https://doi.org/10.1051/e3sconf/202454903016

# Soil salinity effects on nitrogen fixers and cellulose decomposing microorganisms

*Otabek* Umarov[1*], *Zahro* Bafayeva[1], and *Muhammad* Alimov[1,2]

[1]Bukhara State University, Bukhara, Uzbekistan Street Mukhammad Ikbol, 11, 200118, Uzbekistan
[2]Bukhara State Pedagogical Institute, Bukhara City, Piridastgir, 2, 200100, Uzbekistan

**Abstract.** This article presents data on the effect of soil salinity on the activity of nitrogen-fixing and cellulose-degrading microorganisms in alluvial soils of widely irrigated meadows in the Bukhara region. According to it, the activity of nitrogen-fixing and cellulose-decomposing microorganisms was studied as a control in non-saline soils, and scientific data was presented on how the activity of these bacteria changes in weakly saline, moderately saline, and strongly saline soils in the order of increasing levels of salinity, and which of the easily soluble salts in water had the greatest effect on it.

## 1 Introduction

Nitrogen fixers are one of the important physiological groups of microorganisms. They absorb atmospheric nitrogen symbiotically and freely [1,2,3]. Bacteria growing in the Ashby medium are free-living aerobic nitrogen fixers. They also absorb nitrogen from the soil air and enrich the soil with nitrogen. It is very important in the nitrogen balance. Because nitrogen in the soil, including mineral nitrogen, is the minimum factor [5,6,8]. Nitrogen deficiency negatively affects soil fertility and plant growth and development. At the same time, nitrogen accumulation is a very complex process and it is very difficult to implement it. The easy passage of nitrogen loss plays a very negative role in the nitrogen balance. Nitrogen is lost in the soil in the form of ammonia $NH_3$, nitrogen oxides, and molecular nitrogen, nitrate, and ammonium forms during the decomposition of organic matter, leaching, denitrification, and ammonia formation. As a result, the amount of organic and mineral nitrogen in the soil is significantly reduced. Therefore, maintaining the nitrogen balance without a deficit is a very difficult issue [4,9,7,10,11]. The positive role of these nitrogen fixers is huge. However, many factors can have a positive or negative effect on the number and activity of nitrogen fixers. This condition also exists in the alluvial soils of the Bukhara desert meadow. The alluvial soils of the Bukhara oasis meadow have varying degrees of salinity. Non-saline meadow alluvial soils are very rare [12,13,14,15,16,17]. This condition also affects the growth and development of free-living aerobic nitrogen fixers

* Corresponding author: z.x.bafayeva@buxdu.uz

characteristics of grafts and their wide implementation in the production of high-efficiency types suitable for production and maintenance in different soil-climatic conditions is a demand of the time.

Intensive fruit growing, including fruit with seeds, is the most important and unique sector in the agricultural sector in recent years, and it is highly productive. The average productivity of intensive apple varieties, orchard areas, and modern serunum grafts is increasing significantly even in the soil and climate conditions of the Bukhara region. Resource-efficient modern technologies and promising varieties of intensive apple orchard care are also being thoroughly studied [1,2,7,8,9,10].

In the establishment and development of intensive (accelerated) apple orchards, first of all, the apple variety and its grafts, the shape of apple trees, i.e. the spread of branches, the compactness of the body and branches, the improvement of light and photosynthesis processes, the use of resource-efficient modern innovative agrotechnological factors, fruit taking into account the biological properties of trees, taking care of trees according to scientifically based technology, and directing them to obtain a continuous abundant and high-quality harvest is considered the most important task and the demand of the time [3,4,5,6,9].

In the soil-climatic conditions of the Bukhara region, orchards that produce intensive, consistently abundant and high-quality crops are being rapidly established. In these intensive apple orchards, in the study of the quality and quantity of the growth, development, and yield of young fruit trees, in recent years, the widely used variety-graft combinations, as well as the wide introduction of the corresponding seedling thickness to the production, after studying the biological characteristics of them on a fully scientific basis, are getting high efficiency and abundant income.

## 2 Materials and Methods

10 g of the soil sample taken from the soil cuttings was taken and put into 90 ml of sterile distilled water and the soil suspension was prepared from the first dilution by shaking for 5 minutes. The soil suspension of the second dilution was prepared by taking 10 ml of the first dilution using a sterile pipette (in a bottle) and adding it to 90 ml of distilled water. Thus, the level of dilutions was brought up to 5 and 6 dilutions. The number of bacteria from the taxonomic groups is determined by taking 1 ml from the soil suspension at 5 dilution, the number of fungi from the soil suspension at 4 dilution, and the number of actinomycetes by taking 1 ml of the soil suspension at 6 dilution and planting them in their selective media. From the physiological group microorganisms, the fifth dilution was used to determine the number of ammonifiers, nitrate reducers, nitrogen fixers, and the fourth dilution soil suspension was used to determine the number of nitrifiers and cellulose-decomposing bacteria.

1. Number of nitrogen fixers - in Ashby medium
2. Cellulose-degrading microorganisms - identified by cultivation in Getchinson's selective nutrient medium.

## 3 Results and Discussion

An increase in the level of salinity, an increase in the amount of harmful and toxic salts in the composition of salts, a decrease in the amount of calcium cations in the water absorption of the soil, and an increase in the amount of magnesium and sodium have a significant negative effect on the number of nitrogen fixers. Therefore, the number of nitrogen fixers in the non-saline meadow alluvial soil was significantly higher than that in

 https://doi.org/10.1051/e3sconf/202454903016

the meadow alluvial soil with varying degrees of salinity. For example, in non-saline meadow alluvial soil, 0-25 of soil in spring; 25-50; The number of nitrogen fixers in 50-80 cm layers is 28.8, respectively; 18.6; 6.2 million (colony forming unit) CFU/g was in the soil, this indicator was 32.5 in the summer season, corresponding to the above-mentioned soil horizons; 21.8; 7.6 million CFU/g of soil, 26.5 in autumn; 19.2; It was 6.5 million CFU/g of soil (Table 1). In non-saline meadow alluvial soil, the number of nitrogen fixers was the highest in summer. This is due to the rapid development of plants in the agrobiocenosis at this time and the release of root secretions to the soil. At the same time, the creation of favorable conditions for nitrogen fixers in the soil due to irrigation and good growth of plants has a positive effect on the number of nitrogen fixers. In non-saline meadow alluvial soil, the number of nitrogen fixers was almost equal in spring and autumn. Only in autumn, the number of nitrogen fixers was slightly higher. A high number of nitrogen fixers in summer has a positive effect on nitrogen nutrition of plants. By autumn, nitrogen absorption by plants decreases sharply.

**Table 1.** Effect of salinity on the number of nitrogen fixers of irrigated meadow alluvial soils, million CFU/g of soil

| **Soil horizons, cm** | **Seasons** | | |
|---|---|---|---|
| | **spring** | **summer** | **autumn** |
| **Unsalted** | | | |
| 0-25 | 28,8 | 32,5 | 26,5 |
| 25-50 | 18,6 | 21,8 | 19,2 |
| 50-80 | 6,2 | 7,6 | 6,5 |
| **Lightly salted** | | | |
| 0-25 | 22,7 | 25,7 | 20,3 |
| 25-50 | 15,6 | 18,9 | 13,7 |
| 50-80 | 4,8 | 5,2 | 3,9 |
| **Moderately salted** | | | |
| 0-25 | 10,2 | 12,1 | 8,8 |
| 25-50 | 7,3 | 7,8 | 6,2 |
| 50-80 | 2,4 | 3,3 | 2,1 |
| **Strongly salted** | | | |
| 0-25 | 6,5 | 7,2 | 5,6 |
| 25-50 | 4,0 | 4,8 | 2,8 |
| 50-80 | 1,5 | 1,9 | 0,8 |
| $S_x$% | 4,67 | 3,39 | 4,35 |
| $NSR_{0,5}$ | 1,44 | 1,21 | 1,22 |

the increase in the amount and share of harmful and toxic salts, the increase in the amount and share of magnesium and sodium ions compared to calcium, and the increase in the amount of chloride anion had a stronger negative effect on the number of free-living aerobic nitrogen fixers. At the same time, the number of nitrogen fixers in moderately and strongly saline meadow alluvial soils decreased sharply. Increasing the alkalinity of the soil reaction (pH) in moderately and highly saline meadow alluvial soil had a negative effect on nitrogen fixers, leading to a decrease in their number. This situation was observed in seasons and soils. In moderately and strongly saline meadow alluvial soils, the increase in the concentration of water-soluble salts by autumn caused the number of nitrogen fixers to decrease dramatically in autumn. At these salinity levels, the relatively highest amount of nitrogen fixers was observed in summer. For example, the number of nitrogen fixers in the spring in moderately saline meadow alluvial soil is 0-25 of the soil; 25-50; 10.2, respectively, in layers of 50-80 cm; 7.3; 2.4 million CFU/g was in the soil, this indicator is 12.1 in the summer season, corresponding to the above-mentioned soil layers; 7.8; 3.3 million CFU/g of soil, 8.8 in autumn; 6.2; It was 2.1 million CFU/g of soil (Table 1). When the salinity level increased, the number of free-living aerobic nitrogen fixers reached a minimum level, when the amount and percentage of harmful and toxic salts, sodium, magnesium, and chloride ions increased. For example, the number of nitrogen fixers in the spring in moderately saline meadow alluvial soil is 0-25 of the soil; 25-50; 6.5, respectively, in layers of 50-80 cm; 4.0; If 1.5 million CFU/g of soil was in the soil, this indicator is 7.2 in summer, corresponding to the above-mentioned soil layers; 4.8; 1.9 million CFU/g of soil, 5.6 in autumn; 2.8; It was 0.8 million CFU/g of soil (Table 1). Due to the increased re-accumulation of water-soluble salts in the soil in autumn, it causes a decrease in the number of free-living aerobic nitrogen fixers.

Thus, the number of nitrogen fixers is maximum in non-saline meadow alluvial soil. Soil salinity, the increase in salinity level leads to an increase in the percentage and amount of harmful and toxic salts in water-soluble salts, a decrease in the amount of calcium cations in soil water absorption, an increase in the amount and percentage of sodium, magnesium, and chloride ions, and a decrease in the number of free-living aerobic nitrogen fixers in the soil. A strong decrease in the number of free-living aerobic nitrogen fixers occurs in the soil profile towards the lower layers, and this is associated with a decrease in soil fertility and oxygen content in the soil air. In the summer, when the nitrogen demand of plants is maximum, the number of nitrogen fixers will have the largest composition. Nitrogen fixation accelerates in non-saline soil, and this has a positive effect on the nitrogen regime of the soil. Nitrogen fixation in saline meadow alluvial soil slows down under the influence of water-soluble salts, and nitrogen accumulation in the soil decreases. This condition is more pronounced when the salinity level increases. This, in particular, has a strong negative effect on the nitrogen regime of highly saline meadow alluvial soils and destroys the normal course of nitrogen nutrition of plants.

In the soil, mainly plant residues accumulate and decompose. Plant residues are mainly composed of fiber or cellulose. Therefore, the decomposition of cellulose is important in the decomposition of plant residues. Decomposition of plant residues plays an important role in the humification process. Cellulose-decomposing microorganisms play a key role in plant decomposition. The number of cellulose-degrading microorganisms is significantly different in saline and non-saline meadow alluvial soil. The non-saline grassland alluvial soil had the highest number of cellulose-degrading microorganisms in the study. Salinity of grassland alluvial soils had a negative effect on the number of cellulose-degrading bacteria. As the salinity level of grassland alluvial soils increased, the number of cellulose-degrading microorganisms also decreased, and the highly saline grassland alluvial soil had the smallest number. In the non-saline meadow alluvial soil, the number of cellulose-degrading microorganisms was highest in summer. This is due to the creation of the most favorable conditions for cellulose bacteria at the time of agrobiocenosis. Root extracts of agrobiocenosis plants are important in this.

A high level of agrotechnology for growing crops during the summer also has a positive effect on the number of cellulose-degrading bacteria in the soil. In particular, irrigation, tillage, and the use of fertilizers create favorable conditions for the development and reproduction of cellulose-decomposing bacteria. It was noted that the number of cellulose-degrading microorganisms was higher in autumn than in spring. This is due to a significant decrease in plant remains that died in the fall. As the dead plant matures, dead plant debris, including root debris, accumulates. This dead plant creates favorable conditions for cellulose-degrading bacteria.

In the non-saline meadow alluvial soil, the number of cellulose-degrading bacteria significantly decreased from the upper to the lower layers in the soil profile. The lowest amount of cellulose-decomposing bacteria was observed in the 50-80 cm layer. This condition is also caused by a significant reduction of vegetation and its remains in the soil profile from the upper layers to the lower layers. At the same time, a decrease in the amount of oxygen in the lower layers, deterioration of aeration, an increase in the soil index, a decrease in productivity in general leads to a decrease in the number of aerobic cellulose-decomposing bacteria. For example, in non-saline meadow alluvial soil, the number of aerobic cellulose-degrading bacteria in the spring is 0-25 of the soil; 25-50; 615, respectively, in layers of 50-80 cm; 527; 115,000 CFU/g was in the soil, and this indicator was 728 in the summer season, corresponding to the above-mentioned soil layers; 615; 185 thousand CFU/g of soil, and 635 in autumn; 550; It was 125 thousand CFU/g of soil (Table 2). This indicates that cellulose degradation is more rapid in non-saline grassland alluvial soil. Cellulose with soil salinity  the number of degrading microorganisms decreased. This situation was also observed according to the soil layers with the seasons. Even in weakly saline meadow alluvial soil, the number of cellulose-degrading bacteria was highest in summer and in the upper layer. The number of cellulose-degrading bacteria was almost the same in spring and autumn. Cellulose-degrading microorganisms decreased from the upper layer to the lower horizons. For example, in weakly saline meadow alluvial soil, the number of cellulose-degrading bacteria is 0-25 of the soil; 25-50; 525 respectively in layers of 50-80 cm; 386; 78,000 CFU/g was in the soil, while in the summer season it was 610, corresponding to the above-mentioned layers; 420; 85 thousand CFU/g of soil, and 530 in autumn; 380; 75 thousand CFU/g of soil was observed. As the salinity of the grassland alluvial soil increased, the number of cellulose-degrading bacteria in the soil further decreased. Therefore, a strong increase in the concentration of water-soluble salts in the soil, an increase in the amount of harmful and toxic salts in the salts, an increase in the percentage and amount of sodium and magnesium compared to calcium, causes a further decrease in the number of cellulose-decomposing bacteria in the soil. Therefore, the number of cellulose-degrading bacteria was very low in moderately and highly saline meadow alluvial soils. A decrease in the number of cellulose-degrading bacteria was observed in soil layers with all seasons of the year, compared to non-saline and weakly saline meadow alluvial soils, in moderately and strongly saline meadow alluvial soils. For example, in medium saline meadow alluvial soil, the number of cellulose-degrading bacteria in the spring is 0-25 of the soil; 25-50; 280 respectively in layers of 50-80 cm; 175; 53,000 CFU/g was in the soil, while in the summer season it was 310, corresponding to the above-mentioned layers; 200; 61 thousand CFU/g of soil, and 250 in autumn; 150; 45 thousand CFU/g of soil was observed (Table 2). The amount of water-soluble salts in the soil increased to a maximum level, that is, the number of cellulose-decomposing bacteria reached a minimum level when the soil was highly saline. This is caused not only by the maximum concentration of water-soluble salts in the soil, but also by the increased concentration of harmful and toxic salts in the salt composition. Therefore, increasing the concentration of water-soluble salts in the soil, especially harmful and toxic salts, has a negative effect on the number and activity of cellulose-decomposing bacteria. Cellulose-degrading bacteria peak in the summer and in the upper layer.

**Table 2**. Effect of salinity of irrigated meadow alluvial soils on the number of cellulose-degrading microorganisms, thousand CFU/g of soil

| Soil horizons, cm | Seasons | | |
|---|---|---|---|
| | spring | summer | autumn |
| **Unsalted** | | | |
| 0-25 | 615 | 728 | 635 |
| 25-50 | 527 | 615 | 550 |
| 50-80 | 115 | 185 | 125 |
| **Lightly salted** | | | |
| 0-25 | 525 | 610 | 530 |
| 25-50 | 386 | 420 | 380 |
| 50-80 | 78 | 85 | 75 |
| **Moderately salted** | | | |
| 0-25 | 280 | 310 | 250 |
| 25-50 | 175 | 200 | 150 |
| 50-80 | 53 | 61 | 45 |
| **Strongly salted** | | | |
| 0-25 | 145 | 186 | 120 |
| 25-50 | 87 | 101 | 65 |
| 50-80 | 25 | 35 | 20 |
| $S_x$% | 0,72 | 0,34 | 0,51 |
| $NSR_{0,5}$ | 5,18 | 2,86 | 3,59 |

Thus, soil salinity has a negative effect on the number of microorganisms of the physiological group. In saline meadow alluvial soils, the number of microorganisms of the physiological group is significantly reduced, and this has a negative effect on their activity. The most unfavorable conditions for the microorganisms of the physiological group occur in the alluvial soil of the meadow with strong salinity. The number and activity of microorganisms of the physiological group decreases from the upper layers to the lower layers and has the lowest value at the 50-80 cm horizon.

## 4 Conclusion

The number of nitrogen-fixing and cellulose-decomposing bacteria from the physiological group of microorganisms decreases sharply as a result of salinization of meadow alluvial soils. 0-25 of the soil in the spring in non-saline meadow alluvial soil; 25-50; The number of nitrogen fixers in 50-80 cm layers is 28.8, respectively; 18.6; 6.2 million CFU/g was in the soil, this indicator was 32.5 in the summer season, corresponding to the above-mentioned soil horizons; 21.8; 7.6 million CFU/g of soil, 26.5 in autumn; 19.2; It was 6.5 million CFU/g of soil. In saline soils, the amount of water-soluble salts increases in the autumn, causing the number of microorganisms of the physiological group to be at the lowest level during this period.

## References

1. A.Ilyosoy. E3S Web of Conferences **462**, 02001 (2023)
2. B. Mamurov et al., E3S Web of Conferences **538**. 05025 (2024)
3. B. Mamurov et al., E3S Web of Conferences **538**. 05031 (2024)

4. D. Bo'riyeva, M. Xalilova, and Z.Atayeva. E3S Web of Conferences **420**, 03013 (2023)
5. F.A.Ganiyeva. E3S Web of Conferences **389**, 03014 (2023)
6. G. Akramova et al., E3S Web of Conferences **538**. 05034 (2024)
7. H. Salimova and H. Artikova. E3S Web of Conferences **389**, 04012 (2023)
8. Hamroyev, H. Jumayeva, E3S Web of Conferences **420**. 10007 (2023)
9. Kh. Artikova, S. Shadiyeva. E3S Web of Conferences **389**, 04014 (2023)
10. M. Sattorova, and M.Raximova E3S Web of Conferences **420**, 03010 (2023)
11. M. Shirinova et al., E3S Web of Conferences **538**. 05016 (2024)
12. R. Kuldoshev et al., E3S Web of Conferences **371**. 05069 (2023)
13. R. Qo'ldoshev et al., E3S Web of Conferences **538**. 05017 (2024)
14. R. Qo'ldoshev et al., E3S Web of Conferences **538**. 05042 (2024)
15. S.Khojiev E3S Web of Conferences **381**, 01013 (2023)
16. S.M.Nazarova. Factors of soil formation and their evolution in the south of the Zerafshan valley. E3S Web of Conferences **389**, 04016 (2023)
17. U. Khayitov et al., E3S Web of Conferences **538**. 05022 (2024)