Dependence of microbiological activity of alluvial soils of irrigated meadow of Bukhara oasis on salinity levels

Dilorom Bo'riyeva[1*], *Ma'mura* Xalilova[1], and *Zamira* Atayeva[1]

[1]Bukhara State University, Street Mukhammad Ikbol, 11, Bukhara, 200118, Uzbekistan

Abstract. This article presents the problems of studying and improving the physical properties of water, the total porosity of the volume and weight of alluvial soils of ancient irrigated meadows of the Bukhara oasis. Keywords: general porosity, water physical properties, alluvial soils of ancient irrigated meadows of Bukhara oasis volume weight.

1 Introduction

The alluvial soils of the Bukhara oasis, which have been irrigated since ancient times, have a bulk density of 1.3-1.4 g/cm3, a specific gravity of 2.7 g/cm3, and a total porosity of 48-51 percent.

As a result of processes such as tillage, year-round operation of heavy machinery, irrigation in irrigated meadow-alluvial soils, soil aggregates are crushed and the structural condition is disturbed. As a result, soil particles become denser, porosity decreases, and volume mass increases (1.63-1.74 g/cm3), however, according to some scientists, soil volume mass is on average 1.30-1.35 g/cm3 under tillage. layer should be 1.35-1.40 g/cm3. [1-6]

Currently, more than 20 million hectares of agricultural land, including 3.2 million hectares of irrigated arable land, are used to grow food products for the needs of the population and raw materials necessary for economic sectors (https://xs.uz/uzkr/post/qishloq-khozhaligida-er-va-suv-resurslaridan-samarali-fojdalanish-chora-tadbirlari-togrisida).

In order to increase the productivity of irrigated areas, improve land reclamation and water supply, large-scale irrigation and land reclamation activities are being carried out within the framework of state programs.

As a result, during 2008-2017, the water supply of more than 1.7 million hectares of irrigated areas and improvement of land reclamation of 2.5 million hectares was achieved (http://nim.uz/2022/02/01/2022-2026-yillarga-moljallangan-yangi-ozbekistonning-taraqqiyot-strategiyasi-togrisida-ozbekiston-respublikasi-prezidentining-farmoni).

However, as a result of global climate change, water shortages that have been periodically observed in recent years and the fact that most of the internal irrigation networks have

[*] Corresponding author: z.a.ataeva@buxdu.uz

become unusable have led to the deterioration of the reclamation condition of irrigated croplands and their abandonment for years.

However, recently, the amount of humus has been decreasing. This can be explained by the fact that the degummification process is stronger than the gumification process. But these processes are microbiological processes. Therefore, in order to find out the mechanism and causes of humus decomposition, they should be studied from a microbiological point of view, and microbiological processes should be directed towards increasing humification. Thus, by studying microbiological processes and affecting them in the right direction, these negative processes in the soil can be prevented. The role of microorganisms in improving the soil nutrition regime is incomparable.

Farming in the Bukhara oasis is somewhat difficult, because the oasis soils are more or less saline, which leads to a decrease in the number of microorganisms in the soil, a decrease in soil fertility, and a decrease in the yield of agricultural crops. . Therefore, this topic is relevant.

2 Research object

Vobkent district of Bukhara region is a research object of newly assimilated, newly irrigated, irrigated, and old irrigated meadow alluvial soils with varying degrees of salinity.

Kh.T. Artikova's scientific research works contain information on the genesis, occurrence and geographical distribution of saline soils related to natural and anthropogenic conditions. R. Koziev, L.A. Gafurova, Sh. Bobomurodov and M.I. Rozmetov and others conducted research on the origin, composition, properties, and productivity of irrigated soils distributed in the lower part of the Zarafshan River [1-5].

In the scientific research conducted by R. Q. Koziev and V. E. Sektimenko and other scientists, who made a great contribution to the study of the soils of Uzbekistan, the genetic characteristics of the irrigated soils distributed in the lower part of the Zarafshan river, the chemical properties of the soils and their effects on desertification changes, ways to increase productivity have been shown [2,3,4].

3 Experiment method

Genetic-geographic comparison, soil cross-section study, analytical calculation, mapping and semi-stationary methods were used in the research work.

In order to study the development of genetically and geographically diverse soil cover of Bukhara oasis, soil sections were dug and their morphological structure, signs, thickness of horizons, characteristics and composition were analyzed. The section was 1.5-2.5 meters deep, and a soil sample was taken from them according to genetic horizons (Table 1).

Table 1. Specific and volumetric mass of soils by sections

Horizon and depth, cm	**Volumetric mass, g/cm3**	**Relative mass, g/cm3**	**Porosity, %**
Newly reclaimed meadow alluvial soils			
A_1 0-25	1,32	2,60	49,23
A_2 25-40	1,39	2,63	47,15
B_1 40-66	1,44	2,64	45,45
B_2 66-110	1,51	2,65	43,02
Newly irrigated meadow alluvial soils			
A_1 0-26	1,30	2,63	50,57
A_2 26-45	1,37	2,68	48,88
B_1 45-70	1,43	2,65	46,04

B_2 70-117	1,48	2,65	44,15
Irrigated meadow alluvial soils			
A_1 0-29	1,33	2,69	50,56
A_2 29-57	1,39	2,67	47,94
A_3 57-85	1,44	2,70	46,67
V_1 85-140	1,51	2,73	44,69
G_1 140-182	1,53	2,73	43,96
Formerly irrigated meadow alluvial soils			
A_1 0-30	1,29	2,67	51,69
A_2 30-47	1,34	2,67	49,81
A_3 47-85	1,38	2,66	48,12
A_4B_1 85-120	1,40	2,66	47,37
B_1 120-170	1,46	2,69	45,72
G_1 170-230	1,52	2,71	43,91

Additional sections were prepared to determine the salinity level of the soil. The amount of dry residue, anions and cations in their content was determined.

Genetic-geographical, lithological-geomorphological, comparative-chemical-analytical and profile methods were used to analyze the importance of agro-irrigation deposits in the process of soil formation. Statistical analysis of the obtained data Dospekhov [2.73; 351-s.] method.

In this part of the study, soil sections were taken to study the agrochemical and agrophysical properties of the soils distributed in the Bukhara oasis, the amount of water-soluble salts, microbiological and enzymatic activity of the soil.

The length of land use for agriculture in the Bukhara oasis is different. Among them, meadow alluvial soils are included in soils that have been cultivated for many years. In general, the following types and types of soils are distributed in the Bukhara oasis. [3,4,5]

1. Newly cultivated meadow alluvial soils
2. Newly irrigated meadow alluvial soils
3. Irrigated meadow alluvial soils
4. Anciently irrigated meadow alluvial soils

Grassland alluvial soils are widespread mainly in the Zarafshan river bed and above-bed terraces. They differ in the degree of assimilation and salinity. According to the degree of development, there are newly developed, newly irrigated, irrigated, old irrigated and oasis meadow alluvial soils. According to the level of civilization, they are divided into low and medium cultured, cultured and highly cultured groups. According to the degree of salinity, they are grouped into non-saline, weakly saline, moderately saline and strongly saline soils.

The irrigated grassland soils of the Bukhara oasis are covered with agro-irrigation deposits 0.5-1 meters and higher. The effect of irrigation on newly developed and newly irrigated meadow alluvial soils is much weaker. [3,4,5] The morphogenetic structure of these soils, the general appearance of their profile does not significantly differ from that of protected alluvial soils. They have a high role in the morphogenetic structure of the soil profile and genetic layers of the bottom alluvial deposits, and they mainly determine the soil profile. In the extra-arid climatic conditions of the Bukhara oasis, desert-type soil types and types are widespread: brown, sandy, barren, barren, salty. They are divided into automorphic, transitional and hydromorphic soils of the desert zone, and they are composed of deposits of different genesis and age. Irrigated barren soils are distributed in ancient alluvial plains, which were formed in conditions where seepage waters are more than 5 meters deep. Their evolution changed from hydromorphism to automorphism, the process of desertification took place with the disappearance of the genetic signs of meadow alluviality. This soil formation process occurred naturally. This situation is reflected in the morphology of irrigated barren soils.[5,6]

Relief also played a major role in the formation and evolution of the soils of the Bukhara oasis. With the lowering of the sea level, the level of seepage waters increased and their hydromorphism increased. The rise of flood waters is mainly related to irrigation of agricultural crops. Lowering of the earth from the sea level, rise of flood waters will increase along the Zarafshan river downstream. This had an impact on soil evolution. The level of mineralization of Sizot waters also increases with relief. This increases the role of seepage waters in the secondary salinization of the soil. In the upper part of the Bukhara delta, the salinity of seepage waters is 1.5-3.0 g/l, in the middle part of the delta, the mineralization of seepage waters is 5-10 g/l. The level of mineralization of syzot waters has a strong correlative relationship with the level of salinity of the soil. Along with natural factors such as temperature, precipitation, and topography, water is an important soil-forming factor. This is especially important in hot and dry conditions when there is a lack of moisture in the soil. [6,7]

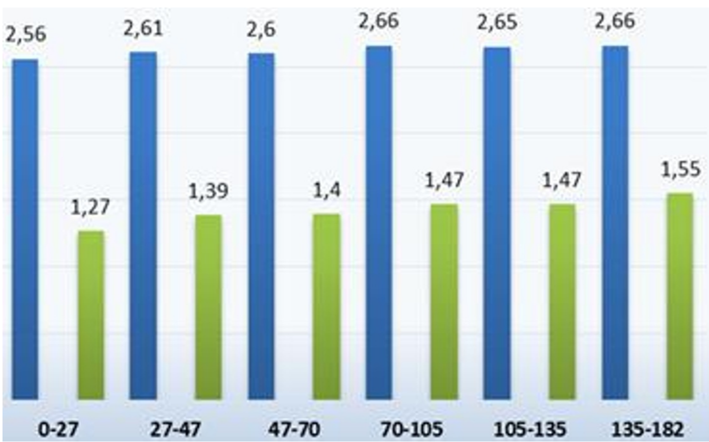

Fig. 1. Specific and volume weights of irrigated meadow soils (Vobkent district) , g/cm3

Unlike natural factors, anthropogenic factors have a strong impact on the lower layers of the soil. The influence of anthropogenic factors reaches the lower deep layers of the soil. If rain and snow water reaches 1-2 meters in natural conditions, irrigation water penetrates very deep and aggravates eluvial-illuvial processes. This situation may be a new process for the desert zone. This is especially important in the automorphic soils of the desert zone. At the same time, the leaching, transformation and migration of nutrients increases. These also cause specific changes in the lower genetic layers of the soil. The horizons in the lower layers also undergo morphogenetic, physical and chemical changes. Construction of salt washing and ditch system has a strong influence on the salt regime of the soil. As a result of irrigation, salts are washed into the lower layers, and the amount of salts in the upper layers of the soil decreases sharply. There is also a change in the movement of salts in the irrigation water regime (S.Abdullayev basics of soil science and soil geography 13-14 p)

In the desert region, the areas where irrigated soils are distributed are often the lower parts, deltas and, in rare cases, the middle parts of Amudarya, Syrdarya, Zarafshan, Kashkadarya, Surkhandarya. The climate of these regions is typical of deserts, very dry, very little rainfall, low cloudiness, very hot summers, high temperatures (table 2).

Table 2. The main indicators of climate (average multi-year data).

Meteorological station	Months												Annual average
	1	2	3	4	5	6	7	8	9	10	11	12	
The average air temperature is C0													
"Bukhara Meteorological station "	-1,8	0,9	7,7	15,1	21,0	25,4	26,7	24,2	18,7	12,4	5,1	0.1	12,9
Rainfall (mm)													
"Bukhara Meteorological station "	41	40	59	50	27	6	2	1	1	24	33	40	324
Average relative humidity (%)													
"Bukhara Meteorological station "	82	79	74	67	56	48	50	55	57	64	75	82	66

Characterized by the size of daily and annual amplitude. The intensity of solar radiation and the dryness of the air cause strong evaporation. Annual evaporation from the water surface reaches 1350-2500 mm. So, evaporation of water from the water surface or moist soils increases several times the amount of annual precipitation.[4,5,6]

As a result of the observations, it was found that some negative aspects in the maintenance of irrigated agricultural crops in the soil climate of the Bukhara oasis are noticeable. Low precipitation and overnight temperature changes cause salinization of the surface layer of the soil and the occurrence of swamping processes. These processes hinder the normal development of agricultural plants.

Section 1 (Renewed grassland)

A1 = 0-25 There are small lumps with structure. Moist sand with heavy mechanical composition. Plants have small roots. Low density. From top to bottom, the remains of plants can be found. The transition is slower than the density.

A2= 25-40 color light gray. Yellower than the upper layer, the mechanical composition is light sand. Structureless, medium moisture. Plant roots are not visible. Additions include undecayed remains of plants. Medium density. The transition is slower than the density. V1= 40-66 color is light yellow, light gray. Unstructured, mechanical composition is light sand. There are few plant roots. The inclusions are the decayed remains of plants, the density is denser than the upper layer. The yellow spots gradually decreased due to the intensity of the transition.

V2= 66-110 light gray-yellow spots are found. Structureless mechanical composition sand. New lesions are dark gray Fe2O3 yellowish spots. Compounds include undecayed remains of plants. Due to the density of its passage.

Section 2 (Freshly irrigated grassland)

A1= 0-26 yellowish gray, higher humidity, light sand structure is not expressed, moist, medium density, many plant roots, small stones from inclusions, carbonate stains from wounds, transition to the next layer color and density. A2= 26-45, the color is yellow, the mechanical composition is light sand, slightly moist, moderately dense, denser than the upper layer, plant roots are found, new lesions are plant roots and brown spots. The transition to the next layer is noticeable due to its mechanical composition and density. V1= 45-70, the color is darker than the upper layer, sandy, the density is lower than the upper layer, wet, plant roots are visible, the transition color and mechanical structure are sharp.

V2= 70-117 white sand, there are yellow spots. Gravel comes out from 150 cm.

Section 3 (Irrigated grassland)

Ax= 0-27 pale yellow, heavy sand, moderately dense, lumpy light-colored, almost dry plant roots with many roots, because of the density of the transition.

Ax/0 = 27-57 light gray with very little moisture, medium sand, lumpy structure, slightly thickened, with plant roots, transition color.

A3= 57-85 yellowish gray, very moist, medium sand, powdery, medium dense fine, scaly, plant roots are not visible, no lesions or inclusions, from the humidity of the transition.

V1= 85-140 yellowish gray, medium sand, small grain structure, well moistened, porous, from the color of the transition and moisture.

G1= 140-182 yellowish, loose, lower part is clay, light sand, structure is unclear, porous, brown, many iron oxide blue spots. There are a lot of small pores, no joints and plant roots are visible, seepage water came out at 230 cm.

Section 4 Formerly irrigated grassland

A1= 0-30 dark gray color, wet, mechanical composition heavy sand, powdery lumpy structure, medium density. No new lesions are visible. Among the new inclusions there are prematurely rotted roots of plants, stone deposits with a diameter of 1-1.5 cm. There are plant roots. The transition to the next layer is noticeable by its color, density and mechanical structure. A2= 30-47 light gray color, almost oozing, wet, heavy sand, layer with different thickness of soil and sand with mechanical composition. Structureless, less dense than the upper layer.

A3= 47-85 is light gray and gives a yellowish appearance. Moist, light sugar, small lumps. Medium density. No injuries. There are remains of pottery. Plant roots are not found. It is not noticeable to move to the next layer.

A4V1= 85-120 morphological characters repeat the upper layer. The density is slightly reduced. V1= 120-170 light gray close to yellow, moist, light sand. The structure is not expressed. There are ceramic remains, fresh wounds, no plant roots. Stone fragments are found. From the color of the transition to the next layer.

S= 170-230 yellowish, the structure is not expressed, moist, sandy, the lower part is wet (table 3).

Table 3. Limits of physical maturity (granularity) of irrigated grassland soils of the Bukhara oasis

Section №	Layer depth, cm	Physical clay quantity (<0.01mm)	High compatibility limit, %	Lower contact limit, %	Compatibility the number %
Vobkent district					
9	0-46	16,2	20,09	15,39	4,7
	46-66	23,5	21,61	16,72	4,89
	66-85	16,7	20,42	14,95	5,47
	85-106	10,0	14,60	12,19	2.41
	106-137	16,0	16,76	12,67	4,09
	NSR 19,4; R% 0,01				

Soils distributed in the Bukhara oasis differ sharply from natural soils as a result of being used in irrigated agriculture for many centuries. The average statistical indicators of the morphological structure of the soils distributed in the studied area in field conditions were summarized, the thickness of their main genetic horizons, carbonates and gypsum, information about the maximum accumulation layers were analyzed.[1,2, 3.4]

Thus, in the study of the morphological features of the soils of the Bukhara oasis, it was analyzed that the duration of irrigation and related crop cultivation technologies, the depth of seepage water, and the topography of the place are important indicators. The formation of agro-irrigation deposits with irrigation water had an effect on the soil profile and its morphogenetic structure.

After studying the above-mentioned soils, it was determined that the following soil types, types and groups exist in the area:

1. Newly cultivated meadow alluvial soils
2. Newly irrigated meadow alluvial soils
3. Irrigated meadow alluvial soils
4. Formerly irrigated meadow alluvial soils

These soils are divided into thick, medium-thick and low-thick groups depending on the thickness of the layer of agro-irrigation deposits among the types and types. According to the degree of cultivation, these soils are divided into the following groups:

1. Highly cultured.
2. Cultured.
3. Medium cultured.
4. Less cultured
5. 1.33 respectively in layers V1 (85-140 cm), G1 (140-182 cm); 1.39; 1.44; 1.51; 1.53 g/cm3, A1 (0-30
6. cm), A2(30-47 cm), A3(47-85 cm), A4V1(85-120 cm), V1(120-170 cm), G1(170-230 cm), respectively 1, 29; 1.34; 1.38; 1.40; 1.46; It was found to be 1.52 g/cm3.
7. The specific mass of the soils of Bukhara did not have a large variability. The specific mass of the soil in most cases increases slightly towards the lower layers. The specific mass of the studied soils varied from 2.5 g/cm3 to 2.73 g/cm3 (table 4).

Table 4. The influence of the salinity of meadow alluvial soils on the number of actinomycetes, million/g of soil

№	Salinity level	Soil horizons, cm											
		0 - 30 cm			30-50 cm			50 – 70 cm			70-100 cm		
		In the spring	In the summer	In the autumn	In the spring	In the summer	In the autumn	In the spring	In the summer	In the autumn	In the spring	In the summer	In the autumn
1	Not salted	18	21	19	14	16	15	14	12	12	7	8	6
2	Lightly salted	15	17	15	11	12	10	8	9	7	5	5	4
3	Medium salted	10	9	7	6	5	5	3	2	2	1	1	0,5
4	Strongly salted	7	6	5	4	3	2	1	0.5	0,5	0,3	0,1	0,1

Thus, salt washing and deep digging of ditches lead to an increase in the number of actinomycetes in the soil. This situation is related to the decrease in soil salinity and the concentration of toxic salts. Microbiological analysis of the samples taken before and after salt washing showed that the reduction of salinity, the leaching of salts to the lower layers leads to an increase in the number of actinomycetes in the soil of the upper layers, and has a positive effect on the microbiological activity of the soil. Overfilling of ponds and rise in the level of seepage water has a negative effect on soil reclamation and causes a decrease in the number of actinomycetes in the soil. The number of actinomycetes in meadow alluvial soils also depends on crop agrotechnics. When organic and mineral fertilizers are used, the number of actinomycetes increases dramatically. Organic fertilizers lead to a significant increase in the number of actinomycetes involved in humus production. At the same time, there is a sharp increase in the number of fungi. Organic fertilizers also increase the number of denitrifiers. In general, organic fertilizers are important as a source of carbon in the soil. Actinomycetes take an active part in the formation of humus and are more resistant to adverse conditions than other microorganisms. [3,4,5,6]

For example, The number of actinomycetes in the 0-30 cm layer of non-saline soils was higher in summer, in moderately and highly saline soils, in spring, and in autumn in strongly saline soils. that is, it fluctuated between 21 mln/g and 5 mln/g. It was found that the number of actinomycetes in the plow layer of 1 gram weakly saline soil was 15 million/g in spring, 17 million/g in summer, and 15 million/g in autumn. decreased from 4 million/g to 4 million/g. These indicators continued to decrease in moderately and strongly saline soils and reached 0.1 million/g to 10 million/g.

4 Conclusions

Soils distributed in the Bukhara oasis differ sharply from natural soils as a result of being used in irrigated agriculture for many centuries. The average statistical indicators of the morphological structure of the soils distributed in the studied area in field conditions were summarized, the thickness of their main genetic horizons, carbonates and gypsum, and data on the maximum accumulation layers were analyzed.

The soils of the Bukhara Voxas have varying degrees of salinity, and it was determined that this type of salinity is chloride-sulfate or sulfate-chloride. It was found that the amount of carbonate and hydrocarbonate ions in water absorption of all studied soils is at the lowest level and significantly below the salinity limit.

The nutrient regime of the soils of the Bukhara oasis is formed under the influence of such factors as irrigation, seepage water, soil mechanical composition, humus content, microbiological activity, and the level of aeration. In this case, the best soil agrochemical properties and nutrient regime occur in meadow alluvial soils that have been irrigated for a long time.

5 Gratitude

First of all, to the managers of the farm named after A. Razzokov, located in Ohunboboyev massif, Vobkent district, Bukhara region, who made it possible for us to conduct experiments, carry out research one by one, and take soil cross-sections during the writing of this scientific article, who helped us to improve our knowledge. We express our gratitude to our teachers H.T.Artikova, R.Yunusov, I.B.Boriyev and our teachers D.Toymurodova M.Istamova, L.Gafurova who are using their scientific articles and patents.

References

1. Decree of the President of the Republic of Uzbekistan on the development strategy of New Uzbekistan for 2022-2026.
2. Land Fund of the Republic of Uzbekistan. Tashkent "Yergeodezkadastr" state committee, 2016.- P.16-18.
3. Artikova H.T. Change of the ancient irrigated meadow-alluvial soils spread in the Bukhara oasis under the influence of irrigation. / Collection of materials of the 5th congress of the Society of Soil Scientists and Agrochemists of Uzbekistan. - Tashkent. 2010. – P. 51-55.
4. Artikova Kh.T., Yunusov.R., Tuymurodova D., Istamova M., Factors to increase the productivity of the anciently irrigated meadow soils of Bukhara region // Scientific-practical conference on increasing soil fertility, soil protection, effective use of land and improvement of land reclamation a collection of materials. - Bukhara. 2015. – P.189-191.
5. Artikova H.T. General physical and some water-physical properties of the alluvial soils of the irrigated meadow of the Bukhara oasis, their importance // Journal "UzMU news" - №3/1. 2018.- P. 47-51.
6. Artikova H.T., Torayeva N.M. Physical features of the permeability of treated meadow-alluvial soils of the Bukhara region and the scientific basis for their improvement. // Journal. Bulletin of the Karakalpakstan branch of the Academy of Sciences of the Republic of Uzbekistan. - No. 3 (252) 2018.-P. 60-61.
7. Burkhonova D.U. Ways to increase the productivity of irrigated typical gray and meadow soils. Abstract. (Phd) f.f.d. - Tashkent. 2019.- P.44 p.
8. Gafurova L.A., Nabieva G.M., Ergasheva O.Kh., Makhkamova D.Yu. Monitoring of degraded land with the use of bioindicators. Sevastopol, 2016. - P.86.