UDC 631.95: 628.516: 615.849

S.Yu. Bulygin,
Academician of the National Academy of Sciences of Ukraine, Doctor of Agricultural Sciences,
National University of Bioresources and Nature Management of Ukraine
O.I. Dutov,
Doctor of Agricultural Sciences
State Ecology Academy of Postgraduate Education and Management

Scientific aspects of lowering criticality of radioactively polluted agricultural landscapes in distant period of development of radiation situation

Goal. To determine the regularities of the receipt of radionuclides to agricultural products in the remote period of the development of the radiation situation at different levels of mineral nutrition of plants and saturation of crop rotation with agricultural crops, which are characterized by relatively low ability to accumulate radionuclides. Methods. The content of 137Cs as the main dosage form of radionuclide in soil and vegetation samples was determined by spectrometric method on the gamma spectrometric equipment with semiconductor detectors GEM-30185, Ge (Li), GMX series EG & G ORTEC with multichannel ADCAM-300 analyzer. Results. The laws of 137Cs' receipt of agricultural products on different soils depending on fertilization and selection of crops are established. Conclusions The saturation of field crop rotation with agricultural crops that are characterized by a potentially low ability to accumulate radionuclides can reduce the criticality of radioactive contaminated agro-landscapes by up to 13 times.

Key words: radiation protection measures, specific activity of radionuclides, agricultural products, 137Cs, norms of radionuclide content.

The Chernobyl disaster is unprecedented man-made disaster of mankind, which significantly changed the traditional way of life and doing business diyal¬nosti more than 2 million people. Prozhyva¬yut permanently in the territory's 74 regions 12 regions of Ukraine [4, 11, 13]. The current legislation of Ukraine [8, 9] specifies 4 zones of radioactive contamination of the territory. Separation of radioactive by-brudnenoyi area of agricultural land (except Zone - the area from which in 1986 evacuated population) ba-zuvalosya on the density of soil contamination. The work of scientists [7, 12, 14] suggested that in the structure of the total dose of irradiation of the population prevailing internal irradiation with food products that are produced in radioactive contaminated areas. There remains a lot of problems associated with radiation environmently-term criticality agricultural landscapes, which are characterized by abnormally high koefitsiyen¬ty transition radioactive cesium from soil to plants, resulting in frequent vypad¬ky agricultural pro¬duktsiyi contaminated with 137Cs [1 , 5, 6]. Studying the scientific aspects to reduce the degree of criticality of radioactively contaminated agricultural landscapes in the remote period of ra-diatsiynoyi situation, in particular through the optimization of mineral nutrition of plants and crop rotation saturation characterized by relatively low riv¬nem radionuclide accumulation is an important and urgent task. Materials and methods of research. Dosli¬dzhennya to determine the criticality reduce radioactive contaminated agricultural landscapes conducted on sodpodzolic soils in the area and ashed Polesie and forest-steppe zone in ty¬povyh 5 most contaminated areas of Ukraine (Volyn, Zhytomyr, Rivne, Kyiv and Chernihiv). The content of 137Cs as the main dose-forming radionuclide in soil and vegetation samples was determined by spectrometric method on gamma spectrometric equipment with semiconductor detectors GEM-30185, Ge (Li), GMX series EG & G ORTEC with multichannel analyzer ADCAM- 300 The selection of samples and their preparation for analysis was carried out according to generally accepted methods, taking into account the specifics of scientific research in the field of agricultural post-graduate radiology [10]. To estimate the accumulation of radionuclides in the crop at different densities of soil contamination, the coefficient of transition (CP) of 137Cs from soil to plants was used - the content of radio nuclide in the plant at the density of soil pollution equal to 1 (Bq / kg of airborne mass of plants / kBq / m2 of soil) . Research results. Application of mineral fertilizers is one of the most effective factors of intensification

of crop production for obtaining stable high yields of agricultural crops and formation of their qualitative indicators. The role of mineral fertilizers and in the conditions of radioactive contamination of the soil does not change. In this case, their application also has a well-defined radiation and ecological specificity due to the necessity of obtaining guaranteed normatively safe agricultural products. Accumulation of 137Cs in the crop Farm-podarskyh cultures that were studied in the experiment (Fig. 1), primarily due to certain une¬sennyam the soil of nitrogen and potash fertilizers and their combination. Thus, for the introduction of nitrogen (N120), the content of radionuclide increased in all cultures without exception. With the use of phosphorus tuples (120 kg / ha d.r.) in potato tubers, oat grains and lupine there was a tendency to decrease the content of radionuclide (up to 17%). In the case of the introduction of potassium fertilizers separately and in combination with phosphoric (K120 and P120K120) found significant (up to 3 times) decrease in the accumulation of 137Cs in the crop. The application of nitrogen and potassium fertilizers (N120K120) and full mineral fertilizers in potato tubers, pea grains and lupine also showed a decrease in the content of 137Cs by almost 1.5 times. For the introduction of these fertilizers under oats, the content of radionuclide in grain crops increased respectively by 15 and 19%, for wheat of winter - by 42 and 58%.

Fig. 1. the influence of mineral fertilizers on the intensity of accumulation of 137Cs in the crop of agricultural crops on sod-podzolic soils and chernozems: - potatoes, tubers (derenovogo-podzolic soils); - potatoes, tubers (chernozem); - oats (sod-podzolic soils); - oats (chernozem); - rye in winter, grain (sod-podzolic soil); - winter wheat, grain (chernozem)

Somewhat differently, different types of mineral fertilizers influenced the accumulation of 137Cs in a crop of crops under the conditions of chernozem of the forest-steppe. A noticeable increase in the content of radionuclides in these conditions was noted only in winter wheat grains for the introduction of ammonium nitrate in a dose of 120 kg / ha d.r. The introduction of superphosphate (P120), as well as the use of full mineral extraction (N120P120K120), had no significant effect on the accumulation of 137Cs in crops. However, the addition of potassium salts (K120), as well as its application with superphosphate (P120K120), also led to a decrease in the parameters of the accumulation of radionuclide in the crop of agricultural crops. Thus, the effectiveness of mineral fertilizers as a means of reducing the accumulation of 137Cs in sod-podzolic soils of Polissya and on the black soil of the forest-steppe was quite different. Thus, the content of 137Cs in the potato tuber yield in the control variant without the application of mineral fertilizers on turf-podzolic soils was 20 times higher than that of black soil, in the oats grain yield - 18, and in the corn - 32 times, respectively . It can be argued that the accumulation of 137Cs in agricultural crops depended predominantly on the use of nitrogen and potash fertilizers. The maximum accumulation of 137Cs was observed for the introduction of nitrogen, the minimum - for the introduction of potassium. The use of phosphorus fertilizers separately and in combination with nitrogen or potassium did not significantly affect the parameters of contamination of crop rotation. In view of this, the study of the efficiency of potassium fertilizers, their ecological and radiological evaluation as a measure aimed at reducing the accumulation of 137Cs in plants for their cultivation in different soil-climatic conditions on radioactively contaminated territories becomes relevant. According to the results of the research, the parameters for reducing the accumulation of 137Cs in different soil-climatic conditions depended on the dose of potassium, but differentiated depending on the biological characteristics of the agricultural crops that were studied in the experiment (Fig. 2). The minimum accumulation level of 137Cs was observed in winter cereal crops, and the maximum in pea grains. Increasing the dose of potassium fertilizers significantly affected the reduction of 137Cs in the crop of all crops without exception. At the same time, on the Chernozem forest-steppe, the coefficients of transition of 137Cs to the crop were much smaller. If, depending on the dose of potassium fertilizer, divergence in the accumulation of 137Cs in grain of rye of winter on sod-podzolic soils of the Polissya amounted to 0,08-0,38 (Bq / kg) / (kBq / m2), then on the chernozem forest-steppe - 0,001 - 0,008 (Bq / kg) / (kBq / m2), in oats - 0,10-0,38 and 0,016-0,026 (Bq / kg) / (kBq / m2), peas - 0,38-1, 03 And 0,026-0,042 (Bq / kg) / (kBq / m2) respectively. Radionuclide efficiency of potassium before-bay was much less on chernozem. On sod-podzolic soils, the content of 137Cs in the grain yield for the maximum dose of potassium (K600) decreased by 2.5-3 times in comparison with the control, 1.2-1.6 times in the black earth. The decrease in the parameters of accumulation of 137Cs in the case of potassium fertilizers, according to the scientists' opinion [2, 3], is due to the change in the soil concentration of radiocaesium to its non-isotopic carrier - potassium, that is, the decrease of soil normalized by potassium due

to soil pollution. If this ratio is maintained for the transition of radionuclide to the rose line, then the content of 137Cs and in crop yields decreases.

Fig. 2. The influence of doses of potassium fertilizers on the intensity of accumulation of 137ss in the crop of agricultural crops on sod-podzolic soils and chernozems: potato fertilizers under peas were used against the background of N30r120, under winter crop of grain and oats on the background of N120r120; - rye in winter (sod-podzolic soil); - rye in winter (chernozem); - oats (sod-in-podzolic soils); - oats (chernozem);

According to the results of research carried out in the field conditions of radioactive contamination due to the Chernobyl catastrophe, field crops can be divided into separate groups at the potential to accumulate 137 Cs in the crop (Fig. 3). Cereal crops were the least accumulated at 137Cs under the same conditions of breeding. In corn grain, the content of radionuclides was minimal - 0.07 (Bq / kg) / (kBq / m2), in oats grain - the maximum within this group of crops (almost 5 times higher than corn grain). The intermediate position was occupied by such crops (in the order of increasing the coefficient of transition of 137 Cs from the soil to the crop), such as winter wheat, barley, triticale, wheat and spring rye. Potatoes and millet belong to a group of crops with a potentially poor capacity to accumulate 137Cs. Thus, the KP of radionuclide in potato tubers occupied an intermediate position between winter wheat and barley, but was 71% higher than that of corn grain. The content of 137Cs in grains of millet was somewhat larger and occupy a place between wheat with yarrow and rye in winter. Increased potential accumulation of radionuclide was characterized by buckwheat and soy, however, its maximum accumulation was observed in pea grains. The 137Cs content in it was almost 13 times higher than in corn grain.

Conclusions

The scientific aspects of reducing the criticality of radioactive contaminated agricultural landscapes in the remote period of radiation development are aimed at minimizing the intensity of migration of radionuclides in the soil-plant system through the introduction of a complex of pro-radiation measures, in particular the application of mineral fertilizers and the saturation of crop rotation with characteristic bacteria Low ability to accumulate radionuclides. In the conditions of radioactive contamination of soil, the application of mineral fertilizers has a clearly defined radiation and ecological specificity, conditioned by the necessity of obtaining guaranteed normatively safe agricultural products. Efficiency of mineral impurities as a means of reducing the accumulation of 137Cs in agricultural crops on sod-podzolic soils Polissya is an order of magnitude higher than that of the forest-steppe black soil. The saturation of field crop rotation with agricultural crops with a relatively low capacity to accumulate radionuclides can reduce the criticality of radioactive contaminated agro-landscapes by up to 13 times.

Bibliography

1. Actual problems and tasks of the scientific Chernobyl nuclear power plant / M.V. Zubets, B.S. Priester, accompaniments of agricultural production-RM. Aleksakhin et al. / Agroecologist. Journ - 2011 products in the area of radioactive contamination number 1. - S. 5-20.

2. Bondar P.F. Parameters of transition of radioceesia to oat crop on grown soil in dependence on application of mineral fertilizers and chemical meliorants / P.F. Bondar, Al Dutov; Ed. ON. Loshchilova // Problems of c.-h. Radiology: Sat Scientific Tr Ukr Scientific Research Institute Radiology. - K., 1992. - Issue 2. - P. 125-132.

3. Bondar P.F. Estimation of efficiency of potassium fertilizers as a means of reduction of contamination by radiocaesium production / P.F. Bondar, Al Dutov // Ibid. - 1993. - Issue 3. P. 69-83.

4. Bulygin S.Yu. On the program of safe agricultural production on the territories contaminated with radionuclides as a result of the Chornobyl catastrophe / S.Yu. Bulygin, B.S. Pryster, O.I. Furdichko, OI Dutov // Visn. Agrar Science - 2012. - No. 5. - P. 53-57.

5. Determination of the criticality of agricultural production in the land degradation of radioactive contaminated regions / S.Yu. Bulygin, OI Furdichko, OI Bondar, OI Dutov // Visn. Agrar Science - 2013. - № 1. - P. 55-58.

6. Dutov OI Modern approaches to the rational use of radioactively contaminated land (for example, the Chernobyl accident) // Agrochemistry and soil science: intersection. Topic Sciences Save - Kh .: NNC "IGA them. O.N. Sokolovsky ", 2012. - Vip. 77. - P. 38-43.

7. Dutov O.I. Agroecological approaches to minimizing doses of radiation to the population in the remote peripheral development of the radiological situation after the Chernobyl accident // Ecological sciences: sciences. magazine. - K .: DEA, 2014 - No. 1 (5). - pp. 24-30.

8. The Law of Ukraine "On the Legal Regime of Territory Contained by Radioactive Contamination as a Result of the Chornobyl Disaster" / / Bulletin of the Supreme Council of the Ukrainian SSR (BPD). - 1991. - № 16. - C.199.

9. The Law of Ukraine "On the Status and Social Protection of Citizens Affected as a result of the Black Cat Accident" / / Ibid. - P. 200.

10. Methodical manual on the organization of conducting research works in the field of agricultural radiology. - K., 1992. - 136 p.

11. National report of Ukraine "25 years of the Chernobyl disaster. Security of the future. " - K .: KIM, 2011. - 395 p.

12. Priester B.S. Model for forecasting the dose of internal radiation of the population in the soil pathway of the inclusion of long lived radionuclides into food chains / B.S. Priest, V.D. Vinogradskaya // Safety problems of nuclear power plants and Chornobyl. - 2009. - Vip. 11 - C. 128-135.

13. Fesenko S. An extended critical review of the twenty years of countermeasures used in agriculture after the Chernobyl accident / S. Fesenko, R. Aleksakhin, M. Balonov // Science of total environment. - 2007. 383 (1). - P. 1-24.

14. Rural areas affected by the Chernobyl accident: Radiation exposure and remediation strategies / R. Jacob, S. Fesenko, I. Bogdevitch et al. // Science of the Total Environment. - 2009. - V. 408. - Issue 1. - R. 14-25.

Launched on March 10, 2015