MANAGING BIODIVERSITY IN CROPPING SYSTEMS: THE CASE OF SYMBIOTIC AND NON-SYMBIOTIC MICROBES AND THEIR ASSOCIATED HOST PLANTS

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Microbes are a major component of biodiversity in cropping systems, and can increase grain yields through their mutualistic and symbiotic interactions with host plants, or reduce crop productivity via their pathogenic effects on plant growth. Mixed intercropping of legumes, cereals, tuber crops and vegetables, which is the mainstay of traditional agriculture in the tropics, allows for greater exploitation of symbiotic microbes and/or better control of microbial pathogens for higher yields. While farmers have historically exploited N_2 fixation in legumes for increased grain yields via the practice of crop rotation, other benefits of biodiversity in cropping systems have remained unknown in crop production. In addition to N_2 fixation, rhizobia (species of soil bacteria belonging to *Rhizobium, Bradyrhizobium, Allorhizobium, Sinorhizobium* and *Mesorhizobium*) produce chemical molecules that promote plant growth. These bacterial metabolites include phytohormones, lipo-chito-oligossacharide Nod factors, lumichrome, riboflavin and H_2 molecules that collectively or individually affect biodiversity in the cropping system. Nod factors, for example, stimulate seed germination, promote plant growth and increase grain yields in legume and non-legume crops. Recent field reports show that these increases in yields is due to increased photosythesynthetic rates in a wide range of crop species including corn, rice, common bean, canola, apple and grape plants. Lumichrome also stimulates plant growth and increases biomass in corn, sorghum, soybean and cowpea under glasshouse conditions, thus suggesting that its release into cropping systems can potentially enhance growth and possibly yields of plant biodiversity in the ecosystem. H_2 gas, which is a byproduct of N_2 fixation by rhizobia in symbiotic legumes, is also known to stimulate biomass accumulation in soybean, wheat, barley, and canola, as well as increase tillering, head number and grain yields of field-grown wheat and barley. Recent evidence also shows that rhizobia occur as natural endophytes of non-legume plants such as rice, corn, wheat and canola. Eventhough they do not fix N_2 in these hosts, they are able to significantly promote rice grain yields with optimal N fertilization. Additionally, rhizobia can suppress soil pathogen populations, and thus contribute to plant health in natural and agricultural ecosystems. The legume itself releases phenolics that suppress pathogens, solubilize nutrients, and promote growth of mutualistic microbes, in addition to forming nodule symbioses with rhizobia. Phytosiderophores and organic acids exuded by the host plant further enhance mineral nutrition in the cultural system. The biodiversity components of a cropping system, which includes cereals, vegetables and legume species, also emit green leaf volatiles as defense signals against insect attack. In so doing, some components of the biodiversity help control insect pests in mixed plant cultures. This paper provides new insights into how management of microbial biodiversity and the associated host plants can enhance productivity in natural and agricultural ecosystems.