

ACCUMULATION OF CS-134 IN THE OAT DEPENDING ON SOIL CHARACTERISTICS УСВОЯВАНЕ НА CS-134 В ОБЕС В ЗАВИСИМОСТ ОТ ПОЧВЕНИТЕ ХАРАКТЕРИСТИКИ

BINEVA, TZ. , STANEVA, D., YORDANOVA, I.

Institute for Cryobiology and Food Technology, Laboratory of Radioecology and Radioisotope Research 7, Shousse Bankya Str, 1080 SOFIA, BULGARIA, e-mail: cbineva@mail.bg; donastaneva@abv.bg

Manuscript received: December 19, 2004; Reviewed: February 24, 2005; Accepted for publication: March 12, 2005

ABSTRACT

Vegetation pot experiments with spring oats, cultivar Obrazcov Chiflik – 4, were carried out. The plants were grown on four different soil types, typical for Bulgaria: Haplustoll, Udolls, Ustifluvents, Albaqualf /USA. The soils were contaminated with the Cs-134.

It was concluded that the radio-caesium accumulates unevenly in the different plant organs, as its highest concentration was found in the leaves and lowest in the grains of the researched culture.

Substantial differences were discovered in the accumulation of caesium –134 in the plants, depending on the soil differences. According to the accumulation of the radio-caesium in the plants, the different soils can be arranged as follows: Albaqualf >

Vdolls >Ustifluvents > Haplustoll.

KEYWORDS: Cs-134, plants, soil, factor of transfer

РЕЗЮМЕ

Проведени бяха съдови опити с пролетен сорт овес Образцов Чифлик-4. Растенията бяха отгледани върху орницата на четири почвени различия, характерни за България и контаминирани с радионуклида цезий-134. Експериментите бяха проведени върху почви, различаващи се по механичен и физикохимичен състав: Haplustoll, Udolls, Ustifluvents, Albaqualf / USA.

Констатирано бе, че радиоцезия се натрупва неравномерно в различните органи на растенията, като най-висока концентрация бе установена в листата, а най-ниска в зърната на изследваната култура.

Установени бяха съществени различия в усвояването и натрупването на цезий-134 в растенията в зависимост от почвеното различие. Според акумулацията на радиоцезия от растенията, изследваните почви могат да се подредят в следния ред : канелено подзолиста > сива горска почва > алувиално.ливадна > излужен чернозем

КЛЮЧОВИ ДУМИ: Cs -134, растения, почва, трансферен фактор

РАЗШИРЕНО РЕЗЮМЕ

Изучаването на особеностите в поведението и миграцията на радионуклидите в системата почва-растение е необходимо за прогнозиране на натрупването им в растенията, животните и човека, а също за разработване на мероприятия, намаляващи радиационната опасност.

Проведени бяха съдови опити с пролетен сорт овес Образцов Чифлик-4.

Растенията бяха отгледани върху орницата на 4 представителни за България почвени различия: Haplustoll, Udolls, Ustifluvents, Albaqualf / USA. Експериментите бяха заложили във вегетационни съдове с вместимост 5 kg. почва при контролирани условия. Почвата бе контаминирана с воден разтвор на цезий-134 с активност 0,56 kBq.g⁻¹ почва. Опитът бе проведен в 4 повторения. Растенията бяха отгледани до фаза пълна зрялост. На въздушно сухата растителна маса / листа, стъбла и зърна / бе извършено гама-спектрометриране.

За оценка на преминаването на радионуклида в различните органи на растенията бе използван показателя "трансферен фактор", изразяващ отношението на активностите в 1g въздушно суха растителна маса и 1g почва.

От получените резултати могат да се направят следните изводи:

- Съществуват различия в усвояването и натрупването на цезий-134 в растенията в зависимост от почвеното различие.

- Според акумулацията на радиоцезия от растенията, изследваните почви могат да се подредят в следния ред : канелено подзолиста > сива горска почва > алувиално.ливадна > излужен чернозем

- Цезий-134 се натрупва неравномерно в различните органи на растенията, като най-висока концентрация бе установена в листата, а най-ниска в зърната на изследваната култура.

INTRODUCTION

The investigation of peculiarities in behavior and migration of radionuclides in the system soil – plant is necessary in order to prognosticate their accumulation in plants, animals and man. It is also needed in the process of developing enterprises decreasing the danger of radioactivity. The movement and migration abilities of radionuclides in the soil depend on the intensity of binding and the absorption mechanisms which is defined by their chemical properties, physical and chemical composition of the soil, the characteristics of the type and sort of the

plants [3,4,5,6].

The purpose of this investigation was to study the influence of different soil types over the entering of radionuclide Cs – 134 from different types of contaminated soils in the plants of oats as well as its accumulation and distribution in the epigeous organs.

MATERIAL AND METHODS

Vegetation pot experiments with spring oats, variety *Obrazcov Chiflik – 4*, were carried out. The plants were grown on four different soil types, typical for Bulgaria: Haplustoll, Udolls, Ustifluvents, Albaqualf/USA. The agrochemical characteristics of the examined soils are presented in table 1.

The experiments were set in vegetation vessels with capacity of 5 kg of soil under controlled conditions. The soil was contaminated with water solution of Cs – 134 with activity 0,56 kBq.g⁻¹ soil. The experiment was carried out four times. Fifteen normally developed plants were placed in each vessel. The plants were grown till the state of full ripeness. The air – dried plant material /leaves, stems, grains/ was analyzed by a multi-channel analyzer CANBERRA with a HPGe detector. The miscount did not exceed 5 %.

For the estimation of the transition of radionuclide into the different plant organs was used the index "transition factor". It represents the ratio of the activities in 1g of air – dried plant material and 1g of soil.

RESULTS AND DISCUSSION

Figure 1 represents the data about the stage of radioactive pollution with Cs – 134 in the different organs of oats depending on the type of the soil.

It is apparent that at all experimental versions it is found a relatively high level of accumulation of radionuclide in the vegetative organs of the plants – leaves and stems. The contents of Cs-134 in the leaves is 2 to 2,5 times higher than in the corn . The lowest accumulation was registered in the corn (Tf = 0,02).

The influence of soil type over the level of extraction of nuclide and accumulation in the plants appears most distinctly at the experimental versions grown in Albaqualf. At all experimental versions was found 5 to 6 times more intensive accumulation of radio-caesium in comparison with this grown in Haplustoll. The highest accumulation of radionuclide was found in the leaves, lower – in the stems and the lowest – in the grains of the plants. The differences in content of radio-caesium in leaves and grains fluctuate from 100% to 177%.

The results obtained are in correspondence with the

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Table 1: Agrochemical characteristics of the examined soils
Таблица 1: Агрохимически характеристики на изследваните почви

Soil types	pH KCl	Humus %	Ca + Mg meq/100g	Ca meq/100g	K ₂ O mg/100g	Σ<0.01 mm
Ustifluvents	5,1	2,4	8,3	7,4	23,2	22,9
Udolls	3,8	1,5	14,0	12,8	20,0	43,0
Haplustoll	5,2	3,5	24,9	24,0	28,2	56,6
Albaqualf	3,8	1,7		9,3	20,0	24,2

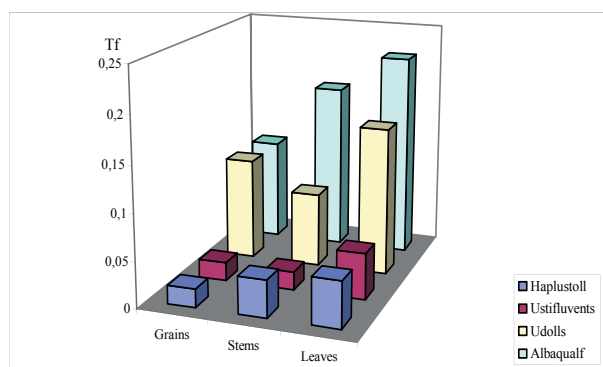


Fig 1: Accumulation of Cs-134 in different organs of oats depending on the type of the soils.

Фиг. 1: Усвояване на Cs - 134 в различни органи на овес в зависимост от почвения тип

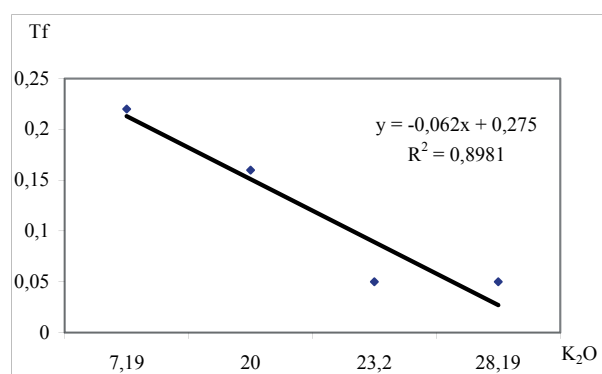


Fig. 3: Accumulation of Cs-134 in plants of oats depending on concentration of K₂O in the soil.

Фиг. 3: Усвояване на Cs-134 от овес в зависимост от съдържанието K₂O в почвата

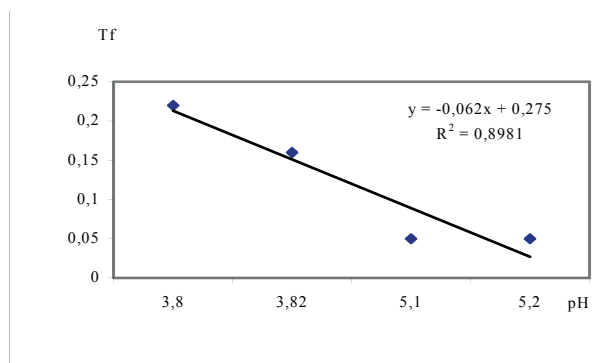


Fig. 2: Accumulation of Cs - 134 in plants of oats depending on the pH of the soil

Фиг. 2: Усвояване на Cs - 134 от овес в зависимост от рН на почвата

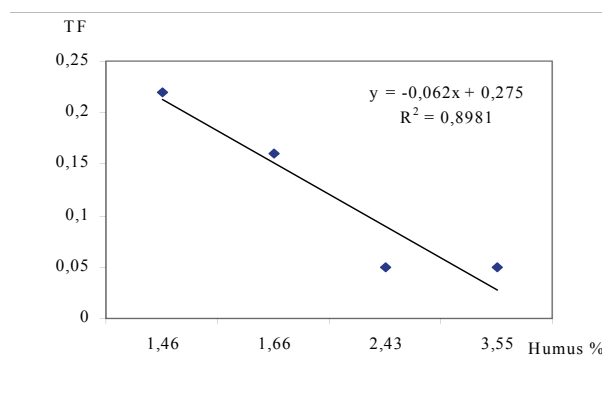


Fig. 4: Accumulation of Cs - 134 in plants of oats depending on the content of humus in the soil

Фиг. 4: Усвояване на Cs-134 от овес в зависимост от съдържанието на хумус в почвата

conclusion of Gouliakin, Udinceva [1] that at transfer of radionuclides in the epigeous organs of grain crops is observed a general rule – their accumulation in the vegetative mass of the plants.

The higher accumulation of Cs-134 at the versions grown in Albaqualf is determined by the relatively low absorption capacity of this type of soil. It is determined also by the lower content of humus and absorptive potassium in it and their increased acidity which contributes to a more intensive entering of radionuclide in the plants.

It was established from the carried out correlative analysis that there exists an empirical correspondence between the soil acidity and the transfer factor, which could be described by a linear function. As it is seen in fig. 2. the correlative function has a high correlative coefficient $R^2 = 0,89$. Therefore, a conclusion could be made, that with the increase of pH of the soil the coefficients of accumulation in the plants decrease in inverse proportion to the change of level of pH of the soil.

As it is seen in fig.3., there is an inverse proportion between the absorption of Cs – 134 from the soil to the plants and the content of potassium in the soil. This correspondence could be described by a linear function with a high correlation $R^2 = 0,898$. That verifies the received statistic correspondence.

Figure 4 represents the established correspondences between the content of humus in the soil and TF in different organs of oats plants. As it is seen the empirical correspondence could be described by a linear function – there exists an inverse proportion. The correlations $-R^2 = 0,89$ verify the established correspondence.

Cs-134 accumulates at lowest levels in the reproductive organs of the plants – in the corn, and at higher levels in the vegetative organs – stems and leaves.

Radio-caesium accumulates at lowest levels in the plants grown in Haplustoll – a soil rich in colloids and containing great quantities of montmorilonitic clay.

It was established a functional inverse proportion with very high coefficients of correlation between the accumulation of Cs-134 from the soil into the plants and the concentration of potassium in the soil.

It is important that at soils containing high levels of humus – Haplustoll, Resinous soil – the absorption of radio-caesium by the plants is the lowest, while at Vdolls and Albaqualf the coefficients of transfer are the highest. An inverse proportion exists therefore between the content of humus and the coefficients of transfer.

CONCLUSIONS

The following conclusions could be drawn from the results obtained:

Significant differences are established in the absorption and accumulation of Cs – 134 in the plants depending on the soil differences. According to the accumulation of radio-caesium in the plants the examined soils could be arranged as follows: Albaqualf, Vdolls, Ustifluvents, Haplustoll.

Cs – 134 accumulates unevenly in the different plant organs. Its highest concentration was found in the leaves and the lowest – in the grains of the examined crops.

REFERENCES

- [1] Gouliakin, I.V., Udinceva E.V., Agricultural Radiobiology, M., (1973), p.272.
(In Russian).
- [2] Koinov, V., Gurov,G., Kolcheva,B., Soil science, Sofia, (1980), p.302
- [3] Mascanzoni D., J of Envir. Radioactivity, (1989), 233-249.
- [4] Skarlou, V., Nobeli, C., Anoussis, J., Haidouti,C., Papanikolau,E., J of Envir. Radioactivity, (1999),V.45, Issue 2, 139-147.
- [5] Skarlou, V., Massas,L., Haidouti,C., Papateonari Y., XXXII Ann. Meeting of ESNA, (2002),Warsaw, Poland, Sept., 9-14.
- [6] Staneva D. Soil science, Agrochemistry and Ecology, (2002), vol. 37, № 1-3, 80-82.