A Comparative Study of Physicochemical Properties Previous and after Remediation of Contaminated High-sulfur Soil in Huanjiang

Su-fen Lu[1], Bo Song[1], Feng-yan Fu[1], Yuan-yuan Yu[1], Dong Liu[1],
[1]College of Environmental Science and Engineering,
Guilin University of Technology,
Guilin, China

Xue-mei Zhong[2]
[2]College of Earth Sciences,
Guilin University of Technology,
Guilin, China

***Abstract*—In 2001,the Huanjiang suffered heavy rain makes the fall of tailings, so Huanjiang river basin along the farmland is heavily polluted. The study focuses on the contaminated high sulfur polymetallic soil of Huanjiang, and conduct a preliminary evaluation on it. According to the pre-collection, the experiment adopt a total of 54 samples, analysis the pH, density, organic matter, available phosphorus, total phosphorus, nitrogen, potassium, and nutrients preliminary of the soil.**

The data shows that thesoil remediation pH, density, organic matter, available phosphorus, total phosphorus, nitrogen and total potassium mean were 6.15,1.56g/cm329.60g/kg, 9.54mg/kg, 0.57g/kg, 87.724mg/kg, 12.43g/kg respectively, Coefficients ofvariation were15%, 15.5%, 80.61%, 42.23%, 84.73% , 16.6% respectively.however, the pH, density, organic matter, nitrogen, available phosphorus mean of were6.15, 1.56g/cm3, 29.60g/kg, 9.52mg/kg, 0.57g/kg , 84.724mg/kg , 12.43g/kg. The results showed that various nutrients in the soil is still insufficient, and the spatial distribution of the difference. To ensure the growth of crops and harvest, Should be noted that in the process of planting fertilizer applied.

Keywords-HuanJiang; physical and chemical characteristics; Soil remediation; Mining area pollution.

I. INTRODUCTION

Huanjiang County is located in the south of the Yunnan-Guizhou Plateau, ranking northwestern Guangxi Hechi City, northeast(The group of Huanjiang County Writing. 2008).There are big Huanjiang River water system, injection southern rivers. the Huanjiang Fulong Village in the study area, Downstream of the big Huanjiang River, the geographical is longitude 107º51'-108º43 ', latitude 24º44'-25º33'.

In 2001, the Huanjiang suffered heavy rain makes the fall of tailings, It's Great impact on farmland and crops ring river basin edge. Contaminated soil leads to soil compaction, land barren, low-yielding crops. So, the preliminary analysis of high sulfur pollution polymetallic deposits on its physical and chemical properties of the soil by farmland, Arearable crops to make a Scientific evaluation after repair the soil.

II. MATERIALS AND METHODS

A. Sample collection and processing

The sampling were collectedin the ring Jiang Fulong mulberry areas landlords, collection points are mainly concentrated in mulberry root, with a sampler drilled to a depth of 0-20mm soil. Soil samples were collected using mesh point method, about 10 m × 10 m square vertex and the center depicting the soil about 1kg, quartering specimens after mixing 1kg bag. According to research an area to determine the number of samples, before repairing a total of 37 samples collected, a total of 18 samples were taken after the repair. Soil samples were collected mainly planted mulberry bags stored in a clean compile good numbers in the soil samples back to the laboratory, drying, grinding, respectively, over 2mm, 0.25mm,0.15mmaperture sieve and set aside. Soil samples prior to assay a variety of indicators, according to the experimental requirements, soil samples should be further processed.

TABLE 1-1. ANALYSIS PROJECT AND METHODS

Analysis Project	methods	Instrument or device
pH	Potential method	PH meter
Available nitrogen	Alkaline hydrolysis diffusion method	Hanon Group K9840 Nitrogen tester
Available phosphorus	Sodium bicarbonate extraction molybdenum, antimony yanticolorimetry	The spectrophotometer
Organic matter	Potassium dichromate oxidation– heating oil bath	Oil bath

Used Excel, OriginPro8 and SPSS18.0software sample data descriptive analysis, and data Kolmogorov-Smimov (K-S) test.

III. RESULTS AND DISCUSSION

Soil is a space-time continuum of variants, with a high spatial heterogeneity(Kabata-Pendias A and PendiasH 2001).there is a big difference content of the soil nutrients. Using statistical analysis characteristics and distributing of data related to soil nutrient content, and further understanding of the characteristics of the soil nutrient content of apparent data, the results provide a basis for analysis, and reduce the uncertainty of the calculation(Cheng-jiang HUANG, Tian-fu LI,et al. 2007).Table 1-2, the mean and deviation of the center of the sample reflects the tendency or trend in the distribution of concentration, The coefficient of variation and standard deviation reflect the degree of sampling variability or discrete samples, the $P_{K\text{-}S}$ reflects the distribution of the sample. Little difference between mean and median, indicating a smaller numerical value or special effects of large samples of small value(B 1993).The $P_{K\text{-}S}$ show that the soil fertility of various elements of the ring of high

sulfur pollution in the river, in addition to available phosphorus, other nutrients in the soil are normally distributed ($P_{K\text{-}S}$>0.05).Soil available phosphorus content logarithmic conversion normally distributed ($P_{K\text{-}S}$ = 0.418).After the repair value are normally distributed of the various indicators.

TABLE 1-2. BEFORE RESTORATION OF SOIL NUTRIENTS

	pH	Organic matter	Available nitrogen	Total phosphorus	Available phosphorus	Total K
N	36	37	37	37	37	37
Mean	4.60	27.23	115.11	0.41	8.48	18.91
Median	4.18	25.42	112.02	0.39	2.29	18.64
Standard deviation	1.17	7.35	39.36	0.14	19.27	4.70
The coefficie-nt of variation	0.25	0.27	0.34	0.34	2.27	0.25
$P_{K\text{-}S}$	0.068	0.137	0.883	0.871	0.000	0.466
Skewness	1.310	1.777	0.569	0.078	3.738	0.061
Kurtosis	0.62	3.699	0.250	0.122	14.278	-1.110
Minimum	3.50	17.61	57.30	0.055	0.50	10.81
Maxima	7.35	51.31	209.7	0.690	95.84	26.84

a. soil organic carbon, total nitrogen, total phosphorus units of g / kg;
b. soil available nitrogen, available phosphorus units are in mg / kg;
c. $P_{K\text{-}S}$ ＞0.05, Indicates that the data follow a normal distribution.

Table 1-2, the coefficient of variation ranged from 25% -227%of soil fertility factors, Where the soil pH and total K coefficient of variation of 25%, which is measured in several soil nutrient indicators smallest. The available phosphoru was 227%, which is the maximum coefficient of variation. Combination described above, soil fertility nutrient elements in the study area are variations, The available phosphorus content are strong variability, indicating its content varied widely.

A. Soil Physical Properties

1) The pH

Soil pH not only directly affect crop growth, but also closely related to soil microbial activity, soil nutrient absorption, utilization, etc(Yong-qiang YI. et al. 2007).The pH range of the study area before restoration were 3.50-7.35, after repair were4.95-7.50.before and after the average repair 4.60,6.15, Respectively. Repair before the pH at 6.5 or less acidic, strongly acidic soils accounted for 93.57%,Where pH < 4.5 strong acidic soils and pHin acidic soils between 4.5-5.0 accounted 67.57% and 13.51% of the total sample, respectively. After the repair pH values below 6.5 in the acidic, strongly acidic soils representing 58.82%,Which strongly acidic soil pH <4.5 has been improved.

2) Comparison of the soil bulk weight

Soil bulk density is one of the basic physical properties of the soil, It is large impact for the permeability, infiltration capacity, water holding capacity, solute transport characteristics and resistance to erosion of soil(Ji-yong ZHENG et al. 2004).The more soil bulk density, the less saturated water content, water content of gravity, the water content. the wilting moisture and invalid water content is increasing(Zhen CHEN.2010).Generally contain minerals and the poor of soil structure (such as sand), soil bulk density between 1.4 -1.7g/cm^3; structure containing many and good soil organic matter (such as agricultural soils), soil bulk density between 1.1g/cm^{3}and 1.4g/cm^3.The study results showed that the contaminated soil, the initial restoration of soil and the contrast of soil bulk density averages were1.56±0.083g/ cm^3,1.43±0.073g/cm^3, 1.31±0.021g/cm^3, respectively. the contaminated soil bulk density higher than clean soil, after the initial repair still did not reach the level of clean soil. For growth of plants, the repair processing should pay attention to the soil bulk density.

B. Soil chemical properties

Before restoration of the soil organic matter, nitrogen, total phosphorus, available phosphorus, total potassium averages were 27.23g/kg, 115.1mg/kg,0.41g/kg, 8.48mg/kg, 18.91g/kg, respectively. After the restoration of soil organic matter, nitrogen, total phosphorus, available phosphorus, total potassium averages were 29.74 g/kg, 84.72 mg/kg, 0.57g/kg, 11.81mg/kg, 12.43g/kg, respectively. After the restoration of soil organic matter, available phosphorus, total phosphorus is improved, Study area planted mulberry trees, The main reason is the plants absorb or unreasonable fertilizer nitrogen, reducing the total potassium.

Phosphorus is one of the three basic elements to required for plant growth and development. Total phosphorus, available phosphorus in the soil before and after the repair averages were 0.41g/kg, 0.57g/kg, 8.48mg/kg, 9.52mg/kg , respectively(3-2). According to the results, its content is varied widely before the repair soil, but after the restoration of soil phosphorus content to get uniform.

TABLE 3-2. NUTRIENT DISTRIBUTION AROUND THE SOIL REMEDIATION IN HUANJIANG FULONG

		The range of values	mean	CV(%)		Distribution ratios(%)						$P_{K\text{-}S}$
						6	5	4	3	2	1	
TP(g/kg)	1	0.05-0.69	0.41	4.00	3	5.41	8.65	37.84	8.11	0.00	0.00	0.871
	2	0.21-0.81	0.57	2.23	4	0.00	23.53	35.29	17.65	23.53	0.00	0.890
Available phosphorus (mg/kg)	1	0.50-95.84	8.48	27.0	2	64.86	8.11	10.81	8.11	2.70	5.41	0.000
	2	0.47-33.97	9.52	0.61	8	0.00	17.65	47.06	17.65	17.65	0.00	0.245
Available nitrogen (mg/kg)	1	209.8-57.31	115.2	4.00	3	0.00	5.41	24.32	27.03	27.03	16.22	0.883
	2	26.24-158.2	84.72	2.17	4	0.00	35.29	29.41	11.76	17.65	5.88	0.958
TK(g/kg)	1	8.76-17.11	18.91	5.00	2	0.00	0.00	24.32	27.03	37.84	10.81	0.704
	2	10.81-26.81	12.43	6.60	1	0.00	5.88	76.47	17.65	0.00	0.00	0.466
Organic matter(g/kg)	1	17.61-51.36	27.23	7.00	2	0.00	0.00	8.11	67.57	24.32	0.00	0.137
	2	21.44-37.04	29.60	5.50	1	0.00	0.00	0.00	47.06	52.94	0.00	0.992

a. 1 represents before repair,2 represents after repair;
b. Test distribution is a normal distribution (P> 0.05)

From the distribution of nutrients in the proportion of contaminated soil, phosphorus are most lacking in Soil

nutrients. South acidic soil is easy to phosphorus deficiency, Because in acidic soils phosphorus is easily administered fixed invalid, Many small amount of insoluble phosphates and phosphate are often weak acid-soluble ironaluminum oxide film formed by so-called wrap occluded phosphorus, This form of phosphorus is difficult to release the crop absorption, belongs invalid phosphorus.

Nitrogen fertilizer is one of the indispensable crop growth and development. The mean were 115.14 mg/kg, 84.72mg/kg before and after soil remediation soil available nitrogen. Available nitrogen content are mostly concentrated in four, five. The main study area planted mulberry, mulberry root development is conducive to absorb soil nutrients are also conducive to the absorption of heavy metals in soil(Gang LIU et al. 2012).Mulberry different parts of N,P,K content and uptake of both N> P> K(Hua ZHENG et al. 2008),because most nitrogen in soil is absorbed after Mulberry.

Organic matter is an important feature of soil fertility, which is an important factor to measure the levels of soil fertility(Ji-yong ZHENG et al. 2004; Qian LI 2008).The average content of organic matter in the soil before and after the repair was 27.23g/kg, 29.60g/kg, Before and after the restoration of soil organic matter content were mainly distributed in four or five. Before and after the restoration of organic matter variability coefficients were 27.00%, 15.50%.After the instructions to repair the soil organic matter content increased, and the content is insignificant.

As the essential foundation for plant growth nutrients, potassium involved in almost all metabolic processes in plants. Under normal production conditions, crops need to absorb large amounts of potassium, and nitrogen is almost required amount of potassium. In the mean total potassium content in soil rehabilitation before and after were 18.91g/kg, 12.43g/kg, low nitrogen content of soil after the repair. Contaminated soil mainly acidic, phosphorus and nitrogen deficiency and the condition of the soil bulk density is too large, so that soil compaction is serious, and even affect the normal growth of plants can not grow. Mean contaminated soil organic matter is 27.23g/kg, its content is mainly distributed in two or three trophic levels in the soil; soil potassium content of the mean of 18.91g/kg at its content mainly distributed in two, three, four soil nutrient levels. Contaminated soil resulting in a large number of plants to wilt, Plant litter dropped in the soil are not artificially direct clean up, thereby recycling fertility through natural increase soil fertility purposes, and finally to the soil organic matter content saved.

C. Arability of the soil

Distribution and nutrient content of the soil affects the growth of various crops were compared based on the average of the ratio and the value of the content of soil nutrients before and after each repair $P_{k\text{-}s}$. After the remediation of contaminated soil pH values increased an average of 1.34 times the average of the soil available phosphorus content is also increased by 1.39 times. Soil organic matter and phosphorus content remained stable, repair of regional pollution at the same time cultivating the soil, indicating that after the restoration of soil nutrients may be sufficient to supply the growth of plants.

Comparison of the results from the soil fertility status of the overall study area and the second survey, after the restoration of soil organic matter levels to achieve the rich (>30g/kg) increased (52.94%), the average value of maintaining a moderate level; Nitrogen at moderate levels (100-200mg/kg) majority; Available phosphorus has greatly improved, an increase of 139%, the majority reached the middle level, Since the restoration of low levels of available phosphorus ago, is still in the state after the repair, but the increase in total phosphorus content; Total potassium content is low, the majority in the in the lower potassium levels; soil acidity is greatly improved.

After the restoration of soil nutrients from the overall trend in the overall results, the majority of medium fertility level of the soil after the repair, moderate organic matter content, soil pH is worth to further treatment, a general lack of phosphorus content.

Liu Bin(Bin LIU et al. 2011) Mulberry Soil Fertility Survey of Guangxi, Guangxi Mulberry draw overall soil fertility level is not high, the general lack of available nitrogen, phosphorus, potassium and magnesium, other nutrients are also some degree of deficiency or excess phenomenon, Soil Nutrients mulberry planting zone between the different degree of abundance and deficiency quite different. Soil restoration in the number of samples before the pH reached for farming accounted for only 12.81% of all samples, and 64.86% of the sample in the absence of the state. Repair Houtu sample mean pH values increased, but the number of samples to achieve a more appropriate only 41.18%.

High content of organic matter in the soil after the repair. Before Remediation of soil available nitrogen in the right amount accounted for 51.35%, 43.24% of the sample is the lack of volume. After the restoration of soil suitable for cultivation accounted for only 29.41%, while 64.71% of the sample is in the lack of volume. Soil nutrients absorbed in Mulberry, occupy most of ratio the nutrients nitrogen. In the process of fertilization is not able to reasonably control the dose of fertilizer, resulting in a serious lack of soil nitrogen.

The study area soil phosphorus scarcity highest proportion of phosphorus in soil after the repair has been some improvement. The ratio before and after an appropriate amount of repair were 10.81%, 35.29%, and some reach the nutrient content of the soil suitable for planting, but the proportion is still in lack of 47.06%,the study area is still in a lack of available phosphorus in most of the range. Organic matter, the correlation between pH and cation exchange capacity reached a significant and extremely significant level(Ding-hua ZHANG et al. 2008).Farmland in the business process, increase soil organic matter content, reduce soil acidity and improve the cation exchange capacity of the soil, can effectively reduce the phosphorus content of the soil occluded, thereby effectively improve the effectiveness of soil.

The study area is mainly used for planting mulberry, mulberry's soil is the foundation of growth, Only by understanding the situation Mulberry soil nutrient content,

in order to provide scientific guidance for crop fertilization and management of mulberry. In order to improve the utilization of the land, the soil should be reasonably applied to the lack of nutrients in order to ensure the quality of the growth of agricultural products.

IV. CONCLUSION

The results showed that the pH value of the study area after the repair is less than 6.5 accounted for 58.82% of samples, available phosphorus, nitrogen is the average value of 9.52mg/kg, 84.72mg/kg, Total phosphorus, total potassium is the average of 0.57g/kg, 12.43g/kg, the average value of organic 27.6g/kg. Derived from the various Fertility, and after the study area repair improved initial soil pH, nitrogen and phosphorus, but still in the range of extremely lacking or missing.

The presence of former major soil acidity soil remediation, compaction and lack of serious individual nutrients, After the restoration of soil acidity eased, soil potassium levels reached mulberry cultivation, but does not meet the phosphorus needed for growth of mulberry.

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