Hidden from view beneath the soil surface in the farmer’s field there is a relationship between fungi and plants that is fundamental to life on the planet. Fungi can’t make their own food, they have to absorb their nourishment from living or dead organic matter. Organisms like fungi help assure the earth’s resources recycle as they should. There is one particular group of fungi that works in cooperation with important crop species. This article will shed some light on this special “farmers’ fungus” that pays big dividends.

We have come to understand that in natural habitats, plant roots are a complex mixture of both fungi and plant. This relationship is called a “mycorrhiza” which literally means ‘fungus-root’. Approximately nine out of every 10 species of plants form an association with these specialized mycorrhizal soil fungi in order to thrive. The plant needs the fungus and the fungus needs the plant. The fungus is responsible for getting the nutrients and water from the soil, and in return, it gets carbohydrates from the plant (figure 1). This is what is called a “symbiotic” relationship; one in which both plant and fungus benefit. The fossil evidence indicates that this plant/fungus relationship dates back over 460 million years.

What are they?

The body of the fungus consists of very thin strands called hyphae (figure 2). In healthy soils, these strands grow from within the root cells of the crop and spread out into the soil, greatly increasing the surface area of the root system. The most widespread type of mycorrhizal relationship are known as arbuscular mycorrhizae (also known as “endo” mycorrhizae) and are formed by most agricultural plants. These plants include most grains, vegetables, fruit and nut trees, vines and turf grasses.

What they do

The mycorrhizal relationship effect on the root system is dramatic. Most of the absorbing area of the root system is actually fungal hyphae. Hyphae are much thinner than roots or root hairs and are able to penetrate the tiniest pores in the soil. A thimbleful of healthy soil can contain miles of fungal hyphae! As a result, the efficiency of the plants’ nutrient and water uptake is increased enormously.

Agricultural soil often contains abundant nutrients but availability to the crops themselves can be limited. Research demonstrates that mycorrhizae are particularly important in mobilizing phosphorus, nitrogen, zinc, iron, calcium, magnesium, manganese, sulfur and other tightly bound soil nutrients, transporting them back to the plant. This plant-fungus relationship can pay off...
big on the farm. Crop plants become able to absorb soil nutrients previously unavailable and utilize fertilizer inputs more efficiently. The result is often significant savings in fertilizer costs (figure 3).

Mycorrhizal benefits do not stop there. They play a role in the root zone defense against fungal root diseases such as phytophthora, fusarium, pythium and rhizoctonia. Mycorrhizal fungi provide the plant with various suppressive exudates, such as antibiotics, that deter establishment of these pathogens. Studies have documented that mycorrhizae also protect root systems by creating a layer of chitin protecting root cells. Chitin is the same tough material as in insect shells and helps create a physical barrier deterring the invasion by soil pathogens.

Water, water everywhere?

Agriculture’s need for fresh water is growing faster than nature can provide. It’s quickly becoming one of the key resource issues of the 21st century. How do natural areas provide for such luxuriant plant growth without irrigation? One key factor are the mycorrhizal threads attached to plant roots according to the soil for available resources. They absorb water during periods of adequate soil moisture, then retain and slowly release them to the plant during periods of drought. Natural areas have achieved a level of drought tolerance that far exceeds agricultural areas partially because an enormous food web of mycorrhizal threads act as a sponge, protecting plant communities from extreme moisture deficits. The mycorrhizal threads can penetrate into the small soil pores to access pools of water that are unavailable to the thicker roots. An extensive body of research has documented the importance of the mycorrhizal relationship for efficient water use and drought protection for a wide array of important crop species. The ever-increasing cost and declining quality of water are formidable issues facing farmers today. Today, mycorrhizal fungi can be a powerful tool for farmers seeking to improve water-use efficiency and lower irrigation costs.

Does my farm have mycorrhizal fungi?

Some modern agricultural practices reduce the biological activity in soil. Fungi, chemical fertilizers, cultivation, compaction, irrigation and pest and disease control can all adversely affect beneficial mycorrhizal fungi. Extensive testing of agricultural soils indicates that many intensively managed soils are deficient in mycorrhizal fungi. Adequate populations of mycorrhizal fungi are necessary for soil structure and drought protection. Farming extensive acreage affects the mycorrhizal relationship in two fundamental ways. First, it isolates the crop plant from the mycorrhizal inoculant before, during, or following planting. Mycorrhizal inoculants come in liquid, powder and granular forms. They can be sprinkled onto roots during transplanting, seed coating or watered in via existing irrigation systems. However, to be successful the farmer requires an application approach to crop establishment and growth including using mycorrhizal fungi as an inoculant before, during, or following planting. The goal is to create physical contact between the mycorrhizal inoculant and the crop roots. Mycorrhizal inoculants come in liquid, powder and granular forms. They can be sprinkled onto roots during transplanting, banded with or beneath seed, used as a seed coating or watered in via existing irrigation systems. Treating seed either before or during sowing produces excellent results. Just one pound of a MycoApply® 4-spece concentrated powder can easily treat enough seed to plant one acre. The type of inoculum product and application method depends upon the conditions and needs of the crop and farmer. Generally, mycorrhizal application is easy, inexpensive, and requires no special equipment. Liquid forms of mycorrhizal inoculants are becoming very popular due to the ease of handling, mixing, storage, and their effectiveness in penetrating many soil types and treating existing plants.

Farmers’ Fungus That Pays Big Dividends

It is also now possible to have vegetables, fruit and nut crops which begin their life cycle inoculated with soil mycorrhizal fungi. Unfortunately, most crop plants raised in nurseries are started in sterile soils and receive intensive fertilization, water, and pest control. Although these ideal growing conditions can produce vast volumes of plants, they also result in non-mycorrhizal growths that are often poorly adapted to the eventual out-planted conditions on the farm where they will be subject to the harsher environment of the open field. Conversely, many strong, vigorous plants that have already been colonized with mycorrhizal fungi are better equipped to take advantage of soil resources and can establish rapidly and successfully in the field.

What about Fungicides?

Of course, mycorrhizae are fungi so it stands to reason that some fungicides will reduce or eliminate them from the soil and roots. Fortunately, research and experience indicates that certain types of fungicides do not adversely affect mycorrhizae. A list of common agricultural fungicides and their effects on mycorrhizal fungi can be found at www.mycorrhizae.com. Sometimes it helps to apply fungicides four to six weeks prior to inoculating the crop. Mycorrhizal inoculums may also be applied after the use of a fungicide. Follow manufacturers’ guidelines for the time required for the fungicide to clear the soil before inoculation and that mycorrhizae do play a role in a plant’s natural defense against fungal root diseases.

Farm fungi pay dividends

Many mainstream agricultural markets are already relying on the use of mycorrhizal inoculums, and use continues to increase dramatically. Recent advancements in mycorrhizal research and application technology have made widespread use of mycorrhizae easier and more cost effective than ever. The economic return for mycorrhizal inoculums can exceed its cost several-fold, not only from increased yields, but also by reduced fertilizer, water and disease management costs. A granular MycoAp- ply® product, Del Gates of North Dakota increased flax yields by 27%. Ron Miller’s wheat farm in Nebraska increased its yield of organic wheat by 42% by treating the seed with a MycoApply® powder. This is just a fraction of the increase dramatic reports. Mycorrhizal inoculums may also be applied after the use of a fungicide. Follow manufacturers’ guidelines for the time required for the fungicide to clear the soil before inoculation and that mycorrhizae do play a role in a plant’s natural defense against fungal root diseases.