



# What Is pH and Why Do We Care?

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## WHAT IS pH?

In chemistry, pH is defined as the negative logarithm of the hydrogen-ion activity. More simply, it is a measure of the relative amount of free hydrogen ( $H^+$ ) and hydroxyl ions ( $OH^-$ ). That is, it tells the degree to which something—such as soil, water, or any solution—is basic or acidic. pH is reported in logarithmic units, like the Richter scale, which represents strength of earthquakes. Each number represents a tenfold change in the acidity or alkalinity of a substance. The range goes from 0 to 14, and around 7 is considered neutral. For example, water with a pH of 5 is ten times more acidic than water with a pH of 6. Additionally, pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates alkalinity or a base.

This figure shows the pH range of several familiar materials.



**Source:** Modified from “Acid Rain,” Environment Canada, 2012  
(<http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1>).

## WHY DO WE CARE?

**Soil pH.** The pH value of a soil is influenced by many factors, including vegetation, topography, mineralogy, texture, and the kinds of parent materials from which the soil was formed. Soils that are developed from basic rocks, such as basalt rocks found in the Warner Mountains in California, generally have higher pH values than those formed from acidic rocks, such as the granite rocks found in the Sierra Nevada Mountains of California. Rainfall also affects soil pH. Water passing through the soil leaches basic nutrients, such as calcium, sodium, potassium, and magnesium, from the soil. They are replaced by acidic elements, such as aluminum and hydrogen. For this reason, soils formed under high rainfall conditions are more acidic than those formed under arid conditions. Application of fertilizers containing ammonium or urea adds to soil acidity. The decomposition of organic matter also adds to soil acidity.

Optimal plant growth is dependent on soil pH because it affects the availability of all plant nutrients. Plant production and health are impaired at either high ( $>8$ ) or low ( $<6$ ) pH, because of nutrient limitations and potential toxicities. A pH of 6.0 to 6.5 is in an ideal range that optimizes the availability of many micro- and macronutrients. It also minimizes the toxicity of some micronutrients, some of which can be toxic at extreme pH. In highly acid soils, aluminum and manganese can become more available and more toxic to the plant. Another effect of low pH is that calcium, phosphorus, and magnesium are less available to the plant. At a pH of 6.5 and above, phosphorus and most of the micronutrients become less available. pH directly affects how fertilizers change into a form that plants can easily uptake. Different environments will influence the pH needs of an agricultural crop. However, most productive agricultural soils range from 6.0 to 7.5.

**Water pH.** The pH of water is most affected by the soils through which the water flows before getting into the stream, ditch, or river channel. Additionally, many other factors influence the pH of stream water: the source of the water, precipitation, root and microbial respiration, and contaminants. The only one of these factors that can be controlled is the input of contaminants.

The main use of pH in a water analysis is for detecting abnormal water. The normal pH range for irrigation water is from 6.5 to 8.4. An abnormal value is a warning that the water needs further evaluation. Irrigation water with a pH outside the normal range may cause a nutritional imbalance or may contain a toxic ion.

Low-salinity water sometimes has a pH outside the normal range since it has a very low buffering capacity. This should not cause undue alarm but should alert the user to a possible imbalance of ions and the need to establish the reason for the adverse pH through a full laboratory analysis. Such water normally causes few problems for soils or crops but is very corrosive and may rapidly corrode pipelines, sprinklers, and control equipment, especially when associated with a low pH.

Pollution can change water's pH, which in turn can harm plants and animals living in the water. Pollution is categorized by its source point or nonpoint. Point source pollution is an observable, specific, discharge of pollutants into a water body, for example, from feedlots. Nonpoint source pollution consists of diffuse discharges of pollutants through the natural environment, and it is usually associated with agriculture and forestry. One of the main nonpoint source contaminants of concern is phosphorus. Phosphorus contamination leads to blooms in microbial population, which increase the amount of carbon dioxide in the water source. Increasing carbon dioxide leads to a decrease in pH, thus making the water more acidic.

Water pH can vary with seasonal temperature changes. One of the causes for this is microbial respiration and the resulting carbon dioxide. Carbon dioxide is more soluble at cooler temperatures, thus decreasing the pH and making the water more acidic. Conversely, carbon dioxide is less soluble in warmer temperatures but there is more respiration taking place, so the actual change in pH is variable.

## HOW DO WE MEASURE pH?

**Soil pH.** It is important to know the pH of soil before seeding any plant. By knowing the pH of the soil, a person can choose plants that are adapted to that condition or amend the soil to fit the chosen crop's needs. A soil test performed by a trustworthy lab is relatively inexpensive and will also have other

information incorporated in it. Soil pH can also be measured using pH meters, standard dyes, or paper pH indicator strips. Each has pros and cons related to its ease of use, capability, hardiness, and expense.

**Water pH.** The same three methods for measuring pH in soil can be used in measuring pH in water. The main difference is that water should be measured as soon as possible after taking the sample.

This will decrease changes due to temperature variations, microbial respiration, and so on.

As discussed previously, the level of pH in soils and water has a significant impact on the productivity, sustainability, and relative health of an area. Measuring pH is a fairly simple, cost-effective process. Plans for monitoring pH can be developed with the local farm advisor.

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