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Editorial: Elucidating the roles of plant-microbe interactions, biological control and plant breeding in the promotion of soil health and sustainable crop production systems

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Editorial on the Research Topic
Elucidating the roles of plant-microbe interactions, biological control and plant breeding in the promotion of soil health and sustainable crop production systems

It is worrying that prolonged intensive arable agriculture, coupled with climate change, undoubtedly results in huge loss of soil fertility, crop productivity, biodiversity, and leads to environmental crisis. If no alternative sustainable solutions are implemented, the world can no longer feed its alarmingly increasing population, which is estimated to be around 10 billion by 2050. This Research Topic served as a platform to gather essential research contributions on the roles of plant-microbe interactions, plant breeding, and biological control in promoting sustainable crop production and maintaining soil health. The four articles published under this Research Topic reported various findings on investigations that address sustainability in agriculture largely brought about by the interactions of plants with their microbial symbionts in the rhizosphere. The combined characteristics of breeding and effective symbiotic properties such as nodulation performance, have been proven effective in several field trials.

The first article by Ajilogba et al. reports the community level metabolic profiling of the rhizosphere soil of bambara groundnut (*Vigna subterranea* L. Verdc) using the BIOLOG™ method. In their study, the authors investigated the functional diversity of the soil microbial community at different stages of the plant growth as one of the essential indicators of soil health. According to the authors, this is the first report of the metabolic profiling of bambara groundnut in South Africa analyzed using the BIOLOG™. The study evaluated

the utilization of 31 carbon sources by the soil microbial communities and determined the functional diversity of the bambara rhizosphere microbiome. Rhizosphere soils removed at different growth stages of the bambara groundnut were analyzed and the finding of this study suggests the functional diversity of the soil microbial community at different stages of plant growth as an essential indicator of soil health.

Another important aspect of sustainability topic is discussed in the second paper by Mekonnen et al.. Here, the authors presented that breeding has an important implication in nodulation performance and root structure under natural inoculation, which improve soil fertility and enhance cowpea production. It is noteworthy that nitrogen (N) deficiency is one of the most important limiting factors that affects plant growth and yield worldwide. Several thousands of legume species are capable of fulfilling their nitrogen requirement by symbiotic nitrogen fixation in association with rhizobia, which significantly reduces the use of chemical fertilizers in agriculture (Berrada and Fikri-Benbrahim, 2014). In this work, the authors demonstrated the existence of a high genetic diversity in cowpea, which has a considerable impact on the nodulation capacity, root architecture, morphology and yield. Thus, selecting the most divergent parents for hybridization in successful crop improvement is essential. However, we recommend legume crop genotype selection for high productivity should also consider the genotypes that show the traits for effective nodulation with naturally occurring soil rhizobia to increase productivity. This can be done not only considering the numbers and position of nodules, but also their potential to fix nitrogen gas (N2) as can be identified by their pinkish appearance inside or using more reliable methods such as the determination of nodule dry weight, the acetylene reduction assay (ASA) or the N-15 natural abundance technique (Boddey et al., 2003; Saiz et al., 2019).

In the third article, Ojuederie and Babalola looked into a more specific, but very essential mechanism of action by plant growth promoting rhizobacteria (PGPR), which enhance the growth of maize under drought stress condition. In their investigation, the authors selected three PGPR strains based on their ability to produce 1-aminocyclopropane 1-caboxylic acid (ACC) deaminase, indole-3-acetic acid, and solubilize phosphate. They also based their screening on the tolerance of the PGPR strains to low water activity and high temperatures. The effect of PGPR on maize plants (*Zea mays* L.) under drought stress was investigated in a glasshouse study. Their results revealed that co-inoculation of three elite strains, *Pseudomonas* sp. MRBPR, MRBP14, and *Bacillus* sp. MRBP10 enhanced the growth of the maize plants, not only by mitigating the effect of induced drought stress, but also by alleviating water deficiency. At a time when it is desirable to minimize intensive arable farming which uses excessive external chemical inputs to increase plant productivity, the work presented in this study suggests an alternative solution to promote sustainable agriculture using PGPR as biofertilizers.

The last article under this Research Topic was on Cassava Brown Streak Disease (CBSD), a viral disease in cassava. The authors investigated the causes, spread and management practices to control this disease (Munguti et al.). Cassava was selected as it is one of the most important food security crops for almost one billion people, mainly grown by smallholder farmers in tropical and sub-tropical region, but its growth is largely constrained by CBSD. The disease is caused by two genetically distinct virus species, Cassava brown streak virus (CBSV) and Ugandan cassava brown streak virus (UCBSV) and it is transmitted by the white fly (*Bemisia tabaci*). Various methodologies were used in this study starting with a survey of the study sites, interviewing farmers and collecting samples. Diagnostics experiments to detect CBSD virus included total RNA extraction from the collected diseased leaf samples and carrying out complementary DNA (cDNA) synthesis and reverse transcription-polymerase chain reaction (RT-PCR). Low to moderate incidence and severity of the virus infection were detected as chlorosis on leaves, stem lesions and chlorotic blotches on leaf veins. Among the symptomatic samples tested, 91% tested positive for both UCBSV and CBSV viruses occurring either singly or as dual infection. In their final statement for a possible solution to control the cassava virus, the authors suggested encouraging farmers to plant certified cassava seeds, the need for a sustainable supply of disease-free cassava plant material and the use of host resistance against CBSD.

Considering the information gathered from the four articles published under this Research Topic, we strongly believe that the use of natural microorganisms, such as nitrogen fixing rhizobia and PGPR is very sustainable. Coupled with this, breeding for essential plant growth and yield enhancing traits and good management practices to control plant pathogens can provide concrete strategies in increasing crop productivity and improving soil health.

Author contributions

AH wrote the final draft of the manuscript. All authors have made substantial contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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