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The effect of salinity levels on certain physiological groups of microorganisms in irrigated soils of Bukhara region

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Abstract. This article describes some physiological classes of microorganisms (nitrifiers, ammonifiers, and nitrate reducers), their activity, and the variables influencing it in the alluvial soils of irrigated meadows in the Bukhara region.A thorough analysis of the effects of an excess of readily soluble salts in water on ammonifiers, nitrifiers, and nitrate reducers belonging to the physiological group of microorganisms, as well as the influence of soil salinity levels and salt content on these microorganisms, is provided.

1 Introduction

Microorganisms and mineral, organic, and micronutrient fertilizers applied to agricultural crops play a critical role in the breakdown of organic materials in the soil. These materials break down in the soil mostly because to the urease enzyme.

Based on the findings of microbiological research, it is reasonable to assume that the number of microorganism's peaks in the spring, when the soil's biological cycle of nutrients contributes to the increased mineralization of easily digested organic matter [1-20].

Meadow-alluvial soils that are irrigated with low-salinity escite have the highest concentration of microorganisms among soils with varied salinities. Conversely, microorganisms in high-salinity meadow-alluvial soils are less developed, which leads to sparser plant growth and lower plant productivity. Furthermore, from top to bottom, there are less microbes [3, 4].

The quantity and activity of microorganisms in the soil have a major impact on the development and condition of soil humus. Older irrigated soils and upper layers have more microorganisms than recently irrigated soils and lower layers. Compared to pale gray soils, meadow and typical gray soils have a greater microbial population [1,4,7,8].

The ratio of various ecological and trophic groups of microorganisms provides a more objective picture of the features of the structural distribution and direction of microbiological processes in the soil. The primary determinant of ammonifier absolute abundance is their dietary milieu. This topic is relevant since there has been a growth in the relative composition of the group of ammonifications in forest soils [3,5,6,10,11,12,14].

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2 Materials and Methods

The fifth dilution was used to determine the number of ammonifiers, nitrate reducers, and the fourth dilution soil suspension was used to determine the number of nitrifiers.

1. Number of ammonifiers – Meat peptone agar
2. Number of heat reducers - in Giltai environment
3. Nitrifiers - on the Vinogradsky plate

To study the composition and properties of the above-mentioned soils, generally accepted methods in soil science were used.

3 Results and Discussion

Microorganisms classified as belonging to physiological groupings share similar functions and take part in specific activities. Important soil microorganisms are those that take part in nitrogen fixation, plant residue degradation, nitrification, ammonification, and denitrification processes. They primarily fall within the taxonomic category of bacteria. They are found in specific settings with selective feeding. Of them, ammonifiers rank among the most significant. Ammonifiers ensure that ammonium is formed from organic molecules that retain nitrogen by taking part in the ammonification process. Meat-peptone agar is used to cultivate and quantify ammonifiers. Additionally, a census of all the microorganisms in the medium is performed. Thus, in the preceding chapter, ammonifiers were also taken into consideration at the expense of bacteria.

In the metabolic state, the nitrification process comes after the ammonification step. The ammonium created during ammonification is changed into nitrate during nitrification. Thus, the process of nitrate synthesis known as nitrification is crucial for soil fertility, which includes nutrition. The amount of nitrifiers in non-saline meadow alluvial soil in the Bukhara oasis was more than that in meadow alluvial soil with different salinities. The quantity of nitrifiers dropped down quickly and became negligible as salinity rose. This shows that too many salts that dissolve in water might cause nitrifiers to become extremely sensitive. When switching from a non-saline meadow alluvial soil to a weakly saline meadow alluvial soil, the number of nitrifiers likewise dramatically fell. Soil horizons and seasons both recorded this condition. High and moderate salinity meadow alluvial soils saw a sharp decline in the number of nitrifiers. This condition is linked to an increase in the quantity and proportion of sodium, magnesium, and chloride ions in the salt in addition to a rapid rise in the concentration of water-soluble salts.

Seasonal variations also affected the quantity of nitrifiers. In meadow alluvial soils, both saline and non-saline, summertime had the highest nitrifier count. In non-saline and mildly saline meadow alluvial soil, there were marginally more nitrifiers in the autumn than there were in the spring. However, springtime brought about a greater abundance of nitrifiers in meadow alluvial soil with medium to high salinity than fall did. Autumn salinity increases in moderately and substantially salinized meadow alluvial soils resulted in fewer nitrifiers.

In non-saline and differentially saline meadow alluvial soils, the number of nitrifiers dropped dramatically from top to bottom along the soil profile. However, there was a significant drop in the number of nitrifiers when the layer was moved from 25–50 cm to 50–80 cm. This was noted at all salinity levels and seasons. For instance, during the spring, there were 63 thousand KHB/g of nitrifiers in the 0–25 cm layer of non-saline meadow alluvial soil, 38 thousand KHB/g in the 25–80 cm horizon, and 12 thousand CFU/g in the 50–80 cm layer. According to the aforementioned horizons, this soil has 72 nitrifiers in the summer, 45 in the fall, and 13 CFU/g of soil in the summer. When compared to non-saline meadow alluvial soil, the quantity of nitrifiers in weakly saline meadow alluvial soil dramatically dropped in both seasons and strata. This decline, meanwhile, was far less pronounced than it was in meadow alluvial soils that were both moderately and highly salinized. because medium and strongly salty meadow alluvial soil has had a dramatic decline in the number of nitrifiers. For instance, 0–25 of alluvial soil from a meadow with weak salinity; 25–50; Within the 50-80 cm strata, there are 55 nitrifiers in the spring; 30; 6 CFU/g of soil was present; this indicator is 61 in the summer; 36; 10,000 CFU/g of soil, 57 in the fall; 30; It was 7 CFU/g of soil (Table 1). When salinity and the concentration of water-soluble salts rose, the number of nitrifiers dropped sharply. Soils that were both mildly and highly salinized mirrored this condition. 0–25 in the spring on slightly salinized meadow alluvial soil; 25–50; 32 nitrifiers in 50–80 cm layers, correspondingly; 20–3,000 CFU/g of soil in the summer, correspondingly, 38 in the layers above; 25–6,000 CFU/g of soil, 28 in the fall; 17–It was equivalent to 2,000 CFU/g of soil (Table 1). Thus, in both non-saline meadow alluvial soils and meadow alluvial soils with different salinities, the number of nitrifiers increased significantly as a result of plant root extracts in agrobiocenosis.

Season and soil horizon both caused a significant decline in the quantity of nitrifying bacteria in severely salinized grassland alluvial soils. This indicates that nitrifiers are resistant to elevated salt concentrations, which raise the quantity of hazardous and poisonous salts and intensify the soil environment's reactivity (Ph). The quantity of nitrifiers is negatively impacted by an increase in sodium, magnesium, and chloride ions in very saline meadow alluvial soil. In this instance, the number of nitrifiers falls down rapidly as one moves down the soil profile from top to bottom, reaching its lowest point in the 50–80 cm layer. From the 25–50 cm layer to the 50–80 cm layer, there was a significant drop in the number of nitrifiers. This condition is linked to the soil's oxygen content decreasing sharply as it descends, with the 50–80 cm layer experiencing an extreme oxygen deficit. As a result, there were remarkably few nitrifiers in the 50–80 cm layer during all seasons.

Table 1. Salinity's effect on the quantity of nitrifiers in the Bukhara region's irrigated meadow alluvial soils, expressed in thousand KHB/g of soil

Horizons of the soil, cm	**Seasons of the year**		
	Spring	**Summer**	**Autumn**
Unsalted			
0-25	63	72	65
25-50	38	45	41
50-80	2	13	10
Weakly salted			
0-25	55	61	57
25-50	30	36	30
50-80	6	10	7
Moderately salted			
0-25	32	38	28
25-50	20	25	17
50-80	3	6	2
Strongly salted			
0-25	21	27	18
25-50	12	16	9
50-80	1	3	0,8
S_x%	3,74	3,28	3,74
$HCP_{0,5}$	2,54	2,78	2,56

As an illustration, consider the following: 0–25 of an alluvial meadow's spring salinity; 25–50; The number of nitrifiers in 50–80 cm layers is 21, respectively; 12; If the soil had 1,000 CFU/g, this indicator would be 27 in the summer; 16–18 of the soil had 3,001 CFU/g, respectively; 9–0.8 of the soil had 0.8 thousand CFU/g (Table 1).

Thus, the non-saline meadow alluvial soil had the largest concentration of nitrifying bacteria. Nitrifier population declines due to salinity in meadow alluvial soils. The number of nitrifiers decreases sharply with increasing salinity, with the severely salinized meadow having the lowest value in alluvial soil. As aerobic bacteria, nitrifiers are found at the uppermost layer of the food chain. In the lower soil profile layers, the amount of oxygen decreases as a result of its scarcity. A robust root structure and summertime planting of plants guarantee significant nitrifier counts. The quantity of nitrifiers is positively correlated with the soil's porosity and adequate aeration.

One of the key physiological groups of soil microorganisms is nitrate reducers. They get their nitrogen from nitrates. They serve the same purpose as denitrifiers. When nitrate reducers employ nitrates, the nitrates break down and vanish into the earth. The amount of nitrates in the soil may decrease as a result of this. The amount and proportion of hazardous and toxic salts and ions in the salts, the depth of the soil layer, the seasons, and the salinity of meadow alluvial soils all have a major impact on the number of nitrate reducers. Compared to meadow alluvial soil with varying salinities, non-saline soil has more nitrate reducers in all seasons and soil horizons. There was a negative correlation between the number of nitrate reducers and increasing soil salinity. The quantity of nitrate reducers started to drastically decline as soil salinity increased. The number of nitrate reducers declined as salinity rose, with the highly salinized meadow alluvial soil having the lowest number of nitrate reducers. Not only did the concentration of water-soluble salts rise with salinity, but so did the quantity and percentage of hazardous and poisonous salts; the most saline meadow alluvial soil had the greatest value of these elements. Concurrently, as salinity rose, so did the quantity and percentage of sodium, magnesium, and chloride ions in the aqueous extract's composition. There was a decline in the calcium to magnesium or calcium to sodium ratio. Nitrate reducer development and reproduction are negatively impacted by this, which results in a sharp decline in the species' population. By soil layer, the quantity of nitrate reducers also differed. In this instance, there were much less nitrate reducers at the top of the soil profile than at the bottom. The alteration in the soil air's composition inside the soil layers is also connected to this condition. Summer was the season when the greatest number of nitrate reducers occurred, coinciding with the rapid development of agrobiocenosis.

For instance, nitrate reducer counts in non-saline meadow alluvial soil are as follows: in spring, 0–25 percent of the soil; in layers of 50–80 cm, 25–50 percent of the soil; 15.8 million CFU/g was in the soil; this indicator was 26.0 in summer; in autumn, 17.8 million CFU/g of soil, 20.5 corresponding to the upper soil layers; in Table 2, 15.1 million CFU/g was found to be in soil. The number of nitrate reducers declined marginally, but not significantly, as the soil grew more salinized. The quantity of nitrate reducers in this water was not significantly impacted negatively by a little increase in the amount of soluble salts. Seasons and soil layers both showed this condition. The detrimental impact of water-soluble salts on the quantity of nitrate reducers increased and resulted in a precipitous drop in their population against the backdrop of moderate and strong salinity. Every season saw the occurrence of this circumstance. However, in meadow alluvial soils that are moderately to heavily salinized, the number of nitrate reducers decreased significantly more in the fall. The fact that salts washed into the lower layers build up in the top layers in the fall may be connected to this circumstance. The quantity of nitrate reducers is further decreased by the increase in soil salinity by autumn. In this scenario, the proportion and quantity of hazardous and poisonous salts in the soil will rise.

Table 2. Impact of salinity on the amount of nitrate reducers, expressed as million KHB/g of soil, in irrigated meadow alluvial soils in the Bukhara region

Horizons of the soil, cm	Seasons of the year		
	Spring	Summer	Autumn
Unsalted			
0-25	22,6	26,0	20,5
25-50	15,8	17,8	15,1
50-80	8,6	10,1	8,4
Weakly salted			
0-25	20,1	24,5	18,5
25-50	12,8	15,3	12,0
50-80	6,3	8,4	6,0
Moderately salted			
0-25	9,5	12,1	8,1
25-50	7,0	9,3	6,3
50-80	3,2	4,8	2,7
Strongly salted			
0-25	6,0	7,5	4,8
25-50	3,7	5,4	2,9
50-80	2,0	3,7	1,2
S_x%	4,61	4,49	4,59
$HCP_{0,5}$	1,30	1,57	1,17

For nitrate reducers, this results in adverse conditions. For instance, in a layer of 50–80 cm of medium-saline meadow alluvial soil, the number of nitrate reducers in the spring is 0–25; 25–50; 9.5, respectively; this indicator was 12.1 in the summer, corresponding to the above layers; 9.3; 4.8 million CFU/g of soil, respectively 8.1 in autumn; 6.3; It was 2.7 million CFU/g of soil (Table 2). Extremely salinized meadow alluvial soil has the least number of nitrate reducers. Nitrate reducer levels sharply decreased in very salty soil due to a large increase in water-soluble salts, the maximum level of hazardous and poisonous salts. In autumn, this predicament was more apparent. Compared to other seasons, the summer had a higher concentration of nitrate reducers. When comparing the number of nitrate reducers in the soil profile to the amount in 1.2 million CFU/g soil (Table 2), the indicator was 7.5 corresponding to the above soil layers in summer; 5.4; 3.7 million CFU/g of soil, respectively 4.8 in autumn; 2.9. If 2.0 million CFU/g was in the soil, this indicator was 6.0, respectively, in layers of 50-80 cm; 3.7. This demonstrates how sensitive nitrate reducers are to excessive salt.

Consequently, non-saline meadow alluvial soil has the largest concentration of nitrate reducers. The quantity of nitrate reducers is negatively impacted by the salinity of meadow alluvial soils. When the salinity of grassland alluvial soils rises, the quantity of nitrate reducers falls. This can be attributed to many factors such as a rise in the concentration of water-soluble salts, an increase in the proportion of hazardous and dangerous salts in these salts, an increase in the ratio of sodium and magnesium ions to calcium ions, and an increase in the quantity of chlorides. The depth of the layer has a significant impact on the quantity of nitrate reducers as well. There are fewer nitrate reducers as the soil layer becomes deeper. Seasons also affect how many nitrate reducers there are. Summertime is when there are the most of these nitrate reducers. This is because agrocenosis causes plant roots to secrete their highest amount throughout the summer. Fall nitrate reducer counts in moderately and heavily salinized meadow alluvial soil were lowest. This is because during this time, the amount of salts in the soil increased.

4 Conclusion

The quantity of physiological group microorganisms, such as ammonifiers, nitrifiers, and nitrate reducers, dramatically declines as salinization of irrigated meadow alluvial soils in the Bukhara region increases. In this instance, the quantity of water-soluble salts, the amount and share of magnesium, sodium, and chloride ions, and the percentage of calcium ions all decrease with increasing salinity, leading to a dramatic drop in the number of physiological group microorganisms.

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