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OPPORTUNITIES AND PERSPECTIVES OF AGRICULTURAL DEVELOPMENT IN RADIATION-POLLUTED TERRITORIES

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На основі аналізу результатів досліджень та наукових публікацій вітчизняних і зарубіжних вчених обґрунтовано можливості та перспективи розвитку сільського господарства на радіоактивно забруднених територіях Полісся. Розглянуто значення питомої активності ^{137}Cs та встановлено, що усім культурам властиве підвищене його накопичення.

Ключові слова: *цезій-137, питома активність, сільськогосподарські культури, радіоактивне забруднення, територія.*

The main radionuclides that determine the radiation state of contaminated area are ^{137}Cs and ^{90}Sr [1] at the later stage of the Chornobyl accident. In human body, they get along with food: as a result of their transition from soil to plants [2, 3].

The amount of radioactive substances released from the soil in the plant depends on the contamination of the territory, the type of soil, the supply of its elements of the feed, the type of its cultivation, the type of plant, weather conditions, the intensity of biomass accumulation. Taking into account these factors it is of great practical importance in predicting the accumulation of radionuclides [4].

Polissya area has a significant potential for the production of plant material, therefore, an extremely important problem in Zhytomyr region has been caused by the provision of radio-ecological safety of the population living in contaminated areas and the development of measures to reduce the accumulation of radionuclides in crop production [1].

The experience of past years has shown that in the area of radioactive contamination, a complete cessation of economic activity is unreasonable. This in no way contributes to the return of contaminated areas to the pre-accident state. And even vice versa: human non-interference with these processes can in many cases lead to secondary negative radiological consequences (fires, uncontrolled proliferation of quarantine weeds and plant diseases), which require urgent decisions due to their danger to the surrounding rural areas [5].

The technologies of cultivating crops on radioactive contaminated lands are devoted to the work of the following scientists: Hudkov I.M., Pristor B.I., Vorona L.I., Kochyk H.M., Storozhuk V.V., Dankevych Ye.M., Kovalov V.B., Martyniuk H.O., Bondar O.I., Dutov O.I., Mashkov O.A., Derebon I.Yu. and others.

This leads to the search for new complexes of measures aimed at obtaining crop and livestock products that meet the radiological standards and the safe use of agrocenoses in radioactive contaminated areas [6].

One such measure is the species and variety selection of crops that least accumulate radionuclides [7]. This makes it possible to adapt agriculture, even at densities of contaminated areas that do not meet the recommendations. This is especially true in agricultural lands with high variability of radioactive contamination.

In addition, this method is conventionally the most economically advantageous, since it does not require additional expenses for reclamation measures aimed at reducing the specific activity of radionuclides in products.

Among the plants that people grow for the sake of obtaining beneficial fruits and seeds, energy and oil crops occupy an important place.

The rapid exhaustion of energy resources reserves prompts society to re-evaluate the energy potential of agro-crops, to change the attitude towards biomass and phyto-energy as a whole. An important argument for the development of green energy is that energy crops can grow on non-fertile soils, as well as on land that is withdrawn from agricultural use, and to create a large amount of biomass under such conditions. That is, they do not create competition for basic food crops [3].

The sowing area of oilseed crops in our state reaches 1.8 million hectares [4]. Consumption of vegetable fats per capita doubled. In the countries of the European Community, 41 kg of oil per year are consumed per person per year, on average in the world — 15.7 kg. An important condition for increasing the production of oilseeds is the sharp increase in the demand for vegetable oils. As a nutrition product, according to the biomedical assessment, they are much more useful and safer for the human body than animal fats [5].

The purpose of researches will be analysis of possibilities and perspectives of use of radioactively polluted areas.

Methods of researches: field (radiometric measurements and sampling), laboratory (radiochemical analysis, gamma- and beta-spectrometry, atomic absorption spectrophotometry, potentiometry, titrimetry), methods of mathematical statistics, cartographic.

The research was conducted in stationary field experiments, located near Khrystynivka village on turf-podzolic sandy soils with a pollution density of 925-1036 kBq/SQM.

The accounting area of each site on which the particular version of the experiment is conducted is 10.15 m^2, the repetition of the four-time.

Breakdown of the experimental plot, field work on the experimental site, fertilization, soil cultivation, sowing and planting, plant care and experiment, crop accounting was performed according to generally accepted methods. Agrotechnical cultivation is generally accepted for Polissya area.

Agrometeorological conditions of the reported year were contrasting both by the amount of precipitation and temperature regime. January was cold: the average temperature of the air was −5,0°C (at a rate of −3,6°C) and low in snow. February — on the contrary, the temperature regime is within the normal range, and by the amount of precipitation exceeded the multi-year indicators by 1.7 times.

March was marked as too warm (5,6°C vs. average-long-term 2,3°C) and rainy — 42% more than normal.

During the spring and summer periods rainfall fell within the normal range, although in the summer months rains fell in the form of short-term showers, which, due to one-sided regulation of moisture, rapidly descended from the arable layer under conditions of flushing type of drained soils. The exception was June month, when the amount of precipitation was only 29% of the average multi-year indicators, while SCC was only 0.35 against the norm — 1.2.

The temperature regime during the growing season was within normal limits, but at the beginning of the restoration of the winter crops vegetation, abnormal deviations were observed, in particular, night frostbite was recorded. Thus, during April 17−21, the air temperature dropped to −1.3−3.0°C; and on the 10th and 11th of May the night air temperature was −0.9 and −0.1°C.

Subsequently, the weather conditions contributed to the active formation of generative organs of crops.

The distribution of rainfall during the growing season was uneven. So, if the beginning of the growing season was characterized by an even distribution of precipitation over decades, in the second and third decades of July and the first decade of August fell the largest amount of precipitation, then the middle of August was marked by aridity.

Beginning of the growing season, namely in April, there was an abnormally low temperature regime of air that suspended the development of plants.

Since stationary research was carried out on a territory that was withdrawn from agricultural use in 1986 and year, data on the type of soil and its main agrochemical characteristics were absent. Therefore, agrochemical analysis of soils was carried out before laying experiments.

As a result of laboratory agrochemical studies for establishing the basic agrochemical characteristics of the studied soils, it has been found that they have such indicators:

1) physical properties of the soil (layer of 0−20 cm): specific mass — 2.62 g/cm^3; density (volume mass) — 1.46 g/cm3; lowest moisture content — 15.33%; total water capacity — 27,65%; moisture reserves with the least moisture content — 23,42%; available moisture reserves — 20.47%; the content of physical clay — 12,21%;

2) chemical properties: the content of humus (0−10 cm layer of soil) — 1,79%; pH of the salt — 6.23; saturation basics — 4,54%; hydrolytic acidity — 1,6; the content of moving aluminum — 0,23 mg/100 g of soil; calcium content — 0.87 mg/100 g of soil; phosphorus content — 17,36 mg/100 g of soil; Potassium content — 1.78 mg/100 g of soil.

According to physical and chemical properties, the soil fully corresponds to the most common soddy podzolic soils in Polissya area.

In order to determine the radiological characteristics of the soil, the distribution of the specific activity of ^{137}Cs on the soil profile (fig. 1).

It is evident from the data that the largest specific activity of ^{137}Cs is concentrated in a layer of soil 0 ... 10 and 0 ... 20 cm, which is affected by 45.3 and 40% of the activity of ^{137}Cs. In the layer 20 ... 30 cm concentrated only 12% of the total specific activity of ^{137}Cs. In layers of 30 ... 60 cm, the activity of ^{137}Cs is less than one percent, and only traces are observed in the soil layer from 60 to 100 cm.

Thus, we can conclude that this type of soil is characterized by a high sorption ability, which characterizes the weak migration of ^{137}Cs by soil profile. The greatest negative factor in this is the concentration of radionuclide in the upper — arable layer of soil, making it the most accessible to the root system of plants.

Therefore, particular attention should be paid to the morphological features of plants, and especially to the depth of occurrence of roots, and the type of root system, which determines the intensity of absorption of ^{137}Cs.

Hence the important factor is the biological features of plants, namely, species and variety characteristics. So the plant's need for potassium determines more accumulation of its analogue — cesium. In addition, the input of radionuclides into plants depends on the distribution of the root system in the soil, their productivity, the length of the growing season, and so on. As a result of radiological studies (on average a few years), the following data were obtained (Table 1).

The highest specific activity is observed in amaranth and acanthate (more than 1120 Bq/kg). The smallest is in buckwheat and sorghum (up to 586 Bq/kg).

The same situation is typical for fertilizers $K_{90}R_{60}$.

However, it is in these plants that the largest percentage of reduction in specific activity is observed. The ranked series has the following form: Sugery Sorghum «Botanichnyi (3.2%), Suripytsia Sunflower (3.8%), Sylphia (4.4%), Miskanthus (5.3%), Topinambur (5.8%) %), Siverska Soya (8.6%), Soya «Amerikanka» (9.2%), Vorskla Soya (10.1%), Rumekes OK-2 (10.7%), Amaranth «Kremovy» (11.4%), Shchavnat «Binar» (12.1%), Amaranth «Carmen» (12.8%) and Amaranth «Hrozynskyi» (13.5 %).

However, even these indicators do not guarantee the receipt of products that are not contaminated with radionuclides in excess of the norm. What makes them look for options for their re-processing.

CONCLUSION

Determination of the specific activity of ^{137}Cs of cultures suggests that these cultures

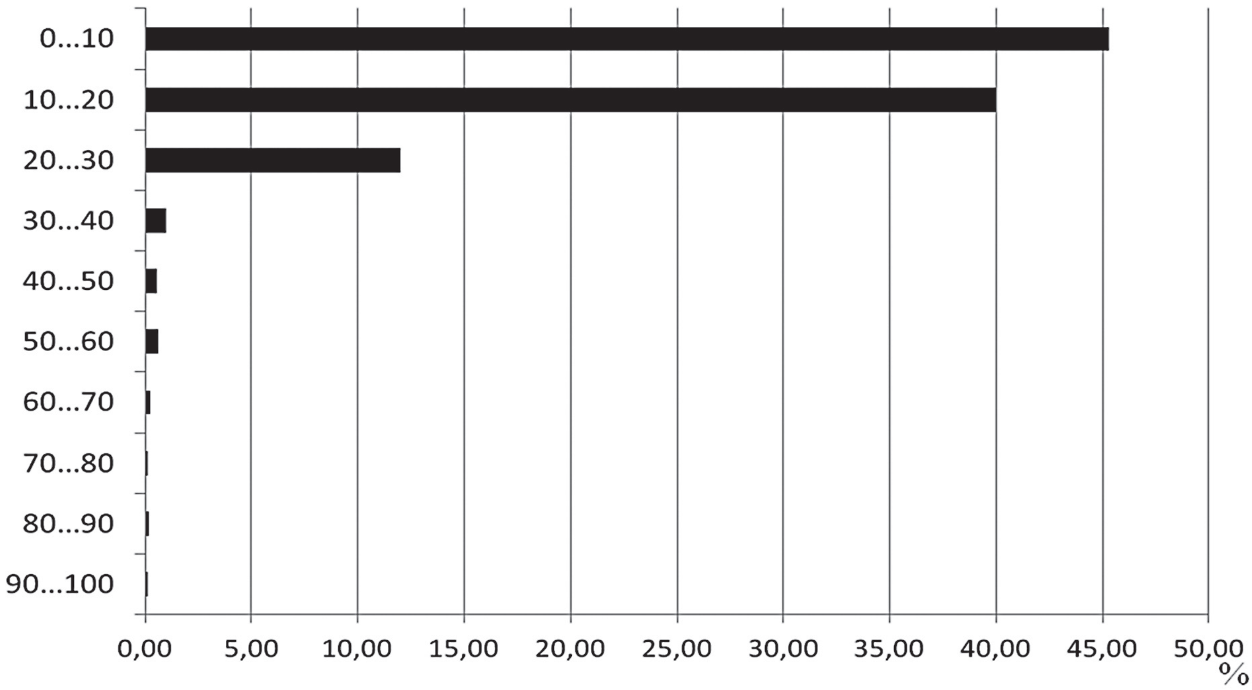

Fig. 1. *Distribution of unit activity of ^{137}Cs by the profile of soil, %*

Table 1

Unit activity of ^{137}Cs in plants, Bq/kg

Plant	Value of unit activity ^{137}Cs	
	Control	Fertilized $K_{90}P_{60}$
Miskanthus	190	180
Sylphia	136	130
Topinambur	224	211
Sorghum «Botanichnyi»	68,2	66
Sovereign «Svitanok»	60,3	58
Soya «Amerykanka»	552	501
Vorskla Soya	586	527
Siverska Soya	475	434
Amaranth «Grozynsky»	4300	3720
Amaranth «Carmen»	2600	2267
Amaranth «Cream»	1220	1081
Shchavnat «Binar»	2000	1758
Shchavnat «Rumex OK-2»	1120	1000

typically have an increased accumulation of radionuclides.

All crops other than amaranth and gaoganbo, taking into account allowable levels of ^{137}Cs and ^{90}Sr radionuclide content in livestock and crop material, are favorable for growing under conditions of radioactive contamination of territories in order to ensure production of guaranteed quality of 600 Bq/kg. The following are unsuitable for feeding animals, but there is the possibility of using them on siderate and raw materials for oil and biofuel production. In addition, it is the amaranth and the acanthus that best remove radionuclides from the soil, which, in turn, accelerates its purification for full use.

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