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Review Article

Ecological importance of strigolactones hormone on arbuscular mycorrhizal fungi symbiosis in plant

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ABSTRACT

Strigolactones (SLs) are versatile compounds that have recently been identified as a special generation of plant hormones. They play a significant role as modulators of coordinated plant development in response to nutrient deficiency and defence, particularly by influencing plant root microbiome and mycorrhization. SLs act as signals molecules that help host communicate with their environment belowground, in addition to regulating root architecture and growth promotion. Alternatively, boosting the SLs hormone level or applying external SLs, SL synthetic analogs e.g. GR24, and SL mimics to plants, can improve the root architecture, and physiological changes, and controls biotic and abiotic parameters by activating regulatory genes and molecular changes. Interestingly, SLs perform a fundamental character in the establishment of arbuscular mycorrhiza fungi (AMF) symbiosis by eliciting mycorrhization in the plant, which allows for adequate phosphorus utilization. Due to various their multifunctional aspect, they have a wide range of possible agricultural and biotechnological applications. We should be able to comprehend the biological mechanisms operating below ground in plant systems and their significance in the ecosystem with greater clarity as more research is conducted into the necessary conditions for various SLs in various biological activities.

1. Introduction

Arbuscular Mycorrhizal Fungi (AMF) are obligate biotrophic roots that exchange mutually beneficial effects with around 80% of plants[1,2] and symbiotic relationship among plants and fungi from a long-gone phylum.[3,4] AMF, which is established by the majority of territory plant species and fungi that are members of a monophyletic phylum called the Glomeromycota, is most likely the most widespread terrestrial symbiotic association.[5–7] Interestingly, this mutualism relation helps host plants develop vigorously in harsh circumstances by facilitating a series of complicated interactions among the fungus and plant that cause an increase in photosynthetic efficiency[8] and additional gas exchange related attributes[9] in addition to increase in water and soil nutrients absorption.[3,10–12] AMF are recognized to tolerate high metal concentrations in the soil and it can reduce heavy-metal toxicity in the host plants reported by several investigators.[13–16] The homeostasis of heavy metals depends heavily on metal transporters.[17] Glomus intraradices has a Zn transporter, according to findings of Gonzalez-Guerrero et al.[18] AMF closely links plants to the fungi's hyphal network,

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which can contain more than 100 meters of hyphae per cubic-centimeter of soil.[19] This AMF hyphal-network has been specifically designed to absorb water and nutrients, primarily phosphate and others nutrients.[20] AMF enhance the soil-quality by changing the texture-structure of the soil, which benefits plant health.[2,16,21] Organic matter in soil can decompose more quickly thanks to fungus hyphae. Additionally, by enhancing the "sink effect" and moving photon -assimilates from the aerial parts to the roots, mycorrhizal fungi may have an impact on how much atmospheric CO_2 fixation occurs by host plants.[22,23]

Now a days, plants are constantly facing the challenges because of unfavourable environmental conditions, resulting in significant reductions in growth, yield, and physiological traits. Hormones have a major influence on the regulation in plant development, overall physiology, and shelf life. Strigolactones (SLs) were discovered to be in charge of altering fungal physiology and mitochondrial activity as well as inducing branching.[24] The parasitic plants Striga and Orobanche are known for using SLs as germination stimulants.[25] In some AMF, SLs can also promote sporulation.[26] It has been discovered that species of Striga take advantage of an ancient and conserved communication system between associated fungi and their host-plants.[27] The physiological functions and molecular signalling involved in root development are carried out by SLs involvement, which also serve as signals to attract the AMF for symbiosis.[28] SLs are new carotenoid-derived signaling molecules (hormones)[29] that developed as controllers of a simple developmental processes in very early plant lineages prior to actually bringing in unique roles to help land plants grow vigorously without any biological complexity[24] (Figure 1). Around 25 different types of naturally present SLs have been documented in various plant species, and they are divided into two groups classified on their chemical structures – (i) canonical and (ii) non-canonical SLs.[30] A butenolide ring (D ring) is joined to a tricyclic lactone (ABC rings) via an enol ether bridge in canonical SLs. The ABC ring is substituted with an irregular ring structure in non-canonical SLs. SL molecules in various forms may have diverse biological functions.[31]

Natural SLs' chemical synthesis is limited by their complicated structure and stereochemistry. GR24 is a generally applied synthetic SL analogue in science. Their adaptability is also demonstrated by the fact that, once released in the rhizosphere but it's extremely low amounts (10^{-7} to 10^{-15} M)[24,32] or externally applied synthetic SLs analogs like GR24,[33,34] they have been used as a signaling compounds for plant- networking organisms and plant growth development from various kingdoms.[35,36]

Plants are regularly exposed to a variety of un-favourable environmental circumstances, resulting in abiotic stress and lower productivity. In this scenario, the microbiota of the rhizosphere must be improved by signalling molecules. New

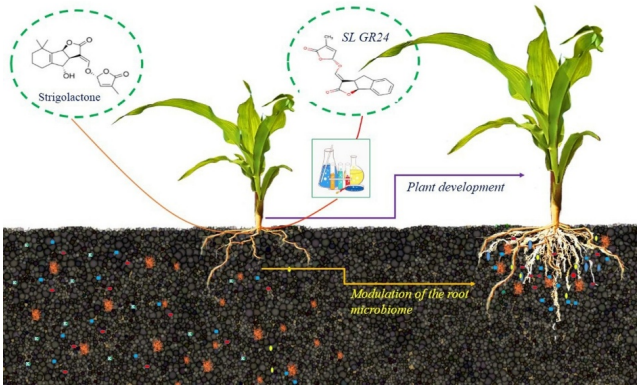

Fig. 1: SLs hormone in plant microbe's interaction and growth promoting

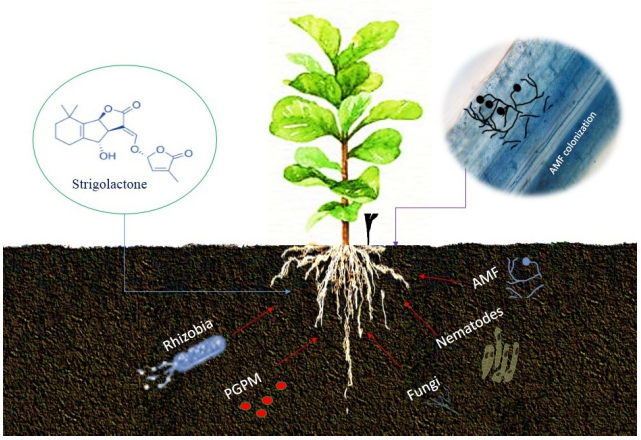

Fig. 2: SLs hormone role in plant interactions with beneficial root microbiome

phytohormones like SLs are important for regulating plant biological activities and assisting them in communicating with the outside microbial community (Figure 2).[35–37] SLs also orchestrate resource distribution modifications by strategically altering plant growth, allowing plants to respond to nutrient availability. SL interacts with auxin, abscisic acid, ethylene, cytokinin, and other plant phytohormones to construct elaborate signalling networks, then instead of functioning independently.[37]

Endogenous plant hormones, on the other hand, play crucial roles in modification to shifting environmental factors by mediating growth, development, nutrient dissemination, and source changes. Moreover, the hormonal interactions can modify how plants react to environmental cues like nutrient deficiency and canopy shade, as well as how plants are arranged. Since the initial discovery, there have been significant developments and fresh insights into the biosynthesis, signalling, and transport of SLs.[38,39] We give a basic overview of SL in this review along with

a thorough discussion of how we currently understand their function in plants and how crucial they are to AMF symbiosis and plant growth.

2. Conclusion

Strigolactones (SLs) play a significant role in modulating coordinated plant development in response to nutrient deficiency and protection, especially by influencing plant mycorrhization and the root microbiome. In addition to controlling root architecture and promoting growth, SLs function as molecular signals that assist plants in interacting with their underground environment. They have a wide range of potential agricultural and biotechnological applications because of their multifunctional nature. We should be able to comprehend the biological mechanisms operating below ground in plant systems and their significance in the ecosystem with greater clarity as more research is conducted into the basic requirements for various SLs in various biological activities.

3. Source of Funding

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4. Conflict of Interest

We have no conflict of interest to declare.

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