THE CROP [PLANT-SOIL] MICROBIOME

A microbiome refers "to a community of microorganisms in a particular environment and includes the biological, chemical, and physical characteristics associated with both the microorganisms and their specific environment". Thus, a crop microbiome is the community of microbes associated with a crop environment.

The following summary points are taken from "Agriculture and the Microbiome" [CAST Issue Paper No. 68] and "The Soil Microbiome".

- Today's agriculture is successful because of the many advancements in breeding, weed and pest management, etc. 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, dwindling resources needed to grow crops, and stagnating crop yields.
- An expansion/enhancement of crop microbiomes to improve plant production should be a significant part of the next agricultural revolution.
- Advances in technology and analytical methods allow today's scientists to study more complex crop microbiomes.
- The increased interest in the importance and protection of crop microbiomes has been precipitated by the need to couple intensive management of agricultural systems with good stewardship in order to minimize the negative effects on the crop's growing environment.
- Some plants attract or select for specific microbes, which suggests that the crop microbiome is an assembly of microbes that is ecologically dynamic.
- In order for microbes to be used for enhancing crop productivity, there must first be an understanding of how growing different crops under different management systems will affect the stability of a crop microbiome.
- It is recognized that gaps remain in the knowledge of how the exploitation of microbes and microbial activity can positively impact crop production and food security.

The following points pertain to the soil microbiome, arguably the most important component of the crop microbiome.

- Soil is the repository of resources, especially fungal and bacterial microbes, 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.
- The microbes in the soil and the plants growing in that soil form a symbiotic relationship that benefits both entities–i.e. the microbes influence soil properties such as soil structure and nutrient availability that benefit a growing plant, and the plants provide a food source for the microbes through root exudates and decomposition of crop residue.
- The number and diversity of soil microbes depends on: 1) soil properties such as texture, acidity, moisture content, aggregate stability, and organic matter [OM] content; 2) the crop or crops being grown on a site; and 3) site management history that involves tillage practices/intensity, cover cropping, and supplemental fertilization.
- Many of the soil resources needed for a productive crop are derived from or are enhanced by soil microbial activity. For example, nutrients that are tied up in residue from a preceding crop are only released for use by a future crop if the appropriate 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 healthy soil with a robust microbial population can minimize nitrogen [N] and

phosphorus [P] fertilizer losses.

- Both bacterial and fungal components of the soil microbiome are important for the decomposition of OM and the subsequent release of nutrients contained in that OM.
- Fungal hyphae are important for the transport of nutrients to the crop root system. Soil bacteria are a significant source of nutrients to growing plants.
- A robust and healthy soil microbiome can be a significant contributor to improved nutrient use efficiency–i.e. how much of an applied fertilizer nutrient is actually used by the plant growing at the site of application–by enhancing the availability of key nutrients to the plant.
- 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 [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 plant growth, development, and productivity.
- Research to identify practices that favor only beneficial soil microbes should be conducted so these practices can be adopted by crop producers.
- 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 soil and plant health. This research avenue will involve determination of the composition of the soil microbiome in order to identify and enhance the microbial components that are likely to have the most beneficial effect on crop plants being grown on a site.
- 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 the 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 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 will be available to agricultural producers.**

The following articles on this website contain

information that supplements the above subject matter.

- SOIL HEALTH INDICATORS
- SOIL HEALTH AND FOOD SECURITY
- SOIL HEALTH TESTS RELATED TO FARMER EXPERIENCE
- NEWS ABOUT SOIL ADDITIVES & BIOLOGICALS
- ADDITIVES AND BIOLOGICALS FOR AGRICULTURAL USE WHITE PAPER
- SOIL HEALTH WHITE PAPER

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