

Roots and a Happy Plant

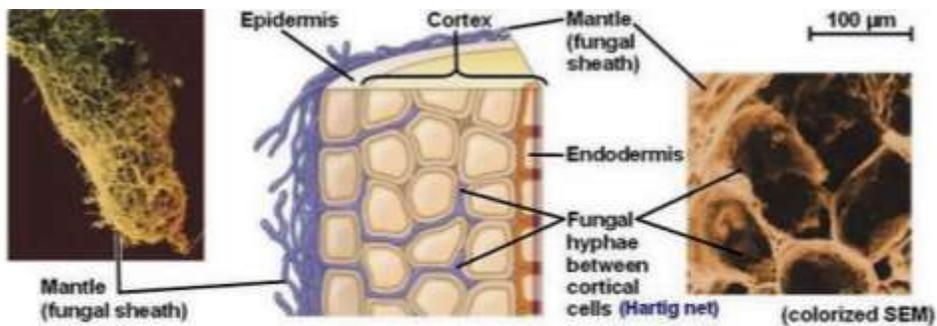
Glen Jamieson

- Plants can often survive a long time with root problems, but the key word here is survive, and does not mean they will thrive!
- If a planted tree doesn't get much taller over time, or each year's new leaves are smaller than the preceding year, these are signs of a problem, and often it relates to the roots or how it was planted.
- Do not plant a tree or shrub so that the root flare (the part of the tree where the stem morphs into the roots) is buried below the surrounding ground level.
- This can for many species interfere with the uptake of oxygen by the roots, as they may then be too far down in the soil. Without sufficient oxygen from the atmosphere, this can negatively affect a root's uptake of both water and nutrients, and hence plant growth.
- If the tree or shrub is planted at the right depth but is still not growing well, grasp the stem and try rocking it. If you can feel movement in the soil, then the roots have not established well, and the question is then why not?
- Since the plant's roots are obviously not exploring the surrounding soil, digging it up and checking its root system can't hurt it, so do so to see what the issue might be.
- What you are likely to find is a root ball that may be surrounded by burlap or else shaped like the container it was bought in, i.e., with the roots curled in a circle.
- The solution is to remove the burlap if present and often the soil around the roots, and if the roots are curled, straighten and spread them out, or if this is not possible, cut them so they now point outwards. This may seem drastic, but root pruning stimulates new root growth. Tough love works!

Mycorrhiza

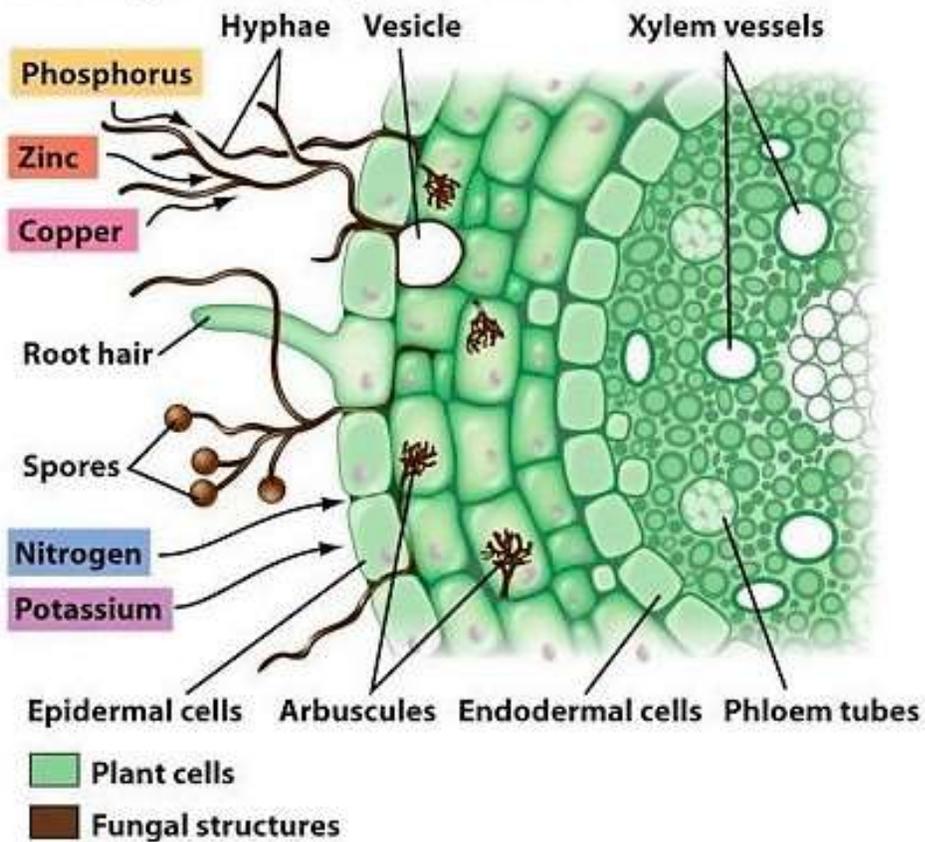
- Mycorrhizal fungi are divided into two types:
- 1) ectomycorrhizae: their hyphae surround the roots and occasionally penetrate the roots, but not the root cells, and are typically associated with woody plants like beech, rose, willow, pine and birch.
- 2) endomycorrhizae: often termed arbuscular mycorrhizae, these fungi also surround the roots, but they penetrate the cortical root cells, of an estimated 80% of vascular plants.

Ectomycorrhizae



Key difference: even in an ectomycorrhizal relationship, fungal hyphae enter the root to form the 'Hartig net' **between** plant cells where nutrient exchange occurs. Unlike endomycorrhizal relationships the hyphae do not **enter** the plant's cells.

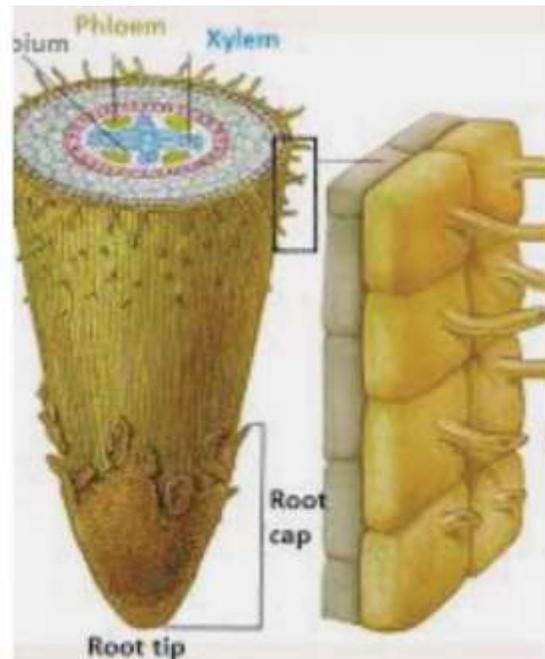
Endomycorrhizae (plant root cross section)



- Ericoid mycorrhizae are a special group of ectomycorrhizal fungi adapted to the acidic and nutrient-poor soils that characterise the habitats of many Ericaceae.
- The delicate tip of a growing ericoid root is different from that of other woody plants.
- Their epidermal cells do not produce root hairs. Instead, many of them are colonized by ericoid mycorrhizal fungi which proliferate in the intracellular position to produce dense hyphal complexes.

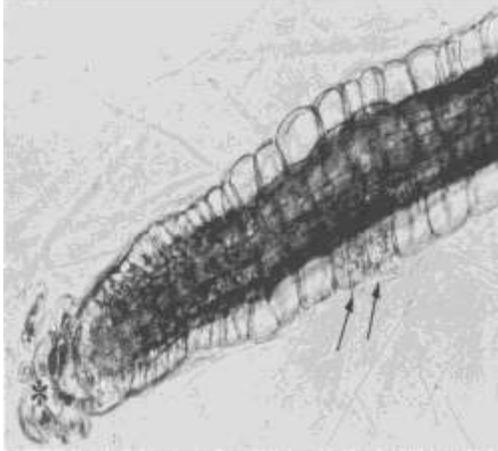


Root hairs on a cabbage seedling

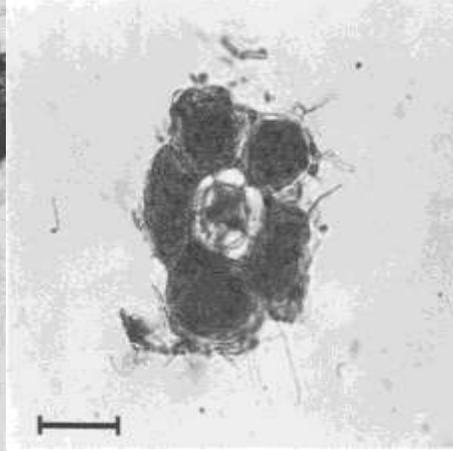


- These dense hyphal complexes are diagnostic of ericoid mycorrhizas, and the diameter of an ericoid root with ericoid mycorrhizae is normally less than 100 μm , and so is referred to as a “hair root”.

A.



B.



- A. The tip of a hair root of the heather *Calluna vulgaris*, showing the root cap (*) and the commencement of mycorrhiza formation in cells behind the root apex (arrowed).
- B. The cortex of one cell layer of a hair root fully colonized by fungal hyphae. Bar = 1 mm.
- Ericoid mycorrhizal colonization is restricted to expanded epidermal cells, which defines a “window of opportunity” for formation of the symbiosis in both space and time.
- Secondary thickening in some cases may provide for longevity in the more mature part of the roots, whereas unthickened hair roots are completely shed each season.
- Receptive plant roots release chemicals that allow hyphae to penetrate the root (or cell walls) and create chemical pathways between the two partners.
- Multiple fungal infection points and hyphal branching create a cottony sheath around the root that extends far into the surrounding soil to reach otherwise inaccessible locations to the roots.



Mycorrhizal networks

- Most plants are colonized by a variety of mycorrhizal fungi, many of which have multiple hosts. This links roots of different plant species, transferring nutrients to the plants with the greatest demand.

- This complex network of fine hyphae aggregates soil particles and improves its stability, while enhancing organic matter decomposition and acidifying the root zone.
-
- All this increases a plant's resistance to environmental stress, such as drought and salinity, as water access is enhanced, and limits the space for possible pathogen establishment, making plants more resistant to disease.
- To achieve this, roots need to be receptive to inoculation, so avoid overwatering and excessive fertilization, especially of phosphate.
- Unnecessary rototilling should also be avoided, as it destroys natural soil structure.
-
- In summary, ecto-mycorrhizae are mostly associated with trees. These are also the type of fungi that form the fruiting bodies you see above ground, better known as mushrooms. All mushrooms are the fruiting bodies of ecto-mycorrhizal fungi.
- Endo-mycorrhizae are associated with plants including vegetables (though not brassicas), grasses, fruits, most shrubs, and, small fruiting trees, like pears, apples and plums. This mycorrhizae does not fruit above ground. They are asexual, and cannot easily repopulate an area from which they have been depleted, and so sometimes need a little help from us at times with an inoculation.