Chelating Agents: Organic vs Synthetic

The Grigg Brothers® brand means foliar fertilizer quality, performance, compatibility, and efficiency. At Grigg Brothers®, we recognize that innovation through research and development provides the best and most trusted agronomic solutions. Our research efforts remain focused and designed to solve golf superintendents’ problems and provide additional turfgrass management tools. Research maintains Grigg Brothers® as an industry leader in science based plant nutrition solutions. Find all of our collaborative research at: http://www.griggbros.com/

History of Foliar Nutrition
Documented foliar absorption dates back over 165 years to the time of Gris (1844), Mayer (1874) and Bohm (1877) who reported iron, ammonia, and potassium absorption respectively. Processes related to foliar uptake, cuticular penetration, and cell to cell translocation of chelated mineral nutrients continue to be researched, including the discovery of some specific mechanisms of action. There are many references showing that monocots, including modern turfgrasses, absorb nutrients through the leaves. Grigg Brothers® has always maintained that a foliar application of nutrients does not substitute for good soil management, but rather supplements it. In many cases, primary macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) are effectively supplied, in part, to the plant through foliar application. Foliar absorption however, should be considered the most efficient method to supply secondary macronutrients such as sulfur (S), calcium (Ca) and magnesium (Mg) and trace nutrients (Gaussoin et al., 2009).

Nutrient Uptake and Chelation Technology
Solubility in water is essential for absorption by plants. This is true of systemic chemicals as well as nutrients. The material must be soluble to pass through the surfaces and into the cells of the plant. Insoluble mineral salts, including all oxides, most hydroxides, carbonates and some sulfates cannot be absorbed by the plant. When liquid solutions of these of minerals are applied, they simply coat the external surfaces of the plant with the unavailable mineral (Anderson, 1996). Chelation refers to the process of attaching a specific organic molecule, called a ligand, to a mineral ion at two or more sites to form a ring structure. Chelates (or chelating agents) can be either synthetic or natural.

ETDA, DTPA, EDDHA and similar molecules are examples of synthetic chelating agents (Ashmead et al., 1986). Amino Acids are an example of natural chelates. Grigg Brothers® amino acid chelates are naturally occurring compounds found in plants. The chelates usually contain 2 moles of ligand (glycine) and one mole of metal Figure 1.

Plant Physiology and Foliar Absorption Mechanisms
In between the leaf epidermal cell wall and cuticular membrane is a layer of pectin. The cuticular permeability of mineral nutrients has most commonly been studied using radio labeled isotopes. These studies indicate that cuticular penetration is largely a diffusion process and that the use of certain facilitators increases the rate of diffusion. The permeability has been shown to differ depending upon the size of molecules. Larger molecules such as EDTA, DTPA and EDDHA penetrate at a slower rate compared to natural chelating agents (Kannan, 1969). Cell membranes do not have the capacity to absorb synthetic chelates. For the mineral to be absorbed into the cell, chelates must release the mineral, leaving a vacancy within the chelate molecule and display charges that must be satisfied. For example, EDTA has a very high affinity for calcium (Jeppsen, 1999). As a result, the synthetic chelate will scavenge existing free calcium from the surrounding environment, including cell walls and membranes. This chain of events has the potential to cause the collapse of the cell walls and the leakage of cell contents, leading to phytotoxicity effects (Salisbury & Ross 1992).
Grigg Brothers® Research
The natural chelates utilized in Grigg Brothers® formulations are very small molecules, and consequently pass through the plant’s barriers including the cuticle, cell walls, and cell membranes maximizing absorption and assimilation. Grigg Brothers® initiated a rigorous research project at four (4) universities from 2005 through 2008. Nutrient uptake by three (3) turfgrass species were evaluated, including creeping bentgrass (Agrostis stoloniferous), annual bluegrass (Poa annua), and Tifeagle Bermudagrass (Cynodon dactylon). The results indicated that plants can absorb 75% or more of Grigg Brothers® foliar applied fertilizer in 4 hours (Figure 2) (Gaussoin et al., 2009). In addition, work conducted in the greenhouse showed that greater than 60% of both macro and micronutrients are getting into the plant within 15 minutes (Figure 3). Due to the high efficiency of Grigg Brothers® products, lower doses produce measurable responses.

![Figure 2. Bermudagrass uptake of secondary macro and micro nutrients with Grigg Brothers foliar fertilizer formulations.](image)

![Figure 3. Bermudagrass uptake of secondary macro and micro nutrients using Grigg Brothers foliar fertilizer.](image)

Problems with EDTA
(Ethylene diamine tetraacetic acid)
EDTA is a chemical compound with massive use worldwide for household and industrial applications. It remains an anthropogenic compound with the highest concentration in inland European waters and behaves as a persistent substance in the environment that potentially contributes to heavy metal bioavailability and remobilization processes in the environment (Oviedo and Rodriguez, 2003). In addition, the interaction mechanisms of EDTA with living organisms are not sufficiently clarified and the range of their potential risks is not known.

Grigg Brothers® Foliar Fertilizer Formulations
- Use only natural chelating agents, placing mineral in a fully bound in a ring structure
- Strong stability constants, allowing for increased compatibility and phosphate (PO4-) stability
- Use organic acids, amino acids and carbohydrates selected either individually or in combination to chelate specific metal nutrients
- Use chelators derived from plants which are quickly biodegradable and used by microorganisms as a food source
- Will not persist to pollute the environment

Today’s most efficient nutrient management programs use both soil and foliar fertilizer applications. These programs optimize nutrient recovery, and can be customized based on turf species, management practices, level of maturity, mowing height, time of year, and soil chemical and physical properties.

Literature Cited