GROWERTALKS

Features

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Beyond Sufficiency

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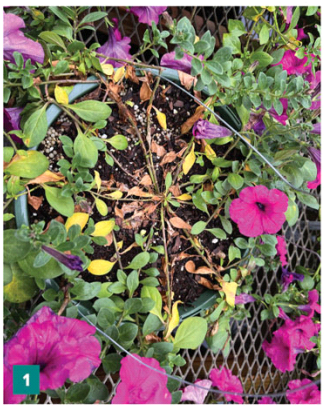
For greenhouse growers, it's imperative to produce visually appealing plants in the shortest amount of time while minimizing inputs such as fertilizers. Nutrient management can significantly impact this goal at both ends of the spectrum, resulting in either nutrient deficiencies or nutrient toxicities. Nutrient deficiencies can stunt plant growth, increase production time and induce visual symptoms such as lower leaf yellowing or loss (Figure 1). Nutrient toxicities, as a result of excess fertilizer, include visual toxicity symptoms and stunted plant growth (Figure 2). To diagnose these problems, foliar tissue analysis is commonly utilized to determine the nutrient concentrations. However, these results must be compared to standard values to make informed decisions for corrective procedures.



Historically, the horticultural industry has relied on the survey approach to establish recommended nutrient ranges for floriculture crops. This method involves sampling a relatively small number of healthy-looking plants to determine what a “normal” nutrient concentration should be. These current ranges don’t account for crop stage, environmental variability, cultivar variability or regional water quality differences, yet most diagnostic labs still rely on them. As a result, growers often receive tissue test reports based on broad averages that don’t reflect real production conditions, making it difficult to pinpoint the true cause of a nutritional issue.

Figure 1: Petunia nitrogen deficiency resulting in lower leaf yellowing and plant stunting.

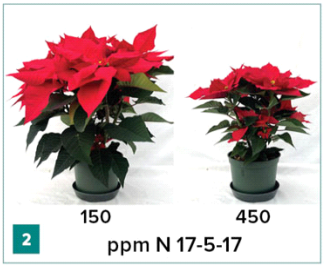


Figure 2: Excessive fertility rates can negatively impact plant growth, resulting in stunted plant growth.

Our research team kept running into the same problem: growers experiencing visual symptoms, but the published standards were too vague to identify what was actually wrong. That gap pushed us to rethink how nutrient standards are developed and reported. Working with North Carolina State University, NCDA&CS, the USDA Agricultural Research Service, and support from the American Floral Endowment and the Fred C. Gloeckner Foundation, we collected tissue samples from across the nation to build a more accurate foundation for foliar nutrient interpretation standards.

Instead of relying on a handful of “healthy” plants, for petunias, we compiled 1,420 samples from across the United States, including university research trials, greenhouse visits and state agriculture department submissions. This broad data set captures the diversity of fertility programs, water sources and production environments that growers actually work with.

For example, greenhouse operations with increased alkalinity water concentrations will generally observe greater calcium and magnesium concentrations compared to operations using low alkalinity water sources. The result is a dataset that reflects current commercial production, not individual growing conditions.

The objective was to develop more defined ranges rather than a wide “sufficiency range.” Traditional sufficiency ranges are too wide to guide decision making and problem diagnostics. A value labeled “sufficient” could be barely adequate or nearly excessive, and growers had no way to tell the difference. To fix this, we developed five nutrient status categories: deficient, low, sufficient, high and excessive (Figure 3). These refined ranges give growers a clearer picture of where their crop stands and how far outside of “sufficient” their sample is and how it compares to other samples.

One of the biggest advances is establishing “high” and “excessive” thresholds for nutrients like nitrogen, phosphorus and potassium. Plants often don’t show classic toxicity symptoms for these macronutrients. Instead, excessive levels can result in nutrient antagonism. For example, high phosphorus can limit iron uptake, leading to chlorosis that looks like an iron deficiency. By identifying excessive levels for the first time, we can help growers avoid over-fertilizing and the costly growth issues that follow.

Smarter diagnostics through machine learning

Even the best nutrient ranges aren't helpful if they're difficult to interpret. Currently, many analytical lab reports are difficult to interpret, and can often result in incorrect diagnoses or the time to diagnosis takes too long, resulting in a missed ability for corrective action. To address this, we evaluated several machine-learning models to determine which could most accurately classify a sample into the five nutrient categories.

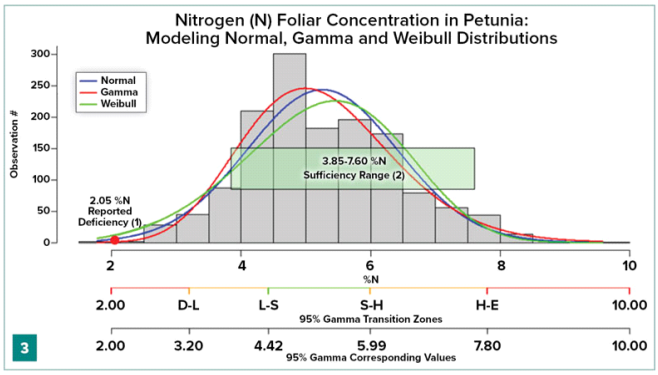


Figure 3: Distribution of N foliar concentrations in petunia modeled using normal, gamma and Weibull distributions. Interpretation ranges are classified as deficient (D), low (L), sufficient (S), high (H) and excessive.

Decision tree models, including J48 and Random Forest, classified nutrient status with over 97% percent correct classification across all nutrients. This level of accuracy makes it possible to build automated, grower-friendly diagnostic tools that factor in nutrient interactions and deliver clearer guidance than traditional reports.

Precision fertility management directly translates to stronger margins and more predictable crop timing. With refined nutrient categories, growers can reduce fertilizer inputs without risking deficiencies, avoid excessive uptake and the antagonisms that come with it, identify developing issues before growth slows, and keep crops moving through the greenhouse on schedule to maximize bench turnover.

Every day a crop sits on the bench because of stunted growth due to low fertility or a grower experiences crop loss due to visual nutrient deficiencies can significantly impact production time and profit margins. These refined nutrient ranges give growers the ability to spot issues early and correct them before they slow growth, helping maintain crop quality while keeping the production schedule on track.

We've already established these refined values for petunia, pentas, gerbera, basil, cilantro, spearmint and greenhouse lettuce and that list continues to grow. Ongoing work is extending the same level of precision to geranium, New Guinea impatiens and poinsettia through continued support from the American Floral Endowment and the Fred C. Gloeckner Foundation. **GT**

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