



CHLORORGANIC PESTICIDES AND PERSISTENT ORGANIC POLLUTANTS: ECOLOGICAL RISK, BIOACCUMULATION, AND CONTROL MEASURES IN THE CONTEXT OF UZBEKISTAN

Jumaboeva Iroda Muratkasimovna

Independent Researcher

Research Institute of Agrobiotechnologies and Biochemistry, Gulistan State University

email: irodajumaboyeva@gmail.com

Abstract: this article analyzes persistent organic pollutants (POPs), particularly chlororganic pesticides, their ecological risk, bioaccumulation, and impact on human health. Measures for the safe disposal of old pesticide stocks in Uzbekistan are reviewed. Bioremediation and monitoring methods are highlighted as effective approaches for the remediation of soils and water bodies contaminated with pesticides.

Keywords: persistent organic pollutants, chlororganic pesticides, bioaccumulation, ecological risk, Stockholm Convention, bioremediation, monitoring.

Non-degradable and environmentally persistent pesticides are highly resistant to photolytic, biological, and chemical degradation. Their widespread distribution is primarily associated with anthropogenic activities, particularly the rapid development of industry; however, natural sources of chlorinated compounds also exist [1, 2]. Persistent organic pollutants (POPs) mainly consist of compounds containing chlorine atoms, with carbon chlorine bonds exhibiting high resistance to hydrolysis. The greater the number of substituent chlorine atoms or functional groups in a compound, the higher its resistance to degradation. Chlorine atoms in a benzene ring confer greater stability compared to aliphatic structures, and persistent chlorinated organic pollutants often possess branched or non-linear ring structures. Additionally, due to their high reactivity in halogenation reactions, these compounds may exhibit low solubility in water but high solubility in lipids [3, 4]. POPs can

penetrate the lipid layers of biological membranes, leading to accumulation in organisms and ecosystems.

There are various reports concerning the quantity and distribution of pesticides within the territory of Uzbekistan. According to official sources, over 14,000 tons of pesticides are stored in the country's disposal facilities, whereas the HCH & Pesticides Association estimates the amount to be around 40,000 tons [5]. Uzbekistan has agreed to cooperate with the United Nations Food and Agriculture Organization (FAO) and the European Union on the disposal of obsolete pesticide stocks. The primary goal of this collaboration is to protect human health and the environment from the harmful effects of pesticides. During the former Soviet era, toxic pesticides were widely used, particularly in cotton fields. According to the State Committee for Nature Protection, at 461 agricultural aerodromes remaining from the Soviet period, toxic pesticide formulations were prepared and, by the mid-1990s, all were deposited in specialized concrete storage facilities [6]. Among the most hazardous pesticides are the Persistent Organic Pollutants (POPs), of which 118 tons are currently stored within Uzbekistan [6].

In 2001, the Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted, aiming to protect human health and the environment from the adverse effects of POPs [7]. The Republic of Uzbekistan has ratified this convention and established the necessary organizational measures for its implementation (Resolution No. 939 of the Cabinet of Ministers, dated 21 November 2019) [8]. The convention was adopted on 22 May 2001 and entered into force in 2004; currently, 182 countries are parties to it [7, 8]. The convention seeks to safeguard human populations, the environment, and ecosystems by restricting the production, distribution, and use of POPs. Moreover, Uzbekistan's accession to the convention enhances the export potential of domestically produced goods. According to the Stockholm Convention, the production and distribution of 12 specific chemicals, including pesticides, polychlorinated biphenyls, dioxins, and furans, are prohibited [7]. Pesticides are classified as the first group of POPs. They are defined as

substances or mixtures of substances used to control harmful organisms, including insects, rodents, weeds, fungi, bacteria, or viruses [9]. Until the late 20th century, in developing countries – particularly in agriculture – 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane (DDT) and 1,2,3,4,5,6-hexachlorocyclohexane (HCH) were widely applied; these compounds are characterized by long-term residues in food products and the environment [10, 11]. Pesticides can alter the organoleptic properties of food (color, odor, taste) and reduce its nutritional value [10, 11]. Their impact on the human body can disrupt physiological and biochemical processes, potentially causing severe poisoning and even death.

Chlorinated organic pesticides are characterized by high lipophilicity, chemical stability, toxicity, and bioaccumulative potential. Among the most hazardous representatives are 4,4'-dichlorodiphenyltrichloromethane (DDT) and γ -hexachlorocyclohexane (γ -HCH, commonly known as lindane), with logP values of 6.91 and 3.72, respectively [1, 12]. The long-term persistence of these compounds in soil, their resistance to degradation, and their estrogenic and carcinogenic properties make them significant environmental concerns. Consequently, their use has been banned in many countries [12, 13]. Their chemical properties – stability, lipophilicity, and long-term bioaccumulation – pose serious environmental hazards. Concentrations of these compounds can be particularly high in lipid-rich food products, and even where their use is prohibited, trace residues are still detected [10, 12, 13]. Due to their high lipophilicity and bioaccumulative potential, chlorinated organic pesticides accumulate in fatty tissues, especially in dairy products, fish, and meat. Once ingested, these compounds are slowly metabolized and exert long-term adverse effects. Their toxicological profile is notable for negative impacts on the reproductive system, endocrine function, nervous system, and immune system. Although substances such as DDT and lindane have been banned in many countries, they continue to persist at low levels in the environment and in food products [12, 13]. The persistence and long-term stability of POPs contribute to their status as a global ecological problem. These compounds can volatilize into the atmosphere,

migrate through water and soil, and bioaccumulate through the food chain from higher to lower trophic levels [9, 10, 13]. Therefore, the handling and regulation of persistent organic pollutants must be strictly enforced at the state level.

Following the ratification of the Stockholm Convention, the Republic of Uzbekistan has been improving its ecological monitoring system related to pesticides. This system encompasses the detection of pesticide residues in soil, water, and food products, the assessment of their risks, and their safe disposal [10, 12, 13]. In parallel, bioremediation methods – utilizing microorganisms to clean pesticide-contaminated soil and water – are being explored as environmentally safe and effective approaches [12]. Measures to reduce pesticide risks and control their use are aimed at protecting the environment, safeguarding human health, and ensuring food safety. Moreover, the application of pesticides in accordance with international standards enhances the country's export potential and increases the competitiveness of agricultural products [8, 10]. Persistent organic pollutants, particularly chlorinated pesticides, represent a serious environmental and public health concern. Their chemical stability, high lipophilicity, and resistance to biodegradation categorize them as long-term pollutants. These properties enable pesticides to bioaccumulate in soil, water, air, and the food chain, resulting in prolonged adverse effects on human health and wildlife [1, 10, 12]. In particular, the concentrations of compounds such as DDT and lindane are high in lipid-rich food products, and their negative impacts on reproductive, endocrine, and immune systems have been confirmed by scientific studies.

In Uzbekistan, toxic pesticides from the Soviet era and their current storage pose significant environmental risks. Additionally, the quantity of obsolete pesticide stocks and improper storage practices necessitate state measures for regional ecological monitoring and safe disposal. The ratification of the Stockholm Convention marked a crucial step for Uzbekistan in fulfilling its international environmental obligations and protecting the environment [7, 8]. This convention

aims to ensure the safety of humans and ecosystems by restricting the production, distribution, and use of pesticides.

Contemporary research highlights the need to improve methods for controlling persistent organic pollutants (POPs) and removing them from the environment. Technologies such as bioremediation, chemical degradation, and safe disposal have proven effective in cleaning pesticide-contaminated soil and water [12, 13]. Furthermore, monitoring systems enable the detection of pesticide residues in food products and the environment, assessment of associated risks, and safe management of their disposal.

Uzbekistan's ecological policy regarding pesticides is focused on ensuring environmental sustainability, protecting public health, and enhancing the quality of agricultural products. Measures implemented under the framework of the Convention and national legislation mitigate the harmful effects of pesticides, improve food safety, and expand export opportunities in compliance with international standards. At the same time, the control and environmentally safe disposal of persistent organic pollutants contribute to the sustainability of Uzbekistan's environmental policy [8, 10, 12]. Consequently, the implementation of measures addressing chlorinated organic pesticides and other POPs is of vital importance for reducing environmental risks, protecting ecosystems, safeguarding human health, and enhancing the country's potential for international economic cooperation. In this way, the regulation and safe disposal of pesticides directly support Uzbekistan's ecological and economic sustainability.

In Uzbekistan, toxic pesticides from the Soviet era and their current storage pose significant environmental risks. Additionally, the quantity of obsolete pesticide stocks and improper storage practices necessitate state measures for regional ecological monitoring and safe disposal. The ratification of the Stockholm Convention marked a crucial step for Uzbekistan in fulfilling its international environmental obligations and protecting the environment [7, 8]. This convention

aims to ensure the safety of humans and ecosystems by restricting the production, distribution, and use of pesticides.

Contemporary research highlights the need to improve methods for controlling persistent organic pollutants (POPs) and removing them from the environment. Technologies such as bioremediation, chemical degradation, and safe disposal have proven effective in cleaning pesticide-contaminated soil and water [12, 13]. Furthermore, monitoring systems enable the detection of pesticide residues in food products and the environment, assessment of associated risks, and safe management of their disposal.

Uzbekistan's ecological policy regarding pesticides is focused on ensuring environmental sustainability, protecting public health, and enhancing the quality of agricultural products. Measures implemented under the framework of the Convention and national legislation mitigate the harmful effects of pesticides, improve food safety, and expand export opportunities in compliance with international standards. At the same time, the control and environmentally safe disposal of persistent organic pollutants contribute to the sustainability of Uzbekistan's environmental policy [8, 10, 12]. Consequently, the implementation of measures addressing chlorinated organic pesticides and other POPs is of vital importance for reducing environmental risks, protecting ecosystems, safeguarding human health, and enhancing the country's potential for international economic cooperation. In this way, the regulation and safe disposal of pesticides directly support Uzbekistan's ecological and economic sustainability.

Moreover, long-term monitoring and research on pesticide residues provide essential data for evaluating environmental trends and potential health hazards, allowing policymakers to make informed decisions regarding agricultural and industrial practices. The integration of advanced analytical techniques, combined with public awareness programs and training for agricultural workers, further strengthens the effectiveness of pesticide management. By maintaining a comprehensive approach that includes prevention, control, and remediation,

Uzbekistan can minimize the ecological footprint of hazardous pesticides while promoting sustainable agricultural development and food security.

REFERENCES

1. Трегер Ю.А. Устойчивые органические загрязнители. Проблемы и пути их решения // Бюллетень МИТХТ. – 2011. – Т. 6, № 5. – С. 96–101.
2. Бобовникова Ц.И., Вирченко Е.П., Малахов С.Г. Проблема глобального загрязнения окружающей среды органохлорными пестицидами. Опыт и методы экотоксикологического мониторинга. – Пушино-на-Оке: Наука, 1978. – С. 201–208.
3. Ишанкулов М. SOS и звук SOS — одно и то же // Терра-Жер-Ана. – 2002. – № 3. – С. 3–6.
4. Hadjamberdiev I., Jumaev I., Gorbatyuk V. Review on Persistent Organic Pollutants. Official ANPED website. Available at: <http://www.anped.org/media.phpid=107> (accessed March 2013).
5. Сметник А.А., Спиридонов Ю.Я., Шеин Е.В. Миграция пестицидов в почвах. М., 2005.
6. Katagi T. Soil Column Leaching of Pesticides // Rev. Environ. Contamin. and Toxicol. 2013. Vol. 221.
7. Kordel W., Klein M. Prediction of leaching and groundwater contamination by pesticides // Pure and Applied Chem. 2006. Vol. 78, N 5.
8. Абдурахманова Угилай Коххоровна, Кушиев Хабибжон Хожибобоевич, Жумабаева Ирода Мураткасимовна ПРИМЕНЕНИЕ МОНОАММОНИЕВОЙ СОЛИ ГЛИЦИРРИЗИНОВОЙ КИСЛОТЫ В КАЧЕСТВЕ БИОСОРБАЦИОННОГО РЕАГЕНТА НА ИОНЫ ЖЕЛЕЗА (III) // Universum: химия и биология. 2021. №3-1 (81). URL: <https://cyberleninka.ru/article/n/primenenie-monoammonievoy-soli-glitsirrizinovoy-kisloty-v-kachestve-biosorbatsionnogo-reagenta-na-iony-zheleza-iii>.

9. I. M. Jumaboeva, Kh. Kh. Kushiev (2023). The Migration of Organic Chlorine Pesticide Residues in the Composition of the Soil Samples from Mirzaabad, Gulistan and Boyovut Districts of Syrdarya Region. International Journal of Current Science Research and Review, 6(11), -. <https://www.europub.co.uk/articles/-A-724307>.
10. Muratkasimovna, J. I. . (2023). Environmental Effects of Pesticide Use in Agriculture. Journal of Innovation, Creativity and Art, 2(3), 29–32. Retrieved from <https://jica.innovascience.uz/index.php/jica/article/view/109>.
11. Nasriddinov D.I. O‘zbekiston agroekotizimlarida kimyoviy moddalarning ekologik oqibatlari // *O‘zbekiston biologik jurnali*. – 2020. – №3.
12. Жумабаева И.М., Джураев Т.А., Кушиев Х.Х. Эффективность микробной биоремедиации загрязненных почв пестицидами Сырдарьинской области (Гулистанский, Баяутский, Мирзабадский районы). *Рахtachilik va donchilik ilmiy amaliy jurnal*. 2025 №1 (18).
13. Muratkasimovna J. I. TUPROQ VA SUV MUHITIDA XLORORGANIK PESTITSIDLARNING MIGRATSIYASI VA MONITORINGI: EKOLOGIK XAVFNI BAHOLASH USULLARI //CONFERENCE OF INNOVATIVE HORIZONS IN SCIENCE & ENGINEERING. – 2025. – T. 1. – №. 2. – C. 118-123.