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Progress of Microplastic Pollution in Vegetable Land in Guanzhong Plain Area

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Abstract

With the advancement of agricultural modernization and the wide application of mulch film in crop planting, the problem of microplastic pollution has gradually become prominent. As an important vegetable production base in Guanzhong Plain area, microplastic pollution in vegetable fields may pose a potential threat to soil ecological environment, vegetable quality and safety and human health. This paper focuses on the current situation of microplastic pollution in vegetable fields in Guanzhong Plain, analyzes the key factors affecting the accumulation and migration of microplastics in soil of vegetable fields, and puts forward targeted prevention and control measures, aiming to provide theoretical basis and practical guidance for protecting the ecological environment of vegetable fields in Guanzhong Plain and ensuring the safe production of vegetables.

Keywords

Guanzhong Plain area, vegetable fields, microplastics, influence factors.

1. Introduction

Microplastics, usually plastic fragments and particles with a particle size of less than 5 mm, have become an environmental problem of global concern due to their wide range of sources, difficulty in degradation and continuous accumulation in the environment. In the field of agriculture, the extensive use of mulch film is one of the most important sources of microplastics in farmland. With its favorable natural conditions, Guanzhong Plain Area has become a larger vegetable production base in Shaanxi Province and even in China[1]. However, the reliance on mulch film during the cultivation of many kinds of vegetables and the non-recycling of mulch film after use have led to the accumulation of microplastics in the soil of vegetable fields. At the same time, there are many river systems in Guanzhong region of Shaanxi Province, and microplastics and accompanying nitrogen and phosphorus pollutants and pesticide residues in the soil can be pooled into rivers through runoff, precipitation, and scouring, which not only affects the health of the river water bodies, but also may cause a chain reaction to the entire ecosystem. Therefore, it is of great practical significance to study the current situation of microplastic pollution in vegetable fields in the Guanzhong Plain, explore the accumulation and migration patterns, and then propose effective preventive and control measures.

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2. Current Status of Microplastic Contamination in Vegetable Fields in Guanzhong Plain Area

2.1. Content and distribution of microplastics

Sampling and analyzing the soil of vegetable plots in different areas of Guanzhong Plain Zone revealed that microplastic pollution was common in vegetable plot soil. The content of microplastics varied in different regions, and vegetable fields close to cities and major transportation routes had relatively high microplastic content, which might be related to factors such as urban garbage emission and transportation dust. In terms of soil depth, the microplastic content in the 0-20 cm soil layer was significantly higher than that in the 20-40 cm soil layer, indicating that microplastics were mainly concentrated in the top layer of the soil[2]. This is because most of the mulch film is laid on the surface of the soil, and with the passage of time, the broken mulch film gradually decomposes into microplastics and accumulates in the surface soil. In addition, agricultural activities such as irrigation and fertilization also contributed to the further enrichment of microplastics in the top soil layer.

2.2. Types and forms of microplastics

The types of microplastics in the soil of vegetable fields in the Guanzhong Plain Area mainly include polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC), among which PE is the most common type, which is closely related to polyethylene mulch film widely used in agricultural production. The morphology of microplastics was diverse, dominated by fragmented and thin film, which accounted for about 45% and 35% of the total microplastics, respectively, with relatively few fibrous and granular microplastics[3]. Fragmented microplastics may be formed when the film is broken by mechanical external force during use, while thin-film microplastics may be fragments of incompletely degraded film. Fibrous microplastics may originate from plastic ropes and bags used in agricultural production, while granular microplastics may be related to industrial production or improper waste disposal.

2.3. Potential impacts of microplastics on vegetable patch ecosystems

The accumulation of microplastics in the soil of vegetable farms may have a multifaceted impact on the soil ecosystem. On the one hand, microplastics can change the physical properties of soil, affecting its aeration, water permeability and water-holding capacity, which in turn affects the growth and development of the plant root system. For example, microplastic particles may block soil pores, hindering the transmission of water and nutrients, leading to oxygen and water deprivation in the plant root system and affecting the normal growth of vegetables. On the other hand, the surface of microplastics can adsorb heavy metals, organic pollutants and other harmful substances, which are migrated and transformed in the soil, and may be absorbed by the root system of vegetables, passed through the food chain, and ultimately threaten human health[4]. In addition, microplastics may also have an impact on the structure and function of soil microbial communities, changing the type and number of microorganisms in the soil, affecting the ecological function of the soil and the material cycle.

3. Key Factors Affecting Microplastic Accumulation and Transport in Vegetable Fields

3.1. Mulch use and management

The amount and length of use of mulch film is an important factor affecting the accumulation of microplastics in vegetable fields. In Guanzhong Plain, in order to improve vegetable yield and quality, many vegetable farmers use large amounts of mulch film, and some of them have been using mulch film for many years, which leads to the continuous accumulation of mulch film in

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the soil and increases the amount of microplastics produced. At the same time, the poor management of film recycling is also a key cause of microplastic pollution. At present, the recovery of mulch film mainly relies on manual pickup, low recovery efficiency, and difficult to completely recover, a large number of residual mulch film in the soil gradually broken down into microplastics. In addition, some vegetable farmers have improper treatment of used mulch, such as randomly discarded or incineration, which not only causes environmental pollution, but also accelerates the fragmentation of mulch and the production of microplastics.

3.2. Soil properties

Soil texture, pH value, organic matter content and other properties have an important influence on the accumulation and migration of microplastics. Generally speaking, the finer texture of soil (such as clay) has a stronger adsorption capacity for microplastics, in which the migration of microplastics is slower and easier to be accumulated in the soil; while the coarser texture of soil (such as sandy soil), microplastics are more likely to be migrated with the movement of water and air. Soil pH also affects the surface charge and adsorption properties of microplastics, which in turn affects their migration and accumulation in the soil. In addition, when soil organic matter content is high, microplastics may interact with organic matter and change their migration properties[5]. For example, organic matter can encapsulate microplastic particles, increasing their stability in the soil and reducing their migration.

3.3. Climatic and hydrological conditions

The Guanzhong Plain area has a temperate continental monsoon climate, where precipitation is concentrated in the summer months and its intensity is high. Heavy rainfall causes soil erosion and accelerates the migration of microplastics. Rainwater washes the soil of vegetable fields, causing microplastics to enter water bodies such as rivers and lakes with surface runoff, resulting in water pollution. In addition, irrigation is also an important factor affecting the migration of microplastics. Unreasonable irrigation methods, such as heavy water flooding, can cause microplastics in the soil to migrate downward with the irrigation water and enter the deep soil or groundwater system[6]. At the same time, winds may also blow microplastics from the surface to other areas, expanding the scope of microplastic contamination.

3.4. Agricultural activities

Agricultural activities such as fertilization and farming also have an impact on the accumulation and transport of microplastics. During fertilization, some organic fertilizers and chemical fertilizers may contain microplastic particles, and their long-term use will increase the content of microplastics in the soil. For example, livestock and poultry manure organic fertilizers may be mixed with plastic waste during the production process, and after composting, the microplastics in them are difficult to be completely removed, which will result in microplastic pollution when applied to the soil. Tillage activities can change the structure and porosity of the soil, affecting the distribution and migration of microplastics in the soil. Frequent tillage will result in a more uniform distribution of microplastics in the soil in the top layer of the soil, and may also promote the migration of microplastics to the deeper layers of the soil[7].

4. Conclusion

The problem of microplastic pollution in vegetable fields in the Guanzhong Plain Region is relatively serious, and the content, type and form of microplastics vary in different regions and soil depths, and have potential impacts on vegetable field ecosystems. Factors affecting the accumulation and transport of microplastics in vegetable fields include film use and management, soil properties, climatic and hydrological conditions, and agricultural activities. In order to effectively prevent and control microplastic pollution in the Guanzhong Plain, it is

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necessary to strengthen the management of mulch film, promote biodegradable mulch film, and improve the recycling efficiency of mulch film; optimize soil management, improve soil texture, adjust soil pH, and increase the content of soil organic matter; reasonably utilize the climatic and hydrological conditions, optimize the irrigation method, strengthen soil and water conservation, and collect and utilize rainwater; and regulate the agricultural activities, strictly control the quality of fertilizers, and reasonably cultivate the soil. Through the comprehensive adoption of the above measures, microplastic pollution in vegetable fields in Guanzhong Plain can be gradually reduced, protecting the ecological environment of vegetable fields, guaranteeing the quality and safety of vegetables, and promoting the sustainable development of agriculture. In the future, it is necessary to further strengthen the monitoring and research on microplastic pollution, to deeply understand the migration and transformation law of microplastic in the soil-plant system, and to provide theoretical support for the development of more scientific and effective preventive and control measures.

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