Microbiology of the Rhizosphere cont’d

Beneficial root-microbial interactions

1. The Legume-Rhizobia Symbioses: This association involves a formal symbiosis in which both partners benefit. Here, Gran negative heterotrophic bacteria originally classified within the genus *Rhizobium* interact with leguminous plants causing profound physiological changes in both organisms. The rhizobia fix nitrogen for a plant host in return for carbon sources supplied by the plant as photosynthates. The symbiosis occurs within the root nodules (newly formed root organs) that develop in response to the presence of specific soil borne rhizobia. The rhizobia themselves undergo physiological changes known as bacterioids and conduct the process of nitrogen fixation. As the plant host matures, ultimately the root nodules lyse and rhizobia are released back into the soil.
2. Mychorrhizal associations: The establishment and growth of plants are enhanced by the presence of specialized fungi in the soil that form close associations with their roots. These fungi are known as the mychorrizal fungi and they act as an extension of the root plant system. This aids in the uptake of almost all plant nutrients and particularly important in the uptake of phosphates which typically have low solubility in the soil solution and therefore exist at low concentrations.

When released from fungal hyphae, such nutrients can be taken up by the plant roots. In addition, when nutrients are stored within the fungus, it can act as reservoir of nutrients for future plant utilization. Roots and fungus complexes termed myccorrhizas (fungus roots).

Types of mychorrizal fungi

1. Vesicular-Arbuscular Mychorrizal (VAMs): These are endomychorrizal fungi and are found mostly within the internal tissues of the soil. The endophytes (fungi) have no septa and commonly produce large globose or irregular vesicles in the intracellular spaces or less commonly within the cells of the root cortex and much branched haustorium- like intracellular structures termed arbuscules which finally disintegrate and probably digested by the host. This type of fungus is frequently found in fertile soils and is characterized by the presence of smooth vesicles and branched arbuscules (threadlike hyphal networks) that are involved in the storage and transfer of nutrients between fungus and the plant. Their functions include reduction of pest and nematode infection, promote seed production, increase drought and disease resistance, facilitate soil aggregate and nutrient (N and P) uptake and transfer. Six genera within this order are recognised of which are *Glomus* and *Gigaspora* spp.
2. Ectomychorrhiza: they are formed by both ascomycete (e.g *Elaphomyces* spp) and basidiomycete (e.g *Agaricus* spp, *Boletus* spp) fungi. Example of the latter are best known for their fruiting bodies which include toadstools and puffballs. These associations are characterised by intercellular hyphae as opposed to intracellular penetrations of the VAMs. These mychorrhizas are formed on the roots of woody plants, with a thick fungal sheath developing around the terminal lateral branches of the roots. This is also known as the mantle and is connected to the network of the intercellular hyphae found in the root cortex known as the **hartig net** carbon substrate is supplied by the plant to the fungus and minerals in particular phosphates are supplied by the fungus to the plant.

A section through an infected lateral or short root shows that the hyphae occupy the intracellular spaces of the cortex forming the hartig net but are chiefly aggregated in a dense covering or mantle outside the root. The cortical cells are much enlarged and become separated by the destruction of the pectic substances of the middle lamella (central membrane of the cell wall between two cells). The mycorrhizal fungi increase the absorbing area of the root and since the hyphae of the mantle are continuous and widespread mycelium in the surrounding soil, they may draw nutrients from a wider area than that reached by the tree root.

1. Orchidaceous mychorrizas: Many orchid plants may never produce chlorophyll while others do so after they have matured past the seedling stage. Therefore, all orchid have an absolute dependence on their endomycorrhizal partners for at least part of their lives. Orchid mycorrhizal fungi are saprophytic. They must degrade organic matter to obtain carbon which the orchids then also consume. In this case, the orchid function as a parasite. This is the only type of mychorrizal association in which the carbon flow is into the plant form the fungus. It is assumed that the fungus obtain nutrients from the orchid and the latter benefits by the synthesis of organic substances by the fungus which become available by the digestion of the hyphae.