FARMING connect
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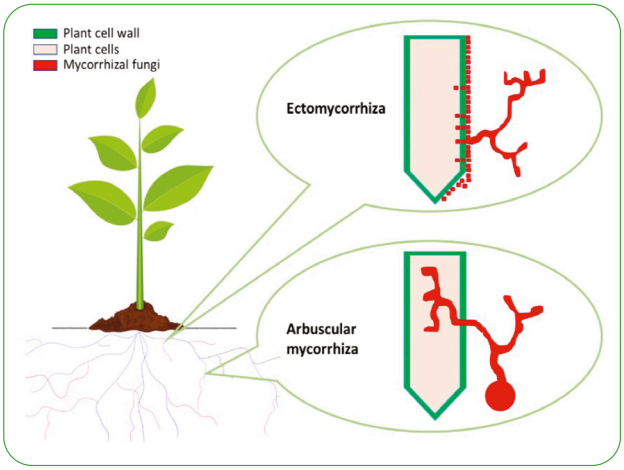
Fungi and roots – July 2022

When we think of fungi, we either tend to think of mushrooms or pathogenic infections, such as powdery mildews, but there are entire groups of **symbiotic 'helper' fungi** present in our soils that are essential for ecosystem functionality. **Mycorrhizal fungi** are species which interact with many crop and pasture plant roots in the soil, **exchanging energy and nutrients** – either inside plant cells (arbuscular mycorrhizal fungi - AMR) or, less commonly, outside plant cells (Ectomycorrhizal fungi - EcM).



- Involved in assisting **over 80% of all plants on the planet**.
- Most symbiotic plants **(~90%) interact with AMR fungi**
- Fewer **(5-10%)** have **EcM interactions**
- Mycorrhizal hyphae networks can **cover up to 700x more soil area than plant roots alone**

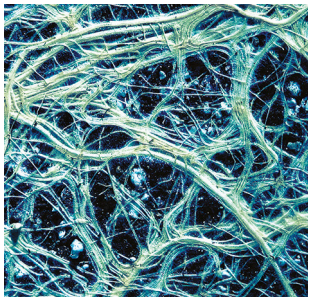
BENEFITS TO SOIL

Mycorrhiza **improve soils** by:

- Assisting the formation of **soil aggregates**
- Improving access to **water and nutrients**
- Reducing the impact of **soil erosion**
- Boosting **soil organic matter (SOM)**
- Benefiting **carbon sequestration**
- **Controlling and cleaning soil pollutants** (heavy metals and agrochemicals)
- **Increasing food safety**.

BENEFITS TO PLANTS

- Extend root networks – **increasing available nutrients and water**
- Improve productivity with lower fertiliser input i.e. **nutrient uptake efficiency**
- Boost growth, **increasing flowering and pollination**
- Provide **below-ground signalling link** for neighbouring plants (assisting pest, pathogen and other environment response controls)
- Fungal cells can **protect plant roots** from pest and pathogen damage
- Mycorrhiza **pH root impacts** can prevent pathogen growth
- Can help **control weeds naturally**, reducing herbicide requirements



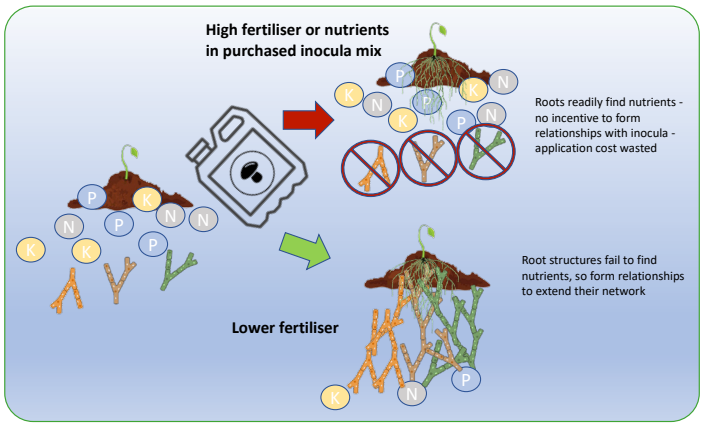
BENEFITS TO ECOSYSTEMS AND SUSTAINABILITY

- Roles in the function and efficiency of biogeochemical cycles such as the **carbon cycle**
- Increases **ecosystem resilience to biotic and abiotic changes** (flood, nutrient changes)
- Acts as **food source for biotrophs and saprophytes**
- **Decomposer/recycling** roles
- May form further symbiosis with other microbes, increasing soil **microbiome diversity**

How to boost mycorrhiza interactions

1. **Min- or zero-tillage** – Avoiding physical disruption of soils allows long-term networks to form
2. **Reduce nutrient applications** – Organic or synthetic nutrients reduce mycorrhiza efficiency
3. **Increase plant species diversity** – More plant species lead to higher mycorrhizal diversity, with these factors being related to improving long-term productivity in a sustainable way
4. **Reduce agrochemicals** – These can impact the functionality and diversity of mycorrhizae
5. **Use native and heritage plants** – Use fewer crop, grass and tree seeds developed for intensive farming, as these often require more fertiliser nutrients and interact less well with mycorrhizae
6. **Consider inoculation carefully** – Where soils and ecosystems are highly degraded, consider adding mycorrhiza back into a system, but ideally use local sourcing of species if possible

Why shouldn't you just inoculate all the time?



In many cases, **inoculating soils with mycorrhiza** to boost plant growth may **waste money**. Mycorrhiza can propagate naturally from the environment and inocula **may not form effective symbiotic relationships** with plants if:

- **significant mycelial networks** are already present in the ecosystem
- **fertiliser is used heavily**, or there are **historically high nutrients**, due to previous intensive strategies
- the plant species being inoculated are **forbs or C3 grasses**
- the current natural soil health and ecosystem is at a stable balance

Sustainable environmental land management

Evidence suggests that **EcM species** have roles in **carbon cycling and climate change mitigations**. They actively release nitrogen (N)-degrading enzymes that compete with soil microbes for the available N. Microbe decomposers need N to function, so limiting its availability limits the decomposers' ability to respire, which is one of the **single largest fluxes of CO_2 on earth**. In experiments, EcM-rich growth systems **reduced the soil carbon respiration rates by up to 67%**. As EcM species are known to form **interactions with woody plants**, this adds further benefit to land management strategies for increased forestry planting and planting of carbon-mitigating **biofuel species like willow**.

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