THE IMPACT OF WASTES GENERATED FROM COAL MINES ON PLANT GROWTH AND DEVELOPMENT

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Abstract: *This article provides a scientific analysis of the impact of wastes generated by coal mining activities on plant growth and development. The study examines the effects of solid wastes, coal dust, and beneficiation residues released during mining operations, as well as the influence of heavy metals and chemical compounds contained in these wastes on plant physiology. Particular attention is given to the negative effects of mining wastes on photosynthesis, biomass accumulation, and morphological development through the soil–plant system. The paper also considers ecological consequences such as vegetation degradation, reduced productivity, and loss of biodiversity in areas surrounding coal mines.*

Keywords: *coal mines, mining wastes, plant growth, heavy metals, phytotoxicity, environmental consequences, reclamation.*

INTRODUCTION

At present, coal continues to play an important role in the energy sector. However, the extraction and processing of coal generate large amounts of waste that exert significant negative impacts on the environment, particularly on vegetation cover. In areas surrounding coal mines, reduced plant growth, disruption of physiological processes, and changes in developmental dynamics are frequently observed.

Plants represent a fundamental biological component of ecosystems, and their condition is closely linked to soil fertility, food security, and the maintenance of atmospheric balance. Therefore, studying the impact of coal mining wastes on plant growth and development is considered one of the most pressing environmental issues.

The influence of coal mining wastes on vegetation has been widely addressed in international and regional studies. In particular, the effects of

heavy metals and technogenic dust associated with mining activities on plant physiology have been scientifically substantiated.

Masindi and Muedi reported that plant growth significantly slows in soils contaminated with heavy metals as a result of mining activities. According to the authors, elements such as lead and cadmium enter plant tissues through the root system, leading to reduced photosynthetic activity and decreased biomass accumulation [1]. Pandey and Singh demonstrated that coal dust dispersed around mining areas accumulates on leaf surfaces, restricting gas exchange and disrupting transpiration processes. As a result, morphological development is impaired, and reductions in leaf area and stem length are observed [2]. Studies conducted by Li et al. analyzed the migration of heavy metals within the soil–plant system in coal mining regions. The authors concluded that high concentrations of metal ions intensify oxidative stress in plant cells, resulting in disturbances of physiological processes [3]. In turn, Ali, Khan, and Sajad found that mining wastes lead to reduced seed germination rates, inhibited root and shoot development, and decreased crop productivity. These effects were attributed to the phytotoxic impact of heavy metals, and phytoremediation was proposed as an effective mitigation approach [4]. Overall, these studies confirm that coal mining wastes exert a complex and adverse influence on plant growth and development. At the same time, there remains a need to expand scientific research aimed at environmental restoration and the reduction of phytotoxic effects.

RESULTS

Main factors influencing plants under the impact of coal mining wastes. Coal mining wastes contain a wide range of toxic substances, including heavy metals (lead, cadmium, mercury, manganese), sulfide compounds, and fine coal dust particles. These substances reach plants either through soil contamination or by direct deposition on leaf surfaces, thereby negatively affecting physiological processes. Coal dust accumulation on leaves reduces photosynthetic intensity, limits gas exchange, and disrupts transpiration. Heavy metals, on the other hand, enter plant organisms through the root system and exert toxic effects at the cellular level.

Changes observed in plant growth and development. Under the influence of coal mining wastes, plants exhibit adverse morphological and physiological changes. Root development is inhibited, stem and leaf sizes decrease, and biomass accumulation is reduced. In contaminated areas, seed germination rates decline, the vegetation period shortens, and crop yields decrease significantly. These processes ultimately lead to vegetation degradation and destabilization of natural ecosystems.

Environmental and socio-economic consequences. The negative impact of coal mining wastes on plants results in broad environmental consequences. A reduction in vegetation cover intensifies soil erosion, decreases biodiversity, and accelerates landscape degradation. From a socio-economic perspective, reduced agricultural productivity leads to declining incomes, poses threats to food security, and contributes to the expansion of environmentally hazardous areas.

Ways to mitigate the problem. Reducing the negative impact of coal mining wastes on plants requires the implementation of comprehensive environmental measures. These include reclamation of contaminated soils, application of phytoremediation techniques, introduction of resistant plant species, and establishment of green buffer zones. In addition, the adoption of environmentally safe technologies in mining operations and the implementation of regular environmental monitoring are of critical importance.

Conclusion. In conclusion, wastes generated from coal mining represent a significant anthropogenic factor adversely affecting plant growth and development. These impacts are manifested through disruptions of physiological processes, decreased productivity, and destabilization of ecosystem sustainability. Addressing this problem requires strengthening environmental management in the mining sector, implementing scientifically grounded reclamation and phytoremediation measures, and ensuring sustainable use of land resources.

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