Delaware Gardener's Guide to Soil pH

Soil pH is a measure of soil acidity or alkalinity. On the pH scale a value of 7 is neutral, pH values less than 7 are acidic, and pH values greater than 7 are alkaline. Homeowners and gardeners are interested in soil pH because soil pH directly affects the growth and quality of many landscape plants. The purpose of this publication is to explain soil pH and provide strategies for homeowners to make the most of the pH in the home landscape or garden.

Soil pH influences the chemical form of many elements in the soil that are essential to plant and soil microbial processes. As a result, landscape plants may exhibit nutrient deficiency or toxicity symptoms as a result of highly acidic or alkaline soil pH. In acidic soils, the availability of plant nutrients such as potassium (K), calcium (Ca), and magnesium (Mg) is reduced, while availability of potentially toxic elements such as aluminum (Al), iron (Fe), and zinc (Zn) is increased. In alkaline soils, iron, manganese (Mn), zinc, and boron (B) are commonly deficient. Soil pH can also affect soil bacterial and fungal activity, enhancing or inhibiting the development of soil-borne plant diseases or how efficiently microbes function as decomposing organisms.

Delaware soils formed from unconsolidated sediments under the oak-hickory-pine forests of the Middle Atlantic Coastal Plain or from metamorphic rocks under the Appalachian oak forests of the Northern Piedmont; these soils tend to be slightly to moderately acidic. The median soil pH for home lawn, landscape, and garden soil samples tested over the last five years by the University of Delaware Soil Testing Program is 6.1, which is characterized as slightly acidic. However, it is possible to encounter more alkaline conditions in newer home landscapes due to use of calcium carbonate-rich building materials (i.e., concrete, stucco, etc.) during construction or more acidic soils when wooded lots are cleared or when acidic subsoils are exposed. As landscapes age, soil pH tends to become more acidic. The pH of artificial soils and potting mixes that are often used in raised beds will differ from natural soils found in the home landscape and garden. Typically, artificial soils and potting mixes will be quite acidic, with pH <5.5 in many cases.

Determining Soil pH

Soil pH can be determined by sending a soil sample to a reputable lab, such as the University of Delaware Soil Testing Program. All Delaware Extension offices and several retailers and Extension offices in Delaware, Maryland, and New Jersey offer home lawn, garden and landscape soil test kits that consumers can use to submit a soil sample to the University of Delaware Soil Testing Program. Information on how to properly take a soil sample is available on the Soil Testing Program website and in the soil test kit. Once you receive the results of a soil pH test, you can determine which plants are best suited for your soil.

Most common landscape plants are well-suited to a wide soil pH range. For example, popular woody shrubs and trees (e.g., yew, viburnum, oak, and pine) grow well in acidic to slightly alkaline soils. Cool and warm-season lawn grasses grow best in a pH range between 6.0 and 7.0. The best pH range for vegetable and flower gardens is 5.8 to 6.3. If your soil pH is between 6.0 and 7.0, there is usually no need to adjust soil pH. However, there are a few acid-loving plants like azalea, blueberry, and rhododendron that do not grow well in soils with pH greater than 5.5. Some plants, like Osage orange, black walnut and many herbs, tend to prefer slightly acidic to slightly alkaline soils (6.5 to 8.0).

Changing Soil pH

The best advice about dealing with soil pH is to choose landscape plants suited for the natural pH of your landscape soil. Utilizing native plants in your landscaping will provide an advantage due to their suitability for native soils. The publication Plants for a Livable Delaware provides helpful native plant suggestions. While some soil additives can raise or lower the pH of soils, the effects of these materials are often short-lived. In addition, if your soil pH is within 0.5 of a pH unit of the ideal range, adjusting the pH will probably not improve plant performance. However, if you want to try to change your soil's natural pH to grow a specific plant, you have the following options.

Raising the pH of Acidic Soils

Have your soil tested by a reputable soil testing laboratory before applying any liming materials to prevent under or over-liming. We do not recommend using home testing kits that are available to consumers at many garden centers because they tend to be unreliable. If a soil pH test indicates that your soil is acidic, a reputable laboratory will also run a lime requirement test before providing a liming rate recommendation. The lime requirement test measures your soil's natural ability to resist (buffer) changes in pH. This test is part of the standard landscape and garden soil test offered by the UD Soil Testing Program. Results of this test will indicate the amount of agricultural limestone you should apply to a specific area to reach a target pH. The lime requirement test is not available in home soil testing kits and therefore, these kits do not provide appropriate lime recommendations.

A liming material like calcium carbonate (calcitic or “Hi-Cal” lime) or dolomite (dolomitic or “Hi-Mag” lime) is used to raise the pH of acidic soils. In certain situations, it may be beneficial to choose liming materials to allow adjustment of soil Mg or Ca levels. Dolomite has the added benefit of supplying Mg.

For lime to be most effective, it should be thoroughly mixed into the top 6 to 8 inches of soil. Mixing is easily accomplished prior to planting a garden or landscape. If applying lime to established landscapes or turf, incorporation can damage plant roots. In established landscapes, lime can be surface-applied and watered in, but take care not to overwater (e.g., no more than 0.5 inches of water over the treated area). Also, when applying lime to established areas (such as turf), choose non-caustic liming materials (e.g., ag lime vs. calcium oxide [CaO]). If the recommended lime rate exceeds 100 lb per 1000 ft^2 (0.5 tons per acre), splitting the application is recommended. Apply 40-50 lb of lime per application and wait approximately 3-4 months between applications to reduce the chances for plant-related issues.

Lowering the pH of Alkaline Soils

Unlike liming, lowering the pH of strongly alkaline soils is much more difficult and sometimes impossible. In fact, there is no way to permanently lower the pH of naturally alkaline soils or soils severely impacted by alkaline construction materials. In these circumstances, it is best to select plants that are tolerant of high pH conditions to avoid chronic plant nutrition problems.

Soil pH can be temporarily lowered by adding elemental sulfur. Bacteria in the soil change elemental sulfur into sulfuric acid, effectively neutralizing soil alkalinity. However, the effect of elemental sulfur is localized to the area that was amended, and the effect is temporary. Soil pH will begin to rise shortly after soil bacteria exhaust the added sulfur supply. This effect prompts repeated applications of sulfur to ensure that the soil remains at the desired pH. Using sulfur to amend a soil is complicated. Adding sulfur at high rates or applying it too frequently can damage your plants. If you decide to apply sulfur, be sure to look for signs of plant response after the application.

Depending on the measured and desired soil pH and the soil texture, elemental sulfur should be added to sandy soils at the appropriate rate (Table 1). Note that lowering soil pH below 5.0 is not recommended because of the potential for Al toxicity. The only notable exception is blueberries, which prefer soil pH between 4.5 and 5.0. Also, to avoid burning plants, add no more than 20 lbs of sulfur per 1000 square feet of soil in a single application to bare soils. Prior to plant installation, sulfur can be incorporated directly into the entire planting bed to the depth of the root zone of the plants to be established. Soils should be tested again in 4-6 months to determine the need for additional sulfur.

When applying sulfur to planted areas, no more than 8 lbs of sulfur should be applied per 1000 square feet in a single application to avoid burning plants. A partial root zone treatment can be used to apply powdered or granular sulfur to areas that are already planted. This practice allows the sulfur to lower the pH in the root zone quickly and be of more benefit to the existing plants. To use the partial root zone treatment, remove soil in the root zone of existing plant material and set it aside. Incorporate sulfur into the excavated soil at the appropriate rate to achieve the desired soil pH (Table 1). Refill the hole with amended soil.

It will take some time for elemental sulfur to lower the soil pH, so applying sulfur well in advance of planting is suggested. If waiting to plant is not an option, a small amount of peat moss can be incorporated into the planting hole along with sulfur to help acid loving plants thrive until the sulfur has time to react with the soil.

Elemental sulfur is the acidifying material recommended by the University of Delaware. Other soil amendments, such as ammonium sulfate, iron sulfate, and aluminum sulfate, can also be used to lower soil pH. These amendments are often included in "acid-forming fertilizers" commonly applied to azalea. However, not all sulfate materials (e.g., calcium sulfate [gypsum], magnesium sulfate [Epsom salt], and potassium sulfate) will acidify soil. Alternatively, organic materials like peat or animal manure also counter the effects of alkaline soil pH on some landscape plants. Since these materials decompose with time, annual or semiannual applications are usually required.

Summary

Always consider the pH of your soil when selecting new plant material for your home landscape or garden. Take action to correct soil pH only when it is substantially higher or lower than the desired pH for the plants you are growing. To avoid damage to your landscape plants, always have your soil tested for pH and lime requirement (if soil pH is acidic) before adding lime or sulfur to the soil. Remember that pH will change over time and should be checked routinely every several years. Finally, if you are interested in growing specific plants that are not suited for your soil pH, consider growing them in pots, where you are able to amend small volumes of soil to reach the desired pH.

Table 1. Recommended elemental sulfur rates to reducing soil pH in Delaware soils. Do not exceed more than 20 lb S per 1000 ft^2 in a single application. (Adapted from Sims and Gartley, 1996).

Initial Soil pH	**Elemental Sulfur Required to Achieve Desired Soil pH***			
	5.0	**5.5**	**6.0**	**6.5**
	——————————— lbs/1000 ft^2 ———————————			
	Loamy sand and sandy loam soils**			
6.0	8	4	0	0
6.5	12	8	4	0
7.0	15	12	8	4
7.5	20	15	12	8
8.0	25	20	15	12
	Silt loam and loam soils**			
6.0	25	10	0	0
6.5	35	25	10	0
7.0	45	35	25	10
7.5	60	45	35	25
8.0	70	60	45	35
*To convert to aluminum sulfate multiply the amount of element sulfur × 6.				
**For black soils, increase the S application rate by 25-50%.				

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Revised Document Prepared by:
Amy L. Shober
Department of Plant and Soil Sciences
University of Delaware

Based on original documents prepared by: A.L. Shober, C. Wiese, and G.C. Denny

Reviewed by:
Susan Barton, Associate Professor and Extension Specialist, Landscape Horticulture
Karen Gartley, Director, University of Delaware Soil Testing Program

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