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2.4 A holistic view on root systems - integrating the data from roots, root biota, and soils

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In the context of climate change, more frequent drought events and heatwaves predict a significant decrease in soybean yields. As the world's most widely grown legume crop, there's an urgent need to enhance its resilience to ensure productivity. This study explores how heat and water stress, alone or combined, impact soybean nutrition and growth, including root morphology, nutrient uptake and efficiency, and the surrounding microbial environment. The aim was to identify if root architecture can confer resistance to these stresses and identify the structural and functional changes implemented by the plant during these stresses.

Two soybean genotypes with contrasted root architectures were grown in the 4PMI high-throughput phenotyping platform during their vegetative stage, under various climate conditions. Conditions included control, heatwaves, water deficit, and combined heatwaves and water deficit. A holistic approach was adopted, encompassing plant ecophysiological, metabolic, and transcriptional measurements and rhizospheric microbiome analysis. At transcriptomic level, the effect of stress was much greater than the effect of genotype. Moreover, combined stresses provoked a specific response that was not simply the sum of the effects of water deficit and heat stress. Among the many stress-induced deregulations, we observed a concomitant increase in the level of expression of root sulphur (S) transporters, and in the concentration of S in shoots. In case of combined stresses, arginine, and asparagine (osmoprotective amino acids) concentrations increased significantly in roots and exudates, as did the presence of actinobacteria in the root endosphere. We will discuss the close relationship between compounds produced by the plants in response to stress and the modulation of associated microbial communities in the rhizosphere.

This study highlights the need to consider plant interactions with micro-organisms to understand and enhance its resilience to stress.