Fungal Genomics & Biology
ISSN: 2165-8056
OPEN ACCESS Freely available online
Short Communication

Mycorrhizae: Potential Biocontrol for Crop Plants

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ABSTRACT

Besides functioning as an effective bio fertilizer mycorrhizae offers plant immunity to some degree, known as Mycorrhiza Induced Resistance (MIR) in plants. This immunity is effective against a variety of air and soil borne pathogens. Plant receptor protein complexes or pattern-recognition receptors recognize the Effector Proteins (EP) and Microbe-Associated Molecular Patterns (MAMPs) of mycorrhizae as these are very much related to other possible pathogens. So MAMP Triggered Immunity response (MTI) is activated in plants and inhibit further invasion of pathogens. This offer both short time and long-time defence in plant with systemic acquired resistance and induced systemic resistance. In this process defence related genes are activated in response to different pathogens and antipathogenic secondary metabolites are produced. Mycorrhizae also modify plant root exudates to attract beneficial microbes which also offer induced systemic resistance and act as consortium.

Keywords: Mycorrhizae; Plants; MAMPs; MTI; Effector protiens

DESCRIPTION

Mycorrhiza is the composite structure of plant root and mycelia of obligate symbiotic fungi. Frank [1], reported first 'mycorrhizae' and its growth induction properties in pine seedlings. Among different types of mycorrhizae, *Arbuscular mycorrhiza* (AM) is most common, as they form symbiosis with more than 90% terrestrial plant species. AM produce 'arbuscles' – a bush like structure by continuous bifurcation of hyphal tip in host cortical cells, for transfer of nutrients from soil to root [2]. Besides uptake of nutrients and water, mycorrhizae perform other functions too, as maintain soil sustainability with hyphal protein-glomalin to stabilize soil aggregates and boost up plant immunity [3-6]. As AM are widespread and most of the crops are host plants, AM may be utilized as a biocontrol agent, when agrochemicals have negative impact on human health and environment. Different studies showed that plants are benefited from the symbiosis with increased tolerance to wide varieties of pathogens-fungi, bacteria, viruses and nematodes [7,8]. Though works are limited and Mycorrhizae Induced Immunity (MIR) is an aggregation of complex phenomenons, information regarding the possible molecular pathways is recently being revealed. As a biotroph, when mycorrhizae invade in plant root, plant receptor protein complexes or Pattern-Recognition Receptors (PRRs) recognize the Effector Proteins (EP) and Microbe-Associated Molecular Patterns (MAMPs) of mycorrhizae [9]. These are very much related to other possible pathogens. So MAMP triggered immunity response is activated in plants and inhibit further invasion of potential pathogens in plants. The next reactions are as usual–oxidative burst in cytosol, increase of Ca^{2+} influx and induction of synthesis of defence related genes to produce antipathogenic secondary metabolites through salicylic acid pathway. MIR produce both short time and long-time defence in plant and also Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), which occur in response to pathogens and non-pathogens respectively. SAR can be explained as keeping MAMPs in memory and quick recognition, action and long-lasting resistance to secondary infection throughout the uninoculated plant parts also. SAR is active against a wide range of pathogens, including bacteria, fungi, oomycetes and viruses [10]. Some important metabolites such as salicylic acid, pipecolic acid, jasmonic acid are vital for SAR, in activation of defense related genes.

Pre-inoculation of plants with AM have shown to induce different defence related genes in different plants in response to later invasion of different types of pathogens. Marquez, et al., [11] showed that increased transcriptional up-regulations for the defense-related genes, which encode simple phenols, flavonoids

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Received: 04-Mar-2024, Manuscript No. FGB-24-30172; **Editor assigned:** 06-Mar-2024, PreQC No. FGB-24-30172 (PQ); **Reviewed:** 20-Mar-2024, QC No. FGB-24-30172; **Revised:** 27-Mar-2024, Manuscript No. FGB-24-30172(R); **Published:** 03-Apr-2024, DOI: 10.35248/2165-8056.24.14.241

Citation: Dutta SS, Ghosh S (2024) Mycorrhizae: Potential Biocontrol for Crop Plants. Fungal Genom Biol. 14:241

and lignin in mycorrhizal soybean seedlings infected with *Fusarium virguliforme*. Transcription of *C4H* encoding gene, which regulates the hydroxylation of t-cinnamic acid to form p-coumaric acid, flavonoid and chlorogenic acid biosynthetic pathways genes, was found to be enhanced against tomato mosaic virus in mycorrhizal plants [12]. Mycorrhiza inoculated *Poncirus trifoliata* host upregulated the expression of genes (*PtLOX and PtAOS*) involved in Jasmonic Acid (JA) biosynthesis when infected by the root rot fungus *Phytophthora parasitica* [13]. The Jin Bao cultivar of tomato (*Solanum lycopersicum* Mill. cv. Jin Bao) when prior inoculaed with the AMF *Funneliformis mosseae* elevated the expression of three defense-related genes (*LOX, AOC* and *PAL*) and three pathogenesis-related genes (*PR1*, *PR2* and *PR3*) upon infection by the early blight pathogen, *Alternaria solani*.

Mycorrhiza modifies the secretion of strignolactones and other biochemical compounds in host roots, which attract other beneficial ISR-inducing bacteria [14]. This antagonism is a part of 'mycorhizospheric effect [15]. Thus, mycorrhiza provides an overall defence in host plant. In sustainable cultivation, this benefit of MIR could be fully availed. The schematic representation is shown (Figure 1).

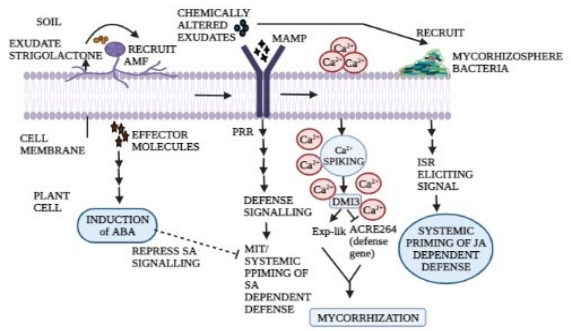

Figure-1: Schematic representation of Mycorrhiza Induced Resistance (MIR) interaction between Mycorrhiza -Associated Molecular Pattern (MAMP) and Pattern Recognition Receptor (PRR) induce MAMP Triggered Immunity (MTI) and systemic priming of salicylic acid dependent defense. MAMP triggered calcium spiking and as result activate calmodulin kinase DMI3 which represses the expression of the defense gene and promotes mycorrhization. The mycorrhizal association can chemically alter exudates and recruit rhizobacteria in the mycorrhizosphere. Mycorrhizosphere exert Ethylene (ET) and Jasmonic Acid (JA) dependent defense and promote Mycorrhiza induced systemic resistance. **Note:** Figure courtesy: Dey, et al., [6].

CONCLUSION

The recent evidences of AMF enhancing defence against soil born and aerial microorganisms and pest, by physical means and molecular mechanisms, mainly by induced systemic resistance is increasing the expectation of utilisation of AM as effective biocontrol tools. New researches in role of AMF in transcription of different defence related genes and are putting lights. Some more investigations in interactions of different AMF with pathogens and mode of actions and the investigation in the synergistic action of rhizospheric consortia in field application is important.

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