MYCORRHIZAE

1. What are mycorrhizae?

Mycorrhizae literally translate to "fungus-root." Mycorrhiza defines a (generally) mutually beneficial relationship between the root of a plant and a fungus that colonizes the plant root. In many plants, mycorrhiza are fungi that grow inside the plant's roots, or on the surfaces of the roots. The plant and the fungus have a mutually beneficial relationship, where the fungus facilitates water and nutrient uptake in the plant and the plant provides food and nutrients created by photosynthesis to the fungus. This exchange is a significant factor in nutrient cycles and the ecology, evolution, and physiology of plants.

In some cases, the relationship is not mutually beneficial. Sometimes, the fungus is mildly harmful to the plant, and at other times, the plant feeds from the fungus.

Not all plants will have mycorrhizal associations. In environments in which water and nutrients are abundant in the soil, plants do not require the assistance of mycorrhizal fungi, nor might mycorrhizal fungi germinate and grow in such environments.

2. What do mycorrhizae do?

Nutrients and water: Mycorrhizae are essential in areas where soils are deficient in water and certain nutrients - conditions that are found in the desert. Even when there is an ample amount of a nutrient, it may not be readily accessible to the plant. A dramatically larger root system (or mycorrhizae) permits the plant to obtain additional moisture and nutrients. This is particularly important in uptake of phosphorus, one of the major nutrients required by plants. When mycorrhizae are present, plants are less susceptible to water stress. Not only do the fungal threads help to bring water and nutrition into the plant, but they also can store them for use when

rainfall is sparse and temperatures are high. When organic matter (compost) is added to improve a soil, mycorrhizae are important in making its nutrients available. The residual organic matter and the hyphae improve the structure of the soil. Recent research indicates that the fungi even help break down rock, increasing availability of the essential nutrients within, such as potassium, calcium, zinc and magnesium.

Disease resistance: Mycorrhizae also help the plant resist infection by other fungi and even bacteria. This may be because the plant, being better nourished, is healthier and has better resistance to the invader. It may also be that the large physical presence of one fungus impedes infection by others. Another possibility is that either the plant or the fungus produces compounds that prevent infection by pathogens.

Interaction with other soil microbes — a cycle of benefit: Desert plants interact with other organisms in the soil. Many of these microorganisms fertilize plants by "fixing" nitrogen, which is then available for plant growth. When mycorrhizae are present, the number and vitality of these nitrogen fixers increase. As a result, the plant‘s health and vigor improves, as does the health and vigor of the beneficial fungi.

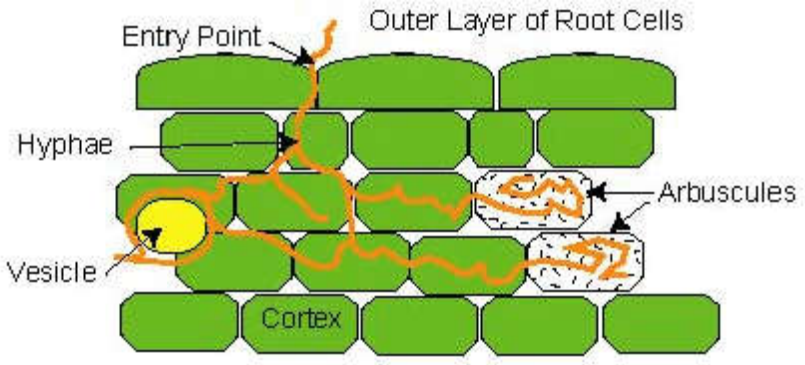
3. **Will any fungus form mycorrhizae?**

Many fungi will form associations with plants, and many plants will form mycorrhizal associations. These interactions appear to be plant- and fungus-specific. Not all mycorrhizae-forming fungi will work with all desert plants. There are research reports which show that association with the "wrong" fungus actually decreases the health and vigor of the plant. Because there is a requirement for specific plant-fungus association, mycorrhizae can be important in reestablishing native species in areas where they have been lost.

Introducing mycorrhizal fungal spores (inoculation) is sometimes suggested to improve yields and plant vigor, particularly for container and landscape ornamentals. Inoculation with mycorrhizal fungi may not be a benefit unless it is specific to the plant, because there is a requirement for a specific fungus-plant interaction for optimum benefit. It would also be counterproductive to inoculate with a fungus that could strongly benefit a weedy species.

4. How do mycorrhizae get into a soil?

Many desert soils already have mycorrhizal fungi present, at least in small amounts. Even without inoculation, spores can be found in many desert locations. If host plants are grown where there are spores of these fungi, then both thrive. The mycorrhizal fungi may continue to survive even after the original host is no longer present.



Cross Section of Root Showing Endomycorrhizae

The hyphae enter the root and create swellings (vesicles) for nutrient storage structures where nutrients are transferred between fungus and plant (arbuscules). The names of these two structures are combined into "vesicular-arbuscular mycorrhizae" (VAM), the term for the most common type of mycorrhizal association.

5. How could be maintained mycorhizae in the soil?

There is no sure-fire way to guarantee natural mycorrhizal populations, but in order to increase the amount of fungi, follow a couple of basic rules. When planting a desert native, make sure that

the root ball contains native soil. This is where the mycorrhizal fungi reside; without the fungi, there can be no associations. Just as important, be very careful when using pesticides, particularly fungicides. Do not apply them to the soil. Fungicides kill all the fungi they encounter. While they can be effective against plant disease, they can destroy beneficial fungi and cause serious problems to plant survival.

6. What are the types of mycorhizae?

There are two predominant types of mycorrhizae: ectomycorrhizae, and endomycorrhizae. They are classified by where the fungi colonize on the plants.

Ectomycorrhiza

Ectomycorrhiza tend to form mutual symbiotic relationships with woody plants, including birch, beech, willow, pine, oak, spruce, and fir. Ectomycorrhizal relationships are characterized by an intercellular surface known as the Hartig Net. The Hartig Net consists of highly branched hyphae connecting the epidermal and cortical root cells. Additionally, ectomycorrhiza can be identified by the formation of a dense hyphal sheath surrounding the root's surface. This is known as the mantle. In other words, ectomycorrhiza live only on the outside of the root. Overall, only 5-10% of terrestrial plant species have ectomycorrhiza.

Endomycorrhiza

On the other hand, endomycorrhizae are found in over 80% of extant plant species -including crops and greenhouse plants such as most vegetables, grasses, flowers, and fruit trees. Endomycorrhizal relationships are characterized by a penetration of the cortical cells by the fungi and the formation of arbuscules and vesicles by the fungi. In other words, endomycorrhiza

have an exchange mechanism on the inside of the root, with the fungi's hyphae extending outside of the root. It is a more invasive relationship compared to that of the ectomycorrhiza.

7. **Give some example of mycorrhiza.**

Orchid Mycorrhiza

As mentioned above, some orchids cannot photosynthesize prior to the seedling stage. Other orchids are entirely non-photosynthetic. All orchids, however, depend on the sugars provided by their fungal partner for at least some part of their lives. Orchid seeds require fungal invasion in order to germinate because, independently, the seedlings cannot acquire enough nutrients to grow. In this relationship, the orchid parasitizes the fungus that invades its roots. Once the seed coat ruptures and roots begin to emerge, the hyphae of orchidaceous mycorrhiza penetrate the root's cells and create hyphal coils, or pelotons, which are sites of nutrient exchange.

Arbuscular Mycorrhiza

Arbuscular mycorrhizae are the most widespread of the micorrhizae species and are well known for their notably high affinity for phosphorus and ability for nutrient uptake. They form arbuscules, which are the sites of exchange for nutrients such as phosphorus, carbon, and water. The fungi involved in this mycorrhizal association are members of the zygomycota family and appear to be obligate symbionts. In other words, the fungi cannot grow in the absence of their plant host.

Ericaceous Mycorrhiza

Ericaceous mycorrhizae is generally found on plants of the order Ericales and in inhospitable, acidic environments. While they do penetrate and invaginate the root cells, ericoid mycorrhiza do not create arbuscules. They do, however, help regulate the plant's acquisition of minerals

including iron, manganese, and aluminum. Additionally, mycorrhizal fungi form hyphal coils outside of the root cells, significantly increasing root volume.

Arbutoid Mycorrhiza

Arbutoid mycorrhiza are a type of endomycorrhizal fungi that look similar to ectomycorrhizal fungi. They form a fungal sheath that encompasses the roots of the plant; however, the hyphae of the arbutoid mycorrhiza penetrate the cortical cells of plant roots, differentiating it from ectomycorrhizal fungi.

Ectotrophic Mycorrhiza

The fungi involved in this mycorrhizal association are from the Ascomyota and Basidiomyota families. They are found in many trees in cooler environments. Unlike their wood-rotting family members, these fungi are not adapted to degrade cellulose and other plant materials; instead, they derive their nutrients and sugars from the roots of their living plant host.

References:

1. https://www2.nau.edu/~gaud/bio300/mycorrhizae.htm#:~:text=mycorrhizae)%20permits%20the%20plant%20to,less%20susceptible%20to%20water%20stress.
2. https://biologydictionary.net/mycorrhizae/

(All the information is collected from above references and will be used only for teaching and learning purposes)