

THE EDIBLE GARDEN

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A World Below Our Feet: An Exploration Into Mycorrhizal Fungi

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When fungus is brought up as a light-hearted topic of conversation during a family dinner, at the immaculately dressed dining room table, it is usually met with mortified looks from grandma and the relatives. After cutting into the Christmas turkey for a celebration abounding with the rich flavours and delights of the holiday season, most would cringe with horror, as they conjure images of distorted toe nails, or creatures that have evaded the aromatic sting of tee tree oil, while feasting upon their perfectly cooked bird and late-season harvests. However in the context of plant biology and symbiotic relationships, it stirs up fascination and intrigue into a world that can only be truly appreciated under the microscope. Let's delve into the world below our feet and take a look at mycorrhizal fungi.

In this article, we will focus on one of the two broad groups of mycorrhizal fungi, endomycorrhizal fungi. This is the type of mycorrhizal fungi penetrate the cell wall of root cells to facilitate nutrient exchange and is of use to gardeners and horticulturalists alike. Most vegetables, annuals, grasses, shrubs, soft-wood trees, and perennials naturally form symbiotic relationships with endomycorrhizal fungi. The other broad grouping of mycorrhizal fungi is ectomycorrhizal fungi, which form a sheath around the root. Most conifers and hardwood trees such as birch, oak, beech, and hickory form symbiotic relationships with ectomycorrhizal fungi.

What is Mycorrhizal Fungi?

Mycorrhizal fungi is a fungus that affixes itself to the root system of a plant. In turn, the fungi and the plant enter a symbiotic relationship, whereby they assist each other in sustenance and development. (Its name—endo or ecto - is in reference to the role the fungi play in the plant's rhizosphere; the rhizosphere is a plant's root system).

What is the role of Endomycorrhizal Fungi?

The host plant collects energy, as carbohydrates, via photosynthesis, from the sun. In the process of using this energy, the plant releases carbon through its root system. Carbon, the endomycorrhizal fungi are unable to produce, but need in order to survive. These fungi will become a major carbon storage mechanism, holding almost 30% of soil carbon. In addition to carbon, the host plant will provide the fungi with glucose, through its use the mycorrhizal fungi proliferate, and live intertwined in the plant's root system.

In exchange for carbon and glucose, endomycorrhizal fungi break down organic matter, and provide nutrients and water from the soil to the host plant. Without these fungi, plants do not perform as they should and can become compromised or weakened as their life cycle continues.

When plants are inoculated with endomycorrhizal fungi, the fungi can actually prevent the infection of the host plant by pathogens (disease producing organisms). An additional function of mycorrhizal fungi is to act as a first line of defense in the protection of the plant's root system from opportunistic invaders.

Under normal circumstances, garden soil should contain all of the mycorrhizal fungi it needs. However fungi are delicate, and a wide array of horticultural practices, including, but not limited to, rototilling, sterilization, use of fungicides, and soil compaction can all



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Vermicomposting – the missing link in composting household scraps!

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To the uninitiated, vermicomposting often appears to be one of those practices best left to the quirky and the eccentric. While it may be of passing interest to many gardeners, the idea of disposing of kitchen waste in a household worm bin may be unappealing to many.

This author recommends taking another look at this wonderful practice, in order to reap its numerous benefits.

Many gardeners will have found that backyard composting is a relatively inefficient way of transforming kitchen waste into compost. This is because one of the fundamental pillars of composting is achieving the right balance between carbon and nitrogen. Kitchen waste is "green" waste, high in nitrogen, rather than "brown" waste, high in carbon, and backyard aerobic composting works far better with brown waste. This is why fall leaves, pine needles and paper decompose better than kitchen leftovers, and it is often why gardeners end up turning over their compost bins months after depositing kitchen scraps, only to find completely undecomposed banana peels.

Rather than giving up on producing one's own compost, the solution is to find better more efficient method for disposing of kitch-

have detrimental impacts on soil ecology and the development of endomycorrhizal fungi.

How do Endomycorrhizal Fungi work?

When endomycorrhizal fungi take hold of a plant's root system, these fungi penetrate and grow inside the walls of roots and extend outward from them. These extensions (envison something similar to the roots of a plant, but much smaller and thinner) aid the plant's root system in obtaining nutrients and water, are known as the hyphal strands. The hyphal strands or hyphae have a much broader reach than the plant's own root system. The hyphal strands extend the plant's reach well beyond that of its non-inoculated counterpart dramatically, and as a result, can obtain water and nutrients from greater distances, ensuring the host plant can maintain a certain level of health. These hyphal strands also increase the surface area for the uptake of nutrients, thus ensuring the host is well nourished.

Plants that enter a symbiotic relationship with mycorrhizal fungi often grow larger, have healthier roots, stems and leaves, and grow more robustly. Mycorrhizal fungi will form extensive networks, with the ability to feed multiple plants at the same time.

Mycorrhizal fungi are particularly skilled at breaking down organic matter and providing a reliable supply of nitrogen, phosphorus and copper, as well as potassium, calcium, magnesium, zinc and iron to the host plant, and improve the uptake of amino acids.

In addition, mycorrhizal fungi will also produce vitamins for the host plant, and plant hormones, used primarily in the development of roots and shoots.

When to use Endomycorrhizal Fungi?

A healthy soil contains mycorrhizal fungi, and if you have spent time building-up your soil they will flourish and naturally grow quickly. However when soil has been disturbed in some capacity, these fragile networks will need to be re-established. Here are some instances in which the application of mycorrhizal fungi will be beneficial:

- If the soil has been recently ploughed or tilled.
- If soil has been sterilized to remove pathogens and pests in the last one to two years.
- If starting seedlings in containers, most potting soil and mixes can lack mycorrhizal fungi.
- If the soil has become compacted from years of use and environmental wear; aerating the soil will improve the growth of mycorrhizal fungi.
- If fungicides have been used in the last one to two years.
- If mycorrhizal fungi are naturally absent from the soil (e.g. poor sandy soil) or in areas with high incidence of drought.

Mycorrhizal fungi are magical organisms that can dramatically improve soil and plant health and increase yields. If you are looking for ways to improve the biodiversity and ecology of your soil, consider inoculating your soil and plants with mycorrhizal fungi, or adding organic material such as leaf compost that will already have an abundant supply of mycorrhizal life and can be gently added to your soil. Once established, mycorrhizal fungi will assist you for years to come.

Happy Growing!



Vermicompost bins, with red Wrigglers and carrot peel

Len Schmidt

en scraps. Enter worms. Worms break down organic matter when they eat, and leave behind castings that are an exceptional fertilizer.

Adding worm castings to plants and crops comes with enormous benefits. Gardeners and vegetable growers have long been aware of the beneficial impacts of worm castings on their plants, and the scientific literature is rapidly catching up. For example, Ohio State University has developed a comprehensive research program on vermicomposting which include experiments investigating the effects of vermicompost's on the germination, growth, flowering, and fruiting of vegetable plants such as bell peppers and tomatoes (as well as on a wide range of flowering plants including petunias, marigolds, bachelor's button, chrysanthemums, impatiens, sunflowers, and poinsettias). ¹A consistent finding is that commercial horticultural potting mediums are enhanced significantly upon incorporation of vermicompost food wastes. Other studies have shown that vegetable crop response to vermicompost exceeds crop response to conventional rates of synthetic fertilizers. Plants were larger, the soil was richer and well inoculated with microbial biodiversity, and growth rates and crop yields could increase by as much as 50 percent following proper application of vermicompost!

Garden beds amended with vermicompost have better soil aeration, texture and lower soil compaction. They have improved water retention capacity, better root growth, nutrient absorption, and nutrient composition, both on the macro and micro-nutrients fronts. For example, vermicompost contains nutrients in forms that are readily taken up by the plants such as nitrates, exchangeable phosphorus, and soluble potassium, calcium, and magnesium. ²As vermicompost introduces beneficial microbes, it can enhance plant growth through the production of plant hormones and enzymes, and also control plant pathogens and nematodes, all of which can minimize crop yield losses.

Further since the negative effects of chemical fertilizers on soil are well known (i.e. alter the chemical properties, adversely affect microbial populations and can decrease overall soil productivity), ³it only makes sense to turn to nature's soil scientists, the earthworm!

Indian Woman Yellow Beans

*Faith Schmidt
Master Gardener of Ottawa Carleton*

This past spring, my husband did some research and decided to plant a heritage pole bean that we had never tried before. This bean is apparently native to Mexico, but made its way to Montana via a Swedish settler. I decided to write this brief article as I am so impressed with them - both the flavour and texture are awesome!

We grew eleven plants and from them harvested about one pound of dried beans. The beans were left to dry outside and then in our small greenhouse. When the beans were removed from the dried pods, they were left to air dry for a few weeks in a net bag. The pod is not edible even when still young. The bean itself is a sandy colour with a creamy texture and has a smooth, nutty flavour.

To use them, I soak the beans overnight in a large bowl of cold water. The next morning, after draining and rinsing placed the beans in a pot with water to cover them. After bringing the water to a boil, simmer for about 45 - 50 minutes. I saved about 4 cups of this liquid to use when baking them.

I then placed the beans with my favourite ingredients for "Boston Baked Beans" in my slow cooker with a smoked pork hock and let them simmer all day. The aroma was incredible! They were delicious, creamy and not at all mushy. I must say that although I never particularly liked Baked Beans, these Indian Woman Yellow Beans have made me a convert. Next year, I would like to have about 22 plants so we can harvest about two pounds of dried beans.

We found the seeds at a seed exchange last year so, if you go to one, be sure to look for this heritage variety. Otherwise, when you are browsing through seed catalogues this next while, look for these gems as they are definitely worth planting - and savouring!

Nurturing the gardener

Some excellent exercises for a healthy back can be found on the website of Canadian Centre for Occupational Health and safety:

<https://www.ccohs.ca/oshanswers/psychosocial/backexercises.html>

There are 4 gentle exercises with easy and more advanced options based on research by Stuart McGill of the University of Waterloo. A second page offers some more challenging exercises.

https://www.ccohs.ca/oshanswers/psychosocial/backexercises_advanced.html

References for Vermiculture

1. R. M. Atiyeh, S. Subler, C. A. Edwards, G. Bachman, J. D. Metzger and W. Shuster, Effects of vermicomposts and composts on plant growth in horticultural container media and soil, 2000
2. Edwards & Burrows 1988; Orozco et al. 1996
3. Bargali and Shrivastava, 2002; Bargali et al, 2015. Many studies have shown that vermicomposts are able to improve the physical properties of soils (Ferrerias et al., 2006; Marinari et al., 2000; Gopinath et al., 2008; Lazcano and Dominguez, 2011; Vo and Wang, 2014).

Watch for *Trowel Talk* the Master Gardeners of Ottawa Carleton electronic monthly gardening newsletter available on the 15th at <http://mgottawa.ca/>

Visit the Almonte online community newspaper 'The Millstone' - <http://millstonenews.com/> - for a column by David Hinks of the Lanark County Master Gardeners; under the Gardening tab.

Master Gardeners of Ottawa-Carleton and Master Gardeners of Lanark County are member groups of Master Gardeners of Ontario Inc., a registered charity with the mission of providing gardening advice to homeowners. The Edible Garden logo was created by Jon Last (jonlast13@rogers.com).

So how might the average home gardener make use of this exceptional process?

The good news is that it can be easy. There are numerous ready-to-use worm bin "kits" for sale, and these provide an ideal entry point into the wonderful world of vermicomposting. Simply add worms and a bit of bedding (shredded newspapers, leaves, etc.) and your kitchen scraps will soon turn to black gold! Other gardeners may wish to build a worm bin out of materials they have around the house (such as Rubbermaid bins). This author can attest to numerous wonderful resources being available online and at the public library in order to help with getting started.

Those ready to embark on the vermicomposting journey will need to acquire red wiggler (*Eisenia foetida*) earthworms. These are a species of earthworm adapted to decaying organic material. Much smaller and quicker than the languid earthworms generally found in the garden, red wigglers rapidly chow through kitchen scraps.

It may also be worth highlighting a few keys to success. Foods to avoid putting in the bin include meats, bones and onions, to avoid smells, and the addition of citrus scraps should be minimized to avoid overly acidic soil levels. The addition of a bit of grit (sand or ground eggshells) will ensure the worms can use their gullets to work their magic. As worms breathe through their skin, and require moisture to do so, keeping the bin humid is a must.

This author keeps his worm bin in his basement year-round, and after four years has yet to experience any significant issues or downsides to the process (including smells, which don't arise when the worm bin is well cared for).

Aside from being an interesting conversation starter, there is almost nothing quite like pulling out a handful of worms to show the children of guests and hearing their laughter and squeals of joy. Perhaps the only thing that can match that joy is my own at observing the health of my garden vegetables a few weeks after vermicompost application!