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PAPER

SOIL - BIOGEOCHEMICAL CHARACTERISTICS OF CALCIUM, STRONTIUM AND BARIUM ELEMENTS IN INDIGOFERA TINCTORIA CHAIN

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Abstract

This article describes the biogeochemical properties of calcium (Ca), strontium (Sr), and barium (Ba) elements in meadow oasis soils and the Indigofera tinctoria plant grown in them. The elements of the soil and plant samples selected as the research object were analyzed by neutron activation analysis (NAA). In this case, soil and indigofera tinctoria plant samples are 5 • 1013 neutrons/cm2 seconds in a nuclear reactor. irradiated with a neutron stream, their quantities were determined based on the half-life periods of chemical elements. Based on the obtained results, Clarke and Clarke distributions of elements concentration, biological absorption coefficients were calculated. It was found that barium element accumulates in the soils of the research area (Kk>1), and calcium and strontium elements are scattered (Kk<1). In the Indigofera tinctoria plant, it was found that calcium element is biologically accumulating (Kb>1) and strontium, and barium elements are biologically retained (Kb<1).

Key words: grassland oasis soils, Indigofera tinctoria, calcium (Ca), strontium (Sr), barium (Ba), neutron activation analysis (NAA), Clarke concentration, Clarke distribution, biological absorption coefficient.

INTRODUCTION

The amount and properties of chemical elements in the soil-plant chain are directly related to the sufficient and safe content of elements such as calcium, strontium and barium. The state of the environment and the health of the population depend on the mobility and biological availability of many chemical elements. Therefore, the processes of migration, accumulation and transformation of chemical elements in ecosystems, as well as the rates of biological absorption, are a priority problem of modern biogeochemical research [1, 15-b; 2, 352-b].

The efficient use of mineral fertilizers in

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agriculture is also important. Because the extensive use of mineral fertilizers is a source of chemical elements. In these processes, it is important to study the beneficial or harmful aspects of the entry of chemical elements into living organisms, including the human body through plants, in excess of the normal amount, their retention, accumulation and excretion in the soil and in plant roots, stems, leaves, fruits and seeds.

LITERATURE REVIEW AND METHODS

In the soil, all elements of group II of D.I. Mendeleev's periodic system are found in small or large quantities, and their compounds are found in various percentages, with large amounts of Ca, Sr, and Ba as group elements. These elements, namely calcium, strontium and barium (Ca, Sr, Ba), form minerals and rocks with different crystal lattices in the soil according to their valences, in particular ionic radii, atomic number, etc. They form feldspars, feldspars, silicates, micas, etc. One of the most common barium minerals is barite ($BaSO_4$), which, like gypsum and strontium sulfate, is practically insoluble in water [1, 187-b].

Calcium is also a member of the group of elements found in biophilic plants, its main source is the lithosphere. The lithosphere accounts for 2.96percentage. This element enters the biosphere in various ways. In particular, it enters the biosphere as a product of weathering from the lithosphere. During the weathering process, calcium silicates first erode [1, 127-b].

According to N.S. Kasimov (1982), the main factor in the concentration of strontium is the influence of water-soluble salts. In sulfide saline soils, soils with a gypsum layer, the strontium content can be 1percentage. In chloride and weak carbonate forms of salinity, strontium does not accumulate [1, 213-b].

Perelman ma'lumotlariga ko'ra bariyning yer po'stidagi klarki 0,065, asosiy jinslarda 0,46, gillar va slanetslarda 1,2, tuproqda 1,7, gidroslyudada 3·10-5, arid iqlim mintaqalarining tez almashinib turadigan suvlarida n·10-5 percentageni tashkil etadi. [1, 185-b]

Chemical element analysis of the soil sample of the cultivated area selected as the research object (Abdurazzaq-Mukhtorjon Yuksalish farm located in the Katta Karakul MFY area of Uchkuprik district of Fergana region) and root, stem, leaf and seed samples of the Indigofera tinctoria plant (belonging to the Fabaceae family) was carried out in the "Ecology and Biotechnology" laboratory of the Nuclear Physics Research Institute under the Academy of Sciences of the Republic of Uzbekistan using the neutron activation (NAA) method. In this case, the soil and Indigofera tinctoria plant samples were irradiated in a nuclear reactor with a neutron flux of 5 x 1013 neutrons/cm2 sec. and their amounts were determined based on the half-life of the chemical elements.

RESEARCH RESULTS AND DISCUSSION

Each plant species, depending on its life form and individual characteristics, has the ability to selectively absorb chemical elements from the soil in accordance with its needs. However, in this complex physiological process, the composition and quantity of chemical elements in the soil are of great importance, and the provision of the plant's need for each chemical element depends on its quantities in the soil.

According to our research, in the meadow-oasis soils, a higher Ca content was observed compared to Sr and Ba. However, this value is less than the average value of calcium (Ca) in the lithosphere, but more than the average value in the soil. Also, the amount of Ba determined in the soil section is much higher than the average values in the lithosphere and soil. There is a weak stratification in the distribution of Ca, Sr and Ba in the soil section. Of these elements, the highest amount of Ba (1310 µg/g) is characteristic of the tillage layer of the soil section, while those of Ca and Sr (22100 and 410 µg/g, respectively) are located in the lower layers of the soil layer, which is also reflected in Table 1 below.

1-table

The amount of chemical elements in meadow-oasis soils, (µg/g).

Depth of soil cut, cm	Chemical elements		
	Ca	Sr	Ba
0-30	18200	312	1310
30-52	20300	335	1150
52-64	19500	290	1240
64-77	22100	350	1175
77-96	18500	410	1248
96-123	19400	295	1220
Lithosphere Clark [1]	29600	340	650
Soil clarke [1]	15000	300	500

According to the teachings of V.I. Vernadsky (1937), the proposed concentration Clark - if a

chemical element accumulates in the soil or other natural object, then its concentration value is greater than one - Kk>1. For example, the Clark concentration value of barium (Ba) varies from 1.77 to 2.01 across the entire section of meadow-oasis soils in the studied research area, which means that the barium element accumulates in the soil (Table 2). The Clark distribution characterizes the relative distribution of chemical elements in nature [1, 352-b; 3, 252-b].

The amounts of calcium (Ca) and strontium (Sr) in the studied meadow-oasis soils are much lower than their average amounts in the earth's crust - Clark's - Kk<1. These elements are not concentrated in soils, but rather dispersed. In such cases, the concept of "Clark's distribution" is usually applied

2-table

Clark distribution of chemical elements and Clark concentration.

Depth of soil cut, cm	Concentration clerk			Clark distribution		
	Ca	Sr	Ba	Ca	Sr	Ba
0-30	0,61	0,92	2,01	1,63	1,09	0,49
30-52	0,69	0,99	1,77	1,46	1,01	0,57
52-64	0,66	0,85	1,91	1,52	1,17	0,52
64-77	0,75	1,03	1,81	1,34	0,97	0,55
77-96	0,63	1,21	1,92	1,60	0,83	0,52
96-123	0,66	0,87	1,88	1,53	1,15	0,53

As a result of our research, we found that the chemical elements barium Ba(2.01) and strontium Sr(1.21) are among the elements that accumulate in meadow-oasis soils. In terms of the rarefaction of the scattered chemical elements, the element calcium fluctuates between 0.63 and 0.75.

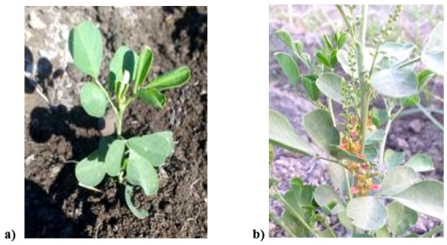
According to the results of our research, it was determined that the amount of calcium, strontium, and barium elements in the roots, stems, leaves, and seeds of Indigofera tinctoria L., which was acclimatized and cultivated in 2021 on the land of the Abdurazzoq - Mukhtorjon Yuksalish farm, increases in the following order: Ca → Sr → Ba (Table 3). It can be seen that the leaves of Indigofera tinctoria L. contain the highest amounts of calcium - 29400 µg/g, strontium - 290 µg/g, and barium - 67 µg/g.

3-table

The amount of chemical elements in the organs of *Indigofera tinctoria L.*, (µg/g).

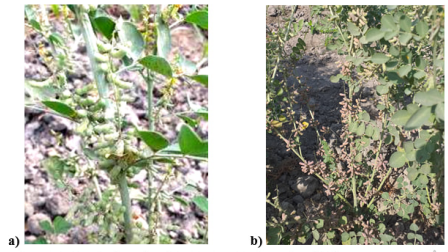
Plant		Amount of chemical elements, µg/g		
Name	Organs	Ca	Sr	Ba
Indigofera tinctoria L.	Ildiz	6300	81	17
	Poya	6100	80	7.8
	Barg	29400	290	67
	urug'	15800	160	22

The amounts of chemical elements are also not the same in different organs of plants. For example, in the organs of Indigofera tinctoria, the amount of Ca varies from 6100 to 29400 µg/g, the amount of Sr from 80 to 290 µg/g, and the amount of Ba from 7.8 to 67 µg/g.



a) b)

1- picture *Indigofera tinctoria L.* plant growth period (a), flowering period (b)



a) b)

2- picture *Indigofera tinctoria L.* plant budding period (a), bean ripening period (b).

The biological absorption coefficient (BAC) characterizes the ability of plant organs to absorb and accumulate chemical elements. BAC is an important indicator in the analysis of issues related to the biogenic migration of chemical elements. The BAC value is a quantitative characteristic of the transfer of elements from soil to plants and is considered an indicator reflecting the regional characteristics of soil geochemical conditions for the migration of chemical elements in the monitoring system. [3, 71-b]. According to the value of the bioavailability coefficient, chemical elements are divided into bioaccumulative (Kb>1) and bioretentive (Kb<1) groups.

According to our research results, it was determined that only in the leaves of Indigofera tinctoria, the element Ca(1.615) belongs to the group of bioaccumulative elements, and the elements Sr(0.259-0.929) and Ba(0.013-0.051) belong to the group of bioretentive elements (Table 4).

4-table

Biological absorption coefficient of chemical elements in the organs of *Indigofera tinctoria L.* plant (0-30 cm)

Plant		Amount of chemical elements, μg/g		
Name	Organs	Ca	Sr	Ba
Indigofera tinctoria L.	root	0,346	0,259	0,013
	stem	0,335	0,256	0.006
	leaf	1,615	0,929	0,051
	seed	0,868	0,513	0,017

Calcium (Ca) is most abundant in the bark of plants, as well as in old organs and leaves. Because Ca has little reutilization (re-absorption) properties. Of cultivated plants, Ca is most abundant in legumes, sunflowers, potatoes, cabbage, hemp, etc. The amount of Ca depends on the type of soil, being low in podzolic soils with an acidic reaction and high in soils with a neutral reaction. Plants absorb Ca from the soil in the form of a cation (Ca^{2+}). Calcium increases the immunity of plants, participates in the development of a strong root system, and helps to form a large number of root hairs. With a lack of Ca, young meristematic tissues and the root system of plants are damaged.

If the nutrition of strontium is disturbed, rickets occurs in humans, and bone fractures in animals, that is, Urov's disease. Strontium is almost always and everywhere found together with calcium as a paragenetic element. Strontium is also found in calcium crystal lattices. Similar situations occur in the body [1, 76-b, 183-b]. Barium is a relatively passive element from a chemical and geochemical perspective, and ranks as follows in terms of solubility in sulfate salts: $CaSO_4 \rightarrow SrSO_4 \rightarrow BaSO_4$

CONCLUSION

Meadow-oasis soils are of particular importance due to the high content of the element Ca, but less than in the lithosphere and soil, therefore, the calcium (Ca) element is considered a diffuse element. The element barium (Ba) accumulates, since the amount of this element is higher than the average value in the lithosphere and soil, while the element strontium (Sr) is accumulated only in the lower layers of the soil cross-section.

The leaves of the indigofera tinctoria plant grown on meadow-oasis soils accumulate more Ca, Sr, and Ba elements than the rest of its organs. The amount of Ca element in the leaves of this plant is almost five times more than in the stem, Sr element is three and a half times more than in the stem, and Ba element is eight and a half times more than in the stem. According to the BSK value, only Ca element is considered a bioaccumulative element in the leaves of the plant. Sr and Ba elements are biologically retained in all organs.

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