INFLUENCE OF SOIL CHARACTERISTICS ON THE UPTAKE OF Ce-144, Ag – 110^m, Sb – 125 AND Ru – 106 BY PLANTS

ВЛИЯНИЕ НА ПОЧВЕНИТЕ ХАРАКТЕРИСТИКИ ВЪРХУ УСВОЯВАНЕТО НА Ce-144, Ag – 110^m, Sb – 125 И Ru – 106 ОТ РАСТЕНИЯТА

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ABSTRACT

The soil special features as a sorbent, its complicated composition and the differences in its characteristics impose the necessity of a research on the uptake of certain radio-isotopes by the plants, cultivated on the most typical soil types of Bulgaria. Carrying this goal a series of cultivation vegetative experiments on five different soil types, with wheat, bean, spinage, turnip and alfalfa were made.

After the analysis of the results of the vegetation experiments could be concluded that the transfer of Ce-144, Ag-110^m, Sb-125, Ru-106 from the soil into the plants depends on a high extent on the soil characteristics, as the accumulation in the different plants organs considerably differs.

After the so made correlation analysis, it was found out the existence of functional dependence between the coefficients of transfer for the researched radio-active isotopes and some soil characteristics as pH, consistence of humus, concentration of exchangeable Ca and Mg in the soil, which all is presented below in this research.

KEYWORDS: factor of transfer, soil, plant, radio-active elements

РЕЗЮМЕ

Особеностите на почвата като сорбент, сложния и състав и различията в свойствата и, налагат изследване на усвояването на радиоизотопите от растения, отглеждани на типични за България почви. За целта бяха изведени серия съдови вегетационни опити върху пет почвени различия, типични за България с ечемик, пшеница, фасул, спанак, репички и люцерна.

След направения анализ на резултатите от вегетационните опити, може да се направи изводът, че преминаването на церий-144, сребро-110m, антимон-125, рутений-106 от почва в растенията зависи в значителна степен от свойствата на почвата, като и натрупването в различните органи на растенията се различава съществено.

След направения корелационен анализ беше установено съществуването на функционални зависимости между коефициентите на трансфер за изследваните радиоактивни изотопи и някои характеристики на почвите като pH, съдържание на хумус, концентрацията на обменните катойни на калции и магнезий в почвата, които са представени в статията.

КЛЮЧОВИ ДУМИ: трансферен фактор, почва, растение, радиоактивни елементи

РАЗШИРЕНО РЕЗЮМЕ

Почвата по своята същност се явява естествено депо и резервоар за разпространение на радионуклидите. Усвояването им от растенията зависи както от почвения тип, така и от спецификата на отглежданите растения. Практически и стратегически интерес, в случай на радиоактивно замърсяване на почвата, представлява изследването на поведението и миграцията на радиоактивните изотопи - продукти на делене на трансурановите елементи: Sb-125; Ru-106; Ce-144. Цел на тези изследвания е даването на препоръки за подбор на най-подходящите почви и култури за даден вид почва при радиоактивно замърсяване на територията на страната.

За проучване на трансфера на кратко и средно живущите продукти на делене и неутронна активация от почвата в растенията в рамките на десетгодишна изследователска програма бяха проведени серия съдови вегетационни опити със следните растения: пшеница сорт "Садово", ечемик сорт "Алфа", фасул сорт "Добруджанка", спанак сорт "Матадор", репички сорт "Любими" и люцерна.

За да се изследва влиянието на някои почвени характеристики върху трансфера на радионуклидите от почвата в растенията беше направен корелационен анализ на получените данни.

Бяха търсенистатистически зависимости между pH, съдържанието на хумус, и др. почвени характеристики и коефициентите на трансфер.

Изследваните продукти на делене и сребро-110^m се натрупват най-слабо при растенията, отгледани върху смолницата - тежко глинести, богато колоидни почви, съдържаща големи количества монтморилонитови глини.

Беше установено съществуването на функционална зависимост с много високи коефициенти на корелация между натрупването на сребро-110^m, церий-144, антимон-125 и рутений-106 от почвата в растенията и съдържанието на обменни Ca и Mg, процентното съдържаниена хумус и pH на почвата.

INTRODUCTION

The soil by its essence could be regarded as a natural reserve for spread over of radioisotopes. Their accumulation by the plants depends on the soil type and also on the specification of the cultivated plants themselves. In case of a radioactive pollution, a certain and practical interest is the research of the migration of the radioactive isotopes –Ab-125; Ru-106; Ce-144. The main purpose of such researches is the providing of certain recommendations for selection of the most appropriate soil types and plants for a given type of soil, subdued on a radioactive pollution spread over the country's territory.

For the purpose of the research a series of cultivated vegetation experiments with agricultural plants on different soil types have been made.

MATHERIAL AND METHODS

For the study of the transfer of the short and medium living fission and neutron activation products from the soil in the plants in the frames of a 10 years research program, a series of certain vegetation tests with the plants: wheat type 'Sadovo', barley type 'Alfa', beans type 'Dobrudjanka', spinage type 'Matador', radishes type 'Liubimi' and alfalfa were made [5].

In table 1 are presented the agrochemical characteristics of the soils on which the vegetation experiments were made[1]. The acidity of the soil types varyes in a big range – from pH = 3.8 of the Pellic vertisols. (FAO) soil – a strongly acid one, to pH=7.3 of the Fluvisols soil[2,3]. The contents of changeable calcium and magnesium varyes from 6.5 meq/100g soil of the soil Dystric Planosol of Primorsko to 51 meq/100 g soil of the Pellic vertisols [4, 6].

After the treatment of the soil with nutritious solutions, it was waited for 10 days for reaching of the natural humidity and balance in the soil.

The radioactive isotopes in the respective activities in the presence of a specific amount of distillated water / enough to humiliate the whole volume of soil in the container / were introduced in a way so that the conditions of contamination of the soil through the irrigation waters could be imitated. After another 10 days the plants were sowed [5].

The following fission products of the uranium were introduced in the soil – Ce-144. Sb-125, Ru-106 and the product of neutron activation - Ag-110^m in activities permitting their detection in the plants mass / with a mistake no more than 5 % / and not damaging the plants during the vegetation – respective: Ce-144- 0,94 MBq/ kg soil, Sb-125 – 1,5 MBq/kg soil, Ru-106-0,83 MBq/kg soil and Ag- 110^m – 0, 94 MBq/kg.

The upper mentioned radio isotopes are gamma emitters, which provides the possibility for them to be detected with the help of gamma-spectrometric analysis with a low background protective camera of old steel and a HPGe detector CANBERRA with efficiency of 20 % and energetic solution of 1332 keV by Co-60 -1,3 keV.

For the purpose of research of the influence of some soil characteristics on the process of transfer of the radionuclides from the soil in the plants, a correlation analysis of the results was made.

Table 1: Agrochemical characteristics of the researched soil types
Таблица 1: Агрохимически характеристики на изследваните почви

Soil	pH		$H_{2,8}$	Ca^+	$Ca^+ + Mg^+$	P_2O_5	K_2O	Zn	Fe
	H_2O	KCl	meq	meq	meq	meq	meq	mg	Mg
			100g	100g	100g	100g	100g	1000g	1000g
1.Pellic vertisols(FAO)	7,4	6,5	1,60	43,9	51,0	12,9	37,7	1,08	1,6
2.Vermi-calcic chernozem	8,0	7,3	0,45	24,1	24,9	17,2	22,2	3,00	2,8
3.Orthic Luvisols	5,2	4,2	-	-	-	9,6	20,0	1,52	38
4. Fluvisols	5,9	5,1	3,40	7,45	8,3	16,6	23,2	3,20	29,6
5 Dystric Planosol , Primorsko	4,9	3,8	11,45	12,80	14,0	-	-	-	60,0
6. Dystric Planosol, Sekirovo	5,5	4,6	4,56	3,50	6,5	1,8	17,8	1,00	46,4

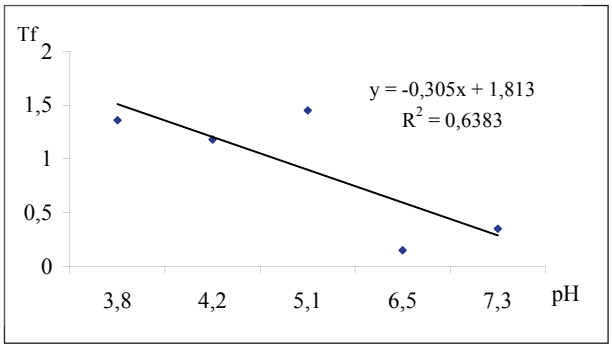

Fig.1: Ag-110^m in grain of wheat
Фиг.1: Ag-110^m зърно на пшеница

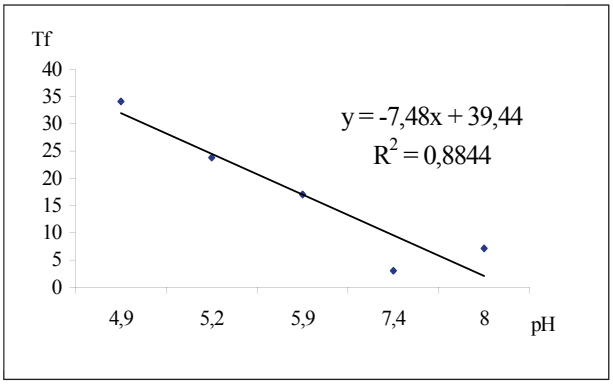

Fig.2: Ce-144 in the roots of barley
Фиг. 2: Ce-144 в корените на ечемик

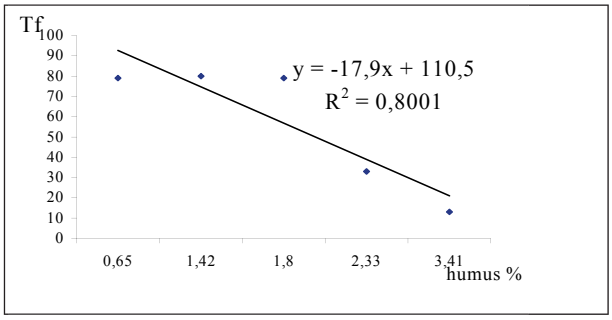

Fig.3: Ag-110^m in the roots of barley
Фиг.3: Ag-110^m в корените на ечемик

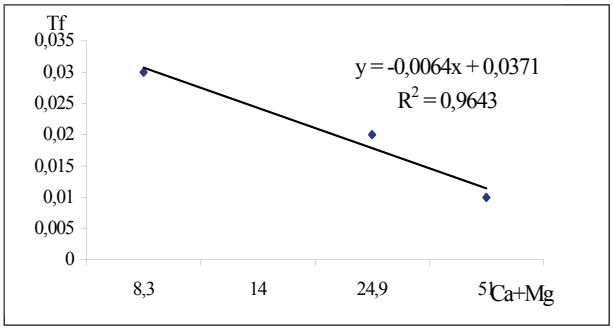

Fig.4: Sb-125 in the leaves of spinage
Фиг.4: Sb-125 в листа на спанак

It was looked for empirical strategic relations between pH, content of humus, and other soil characteristics and "transfer factor" /Tf/ - it represents the ratio of the activities in 1g of air – dried plant material and 1g of soil.

RESULTS AND DISCUSSION

From the so made correlation analysis, the existence of a statistical dependency between pH and Tf was discovered, which can be expressed by a lineal functional relationship.

As it is seen from fig.1 and fig. 2 the correctional functional relationships have high enough correlation references about 0,8. Therefore, the conclusion could be made that with the increase of pH of the soil, the transfer factors decrease opposite– proportionally to the change of pH of the soil, as the correctional dependencies have highest correctional references – those of barley, spinage, alfalfa and radishes / R^2 are about 0,7 – 0,9 /.

On fig .3 the relation between the humus content and the transfer factors - Tf - for Ag-110^m is shown. As it is seen the empirical relationship can be described by a lineal function – there is an opposite proportional relationship. It should be marked out that for the Ce-144, Sb-125, Ru-106, the same relations were discovered for all of the studied plants.

On fig. 4 are shown the obtained references of relation between the concentration of / Ca^{2+} + Mg^{2+} / in the soil and Tf for the researched radioisotopes.

The so obtained linear functions describe the empirical relationship with a very close reference – the correctional references are very high – for example R^2 = 0,9524 in the leaves of spinage, R^2 = 0,966 in radishes. This proves the existence of an opposite functional relationship between the accumulation of this radioisotopes and the concentration of exchangeable calcium and magnesium in the soil.

CONCLUTIONS

The tested fission products of division and silver 110^m are accumulated slightly by the plants, cultivated on the Pellic vertisols – heavy cloyed, colloids rich soils, having big amounts of montmorilonitovely clays.

It was discovered the existence of a functional relationship with very high coefficients of correlation between the aggregation of Ag - 110^m , Ce-144, Sb –125, Ru –106 from the soil in the plants and the contents of exchangeable Ca and Mg. Therefore, it can be stated that exists an opposite functional relationship between the concentration of exchangeable Ca^{2+} and Mg^{2+} in the soil absorbing complex and the accumulation of radioisotopes in the plants.

It should be marked out that in the soils containing highest content of humus- Pellic vertisols these radionuclides have been absorbed by the plants with lowest transfer factors, as by the Orthic Luvisols and Dystric Planosol the coefficients are highest, i.e. exists an opposite functional relationship between the humus content and the transfer factors for Ag - 110^m , Ru– 106, Sb –125 and Ce-144.

The same could be stated as the soil pH is concerned – Tf are minimal for the soils with highest rates of pH in all of the tested plants.

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