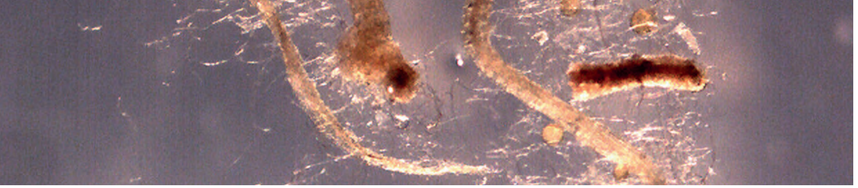

Types of mycorrhiza

There are several types of mycorrhiza. For agriculture, tree nurseries and other land-based cultivation, there are two key groups: endomycorrhiza and ectomycorrhiza.

Endomycorrhiza or Arbuscular mycorrhiza

These occur all over the world and are important for agriculture and horticulture. Endomycorrhiza grows with fungal threads (hyphae) down into the root cells where they form exchange organs in the form of a tree (arbuscules). They also make vesicles in the roots for harder times. Endomycorrhizas produce spores (seeds) on the ends of the hyphae under the ground. They reproduce via the spores and via root contact of hyphae with many different types of plants. They are not very selective in their choice of host plant. Worldwide there are around 140 types of endomycorrhiza and they remain loyal to their host plant for as long as it is alive.

Ectomycorrhiza

These types are only found in a limited number of tree species. The fungal threads grow around the outside of the plant root. Ecto means “outside”. Worldwide there are around 6,500 types of ectomycorrhiza, 3,000 of which occur in Europe. They form mushrooms with spores. These spores are distributed via the wind, people and animals. Unlike endomycorrhizas, the ectomycorrhizas are not loyal to their host tree. Several types may grow on a root. There’s a constant coming and going of different types of ectomycorrhizas. All of them want to survive and with a few thousand types, they only have a small number of tree species to choose from.

Finally.

Research has shown that use of PHC Mycorrhiza products increases root weight by an average +84%. The greater root weight is largely caused by a more extensive root system, but also by bigger roots which are richer in nutrients. We will be happy to advise you.

Cultivation action	We recommend the use of:
Planting big trees Fast rooting process of new plants/ Prevent/reduce losses.	**PHC TreeStart** All-in-one biodegradable sachets, apply directly in the plant hole. Endomycorrhiza/ectomycorrhiza inoculant with 4-3-4 fertilizer. **PHC TreeSaver Transplant** Transplant pack, spread and mix in the plant hole. Endomycorrhiza/ectomycorrhiza planting inoculant.
Plants from bare root seedlings Improves survival, rooting process and growth of bare root and container plants. Prevents root ball from drying out.	**PHC MycorDip** Root dip for use on plants with roots. Endomycorrhiza/ectomycorrhiza root dip with growth-promoting bacteria.
Planting container plants Create ideal planting conditions for all pot/ornamental plants	**PHC FlowerSaver Plus** Endomycorrhiza inoculant with organic fertilizer, including growth promoting bacteria and biostimulants.
Laying of grass - field - sports fields Fast start up and strong growth	**PHC TurfSaver** Endomycorrhiza inoculant with growth promoting bacteria and biostimulants.
Recovery of existing plants Revitalise plants with declining growth, reduce stress, stimulate root growth and improve soil quality.	**PHC Injectable** Soil injection for established plants. Endomycorrhiza/ectomycorrhiza with growth-promoting bacteria and biostimulants.
Vertical soil improvement for existing plants Restores root growth after soil compaction, improves structure and growth conditions.	**PHC Vertimulch** Mycorrhiza mulch mix for holes for trees and plants. Endomycorrhiza/ectomycorrhiza with growth-promoting bacteria and 3-0-3 fertilizer.
Planting seedlings, plug and container plants Fast rooting of new plants, improved growth when transplanting the seedlings/plug plants.	**PHC Mini Plug** Mycorrhiza plant mix which blends well with potting soil. Intended for plugs/volumes up to 450 cc. 2 types of endomycorrhiza mixed with vermiculite.
Planting pot and container plants Fast rooting & improved growth of abiotic stress tolerance.	**PHC VA Cocktail** Mycorrhiza plant mix with growth-promoting bacteria for mixing with potting soil for volumes above 450 cc. Endo mycorrhiza with growth-promoting bacteria and biostimulants.
Injecting agricultural land Fast rooting process of new plants, revitalises existing plants.	**PHC VA-PWI** Mixable mycorrhiza inoculum for dosing injection machine or wheel injection. 4 types of endomycorrhiza inoculum.
Sowing with sowing machines with granulate spreader Fast rooting of seeds, improved growth, better absorption of nutrients, increased abiotic stress tolerance.	**PHC MycorGran** Mycorrhiza granulate for sowing crops or mixing with green manure. 2 types of endomycorrhiza with growth-promoting bacteria. **PHC MycorGran Plus** Mycorrhiza and Trichoderma granulate for sowing crops, or mixing with green manure. 4 types of endomycorrhiza with Trichoderma and growth-promoting bacteria and biostimulants.
Microbial and mycorrhiza stimulator Stimulates the activity of mycorrhiza and bacteria which are already present. Improves the colonisation of mycorrhiza fungi.	**PHC Myconate** To promote germination of present mycorrhiza fungi and bacteria.

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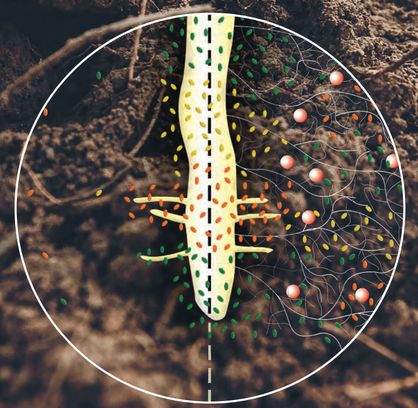
Plant Health Cure

Veldweg 7 5061 KJ Oisterwijk | Netherlands
+31 (0)13 - 7200 300 | www.phc.eu | info@phc.eu

Mycorrhiza.
What, when, why?



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Mycorrhiza

“Mycorrhiza in the roots are as normal as chlorophyll in the leaves” *Pius Floris 1996.*

Mycorrizha is the collective name for beneficial fungi which enter into a relationship with the root system of plants. In exchange for plant sugars from the roots, they make it easier for plants to absorb minerals, enabling them to stay healthy and make better use of the nutrients.

Without useful mycorrhizas and specific bacteria around their roots, plants are vulnerable. This results in a weaker crop with little resistance to disease and infestations.

The word mycorrhiza comes from the Greek mukès (fungus) and rhiza (root).

Photo of spore production for mycorrhiza products.

Origin

In an undisturbed ecosystem, the roots of most plants are able to enter a symbiotic association with mycorrhiza. This is the most usual form of association in plants and for many it is vital to their survival. The oldest known mycorrhiza are 400 million years old and were found in plant fossils.* T.N. Taylor Mycologia 87/4 1995 The first land plants had already entered into symbiotic association with mycorrhiza. That was necessary for them to survive as well as to improve the soil around their roots. This enabled them to facilitate their own growth conditions. The fungi were adapted to find water and minerals. Like plants, root fungi have developed into several types and forms.

Why mycorrhiza?

> “With a good start, you always stay ahead”

Healthy soil is vital for the development of strong, healthy plants. Such a base makes plants less susceptible to disease, infestations and stress and boosts their performance. Two factors are crucial for healthy soil: mycorrhizas and beneficial root bacteria.

We have all learned that roots absorb water and minerals via osmotic pressure (with salts) and ion exchange. But that’s only partly true. Only young absorbing roots can do this for around three weeks. If no colonisation with mycorrhiza takes place during that time, these roots will die. Plants will then have to continue creating new roots.

Difference in quality

There is a wide range of mycorrhiza products. However, there is a significant difference between the various types. There is a big difference between spores and propagules. The production method also makes a big difference in quality and performance.

Propagules
Propagules are produced in the open field (usually in the open air). In their production, root fragments of plants which are being propagated are given root fragments with one or more types of mycorrhiza from the cultivation of the previous year. After lifting, the fine roots are sieved out of the sand, finely ground and mixed with seaweed or humus extracts. The propagules keep for around 2 months. After these 2 months, the germination capacity depends on the (coincidental) presence of spores in the mixture. Because the number of spores in the ground roots is unknown, it is enough to state the number of root fragments on the packaging. The production of propagules is the most common, but also the cheapest and simplest production method. The main disadvantage is the limited keepability and the fact that there is no guarantee of authenticity or absence of pathogens.

Spores
The production of spores (by PHC) takes place in glasshouses under controlled conditions. Here the various mycorrhiza types are grown in different locations to prevent mixing the types. The reproduction of spores is done in pots which are filled with a sterilised medium. Seedlings from host plants (usually Maize) are then given spores from the master culture. The plants are then grown organically for 70-90 days before being allowed to dry.

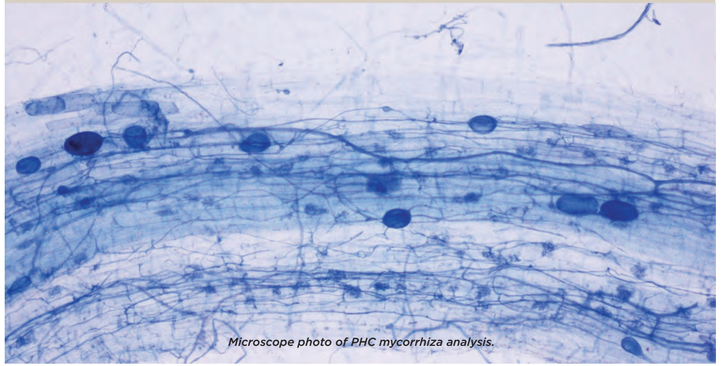
While the host plants are drying, the mycorrhizas, fighting to survive, create a huge number of spores. Using a certain method, these spores are then sieved, purified, dried and counted. The sealed conditions and sterilised growth medium prevent contamination by pathogens. Each batch of spores is tested for pathogens. Because the harvest can differ each year, spores from 3 years are mixed to ensure a constant quality. Depending on the application and processing method, the types are mixed and packed. In this process, the exact types and number of spores are described on the packaging.

The spore production by PHC demands accuracy and expertise. This allows us to demonstrably guarantee the best quality. PHC products are free from pathogens and can be kept for at least 5 years in closed packaging.

Propagules	Spores
Different types mixed together	Separate production of different types
Simple production method in the open field or containers	Complex production method in pots under controlled circumstances
Limited keepability	Can be kept for at least 5 years
No guarantee of absence of pathogens	Guaranteed free of pathogens
Mixture of a single cultivation cycle	Mixture of three separate cultivation cycles

Application

Mycorrhiza spores and propagules must be stored with 15% moisture in sealed packaging. In mixtures with fertilisers, they cannot be kept for very long. In compost, mycorrhizas live less than 3 days. For a good result, Mycorrhiza spores must be applied near the roots or where there will soon be roots. Research has shown that applying Mycorrhiza via drip tube or by scattering on the ground has no result. Application of mycorrhiza on soil-less growing systems never produces results.



Microscope photo of PHC mycorrhiza analysis.

Mutual advantages

Due to the robust growth and small diameter of the fungal threads or hyphae (approx. 3µm), mycorrhiza fungi can spread over a large area of soil. They can release minerals and transport them via the fungal threads to the plant roots. In nature, 95% of all plants cohabit with mycorrhizas. The absorption capacity of the roots increases by as much as 700% on average, enabling plants to absorb water and nutrients more easily and efficiently. Mycorrhiza fungi have been proven to contribute to resistance of plants to pathogens in the soil, drought and heavy metals. Furthermore, these beneficial fungi occupy the space around the roots so that pathogens have much fewer opportunities.

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