Long-term Cultivation and Fertilizer Changes Soil Chemicals

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Abstract. This paper briefly summarizes the effects of long-term cultivation and fertilizer on soil chemistry in recent years. The effects of different topography, long-term fertilization, different farming patterns, and different drainage modes on the dynamic changes of soil pH, large amounts of elements (effective phosphorus, quick-impact potassium), and medium and small elements (exchangeable calcium, magnesium) were mainly introduced and discussed. Due to the misuse of chemical fertilizers and pesticides in recent years, the phenomenon of soil chemistry has become increasingly serious. Only by comprehensively analyzing the effects of farmland management measures on soil chemistry and understanding the changing laws of soil chemical quality can sustainable agriculture and eco-friendly agriculture be better developed.

1. Introduction

Soil quality is the interaction between chemical, biological, and physical components of soil systems. In recent years, more and more attention has been paid to the sustainable development of agriculture at home and abroad, and the quality of soil, as an inevitable problem in the study of sustainable development of agriculture, has also received close attention from many soil scholars and ecologists. Soil pH, organic matter, effective phosphorus, cation exchange capacity, etc. are often used as indicators to measure soil quality [1]. The change in soil pH is not only related to crop yield and crop suitability, but also affects the activity of soil microorganisms and the availability of micronutrients [2-4]. At the same time, pH has a very significant negative correlation with soil quick-impact nutrients. In agricultural production, the amount of fertilizer and pesticides input is high, the utilization rate of nitrogen and phosphorus fertilizer is low, and the amount of fertilizer input is often higher than the amount of biological carried out, resulting in the accumulation of nutrients in the soil, which has a serious negative impact on soil quality and food production.

In recent decades, many studies have discussed the effects of different planting patterns and management on the chemical properties of cultivated soil. It is reported that agricultural management,
such as farming years, farming methods, etc., will lead to changes in phosphorus content in the soil [5, 6]. The loss and leaching of phosphorus in arable land soil will lead to the eutrophication of groundwater and drinking water [7]. Long-term rice cultivation can increase the effective phosphorus content of the soil while reducing the soil pH [8]. Due to the low amount of application and large amount of leaching, the content of soil exchangeable potassium ions, magnesium ions, and calcium ions under long-term cultivation will also continue to decrease [9]. Measures such as tillage, drainage, and over-irrigation can effectively reduce the salt content in the soil and are often used as an important means of soil desalination.

In recent years, due to the massive use of fertilizers and changes in farming methods, farmland soil is developing in the direction of non-biological, soil resistance is being lost, and various physiological and nutritional diseases are frequent. Therefore, it is of great significance for agricultural production to study the effects of long-term tillage on soil chemistry. Only by fully understanding the long-term effects of agricultural activities on the chemical properties of the soil can we reasonably and effectively fertilize, increase crop yields, maintain ecological balance, and prevent soil degradation and erosion.

2. Effects of long-term rice cultivation on soil nutrient content under different terrain

Farming has a double effect on soil improvement and destruction, and this problem has been a hot topic in academic circles. Frequent ploughing will increase the mineralization of organic matter, resulting in loose soil, easy erosion, and soil unity. But proper farming can bring together soil fertilizer, promote the fragmentation of large soil structures, improve the ventilation and biological environment inside the soil, improve the extension space of plant roots, and farming plays an important role in agricultural production. It can accelerate soil erosion, consume soil organic matter and fertility, and determine the distribution of water cycle, carbon, and other major nutrients [10]. It is well known that long-term farming can lead to soil structural damage, changes in soil density, permeability, and microbial activity. On the contrary, no-tillage can effectively increase the chemical properties of the soil [11].

Some people think that different farming methods have no significant effect on the change of soil pH [12]. However, it has been confirmed by experiments that long-term no-tillage can lead to a decrease in soil pH [13]. Others believe that farming patterns can only indirectly affect soil pH and depend on climatic conditions, soil types and other man-made factors [14].

Farming can affect the availability of soil nutrients [15]. Some people think that deep tillage can change the distribution and activity of soil microorganisms and soil enzymes, thereby promoting the decomposition or composition of effective phosphorus in the soil; Mineral soil and crop residues can promote the accumulation of effective phosphorus [16]. Farming can also affect the absorption or desorption of phosphorus in the soil through aggregation. When people observed the soil layer of 0-20 cm, it was found that the effective phosphorus content of no-tillage soil was significantly lower than that of deep tillage [17]. This difference may be due to the top-down loss of soil nutrients under no-tillage. Traditional farming breaks the soil pores, so it can prevent the leaching of dissolved phosphorus [18]. The application of organic fertilizer under no-tillage treatment can increase soil microbiological activity and promote the conversion of useable phosphorus into solid form [19].

By comparing the soil nutrient content under traditional farming and no-tillage mode, the content of soil exchange sodium ions under no-tillage was relatively low, but the content of exchangeable potassium ions, calcium ions, and magnesium ions was relatively high. Ismail [20] also pointed out that the content of soil exchangeable ions under no-tillage is higher. The experiment found that the increase of acid nitrogen fertilizer in the long-term no-tillage mode can lead to the reduction of soil exchange calcium ion content, which is mainly caused by reducing soil pH and increasing exchangeable aluminum manganese [21]. In contrast, it is pointed out that the exchange potassium ion content in no-tillage soil is much higher than that in deep tillage soil [22, 23]. It has also been confirmed that deep tillage has no effect on the content of nitrogen, potassium, and magnesium in the soil [24].
3. Effects of long-term fertilization on soil nutrient content change

Different kinds of fertilization have different effects on soil nutrient changes. Many studies have shown that organic fertilizers as buffers can effectively relieve soil acidification [25]. It can adsorb a large amount of $H^+$ and $Al^{3+}$, thereby avoiding the root toxicity effect of crops. When agricultural products are harvested, they take away a large amount of alkaline substances from the soil. Long-term application of organic fertilizers can make up for the loss of alkaline substances and effectively control soil acidification. The application of fresh cow dung will lead to a sudden increase in the soil pH, which will immediately increase with the application of fresh cow dung, but will be reduced in some manure correction soil manure-modified silk [26]. It is proved that the application of organic fertilizer can increase soil acidity by increasing soil organic matter and promoting soil maturity [27]. In fact, the influence of organic fertilizer on soil pH also depends on the source of the fertilizer and soil characteristics. Soil acidification may be caused by nitrification of soil surface nitrogen fertilizer or accumulation of organic matter in surface soil.

Manure can induce the release of organic acids, thereby promoting the desorption of phosphorus, and thus increasing the effective phosphorus content of soil. The study of others showed that after 21 years of long-term observation, long-term application of nitrogen phosphorus fertilizer, nitrogen phosphorus and potassium fertilizer can significantly increase the effective phosphorus content in the soil, and single application of nitrogen fertilizer will lead to a large decrease in the effective phosphorus content in the soil. Long-term excessive use of phosphorus fertilizer will lead to the accumulation of organic phosphorus and inorganic phosphorus in the soil. Phosphorus fertilizer can effectively promote the saturation of surface phosphorus content and increase the concentration of soluble P in soil.

Under organic fertilizer treatment, soil exchangeable calcium increased by 20%, while reducing the exchangeable magnesium and potassium content. And it is believed that single application of manure or mixed with phosphorus fertilizer can increase the content of magnesium and potassium, and application of phosphorus fertilizer can also increase the content of magnesium and potassium in soil. Gill believed that inorganic, especially inorganic nitrogen fertilizer can increase the effective potassium content of soil. Steiner suggested that manure can significantly increase the content of calcium and magnesium in the soil, apply mineral fertilizers, increase the content of exchangeable potassium and magnesium after the first harvest of crops, and reduce the content of exchangeable aluminum. There was no effect on soil pH change.

4. Conclusion

Soil fertility and chemical properties play an important role for plant production, as well as for soil erosion. Thus, under continuous rice production, there is a great need to assess soil chemical properties. As two important factors, long-term cultivation and fertilizer have both spatial and temporal effect on soil nutrient content. Nothing but understanding the long term changes of soil chemical properties with long-term cultivation and fertilizer could help for agriculture production and provide guidance of soil nutrients management and soil improvement and crop production.

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