Changing pH in Soil

Soil pH directly affects the life and growth of plants because it affects the availability of *all* plant nutrients. Between pH 6.0 and 6.5, most plant nutrients are in their most available state. A nutrient must be soluble and remain soluble long enough to successfully travel through the soil solution into the roots. Nitrogen, for example, has its greatest solubility between soil pH 4 and soil pH 8. Above or below that range, its solubility is seriously restricted.

Soil acidity or alkalinity (pH) is extremely important because it has an effect on the decomposition of mineral rock into essential elements that plants can use. It also changes fertilizers from their form in the bag to a form that plants can easily uptake. Soil microorganisms that change organic nitrogen (amino acids) to the ammonium form of nitrogen to the nitrate form that plant can use also depends on the soil pH.
Soil pH should be checked periodically and consistent testing will indicate whether your pH-control program is working.

Raising pH

The ideal pH range for soil is from 6.0 to 6.5 because *most* plant nutrients are in their most available state. If a soil test indicates a pH below 6.5, the usual recommendation is for the application of ground limestone. In addition to having the ability to raise pH, limestone contains calcium. Some prefer dolomitic limestone because it contains both calcium and magnesium, however soils high in magnesium (serpentine) do not need more magnesium. Table 1 indicates the number of tons per acre of ground limestone required to raise the pH of a given soil to based on the original pH, desired pH, and soil type.

In order to select the correct application rate use a soil test to determine both the soil texture group and the current pH. As the percentage of clay in a soil increases, it requires proportionately more limestone to raise the pH. This means it is much harder to change the pH of clay soil than sandy soil. Consider that limestone moves *very slowly*, taking years to move down a few inches in the soil. This is why it is so important to test soil early in the planning process. Limestone should be tilled into the soil root zone (top 7 inches).

Table 1. Approximate Amount of Finely Ground Limestone Needed to Raise the pH of a 7-inch Layer of Soil

	Lime Requirements (Tons per Acre)	
Soil Texture	**From pH 4.5 to 5.5**	**From pH 5.5 to 6.5**
Sand and loamy sand	0.5	0.6
Sandy loam	0.8	1.3
Loam	1.2	1.7
Silt loam	1.5	2.0
Clay loam	1.9	2.3
Muck	3.8	4.3

Table 2. Common Liming Materials

Name	**Chemical Formula**	**Equivalent % $CaCO_3$**	**Source**
Shell meal	$CaCo_3$	95	Natural shell deposits
Limestone	$CaCO_3$	100	Pure form, finely ground
Hydrated lime	$Ca(OH)_2$	120-135	Steam burned
Burned lime	CaO	150-175	Kiln burned
Dolomite	$CaCO_3 – M_gCO_3$	110	Natural deposit
Sugar beet lime	$CaCO_3$	80-90	Sugar beet by-product lime
Calcium silicate	$CaSiO_3$	60-80	Slag

Lowering pH

Some soils are alkaline and have a pH above 6.5. Some fertilizers (ammonium sulfate, urea, and ammonium nitrate) create an acid reaction in the soil, so they aid in lowering or maintaining a specific pH. Certain acidifying organic materials such as pine needles or peat moss can lower soil pH gradually over many years. In nature this takes thousands of years. For more rapid results in lowering pH, sulfur is used. Sulfuric acid forms when sulfur is added to the soil, the smaller the particles of sulfur, the faster the reaction. Lowering the pH is a *slow* process and will take 1-2 years to see a reaction.

Table 3. Tons of sulfur needed per acre to lower pH to 6.5

Original pH	Sandy Soil	Clay Soil
8.5	0.7 - 1.0	1.0 - 1.3
8.0	0.5 - 0.7	0.7 - 1.1
7.5	0.2 - 0.3	0.4 - 0.5

Table 4. Commonly Used Materials and Their Equivalent Amendment Values

		Tons of Amendment Equivalent to	
Material (100% Basis)*	**Chemical Formula**	**1 Ton of Pure Gypsum**	**1 Ton of Soil Sulfur**
Gypsum	$CaSO_4 \cdot 2H_2O$	1.00	5.38
Soil sulfur	S	0.19	1.00
Sulfuric acid (conc.)	H_2SO_4	0.61	3.20
Ferric sulfate	$Fe_2(SO_4)_3 \cdot 9H_2O$	1.09	5.85
Lime sulfur (22% S)	CaS	0.68	3.65
Calcium chloride	$CaC1_2 \cdot H_2O$	0.86	--
Aluminum sulfate	$A1_2(SO_4)_3$	--	6.34

** The percent purity is given on the bag or identification tag*

Common Amendment Reactions in Soil

- Gypsum (calcium sulfate) + sodic soil → calcium soil + sodium sulfate (leachable with water)
  Sodium sulfate is then leached out of the soil by rainfall or heavy irrigations. The removal of sodium lowers the sodium permeability hazard allowing for soil aggregation and improved drainage. Gypsum does not change pH nor improve drainage in non-sodic situations. Gypsum is used to add calcium to soils such as serpentine with very high or toxic Mg levels.

- Sulfur (elemental) + oxygen + water → sulfuric acid + soil calcium → gypsum
  Gypsum then acts as above. Sulfur and sulfuric acid also lower pH

- Lime (calcium or magnesium carbonate) + water → calcium soil + OH
  Lime neutralizes the (acidity) - H^+ ion concentration and adds calcium to soil

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