DOI: 10.46793/SBT29.39DDJ

THE INFLUENCE OF SATURATED SOLUTIONS OF MINERAL SALTS ON SAPROPHITIC BACTERIA IN THE SOIL

Dragutin Đukić[1], Leka Mandić[1], Vesna Đurović[1], Monika Stojanova[2]

Abstract: The paper provides an overview of the influence of saturated salt solutions on the number and structure of bacterial complexes in soil, as well as pure cultures of bacteria isolated from that soil. The short-term action of high doses of salt is not fatal for saprophytic bacteria in the soil. Nitrogen salts exert the greatest influence on the mentioned parameters, especially ammonium nitrate. Bacilli and sliding bacteria are the most resistant to the effects of salt.

Keywords: bacteria, mineral salts, soil

Introduction

Application of mineral fertilizers is a very pronounced anthropogenic impact on the biosphere. The introduction of granulated mineral fertilizers into the soil is very common, whereby loci with high concentrations of salt are formed near the granules, which can lead to disturbances in the normal functioning of the living world. Many studies have determined the unique stability of the soil microbial system (Mihnovska, 1982; Pavlenko, 1982; Jemcev, Mišustin, 1993; Jemcev, Đukić, 2000; Đukić et al., 2020), however, based on the data from the existing literature, it cannot be given a clear answer about the reaction of bacteria to the introduction of high concentrations of mineral salts.

The aim of this review is to look at the short-term impact of high salt concentrations on saprophytic bacteria in the soil and determine the specificity of the resulting changes.

The influence of saturated salt solutions on the taxonomic structure of saprophytic bacteria in the soil

The influence of saturated salt solutions $CaHPO_4$, KCl, NH_4NO_3, NH_4Cl and KNO_3 during 24 hours on the taxonomic structure of bacteria in the meadow soil of the flood zone will be presented. The introduction of NH_4NO_3, NH_4Cl and

[1]University of Kragujevac, Faculty of Agronomy, Cara Dušana 34, Čačak, Serbia (lekamg@kg.ac.rs)
[2]Faculty of Agricultural Sciences and Food, Ss. Cyril and Methodius, University, Skopje, North Macedonia

KNO_3 into the soil leads to a decrease in the number of saprophytic bacteria by 1.3 to 2.5 times. At the same time, the maximum effect is observed when introducing NH_4NO_3 (Fig.1). The introduction of KCl does not have a significant effect on the number of bacteria, while the introduction of $CaHPO_4$ and $CaCO_3$ slightly increased the number of bacteria in the soil. NH_4NO_3 shows the greatest toxicity to saprophytic bacteria. However, the decrease in abundance by only 2.5 times testifies to the relatively weak effect of short-term introduction of saturated salt solutions on bacteria (Lapigina and Lisak, 2001).

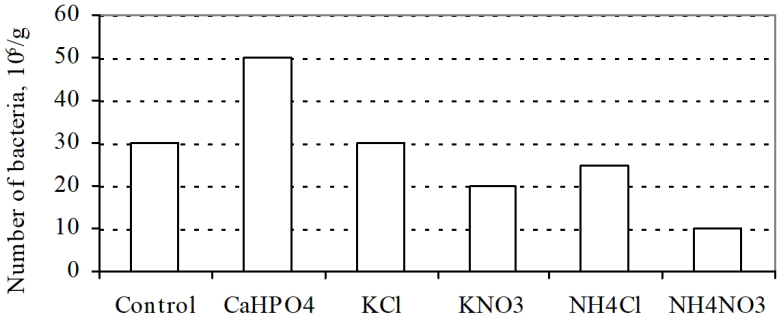

Fig. 1. Change in abundance of saprophytic bacteria in meadow soil under the influence of high doses of mineral fertilizers (Lapigina and Lisak, 2001)

The change in the abundance of saprophytic bacteria is not related to differences in soil acidity (before and after soil treatment with mineral fertilizers). It was shown that the single intake of high doses of salt does not cause significant changes in pH value - the maximum decrease in pH (from 7.7 to 6.4) occurs only with the intake of NH_4NO_3. The introduction of NH_4NO_3 causes significant changes in the structure of the saprotrophic complex of bacteria in the meadow soil (Fig. 2). In the control soil, streptomycetes and gram-negative bacteria dominate, arthrobacteria and bacilli are subdominant, and minor components are rhodococci, micrococci and sliding bacteria, while when NH_4NO_3 is introduced, streptomycetes absolutely dominate (63%), and the subdominant position is occupied by arthrobacteria, bacilli and gram-negative bacteria. The introduction of KNO_3 and NH_4Cl leads to a significant redistribution in the structure of bacteria, while the introduction of $CaHPO_4$ and KCl does not cause significant changes in the taxonomic composition of saprophytic bacteria. With the introduction of salts KCl, NH_4NO_3, NH_4Cl and KNO_3, gram-negative bacteria of the genera *Spirillum, Vibrio* and *Pseudomonas* are completely inhibited. Bacteria of the genera *Polyangium, Cytophaga* and *Myxococcus* are less sensitive to the effects of salt.

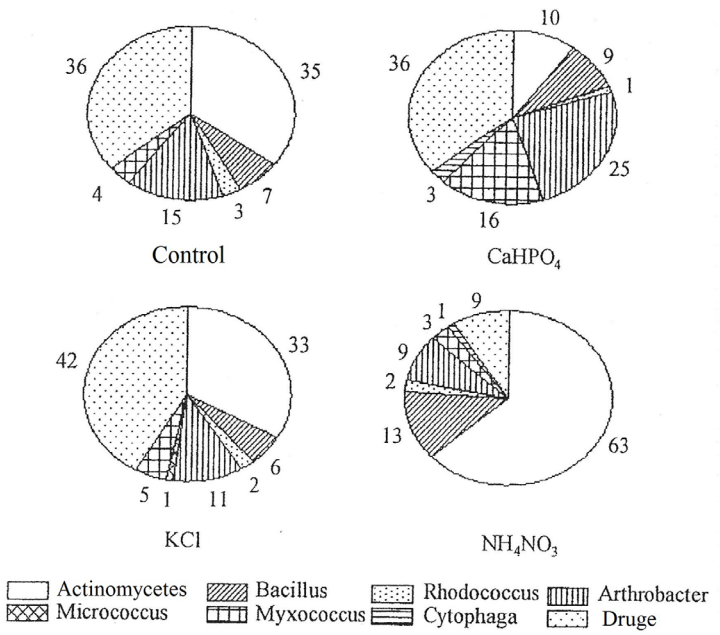

Fig. 2. Changes in the structure of the bacterial complex in meadow soil under the influence of high doses of mineral salts (Lapigina and Lisak, 2001)

Among pure cultures of bacteria isolated from meadow soil (genera *Bacillus, Arthrobacter, Rhodococcus, Polyangium, Cytophaga, Myxococcus*) *Bacillus* are the most resistant to saturated salt solutions, which can obviously be related to their ability to form spores, while arthrobacteria and rhodococci are less resistant (Zhang et al., 2017; Mandić et al., 2022). Among gram-negative bacteria, bacteria of the genera *Myxococcus* and *Polyangium* exhibit significant resistance, which are capable of creating myxospores with high resistance to various unfavorable factors, while representatives of the genus *Cytophaga* are less resistant (Fig. 3).

A comparative analysis of the behaviour of bacteria in pure cultures and directly in the soil during the introduction of mineral salts (Fig. 4) shows that bacteria in the soil are more resistant to salts than pure cultures of bacteria, which is manifested by a less pronounced decrease in their number which is in agreement with the results of other authors (Mandić et al., 2005).

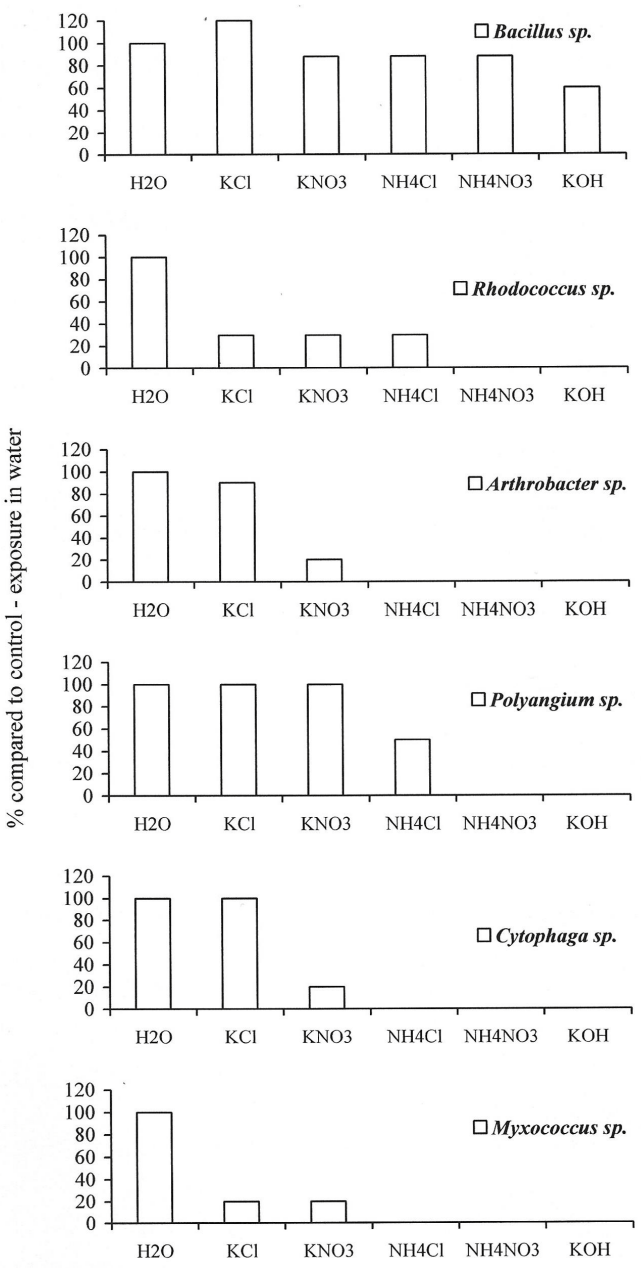

Fig. 3. Effect of short-term exposure (24h) of saturated salt solutions and 1N KOH on survival (in % compared to control - exposure in water) of pure bacterial cultures (Lapigina and Lisak, 2001).

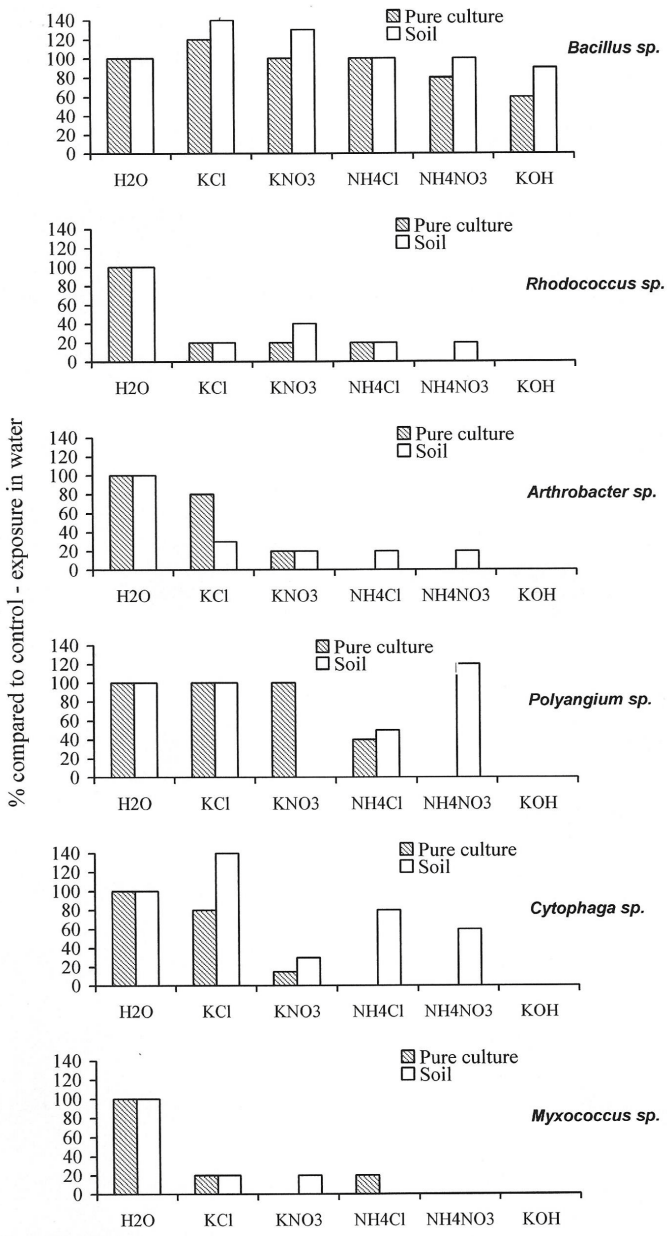

Fig. 4. The influence of short-term action of saturated salt solutions in 1N KOH on the survival of bacterial cultures (in % compared to the control - exposure to H_2O) and bacteria in the soil (in % compared to the control - the number of bacteria in the soil without introducing salt) - (Lapigina and Lisak, 2001).

Conclusion

Based on the above data, it can be concluded that the short-term action of high doses of salt does not have a detrimental effect on saprophytic bacteria in the soil. Nitrogen salts (NH_4NO_3, NH_4NO_3, KNO_3 and NH_4Cl) have the greatest impact on the number and taxonomic composition of saprophytic bacteria, with the greatest effect being the introduction of ammonium nitrate, which is manifested by a 2.5-fold reduction in the number of bacteria and a significant redistribution in the structure of bacteria. Among gram-positive bacteria, bacilli are the most resistant to the action of salt, and among gram-negative bacteria, sliding bacteria. Pure cultures of bacteria are more sensitive to salt than those in the soil.

Acknowledgement

This study was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract numbers: 451-03-66/2024-03/200088).

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