Chapter 5
Potential Role of Endophytes for Sustainable Environment

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ABSTRACT

Endophytes are symptomless fungal and bacterial microorganisms found in almost all living plants. They are vital components of plant microbiomes. Endophytes affect plant growth and plant responses to pathogens, herbivores, and environmental change by producing a range of natural products having antifungal, antibacterial, and insecticidal properties. Endophytes have shown particular promise in agriculture particularly as beneficial crop inoculants and are known to enhance abiotic and biotic plant stress tolerance by increasing tolerance to drought and water stress, as well as tolerance to high temperature and high salinity. A better understanding of their plant growth-promoting mechanisms could simplify higher production of energy crops in a more sustainable manner even on marginal land and feed stocks for industrial processes, thus contribute to avoiding conflicts between food and energy production Many endophytes can be exploited to improve the efficiency of phytoremediation as they are found to be resistant to heavy metals and capable of detoxifying organic contaminants.

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INTRODUCTION

The term endophyte was originally defined by De Bary in 1866 as "Any organism occurring within plant tissues". The word endophyte means in the plant (derived from the Greek-endon = within, phyton=plant) this term can be used for a wide spectrum of potential hosts inhabitants, e.g. bacteria, fungi, etc. (Stone et al., 2000).By definition, an endophytic fungus lives in mycelial form in biological association with living plant at least for some time. Endophytes are very diverse group which include endophytic bacteria and endophytic fungi (Raghukumar, 2008).There are approximately 300,000 plant species on earth and each plant is the host to one or more endophytes, and many of them may colonize certain hosts (Petrini, 1991). Endophytes are ubiquitous in nature as they have been recovered from plants adjusted to a wide range of ecosystems that include hot deserts, temperate, arctic tundra, tropical forests, grasslands and croplands (Arnold, 2007, 2008; Arnold & Lutzoni, 2007). They are present in all the major lineages of land plants (conifers and flowering plants, mosses and other non-vascular plants, ferns and other seedless plants) (Arnold, 2007). It has been estimated that there are at least 1 million endophytic fungal species which signifies the importance of fungal endophytes as vital constituents of fungal biodiversity (Ganley et al., 2004). These microorganisms reside in the intercellular spaces of plants with no antagonistic manifestation and exhibit a relationships with specific plants and produces bioactive substances (plant growth regulatory, antibacterial, antiviral, antifungal, insecticidal, etc.) enhance the growth and competitiveness of the host in nature (Shentu et al., 2014;Hardoim et al., 2015; Card et al., 2016). Some endophytes could be reliable sources of materials of the agricultural and pharmaceutical potential (Nisa et al., 2015). Endophytic microbes initiate the biological degradation of dead or dying host-plant which is necessary for nutrient recycling (Hungria et al., 2010). These microbes inhibit the plant without causing any harm and can ascertain a mutualistic association (Azovedo et al., 2000).

Endophytic bacteria also known as endosymbiotic microorganisms live in internal plant tissues of healthy host plants and inhabit an ecological niche similar to that of phytopathogens, as suitable biocontrol agents (Berg et al., 2005). These biocontrol or biofertilizer agents have replaced harmful chemical fertilizers which have increased the quality of yield without compromising on its quantity. These microorganisms precondition plant internal environment which result into disease suppression and better cope against pathogen in a specific host. Biological control is likely to be less spectacular than most harmful or chemical controls but is generally more stable and environmentally sustainable. Phytoremediation may be repressed because the plant experiences phytotoxic effects from contaminants such as heavy metals, polycyclic aromatic hydrocarbons (PAHs), and halogenated hydrocarbons. Though, some endophytes show plant-growth-promoting potential, but they also possess several traits that can alter contaminants' through the production of iron chelators, siderophores, organic acids and various degrading enzymes (Yousaf et al., 2010; Soleimani et al., 2010). The plant roots offer an impeccable environment for degradation of heavy metal by microbes. These microbes help in production of exudates, enhances the microbial activity, increases the movement of gases and water within soil environment (Weyens et al., 2010).Combined effect of all these influences the contaminant availability for uptake and degradation of pollutants. This type of mechanism is an advantage over bioremediation, where the microbes may not be able to survive at a site or degrade a pollutant because it may not be bioavailable (Newman & Reynolds, 2005). Hence using plant-microbe association for removing heavy metals is a promising green technology. Endophytes are the synthesizers of various bioactive chemicals inside the plant that can be used as potential sources of many pharmaceutical leads. These compounds have been optimized by ecological and environmental factors yielding effective bioactive agents and useful for novel drugs

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