Samples in Research Area

2.2.1 Research area sampling method

Through field survey, soil samples were collected in 8 areas (Dahe Zhonglu, Renhe Town, Jinjiang Town, Datian Town, Pingdi Town, Futian Town, Tongde Town and Bude Town) of the study area. This sampling method adopted five-point sampling method. The distribution of five-point sampling methods should be as uniform as possible, and the depth and weight of sampling should also be equal. Each sampling area is divided into three areas. Five soil samples are taken from each area by five-point sampling method, and the redundant parts are discarded by four-point sampling method. Parallel samples are taken from each area to retain 1 kg of soil to bring back to the laboratory. According to the requirements of sampling standards, as a regional soil classification study, the soil sample adopted in this research must be a fully developed and representative soil morphology. The collected soil samples were taken back to the laboratory and dried naturally. The impurities such as roots and stones were removed from the soil samples, and the samples were prepared by grinding and sieving.

At the same time, the soil samples were collected and the soil research records of the sampling area were recorded. The representative soils in the relevant areas were classified and named. The soil classification and systematic nomenclature of the sampling sites in the sampling area were shown in Figure 2.1.

Figure 2.1 Distribution of sampling points

2.2.2 Technical route of research area

Based on field investigation and sampling analysis, referring to relevant background data and historical data, this paper clarifies the soil forming conditions, soil morphological nutrient content and other related information of Typical Soils in Renhe District. According to the principles and methods of Soil Taxonomy in China, the taxonomic units of typical individuals at different levels are determined. Based on the historical survey data of regional soil, the classification of soil system in Renhe District was studied. The overall technical route is shown in Figure 2.2 below:

Figure 2.2 Technical Roadmap

2.3 Analytical Testing Method

2.3.1 Sample pretreatment

(1) Sample air-drying: In the laboratory, wet soil samples are poured onto white plastic bags or plastic films, spread into thin layers about 1 cm thick, crush large pieces of soil, turn over, and make them evenly air-dried. During the drying process, impurities such as gravel, gravel and plant residues are picked up.

(2) Grinding and sieving: After the soil sample is air-dried, it is grinded repeatedly in a grinding bowl. After grinding, 100 mesh nylon sieve is passed, and the bag is sealed for reserve.

2.3.2 Experimental Principle and Operating Method

See TPY-6A soil nutrient analyzer operation method.

2.3.3 Determination Content

Soil water content: The basic index of soil physical properties in response study area, and the overall description of soil moisture in this area.

Soil pH: Soil pH is closely related to the content of calcium carbonate in soil. It is an important basic property of soil and one of the important factors affecting soil fertility. It not only directly affects the existing state of soil nutrients, but also affects the transformation and availability of soil nutrients.

Soil organic matter: Soil organic matter is an important source of plant nutrients. It has a great influence on the physical, chemical and biological characteristics of soil. It is one of the important indicators of soil fertility and plays a variety of roles in crop development.

Soil ammonium nitrogen: Nitrogen is the main nutrient of plants, and the amount of soil nitrogen is one of the important indicators to measure soil fertility. However, most of the nitrogen in the soil is organic, so it must be converted into available nitrogen to be used by plants. Therefore, the content of ammonium nitrogen can roughly reflect the real level of soil nitrogen in the near future, and also has a certain correlation with crop growth.

Soil available 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. The content of available phosphorus in soil reflects how much phosphorus can be absorbed and utilized by crops in the current season.

Soil effective potassium: Potassium in soil can promote the growth of plant stems and leaves, make stem strong, not easy to lodge, enhance disease resistance, etc. The content of available potassium in soil reflects how much potassium can be absorbed and utilized by crops in the current season.

III. RESULTS AND DISCUSSIONS

3.1 Soil nutrients

The average contents of soil water content, soil acidity and alkalinity (pH), soil organic matter, soil ammonium nitrogen, soil available phosphorus and soil effective potassium were obtained by processing the relevant data of each group of parallel soil samples. The standard deviation of each group of average data was obtained by excel. Finally, each group of parallel data was processed by SPSS. Statistical analysis was conducted to find multivariate statistical analysis of common factors hidden in multivariate data that could not be observed directly. Its purpose is to find out a few independent common factors that govern the relationship between multiple indicators through the analysis of observation data of multiple variables, and to predict the state of common factors by establishing the quantitative relationship between common factors and original variables, which can help to discover some objective law hidden among variables. Univariate analysis can visually see the difference between different soil nutrient contents in each region, such as a and f, which shows that there is a significant difference between them. The average nutrient composition of specific soil is analyzed as shown in Table 3.1 and Table 3.2.

Table 3.1 Average Nutritional Components of Soil

Table 3.2 Average Nutritional Components of Soil

3.2 Distribution of Soil Types in the Research Area

The soil types in different areas of Renhe District were investigated in the field and classified and named. The distribution maps of different types of soils in different regions were drawn by ARCGIS software. Complete the task of land resources survey in Renhe District, clarify the types and distribution of soil in Renhe District, and enrich the content of soil science. The soil in each region is roughly divided according to the type of soil as shown in Figure 3.1.

Figure 3.1 Soil Type Distribution Map

According to the soil type distribution map of Figure 3.1, it can be seen that the soil samples collected from 8 areas in the study area are 24 parallel samples. The soil samples of Renhe Town are named shallow brown soil, the middle road of Dahe is yellow soil, the town of Datian is white sandy soil, the town of Pingdi is lateritic red soil, the town of Jinjiang is brown red soil, the town of Budezhen is deep brown soil, the town of Tongdezhen is shallow brown soil, and Futian is shallow brown soil. The town is brown soil. The soil classification area is generally shown in Figure 3.1.

3.3 Analysis of Soil Water Content

Through data analysis and processing, the ARCGIS software was used to draw the soil moisture distribution state map of the study area of Renhe District. The towns with darker colors showed that the water content was higher, while the areas with lighter colors showed that the water content was relatively lower. The soil moisture distribution map was shown in Figure 3.2 below.

Figure 3.2 Soil Water Content Distribution Map

Finally, Sigmaplot was used to map, and SPSS was used to analyze the single factor data. The parallel data of each group were statistically analyzed. The single factor analysis could visually show the difference of soil nutrient content in each region, and the analysis of water content data was shown in Figure 3.3.

Figure 3.3 Soil water content one way ANOVA analysis graph

The water content classification table in China is shown in Table 3.1 below.

Table 3.1 Soil water content (%) classification

From figure 3.2, it can be seen that the water content of Dahe Middle Road Street and Pingdi Town is relatively low, while that of Jinjiang Town, Bude Town and Renhe Town is relatively high. The soil moisture content in Pingdi Town, Tongde Town and Futian Town is relatively moderate. Dazhong Road and Datian Town have very low soil moisture content, while Renhe Town, Pingdi Town, Jinjiang Town, Bude Town, Tongde Town and Futian Town have low soil moisture content. Through Figure 3.3, we can also see that the soil moisture content in Renhe District is relatively correlated, and the difference is not obvious. It shows that the difference of soil water content in Renhe District is small. At the same time, it can be seen from Table 3.1 that the water content in Renhe Town is at a lower level, and the soil water shortage is serious as a whole. It is unfavorable to the growth of crops.

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 yield, reducing irrigation, reducing evaporation and transpiration, reducing surface runoff, and reducing underground leakage are all ways to increase water use efficiency. At the same time, if necessary, artificial water replenishment can also be used to meet the growth requirements of related plants. Increase cash crop yields.

3.4 Soil pH Analysis

Through data analysis and processing, ARCGIS software was used to draw the distribution state map of soil acidity and alkalinity (pH) in the study area of Renhe District. The villages with darker colors showed that the soil acidity and alkalinity were higher, while the areas with lighter colors showed that the soil acidity and alkalinity were relatively lower. The distribution of soil pH is shown in Figure 3.4 below.

Figure 3.4 Soil pH Distribution Map

Sigmaplot was used to build figure and SPSS was used to perfume one way ANOVA analysis. The acid-alkalinity (pH) data were analyzed as shown in Figure 3.5.

Figure 3.5 Soil pH one way ANOVA analysis graph

The acid-alkalinity grading table in China is shown in Table 3.2 below.

Table 3.2 Soil pH grade

From Figure 3.4 and Figure 3.5, we can see that except Pingdi Town, the soil is weak acidic, other soils are alkaline. Except Pingdi Town, the difference of pH value of other soils is small. On the whole, the soil in Renhe Town is alkaline, which may be related to the special topography and landform of Renhe Town. In terms of soil correlation, the soil in Renhe District can be divided into six aspects. However, they have the same subset in the division of similar subsets, indicating that they have some similarities in the acidity and alkalinity of the land. However, the difference of statistical analysis value of yellow soil in Dahe Middle Road is significantly higher than that of lateritic red soil in Pingdi Town, and the difference between the two is more obvious. At the same time, most of the soil samples in Renhe Town are alkaline, which needs to be improved.

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-alkali soil with appropriate organic fertilizer. Organic fertilizer can not only improve 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 can increase coverage, reduce water evaporation and inhibit salinity. At the same time, green manure is also an important source of organic fertilizer. (3) Reasonable tillage and timely loosening of soil can improve soil aeration, change the state of soil compaction, reduce evaporation and inhibit salt return. But for acidic soils in Pingdi Town, the measures to improve pH are: (1) Rational use of organic fertilizer is the most fundamental measure to regulate soil acidity and alkalinity, which can improve soil buffer performance. (2) Strong acidity (below pH 5.5), soil cohesion, appropriate application of lime. Usually 50-100 kg per mu is applied, once every 2-3 years.

3.5 Analysis of Soil Organic Matter

ARCGIS software was used to draw the distribution state map of soil organic matter in the study area of Renhe District. The towns with darker colors showed that the soil organic matter was higher and the areas with lighter colors showed that the soil organic matter was lower. The distribution of soil organic matter is shown in Figure 3.6 below.

Figure 3.6 Soil Organic Matter Distribution Map

Sigmaplot was used to build figure and SPSS was used to perfume one way ANOVA analysis. The Organic Matter data were analyzed as shown in Figure 3.7.

Figure 3.7 Soil organic matter one way ANOVA analysis graph

The classification table of organic matter content in China is shown in Table 3.3 below:

According to Figure 3.6 and Figure 3.7, the organic matter level of Jinjiang Town is in Grade 2 of Organic Matter Grade Standard. However, Renhe Town, Dahe Middle Road, Datian Town, Pingdi Town, Bude Town, Tongde Town and Futian Town are all in the first level. Generally speaking, Renhe Town is rich in soil organic matter, which is suitable for crop growth. For Panzhihua Renhe and regional crop-related experience, it is especially suitable for planting mango, pomegranate and other fruits. From the aspect of soil correlation, in the aspect of organic matter, the soil in Renhe District can be divided into four standards, among which Datian Town, Pingdi Town and Bude Town are at the same level. The other townships have similarities with the above three townships, of course, they also have certain correlation with each other. However, there were significant differences in statistics between the brown red soils in Jinjiang Town and the shallow brown soils in Tongdezhen, with little correlation and great differences in 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. In view of the organic matter content in Renhe District, 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.

3.6 Analysis of Soil Ammonium Nitrogen

Through data analysis and processing, the distribution state map of soil ammonium nitrogen in the study area of Renhe District was drawn by using ARCGIS software. The deeper towns showed that the content of soil ammonium nitrogen was higher, and the lighter areas indicated that the content of soil ammonium nitrogen was relatively low. The distribution of soil ammonium nitrogen is shown in Figure 3.8 below.

Figure 3.8 Soil Ammonium Nitrogen Distribution Map

Sigmaplot was used to build figure and SPSS was used to perfume one way ANOVA analysis. The Ammonium Nitrogen data were analyzed as shown in Figure 3.9.

Figure 3.9 Soil Ammonium Nitrogen one way ANOVA analysis graph

The ammonium nitrogen content classification table in China is shown in Table 3.4 below:

Table 3.4 Soil Ammonium Nitrogen (mg/Kg) grade

From Figure 3.8 and Figure 3.9, we can see that the content of ammonium nitrogen is relatively high in the yellow soil of Dahe Middle Road, and the difference between the yellow soil of Dahe Middle Road and the lateritic red soil of Datian Town is significant in statistics. However, the soil ammonium nitrogen content in Renhe Town is very low, and the ammonium nitrogen content needs to be improved urgently.

Nitrogen is not only an integral part of plants, but also participates in many biochemical processes of plants. Nitrogen is closely related to plant life activities. When nitrogen deficiency occurs, plants will lose their green color due to nitrogen deficiency. They grow short and weak, have fewer branches and tillers, and have light green or yellow-green leaves with uniform color. At the same time, ammonium nitrogen is positively charged, while soil is negatively charged, which is easy to be adsorbed by soil colloids and thus not easy to drain (such as rainwater, flooding, etc.). There are two ways for plants to absorb ammonium nitrogen: one is directly absorbed by plants in the form of ammonium ions, the other is oxidized to nitrate, which is absorbed by plants in the form of nitrate. Ammonia is easily volatilized in alkaline environment. High concentration of ammonium nitrogen is easily toxic to crops. The excessive ammonium uptake by crops inhibited the absorption of calcium, magnesium and potassium. However, this characteristic is suitable for tobacco requirements, so Renhe Town soil is more suitable for tobacco crops, and other crops need to increase ammonium nitrogen content appropriately.

Therefore, some methods to increase the content of ammonium nitrogen are as follows: (1) Applying ammonium nitrogen fertilizer and deep application at 8-15 cm is the most suitable, covering the soil, increasing the adsorption of ammonium ions in the soil, reducing the volatilization of nitrogen nutrients, and improving the utilization rate of nitrogen fertilizer; (2) mixing with other fertilizers, the release ratio of nitrogen fertilizer. Slow, creating suitable nutrient supply conditions is an important measure to increase the yield of nitrogen fertilizer.

3.7 Analysis of Soil Available Phosphorus

Through data analysis and processing, ARCGIS software was used to draw the distribution state map of soil available phosphorus in the study area of Renhe District. The deeper villages and towns showed that the content of soil available phosphorus was higher, and the lighter areas indicated that the content of soil available phosphorus was relatively low. The distribution of available phosphorus content in soil is shown in Figure 3.10 below.

Figure 3.10 Soil Available Phosphorus Distribution Map

Sigmaplot was used to build figure and SPSS was used to perfume one way ANOVA analysis. The Available Phosphorus data were analyzed as shown in Figure 3.11.

Figure 3.11 Soil Available Phosphorus one way ANOVA analysis graph

The classification table of available phosphorus content in China is shown in Table 3.5 below:

Table 3.5 Soil Available Phosphorus (mg/Kg) grade

From the above figure 3.10, figure 3.11 and table 3.5, it can be seen that the phosphorus content of Futian Town belongs to the general level in the standard of available phosphorus grade. The yellow soil of Dahe Middle Road, the shallow brown soil of Renhe Town, the brown red soil of Jinjiang Town, the white sand soil of Datian Town, the lateritic red soil of Pingdi Town, the shallow brown soil of Tongdezhen and the deep brown soil of Budezhen belong to the higher level. On the whole, most of the areas in Renhe District belong to phosphorus-rich areas. In the analysis of soil correlation, the difference between the shallow brown soils in Renhe Town and the brown soils in Futian Town is obvious in statistics. In view of phosphorus deficiency and low phosphorus areas, we can make the following improvements:

Because of the close relationship between phosphorus and nitrogen, the effect of phosphorus fertilizer can not be brought into full play when nitrogen is deficient. Only when combined application of nitrogen and phosphorus can the effect of phosphorus fertilizer be brought into full play. Because phosphorus promotes the synthesis, transformation and transportation of carbohydrates and is beneficial to the growth of seeds, tubers and tubers, the yield of potatoes, sweet potatoes and cereals is obviously increased after phosphorus application. Generally, phosphorus-deficient soils are alkaline soils. Alkaline soils are not really phosphorus-free, but phosphorus in general soils exists in soluble phosphates such as sodium hydrogen phosphate and sodium dihydrogen phosphate. In alkaline soils, these phosphates exist in insoluble substances such as calcium phosphate and can not be dissolved in soil solution, so they can not be vegetated. 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, the commonly used method is to apply phosphorus fertilizer to the soil, such as phosphate rock powder, bone powder, phosphate rock potassium dihydrogen. Secondly, in daily life, grass ash is also a relatively convenient and common substance to improve soil phosphorus content. Quality is a more economical and affordable choice.

3.8 Analysis of Soil Effective Potassium

Through data analysis and processing, ARCGIS software was used to draw the distribution state map of soil available potassium in the study area of Renhe District. The villages and towns with darker colors showed that the content of soil available potassium was higher, while the areas with lighter colors showed that the content of soil available potassium was relatively low. The distribution of available potassium in soil is shown in Figure 3.12 below.

Figure 3.12 Soil Effective Potassium Distribution Map

Sigmaplot was used to build figure and SPSS was used to perfume one way ANOVA analysis. The Effective Potassium data was analyzed as shown in Figure 3.13.

Figure 3.13 Soil Effective Potassium one way ANOVA analysis graph

The classification table of effective potassium content in China is shown in tables 3.6 below:

Table 3.6 Soil Effective Potassium (mg/Kg) grade

From the above analysis of Figure 3.12, Figure 3.13 and Table 3.6, it can be concluded that the available potassium of brown soil in Futian Town belongs to the medium level; the white sand soil in Datian Town and the deep brown soil in Bude Town belong to the high level; the shallow brown soil in Renhe Town, the yellow soil in Dazhong Road, the lateritic red soil in Pyongdi Town, the brown red soil in Jinjiang Town and the shallow brown soil in Tongde Town belong to the extremely high level. Level. The correlation analysis showed that there were significant differences between the brown red soil in Jinjiang Town and the brown soil in Futian Town. On the whole, the soil available potassium content in Renhe District is relatively rich.

In Futian Town, where potassium content is relatively low, measures to increase potassium content include: applying different kinds of potassium fertilizers, potassium chloride and potassium sulfate are commonly used as potassium fertilizers. 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, namely magnesium sulfate. Potassium fertilizer; Utilizing organic fertilizer as far as possible, our country lacks potassium fertilizer resources, and a large amount of potassium fertilizer needs to be imported. Therefore, we should take local materials and increase the sources of potassium fertilizer, such as returning straw to the field, returning plant ash 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.

3.9 Soil Fertility Radar Graph

Radar graph of soil fertility in the study area was made by excel. To study the soil types and soil fertility in Renhe District, and to provide guidance for agricultural production. The radar graph of soil fertility is shown in Fig. 3.14.

Figure 3.14 Soil Fertility Radar Graph

The above radar maps are constructed from the average values of soil water content, organic matter content, ammonium nitrogen content, available phosphorus content, available potassium content and so on.

Based on the above principle, three soil samples of each plot are analyzed by radar plot according to the changed range, and the area of each soil sample is calculated by radar plot. The area obtained by radar plot is analyzed by one-way ANOVA using SPSS software again. The average value and standard deviation are calculated and the same subset is calculated and labeled. The results are shown in Table 3.7.

Table 3.7 Soil Fertility Data Table

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

Through the area of soil radar map, we can find that the soil fertility of Renhe Town, Dahe Middle Road, Jinjiang Town and Tongde Town is relatively high, and all the indexes belong to the upper and middle level. The soil fertility meets the requirements of crop growth. The soil fertility of Datian Town, Pingdi Town and Bude Town is moderate, but some indexes are not suitable for crop growth, but they are not suitable for crop growth. Generally speaking, the soil fertility of Futian Town is very poor, and the soil fertility needs to be changed urgently. The improved method can be used according to the above analysis methods.

Pearson's correlation

Table 3.8 Pearson's correlation coefficients for relationships among soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Renhe District.

As the table 3.8 shown, significant negative correlations of organic matter with pH -0.420 ($P<0.05$), pH with K -0.419 ($P<0.05$), significant positive correlations of pH with N 0.410 ($P<0.05$), pH with P 0.553 ($P<0.01$) and N with P 0.577 ($P<0.01$) were observed. This means higher organic matter content can decrease pH value to adapt to plant growth; lower pH values can increase K content; higher pH values can increase N and P contents, especially P content; N and P content are positive correlated.

Principal component analysis

Table 3.9 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 Renhe District.

Figure 3.15 Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Renhe District.

Figure 3.16 Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Renhe District, based on ordination of the plots of the different soil types by the first two principal components (PC). 1=Light brown soil 1 in Renhe; 2=Yellow soil in Dahezhonglu; 3=White sandy soil in Datian; 4=Lateritic red soil in Pingdi; 5=Brown red soil in Jinjiang; 6=Dark brown soil in Bude; 7=Light brown soil 2 in Tongde; 8=Brown soil in Futian. The number 1, 2, 3 for example 7-1, 7-2, 7-3, are three sample reduplicate for each soil type.

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 Renhe District soil Table 3.9 showed that the first two components accounted for 62.6% of the total variance. The first component (PC1, 37.5%) was mainly positively associated with the parameters pH (variable loadings: 0.832), N (variable loadings: 0.767) and P (variable loadings: 0.788). The second component (PC2, 25.1%) was mainly positively associated with organic matter (variable loadings: 0.576) and K (variable loadings: 0.831). Figure 3.15 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 3.16 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 research, eight townships in Renhe District of Panzhihua City were taken as research objects. Through the classification of soil system in sampling area, Tpy-6a measuring instrument was used to analyze the data of soil moisture, pH, organic matter, ammonium nitrogen, available phosphorus and available potassium. The following conclusions were drawn:

(1) The analysis of soil water content shows that the soil water shortage is serious in most areas of Renhe District, which can hardly reach the normal level. In view of this result, we can consider opening reservoirs, constructing ditches and using greenhouse planting at the edge of the plot to realize the efficient utilization of water resources and the improvement of soil water content. At the same time, regular artificial water spraying can be used to replenish water for crops to meet the needs of crop growth.

(2) The analysis of soil pH shows that the soil in this area is weak alkaline except Pingdingzhen which is weak acidic. The alkaline soil is not conducive to the growth and development of some plants and will affect the retention of soil phosphorus. Therefore, it is necessary to improve the soil as a neutral soil, and improve water conservancy facilities through agricultural improvement. Or apply fertilizers, phosphogypsum, salt inhibitors and other chemicals to reduce soil pH to meet the growth needs of related crops, while increasing the content of soil phosphorus.

(3) The analysis of soil organic matter shows that the content of soil organic matter in Renhe District is generally higher than the normal level, which may be related to the special soil quality in Renhe District, or it may be that there are too few sampling points in the process of sampling in this study, resulting in a higher content of soil samples.

(4) Through the analysis of soil ammonium nitrogen, it was found that the whole area of Renhe District was deficient in nitrogen, and nitrogen was an essential element for plant growth, which needed to be taken measures. In order to improve the nitrogen content, the most effective method at present is to apply ammonium nitrogen fertilizer, which is most suitable for deep application in 8-15 cm of soil, cover the soil, increase the adsorption of ammonium ions in the soil, reduce the volatilization of nitrogen nutrients, and increase the utilization rate of nitrogen fertilizer, so as to improve the fertility status of the whole soil in Renhe District. High crop yields.

(5) Through the analysis of available phosphorus in soil, it is found that the phosphorus content in most areas of Renhe District is relatively abundant, and in a few areas is deficient. Another way to improve this index is to adjust the acidity and alkalinity of soil. Secondly, we should pay attention to the addition of phosphorus fertilizer to make rational use of it.

(6) Through the analysis of available potassium in soil, it is found that the whole area of Renhe District is in the state of potassium surplus. For the areas with lower potassium content in Futian Town, the measures of returning plant ash to the field can be implemented. At the same time, the mixed application of nitrogen and phosphorus fertilizer should be noticed to improve the potassium content in the soil.

Generally speaking, the soil types in Renhe District are relatively rich, the soil structure is relatively complex, and the causes of soil formation are diverse, which leads to the diversification of related soils in different regions and good soil fertility.

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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

Dahezhonglu Yellow soil

Renhe Light brown soil

JinJiang Brown red soil

Datian White sandy soil

Futian Brown soil

Pingdi Lateritic red soil

Bude Dark brown soil

Tongde Light brown soil

Figure 2.1 Distribution of sampling points

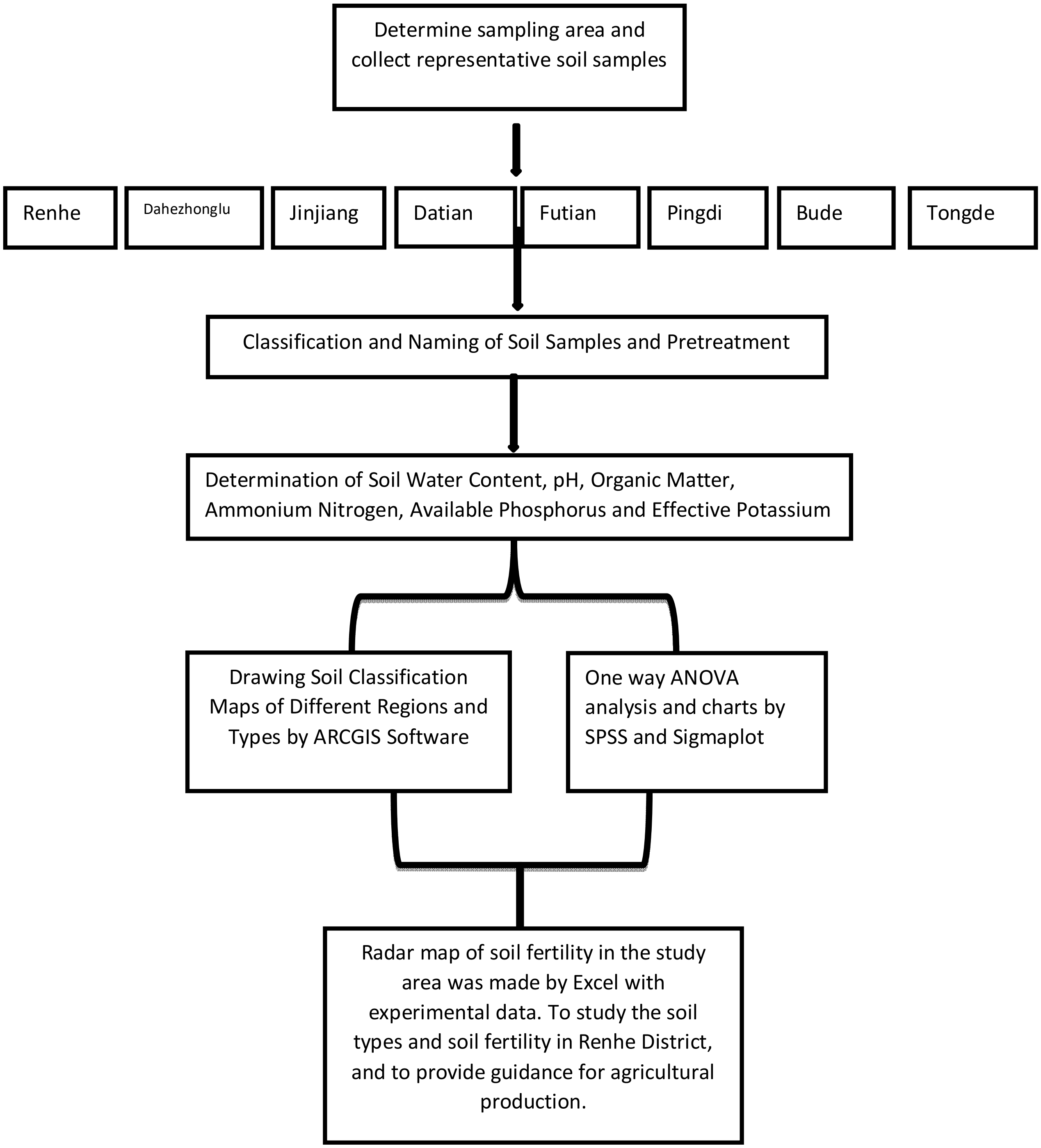

Figure 2.2 Technical Roadmap

Table 3.1 Average Nutritional Components of Soil

Region	Soil type	Water content（%）	pH	Organic matter（%）
Renhe	Light brown soil 1	2.17%±1.75%a	8.27±0.09ef	7.69%±1.90%b
Dahezhonglu	Yellow soil	0.56%±0.14%a	8.33±0.08f	6.04%±0.57%ab
Datian	White sandy soil	0.36%±0.48%a	8.15±0.05def	7.15%±0.44%b
Pingdi	Lateritic red soil	1.51%±0.24%a	6.14±0.08a	12.57%±0.39%c
Jinjiang	Brown red soil	2.66%±0.18%a	7.78±0.02bc	3.94%±0.35%a
Bude	Dark brown soil	2.23%±0.43%a	7.57±0.07b	12.41%±0.50%c
Tongde	Light brown soil 2	0.94%±0.58%a	7.96±0.04cd	16.63%±0.89%d
Futian	Brown soil	1.61%±0.19%a	8.07±0.05de	5.37%±0.22%ab

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

Table 3.2 Average Nutritional Components of Soil

Region	Soil type	Ammonium Nitrogen（mg/kg）	Available Phosphorus (mg/kg)	Effective Potassium（mg/kg）
Renhe	Light brown soil 1	15.67±3.29ab	27.27±0.57d	179.67±19.70abc
Dahezhonglu	Yellow soil	24.80±1.39c	26.93±1.24d	250.00±47.46bcd
Datian	White sandy soil	12.40±1.73ab	22.80±0.16c	158.00±26.94ab
Pingdi	Lateritic red soil	10.00±1.63a	16.07±0.77ab	323.67±40.74d
Jinjiang	Brown red soil	18.00±1.63bc	18.40±0.75b	333.00±54.70d
Bude	Dark brown soil	14.00±1.63ab	17.00±1.18ab	147.67±27.18ab
Tongde	Light brown soil 2	13.67±1.69ab	24.60±1.39cd	291.00±31.28cd
Futian	Brown soil	9.33±2.81a	13.87±0.77a	71.67±9.17a

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

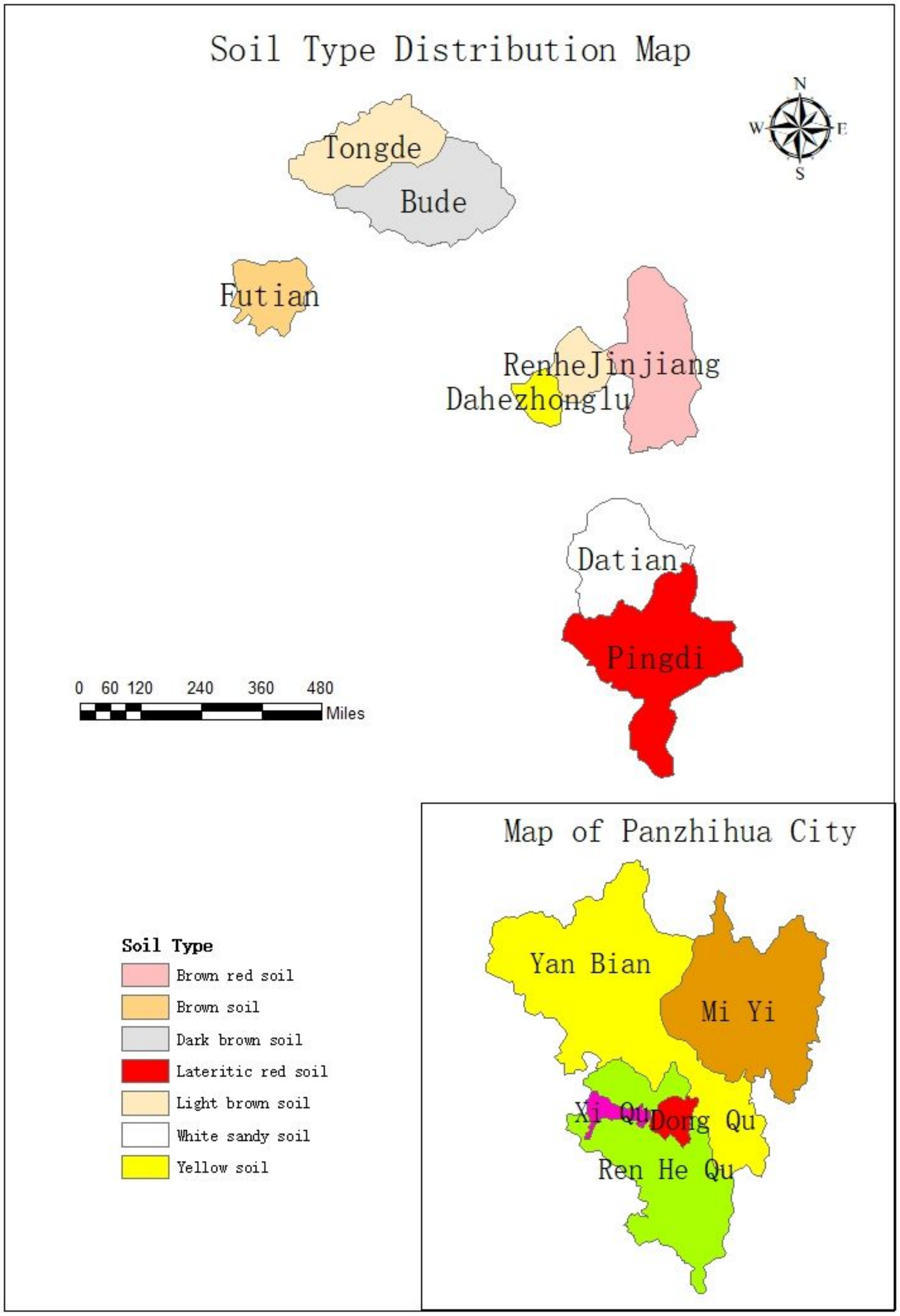

Figure 3.1 Soil Type Distribution Map

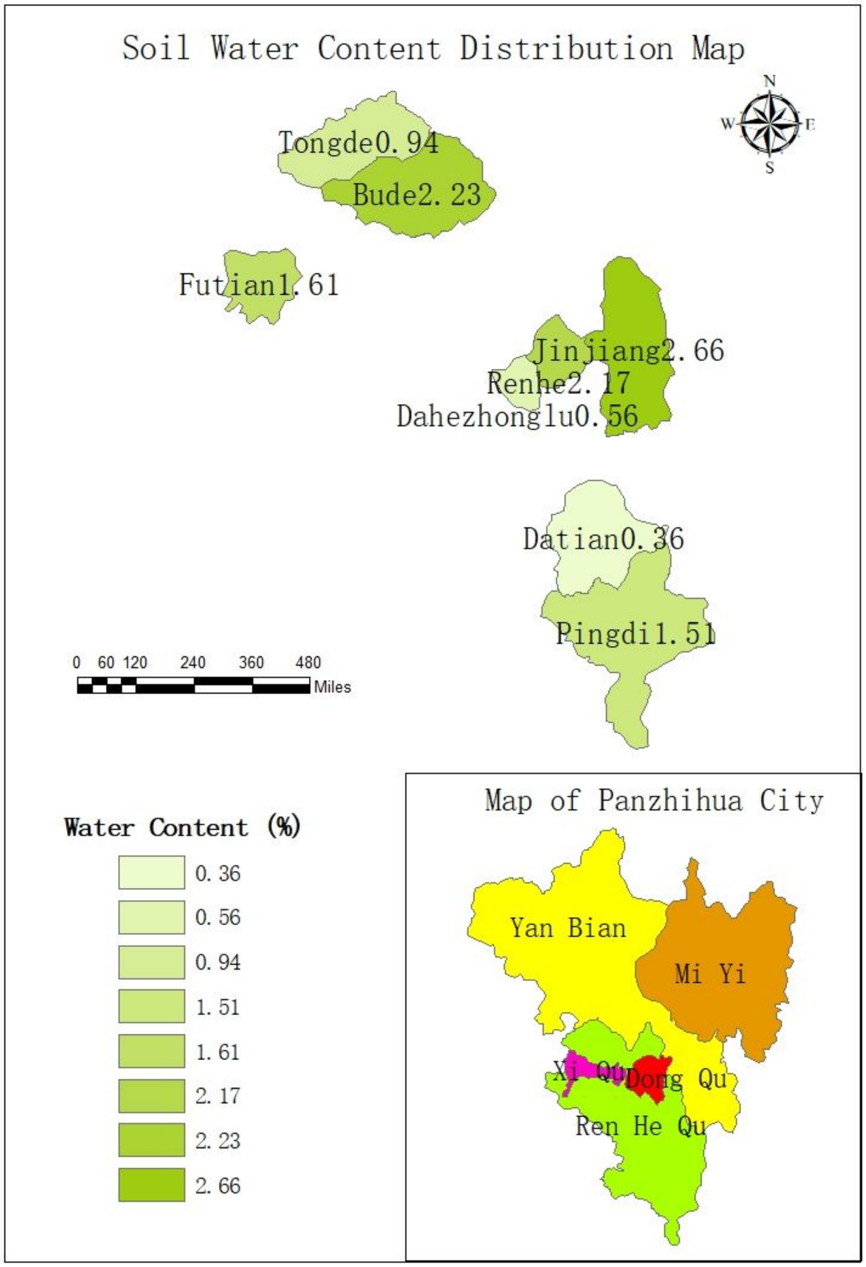

Figure 3.2 Soil Water Content Distribution Map

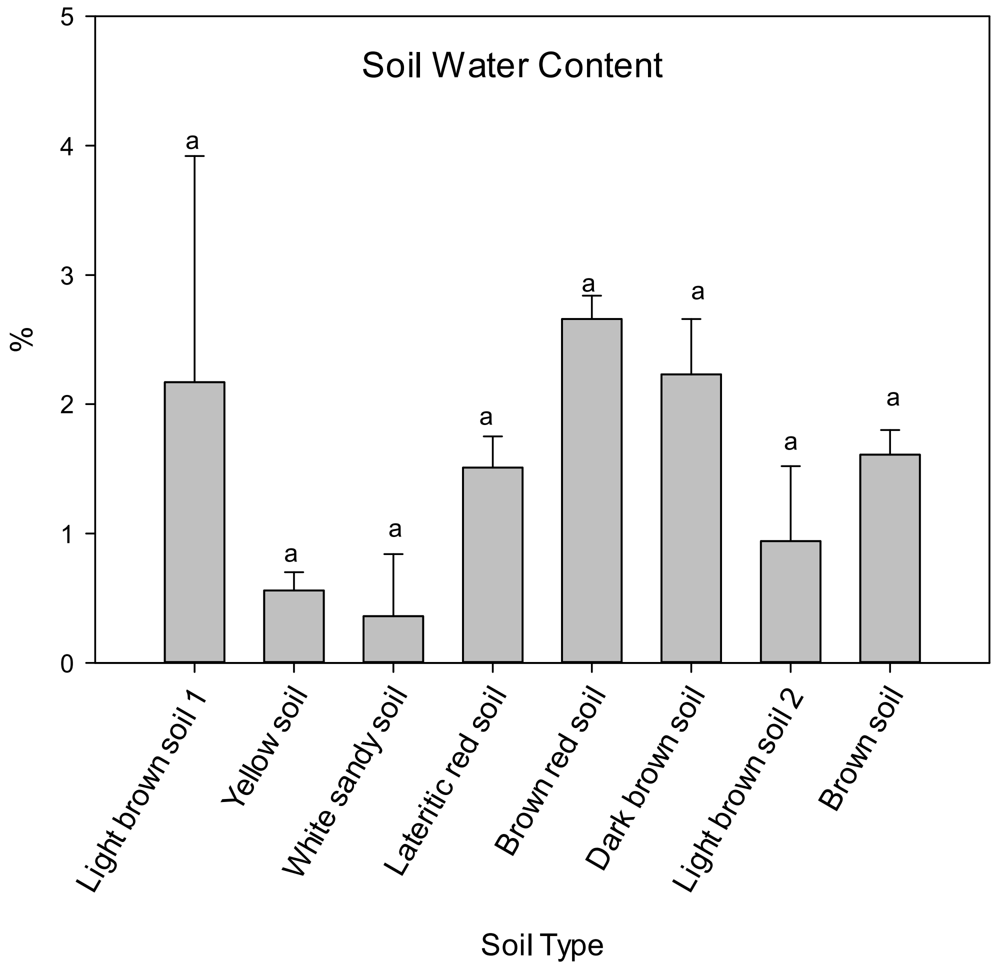

Figure 3.3 Soil water content one way ANOVA analysis graph

Table 3.1 Soil water content (%) classification

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

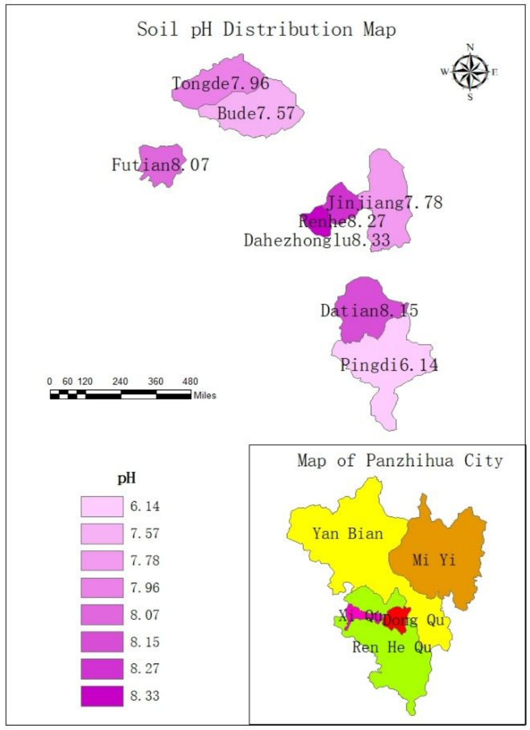

Figure 3.4 Soil pH Distribution Map

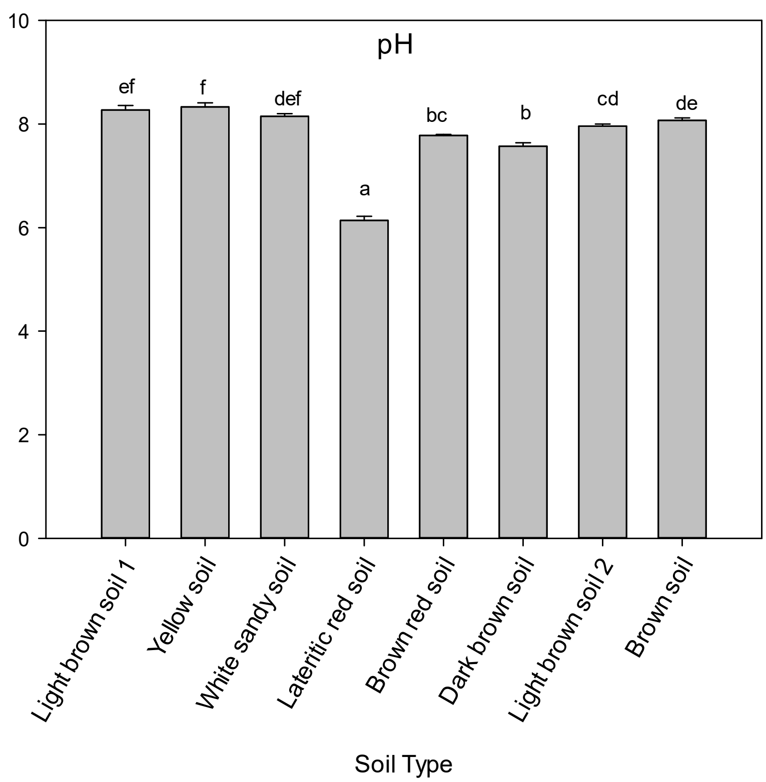

Figure 3.5 Soil pH one way ANOVA analysis graph

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

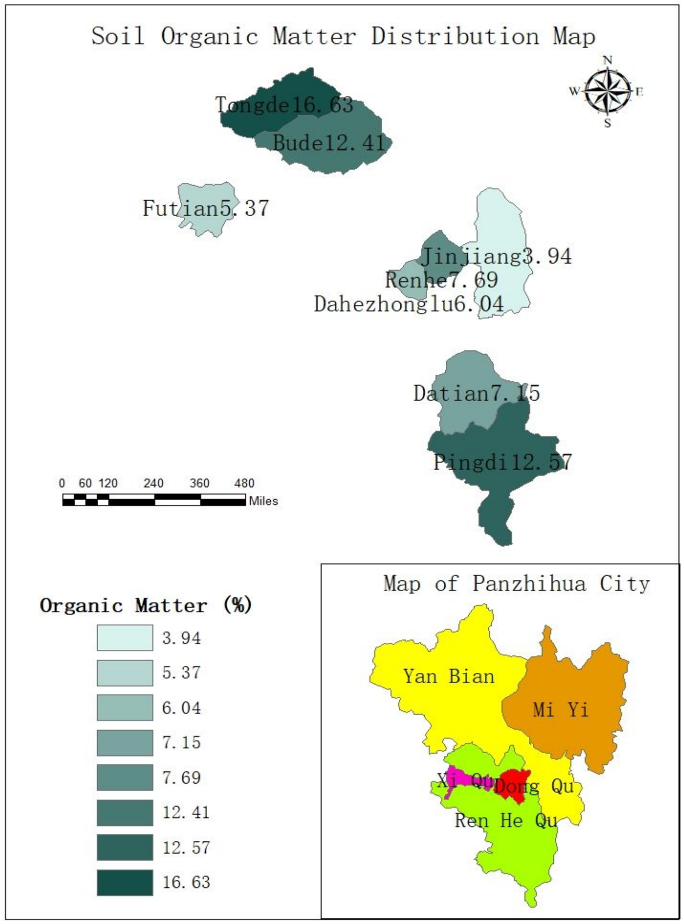

Figure 3.6 Soil Organic Matter Distribution Map

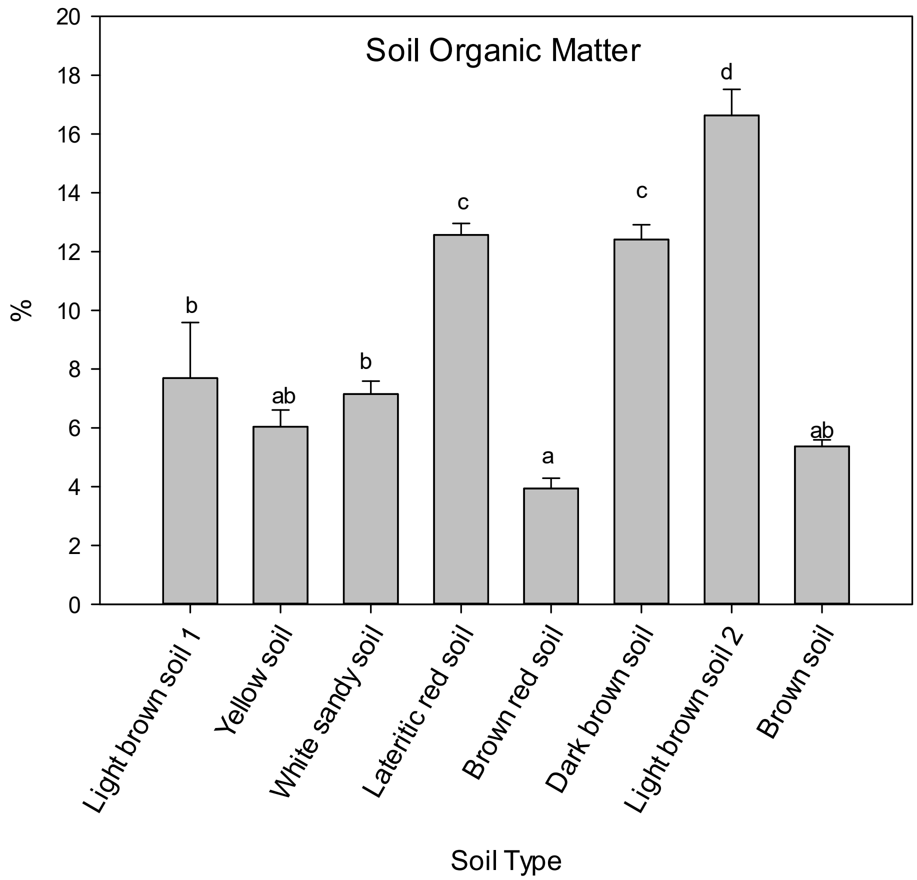

Figure 3.7 Soil organic matter one way ANOVA analysis graph

Table 3.3

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

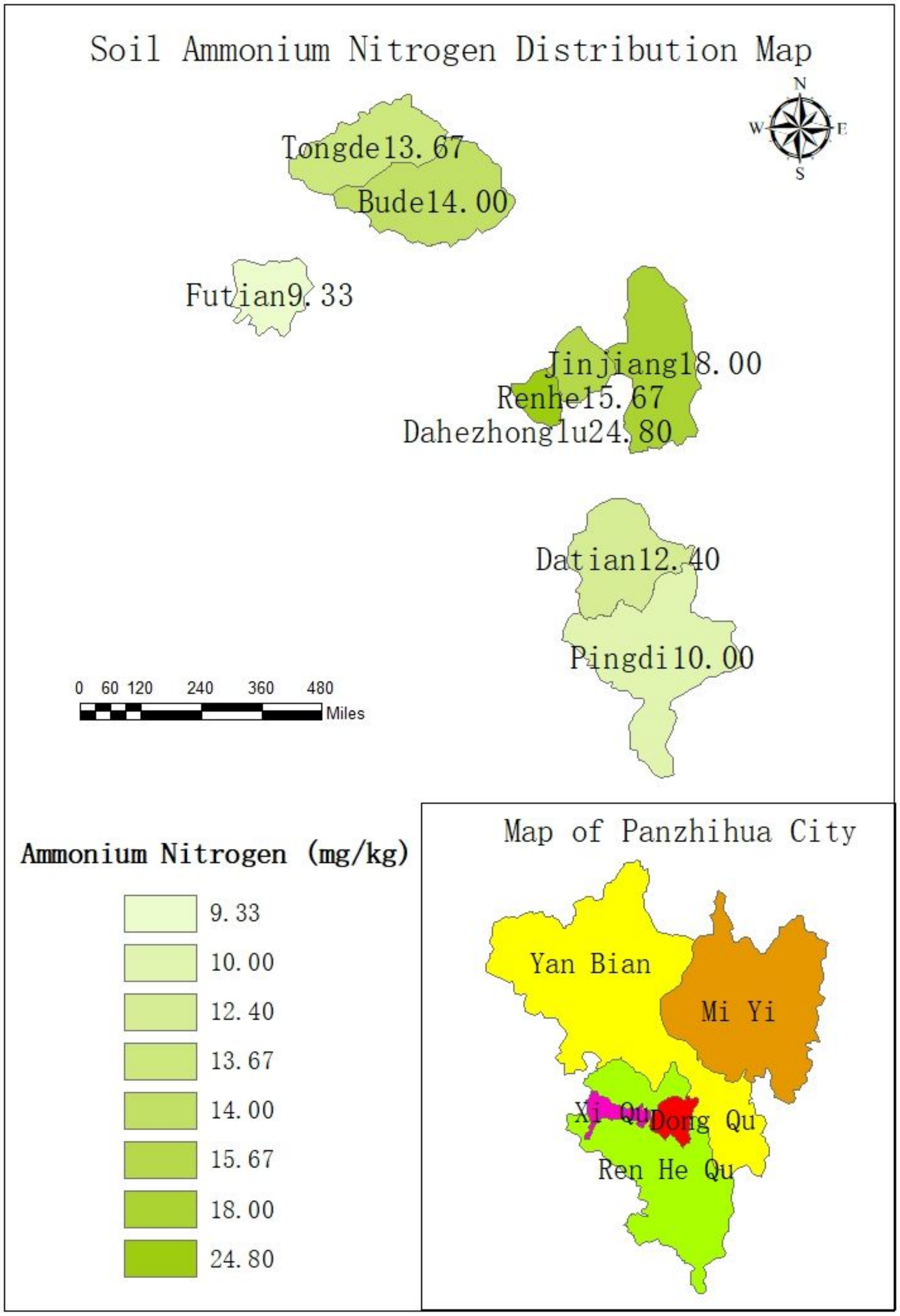

Figure 3.8 Soil Ammonium Nitrogen Distribution Map

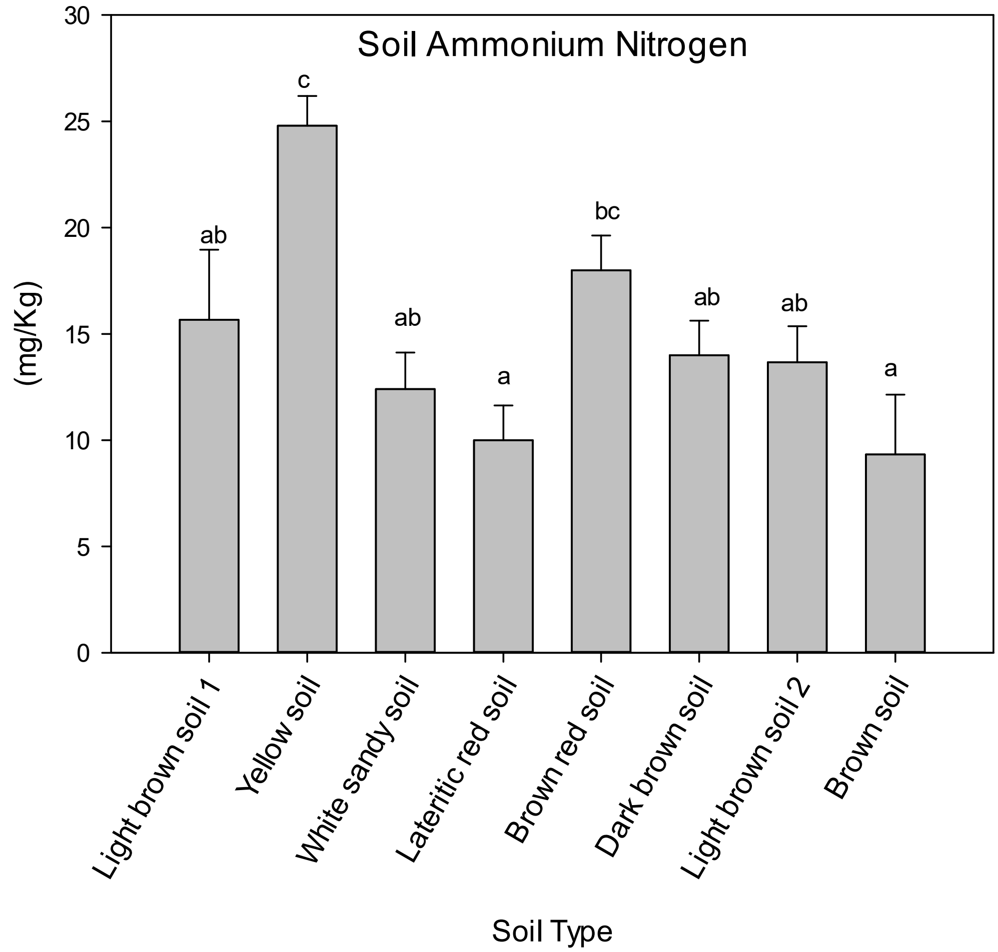

Figure 3.9 Soil Ammonium Nitrogen one way ANOVA analysis graph

Table 3.4 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

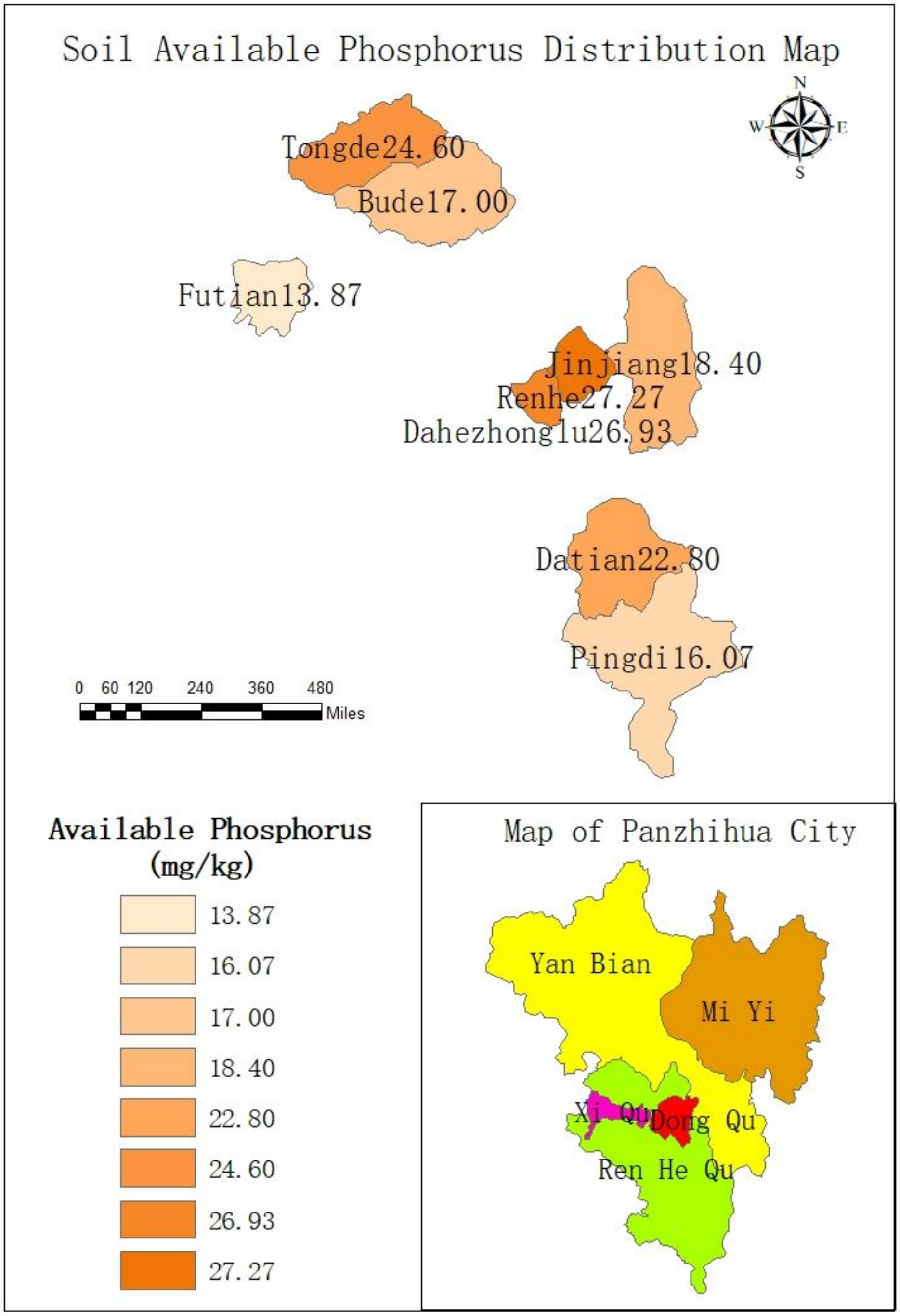

Figure 3.10 Soil Available Phosphorus Distribution Map

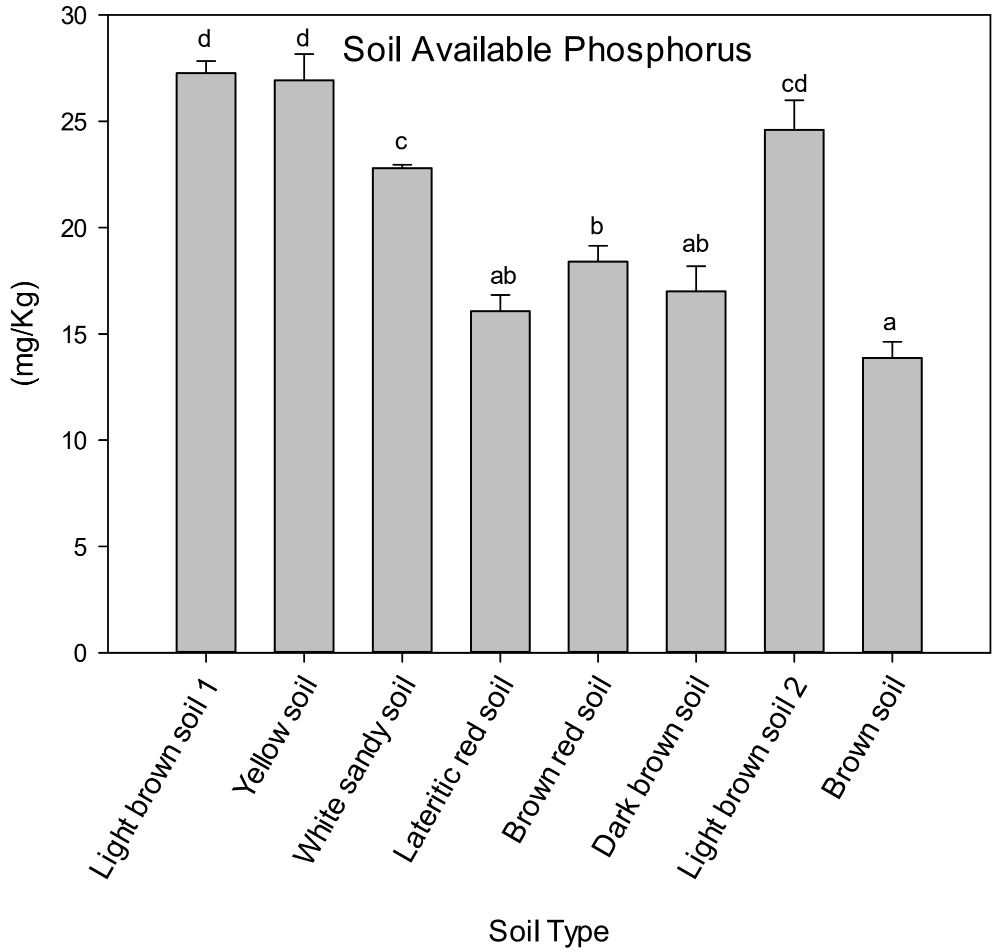

Figure 3.11 Soil Available Phosphorus one way ANOVA analysis graph

Table 3.5 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

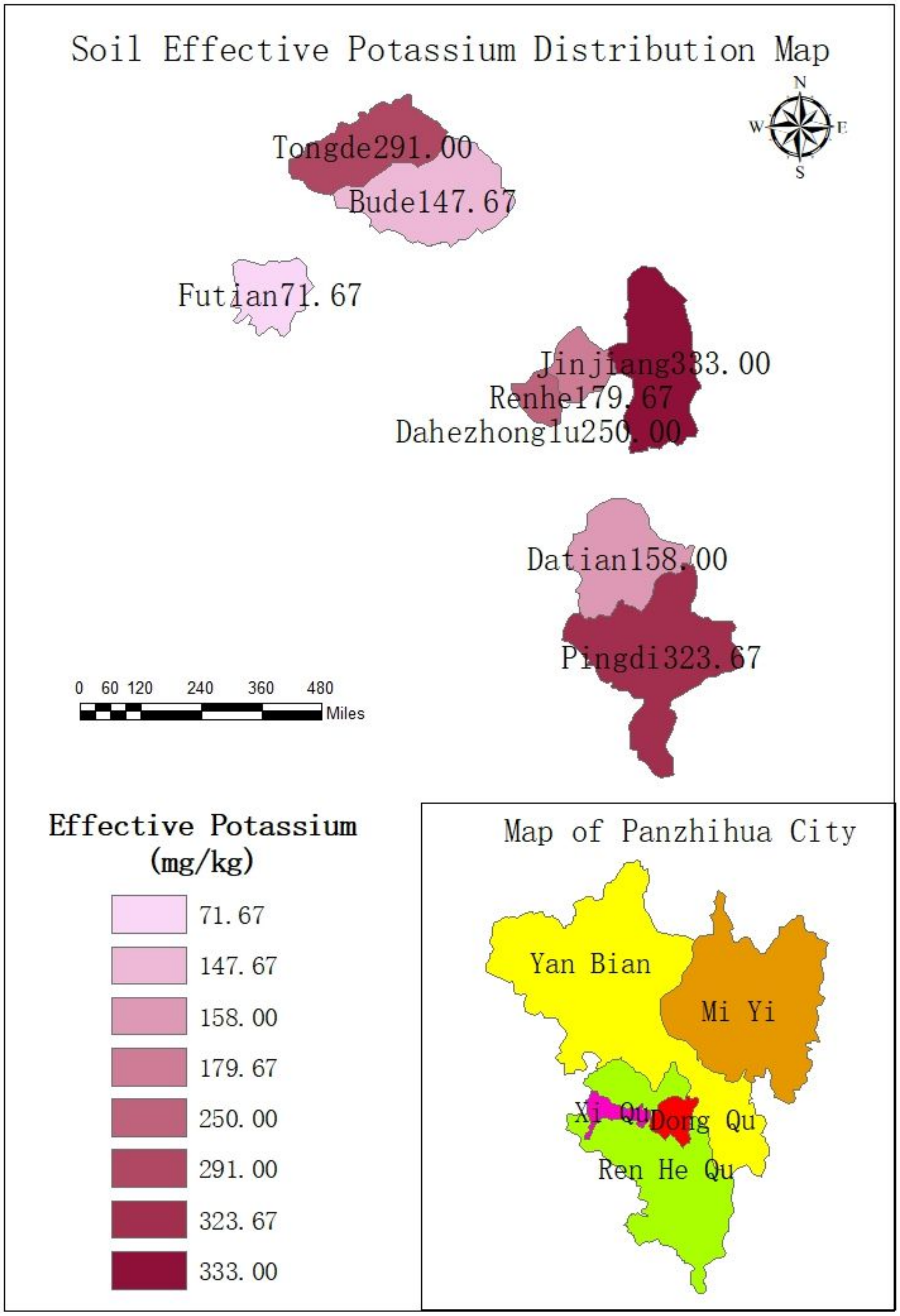

Figure 3.12 Soil Effective Potassium Distribution Map

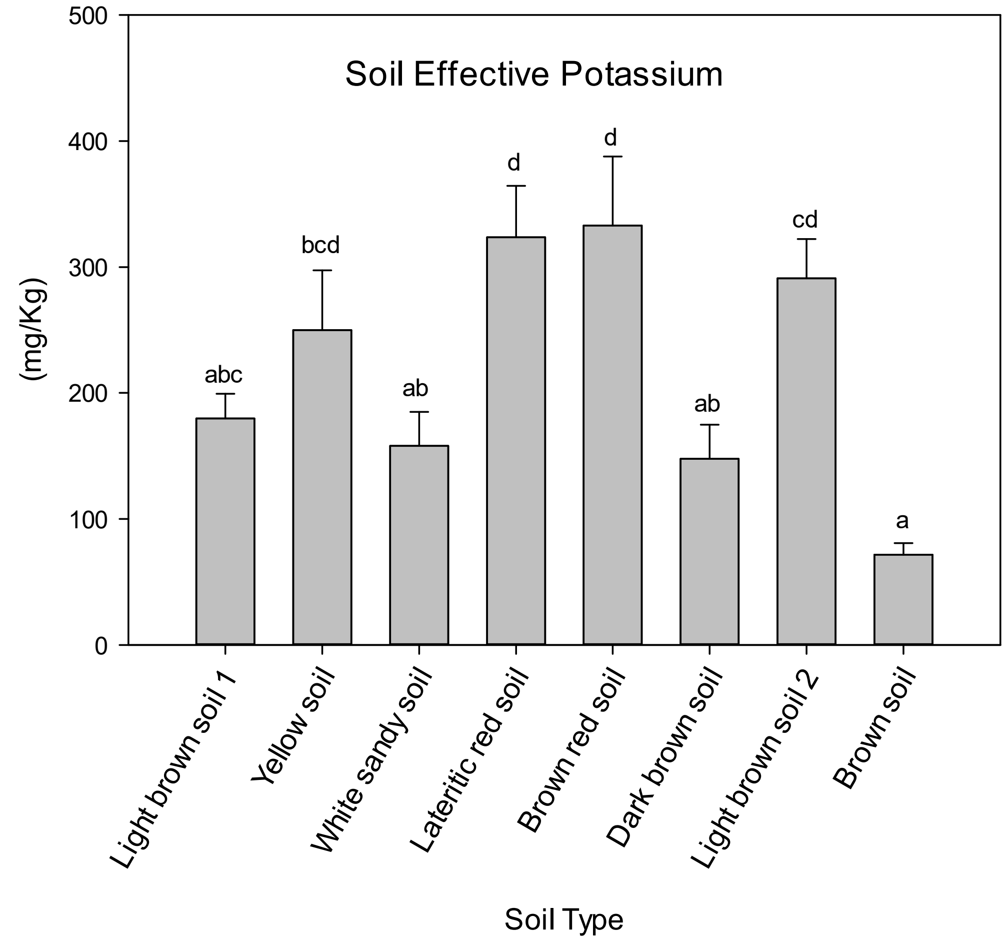

Figure 3.13 Soil Effective Potassium one way ANOVA analysis graph

Table 3.6 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

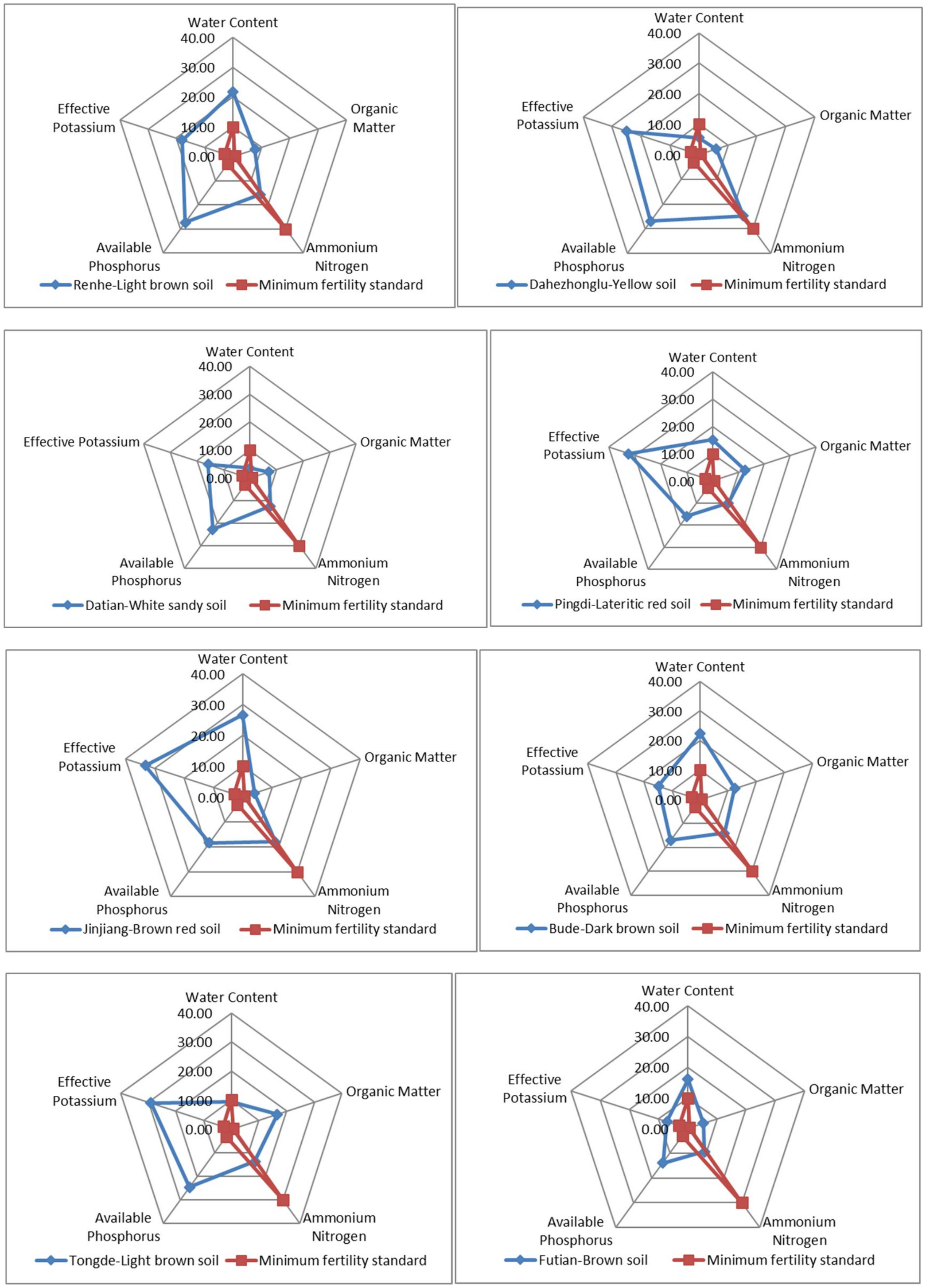

Figure 3.14 Soil Fertility Radar Graph

Table 3.7 Soil Fertility Data Table

Region	Soil sample1	Soil Sample2	Soil sample3	Average±S.D.
Renhe- Light brown soil 1	317.75	348.10	575.70	413.85±115.12ab
Dahezhonglu- Yellow soil	472.15	416.69	377.17	422.00±38.96c
Datian- White sandy soil	195.04	197.43	219.21	203.89±10.89ab
Pingdi- Lateritic red soil	314.97	380.88	437.39	377.75±50.3bc
Jinjiang- Brown red soil	507.52	417.39	612.48	512.46±79.72c
Bude- Dark brown soil	330.81	283.84	344.16	319.60±25.87abc
Tongde- Light brown soil 2	451.84	324.70	523.07	433.21±82.05c
Futian- Brown soil	116.31	135.46	114.20	121.99±9.56a

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

Table 3.8 Pearson's correlation coefficients for relationships among soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Renhe District.

Variable	Water	Organic Matter	pH	N	P	K
Water	1	-0.087	-0.153	-0.193	-0.298	0.063
Organic Matter		1	-0.420*	-0.280	0.038	0.220
pH			1	0.410*	0.553**	-0.419*
N				1	0.577**	0.245
P					1	0.160
K						1

*Significant at $P<0.05$ (n=24); **Significant at $P<0.01$ (n=24).

Table 3.9 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 Renhe District.

Variable	PC1	PC2
Water	**-0.386**	-0.245
Organic Matter	-0.423	**0.576**
pH	**0.832**	-0.386
N	**0.767**	0.329
P	**0.788**	0.405
K	-0.122	**0.831**
Variance explained (%)	37.5	25.1

Figure 3.15 Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Renhe District.

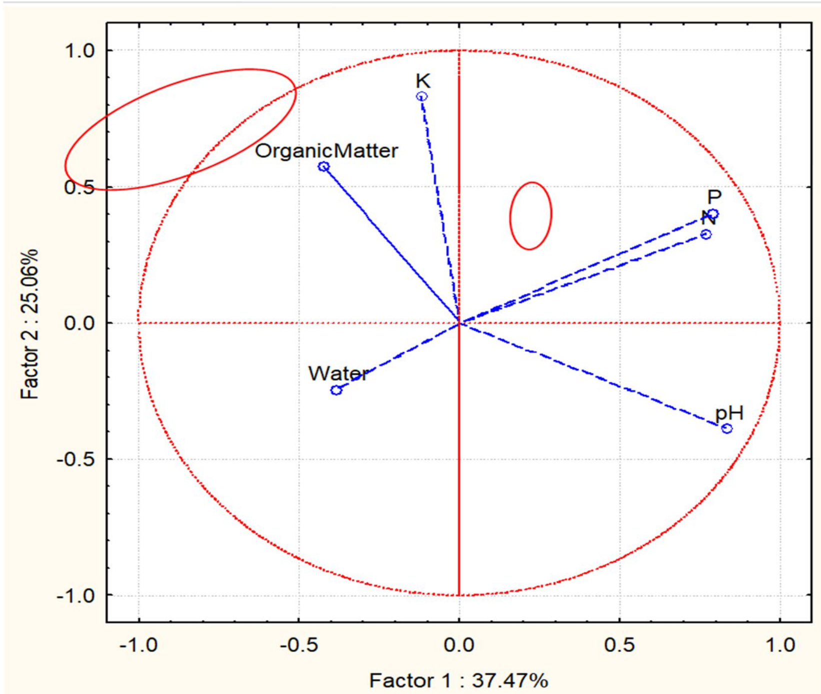

Figure 3.16 Principal component analysis of soil water content, organic matter, pH, ammonium nitrogen, available phosphorus, and available potassium content in Renhe District, based on ordination of the plots of the different soil types by the first two principal components (PC). 1=Light brown soil 1 in Renhe; 2=Yellow soil in Dahezhonglu; 3=White sandy soil in Datian; 4=Lateritic red soil in Pingdi; 5=Brown red soil in Jinjiang; 6=Dark brown soil in Bude; 7=Light brown soil 2 in Tongde; 8=Brown soil in Futian. The number 1, 2, 3 for example 7-1, 7-2, 7-3, are three sample reduplicate for each soil type.