PENETRATION OF CS-134 FROM CONTAMINATED SOIL INTO DIFFERENT CULTIVARS OF SOME LEGUMINOUS PLANTS

ПОСТЪПВАНЕ НА CS-134 ОТ КОНТАМИНИРАНА ПОЧВА В РАЗЛИЧНИ СОРТОВЕ НА НЯКОИ ЗЪРНЕНО-БОБОВИ КУЛТУРИ

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РЕЗЮМЕ

Проведени бяха съдови опити с фасул – сортове Пловдив 10, Пловдив 164 и Добруджански 7; грах – сортове Мира, Искър и Пулпудева; и соя – сортове – Павликени 121, Ходзон и S - 1346, разпространени в България. Растенията бяха отгледани върху орницата на почвения тип излужен чернозем, контаминиран с радионуклида цезий-134.

Констатирано бе, че радиоцезият се натрупва неравномерно в различните органи на растенията, като най-висока концентрация бе установена в листата, а най-ниска в семената на изследваните култури.

Установени бяха сортови различия в адсорбцията на радионуклида в растенията. Най-ниска степен на натрупване на Cs-134 бе отбелязано при фасул-сорт Добруджански 7, грах - сорт Мира и соя – сортове Ходзон и S – 1346.

Не се наблюдават съществени видови различия при натрупването на радионуклида в изследваните култури. Сравнително по-слабо извличане и акумулиране на

Cs-134 е установено във всички надземни органи на фасула в сравнение с останалите култури.

КЛЮЧОВИ ДУМИ: постъпване, Cs-134, почви, радионуклеиди, коефициент на натрупване

ABSTRACT

Pot experiments with different cultivars of beans, peas and soya spread in Bulgaria were carried out. The following cultivars were analyzed: beans - cultivars Plovdiv 10, Plovdiv 164 and Dobrudjanski 7; peas - cultivars Mira, Iskar, and Pulpudeva; soybeans - cultivars Pavlikeni 121, S – 134, and Hodzon. The plants were grown on the soil type Haplic chernosem, contaminated with the radionuclide Cs-134.

It was established that the radiocesium was accumulated unevenly in the different plant organs, and the highest concentration was recorded in the leaves, while the lowest was found in the seeds of the studied crops.

Cultivar differences with regard to the absorption of the radionuclide by the plants were established. The lowest degree of accumulation of Cs-134 was found in beans –cultivar Dobrudjanski 7, in peas – cultivar Mira, and soybeans – cultivars Hodzon and S 1346.

No considerable cultivar differences were observed with respect to the radionuclide accumulation in all studied crops. A comparatively weaker extraction and accumulation of Cs^{134} was recorded in all above-soil organs of the bean plants, in comparison with the remaining crops.

KEY WORDS: Penetration, Cs-134, soils, radionuclides, coefficient of accumulation.

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DETAILED ABSTRACT

Pot experiments with different cultivars beans; peas and soy spread in Bulgaria were carried out. The following cultivars were analyzed: beans - cultivars Plovdiv 10, Plovdiv 164 and Dobrudjanski 7; peas - cultivars Mira, Iskar, and Pulpudeva; soybeans - cultivars Pavlikeni 121, S – 1346, and Hodzon. The plants were grown on the soil type Haplic chernosem, contaminated with the radionuclide Cs-134.

After the seeds germination, in each pot there were left five normally developed plants. During the vegetation process mineral fertilizer nourishment was applied and the soil humidity was kept at 60-70 %. The test plants were grown until the phase of full ripeness. The epigeous parts of the plants (leaves, stems, capsules, and seeds) were checked with a multichannel gammaspectrometer canberra equipped with a germanium detector with an effectiveness of 20% and a measuring error of under 10%.

It was established that the radiocesium was accumulated unevenly in the different plant organs, and the highest concentration was recorded in the leaves, while the lowest was in the seeds of the studied crops.

Cultivar differences with regard to the absorption of the radionuclide by the plants were established. The lowest degree of accumulation of Cs-134 was found in beans –cultivar Dobrudjanski 7, in peas – cultivar Mira, and soybeans – cultivars Hodzon and S 1346.

No considerable cultivar differences were observed with respect to the radionuclide accumulation in all studied crops. A comparatively weaker extraction and accumulation of Cs-134 was recorded in all above-soil organs of beans plants in comparison with the remaining crops.

INTRODUCTION

The issue of the regularity of accumulation of various radionuclides in the agricultural crops is significant in connection with the fact that these substances, by means of the plants, take on active part in the biological cycle of circumrotation of substances in nature ([2]; [4]).

The study of the radionuclides behavior at the time of their penetration in the plants and accumulation in the yield is important for the elaboration of well-grounded measures, leading to a decrease of the content of radioactive substances in the agricultural produce ([3], [5]).

MATERIAL AND METHODS

Pot experiments with various beans, peas and soy cultivars, grown in Bulgaria, were carried out. The following cultivars were studied: beans cultivars – Plovdiv 10, Plovdiv 164 and Dobrudjanski 7; peas cultivars – Mira, Iskar, and Pulpudeva; soybean cultivars – Pavlikeni 121, S – 134, and Hodzon. The plants were grown on the soil type Haplic chernozem (FAO classification) contaminated with the radionuclide Cs-134. The experiment was carried out in vegetation pots, each with a capacity of 5 kg soil, under controlled conditions. The cesium activity in the soil was 1.0 MBq/pot for beans; 0.45 MBq/pot ror peas; and 0.67 MBq/pot for soybeans. The experiment was conducted in four repetitions. After the seeds germination, in each pot there were left five normally developed plants. During the vegetation process mineral fertilizer nourishment was applied and the soil humidity was kept at 60-70 %. The test plants were grown until the phase of full ripeness. The epigeous parts of the plants (leaves, stems, capsules, and seeds) were checked with a multichannel gamma spectrometer Canberra equipped with a germanium detector with an effectiveness of 20% and a measuring error of less 10%.

In order to assess the penetration of the radionuclide into the separate plant organs we used the index "coefficient of accumulation" (CA), representing the relationship between the radionuclide activity in 1 g epigeous plant tissue and 1 g soil.

RESULTS AND DISCUSSION

Table 1 shows the results from the conducted study with beans – cultivars Plovdiv-10, Plovdiv 164, and Dobrudjanski 7. It is evident that in the variants grown on Haplic chernosem (FAO Classification), the radionuclide Cs-134 is unevenly accumulated at the above-soil plant organs, and it is mainly accumulated in the vegetative tissue - the leaves and stems- and comparatively weaker in the capsules and seeds Depending on the cultivar difference, the accumulation of Cs-134 in the plant leaves is by 22-31 % higher than that in the stems, 45-50 % higher than that in the capsules, and at about 53-60 % higher than that in the seeds.

Table 1: Accumulation of Cs-134 in the yield of different bean cultivars.

Cultivar	Plant organs	Average activity Bq/g Dry tissue	Coefficient of Accumulation
Plovdiv - 10	leaves	5.80± 0,78	0,03
	stems	4.20± 0,70	0,02
	capsules	3.21± 0,17	0,02
	seeds	2.10± 0,16	0,01
Plovdiv - 164	leaves	3.89 ± 0.39	0.02
	stems	2.76 ± 0.18	0.02
	capsules	2.13 ± 0.17	0.01
	seeds	1.96 ± 0.12	0.01
Dobrudjanski - 7	leaves	2.99 ± 0,21	0.01
	stems	2.22± 0,27	0.01
	capsules	1.41 ± 0,50	0.01
	seeds	1.03 ± 0,28	0.01

The study on the cultivar influence on the absorption of the radiocesium by the plants shows that cultivar Plovdiv 10 is characterized by its capacity to accumulate readily the radiocesium in all above-soil organs, and this accumulation is highest in the vegetative tissue. This cultivar accumulates the radiocesim in the leaves and stems by 34,5 % and 35 %, respectively, higher than cultivar Plovdiv 164, and by 52 % and 45 % higher than cultivar Dobrudjanski 7. The differences in the capsules of the studied cultivars vary from 30 % to 56 % and from 10 % to 50 % in the seeds. The lowest accumulation of the radiocesium in the studied plants was recorded in cultivar Dobrudjanski 7. In this cultivar the lowest values of the coefficient of accumulation (CA = 0.01 for all above-soil organs) were registered. The lower accumulation of Cs^{134} in the plants of cultivar Dibrudjanski 7 may lead to its recommendation for application in case of radioactive contamination of the soil.

According to some authors ([6]), the cultivar differences with respect to the radionuclides accumulation in the plant can be explained by the genotype.

The results from the analysis of the studied peas cultivars grown on the same soil type (Table 2) show, that in this crop as well, the radiocesium accumulation is concentrated mainly in the leaves and stems. The Cs-134 content in the leaves is up to 20 % higher than that in the stems, twice greater in comparison with that in the capsules, and from 2,5 to 4 times greater than that in the seeds. The accumulation of the radionuclide is comparatively low in the seeds, and this holds true for all studied cultivars.

Table 2: Accumulation of Cs-134 in the yield of different peas cultivars.

Cultivar	Plant organs	Average activity Bq/g dry tissue	Coefficient of Accumulation
Mira	leaves	3.76 ± 0.36	0.04
	stems	3.01 ± 0.22	0.03
	capsules	2.57 ± 0.27	0.02
	seeds	1.78 ± 0.27	0.01
Iskar	leaves	4.48 ± 0.23	0.05
	stems	3.90 ± 0.31	0.04
	capsules	3.40 ± 0.39	0.04
	seeds	1.80 ± 0.54	0.02
Pulpudeva	leaves	4.16 ± 0.21	0.05
	stems	2.36 ± 0.27	0.03
	capsules	2.29 ± 0.50	0.02
	seeds	2.12 ± 0.28	0.02

The intracultivar comparisons with respect to the radiocesium content in the leaves of the test plants indicate differences at about 20 %, and in the leaves – 25 %. The cultivar differences are more considerable with respect to the radionuclide accumulation in the capsules and the seeds

Of all studied cultivars, Mira is characterized by the lowest degree of Cs-134 accumulation. In this cultivar, in all above-soil organs, there were recorded the lowest values of the coefficient of accumulation (CA=0.04 in leaves; 0.03 in stems; 0.02 in capsules; and 0.01 in seeds).

The obtained results with respect to the distribution of the radionuclides in the economically important plant organs confirm Ambler's thesis ([1]) that the radionuclides are accumulated to the lowest degree in the seeds and that their accumulation depends on the cultivar peculiarities of the plants.

The results from the analysis of the soybean cultivars, grown on Cs-134 contaminated soil, confirm the already observed tendency in the other studied crops about the radionuclide distribution in the above-soil organs of the plants (Table 3). In this bean crop, as well, there is observed a predominant accumulation of the radiocesium in the vegetative organs – mainly the leaves. The uneven distribution of Cs^{134} was registered in all studied cultivars. The lowest radiocesium accumulation was observed in

the soybean seeds. It is up to 5 times smaller than that in the leaves, and from 2.5 to 3.5 times smaller than that in the stems.

The intracultivar comparisons indicate a much more intensive Cs^{134} extraction by cultivar Pavlikeni 121 than that by cultivars S-1346 and Hodzon. In Pavlikeni 121 the recorded values of the coefficient of accumulation in all above-soil organs were twice higher than those in the remaining cultivars (CA = 0.09 in leaves; 0.05 in stems; 0.02 in capsules and seeds). In cultivars Hodzon and S-1346 no considerable differences were observed with respect to the accumulation of the radiocesium in the studied plants.

The analysis of the data on the penetration of Cs-134 from contaminated soil into, the above-soil organs of the studied bean crops does not show the presence of any considerable cultivar differences.

A comparatively weaker extraction and accumulation of Cs-134 was recorded in all above-soil organs of beans, in comparison with the remaining crops.

Table 3: Accumulation of Cs-134 in the yield of different soybean cultivars.

Cultivar	Plant organs	Average activity Bq/g Dry tissue	Coefficient of Accumulation
Pavlikeni -121	leaves	11.80 ± 0.72	0.09
	stems	6.88 ± 0.43	0.05
	capsules	3.50 ± 0.30	0.02
	seeds	2.80 ± 0.16	0.02
Hodzon	leaves	6.60 ± 0.32	0.05
	stems	4.90 ± 0.34	0.04
	capsules	2.18 ± 0.53	0.01
	seeds	2.00 ± 0.10	0.01
S - 1346	leaves	5.90 ± 0.33	0.04
	stems	4.60 ± 0.43	0.03
	capsules	1.60 ± 0.17	0.01
	seeds	1.60 ± 0.21	0.01

CONCLUSIONS

Cs-134 is distributed unevenly in the different organs of the plants. The highest accumulation was recorded in the vegetative tissue, and lowest – in the seeds.

There were registered cultivar differences with respect to the radionuclide absorption by the plants. The lowest degree of Cs-134 accumulation was found in leaves – cultivar Dobrudjanski 7, peas – cultivar Mira, and soybean – cultivars Hodzon and S – 1346.

No considerable cultivar differences were observed with respect to the accumulation of the radionuclide in the studied crops. A comparatively weaker extraction and accumulation of Cs-134 was recorded in all above-soil organs of beans in comparison with the remaining crops.

REFERENCES

[1] Ambler (1964): J., Radiat. Bot., 4, No 3, 259-269.

[2] Bufatin O., N.Parashtukov, N.Fomkina, P.Alexahin (1983): Agricultural Biology, No 6, 58-61.

[3] Guczy J., A. Capote-Cuellar, A.Kerekes, E.Koblinger-Bokori, G.Koteles (1998): Environmental radiohygienic measurement data in Hungary, Egeszsegtudomany, 42:4, p.355-366.

[4] Gulyakin I., E.Yudinceva (1962): Radioactive products of division in soil and in plants. M, Gosatomizdat,(Russian).

[5] Jouve A., M. Lejeune, S. Rey (1992): A new method for determining the bioavailability of radionuclides in the soil solution. Journal of Environmental Radioactivity, 43:3, p.277-289.

[6] Lambrecht M. (1956): Empfindichkeit und genotypische Kontitution bei Pisum, Agric. Hort. Genet., 14, 4, p. 47-53.

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