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Can soil microorganisms support plants under hydrological events?

Soil moisture is defined as the water content of the soil. Natural moisture fluctuations associated with the seasons are an environmental factor that regulates microbial activity. The amount and distribution of precipitation over time and air temperature are regulated by climatic conditions, which are also influenced by human activities, especially industrial activities. Studies on soil moisture confirm the complexity of interactions between environmental elements. In recent years, the frequency of floods across Europe has been increasing and drought periods have become longer. The hydrological stress caused by these phenomena affects the soil environment and plants. Drought causes soil drying and the reduction or complete destruction of crops. On the other hand, excess water results in difficulties in field work, rotting of plants and the development of many fungal diseases.

Some soil bacteria (e.g., Bacillus sp., Alcaligenes sp.) displayed resistance to low water content in soil and related osmotic stress and excessive oxygenation. Their ability to produce siderophores, indole-3-acetic acid and exopolysaccharides (EPS) has been demonstrated. These mechanisms allow the bacteria to survive changes in osmotic pressure caused by lack of water in the soil. Little is known, however, about bacteria in a moisture stress condition.

We conducted research based on a microcosm model experiment in which selected fluvisols were taken from floodplain meadows and subjected to simulated flood conditions. Fresh soils and soils collected after 7 and 14 days of flooding were analyzed. The structural diversity of the soil microbiome at each stage of the experiment was determined using next-generation sequencing (NGS, Illumina).

Results showed an increase in the structural diversity of the bacterial community under flooded conditions. Considering only the identified bacterial sequences, it was observed that although the individual soils were characterised by a different core microbiome, 5 types of bacteria were common to all the river muds: Actinobacteria, Bacteroidetes, Firmicutes, Nitrospirae and Proteobacteria. Bacteria of the Actinobacteria type were the most abundant. Moreover, bacteria of the family Flavobacteriaceae, Desulfovibrionaceae, Streptomycetaceae, whose representatives are known for their ability to produce EPS, were present in flooded soils. The results obtained from this experiment were so intriguing that it was decided to extend the research in search of bacteria capable of surviving in these conditions and with potential positive effects on plants/environment. Thus, the project entitled: The search for bacteria adapting to extreme soil moisture conditions and the assessment of the effects of hydric stress on the quality of the soil environment (National Science Centre Poland), was created. The aim of the project is to assess the rate of change in the soil environment following changes in moisture content and to isolate bacteria that survive water stress, and to investigate whether the bacterial isolates obtained have the characteristics to survive osmotic stress. Once the bacteria have been characterized, it will be possible to assess their potential impact on plants under conditions of excessive moisture.

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The study was prepared within the framework of project No. 2019/35/N/NZ9/00830 „The search for bacteria adapting to extreme soil moisture conditions and the assessment of the effects of hydric stress on the quality of the soil environment" granted by National Science Centre Poland.