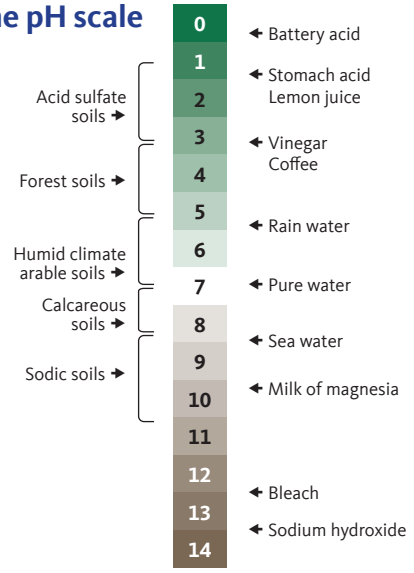
Managing Soil pH

Your soil pH strongly influences soil productivity. It's critical to understand soil pH to enhance plant growth.

What is soil pH?

A solution's pH is the measure of how acid or alkaline (base) it is. The pH scale ranges from 0 to 14. A pH of 7 is neutral, a pH less than 7 is acidic, and above 7 is alkaline (Figure 1). The pH scale is logarithmic, meaning a pH of 6.0 is 10 times more acidic than a pH of 7.0.

The pH scale



Graphic adapted from McCauley, Jones and Olson-Rutz

Figure 1. Most soils range in pH from 4.0 to 10.0.

Soil pH measures how acid or alkaline the soil water solution is. Soil pH of 6.0 to 7.0 is ideal for most plants, but each plant has its own range (Table 1).

Table 1. Ideal pH ranges for plants

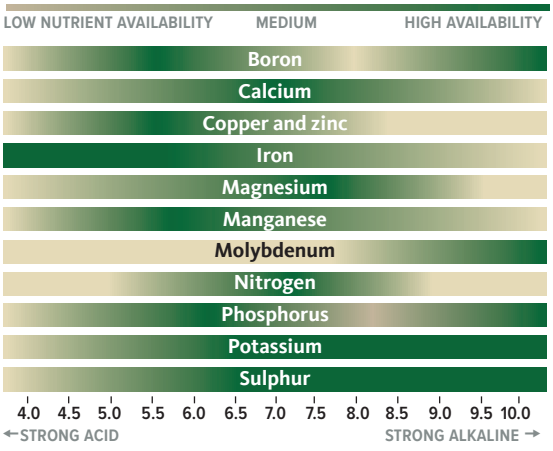
Plant	Soil pH
Alfalfa	6.5–7.5
Barley	5.5–7.0
Blueberries	4.5–5.5
Carrots	6.0–6.8
Corn	5.8–6.8
Potato	5.0–5.5
Tomato	6.0–6.8
Wheat	6.0–7.0

Soil pH influences many soil functions, including:

- How available plant nutrients are for plant health (Figure 2).
- How soluble aluminum is before becoming toxic to plants.
- How effective pesticides are.
- Whether legumes can fix soil nitrogen.
- How susceptible plants are to disease.
- The biological activity of soil organisms.

Soil nutrient availability

How soil pH affects plant nutrient availability



Graphic: Elli Korthuis, © Oregon State University

Figure 2. Nutrient availability changes with soil pH. Dark parts of bars indicate higher availability of nutrients.

Measuring soil pH

You can test soil pH using meters or test kits you can buy online or at garden stores. For best results, send soil samples to a qualified laboratory (see *Analytical Laboratories Serving Oregon*, EM 8677, https://catalog.extension.oregonstate.edu/em8677). The best practice is to take soil samples before and after each growing season.

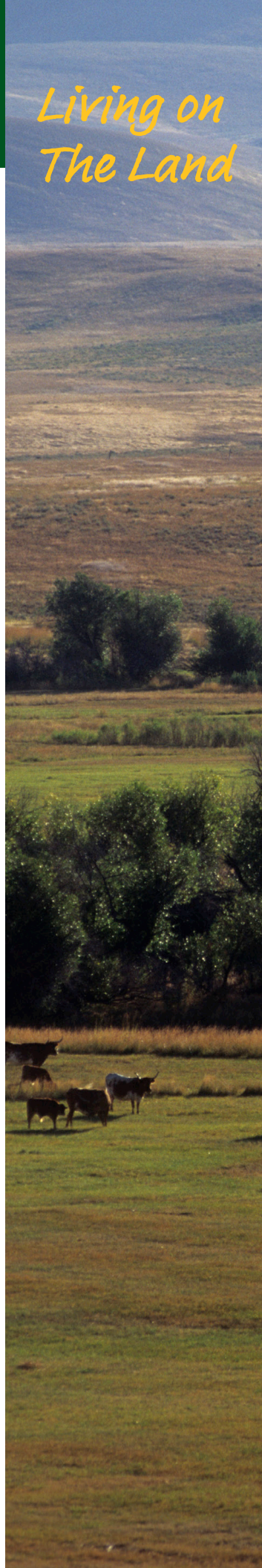
For more info, see *A Guide to Collecting Soil Samples for Farms and Gardens*, EC 628 (https://catalog.extension.oregonstate.edu/ec628). Your local OSU Extension office and Master Gardener™ program can help with soil questions.

The nature of soil pH

Initial soil pH depends on the rocks from which the soil is formed. Higher pH soil derives from rock that is high in basic (alkaline) cations, like basalt, while lower pH soil derives from rock that is high in acidic cations, like granite.

Over time, soil tends to decrease in pH. This process, known as acidification, is driven by the loss of basic cations (calcium, magnesium, potassium, sodium), leaching of nitrate and the addition of acid-forming cations. These changes can be caused by:

- Weathering of minerals releasing acidifying cations.
- Rain or snow adding acids and leaching basic cations and nitrate.



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- Decomposition of organic matter.
- Plants releasing hydrogen ions through roots.
- Conversion of ammonium-N fertilizers to nitrite.

Soil seldom has the same pH at all depths. Change in soil pH from one depth to another is called stratification. A common cause of stratification is repeatedly applying fertilizer, which results in acidic soil at the depth of application.

Soil erosion removes topsoil and exposes subsoil that may have a different pH. Tillage can mix stratified soil and distribute the pH throughout the tillage depth. Doing this can delay the need for correction but does not resolve the causes of acidification.

The following techniques can effectively reduce soil acidification.

Managing soil water

Excessive soil water leaches basic cations and nitrate. You can prevent this by applying irrigation water efficiently and using slow-release fertilizer formulations or nitrification inhibitors that slow ammonium's conversion to nitrate. Design crop rotations to complement low water-using crops with high water-using crops to avoid excessive soil saturation.

Managing fertility

Use precision nutrient management and similar techniques to apply elemental sulfur, ammonium-N fertilizer and organic matter efficiently. Or, use nitrate fertilizers (sodium nitrate, calcium nitrate, potassium nitrate) or poultry manure. You can also grow legumes to meet crop needs with less acidification. Apply fertilizer as close to the time that crops need it as possible.

Managing the crop

Harvesting crop residues, especially forage crops, removes basic cations in the plant matter. Keep the crop residue and rotate it with grain crops to reduce soil acidity. Grow deep-rooted crops and cover crops to capture nitrate, prevent leaching, and draw up basic cations from lower depths to stabilize pH changes.

Correcting soil acidity with lime

Applying lime, which often contains calcium carbonate, can increase soil pH. Lime products come as crushed, ground, pellets or suspended in solution. Each form has pros and cons for application, reaction speed and cost. You'll need to till to incorporate lime into the soil.

The amount of lime required to correct soil acidity depends on many factors: current soil pH, crop pH requirement, depth of incorporation, soil buffering capacity, and the potential of the lime material to neutralize the soil.

Consult a qualified agronomist for help choosing a lime product and quantity. To find a certified agronomist near you, visit the American Society of Agronomy, https://www.agronomy.org/certifications/professional-search.

Soil pH is dynamic and can reduce yields. Continual management is vital to prevent and remedy soil pH issues.

For more information

- *Applying Lime to Raise Soil pH for Crop Production (Western Oregon)*, EM 9057, https://catalog.extension.oregonstate.edu/em9057.
- *Eastern Oregon Liming Guide*, EM 9060, https://catalog.extension.oregonstate.edu/em9060.
- Fertiliser Technology Research Centre. *Technical Bulletin: Fertilizers and Soil Acidity.* The University of Adelaide, Australia.
- Natural Resources Conservation Service. *Guides for Educators: Soil pH.* May 2014. *Soil Quality Indicators: Soil pH.* April 2011.
- *Soil Acidity Evaluation & Management.* Norcross, GA: International Plant Nutrition Institute, 2013.
- *Soil Acidity in Oregon: Understanding and Using Concepts for Crop Production*, EM 9061, https://catalog.extension.oregonstate.edu/em9061.
- *Soil pH and Implications for Management: An Introduction*, FS170E, Washington State University, 2015.
- *Soil pH and Organic Matter.* Nutrient Management Module 8. 2017.

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For more information on managing soil pH, contact your local Extension agent, your local Soil & Water Conservation District, or Oregon Department of Agriculture (503-986-4700). Technical and financial assistance is available for livestock owners wishing to address resource concerns on their property.

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