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Review Article

DEGRADED SOILS OF SURKHAN-SHERABAD VALLEY AND THEIR BIOLOGICAL ACTIVITY

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Abstract
This article presents data on the study of changes in the number of microorganisms some groups, the activity of hydrolytic and redox enzymes, the intensity of soil respiration in time and space, as well as under the influence of degradation processes. The research results showed that the distribution and quantitative change of the studied groups of microorganisms, enzyme activity and the intensity of soil respiration differed depending on the geographical location of the type and subtype of the soil, genetic characteristics, and the availability of organic substances.

Key words: soil biological activity, groups of microorganisms, enzyme activity, soil respiration rate, erosion, salinization, soil type, degradation.

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INTRODUCTION

Actuality of the research. Scientific studies on systematization of data on types of degradation and their underlying factors, identifying the effect of degradation on changes in soil properties, analyzing the interaction of soil biological activity with factors of the internal and external environment, developing methods of bio-diagnostics of an objective and reliable assessment of the degree of resistance to various negative factors of soil systems are conducted in the world.

In the Republic of Uzbekistan, a wide range of complex measures on enhancing of soil biologic activity are realized, in order to maintain steady level of soil fertility, forecasting and creation of conditions, necessary for growth and development of agricultural crops together with improvement of soil agrophysical and agrochemical properties. In this respect, to characterize the influence degree of degradation process on soil layer of Surkhan-Sherabad valley based on the determination of its diagnostic indicators, namely the dynamics of changes in the activity of microorganisms, enzyme activity and respiration rate in specific physiographic conditions is important in developing measures for their rational use and protection.

MATERIALS AND METHODS

Large-scale studies on exploration of the importance of biological activity in soil fertility and its changes in relation to ecological and geographical environmental conditions in different years were conducted by D.G.Zvyagintsev [19], E.N.Mishustin [14], F.Kh.Khaziev [10], K.Sh.Kazeev [8, 9], S.I.Kolesnikov [12], E.V.Dadenka [1], H.T.Riskieva [16], L.A.Gafurova [2], L.A.Gafurova, D.A.Kadirova [3,4,5] G.M.Nabiyeva [13], D.A.Kodirova [6,7], M.E.Saidova [17], O.V.Myachina [15], and other scientists. But scientific studies on the diagnosis of the state and spatial-temporal changes in degraded soils by using biological indicators of arid soils of the horizontal and vertical zonality of the studied area were not adequately performed.

The object of the study is the soils that are widespread in foothill and mountainous conditions (dark sierozem, developed on loess deposits, dark sierozem developed on tertiary sediments, mountain brown carbonate and mountain brown typical soils), sierozem zone (old-watered swampy meadow, meadow, sierozem meadow, meadow sierozem, light sierozem, newly watered typical sierozem, newly developed bog-meadow soils) and desert zones (old-watered gray-brown, old-irrigated and new-irrigated takyr-meadow, meadow-takyr, takyr-meadow, marsh-meadow, meadow desert-sand, meadow, desert-meadow soils) of Surkhan-Sherabad valley.

Research methods. Field and laboratory studies were conducted according to generally accepted standard methods. The profile-genetic, comparative-geographical and chemical-analytical methods were used in the research. The main agronomical important physiological groups of microorganisms were determined according to the guidelines "Microbiology and Soil Biochemistry" by D.G.Zvyagintsev [19]. Microorganisms calculation, grown on liquid media, made on the basis of Mac-Creed table. The activity of enzymes and soil respiration was determined by the "Methods of soil enzymology" described by F.Kh.Khaziev [11]. The correlation between diagnostic indicators of soil fertility and biological activity was determined using the program of Statgraphics Centure XVII.

Research results. The research results showed that, depending on the soil and climatic conditions of the studied region, the groups of microorganisms are distributed differently. In the soils of the mountain and serozem belts, soil formation processes occur mainly under aerobic conditions, where ammonificators (69-74%) play leading role, these are groups of microorganisms that easily adapt to adverse conditions, such as actinomycetes (42%) and butyric acid bacteria (3-4%) are more developed in the soils of the desert zone. This indicates to the intensive processes of mineralization, which lead to a decrease in the amount of humus.

In the mountain-brown and irrigated soils of serozem belt, the proportion of ammonificators prevailed, in the soils of desert zones an increase in the proportion of actinomycetes, which are able to develop in adverse conditions, and oil-acid bacteria, developing in anaerobic conditions, was observed, which can be explained by the succession of microorganisms, that is, salinization of soil has a strong effect on the development of bacteria and fungi, as a result, their number decreases sharply, which creates a more favorable environment for the development of actinomycetes and butyric acid bacteria. The remaining groups of microorganisms in all soils were found in smaller quantities.

Favorable agrochemical and agrophysical properties of typical mountain-brown soils provide high microbiological activity. In these soils, microbiological processes were more active than in the soils of sierozem belt and the desert zone of the region (Table 1).

A large number of ammonificators indicates to the activity of ammonification process, which testifies the presence of organic matter in a large amount. The activity of the ammonification process, in turn, leads to the intensive development of nitrifying agents. The increase in the number of nitrifying agents contributes to the improvement of plants nitrogen nutrition. Adequate supply of mineral forms of nitrogen contributes to the development of cellulose-depleting microorganisms, to the intensive destruction of cellulose, which in turn leads to the development of nitrogen-fixing microorganisms.

Table 1 The number of microorganisms in the mountain-brown and sierozem soils of Surkhan-Sherabad valley (th/g. of soil)

Depth, sm	Ammonifi-cators	Fungi	Actino-mycetes	Nitrifica-tors	Nitrogen fixer	Aerobic cellulose-decomposing microorganisms	Butyric acid bacteria
Mountain brown typical soils							
0-15	3900	284	875	95	200	40	30
15-30	2270	175	670	40	115	25	16,5
30-50	1580	120	495	25	75	11	9
50-70	700	53	264	9	30	6	4
Dark sierozem, developed on loess deposits							
0-15	1040	51	110	15	30	9	11
15-30	800	30	64	11	16	4	7,5
30-50	355	19	35	6,5	7,5	1,4	4,5
50-70	197	13	20	2,5	3	-	2
Old irrigated meadow soils							
0-15	2605	128	650	45	75	40	35
15-30	2070	87	434	30	45	25	20
30-50	1425	58	296	20	25	16,5	14
50-70	1061	37	143	11,5	9,5	9	9
New irrigated typical sierozem							
0-15	884	44	491	9,5	15	11,5	4,5
15-30	501	30	360	6,5	10	6,5	3
30-50	401	22	218	3	6,5	3,0	1,5
50-70	254	12	110	1,4	3	1,5	0,6

The distribution of the number of microorganisms certain groups according to the profile of irrigated soils of sierozem belt varies depending on their remoteness of irrigation (Table 1). In the old irrigated soils, a greater number of microorganisms was observed than in the newly irrigated and newly reclamated soils. This situation can be explained by the fact that microorganisms penetrate into the deeper layers of old-irrigated soils due to the good supply of nutrients from long-term use of organic and mineral fertilizers.

According to the research, it was observed that in the irrigated soils of the desert zone of Surkhan-Sherabad valley the microorganisms developed less because of varying degrees of salinity, low availability of humus and nutrients, and strong soil compaction (Table 2).

Table 2 The number of microorganisms in the irrigated soils of the desert zone of Surkhan-Sherabad valley (th/g of soil)

Depth, sm	Ammoni-ficators	Fungi	Actino-mycetes	Nitrifica-tors	Nitrogen fixer	Aerobic cellulose-decomposing microorganisms	Butyric acid bacteria
Irrigated takyr-meadow soils							
0-15	1060	81	880	11,5	11	10	20
15-30	705	46	588	7	9	6	10
30-50	304	27	343	3,5	3,5	3,5	6,5
50-70	120	13	128	1,5	2	1,5	2,5
Old irrigated meadow soils							
0-15	1890	150	1390	30	45	40	65
15-30	1380	102	884	16,5	25	20	30
30-50	810	84	626	9	11,5	10	16,5
50-70	405	55	376	4	7,5	4,5	9
New irrigated gray brown soils							
0-15	485	13	550	2	2,5	3	4
15-30	170	9	330	0,7	1,5	1,6	2,5
30-50	80	5	214	0,3	0,6	1	1,1
50-70	40	3	110	-	0,1	0,1	0,1
Old irrigated meadow-takyr soils							
0-15	910	71	768	9,5	11,5	10	16

15-30	580	38	593	4,5	7,5	7	10
30-50	260	16	236	2,5	4	3,5	6,5
50-70	101	11	120	0,9	1,6	1,5	3
Irrigated meadow desert-sandy soils							
0-15	500	14	563	2,0	4,5	2,5	3,5
15-30	201	8	336	0,6	2,5	1,4	1,2
30-50	82	6	118	0,1	1,2	0,7	0,9
50-70	41	2	81	-	0,3	0,3	0,3

It was revealed that all groups of microorganisms were found in very small quantities even in the upper layers of irrigated gray-brown, takyr-meadow, meadow desert-sand and meadow-desert soils, and in the lower layers some groups of them were not found at all. As it is known, microorganisms are very sensitive indicators of soil and environmental conditions. Eroded and salinized soils in varying degrees of the study area are the main limiting factors for the development of microorganisms. As the degree of erosion and salinity increases, their number sharply decreases.

Changes in the basic agrochemical, agrophysical and microbiological properties of the studied soils as a result of degradation processes are also reflected in the activity of enzymes.

RESULT AND DISCUSSION

Invertase, catalyzing the reaction of hydrolytic sucrose splitting, reflects the level of fertility and biological activity of the soil. Therefore, the activity of invertase in connection with provision of soil with organic substances in the foothill and mountain soils varies within 1.80-23.2, in irrigated soils of sierozem belt - 2.45-7.10, and in soils of the desert zone - 1.28 - 3.27 mg of glucose.

Phosphatase activity in soil depends on the content of organic phosphorus and in foothill and mountain soils makes 0.70–7.20 mg P2O5 per 100 g of soil, in irrigated soils of sierozem zone - 1.80–3.20, and in the desert zone – 0.50-1.30 mg P2O5.

Urease activity, catalyzing the hydrolysis of urea in the soil till ammonia and carbon dioxide, in mountain and foothill soils is 1.14-5.72 mg NH3 per 10 g of soil, in irrigated soils of the sierozem zone 1.12-4.70 and in desert soils belts 0.16-0.69 mg NH3.

Catalase is involved in the decomposition of H2O2 accumulated as a result of various biochemical processes in the soil into water and molecular oxygen. Catalase activity in mountainous and foothill soils is 0.98-15.4 ml of O2, in irrigated soils of sierozem belt 3.20-5.04 ml of O2, and in soils of the desert zone 1.9-4.3 ml of O2 per 100g of soil. Low catalase activity in desert soils indicates the accumulation of H2O2 in the soil, which is harmful for living organisms.

Phenol oxidase enzymes carry out redox reactions, which characterize the direction of the processes of decomposition-synthesis of humic substances in the soil, and by their ratio can be calculated the coefficient of humification. Peroxidase activity in mountainous and foothill soils is 1.34–10.2, in irrigated soils of serozem belt 1.30–4.23, and in soils of the desert zone - 2.60–3.29 mg of purpurgalinena per 100 g of soil. The activity of polyphenol oxidase in mountain and foothill soils varies between 1.10 and 11.4, in irrigated soils of serozem belt it is 1.30-4.23, and in desert soils it varies between 1.80-5.80 mg of purpurghalin in 100 g of soil. In the studied soils, the coefficient of humification ranges from 0.6 to 2.3.

The activity of enzymes is mainly manifested in the upper most biologically active layers. However, in catalase activity there was a slight increase in its lower layers, depending on the amount of carbonates in the soil. According to the soil profile, the activity of the studied enzymes decreases very smoothly than the number of soil microorganisms.

According to the ratio of total enzyme activity, an increase in the share of oxidase enzymes in the soils of the region compared to hydrolases was observed, which, on the one hand, is explained by the dry climate of the study area, and on the other hand, activation of enzymes activity of oxidoreductases class while improving the aeration process as a result of processing the arable horizon.

A great diversity in the activity of enzymes creates a degree of eroded soil. Since the washed and non-washed soils have favorable soil conditions and the activity of enzymes is higher than that of washed-off soils. An increase in the degree of salinity led to a decrease in the enzymatic activity of soil.

The process of soil respiration is a complex biochemical process, the release of CO2 varies widely, depending on a number of factors, including the content of organic matter in the soil, chemical and physical properties of soil, the number of microorganisms and hydrothermal conditions, i.e. in mountainous and foothill soils, it ranged from 3.6 to 11.2, in irrigated soils of serozem belt, 3.2-8.1, in the soils of desert zone, 2.2-6.0 mg CO2 per 10 g of soil. It should be noted that the release of CO2 gas also significantly increased in the lower carbonate layers (12.6-16.7 mg CO2 per 10 g of soil), this is especially pronounced in the southern exposure of mountain brown calcareous soils, which are also noted in other studies [18]. It is noted that the intensity of respiration in irrigated soils of desert zones is significantly weaker than in the soils of mountain regions and sierozem zone.

In the course of the research, positive correlations were found between the biological activity of soil and the agrochemical and physical properties. The correlation coefficient between biological activity and humus fluctuated within r = 0.85-0.97, between nitrogen r = 0.75-0.93, between phosphorus r = 0.76-0.95 and potassium r = 0.72 -0.93, between porosity and microorganisms r = 0.67-0.86, between enzymes r = 0.74-0.90.

CONCLUSION

The obtained data showed that it is advisable to use indicators of the biological state of the soil as a multicomponent system for assessing the level of natural and anthropogenic impact on soil conditions.

The soils of the study area differ from each other in the number of microorganisms, depending on the degree of erosion and salinity. The processes of erosion and salinization adversely effect on the development of the studied groups of microorganisms, that is, with the increase of this process, the number of microorganisms sharply decreases. The production of CO_2 in the studied soils depends on the processes of degradation, the properties of the soil, the quantitative composition of the microflora, etc. Increasing the degree of erosion and salinity weakens the release of CO_2 in the soil. As a result of degradation processes, the deterioration of the main soil-ecological parameters controlling the level of enzymatic activity of soil leads to a sharp decrease in their activity. The high activity of enzymes, mainly manifested in the upper layers and naturally decreases towards the lower layers.

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