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Rhizosphere legacy: amelioration of MicroBioPhysical properties of compacted soil

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Soil compaction is a multi-disciplinary problem in which soil, plant, and air operations play an important role and may have dramatic environmental consequences throughout the world. In compacted soils, the increase in bulk density, and the accompanying decrease in porosity hinders the exchange of oxygen, carbon dioxide and other gases, thereby causing hypoxic stress in plant roots. Hypoxic stress can effects root physiological functions, reduce soil enzyme activity, hence reducing soil fertility. For the first time we applied a unique combination of two imaging techniques, zymography and optodes sensors with molecular microbial community analysis to illuminate the rhizosphere self-regulation for amelioration of microbiophysical properties of compacted soil. To this end maize in compacted and uncompacted soil under control condition for 2 weeks was planted.

Soil oxygen map and β-glucosidase activity in compacted maize treatment overlaid with the extracted root system demonstrated more than 65% positive correlation between hotspots of enzymatic activity and localities with high oxygen concentration –which were mostly in association with root. Similarly, extend of rhizosphere for oxygen concentration and enzyme activity across the root of compacted soil was 1mm broader than the uncompacted.

Based on root morphology analysis, compacted maize reduced roots diameter and increased the distribution. Which resulted in 30% higher ratio of rhizosheath mass in compacted than uncompacted soil. Rhizosheath formation changed porosity and aggregation around the root, thus, improved oxygen exchange. Accordingly, bacterial abundance and alpha diversity in hotspots of compacted soils were higher than the one of uncompacted. Thus, microorganisms localized in hotspots (rhizosheath) respond to better aeration, new carbon inputs compared to those inhabiting in the bulk soil. This confirms the distinguished role of rhizosphere-self organization for enzymatic mobilization of nutrients, and point out on the importance of aeration for rhizospheric microbial functionality (such as, enzyme expression for nutrients mining).