## THE SOIL MICROBIOME

The crop microbiome is "the entirety of the microbial community that includes both the community of microorganisms and the biological, chemical, and physical characteristics associated with both the microbes and their specific environment." In CAST Issue Paper No. 68 titled "Agriculture and the Microbiome" that was published in Aug. 2020, the following facts are presented.

- Today's agriculture is successful because of the many advancements [e.g. breeding, weed and pest management] that have enhanced crop productivity.
- The world's expected population growth and the corresponding increased demand for food, feed, and fiber products place a heavy burden on the resources that will be needed to continue to increase commodity production in the face of declining cropland acres and stagnating crop yields.
- The authors present a case for an expansion of crop microbiomes to improve plant production as the next agricultural revolution.

The soil microbiome is a subset of the crop microbiome, and is the repository of resources needed for plants to be productive. In the case of crop plants grown for food, feed, and fiber, this repository harbors and provides the living and non-living resources needed to produce an economical yield of a cultivated crop.

Many of the soil resources needed for a productive crop are derived from or enhanced by soil microbial activity. For example, nutrients that are tied up in residue from a preceding crop are only released for future plant productivity if soil microbes are present in an amount needed to do the job. Products of/from soil microbial activity aid in the establishment and maintenance of good soil structure that will enhance root proliferation and minimize the effects of erosive forces. A White Paper titled "Soil Additives and Soil Biology" on this website provides narrative and links to articles that present a summary about the importance of soil microbes and their activity for the creation and maintenance of healthy soils.

The following points can be used as guidance in the pursuit of an improved soil microbiome that will enhance crop productivity on present cropland.

- An improved understanding of how microbes can enhance the availability and use of nutrients that are already in the soil and previous years' crop residues is needed.
- Abiotic [e.g. weather, soil texture, soil acidity, soil structure] and biotic factors will influence both microbial diversity and activity. Optimum levels of these influencers that will favor beneficial soil microbes need to be determined.
- Ways of or additives for increasing active carbon [C–food source for microbes] in the soil to enhance microbial activity should be determined.
- New technologies must be developed and used to identify both beneficial and pathogenic soil microbes. Without this knowledge, only random good or harm can come from efforts to enhance soil microbial activity since microbes that are in the soil can have both positive and negative effects on plants.
- Research to identify practices that favor only beneficial soil microbes should be conducted so these practices can be adopted when possible.
- Research to discern the interactions between soil microbes and plant health is needed so that agricultural practices and crop management systems that will protect and improve soil and crop health factors can be identified for adoption.
- Research should be conducted to determine which components of the soil microbiome are the biggest contributors to or are the most important for improved and continued plant health. This research avenue will involve determination of the composition of the soil microbiome in order to identify which components are likely to have the most beneficial effect on plants.
- The end-product of all of the above research efforts will be the transfer of positive results toward the production of commercially available products that will be efficacious and versatile, and affordable to the producer of a crop.
- Adoption of any new microbial technology will only be successful if it can be effectively communicated to the producer that it will in fact provide benefits to both grower and consumer.

The above discourse leads to the following conclusions.

- Soil and crop scientists, microbiologists, and pathologists need to plan and conduct cooperative and intertwined research to determine that any newly-developed production practice will benefit the soil microbiome in addition to improving a crop's production potential. This means that new research directions will need to be considered when funding is sought to support planned research.
- Any new research plans should consider improvements in soil health and soil microbial activity that are known to contribute to long-term production sustainability.
- This new research avenue will also likely require a

working relationship between academia and industry to ensure that any effective new technology from this research can be advanced to result in an adequate supply of a commercially viable product that is available to agricultural producers.

The following articles on this website contain information that supplements the above subject matter.

- SOIL HEALTH AND FOOD SECURITY
- SOIL HEALTH TESTS & FARMER EXPERIENCE
- SOIL ADDITIVES & BIOLOGICALS
- SOIL HEALTH WHITE PAPER

An article titled "Unlocking the Secrets of Soil: Exploring the Microbiome and Its Applications–Part I" by Ghimire et al. provides a summary of 1) the components and applications of the soil microbiome, 2) the interaction of the rhizosphere [interface between the soil and plant roots] and soil microbes, and 3) environmental factors that determine the interactions among the soil, soil microbial community, and plants growing in the soil. Major environmental factors that affect these interactions are soil characteristics, climate and weather, practices used for crop production, and the plant species and species diversity at a particular site.

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