Understanding the role of soil microbiota in disease suppression under different farming practices

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ABSTRACT

Controlling soil-borne plant diseases by harnessing the natural potential of soil microbial communities has several benefits, including environmental sustainability and economic advantages for farmers. Disease-suppressive soils can naturally inhibit the development of phytopathogens, reducing the incidence of plant diseases. Organic agriculture relies on natural products and helps maintain ecosystem functionality by enriching soil biodiversity and chemical composition. Adopting organic farming to protect crops from soil-borne diseases can curb the increasing use of pesticides and fungicides since the green revolution to improve crop quality. However, the mechanisms underlying disease suppression in organic agriculture are poorly understood.

In the present study, a comparative analysis of the effects of long-term conventional and organic farming practices was done in terms of identifying characteristic disease-suppressive microbial, molecular, and metabolic markers. Once the higher disease-suppressive ability of organic farming was confirmed, its microbial basis was investigated by understanding the changes in the structural diversity of soil microbiome in conventional and organic agriculture. The bacterial and fungal diversity was analyzed using 16S rRNA and ITS-based amplicon sequencing. The alterations in the structural diversity of the soil microbiome were then correlated with the changes in the functional potential of the soil microbiome in the context of disease suppressiveness in organic and conventional farming. A robust culture bank of biocontrol strains was generated from organic field soil, and functional characterization was done using whole-genome sequencing and untargeted metabolomics. Several antimicrobial metabolic gene clusters related to non-ribosomal peptide synthetases were found in the genomes of biocontrol isolates. Based on the knowledge gained by identifying the structural and functional markers of disease-suppressiveness in organic farming, an attempt to transform a conducive soil into suppressive soil was made by a soil transplantation.