Nebraska

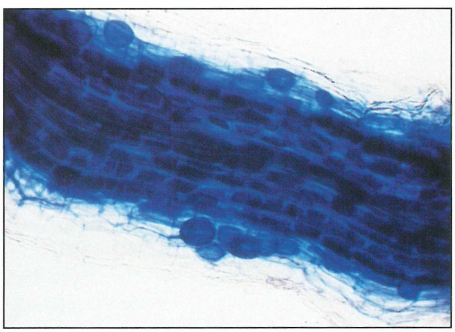
Mycorrhiza–An Essential Part of Most Plant Root Systems

By J. R. Ellis

Mycorrhiza are a group of beneficial soil fungi, living in the soil and colonizing plant roots. Research shows that these fungi have significant effects on ability of plants to absorb nutrients. Fallowing and flooding can severely diminish the numbers of these beneficial organisms, increasing crop plant dependence on nutrients supplied in starters, such as phosphorus (P).

ALMOST all important agricultural crops are mycorrhizal–that is, they can be colonized with mycorrhizal fungi. Mycorrhiza are a group of beneficial soil fungi which live in soil and colonize plant roots. The mycorrhizal fungi grow in the root cells (endo-mycorrhiza) or as a root sheath (ecto-mycorrhiza) and the hyphae (filaments) of these organisms grow out into the soil pores. In general, the normal plant root system is colonized with mycorrhiza, as shown in the photo. Mycorrhizal fungi colonize the root and then grow into surrounding soil to act very much like an extension of the plant root system. Hyphae or filaments of these fungi can be 100 times longer than the entire plant root system.

Mycorrhizal fungi are important in crop production, and coarse rooted plants such as peppers and onions are quite dependent upon nutrients supplied by mycorrhizal fungi. Terminology relative to these organisms includes mycorrhiza, endo-mycorrhiza, VA mycorrhiza, vesicular-arbuscular mycorrhiza or VAM. All refer to the same group of fungi which are important in maintaining healthy, vigorous plants during normal growth and plant stress conditions.



PLANT ROOT filled with the blue stained mycorrhizal fungi.

Symbiotic Association

The symbiotic plant-mycorrhizal relationship is dependent upon the plant supplying the carbon (C) necessary for fungal growth and reproduction in exchange for nutrients transported into the plant by the fungus. Mycorrhiza (the term means root fungus) have been found to affect uptake of nitrogen (N), P, potassium (K), sulfur (S), magnesium (Mg), manganese (Mn), copper (Cu), calcium (Ca), iron (Fe), silicon (Si), aluminum (Al), zinc (Zn) and water by the plant. Positive effects of mycorrhiza also include decreased plant water stress and altered plant transpiration.

Negative Effects of Mycorrhizal Loss in the Field

Plants can be negatively affected when mycorrhizal colonization potential is reduced in soils due to conditions such as long periods of fallow, fumigation, flooding, or severe soil erosion. In Australia, researchers found a problem of P and Zn deficiencies after long fallow (long-fallow

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disorder) in the Darling Downs area of Queensland. The condition was due to the absence of a mycorrhizal plant host during the fallow period and subsequent loss of mycorrhizal inoculation potential for the succeeding crop.

In a fumigation study in Nebraska involving corn, plants were stunted and showed severe P deficiency symptoms (shown in photo) after fumigation. When mycorrhizal fungi were reintroduced into the soil at the time of planting, plant growth and yields were comparable to that for the non-fumigated plot area. In a current research study, we are finding that in fields where crops were killed by flooding in Iowa and Missouri in 1993, there is a low mycorrhizal fungi colonization potential. Where starter fertilizer was not applied, corn in many of these fields had P deficiency symptoms and was stunted, as shown in photo. This type of problem is not exhibited in all soils. It is affected by nutrient availability and the degree of crop dependency on mycorrhiza for nutrient uptake.

THIS SOIL-FUMIGATED area planted to corn was surrounded by plants growing in non-fumigated soil. Plants in the fumigated area showed pronounced symptoms of P deficiency. (Nebraska)

Culturing Problems

Scientists have been able to culture inoculum of ecto-mycorrhizal fungi, which are commonly found on woody plant roots. A host is not necessary for growth and reproduction of this fungal group. The endo-mycorrhiza, which are important for most agricultural plants, cannot be propagated in the absence of growing plant roots. These fungi have great potential benefit to agriculture if isolates could be economically mass produced and introduced into the soil. However, unlike symbiotic N fixers for legumes and ecto-mycorrhiza, we have been unable to unlock the key to growing endo-mycorrhizal fungus without the host plant. If we could economically mass produce endo-mycorrhiza, we could introduce into the soil isolated strains which are more efficient in taking up nutrients, producing soil aggregates and reducing plant stress. Unlike the symbiotic N fixers which have a limited host range, mycorrhizal fungi affect a wide range of crops. Thus they have great potential to significantly affect crop production and soil sustainability. We are fortunate in that most soils have a ready supply of these fungi. But there is a premium for using farming practices that are favorable to mycorrhizal production and that maintain mycorrhizal fungal populations. ■

CORN PLANTS shown at left were growing in a field in Polk county, Iowa, which had flooded the previous year, killing crop plants. Plants on the right were growing in an area of the same field which was not flooded.