Hydroponic Foliar Fertilization
By Dr. Lynette Morgan

The most commonly used method of hydroponic plant fertilization is through a nutrient solution applied to the root zone of the crop. While plant root systems are in the most part efficient at absorbing mineral nutrients, certain conditions can prevent optimal uptake rates of some of the elements plants require. When plants are stressed for some reason, have suffered root death or damage, are showing a nutrient deficiency or are being established from cuttings, then foliar feeding becomes a particularly useful method of nutrient application. Foliar feeding, provides nutrients through the foliage of the plant which has the ability to absorb and translocate certain minerals within plant tissues and this is a technique which growers can use in many situations.

Benefits of Foliar Fertilization

In soilless systems such as hydroponics, many nutrient interactions can occur within the root zone which makes it difficult for the plant to absorb certain minerals. Even well run hydroponic systems can become deficient in nutrients - either because of nutrient depletion, antagonism between certain elements, or due to elements becoming 'bound' and therefore unavailable for plant uptake. Imbalances in the combination of nutrients, pH levels which are too high or low for maximum plant uptake and poor physical properties of the media surrounding the root zone, including oxygen starvation are more common in soilless systems than many growers realize. Furthermore, elements such as iron, an essential trace element, can not only be prone to becoming unavailable for plant use at moderate to high pH levels, but uptake by the plant can also be severely limited under certain environmental conditions such as cool temperatures. Iron chlorosis in many crops which are overly stressed by low temperatures can be a common problem where root uptake is the only source of iron for the plant.

Any situation which damages the root system or restricts its growth, development or physical process such as respiration affects the uptake of minerals. Plant pathogens such as fusarium pythium and phytophthora can not only rapidly destroy a crop, but low, less damaging levels can restrict function of the root zone to the point where mineral uptake is affected. While the crop may not show signs of severe infection, mineral and water uptake can be restricted and therefore crop yields and quality are affected. Other plant stress conditions such as anaerobic conditions in the root zone where oxygen is deficient, can limit nutrient uptake, with trace elements such as iron often affected to the greatest degree. Any other condition which stresses the plant - temperature stress, high or excessively low humidity levels, lack of light, high radiation levels, high plant densities, presence of pests or disease, will affect the efficiency of the root system in taking up mineral elements. These conditions are common and occur in many growing systems from time to time without the grower even realizing that plant growth and mineral uptake is being limited in some way. It is under these types of situations that foliar feeding has its greatest advantage. Since plant stress is dependent on a number of factors --- many are environmental, which growers have limited control over, foliar

fertilization provides an 'insurance policy' against yield and quality loss from limitations in root mineral absorption and transportation.

The Process of Foliar Fertilization

Most leaves have stomata either only on the underside or on both sides of the leaf which enable gas to be exchanged for photosynthesis and respiration as well as releasing water vapor in stomatal transpiration. The leaf with its epidermis can also function as an organ that absorbs and excretes water and substances which may be dissolved in it.

Since foliar absorption is limited because of the relative barrier of the cuticle it is not possible to solely feed plants via the leaves. For this reason the most effective use of foliar fertilization is as a rapid and effective method of supplying the micro nutrients. It can, however also be used to satisfy acute needs with lower concentrations of macronutrients and biuret-free urea is often used to supply nitrogen via the leaves.

Foliar Nutrient Application

One very important criterion of the effectiveness of nutrient sprays is the rate at which the foliar applied nutrients are absorbed by the leaves and translocated within the plant. The uptake of nutrients is further affected by a number of interacting factors of which only part are known at the current time - these are shown in **Table 1**.

It would be difficult to ensure that all of these factors shown in **Table 1**, are optimal for foliar feeding at any one time, but some are more important than others. The use of a good quality, non ionic wetting or sticking agent is vital for foliar feeding. Wetting agents are necessary to ensure the adherence of droplets on difficult to wet leaves as well as assisting with the absorption of the fertilizer solution into the plant tissue.

The foliar fertilizer solution should then be applied as a fine mist until 'run off' so that the entire leaf surface is wetted. The time of day when the solution is applied is also important. Spraying early in the morning, while it is light, but temperatures are still cool, or in the evening is best and conditions that allow the leaf to dry rather than stay wet for an extended length of time is also important to consider. Foliar solutions should not be applied during hot, bright conditions, if the plants are wilting or under water/osmotic stress as the plants stomata are likely to be closed making application ineffective.

Foliar feeding can by carried out on a regular, weekly basis, or can be limited to the times when the crop comes under high nutrient demand such as early fruit set and heavy fruit loading. Often the greatest response to foliar feeding will occur during the active growth phases of plants (period of exponential growth). During these active growth stages, leaves show a particularly high efficacy for absorbing nutrients.

If a period during which the plants have difficulty in absorbing nutrients via the root system should coincide with a period when there is a particularly vigorous demand for nutrients, the result will be a significant loss in yield potential, without the grower seeing

any visible signs of deficiency. Under such conditions foliar fertilization can give particularly impressive results.

Table 1 Influences determining the efficacy of foliar nutrient sprays

PLANT	ENVIRONMENT	SPRAY SOLUTION
Curricular wax	Temperature	Concentration
Epicuticular wax	Light	Application rate
Age of the leaf	Photo period	Application technique
Stomata	Air movement	Wetting agent
Guard cells	Humidity	pH
Leaf hairs	Drought	Polarity
Adaxial leaf side	Time of day	Hygroscopicity
Abaxial leaf side	Osmotic potential of root	Sticking ability
Leaf Turgor	Nutrient stress	Sugars
Surface moisture (dew etc)	Nutrient ratio	
Cation exchange capacity	Carriers, penetrates	
Nutritional status of the plant	Humectants	
Cultivar	Growth stage	

The Role of Foliar Fertilization in Hydroponic Crop

While hydroponic crops may appear to be supplied with optimal nutrition via a well balanced and formulated nutrient, they still benefit from the application of foliar fertilizers. Studies have shown that hydroponic crops such as capsicum, treated with a micro nutrient foliar applied solution, had an increase in fruit yield over control plants and also an increase in the compound capsaicin in the fruit tissue. Hydroponically cultivated potato plants also showed similar results. Potato plants given foliar fertilization treatments with a micro nutrient solution not only had a greater tuber harvest, but also higher dry matter of the whole plants. Rockwool grown tomato crops have shown both yield and fruit quality improvements when given a weekly foliar feed of a micro nutrient complex. These results would also be expected on a number of hydroponic crops with similar nutrient requirements and thus the process of foliar fertilization is a cultivation technique that should be considered as more than just a 'quick fix' for mineral deficiency symptoms.