



Foliar Feeding: The Shortcut to Plant Health

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doi.org/10.5281/TrendsInAgriculture.19998320

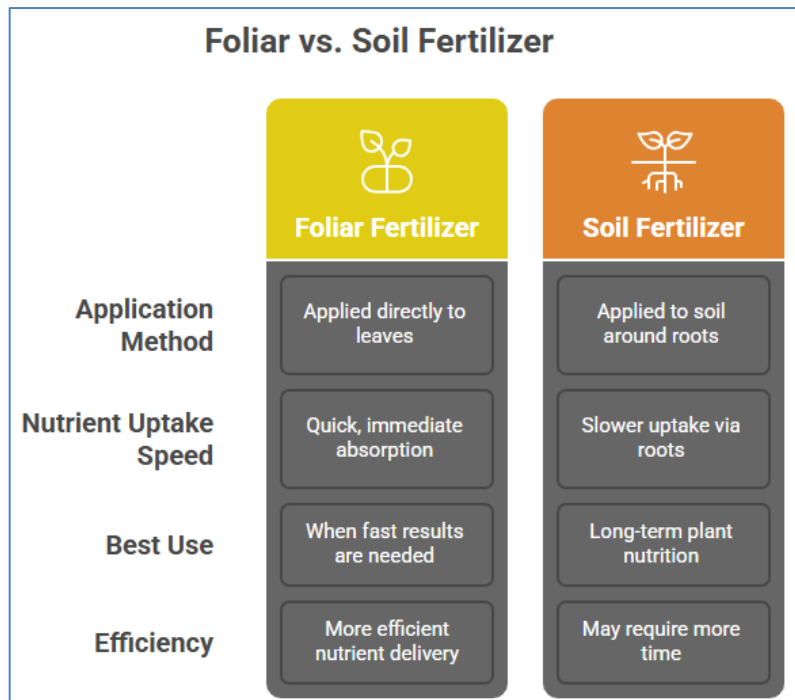
Abstract

Foliar application has emerged as a practical and efficient approach to crop nutrition and protection, enabling direct delivery of essential nutrients and agrochemicals through leaf surfaces. This technique bypasses soil-related limitations such as nutrient fixation, leaching, and poor root uptake, ensuring rapid absorption and immediate physiological responses. Research demonstrates that foliar feeding can enhance nutrient use efficiency, improve yield and quality, and strengthen crop resilience against environmental stresses. While not a replacement for soil fertilization, foliar application serves as a complementary strategy within integrated crop management systems. Its effectiveness depends on proper formulation, timing, and application practices, making it a valuable tool for sustainable agriculture and food security.

Introduction

Foliar application involves directly spraying liquid fertilizers, nutrients, or pesticides onto the leaves of a plant. This enables rapid absorption via the stomata and epidermis to swiftly address problems, assist with growth at critical phases, or control pests and ailments. It is intended to rapidly enhance soil nutrition rather than serve as a substitute. Plants need foliar fertilization when soil conditions hinder proper nutrient absorption or when a quick remedy for deficiencies is crucial for their health. Symptoms such as leaf yellowing, limited growth, or inadequate blooming typically suggest nutrient shortages that foliar application can rapidly remedy, aiding in comprehensive plant care approaches.

Nitrogen in foliar form encourages quick greening and enhances growth recovery, whereas phosphorus aids in flowering and fruit maturation. Potassium improves resilience to stress and resistance to diseases. Iron chelates, as micronutrients, inhibit chlorosis, while zinc aids enzyme function and protein production essential for plant defence against environmental stresses.



Foliar feeding: The shortcut

- Nutrients penetrate the leaf cuticle and stomata, directly accessing the tissues responsible for photosynthesis, typically within 1-2 hours, promoting swift nutrient absorption.
- This is the perfect approach for swiftly addressing nutrient deficiencies (e.g., leaves turning yellow).
- When roots are under stress, affected by disease, or when the soil is excessively cold, dry, or has a pH that prevents nutrient absorption, this practice can be followed.
- It needs less fertilizer than soil application, which makes it economical.
- Boosts resilience to stress factors such as drought, heat, or pest/disease challenges.
- Enhances development at key phases, boosting crop production and nutrient content.

Key factors affecting foliar fertilization

Humidity: Elevated relative humidity decreases the drying rate of the spray droplet, extending absorption durations.

Temperature: Ideal absorption happens within 20-25°C; temperatures exceeding 35°C should be avoided to reduce leaf scorch and swift evaporation.

Duration of daylight: Utilizing cloudy days or applying in the late afternoon/early morning enhances absorption and minimizes harm.

Leaf surface: Features such as cuticle thickness, the presence of leaf hairs, and the frequency/aperture of stomata have a direct impact on nutrient absorption.

Nutrient condition: Plants lacking nutrients usually show more vigorous and rapid uptake of nutrients applied to their leaves.

Plant Age/Growth Stage: Younger leaves tend to utilize nutrients more effectively compared to older, mature leaves; however, spraying is essential during peak demand phases such as fruit setting or the initial stages of pod development.

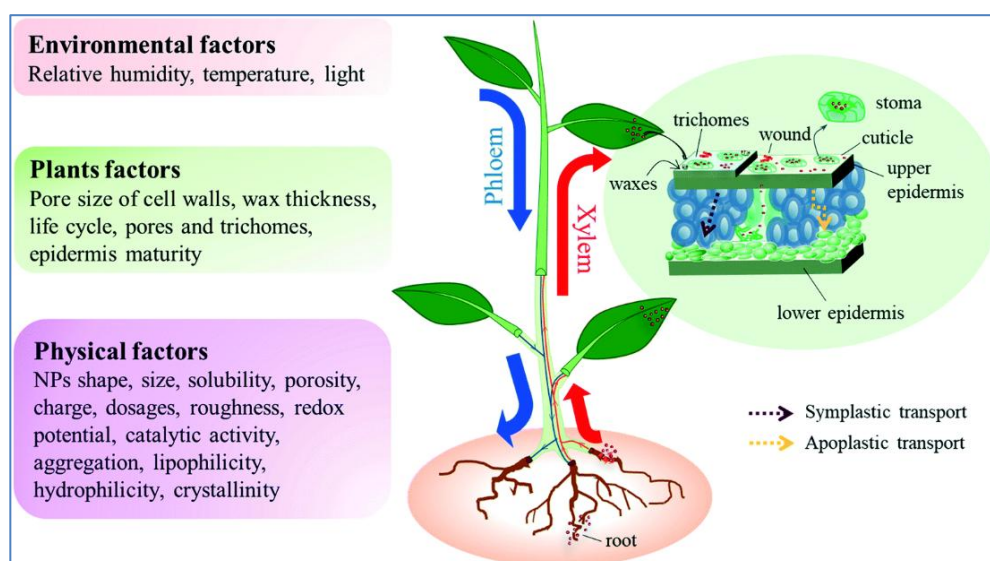
Concentration: Strongly concentrated solutions may lead to phytotoxic effects (leaf burn).

pH Level: The pH influences the dissolution and uptake of nutrients (slightly acidic solutions are commonly favored).

Adjuvants: Wetting agents or stickers enhance coverage and lower surface tension, enabling improved adhesion to leaves.

Solubility and Purity: Nutrient sources should be extremely soluble and clean to avoid harming leaves.

Mechanism of uptake



Hong et al., 2021

Cuticular Deposition & Diffusion: Nutrients applied to the foliage (typically in liquid form) settle on the leaf surface, infiltrating the waxy cuticle and external cell walls.

Stomatal Pathway: Nutrients gain entry via open stomata, the main pathway for gas exchange. The opening of stomata, which takes place when leaf turgor pressure is elevated, greatly aids in absorption.

Micropore Absorption: Nutrient ions travel through tiny openings (micro-pores) in the leaf cuticle.

Internal Transport: After absorption, substances traverse the free space of cell wall and attach to the plasma membrane before entering the cytoplasm through metabolic activities.

Systemic Movement: Within the plant, nutrients are moved through phloem and xylem, enabling quick delivery, especially to growing tissues.

Key benefits of foliar spray

- Applying foliar treatments at key growth phases (flowering, fruiting) can greatly enhance fruit size, quality, and total yield.
- Assists plants in enduring times of drought, high temperatures, or cold stress for efficient stress management.
- Micronutrients such as iron and manganese applied via foliar spray enhance chlorophyll synthesis.
- Plants that are well-nourished and healthy tend to be more resistant to diseases and pests.
- Enhanced resistance to drought
- Enhanced tolerance to soil salinity
- Increased resilience to physiological ailments
- Enhanced absorption of plant nutrients during the initial stages of crop growth, when root systems are not fully established.
- The primary application of foliar nutrition involves the use of micronutrients in minimal quantities, along with macronutrients (such as nitrogen, phosphorus, or potassium), without inducing any phytotoxic effects (Oosterhuis and Weir, 2010).

Best Practices for Foliar Feeding

- Spraying of nutrients should be done during the coolest times, such as early morning or late evening, when stomata are open to avoid leaf damage and enhance nutrient uptake through open stomata.
- Foliar application to be avoided in windy weather, direct sunlight, or when rain is forecasted within the next 4-6 hours. Ideal temperature levels fall within 18-25°C, accompanied by relative humidity exceeding 60%, to facilitate maximum nutrient absorption and reduce evaporation losses.
- Low-volume, high-pressure spray equipment to be used to generate a fine mist that coats both the top and bottom surfaces of the leaves.

- A surfactant or sticker to be added to prevent the spray from beading up and rolling off the leaves.

Limitations

- Improper concentration or application timing can damage leaves.
- Frequent, low-volume applications may be required.
- The wind is a major influence of the uniformity of distribution of the nutrient solution.
- The foliar application is most successful for micronutrients, whereas soil application is effective for both macro and micronutrients.
- Plant response to the foliar application is often only temporary. In cases of severe nutrient deficiency, several foliar applications are needed.

Conclusion

Foliar application represents a highly effective and efficient method of delivering nutrients and protective agents directly to crops. By bypassing soil limitations and ensuring rapid absorption through leaves, this technique can enhance plant health, improve yield quality, and support resilience against environmental stresses. However, its success depends on careful timing, correct formulation, and proper application practices to avoid leaf damage or nutrient imbalance. When integrated thoughtfully into crop management, foliar feeding serves as a valuable complement to soil fertilization, helping farmers achieve sustainable productivity and healthier harvests.

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