

ACCUMULATION OF ^{134}CS IN THE PEPPER DEPENDING ON SOIL CHARACTERISTICS AND METHODS FOR REDUCTION OF THE TRANSFER OF RADIONUCLIDES FROM THE SOIL INTO THE VEGETATION PRODUCTION

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ABSTRACT

The particularities of the soil as sorbent, its complex composition and the differences in its properties impose the research of the accumulation of the The development of methods for reduction of the transfer of radionuclides from the soil into the vegetation production being of particular significance for the implementation agricultural activities in conditions of radioactive pollution of the soil, the impact of potassium, calcium and EDTA or ethylenediaminetetraacetic acid over the accumulation of radio-caesium from the soil into the plants. As it is seen from the results presented, the input of potassium, calcium and EDTA in the Orthic Luvisols significantly decreased the input of Cs-134 into the pepper plants.

Key words: ^{134}Cs , plants, transfer factor, accumulation.

РЕЗЮМЕ

Особеностите на почвата като сорбент, сложния и състав и различията в свойствата и налагат изследването на усвояването на радиоактивните елементи от растения, отглеждани на типични за България почви. От особена важност за провеждането на земеделска дейност в условия на радиактивно замърсяване на почвата е разработването на методи за намаляване трансфера на радионуклидите от почвата в растителната продукция, беше изследвано влиянието на калий, калций и ЕДТА върху натрупването на радиоцезия от почвата в растенията. От получените резултати може да се каже, че с внасянето на калий, калций и ЕДТА в сивата горска почва, значително се намалява постъпването на Cs-134 в растенията.

РАЗШИРЕНО РЕЗЮМЕ

Особеностите на почвата като сорбент, сложния и състав и различията в свойствата и налагат изследването на усвояването на радиоактивните елементи от растения, отглеждани на типични за България почви. Установяването на коефициентите на натрупване в различните растения от една страна и в различните органи на самите растения дава възможност в случай на радиоактивно замърсяване на почвата да бъдат оползотворени онези части от растенията които не допринасят за дозовото натрупване на хора и животни. От особена важност за провеждането на земеделска дейност в условия на радиоактивно замърсяване на почвата е разработването на методи за намаляване трансфера на радионуклидите от почвата в растителната продукция, беше изследвано влиянието на калий, калций и ЕДТА върху натрупването на радиоцезия от почвата в растенията.

За целта беше проведен съдов вегетационен опит с пипер сорт “Софийска капия”, върху две почвени различия – алувиална ливадна почва и сива горска в които бе добавен цезий-134. Радиоактивният цезий-134 внесохме в почвата в активности, позволяващи детектирането им в растителната маса (с грешка не надвишаваща 10%) и неувреждащи растенията при тяхната вегетация – 0,36 kBq.g⁻¹ почва.

От получените резултати може да се каже, че с внасянето на калий, калций и ЕДТА в сивата горска почва, значително се намалява постъпването на Cs-134 в растенията. Най-висок ефект има внасянето на 1 mg ЕДТА на kg почва – Tf намаляват с 94%. Внасянето на калций води до намаляване на Tf с 90 %, а това на калий и по-ниските концентрации на ЕДТА (0,1 mg/kg и 0,5 mg/kg почва) - с 88%. При алувиално ливадната почва най-висок ефект има внасянето на калий в почвата – трансферните коефициенти намаляват с 58 %, при растенията с внасяне на калий този процент е 29, докато внасянето на ЕДТА намалява Tf с 8 и 18 % съответно.

INTRODUCTION

The particularities of the soil as sorbent, its complex composition and the differences in its properties impose the research of the accumulation of the radioactive elements by plants grown on soils typical for Bulgaria. The establishment of the transfer factor in the various plants on the one hand and in the various organs of the plants themselves provides for a possibility for utilization

of those parts of the plants which do not contribute to the dosage loading of people and animals in event of radioactive pollution of the soil.

The development of methods for reduction of the transfer of radionuclides from the soil into the vegetation production being of particular significance for the implementation agricultural activities in conditions of radioactive pollution of the soil, the impact of potassium, calcium and EDTA or ethylenediaminetetraacetic acid over the accumulation of radio-caesium from the soil into the plants.

MATERIAL AND METHODS

For the purpose a vessel vegetation experiment with pepper of the “Sofia Long Fleshy Pepper” sort was carried out over two soil varieties – Fluvisols and Orthic Luvisols (FAO), which cesium-134 was added to.

Tables 1 represent the agro-chemical characteristics and the mechanical composition of the researched soils [2].

The vegetation experiment was carried out in conformity with the generally adopted methodology in vessels with 3,5 kg soil three times and with three controls. We placed the nutrient substances in the soil in quantities guaranteeing the normal development of the relevant culture, prior to the input of the radioactive substances.

We waited for 10 days for the attainment of the natural humidity and balance in the soil after its processing with the nutrient solutions. We input the radioactive isotopes in the relevant activities and a certain volume of distilled water in such a manner that they should imitate the conditions of soil contamination through the irrigation waters. Another 10 days later which were waited for the penetration of the radioactive solutions into the entire volume of soil we sowed the relevant plants [3].

We placed the radioactive cesium-134 into the soil in activities allowing for their detection in the vegetation material (with an error not exceeding 10%) and not damaging the plants during their vegetation – 0,36 kBq.g⁻¹ soil.

We dried the vegetation material up to air-dried status and spectrometered in a multi-channel analyzer CANBERRA with Ge/Li semi-conductor detector with effectiveness 12%, resolution of 1,8 Kev (for 661,6 keV) and detector of pure Ge with effectiveness 20% and resolution 1,3 KeV[1].

“Transfer factor” expressing the ratio of the activities in 1 g air dry mass per 1 g soil was used for the evaluation of the passing of the radionuclide in the various organs of the plants.

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

Soil types /FAO	pH KCl	Humus %	Ca + Mg Meq.100g ⁻¹	Ca Meq.100g ⁻¹	K ₂ O Mg.100g ⁻¹	Σ<0.01 mm
Fluvisols	5,1	0,58	8,3	7,45	23,2	22,9
Orthic Luvisols	3,8	1,46	14,0	12,80	20,0	43,0

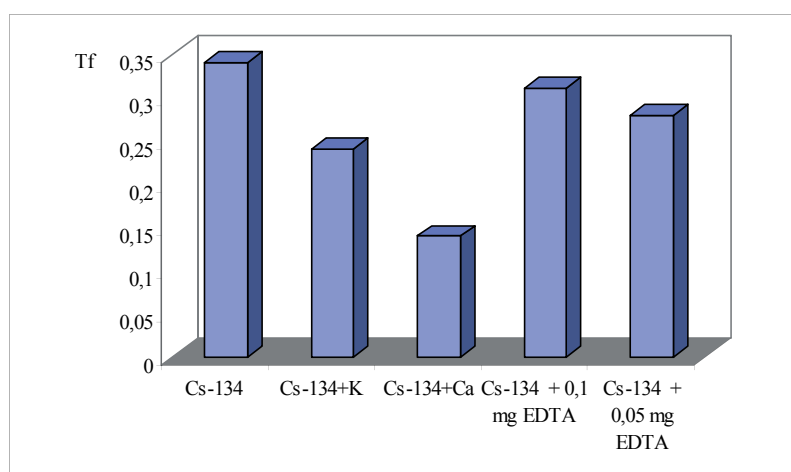


Fig. 1 Transfer factors into the Fluvisols
Фиг. 1 Фактор на трансфер при алувиално-ливадна почва

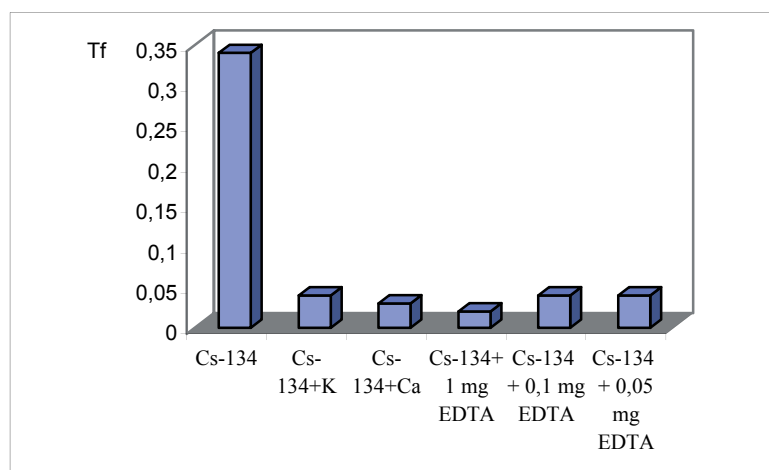


Fig. 2 Transfer factors into the Orthic Luvisols
Фиг. 1 Фактор на трансфер при сива горска почва

RESULTS AND DISCUSSION

As the main goal of these studies is the development of methods for the decrease of the transfer of cesium from the soil into the vegetation production, the impact of potassium, calcium and EDTA or ethylenediaminetetraacetic acid over the accumulation of cesium from the soil into the plants was researched. For the purpose the following quantities of these elements: - potassium, as K_2SO_4 , respectively 444 mg.kg^{-1} soil, calcium as $CaCO_3$ – $26,8 \text{ mg.kg}^{-1}$ soil, EDTA was input in three variants – per 1 mg.kg^{-1} soil, $0,1 \text{ mg.kg}^{-1}$ and $0,5 \text{ mg.kg}^{-1}$ soil were placed into the soils simultaneously with the radionuclide.

Fig. 2 and 3 represent the transfer factors characterizing the migration of radio cesium from the soil into the plants.

As it is seen from the results presented, the input of potassium, calcium and EDTA in the Orthic Luvisols significantly decreased the input of Cs-134 into the pepper plants. The highest effect has the input of $1 \text{ mg EDTA.kg}^{-1}$ soil – Tf decreased by 94%. The input of calcium results in the decrease of Tf by 90 %, and that of potassium and the lower concentrations of EDTA ($0,1 \text{ mg.kg}^{-1}$ and $0,5 \text{ mg.kg}^{-1}$ soil) - by 88%.

In the Fluvisols the highest effect has the input of potassium into soil – the transfer factors decrease by 58

%, in relation to plants with the input of potassium this percentage is 29, whilst the input of EDTA decreases Tf by 8 and 18 % respectively.

The following conclusions may be drawn from the obtained results:

- The coefficients of transfer in plants grown over are comparable with those in the Orthic Luvisols
- The accumulation of radio-cesium with input of potassium, calcium ETDA in the Orthic Luvisols notably decreases - Tf decreases by 80 – 90 %.
- In Fluvisols the input of potassium into the soil has the highest effect.

REFERENCES

[1] Naydenov, M., Yordanova I., Staneva D., Misheva L., “Procedures for Determination of Alpha- Beta- and Gamma-Emitting Radioactive Isotopes in Environmental Samples”, National Center for Agricultural Science, Sofia, 2001, (in Bulgarian)

[2] Rajkov (L.), 1978. - Radioactive elements in soils and their uptake by plants, Zemizdat, Sofia,. (in Bulgarian).

[3] Staneva D(2005), “Influence of soil characteristics on the uptake of Ce-144, Ag-110 and Ru-106 by plants”, JCER, vol. 6, № 1(in english)