

pH

Although it is perhaps one of the most overlooked aspects, pH is very important in hydroponic and organic as well as regular soil gardening. pH is measured on a scale of 1-14 with 7 being neutral. Acids are lower than 7 and alkalis (bases) are above 7.

This article deals with the pH of hydroponic gardening and the availability of nutrients at different pH levels in a soilless growing medium. Organic and soil gardening have different levels, so the following chart doesn't pertain to them.

To be technical, the term pH refers to the potential hydrogen-hydroxyl ion content of a solution. Solutions ionize into positive and negative ions. If the solution has more hydrogen (positive) ions than hydroxyl (negative) ions then it is an acid (1-6.9 on the pH scale). Conversely if the solution has more hydroxyl ions than hydrogen it is alkaline (or base), with a range of 7.1-14 on the pH scale.

Pure water has a balance of hydrogen (H⁺) and hydroxyl (OH⁻) ions and is therefore pH neutral (pH 7). When the water is less than pure it can have a pH either higher or lower than 7.

The pH scale is logarithmic, which means that each unit of change equals a tenfold change in the hydrogen/hydroxyl ion concentration. To put it another way, a solution with a pH of 6.0 is 10 times more acidic than a solution with a value of pH 7.0, and a solution with a pH value of 5.0 would be 10 times more acidic than the solution of 6.0 pH and 100 times more acidic than the solution with a 7.0 pH. This means that when you are adjusting the pH of your nutrient solution and you need to move it 2 points (example: 7.5 to 5.5) you would have to use 10 times more adjuster than if you were moving the pH value just 1 point (7.5 to 6.5).

WHY IS pH IMPORTANT?

When the pH is not at the proper level the plant will lose its ability to absorb some of the essential elements required for healthy growth. For all plants there is a particular pH level that will produce optimum results (see chart 1 below). This pH level will vary from plant to plant, but in general most plants prefer a slightly acid growing environment (between 5.5-6.0), although most plants can still survive in an environment with a pH of between 5.0 and 7.5.

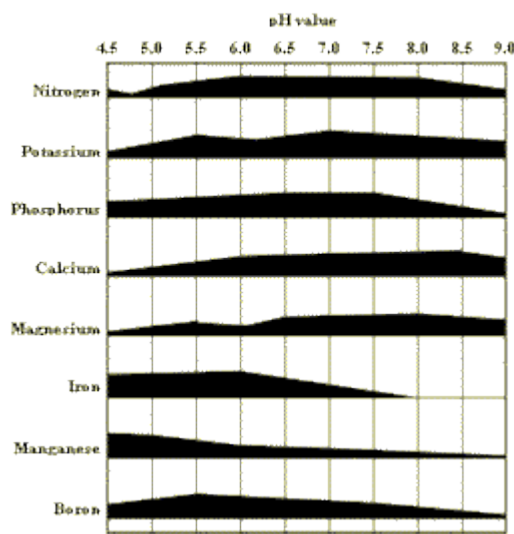
When pH rises above 6.5 some of the nutrients and micro-nutrients begin to precipitate out of solution and can stick to the walls of the reservoir and growing chambers. For example: Iron will be about half precipitated at the pH level of 7.3 and at about 8.0 there is virtually no iron left in solution at all. In order for your plants to use the nutrients they must be dissolved in the solution. Once the nutrients have precipitated out of solution your plants can no longer absorb them and will suffer deficiency and death if left uncorrected. Some nutrients will precipitate out of solution when the pH drops also.

Chart 2 (below) will give you an idea of what happens to availability some of the nutrients at different pH levels:

pH Values For Different Hydroponic Crops	Chart 2
<p>pH Values For Different Hydroponic Crops</p>	<p>Availability Of Nutrients Available At Different pH Levels</p>

(From *Hydroponic Food Production*
by Howard M. Resh
Woodbridge Press, 1987)

Plant	pH Range
Beans	6.0-6.5
Broccoli	6.0-6.5
Cabbage	6.5-7.5
Cantaloupe	6.5-6.8
Carrots	5.8-6.4
Chives	6.0-6.5
Cucumbers	5.8-6.0
Garlic	6.0-6.5
Lettuce	6.0-6.5
Onions	6.5-7.0
Peas	6.0-6.8
Pineapple	5.0-5.5
Pumpkin	5.0-6.5
Radish	6.0-7.0
Strawberries	5.5-6.5
Tomatoes	5.5-6.5



NOTE:
This chart is for soilless (hydroponic) gardening only and does not apply to organic or dirt gardening.

CHECKING pH

When you are growing hydroponically checking and adjusting pH is a simple matter. It can be a bit more complicated when growing organically or in soil. There are several ways to check the pH of the nutrient solution in your hydroponic system.

Paper test strips are probably the most inexpensive way to check the pH of the nutrient solution. These paper strips are impregnated with a pH sensitive dye which changes color when dipped into the nutrient solution. The paper strip is then compared to a color chart to determine the pH level of the solution being checked. These test strips are inexpensive, but they can be hard to read, because the colors differences are subtle.

Liquid pH test kits are probably the most popular method to check pH for the hobby gardener. These liquid test kits work by adding a few drops of a pH sensitive dye to a small amount of the nutrient solution and then comparing the color of the resulting liquid

with a color chart. While slightly more expensive than the paper test strips, they are easier to read and extremely accurate and reliable.

The Most high-tech way to check pH is to use the digital meters. These meters come in a huge array of sizes and prices. The most popular type of pH meter for the hobby gardener is the digital pen. These pens are manufactured by several different companies and are very handy and easy to use. You simply dip the electrode into the nutrient solution for a few moments and the pH value is displayed on an LCD screen.

The pH meters are very accurate (when properly calibrated) and fast. They need to be cared for properly however, or they will quit working. The glass bulb electrode must be kept clean and some are required to be wet at all times. The pH meters are actually very sensitive volt meters and are susceptible to problems with the electrode.

The pH meters are slightly temperature sensitive. Many of the pH meters on the market have Automatic Temperature Compensation (ATC), which corrects the reading with respect to temperature. On meters without ATC the pH should be checked at the same time of day each time in order to minimize any temperature related fluctuations.

The pH meters usually need to be calibrated frequently, as the meters can drift and to insure accuracy you must check calibration often. With most pens, the tip needs to be stored in an electrode storage solution or in a buffer solution and should never be allowed to dry out.

Due to the fact that pH meters have a reputation of breaking down without warning it is a good idea to keep an emergency backup for checking pH (paper test strips or a liquid pH test kit), just in case.

ADJUSTING pH

There are several chemicals used by the hobby gardener to adjust pH. The most popular are phosphoric acid (to lower pH) and potassium hydroxide (to raise pH). Both of these chemicals are relatively safe, although they can cause burns and should never come in contact with the eyes. Most hydroponic supply stores sell pH adjusters that are diluted to a level that is reasonably safe and easy to use. Concentrated adjusters can cause large pH changes and can make adjusting the pH very frustrating.

Several other chemicals can be used to adjust the pH of hydroponic nutrient solutions. Nitric acid and sulfuric acid can be used to lower pH but are much more dangerous than phosphoric acid. Food grade citric acid is sometimes used in organic gardening to lower pH.

Always add the nutrients to the water before checking and adjusting the pH of your solution. The fertilizer will usually lower the pH of the water due to its chemical makeup. After adding nutrient and mixing the solution, check the pH using whatever method you chose. If the pH needs to be adjusted, add the appropriate adjuster. Use small amounts

of pH adjuster until you get familiar with the process. Recheck the pH and repeat the above steps until the pH level is where you want it to be. Once you have done this a few times, you'll nail it the first try. Beyond all the facts and figures, this critical step is truly simple and easy.

The pH of the nutrient solution will have a tendency to go up as the plants use the nutrients. As a result the pH needs to be checked periodically and adjusted if necessary. To start out, I suggest that you check pH on a daily basis. Each system will change pH at a different rate depending on a variety of factors. The type of growing medium used, the weather, the kind of plants and even the age of the plants all effect the pH variations.