



# Mycorrhizal Fungi

**Bruce Dunn**

Associate Professor, Floriculture

**Richard Leckie**

Undergraduate Student

**Hardeep Singh**

Graduate Student

## What are Mycorrhizal Fungi?

Mycorrhiza, which means “fungus-root,” is defined as a beneficial, or symbiotic relationship between a fungus and the roots of its host plant. This relationship is a natural infection of a plant’s root system in which the plant supplies the fungus with sugars and carbon and receives water and/or nutrients in return. This type of relationship has been around since plants began growing on land about 400 to 500 million years ago. There are several thousand different species of mycorrhiza fungi.

## Types of Mycorrhizal Fungi

Mycorrhizae are classified into two types, based on the location of the fungal hyphae in relation to the root tissues of the plant with endomycorrhiza producing hyphae inside the roots and ectomycorrhiza-producing hyphae outside the roots. These are further classified into Arbuscular (AM) endomycorrhizas, Ericoid endomycorrhizas, Arbutoid endomycorrhizas (subgroup of Ericoid), Monotropoid endomycorrhizas (subgroup of Ericoid), orchidaceous endomycorrhizas and ectendomycorrhizas. Arbuscular mycorrhizae (AM) are the most common type of endomycorrhizal (EM) fungi, whose hyphae extend into the cell membrane of the cortex root cells and form vesicles. These vesicles are structures that help the plant-fungi association exchange water and nutrients. Ectomycorrhizae (ECM) form a thick mantle of hyphae (mycelium) surrounding the root and root tip, extending into the spaces between the cortical cells.

## Benefits

Endomycorrhizal fungi benefit not only a large number of desert plants, but a majority of the plants in the world (Table 1). Ectomycorrhizal fungi, which account for about 3 percent of mycorrhizae, are more advanced and benefit mainly woody and tree species (Table 2). In total, mycorrhizal fungi benefit 80 to 90 percent of all plant species. Plants that do not respond to mycorrhizae include azalea, beet, blueberry, broccoli, Brussels sprouts, cabbage/kale, carnation, cauliflower, collards, cranberry, heath, huckleberry, mustard, protea, rhododendron, sedge and spinach.

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The main benefit mycorrhizal fungi provide is access to large amount of water and nutrients (particularly nitrogen, phosphorus, zinc, manganese and copper). This is because the hyphae increase the root surface area of absorption from soil. The mycorrhizal hyphae are smaller in diameter compared to plant roots and can reach areas unavailable to the roots. Other reported benefits of the mycorrhiza include:

- Increased pathogen resistance
- Increased drought and salinity stress tolerance
- Higher transplanting success
- Increased crop yield with enhanced flowering
- Increased water and nutrient uptake
- Improved soil structure

## Use, Products and Cost

Mycorrhizae are designed for many uses, including vineyards/orchards, nurseries, commercial growers, landscapes, homeowners or for land reclamation projects. The use of mycorrhizal fungi is also popular in organic production. It is important to note that mycorrhizae can be found in most soils naturally, so it might not be necessary to purchase mycorrhizae. Most soilless media does not contain mycorrhizae, so they could be incorporated if growing in containers.

Mycorrhizal fungi can be found as granular, powder or in concentrated solution. Products vary in type, number and spore counts of fungi used as well as cost, which can range from a few dollars to several hundred dollars, depending on the product and amount needed. Mycorrhizal fungi can be purchased at garden centers, nurseries or online from companies like Plant Success, Bio Organics, Soil Moist or ARBICO Organics.

## Application

Application of mycorrhizal fungi in production can be conducted as direct infection of cuttings or plugs during transplanting, incorporating into the media or the soil or applied through the irrigation. Application rates vary by product and application area, but rates can be as little as 1 teaspoon or 50 milliliter, if using a liquid solution. Most commercial mycorrhizal fungi products do not require any reapplication; however, others recommend additional applications after several weeks. The inoculant can reproduce with ideal circumstances, such as adding mulch and compost. Avoid over-watering and excessive fertilization applications. However, irrigation, harvesting

**Table 1. Partial list of plants that benefit from endomycorrhizae.**

Acacia	Coral Tree	Lily	Rhaphiolepis
Agapanthus	Corn	Locust	Raspberry
Alder	Cotton	Mango	Redwood
Alfalfa	Cottonwood	Magnolia	Rice
Almond	Cow Pea	Mahogany	Rose
Apple	Crab Tree	Mahonia	Russian Olive
Apricot	Cucumber	Maples	Ryegrass
Artichoke	Currant	Marigold	Sagebrush
Ash	Cypress	Melons	Sequoia
Asparagus	Dogwood	Mesquite	Sorghum
Avocado	Eggplant	Millet	Sourwood
Bamboo	Elm	Morning Glory	Soybean
Banana	Euonymus	Mulberry	Squash
Basil	Fern	Nasturtium	Strawberry
Bayberry	Fescue	Okra	Sudan Grass
Bean	Fig	Olive	Sugar Cane
Begonia	Forsythia	Onion	Sumac
Black Locust	Fountain Grass	Pacific Yew	Sunflower
Blackberry	Fuschia	Pampas Grass	Sweet Potato
Box Elder	Gardenia	Palms	Sweet Gum
Boxwood	Garlic	Papaya	Sycamore
Bulbs	Geranium	Passion Fruit	Tea
Cactus	Grapes	Paw Paw	Tobacco
Camellia	Grass	Peas	Tomato
Carrot	Hemp	Peach	Violets
Cassava	Herbs	Peanut	Watermelon
Ceanothus	Hibiscus	Pear	Willow
Celery	Holly	Pepper	Wormwood
Cherry	Impatiens	Pistachio	Wheat
Chrysanthemum	Jobba	Pittosporum	Yam
Citrus	Juniper	Plum	Yucca
Coffee	Leeks	Potatoes	

<http://bio-organics.com>

**Table 2. Partial list of plants that benefit from the use of ectomycorrhizal fungi.**

Alder	Chestnut	Hickory	Pine
Aspen	Cottonwood	Hemlock	Poplar
Basswood	Douglas Fir	Larch	Spruce
Beech	Eucalyptus	Linden	Walnut
Birch	Filbert	Manzanita	Willow
Burning Bush	Fir	Oak	
Cedar	Hazelnut	Pecan	

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and crop rotation may influence the root-fungi combination. Some fungi can colonize new roots within a week, while others may take as long as a month.

### Precautions

- Product storage temperature should not exceed 140 F or be colder than 40 F.
- Heavy phosphorus, nitrogen and zinc applications will inhibit mycorrhizal infection.
- Most products have a shelf life, which can vary from months to several years.
- Fungicides should be avoided, since mycorrhizae fungi are a type of fungi.

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