Understanding pH management and plant nutrition
Part 1: Introduction

Bill Argo, Ph.D.
Blackmore Company, Tel: 800-874-8660, Int'l 734-483-8661, E-mail: bargo@blackmoreco.com
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Plants are basically water surrounded by a pretty package. If we place 100 lbs. of healthy living plant material into a special oven to remove all the water, we will have only about 10 lbs. of dry plant material left. In general, plants are about 90% water and 10% dry matter.

The 10 lbs. of dry plant material that we have left is made up of carbon (C), hydrogen (H), oxygen (O), and a number of inorganic salts. If we take the 10 lbs. of dry plant material and remove all the carbon, hydrogen, and oxygen, there will be about 1 lb. of ash left. Thus, plant nutrition is the direct management of about 1% of the plant by weight.

The ash that is left is composed of the essential plant nutrient. However, these nutrients are not all taken up at the same rate. The essential plant nutrients can be separated into two groups, macronutrients and micronutrients. Macronutrients are found at relatively high concentrations in the plant tissue and include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S). Micronutrients are found at much lower concentrations in the tissue than macronutrients and include iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), and molybdenum (Mo).

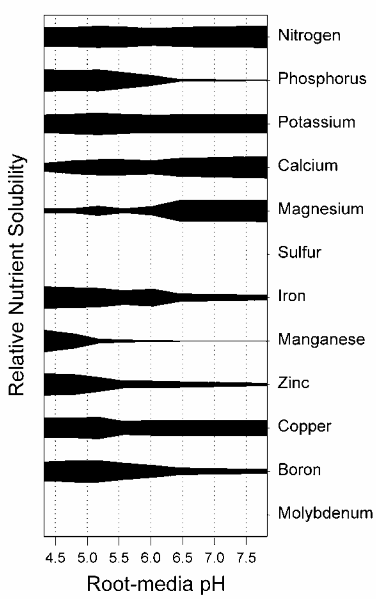

Figure 1.1. Relative solubility of nutrients at different pH levels in one peat-based media (graph based on research by Dr. John Peterson, the Ohio State University).

These twelve essential plant nutrients are commonly provided by various fertilizer sources, which includes not only the water-soluble fertilizer, but also can include the irrigation water and container substrate. There are several other nutrients that are considered as essential for normal growth including sodium (Na), chloride (Cl), Nickle (Ni), and possibly chromium (Cr). However, these later four essential plant nutrients are not required by plants in large amounts. Because they are often found as contaminants in a number of different fertilizer sources, it has not been demonstrated that that they have to be specifically apply to plants.

Substrate pH and plant nutrition

The term pH is a direct measurement of the balance between acidic hydrogen ions (H^+) and basic hydroxide ions (OH^-), and can be measured with a pH meter. The pH of a solution can range between 0 (very acidic) and 14 (very basic). At a pH of 7.0, the concentrations of H^+ and OH^- are equal, and the solution is said to be neutral.

When growing plants in containers, the pH range commonly found in the solution extracted from the substrate is much narrower, from about 4.5 to 8.5. The recommended substrate pH range from growing plants in containers is even more specific, around 5.8 to 6.2, depending on the crop.

The reason that the pH of the solution in the substrate is so important is that it affects nutrient solubility. Using Figure 1 as an example, the solubility of micronutrients (iron, manganese, zinc, boron) and phosphorus decrease with increasing substrate pH.

Substrate pH can also be an indication of problems. For example, low pH can be an indication that sufficient lime was not added to the substrate, or that a fertilizer is being used that is too acidic for the water quality. High pH can be an indication that too much lime was added to the substrate or that there is too much alkalinity left in the irrigation water.

Substrate pH can also affect the uptake of nutrients by the plant. Iron (Fe) uptake generally decreases with increasing pH because it precipitates out of the soil solution at higher pH levels. Phosphorus (P) also will precipitate out of solution at higher pH levels. Phosphorus uptake will be further reduced above a pH of 7.2 because any phosphorus left in solution is converted into a less available form. Nitrogen (N) uptake can be indirectly affected by medium pH because low pH decreases nitrification (conversion of ammoniacal nitrogen to nitrate nitrogen) or the conversion of urea to ammoniacal nitrogen.

Plants and nutrient uptake

Plant species differ in their ability to take up nutrients at a given pH level. While there are not good examples with orchids, there are good examples with other plants produced in containers.

For example geraniums and African marigolds are very efficient accumulators of iron (Fe) and manganese (Mn), and are often grown at a relatively high substrate pH (6.0 to 6.8) compared to most container grown crops. The high pH reduces iron and manganese solubility, which limits the uptake, and prevents toxicity problems.

At the other end of the spectrum are plants like rhododendrons, blue berries, and petunias, which are very inefficient at taking iron from the soil solution, and are often grown at a relatively low substrate pH (5.2 to 6.2). The low pH increases iron solubility, which increases the uptake, and prevents deficiency problems.

There is a third group of plants, like poinsettias, chrysanthemums, and impatiens that can be grown over a relatively wide range of pH's (5.5 to 6.5) without showing any deficiency or toxicity problems.

While I don't know it for sure, I would guess that orchids are like all other plants. Some species will perform better when grown at a low pH, some will perform better when grown at a high pH, and for some, it will not matter. However, for each of these groups, the acceptable range where they will grow and perform the best will be relatively narrow and will be similar that of other plant species. If you had to choose a pH range to grow all orchids, then the recommended range would 5.8 to 6.2, again, just like all other crops.

pH management and plant nutrition.

` Many growers make the assumption that growing in containers is like growing hydroponically. Unless water is constantly dripping out of the bottom of the container, then it is not like hydroponics. Others consider growing in containers like growing outside in soil. It is not like that either.

Research has shown that the pH and nutritional management of container grown crops, including orchids, is affected by the interaction of a number of different factors, including the water quality, water-soluble fertilizer, and the substrate. In the next issue, I will discuss water quality.

For more information on pH management
Understanding pH management of container grown crops, by William R. Argo and Paul R. Fisher.
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