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Effect of Paddy Field Construction on Soil Nutrients of Rice at Different Growth Stages in Xi'an

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Abstract. In this paper, three typical soil types around the banks of the Grand Xi'an River are described. Lou soil, entisols and loessial soil were used as the research objects and the rice growing stages, including pre-treatment, tillering stage, jointing stage, heading stage and maturity stage, in paddy field construction were analyzed. The results showed that: In the field, the effects of Tillage in different types of soil layer ranging from 0 to 20 cm on soil nutrients are obvious, in which available phosphorus, nitrate nitrogen, ammonium nitrogen content decreased during the growth period and the content of available potassium in the overall appear to be rising. It was concluded that the jointing stage was the most prosperous period of rice growth, the potassium content in the region could meet the growth demand, and the amount of potassium fertilizer could be reduced in the coming year.

1. Introduction

The change of land use mode is the embodiment of soil management and decision making, which affects the retention and transformation of soil nutrient flow and also affects the soil development process [1]. This process is actually a process of soil reconstruction, in which soil nutrient content changes. At present, the analysis of the change of soil nutrient pool in the process of changing land use mode mainly focuses on the effect of returning farmland to forest, returning farmland to grassland and long-time closing [2, 3]. The determination and analysis of soil nutrient dynamic changes during the transformation of different soil types into paddy fields still stands in its infancy [4-6]. It has been proved that during the transformation of non-paddy land into paddy field, the changes of land cultivation measures and flooded environment will have a significant effect on the mineralization and accumulation of nutrient elements, such as nitrogen, phosphorus and potassium, especially nitrogen denitrification [7]; Soil salinity decreases and soil maturation accelerates after completion of paddy field [8], but secondary salinization occurs easily in soil. And in the early stage of completion, rice growth may be obviously restricted due to the contradiction between supply and demand of soil nutrition [5]. At present, the relevant research is still not systematic and comprehensive; in addition,

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because of the differences of soil properties and climatic conditions in different regions, the results are also different [7]. Therefore, it is of great significance for soil quality monitoring and ecological benefit evaluation of land consolidation to track and determine the dynamic changes of soil nutrients in the process of changing different soil types into paddy fields.

During the whole period from the construction of paddy fields to completion of the construction in the large Xi'an area, the contents of soil nutrients, relatively widely distributed in lou soil, entisols and Lossiah soil, especially carbon, nitrogen, phosphorus and potassium in soil, were determined in order to provide a theoretical reference for the long-term sustainable use of paddy fields and the environmental benefits of land consolidation.

2. Materials and Methods

2.1. Study area overview

Started from April to October of the year 2016, lou soil, entisols and Lossiah soil, widely distributed around the banks of the Grand Xi'an River, were chosen to test material. The soil samples were collected at fixed site before treatment of tillering, jointing, heading and maturing. The root quality of rice decreased with the increase of soil depth and the root was mainly distributed in the cultivated layer(0-20 cm), of which mostly on the surface(0-10 cm), accounting for more than 80%, so 0-20 cm soil samples are collected according to the five point method. The experiment field used the same fertilization and management methods.

The new soil sampling sites is the town of Dali County, located at north latitude 36° 02 '~35', east longitude 109°43′~110°19′, belonging to the place with climate of warm temperate semi humid and semi-arid monsoon, the average annual precipitation of 514mm, and that the light radiation per year reached a total of 526.3 kcal/cm^2.The site before changing into paddy field was an abandoned pond for lotus and fish and the time for reform is June 5th.

Lou soil sampling locations is Fuping County Chu Yuan Cun, located in the geographic coordinates of north latitude 34°41′ ~ 35°06′, east longitude 108°57′ ~ 109°26′ belonging to a place with climate of continental temperate semi-arid and semi humid. Moreover, the precipitation of annual average precipitation is 533.3 mm and the annual total light radiation reaches 123.9 kcal/cm^2 before. The paddy land vegetation cover was for wheat before. The time to change the paddy field is June 9th.

Loessial soil sampling locations in the city of Xiayukou, Hancheng is located in the geographical coordinates of, north latitude 35°18′~35°52′ and east longitude 110°7′ ~ 110°37″, belonging to place with climate of warm temperate semi-arid continental monsoon. The annual average precipitation is 555.2 mm and the total solar radiation is 121.24 kcal / cm^2 per year. The vegetation is covered with weeds and shrubs before the remake. The time to change the paddy field is June 10th.

2.2. Methods for analysis of soil physical and chemical properties

Laser particle size method was used for soil particle composition. The texture is international system; the pH was determined by potentiometric method. The total content of carbon and total organic carbon in the soil were measured by the combustion oxidation - non dispersive infrared method. The whole N was boiled by the method of Kelvin's elimination. $NaHCO_3$ extraction of available phosphorus - molybdenum antimony anti colorimetric method; K with ammonium acetate extraction - atomic absorption spectrophotometry.

2.3. Data analysis

Microsoft Excel 2013 software was used to process data; Origin2017 was used for cartography.

3. Results and analysis

3.1. Change of ammonium and nitrate nitrogen in cultivated layer of Rice at different growth stages

The nutrient contents of nitrate and ammonium in three soil types at different growth stages are shown in figs. 1 and 2. Soil mineral nitrogen mainly includes soil nitrate nitrogen and soil ammonium nitrogen, which represents the intensity of soil nitrogen supply. Under the treatment of three soil types, the soil ammonium nitrogen content during main growing stages of rice increased first and then decreased at the turning point of jointing stage. Soil ammonium nitrogen content increased during tillering and jointing stage, probably due to the increase of soil temperature and organic acids in soil and the rapid release of nitrogen in soil, while the rice had not yet entered the period with strong nutrient demand. After jointing-heading stage, the content of ammonium nitrogen in soil decreased rapidly and reached the lowest point at maturity stage, resulting from that the rice enters the dry matter accumulation period, during which the rice nutrition growth and the reproductive growth simultaneously carries out,, the metabolism is fast and the demand for nitrogen is large. During the whole growth period, the content of ammonium nitrogen in the soil present an order: entisol > lou soil > Lossiah soil .The main reason is that the organic acid produced in the process of degradation of lotus root residue can promote the conversion of nitrogen to ammonium. As with ammonium nitrogen, nitrate nitrogen is the main inorganic nitrogen absorbed by rice, as Wen Qixiao pointed out that the mobility of ammonium nitrogen is poor and can be fixed by soil lattice, while nitrate nitrogen is easy to move with water. The nitrate nitrogen content in entisol decreased first and then increased with heading time as the node. Li Guihua(2013)indicated that quality is the main factor affecting the nitrate leaching of soil texture; clay content of entisol is lower than 6%, belonging to silt loam, and tillering and jointing stage, encounter the Yellow River wet season, the shallow groundwater, and frequent lifting activities, increasing the risk of nitrate leaching loss. At the heading maturity stage, the groundwater depth increased, and the nitrate nitrogen accumulation in the topsoil increased to a certain extent.

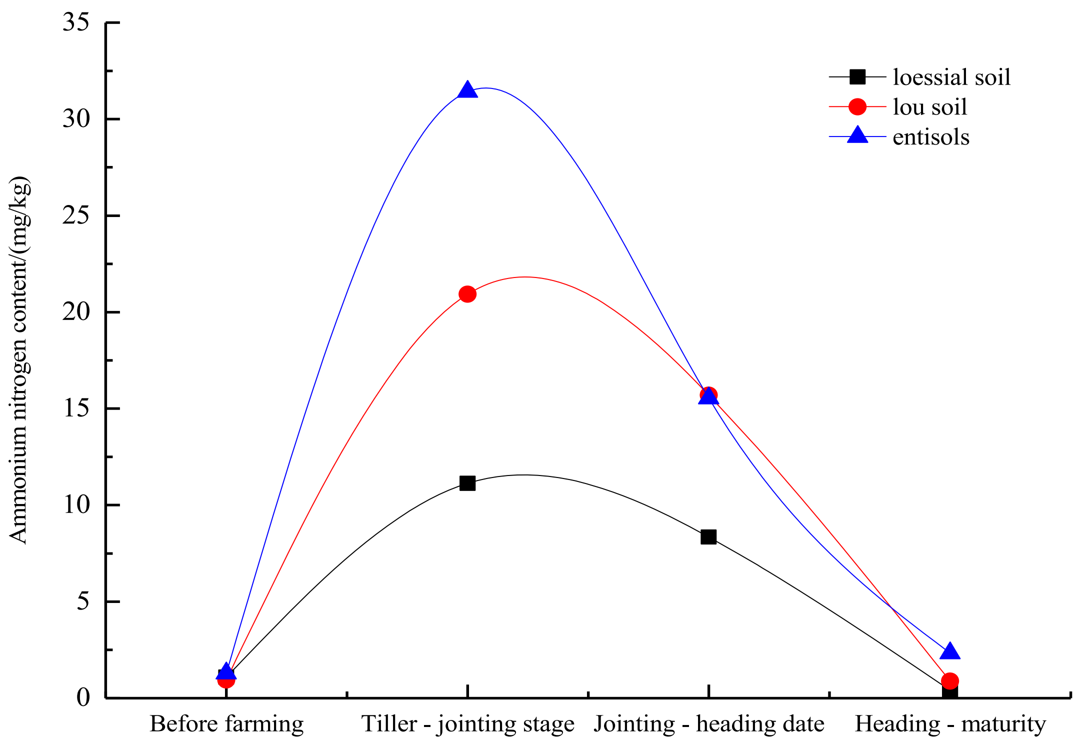

Figure 1. Variation of Ammonium Nitrogen Content in Soil in Different Growth Periods of Rice

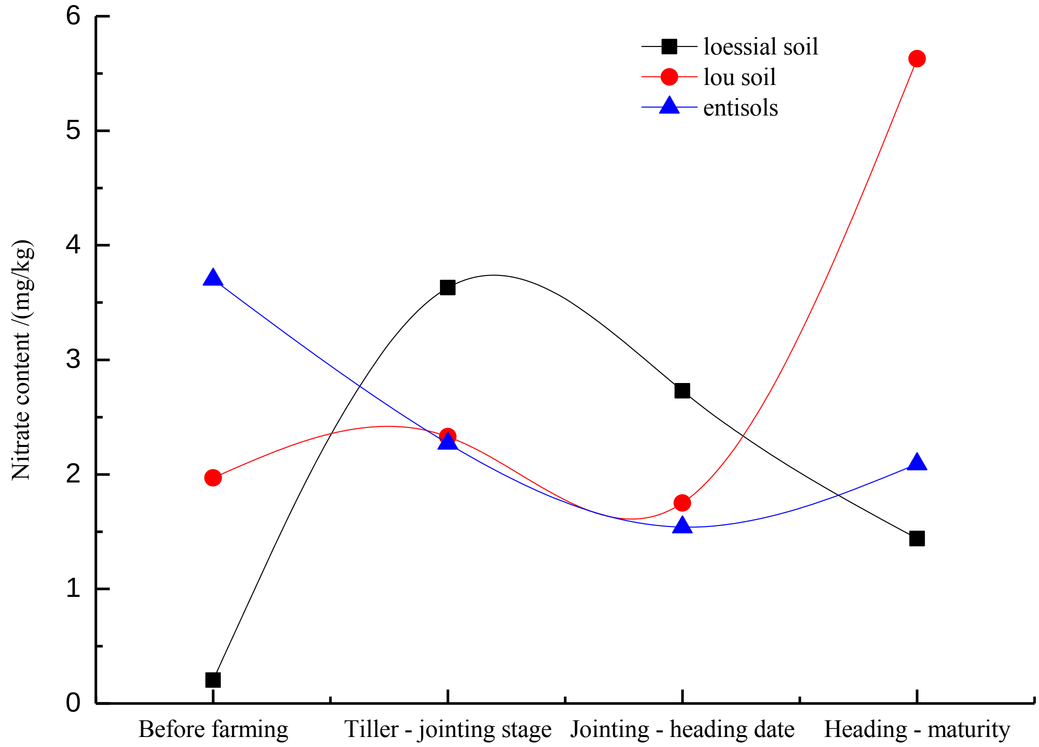

Figure 2. Changes of nitrate nitrogen content in topsoil at different growth stages of rice

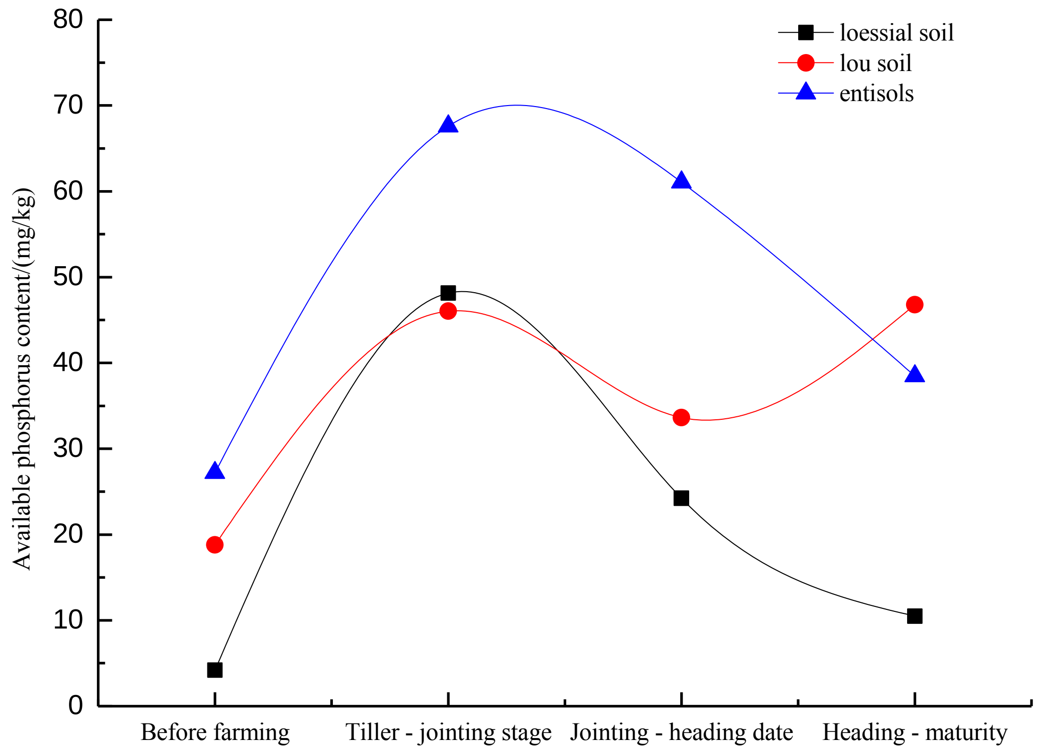

Figure 3. Changes of Available Phosphorus in Topsoil at Different Growth Stages of Rice

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3.2. Change of available phosphorus in soil topsoil at different growth stages of rice
The changes of available phosphorus in three soil types at different growth stages are shown in figure 3.The available phosphorus in soil can promote the growth and development of rice, make rice mature early, increase panicle grains and increase rice yield. As shown in figure 4, the change of soil available phosphorus content in different growth stages of rice was basically consistent with the change of ammonium nitrogen, showing a trend of first rising and then decreasing at jointing stage. The average available phosphorus content of the three soil types was 48.6 mg / kg in entisol, followed by lou soil of 36.3 mg/kg and Lossiah soil of 21.8 mg/kg. It can be seen that from tillering stage to jointing stage, the content of available phosphorus in soil decreases obviously, owing to the increase of phosphorus uptake with the increase of dry matter accumulation at jointing stage of rice. The content of available phosphorus in lou soil is higher than that in loess.

3.3. Changes of available potassium in soil tillage layer at different growth stages of rice
The available potassium content in three soil types at different growth stages is shown in figure 4. The content of available potassium in soil not only determines whether the demand for potassium in rice is sufficient, but also determines the amount of cation exchange in soil, which affects the absorption of nitrogen and phosphorus by plants and the effect of soil moisture and fertilizer retention. As shown in figure 5, the average available potassium content during the growth of the three soil types is as follows:. The highest value of lou soil was 188.9 mg / kg, followed by entisol of 156.9 mg/kg and Lossiah soil of 98.1 mg/kg. During rice growth period, the content of available potassium in Lossiah soil remained basically unchanged. The soil showed an upward trend, and the new soil increased first and then decreased with the heading stage as the node. The results of Dong Yanhong showed that soil texture was one of the important factors affecting potassium leaching, and potassium fixation tended to be strengthened with the increase of clay content. Clay content of three soil types: the soil is the most, the new soil is the second, and the Lossiah soil is the least. So the content of available potassium in the growth period is as follows: lou Soil > entisol > Lossiah soil. Soil nutrient is a process of increasing accumulation, which is helpful to alleviate the application of potassium fertilizer in the second year.

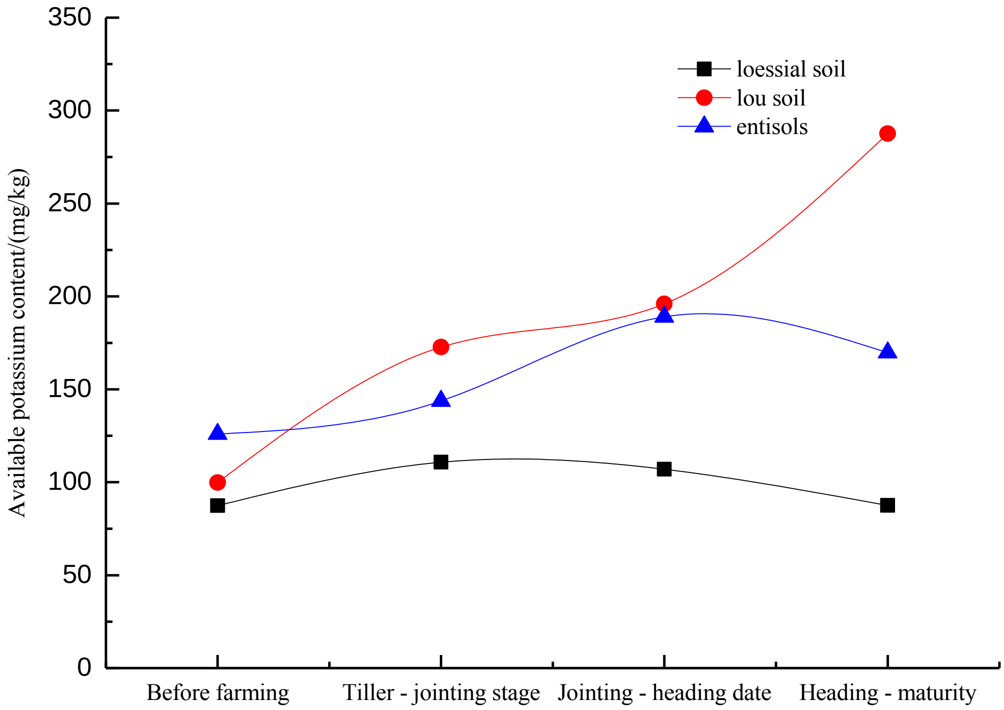

Figure 4. Changes of available potassium content in topsoil at each growth stage of rice

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4. Conclusion

Comprehensive analysis showed that the contents of available phosphorus and available potassium in the soil at harvest period were higher than those before tillage, indicating that the overall quality of soil was improved and the suitable tillage was enhanced after the paddy field was renovated. Soil nitrogen content was lower than that before tillage, indicating that straw should be returned to the field and the application rate of nitrogen fertilizer should be adjusted reasonably next year.

Acknowledgments

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