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Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: UNE1303

Project Title: Microbial Solutions for Sustainable Cotton Soil Health Management

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CRDC Research Program: 1 Farmers

Final Report Executive Summary

The sustainability of crop production is a key issue for agricultural systems. Maintaining soil biodiversity is important for promoting soil health and sustainable crop production. The root zone is rich with microorganisms and nutrients. Soil type and agricultural management practices have great influence on soil biodiversity. Mixed vegetation contributes to an increase in soil biodiversity, while intense mono-cropping supports the growth of only a subset of soil microbes and suggested to be causing a decrease in biodiversity. Furthermore, increased use of fertilisers and pesticides might compromise both the activity and survival of certain microbes in the soil. The first aim of this study was to test cotton-growing soils in Australia that are under different management strategies for the abundance of microbes involved in nitrogen fixation and denitrification. It has been achieved using the quantitative PCR technique – extracting DNA from soils and measuring the presence of nitrogen fixation genes (*nifH*) and denitrification genes (*nirK*, *nirS* and *nosZ*). Soils that were relatively poor or rich in nitrogen cycling genes were identified. It has been noted that soils richer in nitrogen cyclers had also a more intense and diverse carbon utilization patters, indicating larger microbial community with higher biodiversity. Soil N content did not vary much under the different management strategies, but higher soil organic carbon was associated with increased functional capacity. Possible factors influencing the nitrogen cycler community in the tested soils that should be further investigated are the use of organic amendments, soil enhancers and rotation with other crops as well as the intensity of nitrogen fertilisation.

Every soil has potential to promote plant growth, with the most important players being the soil microbial communities. Plant growth promoting microbes contribute to biofertilization, biocontrol, and phytostimulation. Cotton seedling-disease complexes reduce crop establishment and lead to yield loss by causing stunted growth and, in severe cases, plant mortality. The period from seed germination to the establishment of cotton seedling is a critical stage in plant development. The seedling at this stage, lasting up until the development of two to four leaves, is particularly susceptible to soil-borne diseases. Improved plant nutrition and use of plant growth promoting microbes as inoculants could sustainably increase the success of crop establishment and reduce the impact of soil-borne diseases in

cotton growing systems. The second aim of this project was to isolate indigenous plant growth promoting microbes from Australian cotton-growing soils with the aim of developing successful isolates into inoculants for local soils. Methods for direct and rapid isolation of pathogen-suppressive bacteria and fungi were developed in this project and used in an related project for further isolation of a collection of microbes, suppressing black root rot caused by *Thielaviopsis basicola* and pathogens of other seedling diseases such as Rhizoctonia and Verticillium wilts. The collection is ready for testing under field conditions. Selecting for indigenous beneficial microbes increase the chances of survival of the re- introduced microbes in the soil. Other plant-growth-promoting microbes of interest were those that influence water retention and soil aggregation, secrete plant growth hormones, mediate stress response, solubilise phosphate or suppress pathogen growth. Methods for the isolation of such beneficial microbes were optimised for cotton-growing soils and then fine- tuned and used in a related project for producing a collection of beneficial bacteria is ready for testing under field conditions.

In recent years soil scientists have made enormous progress toward understanding soil organisms and their roles in ecosystems. Nonetheless, much remains to be discovered to allow the development of practices that will promote the sustainable use of soils. Understanding what causes changes in the belowground biodiversity and how diversity is linked to soil function, as well as how it influences crops, would contribute to sustainable agriculture and restoration of ecosystems.