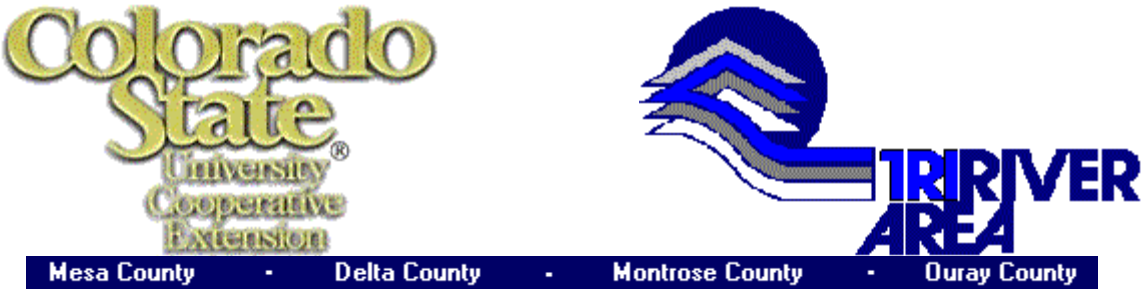

Mycorrhiza and soil phosphorus levels

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Introduction:

Mycorrhizae are an integral part of most plants in nature (Giazninazzi et al., 1982) and occur on 83% of dicotyledonous and 79% of monocotyledonous plant investigated (Wilcox - 1996). All gymnosperms are reported as being mycorrhizal (Newman & Reddell, 1987). Infection of the root system of the plant by these fungi creates a symbiotic (beneficial) relationship between the plant and fungus.

Upon root infection and colonization, mycorrhizal fungi develop an external mycelium which is a bridge connecting the root with the surrounding soil (Toro et al. 1997). One of the most dramatic effects of infection by mycorrhizal fungi on the host plant is the increase in phosphorus (P) uptake (Koide, 1991) mainly due to the capacity of the mycorrhizal fungi to absorb phosphate from soil and transfer it to the host roots (Asimi, et al. 1980). In addition, mycorrhizal infection results in an increase in the uptake of copper (Lambert, Baker & Cole, 1979; Gildon & Tinker, 1983), zinc (Lambert, Baker & Cole, 1979), nickel (Killham & Firestone, 1983), and chloride and sulphate (Buwalda, Stribley & Tinker, 1983). Mycorrhizae also are known to reduce problems with pathogens which attack the roots of plants (Gianinazzi-Pearson & Gianinazzi, 1983).

Influence of Phosphorus on Mycorrhizae:

The benefits listed above are greatest in P-deficient soils and decrease as soil phosphate levels increase (Schubert & Hayman, 1986).

Very high and very low phosphorus levels may reduce mycorrhizal infection/colonization (Koide, 1991). It is well established that:

- infection by mycorrhizal fungi is significantly reduced at high soil phosphorus levels (Amijee et al., 1989; Koide & Li, 1990)
- the addition of phosphate fertilization results in a delay in infection as well as a decrease in the percentage of infection of roots by mycorrhizae (deMiranda, Harris & Wild, 1989; Asimi et al., 1989)
- an increase in the level of soil phosphate results in a reduction in chlamydospore production by the fungus (Menge, et al. 1978). These spores are involved in root infection and spread of the fungus through the soil profile.

Research by Abbott and Robson (1979) concluded that levels of soil phosphorus greater than that required for plant growth eliminated the development of the arbuscles of vesicular-arbuscular (VA) types of mycorrhizae. Arbuscles are structures produced within the host plant cells by the VA mycorrhizae. These structures are responsible for the transfer of absorbed nutrients from the fungus to the plant. The arbuscles resemble miniature shrub-like trees (arbuscular = shrub in Latin). Mosse (1973) reports adding phosphate results in no arbuscles forming.

What levels of P are critical?

When the soil level of bicarbonate-soluble phosphorus exceeded 140 mg kg^{-1} (140 parts per million) the rate of infection was found to decrease (Amijee et al. 1989). Abbott and Robson (1977 & 1978) found the mycorrhizae *Glomus fasciculatum* ceased to be effective when the soil level of phosphorus reached 133 mg kg^{-1} [133 parts per million (ppm)]. Schubert and Hayman (1986) found mycorrhizae was no longer effective when 100 mg or more of P was added per kilogram of soil (100 ppm). Mycorrhizal infection virtually disappeared with the addition of 1.5 grams or more of mono calcium phosphate per kilogram of soil (Mosse 1973). With small additions of phosphorus fertilizer, entry points and fungal growth on the root surface remained normal but arbuscles were small and fewer in number reducing the effectiveness of the fungus/plant relationship. Other researchers have reported mycorrhizal infections tend to die out in soils containing or given much phosphorus (Baylis, 1967; Mosse, 1967). The development of mycorrhizal relationships were found to be the greatest when soil phosphorus levels were at 50 mg kg^{-1} (50 ppm) (Schubert & Hayman, 1986).

Summary and recommendations:

The benefits of mycorrhizae are greatest when soil phosphorus levels are at or below 50 ppm (50 mg kg^{-1}). Mycorrhizal infection of roots declines above this level with little if any infection occurring above 100 ppm P even when soil is inoculated with a mycorrhizae mix.

Prior to inoculating soil with mycorrhizae, a soil test should be conducted. If phosphorus levels are greater than 50 ppm the addition of mycorrhizae will likely be

ineffective.

The level of phosphorus in the plant also has been shown to influence the establishment of VA mycorrhizae with high levels inhibiting colonization by mycorrhizae (Menge, et al. 1978). Foliar applications of phosphorus therefore should be avoided when inoculating soil with mycorrhizae.

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Placed on the web December 9, 1999
Last updated: 01/26/2003 14:29:57

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