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Zinc in Irrigated Soils of The Desert

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Abstract
The research delved into the geochemical and biogeochemical characteristics of hydromorphic soils within the desert area, focusing on the Yazyavan region as a case study. The primary emphasis was on understanding the pedobiogeochemical aspects of Zinc, particularly its accumulation patterns and anomalies. This investigation developed a framework to quantify both positive and negative anomalies.

Keywords: geochemistry, biogeochemistry, accumulation, anomaly, hydromorphic, fertilizers, landscape

Introduction

Zinc, distributed in nature in various sources and forms, its serial number in the periodic table of elements is 30, atomic mass is 65.4. It mainly migrates in the landscape and in its blocks as a divalent metal.
The ionic radius of zinc is 0.83 nm , Clarke of the lithosphere - 83 mg/kg, soil - 50 mg/kg. The main mineral of zinc is sphalerite, that is, ZnS , in addition, its minerals include wurtzite-ZnS , styleite-smithsonite-$ZnCO_3$, grosslorite-$ZnSO_4 7H_2O$, danite-$ZnAl_2O_4$, franklinite -(ZnMg)Fe_2O_4 and others. In arid climatic conditions, goslorite , smithsony - ZnSe , zincite - ZnO , franklinite and others are found [1].
One of the reasons for this is that the soils of the region are carbonate, saline, chloride-sulfate, sulfate type, rich in iron, so zinc accumulates in these soils in neutral and slightly alkaline environments. It migrates quite actively in hydrothermal waters.

Materials and methods

Zinc precipitates together with chalcophile elements and accumulates. It is a major micronutrient among biophilic elements and is a relatively well-studied element for these purposes.
Zinc is involved in the activity of a number of enzymes and has its effect. In particular, its deficiency slows down the synthesis of vitamins, where the synthesis of ascorbic acid is reduced.
Its biological absorption index, that is, the coefficient of biological absorption by plants, is high. Accumulates in the upper layers of soil biogenically. Its accumulation is observed at a level of 45-50 mg/kg in humus soil horizons [2,3,4]. Generally migrates well in acidic environments.
Its migration coefficient is high in gley and acidic waters [5]. The concentration of zinc is relatively high in clayey sedimentary rocks and shales, i.e. 80-120 mg/kg. In sandstones, highly carbonate and gypsum soils it is 10-30 mg/kg. According to information presented in the literature [4], in soils of the USA there are cases of accumulation of 17-125 mg/kg, and in soils of Southern China - up to 236 mg/kg [6,7]. Chernozems contain about 63-97 mg/kg.
Zinc can migrate in the soil in Zn^{+2} , $ZnCl^{+}$, $ZnOH^{-}$, $ZnHCO^{-}_3$, ZnO^{-2} and other forms. Organic matter and humus are strongly absorbed and accumulated in appropriate quantities. In irrigated meadow saz soils, i.e., in carbonate, gypsum, phosphate and iron- and calcium-rich soils, the migration of zinc is sharply reduced, especially in carbonate-gypsum and gley barriers. Therefore, despite the fact that its total amount in the soil is quite large, in such conditions deficiency situations arise for plants. We should not forget that soils in irrigated agriculture, saline and carbonate, are fertilized almost annually with mineral and local fertilizers [5,11].

Even then, there is a deficiency for normal plant growth and development. For example, with wastewater 700-49000 mg/kg, phosphorus fertilizers 50-1450 mg/kg, nitrogen fertilizers 1-42 mg/kg, organic fertilizers 15-250 mg/kg and 1.3 mg/kg pesticides are introduced into irrigated areas zinc [3,5,11]. These quantities are retained in soils of an arid climate region, that is, they accumulate in carbonate, gypsum and bilateral, as well as gley barriers. Where abnormal concentrations may form over the years [8].

According to the literature [10,12], the concentration of zinc in soil, which may indicate the level of phytotoxicity, exceeds 70 mg/kg. Particular attention should be paid to the fact that its phytotoxic concentration depends on a number of factors: mobile form, type of plant, soil pH, content of carbonates, sulfates, sulfur, humus, iron, phosphorus and others. However, it is fair to say that the effects of these conditions are not well understood, especially in saline desert soils. This situation is one of the complex problems.

The object of the study was irrigated, saline meadow saz and sandy desert soils, formed on an area of 19,583 hectares in the Yazyavan district of the Fergana region of Uzbekistan. Field research was carried out on the basis of Dokuchaev's morphogenetic and stationary methods. Mathematical and statistical analysis of the obtained results was carried out using the dispersion method, that is, the methods of Karimov, Yuldashev [5] and Samsonova [9] using Microsoft Excel.

Quantitative determination of zinc in selected samples was determined using the Spivey , Nick method (Perkin ICP-OES spectrophotometer Emler Avio 200 at a wavelength of 206,200 nm , integration time 0.1-5 seconds, sample transfer rate 0.8 ml/min, plasma gas transfer 8 l/min. The correlation coefficient between the amount in the standard solution and the amount in the equivalent sample is reported to be 0.99990.

Theoretically, plants feed on Zn^{++} in the soil solution, but this may be hindered by other elements of the solution, in particular Ca^{++}.

But zinc consumption is controlled by the plant through its metabolism. If you think deeper, then theoretically the factors that cause a state of zinc deficiency in plants include the following: - low Zn content in the soil; soil carbonate content ;

- gypsum content , alkalinity, humus content of the soil; - distribution of the root system in the soil, biological activity; - plant type, growth phase; - antagonistic state with other elements, ions, irrigation regime; - soil contamination with this element and others.

Zinc is a chalcophile element and, in terms of toxicity, belongs to the first group of elements. According to preliminary data, wormwood is among the plants that absorb zinc; according to our information, in wormwood growing on stony-gravelly eroded and leached light gray soils, zinc accumulates in the range of 142-160 mg/kg, in contrast to the medicinal plant lavender where it the content reaches 129 mg/kg.

Thus, the geochemical and biogeochemical properties and distribution of trace elements in the soil, especially zinc, are not uniform in all cases. We can see this situation in the example of the studied soils in the region . For this purpose, first of all, the obtained analysis results were mathematically processed.

According to the data obtained, the coefficient of variation of zinc in the soils of the Yangi Buston , Central Fergana, Karatal, Yangiabad, Istiklal , Karatepa, Ishtirkhan , Khanabad massifs is $V<10$, which means that the spread of data is very low, and in the soils of the Gulistan, Karasokol massif , this indicator is 20-25%, that is, in Karasokol this coefficient is 20%, which means ($V = 10-20$) the dispersion is average, in Gulistan this figure is 25.4%, which means the dispersion is serious (Table 1).

But as a general rule, if the coefficient of variation is less than 33%, the set is considered homogeneous and can be used, which means the results obtained are correct. This law holds true for the dispersion of zinc in the soil of the study area, so the results obtained can be used. When determining the positive and negative anomalous state of zinc in the soil, the background indicator and the 3-fold value of the standard deviation and coefficients of variation are of great importance. It should be noted that classifications have not yet been developed for abnormal cases of zinc and some other trace elements. Therefore, we recommend choosing for positive and negative cases of normal, weak, moderate, strong, high anomalies. To do this, first of all, the background value for the soils of the region is calculated from samples. Due to the fact that the soils of the region are carbonate, gypsum and saline, the background level turned out to be higher than expected, i.e. 83.8 mg/kg. Based on the results of statistical processing, the Zn concentration, that is, background amounts, was determined separately for each array (Table 1).

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Anomalous values can be determined relative to the soil, lithosphere, biosphere or background. At the same time, i.e. When studying the soil-geochemical properties of Zn in the soils of the Yazyavan region, in particular its anomalous state, the amount of zinc in the irrigated soils of the region in the 0-30 cm layer was taken as the background for the soils of the region.

Table 1. Background amounts of zinc in soils of massifs

N/ r.	Arrays	n	Fon	δ	V	m
1	Yangi Buston	14	52.2	2.32	4.44	1.04
2	Central Fergana (state land reserve)	15	64.04	4.03	6.29	1.80
3	Karatal	18	83.025	5.44	6.55	2.72
4	Yangiabad	19	69.82	4.92	7.04	2.19
5	Guliston	21	100.83	25.61	25.39	10.45
6	Karasakal	20	115.0	22.99	19.99	11.49
7	Istiklal	14	54.25	3.77	6.94	1.88
8	Karatepa	13	90.25	3.96	4.39	1.98
9	Ishtirkhan	13	101.25	8.93	8.82	4.46
10	Khanabad	19	115.25	10.84	9.41	5.42

It should be noted that positive and negative abnormal states of the element lead to various endemic diseases. In particular, zinc deficiency affects the growth, development, and height of plants.
The leaves of fruit trees become smaller, as a result, metabolism at the leaf level slows down, ultimately reducing yield and deteriorating quality. In corn and other grain crops, zinc deficiency leads to chlorosis, etc.
The works of A.I. Perelman [8] can be useful in determining positive and negative anomalies of chemical elements in the soil. To determine the positive anomaly, the A.I. formula is convenient. Perelman [8], which has the following form: $Ca \geq Cf + 3\ d$, Ca – anomalous concentration of the element; Cf – background element containment ;
d – standard deviation or dispersion. The negative anomaly of chemical elements in the soil is calculated using the formula
$Ca < Cf - 3d$ (Table-2). For positive abnormal cases <70 there are no abnormalities; 70-100 weak anomalies; 100-130 average anomaly; 130-160 strong anomaly; > 160 high anomaly.

Table 2. Anomalous concentrations of zinc in hydromorphic soils of the massifs

N/ r.	Arrays	Sample numbers	3δ	Anomalies		Degree of anomaly	
				+ 1	- 2	+ 1	- 2
1	Yangi Buston	1, 2, 3, 4, 5	6.96	59.16	45.24	No	weak
2	Central Fergana (state land reserve)	6, 7, 8, 9, 10, 46	12.03	76.13	51.95	weak , average , high	weak
3	Karatal	1 1, 12,13, 14	16.32	99.35	66.71	average	weak
4	Yangiabad	15, 16, 17	14.76	84.56	55.06	weak, average , strong	weak
5	Guliston	19, 24	76.83	177.66	24.0	strong	No
6	Karasakal	18, 40,41,42	68.97	183.97	40.03	strong, tall	No
7	Istiklal	28, 29, 30	11.31	65.56	42.94	No	No

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8	Karatepa	20, 21, 22, 23, 31, 32, 33, 34,35	11.88	102.13	78.37	average	weak
9	Ishtirkhan	36, 37,38,39	24.99	126.24	76.26	average	weak
10	Khanabad	24, 25, 26, 2 7, 43, 44, 45	32.52	147.77	82.73	strong	weak

1-positive, 2-negative;

For negative abnormal cases, the following indications are recommended: <45 no negative abnormalities; 45-60 weak; 60-75 average; 75-100 strong ; > 100 high. According to the results obtained for the zinc anomaly, strong anomy corresponds to the Khanabad , Ishtirkhan , Koratepa and Karasakal , Gulistan massifs, where a zinc province of high content is clearly distinguished.

Conclusions

In conclusion, it can be noted that the state of zinc anomaly in the soils of the region manifests itself both positive and negative. The reason for the high positive anomaly in the old irrigated soils of the region, in particular the Khanabad , Gulistan, Karatepa, Karasakal massifs , is the rather high zinc content in phosphorus and local fertilizers applied to cotton and other agricultural crops, as well as slightly alkaline, neutral reactions of the soils where zinc accumulates in carbonate-gypsum, double-sided and evaporation barriers.

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