

GROWERTALKS

Features

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Achieving Equilibrium

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pH and electrical conductivity (EC) are two of the most important factors affecting the substrate root-zone environment and overall crop health. Without proper management and routine checks, the resulting crop will often experience stunted growth, nutritional deficiencies, reduced quality and, in severe cases, death. The first step in properly managing substrate pH and EC is to understand the factors surrounding them, as well as the effects of both pH and EC on plants, and in this case, in the plug stage.

pH & alkalinity

Alkalinity is a key player in determining how sensitive the substrate pH will be to change. Although pH and alkalinity are closely related, they aren't the same. pH measures the current acidity or basicity, while alkalinity measures the ability to change pH (neutralize acids). Irrigation water with a low alkalinity lacks the ability to resist change. Thus, the fertilizer used will have a greater impact on the substrate pH over time.

Figure 1. Lower leaf speckling and marginal burn are typical symptoms of low substrate pH-induced iron/manganese toxicity.
Photo: Luke Finn.

Figure 2. Iron deficiencies occur as interveinal chlorosis of the new growth due to being over-irrigated in propagation or when the substrate pH is too high.
Photo: Luke Finn.

Figure 3. Lower leaf yellowing (lack of nitrogen) and stunted growth are typical symptoms of low EC induced by overwatering (leaching) in propagation.
Photo: Brian Whipker.

An acidic fertilizer will tend to drop the substrate pH, while a basic fertilizer will increase it. Water with a high alkalinity concentration indicates there's a high buffering capacity, meaning it's more difficult for the pH to fluctuate due to the fertilizer used. However, repeated irrigation with high alkalinity water will gradually raise the substrate pH. Alkalinity levels are based on the amounts of bicarbonate, carbonate and carbonic acid present. These compounds are primarily sourced from limestone and other minerals. It's important for growers to complete a water test so that they're aware of the alkalinity in their water before making any amendments. The main take-home message here is that your water alkalinity concentration plays a far greater role in influencing the substrate pH than does the water pH.

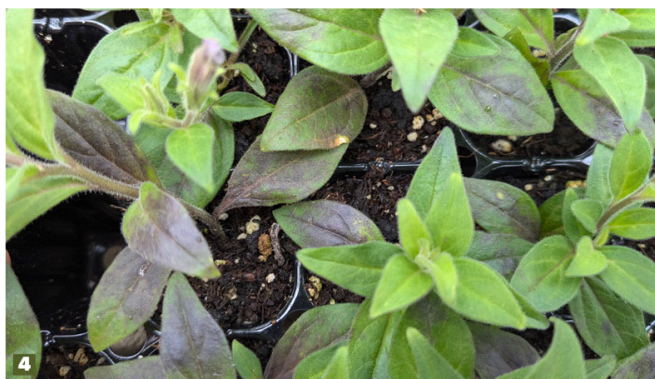
Finding the balance

In most cases, greenhouse crops should have a substrate pH between 5.8 and 6.2. When the pH is outside of that range, nutrients will become either more or less available to the plant. When substrate pH is too low, micronutrients (primarily iron and manganese, but sometimes boron, copper and zinc, too) become highly soluble, leading to excess plant uptake of these nutrients. This excessive uptake may lead to nutritional toxicities that can result in lower leaf speckling, distorted growth and marginal burn (Figure 1). A decline in substrate pH can often be attributed to over-fertilization. To raise substrate pH, growers can apply dolomitic limestone or hydrated lime or utilize a basic fertilizer (13-2-13 Cal-Mag or 15-5-15 Cal-Mag).

Conversely, when the pH exceeds the recommended range, micronutrients become less soluble, leading to nutrient deficiencies in the plant. An increase in pH may be caused by consistently high alkalinity irrigation, excessive lime or nitrate-based fertilizers. Typically, chlorosis, caused by a pH-induced iron deficiency, will be observed if the substrate pH is too high (Figure 2). Shoot tip necrosis may also be observed in plug trays, which can be associated with reduced calcium or boron availability under high-pH conditions. Shoot tip necrosis may also be caused by cool, low-light conditions.

It's important to measure substrate pH before sowing or transplanting, as it's much easier to make amendments. To lower substrate pH, growers can utilize an acidic fertilizer (20-10-20 or 20-20-20) or complete an acid injection. Iron uptake is inhibited by over-irrigation, so in many cases, managing the irrigation so that plants go through the wet and dry cycle will aid in iron uptake.

On the other hand, EC is equally as important. Electrical conductivity is a measure of the concentration of salts in the substrate and reflects the fertility concentration. A lack of fertilizer or overwatering (leaching) will typically result in low EC and will be reflected as a lack of growth and lower leaf chlorosis (Figure 3) or lower leaf purpling due to the lack of phosphorus (Figure 4).



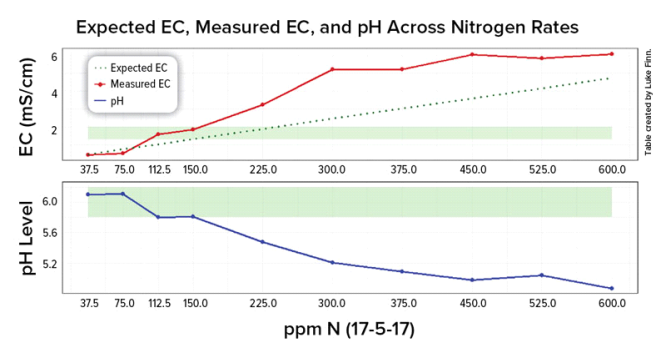
Conversely, over-fertilization will result in a high EC and will typically result in marginal burn, root damage and stunted growth. Fertilizer should be applied at sufficient rates during the plug stage to promote growth while preventing excessive salt accumulation. This will ensure that the plants are receiving adequate feed while avoiding high EC. Low-dose fertilizer applications should begin once roots are visible.

Figure 4. Lower leaf purpling (lack of phosphorus uptake) and stunted growth are typical symptoms of

limited phosphorus applications, root rot or over-irrigation in propagation.

Photo: Brian Whipker.

In the process of balancing and monitoring substrate pH and EC, it's important to understand the inverse relationship between the two. While fertilizers can have a large impact on substrate EC, they can also influence substrate pH, in particular, lowering the pH. Regardless of the formulation (acidic, neutral, basic), over-fertilization can lead to a drop in substrate pH.



As observed in Figure 5, when fertilizer was supplied at higher rates, the nutrient supply exceeded plant uptake capacity (green box), allowing fertilizer salts to accumulate. As salts accumulate, the measured EC (solid red line) increased while measured pH (solid blue line) declined. This demonstrates the importance of an optimized fertilization regimen and the negative impacts of over-fertilization on both plant production and wasted input dollars.

Figure 5. Expected vs. measured EC comparison, pH readings and demonstrated growth curve from low (37.5 ppm N) to high (600 ppm N) fertility on New Guinea impatiens.

Table created by Luke Finn.

The key takeaway is this: Observed symptoms in both high and low pH and EC conditions may appear similar, so it's important to consistently monitor the substrate. Doing this allows a grower to mitigate any issues that may be associated with pH and EC, as well as allowing for a more accurate diagnosis of potential problems. By combining proper fertilization practices with consistent monitoring of substrate pH and EC, growers can optimize plant performance while minimizing unnecessary inputs. Growers should aim to create a plan that best suits their needs and production system. **GT**

Additional information: Jeong, K., Nelson, P., Niedziela, C., and Dickey, D. (2016). Effect of plant species, fertilizer acidity/basicity, and fertilizer concentration on pH of soilless root substrate. *HortScience*. 51. 1596-1601. 10.21273/HORTSCI11237-16.

Plant Root Zone Management. 2026. p. 232. (Print-on-demand book available from [lulu.com](https://www.lulu.com))

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