FIRST YEAR SUGAR MAPLE (*ACER SACCHARUM* MARSH.) SEEDLING NUTRITION, VESICULAR-ARBUSCULAR MYCORRHIZAL COLONIZATION, PHYSIOLOGY, AND GROWTH ALONG AN ACIDIC DEPOSITION GRADIENT IN MICHIGAN

By

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A DISSERTATION

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First year sugar maple (*Acer saccharum*, Marsh.) seedling nutrition, vesicular-arbuscular mycorrhizal colonization, physiology, and growth along an acidic deposition gradient in Michigan

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DISSERTATION ABSTRACT

A field study was conducted to determine the roles of acidic deposition and natural ecosystem stressors on soluble amino acid and sugar cycling and growth of first year sugar maple seedlings along an acidic deposition gradient in Michigan. The results of the study suggested that acidic deposition in Michigan is not affecting sugar maple seedling growth, amino acid cycling or sugar cycling. Strong evidence was obtained that those seedling processes were a result of natural ecosystem dynamics, particularly soil phosphorus, vesicular-arbuscular mycorrhizal colonization of seedling roots, and possibly temperature.

Root growth parameters of seedlings had greatest values at the sites exposed to the highest levels of acidic deposition than at the site exposed to less acidic deposition. However, the sites receiving greatest levels of acidic deposition also had the highest available soil phosphorus contents. There were no differences found for either seedling root or foliar nitrogen levels, suggesting that increased nitrogen deposition was not reflected in seedling tissue nitrogen. Also, no differences were found for root or foliar calcium, potassium, or magnesium, suggesting that those nutrients were not limiting seedling growth. There were, however, significant differences in both root and foliar P, and seedling P levels were significantly negatively correlated with soluble arginine and glutamine accumulation in seedling

foliage and reducing sugars in roots.

Accumulation of amino acids in leaves indicated that phosphorus was limiting seedling growth at the low acidic deposition site. Accumulation may, therefore, have been a seedling strategy to store soluble nitrogen for internal ammonium detoxification due to phosphorus limitations on growth. Reducing sugar accumulation may have also occurred due to reduced phosphorus. Under this scenario, lower phosphorus levels in roots could have resulted in decreased phosphorylation of reducing sugars and their incorporation into structural compounds to be used for seedling growth.

In addition to phosphorus, the frequency of vesicular-arbuscular mycorrhizal colonization of seedling roots were positively correlated with arginine and glutamine accumulation in seedling foliage. This may have been a seedling response to deprive nitrogen from the fungi. Mycorrhizal colonization frequencies were also positively correlated with reducing sugar accumulation and negatively correlated with sucrose levels in seedling roots, suggesting that mycorrhizal fungi stimulated sucrose degradation to reducing sugars. Increased sucrose degradation, coupled with lower seedling root phosphorus levels resulted in less reducing sugar phosphorylation and, thus reducing sugar accumulation at the low acidic deposition site. Accumulation of the amino acids and sugars were negatively correlated with seedling growth, indicating that seedlings at the low acidic deposition site were under greater stress than seedlings at the high acidic

deposition site. The increased stressed conditions at the low acidic deposition site appeared to be a of natural ecosystem and not anthropogenic origins.