Why Foliar Fertilization Works
An Update on Recent Research

Robert H. Faust Ph.D., Agronomist, 1996

My experiences with foliar fertilization over 25 years of use.

During the past 25 years I have been involved in agriculture as both a consultant and as a farmer. My farms have been my experimental laboratories and my goals were always to find the most economical and ecological methods ***for crop and livestock production***. I conducted many experiments on my own land and on crops of my clients. Observation showed that foliar application made the crop "look better" - to a farmer this clearly indicated something was working. Yield measurements and check strips showed the economic benefits to the grower by producing large and significant yield increases, even a 10% yield increase that might be "insignificant" to a university researcher is very significant if farming is how you make your living. A 10% yield increase on hundreds or thousands of acres can be the difference between losing money or breaking even, and a making a good income from the crop. In agriculture the small yield increases derived from management practices like fertilization and pest management are what makes the years profits.

I had tried practically every foliar fertilizer on the market by the time I tried **Agri-Global** products. The **Gainer Fertilizers** were exactly what I was looking for; a product that was **totally soluble and did not plug the sprayers.** They **contain buffering and wetting agents** and are available in a number of formulations. All my client recommendations are based on leaf analysis and each crop and farm required different combinations which is one reason I kept using the **Gainer foliars**, as I could add more zinc or manganese or whatever was needed like sulfur fungicides and pest control products, with good compatibility. The other factor was the inexpensive nature of the products. For a few dollars per acre the farmer could pick up a 6-1 return or so on money invested in foliar sprays. Those on the academic side of agriculture may have a different perception of foliar fertilizer applications. *Very little work has been done in the US universities in regards to foliar application, and not only because it is applied research, which is not favored by U.S. universities.* Based on a limited understanding of plant physiology and the emphasis on soluble fertilizers combined with a hydroponic mindset, *they just didn't want to believe that that* ***tiny amounts*** *of fertilizer would have any effect on crop yields.* Academia wanted to know how this "worked" before they would take it seriously. We now know how it works - ***it works on the cellular level to stimulate chlorophyll production in the cells contained on the leaves most exposed to direct ultraviolet irradiation.*** *The increase in the pigments in the cell including chlorophyll could more efficiently convert sunlight to energy which in turn stimulates uptake from the roots to the leaves. Maybe more important these days is reducing the damage caused by excessive ultraviolet radiation, as more pigmentation protects the cell and "light saturation" can reduce yield and predispose the plant to disease. Additional production afforded by dark pigmentation protects the plant significantly.*

The use of foliar fertilizing in agriculture has been a popular practice with farmers since the 1950's. ***They knew it worked but were told it shouldn't work because so little fertilizer was being applied per acre.*** *[Monsanto wants to sell larger amounts of fertilizers.]* It has only been recently that research has been done that shows how a small amount of potash or phosphate applied by foliar spraying can increase the yield of crops so significantly, actually providing a better return per dollar invested than soil applied fertilizer. Only by understanding the plant/cell physiology can we understand this phenomenon. Foliar fertilization doesn't totally replace soil applied fertilizer but it does increase the uptake and hence the efficiency of the soil applied material. ***The increased efficiency can reduce the need for soil applied fertilizer and reduce leaching and run off of fertilizer nutrients, reducing the impact on the environment of fertilizer salts.***

It was learned in the 1950's that foliar fertilization was effective. ***Radioisotopes (P32) were used to show that foliar applied fertilizers made it through the leaf cuticle and into the cells*** (Brasher, et. al., 1953).

The plant cell is the key; it has a unique capacity to concentrate elements from dilute solutions. As water enters root cells, minerals are not swept into the cells with the water. Water diffuses into cells independently of minerals. Often the concentration of a given mineral is greater inside a cell than in the solution which bathes it. According to the law of diffusion, the mineral in question should diffuse out of the cell. Actually, in many instances the cell continues to take up the mineral. The data obtained by D.R. Hoagland and A.R. Davis from studies of cells of Nitella (an alga) clearly illustrate this fact.

Analysis of the Cell Sap of Nitella and of the Pond Water in Which it Was Growing

Ion	Concentration in **Sap***	Ion	Concentration in **Water***
Calcium	**13.0**	Magnesium	**10.8**
	1.3		**3.0**
Sodium	**49.9**	Potassium	**49.3**
	1.2		**0.51**

*Milliequivalents per liter - A milliequivalent of an ion is one-thousandth its gram ionic weight divided by its valence. In all instances the ions entered the cells even though their concentration was higher in the cell sap than in the pond water. ***The ions moved from where they were less concentrated to where they were more concentrated*** (Northen, 1968).

Research in Thailand showed the beneficial effects of a high potash and/or phosphate foliar is due to an increase in cellular based chlorophyll synthesis (Suwanarit, et. al., 1989).

Timing and alleviation of nutrient stress periods in the physiology of the crop plant is crucial.

Increased absorption & uptake of nitrogen, calcium, magnesium, & phosphorus by 57%.

The summary of findings include yield increases of 74% when all aerial parts were sprayed on the third day after 50% tasseling. Application later than 7 days after 50% tassel, were not as effective or even produced no results, showing that timing is crucial to foliar application of K fertilizer.

Some of the latest published research is of detailed field trials using foliar fertilizer on cotton crops in Northern India (Venugopalan, et. al. 1995) The research showed increased yield and quality by increasing the uptake of N and P and ***providing cellular phosphate at a time of high usage by the plant.***

Summary of findings: The nitrogen uptake was 12-18% higher than controls and phosphate uptake were 24-28% higher with foliar application than with controls. Seed cotton yields were 18% higher than soil application; the result was higher boll number and boll weight. Recovery of soil applied N and P were increased by 17-18% overall.

Effects of Foliar Fertilizing It seems clear from the above data that the application of foliar fertilizers does not replace soil applied fertilizers, but they do increase their uptake. ***When fertilizers are foliar applied to the upper leaves, they provide nutrition to the cells in the leaf at a time when usage by the plant is greater than uptake by roots.*** When fertilizers are applied to the leaf in the right form, the ***fertilizer ions penetrate the leaf and cell walls, increasing chlorophyll production and synthesis.*** We see a "***photon pump priming effect***" ***- an increase in cellular activity and respiration that increases uptake by the plant vascular system in response to the increased water needs by the leaf. This increase in uptake automatically brings more fertilizer elements into the plant via the vascular system.*** The need for more moisture and greater gaseous exchange stimulates additional root mass to provide it. ***Excess carbohydrates produced by the plant due to greater synthesis of sugars by the increased chlorophyll are excreted by the root hairs and stimulate microbial colonies on the roots by providing additional energy sources. The bacterial colonies in turn provide auxins and root stimulation compounds. More root hairs and root tissue further increase the plants ability to uptake water and fertilizer ions.*** A chain reaction is set off, if the right material is applied at the right time to set up this feedback loop. ***Great efficiencies are to be obtained with foliar fertilization because we are stimulating the entire "pumping" mechanism that comprise the leaf cells.***

Using leaf analysis is the best way to select the type and amount of a foliar fertilizer. The choice of which foliar nutrients to use is dependent on existing leaf levels. If one of the major nutrients appears low based on visual or foliar analysis then that element should be applied in a small amount to the plant to get the leaf cells and their chloroplasts working at an optimum rate, which in turn increases the uptake of the deficient elements via the roots. The important thing to remember is that the small amount of fertilizer used actually increases the uptake in terms of total uptake by several fold over the small amount of fertilizer applied.

Foliars are best applied at nutritional stress periods and tend to increase the uptake of major nutrients far in excess of the input levels. Foliars should be applied when the plant is not in water stress, either too wet or too dry. **Foliar applications are best applied when the plant is cool and filled with water (turgid).** Foliar fertilization has elements of both art and science, in that the method and timing is crucial. Foliar applications that are misapplied or too late in the season may not be effective.

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How to use Humisolve-USA in a Foliar program from Fruit

Robert H. Faust M.S. Ph.D.

Robert Faust is an agronomist and soil specialist as well as an entomologist/pest control advisor with over 25 years of experience. Trained in entomology and applied ecology at the University of Delaware with a M.S. in applied science-agronomy, he has researched and developed bio-pesticides, organic and bio-mineral fertilizers, and natural insecticides. Dr. Faust was a licensed Pest Control Advisor in California with licenses in insect and weed management as well as plant pathology. He has consulted with farmers throughout the United States. While living in southern Idaho and California, he gained extensive experience with using foliar fertilizers on beans, corn, potatoes, citrus, avocados, many vegetable crops and golf courses. - Dr. Faust currently lives on the island of Hawaii where he conducts research in integrated polyculture on his 12 acre tropical farm, where he also raises purebred tropical St. Croix hair sheep. He is a founding member of the Hawaii Bio-Organic Growers Association.