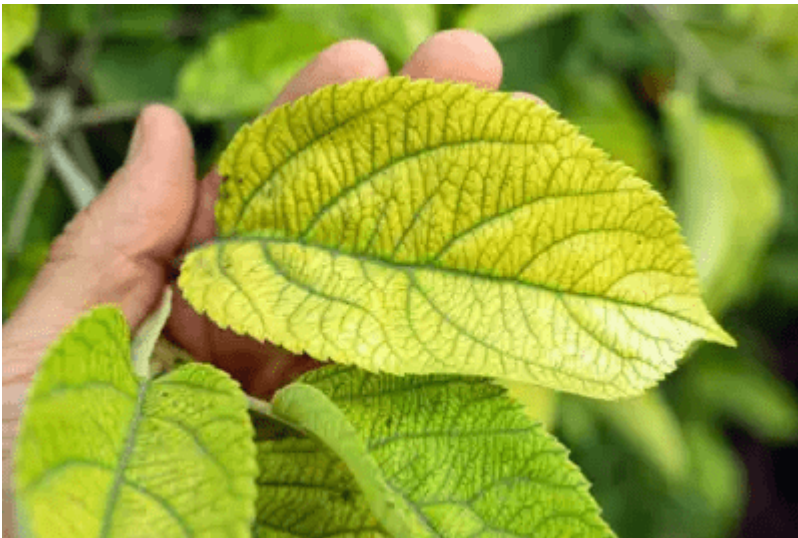


Creating an Effective “Greener” Foliar Spray from Raw Salts to Combat Yellowing in Productive Crops

Yellowing in productive crops represents one of the most common symptoms growers face when nutrient availability becomes limiting. While root zone nutrition remains the foundation of crop feeding, foliar applications offer a rapid and targeted approach to address visible deficiency symptoms. When plants show signs of chlorosis, growers need solutions that work quickly to prevent yield losses. In this post, we'll explore how to prepare an effective foliar spray from common fertilizer salts to tackle the most prevalent causes of yellowing in hydroponic and soilless growing systems.



Typical Fe deficiency that can be targeted with a “greener” spray.

Understanding the Primary Causes of

Chlorosis

Before formulating any foliar spray, it's important to understand which nutrients are most commonly implicated in leaf yellowing. The major players are nitrogen, iron, and magnesium, each producing distinct visual symptoms. Nitrogen deficiency causes uniform yellowing that begins in older leaves since nitrogen is a mobile nutrient within the plant [\(1\)](#). Iron deficiency produces interveinal chlorosis in young leaves, as iron cannot be readily translocated from older tissues [\(2\)](#). Magnesium deficiency presents as interveinal yellowing that starts on older leaves, reflecting its mobile nature within the plant.

The effectiveness of foliar applications varies substantially depending on the nutrient in question. Research has demonstrated that foliar fertilization can achieve higher nutrient use efficiency compared to soil application for certain elements, being particularly effective for micronutrients [\(1\)](#). However, foliar applications should be viewed as a complementary approach rather than a replacement for proper root zone nutrition, especially for macronutrients like nitrogen where plant demand substantially exceeds what can be delivered through leaf surfaces.

The Science Behind Foliar Uptake

Nutrients enter leaves primarily through the cuticle, the waxy protective layer covering epidermal cells. The cuticle contains microscopic pores lined with negative charges, which preferentially allow entry of positively charged nutrients such as ammonium, potassium, and magnesium [\(3\)](#). This explains why certain fertilizer forms work better than others in foliar applications. Urea, despite being a neutral molecule, penetrates the cuticle readily and is considered one of the most effective nitrogen sources for foliar feeding. Negatively charged nutrients like nitrate and phosphate face greater

difficulty penetrating leaf surfaces and must often be paired with cation partners for effective uptake.

Temperature and timing significantly affect uptake rates. Applications should be made during cooler parts of the day when stomata are open and evaporation rates are lower. Research indicates that foliar applications are most effective when leaves remain wet for at least 12 hours for nutrients like urea and ammonium, though other nutrients may require several days of wetting and rewetting cycles for optimal absorption.

Iron: The Chlorosis Specialist

Iron deficiency remains one of the most common causes of chlorosis in productive crops, particularly in systems with elevated pH. Foliar iron applications have been extensively studied, with ferrous sulfate emerging as a highly effective and economical option. Studies with peach trees showed that applications of 2 mM ferrous sulfate (approximately 112 ppm Fe) with a surfactant produced significant re-greening effects in treated leaf areas [\(2\)](#). However, it's critical to understand that foliar iron applications primarily benefit the treated leaf areas, with limited translocation to untreated portions of the same leaf or to other plant parts when chlorosis is already established.

The concentration of iron in foliar sprays requires careful consideration. Research on pear trees found that ferrous sulfate produced re-greening effects similar to more expensive iron chelates when applied to chlorotic leaves [\(4\)](#). Practical concentrations for ferrous sulfate typically range from 0.5% to 0.7% by weight, which corresponds to roughly 1000 to 1400 ppm of iron when using ferrous sulfate heptahydrate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) containing approximately 20% iron. A more conservative approach uses 2 ounces of 20% iron ferrous sulfate per 3 gallons of water for foliar application,

providing approximately 500 ppm iron.

Practical Formulation: A Multi-Nutrient “Greener” Spray

Based on the scientific literature and practical considerations, here is a comprehensive foliar formulation designed to address the most common causes of yellowing in productive crops. This formulation targets nitrogen, iron, and magnesium deficiencies simultaneously while maintaining safety margins to prevent leaf burn. The addition of citric acid improves the effectiveness of the iron component by maintaining it in the more readily absorbed ferrous form and enhancing penetration through the leaf cuticle.

Research with pear trees showed that ferrous sulfate combined with citric acid provided slightly better re-greening results than ferrous sulfate alone [\(4\)](#). Similarly, studies with plane trees found that 0.7% ferrous sulfate combined with 4-8 mM malic acid or citric acid produced superior results compared to ferrous sulfate alone [\(5\)](#). The acidification helps maintain iron in the more readily absorbed ferrous form and may enhance penetration through the leaf cuticle.

Complete Formulation per Gallon of Water

Fertilizer Salt	Amount (g/gal)	Key Nutrient Provided
Low biuret Urea (46-0-0)	4.0	Nitrogen
Magnesium Sulfate Heptahydrate (Epsom salt)	4.0	Magnesium
Ferrous Sulfate Heptahydrate (20% Fe)	2.5	Iron
Citric Acid (anhydrous)	0.8	pH adjustment and iron stabilization

Resulting Nutrient Concentrations

Nutrient	Concentration (ppm)	Effective Range
Nitrogen (from urea)	486	Moderate to severe N deficiency
Magnesium (Mg)	104	Magnesium deficiency
Iron (Fe)	132	Iron chlorosis correction

This formulation provides nitrogen at a concentration suitable for addressing moderate deficiencies without excessive risk of leaf burn. Urea is preferred over ammonium sulfate due to its lower osmotic potential and superior leaf penetration characteristics [\(6\)](#). The osmolality of urea is approximately 1018 mmol/kg compared to 2314 mmol/kg for ammonium sulfate, making urea substantially less likely to cause salt injury to leaf tissues when applied as a foliar spray.

This formulation should be prepared fresh before each application, as ferrous iron oxidizes to the less available ferric form when exposed to air at neutral or alkaline pH. The solution should have a pH around 4.0, which helps maintain iron solubility and prevents oxidation during the brief period between mixing and application.

Application Considerations and Timing

The timing and method of application dramatically influence the effectiveness of foliar sprays. Research on wheat demonstrated that foliar application of magnesium sulfate during the booting stage maintained high canopy photosynthesis after anthesis and improved grain filling [\(7\)](#). For productive crops showing chlorosis symptoms, applications should be made at 7-10 day intervals, with a minimum of two applications to

achieve lasting correction.

Temperature during application matters considerably. Foliar sprays should be applied when temperatures are below 75°F (24°C) to minimize the risk of leaf burn and maximize uptake. Early morning or late evening applications are preferred, as they allow nutrients to remain on leaf surfaces longer before evaporation occurs. Avoid applying foliar sprays in direct sunlight or during the heat of the day, particularly when using iron sulfate, which can cause phytotoxicity under high-temperature conditions.

Limitations and Realistic Expectations

It's important to maintain realistic expectations about what foliar fertilization can achieve. Studies consistently demonstrate that foliar iron treatments produce re-greening effects that are largely limited to the treated leaf areas, with minimal translocation to untreated portions of chlorotic leaves [\(2\)](#). This means that complete coverage during application is critical for optimal results. Missing leaf surfaces or applying insufficient spray volume will result in incomplete correction of chlorosis symptoms.

For macronutrients like nitrogen, foliar applications cannot supply a substantial proportion of total crop needs. The primary route for nutrients to enter plants remains through roots, and foliar fertilization is most useful when soil conditions restrict nutrient availability temporarily [\(8\)](#). Foliar nitrogen applications work best when plants are experiencing temporary nitrogen shortage or when rapid green-up is needed to maintain photosynthetic capacity during critical growth stages.

The effectiveness of foliar magnesium applications varies with crop type and severity of deficiency. Research on soybeans and

corn found that magnesium foliar sprays could improve plant performance under deficiency conditions [\(6\)](#), though results were most pronounced when combined with adequate soil magnesium management.

Safety and Phytotoxicity Concerns

The concentration of salts in foliar sprays must be carefully controlled to prevent leaf burn. Solutions should generally not exceed 5% dissolved nutrients on a weight basis to minimize the risk of desiccation from osmotic stress. The formulations provided in this article fall well below this threshold, but growers should always test on a small area before treating entire crops, particularly when dealing with sensitive varieties or unusual environmental conditions.

Iron sulfate deserves special mention regarding phytotoxicity. While highly effective and economical, ferrous sulfate can stain leaves and cause burning if applied at excessive concentrations or during hot, sunny conditions. The recommended concentration of approximately 500 ppm iron represents a balance between effectiveness and safety based on extensive research with fruit trees and field crops.

Integration with Root Zone Nutrition

Foliar applications should be viewed as a complementary tool rather than a replacement for proper root zone nutrition management. The low environmental impact and cost of foliar fertilization make it a valuable supplementary measure to soil or hydroponic solution applications [\(4\)](#). When crops show signs of chlorosis, the first priority should be to identify and correct the root cause of the deficiency in the growing medium or nutrient solution. Foliar applications then provide rapid symptomatic relief while longer-term corrections take effect.

In hydroponic systems, foliar sprays are particularly useful during the lag period between adjusting nutrient solution concentrations and observing plant response. This period can span several days to weeks depending on growth rate and environmental conditions. Foliar applications bridge this gap, maintaining photosynthetic capacity while roots take up corrective nutrients from the adjusted solution.

Practical Application Protocol

For best results when applying the greener formulation described in this article, follow this protocol. First, prepare the spray solution by dissolving salts in the order listed: urea first, followed by magnesium sulfate, then citric acid, and finally ferrous sulfate. Use lukewarm water to speed dissolution and ensure complete mixing. Adding citric acid before the ferrous sulfate helps achieve the target pH of approximately 4.0 and prevents premature oxidation of the iron.

Apply the spray to both upper and lower leaf surfaces when possible, as research indicates that lower (abaxial) leaf surfaces often show enhanced uptake compared to upper (adaxial) surfaces for certain nutrients [\(4\)](#). Use a sprayer that produces fine droplets to maximize coverage without creating runoff. Leaves should appear wet but not dripping after application.

Make applications in early morning or late evening when temperatures are moderate and relative humidity is higher. Avoid application if rain is forecast within 6 hours, as this will wash off the spray before adequate absorption occurs. Repeat applications every 7-10 days until symptoms improve, typically requiring 2-3 applications for significant correction of moderate to severe chlorosis.

Conclusion

Creating an effective foliar spray to combat yellowing in productive crops requires understanding both the nutrient requirements of plants and the mechanisms governing foliar uptake. The formulations presented here, based on extensive scientific research, provide growers with practical starting points for addressing the most common causes of chlorosis. While foliar fertilization offers rapid correction of visible symptoms, it works best as part of an integrated nutrition program that prioritizes proper root zone management. By combining judicious foliar applications with sound nutritional practices in the growing medium, growers can maintain healthy, productive crops even when transient deficiencies arise.