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Influence of Pesticides on Increasing Soil Radioactivity

Sadridin Eshkaraev[1], Khait Turaev[1], Samariddin Eshkoraev[2]

[1]Department of Organic and Physical Chemistry, Faculty of Chemistry and Technology, Termez State University, Termez, Uzbekistan
[2]Termez Branch, Tashkent State Technical University Named After Islam Karimov, Termez, Uzbekistan

Email address:
esadir_74@rambler.ru (S. Eshkaraev), hhturaev@rambler.ru (K. Turaev), eshqoraevsamariddin@gmail.uz (S. Eshkoraev)

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Abstract: The article examines the effect of pesticides on the number of radionuclides in the soil and, therefore, the effect on the health of animals and humans. In the 60s and 80s of the twentieth century, thousands of tons of pesticides were used in the agricultural sector of the Republic of Uzbekistan to combat pests and diseases. For this, more than 500 agricultural airfields have been created throughout the country. Over the years, due to the use of DDT, HCH, and other types of pesticides, oncological diseases of the cardiovascular and digestive systems have increased by 4-7 times. As a result, in the 1990s, using of pesticides in agriculture was banned by the state. However the hundreds of tons of pesticides mixed with the soil at former agricultural airfields and continue to harm the soil to this day. The only one in the Surkhandarya region alone, there are 52 former agricultural airfields, most of which are now used by farms and the population as agricultural land. Between 1990 and 2018, over 45% of the population living this area was diagnosed with digestive cancer, and almost half of them died before the age of 60. According to the Surkhandarya Regional Oncological Dispensary, the incidence of cancer in the region in 2018 increased 12 times compared to 1990. Of the 176 patients who visited the dispensary in 2018, 128 (72.7%) lived in or near former agricultural airfields. It is determined in the article that pesticides penetrate into the porous parts of the soil and form a thin film, preventing the dissolution of radionuclides in water and the transition to the ground part of the earth. This has been studied and proven by electron microscopy and mass spectrometry. It was also confirmed that the concentration of radionuclides increases in soils with a high content of pesticides. The effect of pesticides and radionuclides in the birth of various oncological diseases in the digestive organs of mammals and humans is shown.

Keywords: Radioactivity, Radiation, Soil Salinity, Radionuclides, Cesium-137, Strontium-90, Degree of Damage, Radiometer, α-hexachlorocyclohexane (α-HCSH), Mass Spectrometer, Agro Technical Treatments

1. Introduction

In the 60s and 80s of the twentieth century, thousands of tons of pesticides were used in the agricultural sector of the Republic of Uzbekistan to combat pests and diseases. For this, more than 500 agricultural airfields have been created throughout the country. Over the last few years, due to the use of DDT, HCH, and other types of pesticides, oncological, cardiovascular and diseases of the digestive system have increased 4-7 times. As result, until the 1990s, the use of pesticides in agriculture was banned by the state. However hundreds of tons of pesticides mixed with the soil at former agricultural airfields and continue to harm the soil to this day. Only in the Surkhandarya region, there are 52 former agricultural airfields, most of which are now used by farms and the population as agricultural land.. Between 1990 and 2018, over 45% of the population living in this area was diagnosed with digestive cancer, and almost half of them died before the age of 60. According to the Surkhandarya Regional Oncological Dispensary, the information on cancer in the region in 2018 increased 12 times compared to 1990. Of 176 patients who applied to the dispensary in 2018, 128 (72.7%) lived at or near former agricultural airfields. Radionuclides that cause cancer in the human body are potassium-40, strontium-90, cesium-137, and others. According to our research since 2018, although radionuclides in soil are more harmful in areas with high pesticide levels, the main goal of our research is to determine how pesticides in soil affect the movement and concentration of radionuclides [1, 2, and 3].

Pesticides [lat. pestis - disease, caedo - kill], are toxic chemicals used in the fight against pests and diseases of plants, weeds, as well as wood, cotton fiber, wool, skin pests, pathogens of dangerous diseases of domestic animals. In addition, the group of pesticides includes gibberellins, defoliants, desiccants, and retardants. Pesticides enter the cells of living organisms and change their physical and chemical properties. Chemically reacts with proteins and other substances in the cell, precipitates them, weakens the activity of enzymes, disrupts metabolic processes, and leads to cell destruction [4, 5, and 6]. Pesticides are classified according to the object of use, route of ingestion, nature of exposure, and chemical composition. Depending on which pest is used, i.e. from the object of application, pesticides are divided into the following types: insecticides - means of exterminating insects; antifidants - substances that protect plants and materials from pests; acaricides - into herbaceous canals; nematodes - for planting nematodes; limacids - mucous worms; rodenticides - from rodents; fungicides - for diseases caused by fungi: bactericides - for bacteria; herbicides - from weeds between crops; arboricides - means used against shrubs and shrubs; attractants - insect repellents, repellents - substances that repel insects and birds, algicides - drugs used against algae, etc. There are also pesticides with complex action. For example, pesticides used for seed treatment can perform fungicidal, bactericidal, insecticidal, and other functions [7, 8].

Pesticides are one of the most effective ways to control weeds, diseases, and pests. Pesticides belong to different classes of organic and inorganic compounds. Most of them are obtained by artificial means. The most important pesticides are organochlorine and organophosphorus compounds, carbamic acid derivatives, and plant triazines (pyrethroids). Compounds of copper, sulfur, and other elements can be shown from inorganic pesticides. Organochlorine pesticides are versatile. They destroy many types of pests; the effect is long-lasting and dangerous for warm-blooded animals. Another disadvantage of organochlorine pesticides is that they are chemically stable in the external environment, soil, vegetation, and water, that is, they remain intact for a long time. This can lead to the accumulation of drug residues in plant foods, animals, and humans. Although the use of highly stable drugs such as DDT is prohibited by the state, several hundred tons remain in former agricultural warehouses and airfields and mix with the soil, damaging the soil in the area for several tens of kilometers with the help of rain and groundwater. Organophosphate pesticides have high biological activity, they differ from others in their ability to penetrate into the plant and maintain the strength of the poison for a long time. Some of them are absorbed through the leaves or roots and are distributed through the vascular system of the plant along with the nutrient solution. Pests that feed on plant sap from this are poisoned and die; these compounds are called internal drugs. The remaining groups of substances are absorbed on the surface of plant tissues, do not spread through the veins, and are called partially absorbed drugs. They are more resistant inside the body than on the surface and kill pests on the untreated back of the leaf. Organophosphate pesticides include insecticides, fungicides, nematicides, and herbicides. In agriculture, insecticides and acaricides such as phosphamide (BI-58), phosphalon, karbofos, zolone, and others are widely used [8, 9].

Synthetic pyrethroids are analogous to pyrethrum material obtained from several types of plant pathways. In recent years, pyrethroids have been widely used to protect many plants from pests. These compounds have the property of selective action. They are effective against pests, even when there are very few of them (due to several grams of active substance per hectare). In Uzbekistan, the use of synthetic pyrethroids is permitted, such as ambush, cymbush, ripcord, sumicidin, decis, etc. Sulfur pesticides are produced based on ordinary sulfur (sulfur powder, colloidal sulfur, lime-sulfur broth, etc.); in addition, organic sulfur compounds are also present [10, 11].

Pesticides are produced in the form of wetting powders, emulsion concentrates, pastes, granules, dust, aerosols, aqueous solutions, soluble powders, etc. However, they also contain other additional components (diluent, filler). Pesticides are used in spraying, pollination, fumigation, and other methods. In some cases, unscientific misuse of pesticides creates hazardous situations for flora, fauna, farm animals, and humans [12]. When choosing pesticides, great attention is paid to their toxicity - the toxic properties of chemicals. The level of toxicity is determined by the dose, i.e., the amount of a substance in mg that disrupts or destroys the vital functions of the body (on average, mg per kilogram of body weight in experimental animals). The toxicity of pesticides is usually determined by comparing the consumed dose with the mortality of a certain part of a group of experimental animals (rats, mice). Such doses of pesticides are characterized by the DS50 mark (the dose that kills 50% of the animals in the experiment). According to the accepted classification, the toxicity of pesticides is conventionally divided into 4 groups: highly toxic (DS 50 50 mg/kg gala); strong poison (DS 50 50-200 mg/kg); moderately toxic (DS 50 200-1000 mg/kg), low toxic pesticides (DS 50 more than 1000 mg/kg). When pesticides exceed the officially recommended dose or concentration, the method and duration of application are chosen incorrectly, and regardless of climatic conditions, they can cause plant burns, a decrease in pollen viability, seed death, and as a result, a decrease in yield. Plants can be contaminated with pesticides, and fruits can have an unpleasant odor and unpleasant taste, as well as these substances can accumulate on the surface of the plant in quantities hazardous to humans and animals [13, 14]. Due to the regular use of pesticides, pests often develop resistance to them. To avoid the emergence of certain pesticide-resistant strains of pests, there must be many types of drugs designed for each pest and they must be used interchangeably. To prevent the negative impact of pesticides on people, animals, plants, water and the environment in general, their use should take into account not only the impact on the pest but also the biocenosis, that is, the consequences. Pesticides should be converted from pest control to pest management. Practically used and recommended for production pesticides are studied and recommended for use by a special commission under the Ministry of Agriculture and Water Resources of the republic [15].

2. Experimental Part

To study the effect of pesticides on increasing the radioactivity of the soil, a pesticide (a-hexachlorocyclohexane - α-HXSH) was artificially added to the soil samples cleaned from additives. The amount of α-HXSH added to the soil is shown in Table 1.

Table 1. *Amount of α-GXSG added to soil.*

№	Barcode probes	Sample weight, g	Weight of α- HXSH added to soil, g
1	T-20-1	50,0	0,001
2	T-20-2	50,0	0,002
3	T-20-3	50,0	0,003
4	T-20-4	50,0	0,004
5	T-20-5	50,0	0,005
6	T-20-6	50,0	0,01
7	T-20-7	50,0	0,05
8	T-20-8	50,0	0,1

The pesticides were added to 8 soil samples and 2 clean soil samples for the background (10 samples in total), each of which was planted with branches of aloe flowers on March 15, 2020. All potted flowers received the same amount of nutrients and mineral fertilizers. Three months later, when the aloe branches in pots 6.7 and 8 were dry, the number of pesticides and radionuclides in all soil samples was checked on a Delta-Plus mass spectrometer. The test results are presented in Table 2:

Table 2. *Mass spectrometric analysis data for soil samples.*

№	Barcode probes	Sample weight, g	Weight of α- HXSH added to soil, g	Cesium-137 radionuclide mass in soil, mg/kg	Stronsium-90 radionuclide mass in soil, mg/kg
1	T-20-1	50,001	0,0008	0,01	0
2	T-20-2	50,002	0,0015	0,02	0,04
3	T-20-3	50,003	0,0026	0,01	0,05
4	T-20-4	50,004	0,0039	0	0,04
5	T-20-5	50,005	0,0046	0,01	0,03
6	T-20-6	50,01	0,095	0,02	0,04
7	T-20-7	50,05	0,048	0,01	0,05
8	T-20-8	50,1	0,097	0,01	0,03
9	Background	50,0	0	0	0
10	Background	50,0	0	0	0

Table 2 shows that in soil samples with a high content of pesticides, their negative effect on the growth of aloe is also enhanced. We can also tell this by the fact that the aloe plant in pots 6, 7, and 8 are withered. It has also been shown to have a positive effect on plant growth when the amount of pesticide is less than 0.003 mg. In particular, the aloe seedlings in the first, second and third inflorescences grew 2 times higher than the rest of the seedlings, their color was also dark green. The insects began to eat the seedlings in the remaining pots, the leaves turned yellow and the height was too low. Seedlings in pots 6, 7, and 8 have dried up. I think the effect was that the number of pesticides in them was much higher than usual. You can see that the content of cesium-137 and strontium-90 radionuclides in the soil is very low. Now, to study the effect of pesticides on the number radionuclides in the soil, the radionuclides in the amounts indicated in Table 3 were added to the soil samples.

Table 3. *The amount of radionuclides added to the soil.*

№	Barcode probes	Sample weight, g	Weight of α- HXSH added to soil, g	Cesium-137 radionuclide mass in soil, mg/kg	Stronsium-90 radionuclide mass in soil, mg/kg
1	T-20-1	50,001	0,0008	0,1	0,5
2	T-20-2	50,002	0,0015	0,1	0,5
3	T-20-3	50,003	0,0026	0,1	0,5
4	T-20-4	50,004	0,0039	0,1	0,5
5	T-20-5	50,005	0,0046	0,1	0,5
6	T-20-6	50,01	0,095	0,1	0,5
7	T-20-7	50,05	0,048	0,1	0,5
8	T-20-8	50,1	0,097	0,1	0,5
9	Background	50,0	0	0,1	0,5
10	Background	50,0	0	0,1	0,5

We can see from Table 3, the quantitive of pesticides and radionuclides remained unchanged because the quantitive of radionuclides was added in the same amount to all samples. On April 1, 2020, soil samples containing radionuclides were transferred to pots, the same aloe seedlings were planted in them, and for 3 months, they were treated with the same feed, mineral fertilizers and the same agrotechnical treatments were carried out. If you look at the results of the study on July 1, 2020, you can see that the aloe plant in pots 6, 7, and 8 have dried up again, the development of plants in pots 4 and 5 is lagging, and plants in pots 1, 2, 3, 9 and 10 are good. The effect of pesticides in the soil on the increase in radionuclides has not been confirmed by mass spectrometric analysis. Surprisingly, quantitative radionuclides in the soil turned out to be much lower than the initial one. In our opinion, the decrease in radionuclides is associated with the constant softening of the roots of aloe plants (constant agronomic measures) and the constant retention of moisture in the soil (constant watering). This was confirmed by the analysis of the wooden shelf on the MKGB-01 radiometer-spectrometer. This means that the quantitative pesticides and radionuclides in the soil can be reduced if agrotechnical measures are carried out in a timely manner and if the soil is constantly provided with humus, mineral fertilizers, water, and other nutrients. However, agrotechnical measures for growing crops in natural conditions are not carried out in a timely manner and in full, including plowing, plowing, timely cultivation, etc. The same is with fertilizers. Even in the desert areas of our region, plants can drink water only 2 times per season. In this case, a study should be made of the effect of several hundred tons of pesticides left on the soil in the 1980s and their effect on the increase in the quantitative radionuclides naturally released from the soil to the soil surface. in vivo. To this end, we continued research at the experimental site of LLC "Agrokhimstantsiya" in the mahalla named after M. Eshtemirov in the village of “Namuna”, Termez district, Surkhandarya region. In September 2020, 1 hectare of land (depth 0.3 m) was plowed, 150 kg of humus, 25 kg of mineral fertilizer ammophos, 0.5 mg per 1 kg of soil (total 39 mg per 78 kg of soil) were finely crushed and fertilized. We mixed the strontium-90 radionuclide from 137 and 1 mg (78 mg for the whole soil). On October 1, 2020, the seeds of Polovchanka wheat were sown in an even layer. The land plot was divided into two equal parts (0.5ar). While part (A) was irrigated, agrotechnical measures and fertilizers were carried out in a timely manner, part 2 (B) was watered with half the water and mineral fertilizers, and agrotechnicall treatment was practically absent. On December 1, 2020 (two months later), we reviewed the survey results. If we see that the growth of wheat on the agro-treated part (A) is better than on other parts of the experimental plot, the development of wheat on the non-agro-treated part (B) lags almost 2 times behind other parts.

3. Analysis of Experimental Results

Five samples were taken from each site and examined on a Delta Plus mass spectrometer. The results are shown in Figure 1:

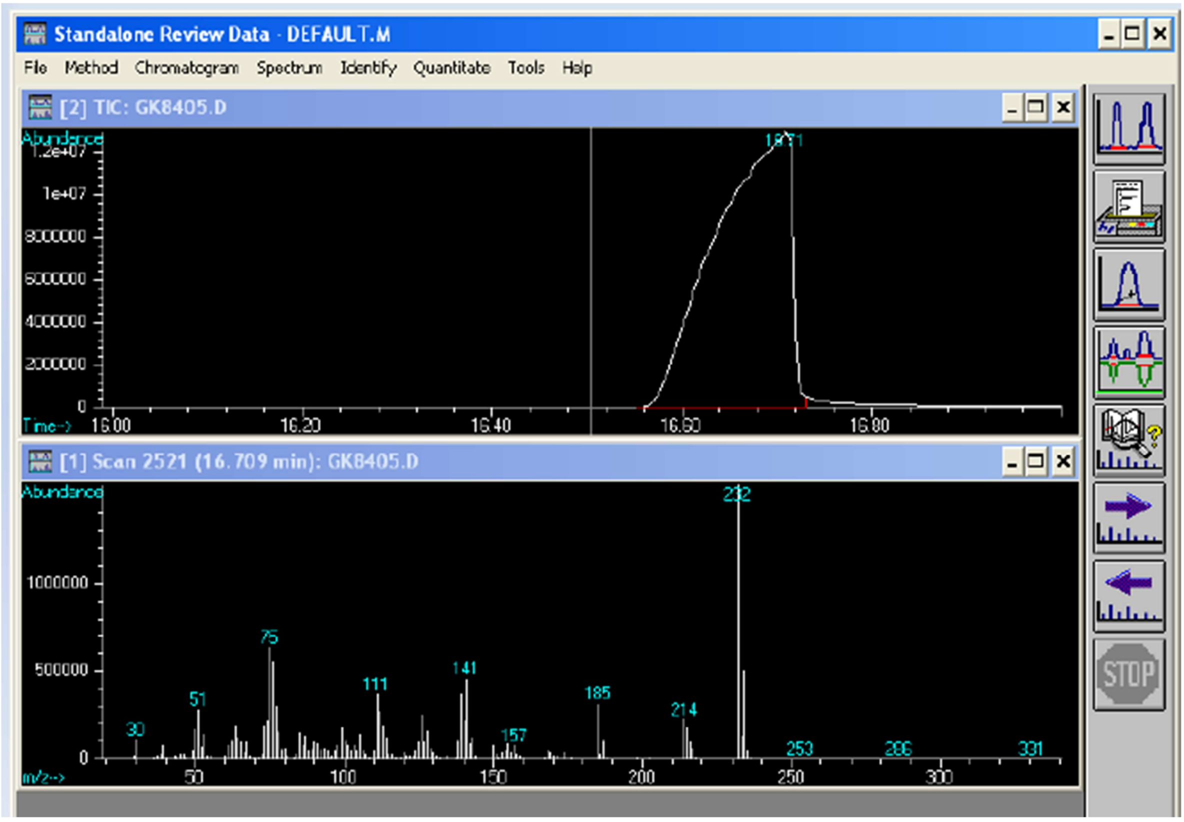

Figure 1. *Mass-spectrometric data of the background and investigated soil sample No. 1.*

As can be seen from Figure 1, in the spectrum of the background sample (clean soil) (upper part in Figure 1), only the spectrum associated with the release of water molecules from the soil composition, which manifests itself in the region of 16.25 ppm, is highlighted. The soil sample is free of pesticides and radionuclides. The spectrum at the bottom of Figure 1 is a view of soil sample 1 with an area of 331 ppm. Belongs to a soil sample with pesticides and radionuclides, 266 ppm the release of a pesticide containing a chlorine atom into the field, 253 ppm the 13th isotope of the carbon atom in the field, the radiation of the 2nd chlorine atom at 232-ppm etc. 51-ppm humus remains in the field. Electron microscopic examination of soil samples also showed that pesticides penetrate and fill the air-permeable pores of the soil and coat the air-permeable pores with a thin film on an area of land that has not been cultivated, irrigated or fertilized properly. When soil samples with high pesticide content were analyzed in Table 2, soil samples 6, 7 and 8 were examined under an electron microscope, and it was confirmed that the porous part of the soil was covered with a thin film and did not completely transfer water to the lower part of the soil.

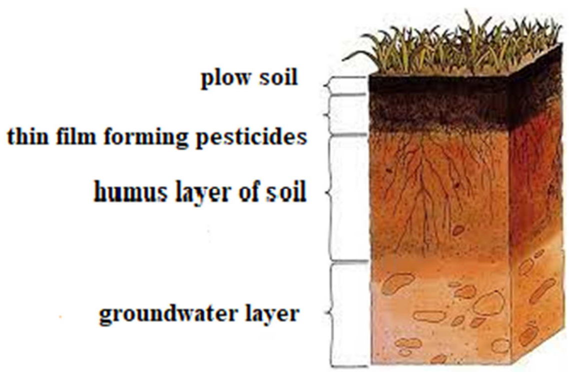

Figure 2. View of a thin film formed by pesticides in the soil.

As the water becomes more difficult to pass through, the radionuclides dissolved in the water also do not penetrate the substrate, and the water rises to the soil surface and leads to soil salinization due to the calcium and magnesium salts dissolved in the water.

4. Conclusion

In soils with a high pesticide content, pesticides enter the porous parts of the soil, forming an organic thin-film insoluble in water and preventing the penetration of mineral nutrients, water and radionuclides into the groundwater layer. As a result, the amount of pesticides, radionuclides, and other toxic substances in the soil accumulates in the fertile part of the soil, concentrates, and penetrates through the soil into plants, animals, and people. Over time, it causes various cancers in animals and humans.

5. Recommendation

It is recommended to check the use of agricultural land for the presence of pesticides and radionuclides, to carry out regular agrotechnical work on land plots with a high content of pesticides and radionuclides. This, in turn, reduces soil salinity by 20%.

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