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Study of factors influencing soil trace element fraction and distribution

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Abstract

Soil trace elements affect crop growth and development, yield and quality through a variety of mechanisms, rational management and regulation of soil trace elements is the key to improving crop quality, but the effectiveness of trace elements is affected by soil pH, organic matter and other factors.

Keywords

Soil, trace element, fraction, distribution.

1. Introduction

Soil trace elements mainly include boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), molybdenum (Mo), etc., which directly affect the nutrient composition of crops, and then affect the growth and development of plants [1]. However, the spatial variability of soil trace elements indicates that there are significant differences in the content of trace elements in soil in different regions, resulting in different growth performance and quality of crops in different regions [2]. Soil trace elements affect crop growth and development, yield and quality through a variety of mechanisms, and rational management and regulation of soil trace elements is the key to improving crop quality [3]. However, the effectiveness of trace elements is affected by soil pH, organic matter and other factors, and the following is a discussion of the form and distribution of soil trace elements and the factors that affec them.

2. Change in chemical behavior and bioavailability of micronutrients in soils due to long-term crop management

Long-term crop cultivation and fertilization have significant effects on the chemical behavior and bioavailability of micronutrients in soils [4]. First, long-term application of organic fertilizers or organic fertilizers in combination with chemical fertilizers significantly increased the effective Cu, Fe, Mn, and Zn content of the soil. This suggests that the addition of organic matter helps to improve the efficacy of these micronutrients in the soil, which may enhance their uptake and utilization by the crop.

In addition, changes in soil pH under long-term fertilization conditions can also affect the effectiveness of trace elements [5]. For example, prolonged periods of no fertilization or chemical fertilization only can lead to soil acidification, which in turn can affect the effectiveness of trace elements. Soil acidification usually leads to a decrease in the effectiveness of certain micronutrients (e.g., iron and manganese) because acidic conditions can change the chemical form of these elements from plant-absorbable forms to insoluble forms.

On the other hand, long-term application of fertilizers, especially organic fertilizers, can indirectly affect the effectiveness of trace elements by increasing the organic matter content of the soil and improving soil structure. The increase in organic matter helps to improve soil aggregation and water-holding capacity, factors that contribute to the stability and effectiveness of trace elements in the soil [6].

Long-term crop management and fertilization significantly affect the chemical behavior and bioavailability of micronutrients in the soil through mechanisms such as changing soil pH and increasing soil organic matter content. These changes not only affect plant uptake and use of micronutrients, but may also affect soil health and ecosystem function. Therefore, rational fertilizer management strategies are essential to maintain soil quality and promote sustainable agriculture.

3. Crop residues, organic matter enrichment affect micronutrient form and efficacy

The influence of crop residues and organic matter enrichment on the form and efficacy of trace elements is a complex ecological process involving many aspects of soil chemistry, biochemistry and microbial activity. This issue can be analyzed from several perspectives in an integrated manner.

The addition of crop residues can significantly alter the physical and chemical properties of the soil, including pH, electrical conductivity (EC), and dissolved organic carbon (DOC). These changes directly affect the form and effectiveness of trace elements in the soil. For example, decomposition products of crop residues can chelate iron, manganese, and zinc oxides, increasing the effectiveness of these trace elements. In addition, the addition of crop residues promotes an increase in soil microbial populations, which play an important role in the biogeochemical cycling of trace elements.

The distribution of trace elements in agricultural soils was significantly affected under long-term micronutrient fertilizer application, especially the apparent enrichment of Zn and Cu elements in surface soils [6]. This suggests that the enrichment of crop residues and organic matter may affect the morphology and efficacy of trace elements by influencing the soil organic carbon structure and the accumulation of organic functional groups.

The effects of different types of crop residues on the efficacy of soil trace elements varied. For example, retention of maize root stubble significantly increased soil effective trace element content, while the trace element accumulation pattern and bioavailability of agricultural wastes changed after pyrolysis treatment. This suggests that the type of crop residues and organic matter and their treatment have a direct effect on trace element morphology and effectiveness.

Soil pH and organic matter content are important factors influencing the effective status of trace elements. It was shown that effective Cu, Mn, Zn and Mo contents tended to increase with increasing organic matter content. This further confirms that the enrichment of crop residues and organic matter has a positive effect on trace element effectiveness.

The enrichment of crop residues and organic matter significantly affects the morphology and efficacy of trace elements by altering the physicochemical properties of the soil, promoting microbial activities, influencing the structure of soil organic carbon and the accumulation of organic functional groups, and regulating soil pH and organic matter content [7]. Together, these mechanisms of action promote the recycling of trace elements in the soil, which is important for maintaining soil health and improving crop yield and quality.

4. Cropping patterns (succession, rotation) affect the chemical behavior and bioavailability of micronutrients in soils.

Cropping patterns (succession, rotation) have a significant effect on the chemical behavior and bioavailability of soil micronutrients. Continuous cropping systems usually result in deficiencies of certain micronutrients, such as active boron, active sulfur, and active zinc, and prolonged continuous cropping can also alter soil micronutrient ratios, resulting in disproportionate ratios of sulfur, boron, copper, and zinc. In addition, intercropping can also cause crop failure, but drought and water intercropping can adequately mitigate the occurrence of crop failure.

In contrast, crop rotation systems can improve soil fertility and microbial community structure, thereby increasing soil bioavailability of micronutrients. For example, the introduction of legume rotations significantly reduced bacterial uniformity and fungal abundance, and altered bacterial and fungal community composition and structure. Both long-term fertilization and crop rotation increased the nutrient levels of SOC and LOC and AN, AP and TN in red loamy rice soils. In addition, studies on the effects of crop rotation combined with fertilization on soil organic carbon and its fractions and soil nutrients showed that crop rotation combined with application of organic compound fertilizer treatment had the highest SOC content.

Fertilization is also a key factor influencing the chemical behavior and bioavailability of soil trace elements [9]. Soil bacterial, fungal, and actinomycete counts were higher in soybean, wheat, and maize rotations under long-term fertilization than in the no-fertilizer treatment. Studies on the effect of organic and inorganic fertilizers on the microbiological characteristics of soils in wheat-rice rotation systems showed that the use of chemical fertilizers with organic fertilizers, especially medium and high organic fertilizers, was more conducive to the improvement of soil microbiological characteristics and the enhancement of soil microbial activity.

5. Conclusion

Crop rotation systems are better able to maintain or improve the bioavailability of soil trace elements than continuous cropping systems, while rational fertilization practices, especially the correct proportion of organic fertilizers, and rational crop management are also essential to increase the bioavailability of soil trace elements and improve soil quality.

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