Mycorrhizal Symbiosis

Omid Alizadeh

Department of Agriculture, Firooz Abad Branch
Islamic Azad University, Firooz Abad, Iran
omid_alizadeh2003@yahoo.com

Abstract

The term mycorrhiza is rooted from two Greek words myco meaning fungi and Rhiza meaning root and its’ meaning in reality means symbiosis between a fungus and root. Mycorrhiza is described as a mutual sharing of life; whereby the fungal is the major partner of the plant has the duty to supply food, growth hormones and protection of plants’ root from pathogens and a fine plant will offer high energetic material to the fungus. Most Higher plants are related to one of the mycorrhizad coexistence. Frank viewed the relationship between the growth of plant and fungus for the first time in forest trees and named it Mycorrhizen. this review gives an overview on the mycorrhizal symbiosis and Classification of mycorrhiza.

Keywords: Ectomycorrhize, Endomycorrhize, Ectendomycorrhiza, symbiosis

Introduction

Living things have a complex and multilateral connection with one another and their surrounding whereby the surrounding and the living things form a related collection and this collection creates a complex ecological system. [15] These types of connections have an effective role in maintaining the natural ecosystem. Therefore if two living things live next to one another and maintain very close connection where following these connections, living becomes possible or better for them, they will be considered as symbiosis. In other words, in any case where living things maintain close connection with each other, a sort of coexistence can be mentioned. In reality
the word coexistence means “participating in life” or having a joint life; in other words, it means forming one life together. Coexistence is a close relationship which exists between most living things in nature; be it plants or animals. There often is no kinship or evolutionary relationship between two coexistent creatures [1]. In complex organisms’ level, various types of coexistence exist. In between them coexistence in a peaceful manner/form (when the two sides benefit) is most common and has the most ecological significance. From various types of peaceful coexistence in nature, we can point out the relationship between fungi and alga in lichen, the relationship between bacteria and angiospermae in nodules in the nitrogen-fixation and the relationship in plants and fungi in the state of mycorrhiza, to which all have an important role in natural ecosystems. [14] In symbiosis between algae and fungi in the state of lichens or plant and algae in the state of mycorrhiza, fungi is a creature which has no chlorophyll, therefore it is unable to synthesize many of its critical living compounds, but in terms of absorbing them from other sources, it has very effective mechanisms. Therefore the fungus must obtain the material that they cannot synthesize, from other sources. Vesicular arbuscular mycorrhiza (VAM) fungi are the most common and abundant coexistent fungi in soil and can coexist with more than 90 percent of plant species to establish a symbiotic relationship. [13] So mycorrhiza is the persistent symbiosis between the roots of the plant and fungi and in the soil where there’s problem with lack of absorbable nutrients for plants, using coexistence method, the mycorrhiza fungus can increased capacity for absorption of nutrient into the host plants. [5] In addition, fungus has the ability to produce and secrete growth hormones, better water absorption and protection against plant pathogens. [14]. These fungus using a triple interaction of soil, fungi and plants are able to provide other benefits to host plants that their most important are: Increase plant resistance to diseases, increased biological nitrogen fixation, increasing plant resistance to drought, increased photosynthesis rates, lower concentrations of elements such as cadmium and arsenic in plant tissues Mycorrhizal and improve soil physical properties. [12] [14] [10]

**Morphology of mycorrhizal fungi**

The term Mycorrhizal meaning fungi to the root, was used for the first time in the year 1885 by Frank. In this participation unlike the attack mode against pathogenic fungi to plants there were no signs of disease seen, but with a biological relationship, their benefits are shared. So the potential of this collection is more than their total potential in singular mode. Mycorrhizal fungi are divided into two general categories endomycorrhiza and ectomycorrhiza. The recent batch establishes a symbiotic
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Relationship with plants, especially tree crops mainly needle leaf forests and eucalyptus trees. Mycorrhizal fungi have two types of mycelium systems: Internal and external mycelium. 

Internal myceliums grow in between and inside the parenchyma cells of the host plant roots. Internal myceliums create many branches within the plant root cells. This collection of branches in each cell is names Arbuscule and it is believed that the exchange of nutrients between fungus and plant is done in the arbuscule. These arbuscule are formed between two and four days after inoculation of the roots. Their life time is short and lasts between 4 to 15 days, and later on they are destroyed and digested and their elements are used by the host plants. New arbuscule are regularly formed. Vesicle are other organs of mycorrhizal fungus which are fitted within the roots of the host plant. Vesicles have a spherical shape and they’re the place where fat is stored and they play no role in the uptake or transfer of nourishment and because of that, sometimes they are called AM instead of VAM. Some vesicles are devoid of mycorrhizal. After the formation of these organs, they do not go away and they last till the end of fungus lifetime. The relationship between fungi and plants is peaceful, because on one side fungus provides the plants with nourishment, and on the other side it receives the necessary carbohydrates and energy from the host plant. A symbiotic system is formed when a fungus is able to infect the cortex primal cells of the root. Therefore this circumstance depends on the physiological conditions too. Intrusion into the fungal cell was a mechanical job and fungi can only attack the roots of plants by passing through the cuticle layer. It has been observed that when the cells of host plant grow immediately, influence into fungus cell becomes slower. So where the roots are strong and fast growing, such as gimnoseeds or plants under conditions of good fertility, the fungus does not penetrate well and penetrate into the cell happens only after a significant reduction in growth.

Classification of mycorrhiza

Although Harley divided the mycorrhizal symbiosis, in 1961 into two groups of Endotheraphic and Ectotheraphic, but since then the two words Endomycorrhiza and Ectomycorrhiza were used, although currently the classification of mycorrhizal is based on the type of relationship between fungi and plant to the state of communication between root cells with fungus mycelium, and respectively the three groups of Endomycorrhiza, Ectendomycorrhiza and Ectomycorrhiza are
characterized. The three groups differed in how the fungus penetrates into the host cell and create various fungal states and its’ structures in host cells. [13]

A – Ectomycorrhize fungus

These fungi are of the class Basimycets and some are from Ascumycets and few imperfect funguses and only of type of Zygomycets called Andogon. These funguses do not enter into root cells and that’s why they are reffered to as Ecto (external). Through the space between the root skin cells the rows of this fungi provide a dense network called the Hartic network for exchange of metabolites with the host plant. In addition by forming a rather thick layer of sheath or a pod on the surface of short and feeder roots, which often by changing the color, the shape of the roots follows frequent branches of two or more. Detection of Ectomycorrhiza is easily done through morphological changes of the root sheath. [12] [6]

B – Endomycorrhize fungus

These fungi are entirely classified as Zygomycets. These types of mycorrhize are called Endomycorrhize fungi because the fungus penetrates into the root skin cells of host plants. The basic principles of naming VAM mycorrhizal is producing specific fungus organs named Arbuscul and Vesicle within the host plants root. In some types of Endomycorrhize fungi, vesicle are not formed; of this type we can refer to the mycorrhizal fungus which belong to the genus Gigaspora and Scutellospora. Vesicle appear mostly in the mid to late vegetative period, but Arbuscul is the original location for metabolic exchanges between the fungus and plant. Arbuscals are usually formed in the inner part Skin stem cells. The fungus roots, after penetrating into the chain of successive cell divisions, while producing bifurcate branches, become progressively thinner and subtle and in total create an organ which looks like small shrubs which facilitate the exchange of metabolites between the two can coexistent, because of the very large contact surface with the host cell. Vesicle or organs that are similar looking to bag or sacks, often result in swelling on the end of fungi and form within or between the root and are gradually accumulated by Lipid droplets and form like storage and resting organs. [6] [8]VAM fungi is of Zygomycets which includes two sets of Glomales and Endogonales.
Table (1-1): overview and classification of VAM fungi

<table>
<thead>
<tr>
<th>VAM</th>
<th>Genus</th>
<th>Under Genus</th>
<th>Family</th>
<th>Substance</th>
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</thead>
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<td>Endogonaceae</td>
<td>Endogon</td>
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<tr>
<td></td>
<td>Glomaceae</td>
<td>Glomus Sclerocystis</td>
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<tr>
<td>Glomales</td>
<td>Glomineae</td>
<td>Acoulsporaceae</td>
<td>Acaulospora</td>
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<td>Entrop Hospora</td>
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<td></td>
<td>Giga sporaceae</td>
<td>Giasporaceae</td>
<td>Gigaspora</td>
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<td></td>
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<td></td>
<td>Scutellospora</td>
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C - Ectendomycorrhiza fungi

In this type of fungal sheath is reduced or it doesn’t exist, the Hartic network has not expanded, but the roots penetrate inside. ectomycorrhize fungi can form Ectendo mycorrhize mode on different hosts and in good conditions. In the first step of classifying, we can find the type of fungi related to each mycorrhize according to the transverse wall. Those that have no walls are Fecomistic Endofits and those that have fungi with transverse walls are Ascomycetes or Basidiomycetes. In the first group where Fecomist fungi have no transverse walls, they belong to Endogonaceae and are Zygomycetes genus. These fungi are rarely seen freely. They are dispersed around the roots and they penetrate in the spaces between cells and into the host plant cells and have particularly formed split suction organs (Arbuscular) inside the cell and the vesicle are inside or outside the host tissue, and mostly form spores or Sporocarps with complex structures. In this case, this type of mycorrhiza is called VAL which is short for Vesiclear Arbuscular mycorrhiza. Walls of fungi contain Ectomycorrhiza, ectendomycorrhiza and Ericoid micorrhizas which can often establish a symbiotic relationship with the root of the tree or Shrubs. Until 1974, VAM fungi was limited only to genus Endogone, but now the fungi are in four genus Glomuse, Sclerocystis, Acaulespora, Gigaspora. In 1978 an investigation to identify around one hundred groups of Endogonaceae family fungi was performed which used isolated spores from soil to classify these groups.
Fungal organs

The fungi morphology in this symbiotic system includes chains outside of root and inside the root, support cells, vesicle inside the root (between the cellular and intracellular) and intracellular Arbusculs. Considering that most of these organs can start a new colonization of plant roots are, a profile for each of them is briefly given below. [15]

A – Chain

Outside root chains that originated from germination spores present in the rhizospher are of different morphology and functioning. Some participate in the colonization of roots, some are responsible for material absorption from the environment (soil), and some are spore producers. These chains have no lateral wall and where surface root cells contact, they are derived and from the end of each branch after forming Aspersorium on the root surface, a thin chain penetrates inside the roots. Intracellular chains are always in plasma membrane surrounding the cell. In pot culture studies have shown that the outward root chain in Glomaceae family and Acaulosporaceae have great ability for root colonization, but in the Gigosporaceae family the ability is very low. [13]

B – Arbuscul

This shrub looking organs from divergence of successive and bifurcate branches of inner root chains, after passing through the cellular wall and in an enclosed case in plasmatic membrane are formed within the root skin cells. With a high level of contact with plant cells, Arbuscul plays the role of an exchange organ for limbs and nutrient exchange between fungus and host plants. Studies have shown that in the chain's core of an Arbuscul a lot of seed, mitochondria, glycogen particles, fat cells and dense granules made of poly-phosphate exist in vacuoles. In the final fine branches, the number of vacuoles are high and the granules inside disappear[7]. Existence of the intense phosphatase enzymes activity in the terminal branches which cause dissection of the poly-phosphates could be the reason for disappearance of
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granules in this area. [9] Phosphate ions from the enzymatic hydrolysis of polyphosphates are transferred to plant cells. [4]

C – Vesicle

They are spherical or oval bodies with a thin wall, and contain lipid cells which in terms of swollen chain ends or some of its’ middle parts, are created inside or between roots’ skin cells, and in the case of intercellular they are confined with plasma membrane similar to Arbuscul. These organs are only formed in fungal species belonging to the Order of the Glomineae. [15]

D - Support cells

Various forms of bulged cells with thin walls, which are sourced from the outer root chains in funguses under the order of Gigasprineae, are called support cells. The level of these cells is in the barbed Gigasprineae genus, but in the Schatelespore they are seen as small bulges with an almost flat surface. Before mycorrhizal colonization begins’ the support cells appear on the Germination tube resulted by the spores. In pot culture, the number of support cells reaches its’ peak point shortly after the start of spores, but after four months onwards, their number is reduced or they completely disappear. [13]

H – Spore

Except the Giga spora genus which forms its’ spores only in soil, all other spores are produced in the soil or in the roots. Although members of the Order Glomal are categorized in Zygomists category, but none of them produce Zygospore and their non-genus spores are in the form of Chlamydospore or Azygospor. Inner root sporisation are formed in some famous genus types of Glomus Intraradices and Glomus Diaghamanum. The time for sporisation, often starts three to four weeks after the onset of root colonization, unless the growth context is of high absorbable phosphorus which in that case all the fungus growth stages will be limited. It is thought that spores of all arbuscolar mycorrhizal fungi have the ability to colonize the
root by forming a germinate pipe. However, if the *Giga spora gigantea* spores are healthy, they have more ability to colonize the root. [5] [13]

**References**


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