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BIODIAGNOSTIC INDICATORS OF IRRIGATED SOILS OF BUKHARA OASIS

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Abstract- This article presents the morphological, agrochemical, physicochemical and chemical properties of soils of irrigated meadow-alluvial and irrigated desert-sandy soils of Bukhara Oasis. Indicators of biological activity of soils, their seasonal dynamics, evaluation of the level of biological activity of soils on the basis of integral indicators of soil main texture-properties, transformation coefficient, biogenicity, ecological-biological status of organic matter of irrigated soils of the territory are given.

Keywords- *Meadow-alluvial soil, desert-sandy soil, morphology, agro-chemistry, physic-chemistry, biological activity, seasonal dynamics, organic matter, transformation, coefficient, biogenicity of soil, ecological-biological condition, integral indicator.*

Relevance and necessity. Today, “the land of resources the world are 13.4 billion hectares, of which 12% are agricultural land, 24% are pastures, 31% are forests and 33% are other types of land. 8-10 million hectares of agricultural land are degraded annually. According to the United Nations, an average of $ 40 billion is lost each year as a result of soil degradation around the world. This is due to the fact that the decline in soil fertility is observed at a high level in developing countries, where the population is growing rapidly and modern agro-technical measures are not yet applied.”[1] Taking into account these, it is important to develop scientifically-based activities aimed at optimizing the biological processes occurring in soils, restoring and increasing soil fertility, as well as preventing degradation processes. A number of scientific works are carried out in the world on the analysis of agrochemical, physical and chemical properties of soils, the state of humus and the interaction of soil biological activity with external environmental factors.

Research purpose: to determine the biological activity of irrigated soils of Bukhara district and to develop measures for their optimization.

Research objectives:

to study morphological, agrochemical, physicochemical and chemical properties of soils, taking into account the specific natural and climatic conditions of the region;

to determine the correlation between the indicators of biological activity of soils, their seasonal dynamics, the main properties of the soil and biological activity;

to assess the level of biological activity of soils on the basis of the coefficient of transformation of organic matter, biogenicity, integral indicators of ecological and biological condition of irrigated soils of the region;

The object of research is the irrigated oasis meadow-alluvial, irrigated meadow-alluvial and irrigated desert-sand soils in Bukhara district.

Research methods. During the research, standard methods generally accepted in the field and laboratory conditions at the Research Institute of Soil Science and Agro-chemistry and the Institute of Microbiology of the Academy of Sciences of Uzbekistan were used. Statistical processing of the obtained

[1] http://www.fao.org

results was carried out using Excel 2015 and OriginProv. 8.5 SR1 programs according to the dispersion method of B.A. Dospekhov. The soil analysis was performed according to the Arinushkina's manual on "Chemical analysis of soil" (1970), the amount of microorganisms in the soil by Zvyagintsev's "Methods of soil microbiology and biochemistry" (1978), the enzyme activity by Khaziev's "Methods of soil enzymology" (1982), the calculation of the value of IIEBCS on "Biological diagnostics and indication of soils: methodology and research method research" (2003). Field experimental studies were carried out based on the "methodology of field and vegetation experiments with cotton under irrigation conditions" and the "methodology of field experiments" (2007).

Implementation of the research results. The Bukhara Oasis consists mainly of irrigated meadow-alluvial soils scattered in the subaeral delta of the Zarafshan River. These soils have their own characteristics, developing under the influence of very complex soil formation processes in the hydromorphic evolutionary stages. In the effect of irrigation and human activity, and the depth of the groundwater was in the range of 1.0-2.0 meters, ensuring their participation in the process of soil formation, development of intensive grunt – capillary wetting conditions. At present, the irrigated meadow-alluvial soils of the oasis have changed directly for many centuries (more than 1000 years) under the influence of human activities (drainage, cultivation, irrigation, etc.), and groundwater plays an important role in their development. The signs of proximity to groundwater, swamping and grazing processes including glaciation, oxidation-reduction and salinization lead to the development of elementary soil formation processes.

Meadow-alluvial soils are saline to different degrees, their mechanical composition is also different, and their natural reclamation conditions are due to the fact that the lands are provided with a collector-trench system. The mechanical composition of meadow-alluvial soils is somewhat slightly sandy, and it can be observed that the mechanical composition is aggravated as a result of long-term irrigation. The formation of agro-irrigation layers with a thickness of up to 1.0-2.0 meters on these soils is evidenced by the fact that they are formed as soils watered from ancient times.

The main genetic characteristics of these soils are:

1) the presence of a layer of agro-irrigation;

2) the renewal of soil formation processes due to the accumulation of agro-irrigation data over the years;

3) the thickening of the humus layer, etc.

The morphological characteristics of oasis meadow-alluvial soils are characterized by the presence of agro-irrigation layer, which is uniform in color, mechanical composition, density, the humus layer is not clearly different from irrigated meadow-alluvial soils, but differs in thickness. However, anthropogenic compounds (ceramic, coal, etc.) can be found in the soil profile. For irrigated meadow-alluvial soils, unlike humus-alluvial soils of the oasis, the humus layer is not relatively thick, the color is relatively stable and the agro-irrigation layer is not sharply separated. On the cross section of the soil there are traces of insects and small roots of the plant and at the bottom there are light blue, dark and rust spots as a result of oxidation and reduction processes. Irrigated desert sandy soils are characterized by light gray, the cross section is not well developed, the mechanical composition is slightly heavier in the upper layer, and the humus layer is poorly developed, the soil is weakly compacted, in some places there are small roots.

The plowed layers of the irrigated oasis meadow-alluvial soils are composed of the same rocks including agro-irrigation layers, according to their mechanical composition and color. In areas with short irrigation periods, irrigated meadow-alluvial soils are developed. The oasis meadow-alluvial of these soils is characterized by the presence of some signs of rust, bluish spots, etc. in its profile, as well as the incompleteness of the agro-irrigation layer of the same color. At the bottom of the soil profile it can be seen that the irrigation process has not changed.

The mechanical composition of the soil has a great influence on the physical, physicochemical, agrochemical and biological activity properties of the soil. The mechanical composition of the soil is determined in accordance with the moisture level of the soil and the nutrients that the plants absorb. Depending on the diameter reduction of the effective mechanical elements in fractions, it was determined that the amount of humus, absorption capacity, as well as wet capacity and soil suppuration increase several times.

As the size of the fractions decreases, the amount of humus and nitrogen increases. It is known that when irrigating the irrigated soils of the Bukhara oasis with turbid water, fine dust particles are mechanically stored in the pores of the soil and form an agro-irrigation layer.

Studies have shown that the soils of the studied area are light, medium and heavy sand, in some places sandy, depending on the mechanical composition.

Table 1

Mechanical composition of irrigated soils in the experimental field (in %)

Horizon (cm)	**Size of fractions (mm)**								Named according to the mechanical composition
	>0,25	0,25–0,1	0,1–0,05	0,05–0,01	0,01–0,005	0,005–0,001	<0,001	Physical (*<0,01*)	
Meadow-alluvial soils of oasis									
Intersection –1									
0-25	1,2	0,3	31,5	24,0	13,7	17,1	12,2	43,0	Medium sandy
25-50	0,8	0,2	27,8	26,8	12,2	14,5	17,7	44,4	Medium sandy
50-76	0,4	0,1	25,5	24	14,2	17,7	18,1	50,0	Heavy sandy
76-100	0,4	0,1	42,5	25,3	8,7	11,0	12,0	31,7	Medium sandy
Intersection –3									
0-23	0,9	0,2	31,1	21,8	15,3	14,2	16,5	46,0	Heavy sandy
23-46	0,8	0,2	37,4	17,6	17,3	10,9	15,8	44,0	Medium sandy
46-70	0,4	0,1	28,5	20,3	18,2	20,8	11,7	50,7	Heavy sandy
71-100	0,4	0,1	22,4	40,0	11,1	12,4	13,6	37,1	Medium sandy
Intersection –10									
0–25	0,8	0,2	19,0	31,1	16,5	17,7	14,7	48,9	Heavy

									sandy
25–50	0,4	0,1	22,3	30,9	14,6	15,8	13,9	44,3	Medium sandy
50–72	0,8	0,2	21,5	25,2	16,8	16,8	18,7	52,3	Heavy sandy
72–100	0,4	0,1	28,0	25,4	17,7	14,1	12,3	44,1	Medium sandy
Irrigated meadow-alluvial soils									
Intersection –14									
0-27	1,6	0,4	10,9	53,2	14,7	10,8	8,4	33,9	Medium sandy
27-43	0,8	0,2	43,7	31,5	9,4	11,0	3,4	23,8	Light sandy
43-74	0,4	0,1	10,2	59,5	18,4	3,3	8,1	29,8	Medium sandy
74-100	0,8	0,2	32,4	45,4	7,6	6,6	7,0	21,2	Light sandy
Intersection –7									
0-24	2,0	0,5	33,5	32,5	15,2	14,1	2,2	31,5	Medium sandy
24-50	0,4	0,1	39,7	32,8	13,1	9,4	4,5	27,0	Light sandy
50-85	0,8	0,2	33,0	37,4	12,5	13,4	2,7	28,6	Light sandy
85-100	2	0,5	49,4	23,7	14	5,9	4,5	24,4	Light sandy
Intersection –5									
0-20	1,2	0,3	28,8	56,7	4,4	4,4	4,2	13,0	Sandy
20-40	0,8	0,2	17,5	59,3	5,8	11,4	5,0	22,2	Light sandy
40-54	0,8	0,2	20,0	50,7	13,8	6,9	7,6	28,3	Light sandy
54-100	0,4	0,1	61,4	8,5	24,5	3,7	1,4	29,6	Light sandy
Irrigated desert sandy soils									
Intersection –9									
0-24	2	0,5	73,2	10,9	2,7	8,8	1,9	13,4	Sandy
24-72	11	3,5	57,0	17,1	4,2	5,1	2,1	11,4	Sandy
72-95	7,6	1,9	71,3	3,4	5,4	6,3	4,1	15,8	Sandy
95-110	1,2	1,3	62,5	10,0	9,3	12,6	3,1	25,0	Light sandy
Intersection –21									
0-15	4	1	63,5	11,3	4,2	8,1	7,9	20,2	Light

									sandy
15-40	2	0,5	70,1	7,6	7	6,8	6,0	19,8	Sandy
40-80	3,2	0,8	74,1	7,9	3,9	4,3	5,8	14,0	Sandy
80-115	8,4	2,1	61,6	9,1	5,4	8,3	5,1	18,8	Sandy

The mechanical composition of the meadow-alluvial soils of the oasis is dominated by fine sand (0.1-0.05 mm) 31.5-39.2%, coarse dust (0.05-0.01 mm) fractions - 20.2-31.1% and the turbidity fraction (<0.001 mm) is less than 12.2-16.8%. In irrigated meadow-alluvial soils the predominance of coarse dust fractions (0.05-0.01 mm) -32.5-56.7% and fine sand fractions (0.1-0.05 mm) -28.8-33.5% and the turbid fraction (<0.001 mm) is lower than the oasis meadow-alluvial soils -2.2-8.4% and differs in the mechanical composition of the soil profile layer (Table 1).

In the mechanical composition of irrigated desert-sandy soils, the maximum amount of fine sand fraction (0.1-0.05 mm) is 63.5-73.2%, coarse dust (0.05-0.01 mm) and fine dust (0.005- 0.001mm) The amount of fractions varies in the amount of 10.9-11.3 and 8.1-8.8%, respectively. In irrigated soils, it was found that the fine dust fraction predominated over the turbid fraction.

In the meadow-alluvial soils of the, the amount of humus in the alluvial soils gradually decreased by the cross section, the amount of humus in the arable layer was determined from 1.079 to 1.489%, in the arable underground layer from 0.808 to 1.026%, in the lower layers (71-80 cm) – 0.557-0.777%. The amount of humus in the lower part of the intersection (100-110 cm) is 0.304-0.380%. Furthermore, in the meadow-alluvial soils of the oasis was observed for the correlation with humus profile agro-innovation layer. In the arable layer of the irrigated meadow-alluvial soils, the amount of humus is slightly greater than in the oasis meadow-alluvial soils (1.215-1.560%), and in the lower layers the difference between the oasis meadow– alluvial soils - its indicators sharply (0.155 – 0.216%) - decreases.

In the meadow-alluvial soils of the oasis, the reserve of humus in the 0-25 cm layer of the irrigated meadow-alluvial soils is slightly lower, at 45.30 t / ha, and in irrigated meadow-alluvial soils - 50.01 t / ha. In the meadow-alluvial soils of the oasis, the humus profile occurs in relation to the depth of the agro-irrigation layer and is 64.90 t/ha in the 0-100 cm layer in the meadow-alluvial soils of the oasis and 34.60 t/ha in irrigated meadow-alluvial soils. In the irrigated desert-sandy soils, humus reserves are 16.08 t/ha in 0-25 cm and 18.40 t/ha in 0-100 cm.

Nitrogen content in the upper layers of irrigated meadow-alluvial soils is 0.066-0.096%, depending on the lower layers, this figure decreases sharply to 0.009-0.028%, in desert sandy soils nitrogen is low and decreases sharply from -0.016-0.038% to 0.005- 0.011% of the amount. The total phosphorus content in the oasis meadow soils is 0.185-0.205% in the topsoil and subsoil layers and 0.091-0.115% in the lower layers, which is higher in the topsoil, which can be attributed to the system of biogenic accumulation and perennial fertilizer application.

The amount of mobile phosphorus is 11.5-21.2 mg/kg in the ploughed and sub- ploughed layers, and in the lower layers of carbonates, under the influence of alkaline environment decreases sharply to 5.2-9.1 mg/kg. In irrigated meadow-alluvial soils, total phosphorus is 0.131-0.182 and 0.066-0.089%, respectively, mobile phosphorus is 14.1-19.2 and 3.9-8.6 mg/kg; in irrigated desert-sandy soils, the total phosphorus in the upper layers is 0.091-0.114 and 0.036-0.062%, respectively, while the mobile phosphorus is 12.3-15.8 and 1.1-2.1 mg/kg. The total potassium content in the studied oasis soils is 1.482-1.843% by the intersection, while the exchangeable potassium is 122.3-176.7 mg/kg. The relative abundance of potassium in the driving layer is the result of its biogenic accumulation and fertilizer application over many years. It is 0.602-1.244%

in irrigated meadow-alluvial soils, 98.8-173.0 mg/kg of exchangeable potassium and 0.661-1.102% and 96.3-168.1 mg/kg of total potassium in irrigated desert-sandy soils, respectively.

The oasis meadow-alluvial soils of the region are characterized by humus content - "low" and “average”, phosphorus – “low” and “very low”, potassium – “low”; according to the irrigated meadow-alluvial soils, humus is described as- “low” and “very low” phosphorus – ‘very low” and “low”, potassium – “low”; while in desert-sandy soils, humus is described as “very low”, phosphorus as “very low”, and potassium as “low”.

The study analyzed the quantitative dynamics of the main components of the soil micro-flora - ammonifiers, spores, actinomycetes and microscopic fungi, which are considered important from an agronomic point of view.

We studied the micro-flora of irrigated oasis meadow-alluvial soils, irrigated meadow-alluvial soils and desert-sandy soils. At the same time, biological activity was studied in soil sections, soil samples were taken from soil layers 0–5, 0–15, 15–30, 30–50, 50–70 cm deep (Table 2).

Table 2

Amount of microorganism groups in irrigated soils of the study area (in thousands per 1 g of soil)

Depth, cm	Ammonifiers	Microscopic fungi	Actinomycetes	Spores	Oligonitrophils	Aerobic cellulose breakdown micro-organisms
Oasis meadow-alluvial soils						
0-15	2355	46	855	53	965	42
15-30	1125	31	521	35	824	26
30-50	705	14	256	21	614	10
50-70	235	9	109	9	305	4
HCP05	8,56	0,91	1,00	4,53	3,78	2,61
P%	7,1	3,7	0,1	3,0	0,4	3,1
Irrigated meadow-alluvial soils						
0-15	1692	35	690	38	720	19
15-30	716	28	398	24	512	11,1
30-50	540	14	214	9	298	6,1
50-70	90	7	97	3	87	1,8
HCP05	4,75	3,45	3,69	2,26	4,66	3,45
P%	0,2	4,3	0,7	3,3	0,6	2,7
Irrigated desert-sandy soils						
0-15	606	31	443	23	367	2,1
15-30	370	24	213	19	216	1,1
30-50	106	12	112	4	114	0,5
50-70	54	5	78	3	67	0,1
HCP05	4,11	3,41	4,64	2,06	2,88	0,71
P%	1,0	2,3	1,3	3,1	1,0	1,6

Among the soils studied, ammonifiers are the largest group, the number of which can be reduced to the following order: oasis meadow-alluvial soils> irrigated meadow-alluvial soils> irrigated desert-sandy soils. The amount of ammonifiers in the soil profile decreases from the upper tillage layers (2355-1125 thousand/g in oasis meadow-alluvial soils, 1692-716 thousand/g in irrigated meadow-alluvial soils, 606-54 thousand/g in irrigated desert-sandy soils) to the lower layers (235-90-54 thousand/g respectively). It should be noted that in the meadow-alluvial soils of the oasis, the amount of these microorganisms was observed to gradually decrease, repeating the humus profile relative to irrigated meadow-alluvial, especially irrigated desert-sandy soils.

The study revealed the presence of agronomically important groups of microorganisms, including *ammonifiers, spores, actinomycetes, microscopic fungi* in the composition of irrigated soils in Bukhara district of Bukhara region (Figure 1).

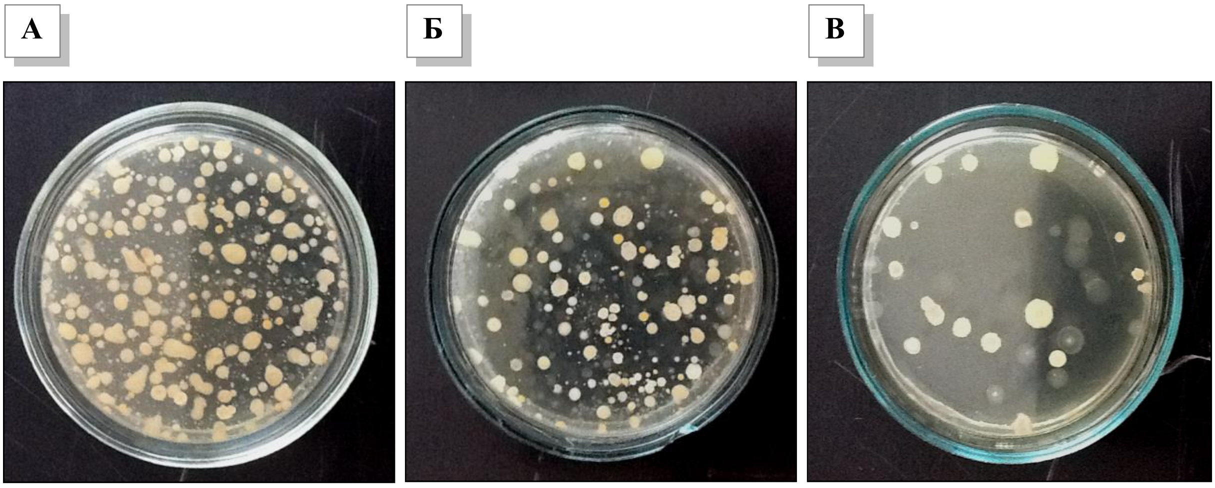

Figure 1. Groups of microorganisms in irrigated soils of the experimental field
Note: *A. Ammonifiers; Б. Spores; В.Colonies of actinomycetes.*

The amount of actinomycetes and oligonitrophils resistant to adverse conditions in all soils was higher than in other microorganisms: 855-521 thousand/g in oasis-alluvial soils, slightly less in irrigated meadow-alluvial soils 690-398 thousand/g, 443-213 thousand in irrigated desert-sandy soils/g, the amount of oligonitrophils is proportional to the amount of actinomycetes - 965-824 thousand/g, 720-512 thousand/g, 367-216 thousand / g, and the lowest number of spore-bearing bacteria (53-23 thousand/g) and microscopic fungi (46-31 thousand/g).

Ammonifier bacteria have a major impact on the intensity of mineralization of nitrogen-fixing organic matter in the soil. In the initial period of the mineralization process, the predominance of ammonifier bacteria in the soil is noted, after the formation of endospores, asporogenous ammonifiers develop.

GPA is characterized by a sufficiently large variety of microorganism-forming colonies in a soil sample in a nutrient medium.

Relatively high levels of micro flora diversity were noted in irrigated oasis-meadow alluvial, meadow-alluvial soil samples. Towards the depth layers, a decrease in the diversity of cultures is observed. The cultures isolated from the samples were composed mainly of bacterial and bacilli forms in the GPA nutrient medium, with actinomycetes occurring in isolated cases, and composed of spore-bearing and single-spore-free rods.

In this nutrient medium, we focus on the morphology of colonies and cells in soil samples taken from different horizons. In this environment, mainly mucous, spreading colonies resembling *Azotobacter* genus cultures were identified. Over time, colonies have been reported to develop dark gray and light greenish-yellow pigmentation.

Based on the analysis of the results obtained, it was noted a decrease in the number of ammonifiers in soil cross-sections (0-70 cm) with increased salinity in irrigated soils distributed in the area where the study was carried out, mainly in desert-sandy soils. It was also determined that the amount of ammonifiers should be the maximum in the spring season, a sharp decrease in the summer season and an increase again in the autumn season. in this regard, a significant reduction in the number of microorganisms in soil composition during the summer months is due to factors such as a sharp rise in temperature in accordance with the natural-climatic conditions of the territory where the research was carried out, a decrease in the level of moisture in the soil composition on account of an increase in the In autumn, an increase in the dynamics of micro-organisms in soil composition was noted on account of the normalization of temperature, precipitation and, in turn, an increase in the level of moisture in the soil.

According to the results of our scientific research, the activity of enzymes in the soils of the steppe zone depends on the hydrothermal conditions, and the relatively high value of this indicator is observed in all soils, mainly in the spring period. Perhaps this situation is due to the fact that in the spring months (April) there are still completely decomposed plant residues in the soil, the amount of toxic substances synthesized by microorganisms is insufficient, humidity and temperature (+24°C) are sufficient, and microbiological processes take place intensively.

After all, the activity of enzymes in the soil depends on the activity and development of soil micro-organism. During the summer months, when there is a decrease in the amount of organic residues in the soil after a low amount of atmospheric precipitation, a sharp increase in temperature (+30°C) and drying of the soil, as well as intensive mineralization, which took place in the spring, unfavorable conditions for biological processes, including the activity of enzymes, occur in the soil layer.

At the end of the vegetation period, precipitation of autumn rains, a decrease in temperature (+10°C) and the fall of fresh plant residues into the soil layer are observed, and in connection with these processes, an increase in the activity of enzymes during this period is noted. Based on the results of the carried out research, we can say that for the soils of the area under study, such legislation is a characteristic feature for the seasonal activity of enzymes.

Enzyme activity also decreases from the top layer of the section to the bottom layer, especially in irrigated desert-sandy and irrigated meadow-alluvial soils. Their seasonal dynamics decrease in the following order: spring> autumn> summer. The respiration value of soils also repeats these laws. The proportions of polyphenol oxidase and peroxidase in the studied soils range from 0.7–1.1, indicating a relative coefficient of humification, with a sharp decrease in soil profile typical of irrigated meadow-alluvial, especially irrigated desert sand soils.

Table 3

Enzymatic activity and respiration of irrigated soils in the experimental field

Depth of soil (cm)	**Inhalation** (at the rate of mg CO2/100 g of soil for 24 hours)	**Catalase activity** O_2 released relative to 1 g of soil for 5 minutes	**Peroxidase activity** (Expressed in mg of purpurgallin/100 g of soil for 24 hours)	**Polyphenol oxidase activity** (Expressed in mg of purpurgallin/100 g of soil for 24 hours)

Oasis meadow-alluvial soils				
0-15	20,0	13,5	2,4	2,5
15-30	15,8	11,1	1,9	2,1
30-50	14,3	6,8	1,1	1,1
50-70	11,3	5,4	0,6	0,5
HCP05	2,28	1,80	1,06	1,04
P%	3,1	4,8	2,1	2,0
Irrigated meadow-alluvial soils				
0-15	17,6	12,1	2,2	2,2
15-30	14,9	11,0	1,9	1,8
30-50	10,1	5,3	1,1	1,0
50-70	8,9	4,5	0,6	0,4
HCP05	1,64	1,60	1,50	1,30
P%	3,7	2,8	2,2	2,7
Irrigated desert-sandy soils				
0-15	8,8	9,0	1,4	1,2
15-30	6,8	6,5	1,2	0,9
30-50	5,0	4,1	0,8	0,6
50-70	4,1	3,1	0,5	0,3
HCP05	1,32	1,24	0,53	1,06
P%	3,5	3,1	3,0	3,1

Specificity of high-performance oasis meadow-alluvial soils, followed by slightly lower-irrigated-meadow-alluvial soils and low-performance irrigated desert-sandy soils was determined. Due to the specificity of irrigated oasis meadow-alluvial soils, their microbiological and enzymatic activity and respiration rates do not decrease sharply from the topsoil to the lower layers compared to other soils of the region, as these soils are irrigated for many years due to long-term use of organic and mineral fertilizers. The thickness of the humus layer in the soils, the relative abundance of nutrient reserves, can be interpreted as unsalted. Irrigated meadow-alluvial, especially irrigated desert-sandy soils are characterized by a low supply of humus and nutrients, microbiological and enzymatic activity of soils due to seasonal, soil profile due to different salinity. The studied soils were “low” and “very low” with ammonifiers and “very low” with actinomycetes on the scale of microbial supply (Zvyagintsev, 1978). Soil is characterized by “moderate” and “weak” on the scale of catalase enzyme activity assessment (Gaponyuk, Malakhov, 1985), “moderate”, “weak” in terms of CO_2 emission, and in some places “very weak” activity.

For the purpose of bio diagnostics of irrigated soils of the studied area, informative indicators of biological activity, including humus, the amount of ecological-trophic groups of microorganisms, enzyme activity and soil respiration rate were used.

The level of total biological activity of the studied soils was assessed according to the value of the Integral Indicators of Ecological and Biological Condition of Soils (IIEBCS). According to the results of the assessment, the overall biological activity of the irrigation period depends on the specific properties of the soil, from “very high” (81-100%) in oasis meadow-alluvial soils, “high” (61-80%) in irrigated meadow-alluvial soils. and irrigated desert-sand soils were found to be “moderate” (41-60%) due to varying degrees of salinity. (Table 4)

Table 4

IIEBCS value of irrigated soils in the experimental field, % (topsoil)

Humus	UBF	UFF	Inhalation of soil	Average	IIEBCS
Oasis meadow-alluvial soils					
90	100	100	100	98	100
Irrigated meadow-alluvial soils					
100	65	79	72	79	80
Irrigated desert-sandy soils					
32	38	58	44	43	44

Therefore, the value of integral indicators (IIEBCS) of the ecological and biological state of soils allows us to determine the general biological activity (BA) for each type and type of soil, to compare the spectrum of soil regions, to conduct a geographical analysis and to describe the degree of influence of degradation processes on soil fertility, and also to compare the degree of general biological activity soils.

A comprehensive study of the main properties of soils and integrated indicators of soil ecological, biological condition can clarify their ecological-genetic properties, as well as the degree of impact of natural-ecological factors on soil fertility. (Table 5-6)

Table 5

Indicators of biological activity (BA) of irrigated soils in the experimental area

Humus, %	Catalase, 1 g of soil for 5 min	Peroxidase, mg/puprurgaline per 10 g of soil	Polyphenol oxidase, mg/puprurgalin per 10 g of soil	Inhalation mg CO_2/100 g of soil for 24 hours	Ammonifiers KOEx10^3	Microscopic fungi, KOEx10^3	Actinomycetes, KOEx10^3	Spores, KOEx10^3	Oligonitrophils, KOEx10^3
Oasis meadow- alluvial soils									
1,19	13,5	2,4	2,5	17	2355	46	855	53	965
Irrigated meadow-alluvial soils									
1,31	12,1	2,2	2,2	18,6	1692	35	690	38	720
Irrigated desert-sandy soils									
0,42	9	1,4	1,2	8,9	606	31	443	23	367

Table 6

Total relative biological activity (RBA) of irrigated soils in the experimental field (in% compared to the maximum)

Humus	Catalase	Peroxidase	Polyphenol oxidase	Inhalation	Ammonifiers	Microscopic fungi	Actinomycetes	Spores	Oligonitrophils	RBA

Oasis meadow-alluvial soils										
100	100	100	100	100	100	100	100	100	100	100
Irrigated meadow-alluvial soils										
90	90	92	88	73	72	76	81	72	75	82
Irrigated desert-sandy soils										
32	67	58	48	45	26	67	52	43	38	45

Based on the results obtained, indicator criteria for degradation of oasis meadow-alluvial soils of the steppe region are recommended. These criteria allow assessing, mapping and maintaining soil-environmental monitoring as an indicator of soil fertility in the area (Table 7).

Table 7

Criteria for the degradation of grassland-alluvial soils of the irrigated oasis of the study area

Indicators	Not degraded	Weakly degraded	Moderately degraded	Strongly degraded
Humus, %	>1,5	1,0-1,5	0,8-1,2	0,8-1,0
Agro-irrigation layer, cm	> 100	70-100	50-70	30-50
Moving P_2O_5, mg/kg	> 60	45-60	30-45	15-30
Interchangeable K_2O, mg/kg	> 400	300-400	200-300	100-200
Dry residue,%	< 0,3	0,3-1	1-2	2-3
Transformation coefficient of organic matter	> 6,0	4-6	2-4	1,0-2,0
BOMK, mg/gr soil	1,0-1,2	0,8-0,9	0,6-0,8	<0,6
Humification coefficient	1-1,5	0,9-1,0	0,7-0,8	0,6-0,7
IIEBCS, %	81-100	71-80	61-70	51-60

The degree of degradation of soils is of 4 types: non-degraded, weakly degraded, moderately degraded and strongly degraded.

Humus content in non-degraded soils is more than 1.5%, agro-irrigation layer thickness is more than 100 cm, mobile P_2O_5 is less than 60 mg / kg, mobile K_2O is less than 400 mg/kg, dry residue is less than 0.3%, organic matter transformation coefficient is 6, more than 0, bioorganic mineral complex (BOMK) 1.0-1.2 mg / g of soil, the coefficient of humification is in the range of 1-1.5, IIEBCS is more than 81-100%.

In weakly degraded soils the amount of humus is up to 1.0-1.5%, the thickness of the agro-irrigation layer is up to 70-100 cm, mobile P_2O_5 is up to 45-60 mg/kg, mobile K_2O is up to 300-400 mg/kg, dry residue is up to 0.3 -1%, the transformation coefficient of organic matter is 4 - 6.0, BOMK is 0.8-0.9 mg / g of soil, the coefficient of humification is 0.9-1.0, IIEBCS is 71-80%.

In moderately degraded soils, the amount of humus is 0.8-1.2%, the thickness of the agro-irrigation layer is 50-70 cm, mobile P_2O_5 is 30-45 mg / kg, mobile K_2O is 200-300 mg / kg, dry residue is 1-2 %, the transformation coefficient of organic matter is from 4 to 6.0, BOMK is 0.6-0.8 mg / g of soil, the coefficient of humification is 0.7-0.8, IIEBCS is 61-71%.

In heavily degraded soils the amount of humus is up to 0.8-1.0%, the thickness of the agro-irrigation layer is up to 30-50 cm, mobile P_2O_5 is up to 15-30 mg/kg, mobile K_2O is up to 100-200 mg/kg, dry residue is up to 2-3 %, the transformation coefficient of organic matter is 2-3, BOMK is 0.6-0.8 mg/g of soil, the coefficient of humification is less than 0.6, IIEBCS is 51-60%.

A complex study of the biological activity value of soils that have different physicochemical, microbiological and biochemical properties, as well as those that do not have the same structure of the soil cross section, undergo degradation, can clarify their ecological and genetic properties, as well as the degree of influence of natural and environmental factors on soil fertility. Based on the results obtained, degradation indicator norms were recommended for oasis meadow-alluvial soils of the steppe region.

With the increase in degradation processes, there was a decrease in the amount of nutrients in the soil, an increase in dry residue, a decrease in the conversion coefficient of organic matter, a decrease in the amount of BOMK, a coefficient of humification and IIEBCS.

Conclusions

The natural conditions of the Bukhara Oasis region are characterized by drought climatic conditions, low plant residue, mineralization of groundwater, location close to the surface of the earth, individual geomorphological, lithological conditions and its properties (morphogenetic, agrochemical, physical-chemical, chemical and biological activity) in soil formation processes under the influence of human activity.

The morphological characteristics of oasis meadow-alluvial soils are characterized by the presence of an agro-irrigation layer and a flat, humus layer in terms of color, mechanical composition, density does not differ significantly from irrigated meadow-alluvial soils, but is characterized by greater thickness. According to the agro-irrigation layer, the oasis meadow-alluvial soils are divided into “thick”, irrigated meadow-alluvial soils - into “moderately thick” groups.

A large group of microorganisms detected in the studied soils was ammonifiers. Soils can be arranged in the following descending order according to the total amount of microorganisms: oasis meadow-alluvial soils>irrigated meadow-alluvial soils>irrigated desert-sandy soils. The amount of microorganisms along the soil profiles decreases from the upper tillage layers to the lower layers. Among the groups of microorganisms, the amount of ammonifiers gradually decreases in the oasis meadow-alluvial soils, repeating the humus profile relative to irrigated meadow-alluvial, especially irrigated desert-sandy soils.

As the activity of enzymes (catalase, peroxidase and polyphenol oxidase) increases in the studied soils, the soils can be placed in the following decreasing order: oasis meadow-alluvial soils>irrigated meadow-alluvial soils>irrigated desert-sandy soils. Enzyme activity also decreases from the top layer of the section to the bottom layer, especially in irrigated desert-sandy and irrigated meadow-alluvial soils.

Depending on the natural and climatic conditions of the region and soil properties (humus, the number of groups of microorganisms, enzyme activity, soil respiration rate) and the value of integrated indicators of ecological and biological condition of soils (IIEBCS), the overall level of biological activity - oasis meadow – “very high” in alluvial soils, “high” in irrigated meadow-alluvial soils, “average” in irrigated desert-sandy soils.

Indicator criteria developed on the basis of the main texture-characteristics of irrigated soils of the Bukhara Oasis and degradation on the basis of integrated indicators of the ecological biological status of the soil are recommended to be used in the evaluation, mapping and soil fertility of the territory-ecological monitoring.

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