Microbiological activity of irrigated meadow-alluvial soil in Bukhara depending on salinity level

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Abstract. The article is devoted to the study of the effect of salinization of meadow-alluvial soils on the number of taxonomic and physiological groups of microorganisms. When the content of water soluble salts in the meadow-alluvial soil deteriorates the conditions for the reproduction of microorganisms, which is reflected in their numbers. The salt mode of meadow-alluvial soil changes greatly in medium and highly degrees of salinization. Therefore, the number of taxonomic and physiological groups of microorganisms was the smallest in the mean and highly salinization meadow-alluvial soils. On highly saline meadow-alluvial soils, the concentration of the soil solution reaches the greatest indicator that negatively acting on the number of microorganisms. Therefore, on highly saline meadow-alluvial soils, the number of bacteria, mushrooms, actinomycetes, nitrogen fixers, ammonifiers, nitrifers,nitrate reductants and cellulose-decomposing bacteria. The number of microorganisms was influenced by the depth of the horizons. Down the soil profile the number of microorganisms of all groups was significantly reduced in the deepest soil horizon (50-80 cm) was the smallest. This may be due to a decrease in the content of humus and oxygen as it deepens in the soil. The decrease in aerobic microorganisms in this direction was more sharp. The number of taxonomic and physiological groups of microorganisms is significantly affected by the seasons. In irrigated meadow-alluvial soils in the summer in agrocenosis of cotton and other cultures, the number of microorganisms was larger than in spring or autumn. In autumn, the soil salinity is enhanced and achieves the worst state. Therefore, in the middle and strong degrees of salinization in the fall, the number of microorganisms was the smallest.

1 Introduction

Microbiological activity is of great importance in the formation of soil fertility and its nutritional regime [1-24]. Because microbiological processes continuously produce nutrients for plants, the soil shows its buffering properties and maintains homeostasis.

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Consequently, microorganisms, participating in all soil processes, make it a dynamic system where there will be opportunity for the life of microorganisms and plant growth [4,20,21,22,23].

At the same time, microorganisms and their activity are influenced by various factors, including soil salinity. An increase in the content of water-soluble salts in the soil increases the concentration of the soil solution, which negatively affects the number and activity of various taxonomic and physiological groups of microorganisms.

Since among the meadow-alluvial soils of the Bukhara oasis there are soils with varying degrees and types of salinity, studying the effect of salinity on microbiological activity is important. The microbiological activity of meadow-alluvial soils of the Bukhara oasis has been studied by some researchers [5,6,7,8,9,10,17,18,19]. These works show how microbiological activity changes depending on various factors. But in these works little attention is paid to the effect of salts on microorganisms.

With an increase in the concentration of water-soluble salts in the soil, the microbiological activity of the soil decreases [5,6,7], which negatively affects the agrochemical and agrophysical properties of the soil.

At the same time, the processes of humus formation, ammonification and nitrification are disrupted. In addition, the type of salinity is important. Soda, chloride and sodium salinity are considered especially dangerous for microorganisms. When soil becomes alkaline, the structure is destroyed, the soil becomes compacted, the air and water properties of the soil deteriorate, which creates unfavorable conditions in the soil for microorganisms.

Therefore, by creating favorable conditions for various groups of microorganisms, it is possible to optimize the processes of increasing soil fertility and improve its properties.

2 Materials and Methods

The object of the study was meadow-alluvial soils of the Bukhara oasis with varying degrees of salinity. For this purpose, expeditionary studies were carried out, where soil sections were made in meadow-alluvial soils with varying degrees of salinity. For microbiological analyses, soil samples were taken from horizons 0-25; 25-50; 50-80 cm. In these soil samples, the number of bacteria, fungi, actinomycetes, ammonifiers, nitrifiers, nitrate reducers, nitrogen fixers, and cellulose-decomposing bacteria was determined. Bacteria and ammonifiers were determined on meat-peptone agar (MPA), fungi on Czapek's medium, actinomycetes on KAA (starch-ammonium agar), nitrifiers on Winogradsky's medium, nitrate reducers on Giltai's medium, nitrogen fixers on Ashby's medium, aerobic cellulose-decomposing bacteria on on Hutchinson's medium.

To determine the degree and type of salinity, a chemical analysis of the soil water extract was carried out, where the content of carbonates, bicarbonates, chlorides, sulfates, calcium, magnesium, sodium and potassium ions was determined.

Taking soil samples, chemical and microbiological analysis were carried out on the basis of methodological guidelines, such as "Methods of agrochemical, agrophysical and microbiological research in irrigated cotton areas",

"Guide to chemical analysis of soils" (E.V. Arinushkina), "Guide to conducting chemical analyzes of soils during land monitoring", "Methods of microbiological research and determination of microelements" [11,12,13,14,15,16].

3 Results and Discussion

In the Bukhara oasis, meadow-alluvial soils with varying degrees of salinity are very common. Low and moderately saline meadow-alluvial soils are widespread. Non-saline and

highly saline meadow-alluvial soils are found to a lesser extent. Salinization involves chlorides and sulfates. As the degree of salinity in the water extract of meadow-alluvial soils increases, the concentrations and proportions of magnesium and sodium cations increase, which worsens the ionic composition of the water extract. Consequently, an increase in the concentration of water-soluble salts is accompanied by an increase in the proportion of harmful and dangerous ions for microorganisms and plants. Thus, meadow-alluvial soils with different degrees of salinity differ not only in the total concentration of water-soluble salts, but also in the ionic composition of these salts. All this affects the number of taxonomic and physiological groups of microorganisms, as well as their activity.

The results of microbiological analyzes of soils show that in non-saline soils the number of bacteria is higher than in saline meadow-alluvial soils (Table 1). This is observed in all soil horizons studied. As the degree of salinity increases, the number of bacteria decreases and the lowest number of bacteria is observed in highly saline meadow-alluvial soils.

A decrease in the number of bacteria noticeably occurs in moderately and highly saline soils compared to non-saline soils. The decrease in the number of bacteria in slightly saline soils occurs less noticeably. A decrease in the number of bacteria due to soil salinity was observed in spring, summer and autumn.

But at the same time, the number of bacteria was greatest in the summer. This is due to the activity of plant roots, where root secretions have a positive effect on the development of microorganisms, incl. bacteria. In all types of salinity, the number of bacteria down the soil profile decreased, this was especially noticeable in the soil layer of 50-80 cm. (Table 1). Consequently, an increase in the concentration of water-soluble salts in the soil has a negative effect on the number of bacteria. This may be due to an increase in the osmotic pressure of the soil solution, which creates unfavorable conditions for bacteria. An increase in the concentration and proportion of chloride ions, sodium and potassium ions in the soil solution further enhances the negative effect of high salt concentrations.

Table 1. The influence of the degree of salinity on the number of taxonomic groups of microorganisms on irrigated meadow-alluvial soils.

Incision №	Soil horizons, cm	bacteria, mil/g			mushrooms, thousand/g			actinomycetes, million/g		
		Seasons			Seasons			Seasons		
		spring	summer	autum	spring	summer	autum	spring	summer	autum
Unsalted										
1	0-25	23,5	31,5	24,8	40,17	50,6	41,5	6,2	7,4	6,5
	25-50	16,6	22,7	18,0	27,1	37,8	30,3	4,7	6,0	5,1
	50-80	7,1	10,9	6,8	6,5	12,3	14,8	2,2	3,2	2,4
Lightly salted										
5	0-25	20,3	24,8	20,5	35,5	42,9	34,6	4,8	6,2	4,4
	25-50	14,5	19,3	14,0	23,4	31,5	21,7	4,0	5,3	3,7
	50-80	5,3	6,2	5,5	6,0	9,7	6,6	1,8	3,6	1,6
Moderately saline										
10	0-25	11,4	14,7	7,5	20,3	26,8	17,7	3,1	3,8	2,8
	25-50	7,8	10,3	5,3	15,6	20,4	13,2	1,4	2,0	1,1
	50-80	2,8	4,6	2,1	3,0	5,3	2,5	0,8	1,0	0,6
Highly salted										
17	0-25	7,6	11,4	6,3	15,2	19,2	13,2	1,8	2,2	1,5
	25-50	4,2	6,1	3,4	8,3	10,7	7,0	0,8	1,1	0,6
	50-80	1,1	1,8	0,8	1,4	2,0	1,0	0,5	0,9	0,3

The number of mushrooms also varied depending on the degree and type of salinity. In non-saline meadow-alluvial soils, the number of fungi was greatest. With the advent and increase of salinity, the number of fungi decreased. This trend was observed throughout all seasons of the study – spring, summer and autumn. Down the soil profile the number of fungi decreases. This is especially noticeable in the 50-80 cm soil layer, which may be due to more anaerobic conditions in this horizon. Since mushrooms are aerobic organisms, oxygen is of great importance for them. At all degrees of salinity, the number of fungi increased in summer, when plants grew rapidly in the agrocenosis. In autumn, especially in moderately and highly saline meadow-alluvial soils, the number of fungi was the smallest (Table 1). This may be due to an increase in the concentration of water-soluble salts in the soil in autumn. Consequently, an increase in the concentration of water-soluble salts contributes to a decrease in the number of fungi in meadow-alluvial soils.

Another representative of taxonomic groups are actinomycents. The number of actinomycetes also depended on the degree of salinity of meadow-alluvial soils. In non-saline meadow-alluvial soils, the number of actinomycetes was greatest. With the advent of salinity and an increase in the degree of salinity, the number of actinomycetes decreased. Therefore, in moderately and highly saline meadow-alluvial soils, the number of actinomycetes was the smallest. In summer, the number of actinomycetes was greatest (Table 1). This trend was observed in all degrees of salinity of meadow-alluvial soils. Consequently, in the rhizosphere and resoplanes of cultivated plants, incl. cotton, the best conditions are created for actinomycetes. The number of actinomycetes in all degrees of salinity decreased down the soil profile, and was the smallest in the 50-80 cm horizon.

In microbiological processes, physiological groups of microorganisms that support microbiological processes in the soil and thereby ensure the life of the soil are of great importance. Ammonifiers participate in ammonification processes, i.e. in the formation of ammonium from organic substances. Ammonifiers and bacteria were determined in the same medium, i.e. on MPA.

The amount of nitrifiers varied greatly depending on the concentration of water-soluble salts. Consequently, salinity, especially its high degree, greatly affects the number of nitrifying bacteria. At all degrees of salinity, the amount of nitrifiers decreased significantly down the soil profile. This is due to an increase in anaerobiosis in the lower soil horizons. Since nitrifiers are aerobic microorganisms, with an increase in the degree of salinity, the number of nitrifiers decreased, and in highly saline meadow-alluvial soil it was the smallest. The number of nitrifiers varied depending on time of year.

Table 2. The influence of the degree of salinity on the number of physiological groups of microorganisms on irrigated meadow-alluvial soils.

Incision №	Soil horizons, cm	nitrate reducers, million/g			nitrifiers, thousand/g			nitrogen fixers, million/g			Cellulose-decomposing microorganisms, thousand/g		
		Seasons			Seasons			Seasons			Seasons		
		spring	summer	autum	spring	summer	autum	spring	summer	autum	spring	summer	autum
Unsalted													
1	0-25	22,6	26,0	20,5	63	72	65	28,8	32,5	26,5	615	728	635
	25-50	15,8	17,8	15,1	38	45	41	18,6	21,8	19,2	527	615	550
	50-80	8,6	10,1	8,4	2	13	10	6,2	7,6	6,5	115	185	125
Lightly salted													
5	0-25	20,1	24,5	8,5	55	61	57	22,7	25,7	20,3	525	610	530
	25-50	12,8	15,3	12,0	30	36	30	15,6	18,9	13,7	386	420	380

	50-80	6,3	8,4	6,0	6	10	7	4,8	5,2	3,9	78	85	75
Moderately saline													
10	0-25	9,5	12,1	8,1	32	38	28	10,2	12,1	8,8	280	310	250
	25-50	7,0	9,3	6,3	20	25	17	7,3	7,8	6,2	175	200	150
	50-80	3,2	4,8	2,7	3	6	2	2,4	3,3	2,1	53	61	45
Highly salted													
17	0-25	6,0	7,5	4,8	21	27	18	6,5	7,2	5,6	145	186	120
	25-50	3,7	5,4	2,9	12	16	9	4,0	4,8	2,8	87	101	65
	50-80	2,0	3,7	1,2	1	3	0,8	1,5	1,9	0,8	25	35	20

Their highest numbers were observed in summer, during the period of rapid development of plant agrocenosis (Table 2). Consequently, salinity significantly affects the amount of nitrifiers, and thereby the formation of nitrates in the soil.

Bacteria growing on nitrate nitrogen are of great importance for the soil. Because they regulate the nitrate content in the soil. However, this has a negative impact on the efficiency of nitrogen fertilizers and plant nutrition. Soil salinity had a negative effect on the amount of nitrate reducers. With an increase in the degree of salinity, the number of nitrate reducers decreased and the smallest amount was observed in highly saline soils. This was noted in all seasons - spring, summer, autumn (Table 2). At all degrees of salinity, the greatest number of nitrate reducers was observed in summer. This may be due to rapid plant growth and increased root secretions of these crops. Down the soil profile, the amount of nitrate reducers decreased and the smallest amount was observed in the 50-80 cm layer. Consequently, the content of water-soluble salts significantly affects the number of nitrate reducers in meadow-alluvial soils.

Nitrogen fixers are of great importance in soil fertility. Free-living aerobic nitrogen fixers growing on Ashby's medium responded significantly to the content of water-soluble salts in the soil. With increasing salt concentration, the amount of nitrogen fixers decreases, and in highly saline soils it was the smallest. Consequently, a high concentration of water-soluble salts negatively affects the number of nitrogen fixers (Table 2). This is observed at all times of the year. However, the largest amount of nitrogen fixers was observed in summer, when plants reach high growth and development. Down the soil profile, the amount of nitrogen fixers decreases and in the 50-80 cm layer reaches the smallest amount.

Aerobic cellulose-decomposing bacteria are of great importance in the formation of soil fertility. The number of cellulose-decomposing bacteria depended on the degree of salinity of meadow-alluvial soils. With increasing concentration of water-soluble salts, the number of cellulose-decomposing bacteria decreased.

The lowest number of cellulose-decomposing bacteria was observed in highly saline meadow-alluvial soil. Their number was highest in summer (Table 2). This was observed in all degrees of salinity. Down the soil profile, the number of cellulose-decomposing bacteria decreased. This may be due to a decrease in the content of humus, plant root residues and oxygen in this direction

4 Conclusion

Thus, salinization of meadow-alluvial soils of the Bukhara oasis negatively affects the number of taxonomic and physiological groups of microorganisms. At the same time, as the degree of salinity increases, the number of microorganisms decreases. The lowest number of microorganisms is observed in the 50-80 cm layer. An increase in the proportion of chlorides, sodium and magnesium cations enhances the negative effect of water-soluble salts. Especially in moderately saline and highly saline soils, the number of microorganisms in autumn is greatly reduced compared to other seasons, which is associated with an increase in salinity at this time of year in these soils. At all salinity levels, the highest

number of microorganisms is observed in summer, when plants achieve their best productivity, indicating the presence of symbiosis between microorganisms and plants. To improve the microbiological activity of meadow-alluvial soils of the Bukhara oasis, it will be necessary to reduce the concentration of salts to normal levels through leaching and chemical reclamation..

References

1. F. Jumayev. The significance of alhagi in climate moderation and prevention of pastures degradation .E3S Web of Conferences 549,03021 (2024)
2. H. Salimova and H. Artikova. Mechanical composition and physical properties of irrigated soils of the gijduvan district of Bukhara region. E3S Web of Conferences 549,03027 (2024)
3. I. Rakhmatov. Evaluation of growing of sweet maize varieties and hybrids as a repeated crop in different planting periods and schemes. E3S Web of Conferences 497, 03038 (2024)
4. I. Rakhmatov. Growing varieties sweet corn main period in Karakalpakstan E3S Web of Conferences 497, 03043 (2024)
5. M. Axmedov and O. Sharipov Efficiency of navmutant lines in the creation of cotton (g. hirsutum l.) varieties. BIO Web of Conferences 113, 01003 (2024)
6. M. Khayrullayev and G. Rajabova. Dynamics of plants and non-quarantine organisms internal quarantine objects spread. BIO Web of Conferences 116, 01022 (2024)
7. N. Khakimova Study on the soil pollution condition around the domestic wastewater. E3S Web of Conferences 497, 03005 (2024)
8. N. Hakimova, Kh. Abdukhakimova and G. Sotiboldieva Formation and properties of agricultural irrigated layers of watered lands of Fergana E3S Web of Conferences 549,03020 (2024)
9. O. Umarov, Z. Bafayeva and D. Bo`riyeva. Impact of soil fertilization levels on the activity of invertase and phosphatase enzymes in the soils of Bukhara region E3S Web of Conferences 549,03019 (2024)
10. O. Umarov, Z. Bafayeva and M. Alimov. Soil salinity effects on nitrogen fixers and cellulose decomposing microorganisms. E3S Web of Conferences 549, 03016 (2024)
11. O. Umarov, Z. Bafayeva and T. Avezov. The effect of salinity levels on certain physiological groups of microorganisms in irrigated soils of Bukhara region. E3S Web of Conferences 549,03018 (2024)
12. O. Umarov, Z. Bafayeva and Z. Atayeva. Soil salinity effects on hydrolase and oxidoreductase class enzymes. E3S Web of Conferences 549,03017 (2024)
13. B. Mamurov et al., E3S Web of Conferences 538. 02025 (2024)
14. B. Mamurov et al., E3S Web of Conferences 538. 05031 (2024)
15. Dilova N. et al. The methodological principles for developing environmental education in the republic of Uzbekistan //E3S Web of Conferences. – EDP Sciences, 2024. – T. 538. – C. 05001.
16. G. Akramova et al., E3S Web of Conferences 538. 05034 (2024)
17. Hamroyev, H. Jumayeva, E3S Web of Conferences 420. 10007 (2023)

18. Kuldoshev R., Rahimova M. Region important directions for developing students' ecological education and thinking //E3S Web of Conferences. – EDP Sciences, 2024. – T. 549. – C. 09028.
19. M. Shirinova et al., E3S Web of Conferences 538. 05016 (2024)
20. O. Umarov, Z. Bafayeva and J. Ravshanov. Salinity level impact on humus and gross npp content in irrigated soils.E3S Web of Conferences 549,03024 (2024)
21. O. Umarov, Z. Bafayeva and E. Qodirov. Impact of salinity levels on the physical properties of irrigated meadow alluvial soils in Bukhara region .E3S Web of Conferences 549,03023 (2024)
22. Qo'ldoshev R., Dilova N., Hakimova N. Guiding left-handed students to a healthy lifestyle during the period of adaptation to school education //BIO Web of Conferences. – EDP Sciences, 2024. – T. 120. – C. 01049.
23. R. Kuldoshev et al., E3S Web of Conferences 371. 05069 (2023)
24. R. Qo'ldoshev et al., E3S Web of Conferences 538. 05017 (2024)