

Micronutrients Are the Key to Better Yields

Sometimes the Smallest Things Can Unlock Our Greatest Potential

By Larry Cooper, with Rita Abi-Ghanem, PhD

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Micronutrients play a critical role in plant vigor, yield, and harvest quality. Yet, they are often overlooked when growers develop their nutrient programs. In this article we provide an overview of what micronutrients are, the roles they play, how availability is affected by soil and other conditions, how to recognize deficiencies, and the important steps to take when developing a micronutrient plan for your crops.

Science has identified 17 essential nutrients for healthy plant growth. Water and air normally provide the three most important: carbon, hydrogen, and oxygen. The rest are generally expected to come from the soil. We are all familiar with those six nutrients required in large amounts (macronutrients and secondary macronutrients): nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. There are also eight nutrients required in smaller amounts (boron, chlorine, copper, iron, manganese, molybdenum, nickel, and zinc), dubbed **micronutrients**—as well as several elements that have been identified as non-essential, yet beneficial plant micronutrients such as cobalt, silicon, selenium, vanadium, etc. Micronutrients are often treated as an afterthought, though. Don't sweat the small things, right?

Wrong! Smaller doesn't mean less important. In fact, in many ways micronutrients hold the key to how well the other nutrients are used and how well the plant grows, develops, and yields.

What Micronutrients Do

Micronutrients are known to play many complex roles in plant development and health. These include photosynthesis, chlorophyll synthesis, respiration, enzyme function, formation of hormones, metabolic processes, nitrogen fixation and reducing nitrates to usable forms, cell division and development, and regulation of water uptake. Micronutrients promote the strong, steady growth of crops that produce higher yields and increase

harvest quality—maximizing a plant's genetic potential. In particular, their presence can have a great impact on root development, fruit setting and grain filling, seed viability, and plant vigor and health.

Micronutrient deficiency or toxicity can result in stunted growth, low yields, dieback, and even plant death. Micronutrients also benefit plants indirectly by feeding the microorganisms in the soil that perform important steps in various nutrient cycles of the soil-plant root system.

Of course, the end product is the role micronutrients play when the harvest reaches the table. Increasing evidence indicates that crops grown in soils with low levels of micronutrients may not provide sufficient human dietary levels of certain elements, even though the crops show no visual signs of deficiency themselves. These unseen deficiencies can readily be found through proper laboratory analysis, which we discuss below.

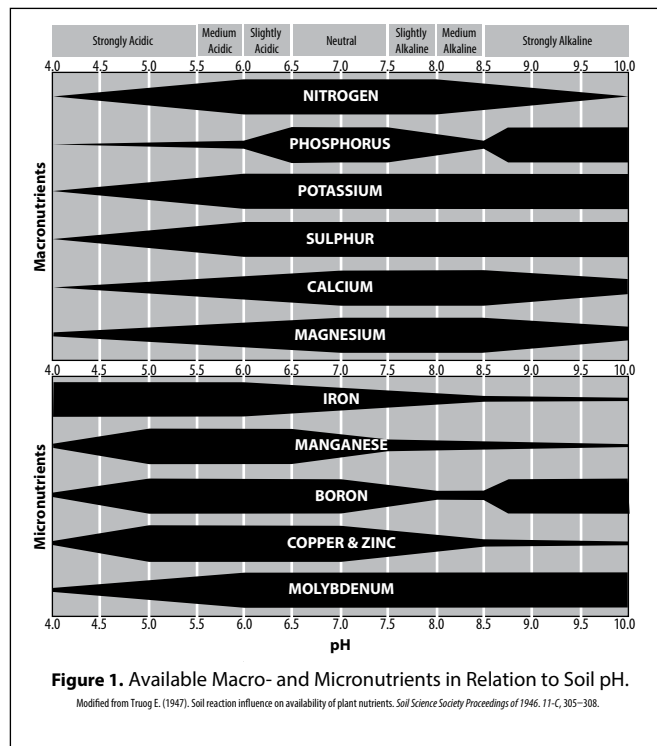
The World Health Organization reports that micronutrient malnutrition contributes substantially to the global burden of disease. In 2000, the *World Health Report* identified iron and zinc deficiencies as being among the world's most serious health risk factors. Micronutrient malnutrition is known or suspected to contribute to a wide range of impairments, including reduced resistance to infections, metabolic disorders, learning disabilities, and stunted development and growth of infants and children.

Micronutrients and Soil

Micronutrients occur naturally in soil minerals, which gradually break down from rock minerals and release in forms that are available to plants. Some micronutrients are re-introduced to the soil during decomposition of organic matter from plants and animals.

A critically important concept related to micronutrients is that of their availability to plants. Micronutrients can sometimes be present in soils but not in a chemical form that roots are able to absorb. Soil physical characteristics and environmental conditions play key roles in determining when and how available soil nutrients—especially micronutrients—are to plants.

- Acid leaching can remove micronutrients from the soil, as can intensive cropping—in which large amounts of plant nutrients are removed in the harvest.
- Excessive use of phosphate fertilizers can diminish the availability of some micronutrients, particularly iron and zinc.
- Extremes in soil pH can result in reduced micronutrient availability (Figure 1) or even cause micronutrient toxicity. Most plants have a pH range “sweet spot” in which the micronutrients in the soil are soluble enough to satisfy plant needs without becoming so soluble as to become toxic.
- Soils very low or very high in organic matter or with sandy texture or heavy clay can result in micronutrient imbalance.
- Soil erosion can carry away humus and organic matter in which some micronutrients are held.
- Cold, wet soils can result in slowing or stopping plant root development; thus, roots explore smaller areas and take in an insufficient amount of micronutrients.



Because micronutrients are required in very small amounts for adequate nutrition, the range between “enough” micronutrient and “too much” micronutrient can be a lot more narrow than for macronutrients. Micronutrient toxicities that occur can damage or retard plant growth and affect yield. Toxicities rarely result from over-fertilization: they are more commonly associated with contaminations such as from concentrated wastewater, waste sludges being continuously applied, or from the excessive application of copper- or zinc-containing fungicides. Contaminated irrigation water can also be a source of micronutrient toxicity.

Common Micronutrient Deficiencies

It is beyond the scope of this article to list all the possible types of micronutrient deficiencies and their characteristic symptoms. Information, photos, and tables of deficiency factors are available from multiple online sources. However, some crops and soil types are more prone to certain types of micronutrient deficiency than others: examples include boron deficiency in alfalfa; copper deficiency in wheat, corn, and soybeans; nickel deficiency in pecans; and molybdenum deficiency in soybeans. Zinc deficiencies frequently occur on calcareous, high-pH, sandy texture, high phosphorus, and eroded soils. Poorly drained soils may also be deficient.

Some of the more common symptoms to look for include stunted growth; delayed maturation; yellowing and wilted

leaves (particularly younger leaves); thickened, puckered, curled, or brittle leaves; dead growing points; aborted flowers, heads, or seeds; poor grain filling; fruit deformities; and increased root disease. These symptoms often occur in irregular patches within fields and can have a drought-like appearance. Keep in mind that there can sometimes be a “hidden hunger” for micronutrients present, in which crops don’t show any overt symptoms until decreased yields are observed at harvest.

Tissue Testing and Soil Testing

While visual symptoms and suspect soil conditions can raise the possibility of micronutrition deficiency, the best approach to identifying a problem and implementing a viable solution lies in regular tissue and soil testing. Your local lab or extension office can guide you through the process, but be aware of the strengths and limitations of each.

Soil testing can only measure the quantity of nutrients identified as present through analytical methods, not their total levels nor their availability to plants. By combining annual soil testing with regular plant-tissue analysis, you can create nutrient ratios providing a much more accurate diagnosis of deficiencies that may be present and the best prescription for addressing those deficiencies. Timing is also an important element. Testing during early to mid-season plant growth can give you time to correct a problem, whereas tissue samples taken during later stages of growth are good to determine corrective actions for the next crop.

If you are dealing with a suspected problem, take plant and soil samples from both the affected areas and the unaffected areas. A comparison of results can help create a much clearer picture of the problem and the actions that should be taken.



4Rs of Nutrient Stewardship


Once the need for a micronutrient supplement has been determined, the next steps are clearly identified by the industry standards set out in the 4Rs of Nutrient Stewardship. These include determining the “*Right Source*” for supplying the target nutrient, applying the “*Right Rate*” for optimal benefit, at the “*Right Time*” of application during day, growth stage, or the growing season. Detailed discussion of those three Rs is beyond the scope of this article; however, we will further expound on the fourth R, “*Right Place*,” which addresses the application placement and method.

Application Methods

The application method involves whether you want to apply a product directly to the soil (like banding or side dressing), directly to the plant surface (such as foliar spray), or through the irrigation water (fertigation). Conventional application of fertilizers to soils is most common prior to planting, using ground equipment for spreading or spraying onto the soil. At planting or post emergence, banding or side dressing of liquids or granular nutrients are common. Soil-applied fertilization places the nutrients directly in the soil where the soil can buffer and store them and make them available to the crop as needed.

Fertigation, on the other hand, provides the additional utility of applying nutrients at critical periods of crop water demand, which gets to the soil but can also penetrate leaves without the risk of ground equipment compacting the soil or damaging plants (so called “iron blight”). One





disadvantage here is that some fertilizers can corrode or stop-up irrigation equipment or may require the expense of specialized equipment for the irrigation system.

Foliar sprays are also well-suited for the application of micronutrients. High-quality sources of micronutrients are able to permeate and diffuse through the leaf surface into the plant. Advantages to foliar sprays are that a uniform field application is easily obtained, nutrient application rates may be lower than rates used for soil application, nutrients may be “piggy backed” with other agrochemical applications to reduce application costs, and the response to the applied nutrient can be almost immediate. Thus, micronutrient deficiencies identified during the growing season can be quickly corrected. An additional benefit is that foliar applications bypass any limitations on soil nutrient availability that may be present due to pH issues. However, foliar sprays may not be as effective on younger plants that have less leaf surface area, may result in leaf burn if salt concentrations of the spray are too high, and may leave very little residual effect to replenish the soil for the next planting.

Developing a Micronutrient Plan for Your Crops

It makes sense to have a comprehensive micronutrient plan in place to ensure that you are getting the best crop yields for your money and the extra effort invested. Remember that if you allow micronutrient deficiencies to become a limiting factor in crop development, further application of water, macronutrient fertilizers, and other resources and time may give a limited return or be wasted.

Planning begins by knowing which of your fields and which of your crops are most susceptible to micronutrient deficiencies and by routinely conducting soil and tissue tests. When problems are identified and successfully treated, you must keep good records of what was done for future reference. It is also essential to continuously monitor your fields for possible future micronutrient problems. Be aware of any special physical or environmental conditions that may affect future micronutrient availability to your crop.

Micronutrient needs vary with the type of soil, crop planted, available nutrient source, and whether or not the crop is irrigated or on dry land. For more specific recommendations, review resources that apply to your locale and discuss your test analyses with your county extension office and your fertilizer retailer. It is important to find the best micronutrient solutions—including the correct amounts and application timing—to help you reach a complete and healthy balance of all the essential nutrients needed for vigorous crop growth and optimal yield.

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For more information or a free consultation:

Contact Huma Gro® at <https://humagro.com/contact/> or call 1-800-961-1220.

To view the entire Huma Gro® product catalog online, go to <http://bit.ly/HumaGroCatalog2017>.

SECONDARY MACRO

Ultra-Efficient AND MICRONUTRIENTS

Secondary macronutrients (Magnesium, Calcium, and Sulfur) and micronutrients (Boron, Chlorine, Copper, Iron, Manganese, Molybdenum, Nickel and Zinc) are known to play many complex roles in plant development and crop yield. In many ways, they hold the key to how well the other nutrients are used. They promote the strong, steady growth of crops that produce higher yields and increase harvest quality—maximizing a plant's genetic potential. In particular, their presence can have a great impact on root development, fruit setting, grain filling, seed viability, and plant vigor. However, these nutrients are quickly mined out of any soil that is repeatedly farmed, resulting in the need for applying ever-increasing amounts of fertilizers to get the same crop yield.

Huma Gro® offers a complete line of liquid fertilizer formulations powered by Micro Carbon Technology® (MCT) that allow a grower to foliarly apply these secondary macronutrients and micronutrients at the exact growth stage when they are most needed. The MCT improves the absorption of nutrients by crops; this improved efficiency saves money and reduces waste because less fertilizer is needed to get great results. Whatever your crop, whatever your soil, we can help you find the best nutrient solution for vigorous crop growth and optimal yield.

"With MCT, we have something no one else has. We are able to get nutrients into the plant faster and with less product. It is without a doubt the most trend-setting technology out there!"

—Mark Gregory



32 Powered by Micro Carbon Technology®

MAX PAK®

The Solution for Micronutrient Nutrition in Plants

Huma Gro® MAX PAK® is a liquid micronutrient formulation containing a complexed, highly stable source of many important micronutrients. MAX PAK® is leaf friendly, salt buffered, and formulated with Micro Carbon Technology® to ensure maximum uptake and translocation of nutrients.



BENEFITS:

- **Micronutrient and fungicide booster**
- **Penetrates the leaf with minimum disruption of leaf cell membranes**
- **Nutrient buffer for tank mixes**
- **Improved plant vigor and suppression of plant diseases**
- **Essential components in chlorophyll, plant enzyme systems, protein and carbohydrate metabolism, photosynthesis, respiration, vitamins, and hormones**
- **Provides essential plant nutrients**



GUARANTEED ANALYSIS:

Sulfur (S).....	3.00%	Molybdenum (Mo).....	0.05%
3.0% Combined (S)		Zinc (Zn).....	3.50%
Boron (B).....	0.60%		
Cobalt (Co).....	0.05%	Derived From: Boric Acid, Cobalt Chloride,	
Copper (Cu).....	1.00%	Sodium Molybdate, Zinc, Manganese,	
Iron (Fe).....	2.00%	Copper, and Ferrous Sulfates.	
Manganese (Mn).....	1.00%		



APPLICATION:

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/acre 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.

"HUMA GRO® liquid fertilizers can save up to 90% of your storage space. They come in a concentrated liquid form, instead of dry sacks as conventional products do. This also makes things easier for the worker in charge of mixing the products, as he not only has to lift less weight but also reduces his exposure to potentially harmful conventional products. 'The staff, the plant, and the environment all benefit.' "

—Red Agricola, Apr 2015, Issue 21, pg 28-29



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44 MAG®

The Solution for Improved Magnesium Nutrition in Plants

Huma Gro® 44 MAG® complexed with Micro Carbon Technology® ensures maximum assimilation of magnesium, which is the essential part of the chlorophyll molecule that gives plants their green color.

BENEFITS:

- *Essential core of the chlorophyll molecule*
- *Is active in the translocation of starches and necessary for sugar formation*
- *Acts as a carrier for phosphorus in the plant*
- *Regulates the uptake of other plant nutrients*
- *Enhances oil and fat formation*

GUARANTEED ANALYSIS:

Magnesium (Mg)..... 5.00%
 5.00% Water Soluble Magnesium (Mg)
 Sulfur (S) 5.50%
 5.50% Combined Sulfur (S)

Derived From: Magnesium Sulfate

APPLICATION:

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1–2 qt/ac 2.5–5 L/ha	0.5–1 gal/ac 5–10 L/ha	Apply as needed.

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.



“Agrícola San José (reduced) not only the size of the warehouses from 2,152 sq. ft. (200 sq. m) to 107 sq. ft. (10 sq. m), but also the irrigation system maintenance investment. ‘Thanks to the Huma Gro® products’ solubility, drip emitters no longer get clogged, resulting in savings for us.’ –Agrícola San José manager”

—Red Agrícola, Sep 2015, Issue 25, pg 42-43



Z-MAX[®]

The Solution for Improved Zinc Nutrition in Plants

Huma Gro[®] Z-MAX[®] complexed with Micro Carbon Technology[®] ensures efficient and effective uptake of zinc, sulfur, manganese, and copper to optimize micronutrient nutrition of the plant and helps suppress certain external and internal plant stresses. This highly concentrated micronutrient solution is designed to improve plant nutrition and vigor. Z-MAX[®] is a great additive to your pest management arsenal.



BENEFITS:

- **Micronutrient and fungicide booster**
- **NPK booster**
- **Nutrient buffer for tank mixes**
- **Improved plant vigor and suppression of plant diseases**
- **Essential components in chlorophyll, plant enzyme systems, protein and carbohydrate metabolism, photosynthesis, respiration, vitamins, and hormones**
- **Regulation of NPK, water, and plant solubles**



GUARANTEED ANALYSIS:

Sulfur (S) 5.00%
 5.0% Combined Sulfur (S)
 Copper (Cu)..... 0.50%
 Manganese (Mn) 2.00%
 Zinc (Zn)..... 8.00%

Derived From: Copper Sulfate, Manganese Sulfate, Zinc Sulfate.

APPLICATION:



CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1–2 qt/ac 2.5–5 L/ha	0.5–1 gal/ac 5–10 L/ha	Apply as needed.

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro[®] Rep for more information.

“We saw really big yield increases in corn and milo these last couple of years using Huma Gro[®] products. We also saw disease control benefits using Z-Max.”

—Mark Gregory



HumaGro.com





CALCIUM

The Solution for Improved Calcium Nutrition in Plants

Huma Gro® CALCIUM complexed with Micro Carbon Technology® ensures maximum calcium uptake and translocation within the plant. CALCIUM is a required nutrient for cellular strength and growth, plant health, and fruit development—which indirectly reduces the risk of fungal diseases.

BENEFITS:

- *Increases stalk strength and reduces lodging in grain crops*
- *Increases shelf life and reduces shipping/storage disorders in fruits/vegetables*
- *Promotes maturity and improves fiber quality in cotton*
- *Reduces susceptibility to fungal disease infection*
- *Enhances nodulation in legumes*
- *Promotes early root growth*
- *Promotes maturity and viability in seed crops*



GUARANTEED ANALYSIS: 8-0-0

Total Nitrogen (N) 8.00%
 8.00% Nitrate Nitrogen
 Calcium (Ca) 10.00%

Derived From: Calcium Nitrate.



APPLICATION:

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1–2 qt/ac 2.5–5 L/ha	0.5–1 gal/ac 5–10 L/ha	Apply as needed.

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.



“These products are highly compatible and can be mixed with all kinds of nutrients without generating any antagonism whatsoever, even when dealing with complex combinations. When we visited the premises, we confirmed that they mixed pure calcium and phosphorous without problem, what is not commonly achieved.”

—Red Agricola, Apr 2015, Issue 24, pg 11



IRO-MAX™

The Solution for Improved Iron Nutrition in Plants

Huma Gro® IRO-MAX™ complexed with Micro Carbon Technology® provides effective and quick iron uptake into the plant. Iron is a key micronutrient involved in photosynthesis that also enables other biochemical processes such as respiration, symbiotic nitrogen fixation, and transfer of ATP within the plant.



BENEFITS:

- *Iron is required by plants for the formation of chlorophyll*
- *Iron is a component of enzymes that activate other biochemical processes within plants such as respiration, symbiotic nitrogen fixation, and energy transfer*
- *IRO-MAX™ relieves chlorotic symptoms of iron-deficient plants.*



GUARANTEED ANALYSIS: 12-0-0

Total Nitrogen (N) 12.00%
 12.00% Nitrate Nitrogen
 Sulfur (S) 4.00%
 Iron (Fe)..... 8.00%

Derived From: Urea, Ferrous Sulfate

APPLICATION:

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1–2 qt/ac 2.5–5 L/ha	0.5–1 gal/ac 5–10 L/ha	Apply as needed.

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.



"I think Huma Gro®'s main advantage is the fast response of the products after application. Another benefit is that inventory, stock, and storage management is much easier, we don't even need big warehouses anymore. The third comparative advantage, which is very important in my view, is the return on investment. . ."

—Red Agricola, Nov 2015, Issue 27, pg 34-35



HumaGro.com



BORO-MAX®

Boron (B).....10.00%

Huma Gro® BORO-MAX® complexed with Micro Carbon Technology® ensures efficient and effective uptake of boron, which is required for cell division, plant metabolism, cell structure, sugar transport, pollination, and seed development. It enhances pollen viability and pollination in flowering crops, and supplies boron nutrition necessary for proper growth and maturation.

- *Is required for cell division and normal tissue differentiation and maturation*
- *Improves protein metabolism and reduces nitrate accumulation in leaves*
- *Functions with calcium to form an "intercellular cement" to maintain plant structural integrity*
- *Improves sugar transport in plants*

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.

COBALT

Cobalt (Co)5.00%

Huma Gro® COBALT complexed with Micro Carbon Technology® is an essential micronutrient involved with nodulation of legumes, microbial function, and recovery from plant stress. It is the center element of the B-12 vitamin.

- *May be applied with Huma Gro® VITOL® or a foliar nutrient to overcome stress caused by over-application of herbicides and pesticides*
- *Buffers excessive ethylene concentrations in plant tissue, preventing the production of abscisic acid and premature fruit drop*
- *Essential element for nodulation or nitrogen fixation in legumes*

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.

COMOL™

Available Phosphate (P₂O₅).....5.00%
Cobalt (Co)1.00%
Molybdenum (Mo).....3.00%

Huma Gro® COMOL™ complexed with Micro Carbon Technology® ensures efficient nutrient uptake and translocation of phosphorus, cobalt, and molybdenum, which indirectly encourages production of amino acids, proteins, and carbohydrates necessary for cellular division, nodulation of legumes, microbial functions, recovery from plant stress, enzyme activities, and nitrogen metabolism.

- *May be applied with Huma Gro® VITOL® or a foliar nutrient to overcome stresses caused by severe weather or herbicide and pesticide residues*
- *Produces coenzymes necessary to convert nitrogen to amino acids for protein synthesis*
- *Buffers ethylene concentrations in plant tissue*
- *Stimulates natural production of enzymes that are required in ascorbic acid synthesis*

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.



Powered by Micro Carbon Technology®

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.

COPPER

Sulfur (S) 3.00%	Copper (Cu)..... 5.00%
3.00% Combined Sulfur (S)	

COPPER complexed with Micro Carbon Technology® ensures efficient and effective uptake of copper, which is a micronutrient involved in many plant metabolic processes including photosynthesis, enzyme activity, protein metabolism, nitrogen regulation, and plant vigor.

- *Increases enzyme activity for greater plant metabolism*
- *Has a role in the production of Vitamin A within the plant and functions in chlorophyll formation*
- *Has a regulatory effect when soil nitrogen is high*
- *May be used with sulfur to aid in the control of a number of pathogenic fungal and bacterial diseases*

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.

MANGANESE

Sulfur (S) 2.50%	Manganese (Mn)..... 5.00%
2.50% Combined Sulfur (S)	5.0% Water Soluble Manganese (Mn)

Huma Gro® MANGANESE complexed with Micro Carbon Technology® ensures efficient and effective uptake of manganese, which is a micronutrient involved in many plant metabolic activities including photosynthesis, enzyme activity, and nutrient regulation.

- *An enzyme activator— aids in chlorophyll synthesis*
- *Activates the lipid enzymes*
- *Essential for assimilation of carbon dioxide in photosynthesis*
- *Functions in the formation of riboflavin, ascorbic acid, and carotene*
- *Improves formation of lateral roots*
- *Closely associated with copper and zinc*

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.

MOLYBDENUM

Molybdenum (Mo) 5.00%

Huma Gro® MOLYBDENUM complexed with Micro Carbon Technology® ensures efficient and effective uptake of molybdenum, which is a micronutrient necessary in enzyme activities and particularly in nitrogen metabolism.

- *Essential for nitrogen fixation*
- *Is a coenzyme necessary to transform nitrogen to amino acids for protein synthesis*
- *Is essential for the functions of symbiotic nitrogen-fixing bacteria*

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.



Powered by Micro Carbon Technology®

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.

NICKEL

Nickel (Ni)10.00%
Sulfur (S)6.00%

Huma Gro® NICKEL complexed with Micro Carbon Technology® is a critical source of nickel, which is necessary in the production of various tree, vine, and nut crops. Nickel is an irreplaceable constituent of the urease enzyme, essential in converting urea to ammonium (NH⁴⁺). When Nickel is insufficient and urea is the major source of nitrogen, urea can accumulate in leaves to the point of plant toxicity—manifested as necrosis of leaf tips.

- **Protects plants against urea toxicity**
- **Involved in the synthesis of chemicals (phytoalexins) that plants produce to defend against pathogens**
- **Contributes to lignin production, a component of cell walls that strengthens plants and contributes to disease resistance**

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1 pt–1 qt/ac 1.25–2.5 L/ha	1–2 qt/ac 2.5–5 L/ha	Apply as needed.

PUR CAL™

Calcium (Ca)8.00%
Derived From: Calcium Acetate.

Huma Gro® PUR CAL™ complexed with Micro Carbon Technology® ensures maximum nitrogen-free calcium uptake and translocation within the plant. Calcium is a required nutrient for cellular strength & growth, plant health, and fruit development—which indirectly reduces the risk of fungal diseases. PUR CAL™ provides calcium without the nitrogen associated with other calcium products, allowing plants to benefit from calcium nutrition for fruiting without the nitrogen stimulus for vegetative growth.

- **Increases stalk strength**
- **Reduces lodging in grain crops**
- **Promotes maturity and viability in seed crops**
- **Reduces susceptibility to fungal diseases**
- **Enhances nodulation in legumes**
- **Promotes early root growth**

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1–2 qt/ac 2.5–5 L/ha	0.5–1 gal/ac 5–10 L/ha	Apply as needed.

SULFUR

Total Nitrogen (N)8.00%
8.00% Ammoniacal Nitrogen

Sulfur (S)10.00%
10.00% Combined Sulfur (S)

Huma Gro® SULFUR complexed with Micro Carbon Technology® enables sulfur nutrient absorption by the plant. Sulfur is a major nutrient involved in respiration, photosynthesis, amino acid metabolism, plant growth, and vigor.

- **Improves plant respiration**
- **Plays a key role in Ferredoxin, a protein involved in electron transfer**
- **Involved in the formation of amino acids such as Cystine and Methionine, which help form protein**
- **Plays an important role in carbohydrate and lipid metabolism**
- **Sulfur deficiencies have been known to increase incidence of certain plant diseases**
- **Increases photosynthetic rates**

CROP	FOLIAR*	IRRIGATION*	FREQUENCY
All crops	1–2 qt/ac 2.5–5 L/ha	0.5–1 gal/ac 5–10 L/ha	Apply as needed.



Powered by Micro Carbon Technology®

*Rates depend on frequency, method of application, and water volume, etc. Please consult a Huma Gro® Rep for more information.