The Invisible Goodies and Baddies

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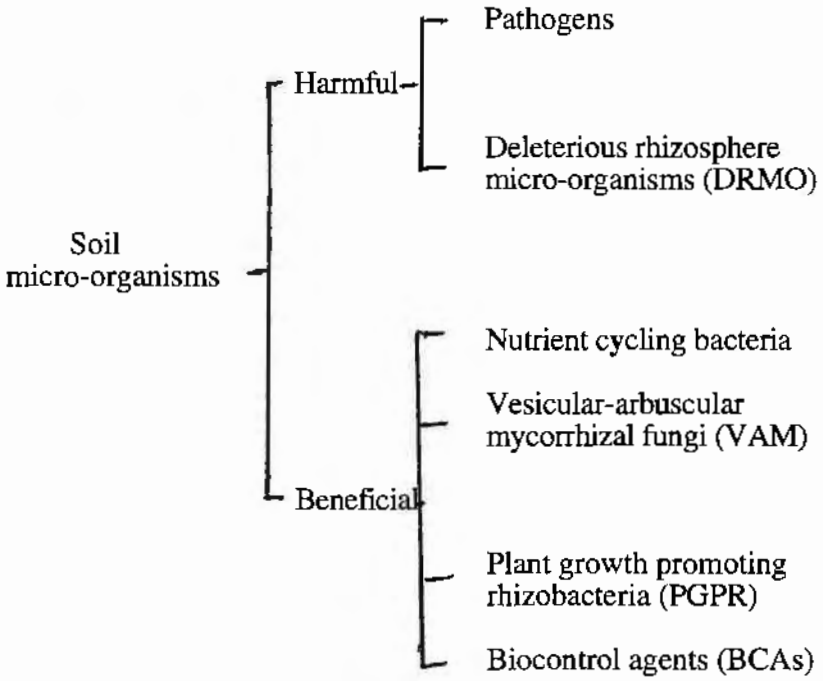
Summary

Soil micro-organisms, which influence crop production, can be classified into the following broad categories.



A research project at the Australian Cotton Research Institute, Narrabri aims at developing biocontrol agents for cotton seedling diseases and Verticillium wilt. This paper describes some of the aspects concerned with the project.

What is in soil?

Soil is a very complex environment. It provides anchorage to plant roots and also serves as a medium for supply of water and nutrients. It harbours macro-organisms such as arthropods, earthworms, nematodes etc. However, there is more to soil than meets the eye.

Soil contains very large number of micro-organisms such as bacteria and fungi that cannot be seen with the naked eye. One gram of a fertile agricultural soil contains hundreds of millions of micro-organisms. These micro-organisms can have a neutral or harmful or beneficial effect on plant.

The micro-organisms that are harmful to plants can be divided into two groups: (1) pathogens which cause diseases and (2) deleterious rhizosphere micro-organisms (DRMO) which retard plant growth without causing obvious disease symptoms.

Beneficial micro-organisms can influence plant growth either directly or indirectly. For example, some micro-organisms make nutrients available to plants by decomposing organic matter in soil or solubilising otherwise unavailable elements. Some bacteria produce a variety of compounds that can stimulate plant growth directly or suppress the DRMO. These bacteria are referred to as the plant growth promoting rhizobacteria (PGPR). Micro-organisms that suppress the pathogens (or their activity) are called biocontrol agents (BCAs).

Can we exploit the plant-micro-organism interactions?

Infection of roots by a pathogen is influenced by the physical and chemical properties of the root environment and the interaction of the pathogen with other micro-organisms in that environment. We can therefore adapt cultural practices that discourage pathogens (eg. planting into receding moisture to prevent seedling diseases). We can also introduce, into the root environment, micro-organisms that stimulate plant growth or suppress pathogens.

Research into biological control is now receiving attention world-wide, mainly due to concern for the environment and for sustainable crop production. Biological and cultural control methods mainly alter the root environment to favour the beneficial micro-organisms as opposed to chemicals which may eliminate not only the target pathogen but also other organisms. Biocontrol methods are less disruptive to the native micro-organisms and thus sustain the existing biodiversity.

Soil microbiology project at the Australian Cotton Research Institute

A research program on soil microbiology, funded by the CRDC, was started in June 1991 at the Australian Cotton Research Institute, Narrabri. The main focus of the project is to develop biocontrol agents against seedling diseases and Verticillium wilt.

At the beginning of the project several existing biocontrol agents from Australia and overseas were tested for seedling disease control. A few biocontrol agents showed some degree of effectiveness, but it was insufficient to give economic control. This underscored the need to isolate micro-organisms that are adapted to the local cotton growing soils and screen them for disease control with emphasis on their ability to perform under Australian field conditions.

Consequently, a large culture collection, which includes bacteria, actinomycetes and fungi, has been established at the Research Institute. A screening procedure, under laboratory conditions, has so far identified several micro-organisms that are antagonistic to *Pythium* and *Rhizoctonia solani* (seedling disease pathogens), *Thielaviopsis basicola* (black root-rot pathogen) *Fusarium* spp. and *Verticillium dahliae* (wilt pathogens). Some of the antagonists were tested in the glasshouse and subsequently in field experiments. A field trial conducted in 1993-94 has identified some promising PGPR.

Prior to the establishment of the current project, very little research was carried out into the microbiology of the cotton soils. Although, the main focus of the current research project is to develop biocontrol agents, it has generated valuable additional information. For example, the systematic study of the culture collection has thrown light on the microbiological diversity in cotton rhizosphere. It has also revealed the range of bacteria and actinomycetes associated with different tillage systems.

When the studies are complete, they will give an indication of the role played by the DRMO and the PGPR in cotton production. The information on microbial ecology, obtained through the current project, can be applied to other disease systems, such as the black root rot and Fusarium wilt, which are becoming important.

Acknowledgements

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