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Mechanism Triggering Fungal to Switch Lifestyles in Plant-fungal Interactions

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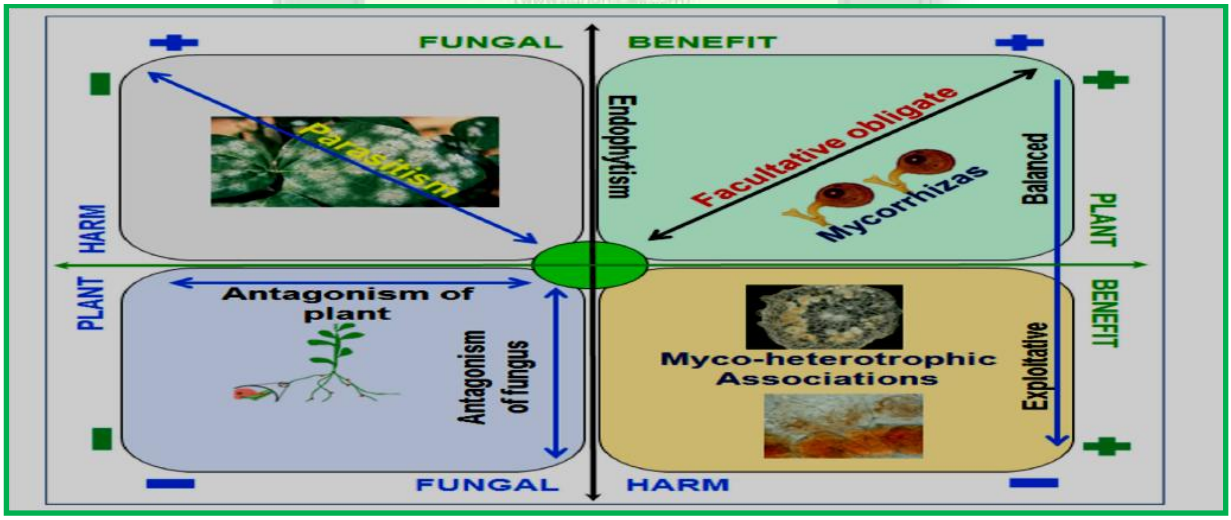
Many fungi may evolve their lifestyles as saprophyte-endophyte- pathogens to adapt to various changes in host and environmental conditions. Many of those interactions are beneficial to the host plants and a few are detrimental to life. The interconversion of one fungal lifestyle into another while interact the plant system meaning endophyte may become parasite or vice versa. The endophytic stage represents a balanced interaction between fungal virulence and host defense factors. When this balance is disturbed or the host dies, endophytes may become pathogens or saprotrophs, respectively. Saprotrophs and pathogens may switch their lifestyles to endophytes/pathogens and endophytes/saprotrophs, respectively, in the presence of appropriate environmental factors. The physiological, biochemical or molecular are the routes to identify the factors that trigger the change in fungal lifestyle, which is entirely different than earlier one and affects the host plant significantly. The molecular and biochemical basis for the switching of lifestyles from endophytic to parasitic are characterized by an imbalance in nutrient exchange between plant and fungus, single gene mutation, light-induced production of H_2O_2 by the fungus, Genetic, Unbalanced interaction with the host. Taking into consideration that a little contribution have been made so far on the lifestyle switching of plant associated fungi, there is an urgent need to study in depth for its better understanding in order to utilize the full potential of endophytes. The endophytic fungi have demonstrated their high biodiversity in recent years. They have proved to be plant growth promotional, useful in pharmaceutical and other industrial products. More number of fungi needs to be screened using advanced molecular biology approaches, which in future may offer better insights into plant–fungal interactions. If some specific genus or species has lifestyle switching ability, they can be put into a separate group to study their ecological and evolutionary consequences. A clear understanding of the mechanism underlying the lifestyle switching of fungi and the factors responsible for these types of transitions are essential to the long-term development of targeted control measures for plant diseases caused by pathogenic fungi.

The close interaction of plants with fungi is very old phenomenon. The fossil records provide evidence that the fungi have been symbiotically associated with plants, since 400 million years ago the period when the plants first established on land (Atsatt & Whiteside, 2014). Almost all the plants in natural ecosystem have been found colonized with one or more fungal and bacterial symbionts. This specifies that these symbionts may have helped the

plants to establish from aquatic environment to the land. The fungi or bacteria, which grow inside the plant tissue without causing any harm to the host are termed as endophytes, confer various fitness benefits to the plants in contrast to the parasites, which cause disease. But there are also reports that endophytes can become parasites under certain conditions and vice versa (Muller & Krauss et al., 2005). Earlier, the fungal symbionts were thought to be restricted to specific symbiotic lifestyles, such as mutualism, commensalism or parasitism. However, recent studies have indicated that the fungi may express different symbiotic lifestyles in response to host internal signals or environmental factors. Thus, the interactions between plants and microbial endophytes may range from mutualism, commensalism to parasitism (Redman et al., 2001). The factors, which are responsible for switching of lifestyle from parasitic to endophytic and vice versa are not exactly known. The biochemical, molecular and genetic basis of plant-fungal symbiotic interactions (from parasitism to mutualism), and the response of host plants to these microbes, is significant for its better understanding. Clearly, the plant– fungal interactions are complex and the level of complexity surrounding such studies is exacerbated by the fact that there are numerous species of fungi differing in the mechanism by which they interact with the host plant. This review is an effort to reveal the mechanism underlying the lifestyle switching of plant associated fungi, based on recent findings.

Lifestyle Patterns of Fungi

- **Symbiotic**: Stable association between two or more distinct organisms, at least for a fraction of the lifecycle. Rodriguez *et al*. (2005) have described three classes of fungal symbionts: mycorrhizae, class 1 and class 2 endophytes. Mycorrhizal fungi are found associated with plant roots, develop an extensive hyphal network in the soil and share nutrients with their plant hosts. Class 1 endophytes: Clavicipitaceous fungi that infect cool season grasses. Class 2 endophytes are largest group of fungal symbionts and colonize all plants in natural ecosystems.
- **Parasitic:** Infect the plant tissue causing the disease symptoms are considered as pathogens.
- **Commensalism:** The undisturbed existence of fungus inside the plant tissue without affecting the host, neither provides any benefit or support in the form of nutrients or secondary metabolites nor causes the disease.



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