

World Experiments Dedicated to the Study of the Process of Formation of Humus in the Soil and the Composition of Humus Substances

Sayyora O. Yunusova¹, Sidiqov Saidjon²

¹PhD Student, National University of Uzbekistan named after Mirzo Ulugbek, Uzbekistan

²Professor, Candidate of Agricultural Sciences, Uzbekistan

Abstract This article focuses on the process of humus formation in the soil and the study of the composition of humus substances. Humus, an essential component for soil fertility, results from the decomposition and transformation of organic materials through microbial activity. The article outlines the main stages of humus formation, including the accumulation of organic matter, mineralization, and humification, and discusses the roles of fulvic acids, humic acids, and humins in improving soil properties. Additionally, it reviews global experiences in humus research, highlighting practices from Russia, the United States, the European Union, Japan, and China. These practices emphasize the use of sustainable soil management techniques, such as minimal tillage, organic fertilization, and crop rotation, to enhance humus content and combat soil degradation. The study of humus formation is crucial for maintaining soil fertility and addressing global ecological challenges.

Keywords Humus, Soil fertility, Organic matter, Mineralization, Humification, Fulvic acids, Humic acids, Humins, Soil science, Sustainable agriculture, Soil degradation

1. Introduction

Humus plays a crucial role in maintaining soil fertility and ecological stability. It is formed from the decomposition of organic matter, such as plant residues and animal waste, through a series of complex biochemical processes involving soil microorganisms. The resulting humus improves soil structure, water retention, nutrient availability, and overall soil health. Understanding the process of humus formation and the composition of humus substances is vital for soil science, as it provides insights into sustainable land management practices and strategies to combat soil degradation.

Research on humus formation has gained significant attention worldwide due to its implications for agriculture and environmental sustainability. Humus not only supports crop productivity by enhancing soil fertility but also plays a key role in carbon sequestration and mitigating climate change. The components of humus—fulvic acids, humic acids, and humins—each contribute differently to soil properties, influencing nutrient cycling, soil structure, and the long-term stability of organic matter in the soil [1].

Global experiments and studies offer valuable insights into the mechanisms of humus formation and strategies to

increase humus content in soils. In Russia, foundational research has established the basis for understanding the interactions between organic matter and soil properties. The United States has implemented innovative agricultural practices, such as no-till farming and crop rotation, to boost humus levels. European Union countries have focused on integrating organic fertilizers and exploring the role of soil microorganisms, while Japan and China have combined traditional farming methods with modern technologies to enhance humus formation [6].

This article examines the various stages of humus formation, its composition, and the factors influencing its accumulation in different soil types. It also provides an overview of global practices and technologies aimed at improving humus content, which are essential for sustaining soil fertility and addressing the challenges of soil degradation and climate change [2].

2. The Main Findings and Results

Research on the formation of humus and the composition of humus substances has yielded several important findings that have significant implications for soil management, agricultural practices, and environmental sustainability. The key results from global experiments and studies in this field can be summarized as follows:

The process of humus formation occurs in distinct stages: accumulation of organic matter, mineralization, and humification. The accumulation stage involves the input of plant residues, animal waste, and other organic materials into the soil. During mineralization, soil microorganisms break down these materials into simpler compounds, such as carbon dioxide, water, and mineral nutrients. In the final stage, humification, the remaining organic substances are transformed into stable humus components, including fulvic acids, humic acids, and humins. These stages are influenced by various factors, such as soil type, climate, and the quality of organic matter inputs [3].

Humus is composed of three primary components—fulvic acids, humic acids, and humins—each playing distinct roles in soil properties:

- Fulvic acids are soluble in water at all pH levels and have a lower molecular weight, allowing them to easily interact with metal ions, improving nutrient availability to plants.
- Humic acids are soluble in alkaline solutions but not in water at acidic pH levels, and they help improve soil structure by binding soil particles together. They also enhance the soil's ability to retain moisture.
- Humins are the most stable and insoluble part of humus, contributing to the long-term stabilization of organic carbon in the soil and increasing soil resilience.

Various agricultural practices have been found to significantly affect humus formation and its stability in the soil:

- Minimal tillage (no-till farming) and crop rotation in the United States have been shown to reduce soil disturbance, increase organic matter input, and prevent soil erosion. These practices enhance the formation of stable humus by slowing down the decomposition of organic material [5].
- Use of organic fertilizers and cover crops in European Union countries has been effective in boosting the levels of humic substances, thus improving soil fertility and reducing the need for chemical inputs.
- Traditional and modern soil management methods in Japan and China, such as the incorporation of crop residues and composting techniques, have helped increase humus levels in degraded soils, restoring fertility and preventing further degradation.

The effectiveness of humus formation and its composition varies depending on regional factors such as soil type, climate, and land use:

- In Russia, the presence of chernozem soils, which are rich in humus, provides a unique environment for studying natural humus dynamics. Research has demonstrated that maintaining natural vegetation and limiting soil disturbance can help preserve humus content in these soils.
- In arid and semi-arid regions, such as parts of the United States and China, humus formation is limited

due to low organic matter input and higher rates of organic matter decomposition. Techniques such as mulching and the use of biochar have been used to enhance humus formation in these areas.

Recent studies emphasize the significant role of soil microorganisms in humus formation. Microbial activity is crucial for the decomposition of organic materials and the transformation of these materials into stable humus substances. Research in Europe has particularly highlighted the importance of promoting beneficial soil microbes through organic amendments and reducing the use of synthetic chemicals, which can disrupt microbial communities. The stabilization of carbon in humus components has implications for climate change mitigation [8]. Humus acts as a long-term carbon sink, and enhancing humus content in agricultural soils can help sequester atmospheric carbon dioxide. Studies in the United States and European countries have shown that adopting sustainable soil management practices can increase soil organic carbon stocks, contributing to efforts to reduce greenhouse gas emissions. The findings from global experiments demonstrate that humus formation is a dynamic process influenced by a range of factors, including agricultural practices, soil type, and regional climate conditions. Sustainable management techniques, such as minimal tillage, organic fertilization, and the integration of traditional and modern soil management practices, have proven effective in increasing humus content. These practices not only enhance soil fertility and productivity but also contribute to environmental sustainability and climate change mitigation. The study of humus and its components remains essential for developing strategies to combat soil degradation and ensure long-term agricultural sustainability [4].

3. Conclusions

Humus is important for soil fertility and ecological stability. Humus is formed through the accumulation of organic matter in the soil, mineralization and humusification processes. This process helps to improve the physical, chemical and biological properties of the soil, as well as to provide a reserve of nutrients for plants. Humus components such as fulvic acids, humic acids and humic substances have a positive effect on various aspects of the soil and play an important role in maintaining the long-term stability of the soil.

Scientific research devoted to the study of humus formation in the world expands the possibilities of improving soil quality, combating soil degradation, and increasing agricultural efficiency. The experience of countries such as Russia, the USA, the European Union, Japan and China shows that minimal tillage, the use of organic fertilizers, crop rotation and sustainable soil management technologies are effective measures to increase the amount of humus.

The process of humus formation is influenced by factors such as climate, soil type and plant residues. Taking into account these factors, it is necessary to use scientifically based methods for the formation and preservation of humus.

As a result, the possibilities of ensuring soil fertility and combating environmental problems will be expanded. Therefore, in-depth study of humus and its components, implementation of various technologies remains one of the urgent issues today.

REFERENCES

- [1] Andreux, F. (1996). Humus in world soils. In *Humic substances in terrestrial ecosystems* (pp. 45-100). Elsevier Science BV.
- [2] Sidiqov, S., Gafurova, L., Ergasheva, O., Yunusova, S., Zakirova, S., Abdushukurova, Z., & Rustamova, R. (2024). Changes in the composition and concentration of soil solutions in seasonal dynamics of irrigated agriculture. In *E3S Web of Conferences* (Vol. 563, p. 03069). EDP Sciences.
- [3] Waksman, S. A. (1936). *Humus* (pp. 212-a). London, UK: Baillière, Tindall & Cox.
- [4] Saidjon, S., Munajat, E., Zamira, A., Olimaxon, E., Dilafruz, M., & Nigora, T. (2020). Degree of humification of cotton, alfalfa and ephemers organs, their effect on the content and composition of soil organic matter. *The land*, 13, 15.
- [5] Baveye, P. C., & Wander, M. (2019). The (bio) chemistry of soil humus and humic substances: Why is the “new view” still considered novel after more than 80 years?. *Frontiers in Environmental Science*, 7, 27.
- [6] Saidjon, S., Olimaxon, E., Salomat, Z., Zamira, A., & Sayyorahon, Y. (2021). Influence of Chemical Composition and Concentration of Soil Solution on Physiological Indicators, Cotton Yield, and the Ways of their Optimization. *NVEO-NATURAL VOLATILES & ESSENTIAL OILS Journal/ NVEO*, 11825-11836.
- [7] Rashad, M., Hafez, M., & Popov, A. I. (2022). Humic substances composition and properties as an environmentally sustainable system: A review and way forward to soil conservation. *Journal of Plant Nutrition*, 45(7), 1072-1122.
- [8] Yang, F., Tang, C., & Antonietti, M. (2021). Natural and artificial humic substances to manage minerals, ions, water, and soil microorganisms. *Chemical Society Reviews*, 50(10), 6221-6239.