ABSTRACT

of the dissertation work of **Aitzhan Mengtay**
titled: "**Assessment of the condition of phytocoenosis of the former pesticide storage facilities in the Almaty region**" submitted for the academic degree "Doctor of Philosophy" (Ph.D.), specialty 6D061700 – "Geobotany"

General Characteristics of the Work. The dissertation is dedicated to the study of flora and plant communities in the areas of former pesticide storage sites in the Almaty region, as well as the accumulation of pesticides, their degradation products, and heavy metals by plants.

Relevance of the Study. Due to the collapse of the state agricultural system, the majority of unusable and prohibited pesticides in the region are stored in unsuitable facilities. Many storage facilities, built in the 1960s, have been abandoned and are in disrepair. This situation facilitates the infiltration of pesticides into groundwater and soil, the release of toxic substances into the air, the occurrence of fire hazards, and the poisoning of plants, animals, and birds. Some storage facilities are located within residential areas, posing a significant threat to public health.

Most domestic and international literature sources report changes in the condition of living organisms under the influence of modern chemical and radioactive environmental pollution. Pesticides are only partially used, while their residual substances remain in the environment. Despite their relatively low concentrations in water, soil, and sediments, pesticides can intensely accumulate in the vital organs and tissues of almost all living organisms. The primary danger of heavy metals lies not in acute poisoning but in their gradual accumulation in the human body through the chain: "soil–plant–animal–human".

The relevance of studying the state of phytocenoses in former pesticide storage sites in the Almaty region is determined by the importance of environmental protection and sustainable development. Pesticides, which have been widely used in agriculture for decades, accumulate in soils, leading to ecosystem degradation and loss of biodiversity. This problem is particularly relevant in areas where soil and plant communities have been contaminated near former pesticide storage sites, as their impact on ecosystems can persist for decades.

Under conditions of global climate change and increasing anthropogenic pressure on natural resources, the need to assess and monitor the state of phytocenoses in such areas is of particular importance. In the Almaty region, where agriculture plays a key role, environmental well-being is directly linked to soil quality and the state of plant communities. Restoring and maintaining the sustainability of phytocenoses in contaminated areas is a crucial step toward ensuring the region's environmental safety.

Modern methods for assessing ecosystem conditions enable a more precise determination of their degradation level and the development of restoration strategies. In this context, studying the phytocenoses of former pesticide storage sites provides an opportunity not only to assess the current state of ecosystems but also to propose effective measures for their restoration. Conducting this research contributes to expanding scientific knowledge in the field of environmental safety

and sustainable land use. Thus, the results of this work will be valuable not only for the scientific community but also for practitioners in environmental protection, land use, and agriculture, making the research topic relevant and significant.

The Role of Plant Biodiversity Inventory. The inventory of plant biodiversity in former pesticide storage areas is critical for assessing and restoring degraded ecosystems. The inventory provides comprehensive information about the species composition, structure, and condition of plant communities, which is necessary to understand the degree of pollution impact on ecosystems.

Assessing plant biodiversity helps identify species most sensitive to pollution and resilient species that can be used in restoration and remediation programs. Additionally, the inventory contributes to understanding the dynamics of ecosystem changes, which is essential for developing strategies for their conservation and sustainable use. Thus, the inventory of plant biodiversity in former pesticide storage sites plays a fundamental role in preserving and restoring natural ecosystems, which is an integral part of the region's sustainable development.

Research Object: Plants and plant communities of former pesticide storage sites in the Almaty region.

Research Objective: To assess the state of phytocenoses in former pesticide storage sites in the Almaty region.

Research Tasks

1. Study the species diversity of phytocenoses in former pesticide storage sites in the Almaty region and characterize the taxonomic composition of the identified flora;
2. Conduct an ecological analysis of the identified plants in former pesticide storage sites;
3. Identify useful plant groups based on the analysis of economically significant species;
4. Investigate the accumulation of pesticides, their degradation products, and heavy metals in certain dominant and forage plants.

Research Methods. The reconnaissance survey method was used to examine the monitoring points. Plant objects were studied using traditional geobotanical research methods, including the description of plant communities. Key scientific references and compendiums such as "Flora of Kazakhstan," "Illustrated Guide to Plants of Kazakhstan," and "Guide to Plants of Central Asia" were used to identify collected materials. The multi-volume "Weed Plants of the USSR" was used for weed analysis. Plants were classified according to life forms based on the classifications of I.G. Serebryakov and K. Raunkiaer. The classification of M.M. Ilyin was used to determine useful groups of the identified plants. The economic significance of individual species was clarified using the "Atlas of Medicinal Plant Ranges and Resources," the collection "Plant Resources," the "Annotated List of Medicinal Plants of Kazakhstan," and the "Catalog of Wild Useful Plants of Kazakhstan." Latin names and taxonomic nomenclature changes were verified using the international electronic resource Plants of the World Online (POWO). Maps and schemes of monitoring and control points were created using the ArcGIS software.

Residual pesticide levels were determined by gas chromatography and mass spectrometry, and total heavy metal content was analyzed by atomic absorption spectrometry.

Scientific Novelty

- For the first time, a detailed floristic analysis was conducted at five monitoring points of outdated pesticide stocks and three environmentally favorable control sites in the Almaty region.

- For the first time, the current species composition of plants at the monitoring points Amangeldy and Belbulak was clarified.

- It was established that the concentrations of Pb, Cd, Zn, Cu, Ni, Co, and Mn in dominant and forage terrestrial plants across the entire study area are within permissible limits or slightly exceed the acceptable levels.

- It was revealed that among the studied plants, *Rumex confertus Willd.* and *Artemisia annua L.* have the highest capacity to accumulate pesticides, while *Artemisia annua L.*, *Trifolium pratense L.*, and *Rumex confertus Willd.* show the greatest ability to accumulate heavy metals.

Theoretical Significance. Theoretical significance lies in expanding scientific knowledge about the state of phytocenoses in pesticide-contaminated areas, developing a scientific basis for their assessment and restoration, and applying modern analysis methods to deepen understanding of the resilience of plant communities to anthropogenic impacts. The results form a foundation for future research and improvement of ecosystem monitoring and restoration approaches. The proposed measures can be applied to enhance environmental safety, ensure sustainable land use, and restore biodiversity in the region.

Practical Value. The practical value of the study lies in its potential application to address environmental issues related to soil contamination by pesticides. The findings can be used to develop ecosystem restoration programs for former pesticide storage sites, assess ecological risks, design phytoremediation methods, and raise public awareness about contamination issues.

The data obtained will be valuable for the scientific community, practitioners in environmental protection, land management, and agriculture, and specialists working on degraded land restoration.

Main Provisions for Defense.

- The current species composition of monitoring points in former pesticide storage sites and control sites in the Almaty region was clarified: 177 species from 130 genera and 45 families, with the highest number of species at Brigade 2 (119 species, 89 genera, 28 families) and the lowest at Belbulak (103 species, 82 genera, 27 families).

- It was found that among the studied plants, *Rumex confertus Willd.* and *Artemisia annua L.* have the highest ability to accumulate pesticides, while *Artemisia annua L.*, *Trifolium pratense L.*, and *Rumex confertus Willd.* are most capable of accumulating heavy metals.

- A reduction in biodiversity (Biodiversity Index = 0.65) was linked to elevated zinc concentrations (12.1 mg/kg), which exert toxic effects on plants and influence the uptake of other elements.

Connection to the Plan of Core Scientific Research. The dissertation was carried out within the framework of the scientific and technical program: No. BR05236379 “Comprehensive Assessment of the Impact of Unutilized and Prohibited Pesticides on the Genetic Status and Health of the Population in the Almaty Region.”

Doctoral Candidate's Contribution. The doctoral candidate’s contribution includes data collection on the research topic, conducting theoretical and experimental studies, including analysis, interpretation, and presentation of results, preparing articles for publication, and writing the dissertation.

Approval of the Work.

The dissertation materials were presented and discussed at the following conferences:

- International Conference of Students and Young Scientists "Farabi World," 2019, Almaty, Kazakhstan;
- European Biotechnology Congress, April 11–13, 2019, Valencia, Spain;
- International Scientific and Practical Conference "Modern Problems of Biotechnology: From Laboratory Research to Production," June 4–5, 2021, Almaty, Kazakhstan;
- The 5th Symposium on EuroAsian Biodiversity, June 1–3, 2021, Almaty, Kazakhstan;
- International Conference of Students and Young Scientists "Farabi World," 2024, Almaty, Kazakhstan.

Publications. As part of the dissertation, 12 scientific papers were published, and one utility model patent application was filed. One publication was in an international peer-reviewed journal with a CiteScore percentile of at least 50 in the Scopus database. Three articles were published in journals from the list recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of Kazakhstan. Additionally, program results included: "Cadastre of Outdated Pesticides in the Almaty Region: A Case Study of Talgar District" (2020) and Brochure: "Outdated Persistent Pesticides: Reality and Threat" (2020).

Structure of the Dissertation. The dissertation is presented in 100 pages of computer-typed text and consists of a list of symbols and abbreviations, an introduction, a literature review, materials and methods, results and discussion, a conclusion, and a list of references. The dissertation includes 8 tables, 23 figures, and 1 appendix.