Some plants need a low pH.

Most plants grow best where the soil is slightly acid in the range of pH 5.8 to 7.0. A few plants, however, such as azaleas, gardenias, and blueberries grow best at lower pH levels. Others such as centipede turf, camellias, and potatoes grow well in a wide range of pH conditions, but seem to thrive best in more acid soils. Centipede turf is prone to iron chlorosis (iron deficiency) when soil pH is too high (above 6) and soil phosphorus is excessive due to over-fertilization.

Why is the pH so high?

Sometimes gardeners inadvertently over lime their soil. They may not have tested the soil but lime just because "Grandaddy always did and he had a beautiful garden." Others rationalize that "Sure I limed according to soil test, but I also used basic slag." Others say, "Wood ashes make a great mulch." There may be a few whose neighbor works for company XYZ. Company XYZ has a huge pile of free lime from the mill so "I just had a few dumptruck loads piled in the garden." Any of these situations could create a very high soil pH - so high that some plants have a difficult time surviving.

If soil pH is above 7.0 anywhere in the Southeast, one needs to find out why. Of course, some soils from the Black Belt prairie region of central Alabama are naturally calcareous and alkaline. They are formed from the soft limestone known as Selma chalk. Some soils could be as much as 50% lime and have a pH value as high as 8.3. There’s not much one can do about this. Just grow plants tolerant of calcareous soils - not azaleas, camellias, gardenias, and blueberries. Soils that have an artificially high pH, however, may also have a high salt content. Some waste products such as wood ashes (not agricultural lime) applied to the soil could be high in salts (salts of sodium, potassium, etc.). High salts probably caused the initial damaging effects to the plants. With time, rainfall will leach the salts out of the rooting zone. A high pH (up to about pH 8.0) would probably create severe micronutrient deficiencies (iron, zinc, and manganese) and result in a general yellowing and poor growth. High salts will kill plants.

Use fertilizer to lower soil pH.

In most cases, the pH can be lowered simply by using fertilizers containing ammonium-N (Table 1). Ammonium sulfate and sulfur-coated urea are two of the best choices for acidifying soils. Most specialty fertilizers for "acid-loving" plants contain ammonium sulfate or sulfur-coated urea. These are popular sources of nitrogen for azaleas and blueberries.

\[
2\text{NH}_4^+ + 3\text{O}_2 \rightarrow 2\text{NO}_2^- + 2\text{H}_2\text{O} + 4\text{H}^+ \\
\text{ammonium + oxygen} \quad \text{nitrite + water + acid}
\]
If you are desperate, try sulfur or aluminum sulfate.

In rare cases, it may be desirable to lower the pH by adding an acidifying agent such as elemental sulfur (flowers of sulfur) or aluminum sulfate. This can be done successfully on soils that do not contain large amounts of free lime. Amounts of sulfur needed to lower the pH of a silt loam soil to a 6-inch depth are given in Table 2. Sandy soils would require less and clayey soils would require more. Elemental sulfur is converted to sulfuric acid by soil bacteria. Therefore, in order for sulfur to work the following must be satisfied:

- Sulfur must be mixed with the soil to provide contact.
- The soil must be moist.
- The soil must be aerated (bacteria need oxygen).
- The soil must be warm for rapid bacterial growth.
- Time is required for the reaction to go to completion.

\[
2S + 3O_2 + 2H_2O \xrightarrow{\text{bacteria}} 2H_2SO_4
\]

sulfur + oxygen + water \rightarrow sulfuric acid

![Effect of particle size on recovery of sulfur added to a silt loam soil at the rate of 1,000 ppm of elemental sulfur and incubated at room temperature](image)

Table 1. Acidifying effect of some common fertilizers and soil amendments.

<table>
<thead>
<tr>
<th>Material</th>
<th>Pure CaCO_3 needed to neutralize acidity in 100 pounds of material</th>
</tr>
</thead>
<tbody>
<tr>
<td>ammonium nitrate</td>
<td>60</td>
</tr>
</tbody>
</table>

---
ammonium sulfate 110
32% liquid nitrogen 55
urea 81
sulfur-coated urea 118
diammonium phosphate 70
flowers of sulfur (elemental S) 312
aluminum sulfate 45

Aluminum sulfate may be better for the home gardener to use because he/she is less likely to over-apply the material. Six times as much aluminum sulfate is needed as elemental sulfur. Aluminum sulfate should also be mixed with the soil, but the reaction is a chemical one rather than a biological reaction.

\[
\text{Al}_2(\text{SO}_4)_3 + 6\text{H}_2\text{O} \rightarrow 2\text{Al(OH)}_3 + \text{H}_2\text{SO}_4
\]

aluminum sulfate + water → gibbsite (solid) + sulfuric acid

<table>
<thead>
<tr>
<th>Present pH</th>
<th>Desired soil pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>6.5  6.0  5.5  5.0  4.5</td>
</tr>
<tr>
<td></td>
<td>- - - - - lb. S per 100 sq. ft. - - - - -</td>
</tr>
<tr>
<td>7.5</td>
<td>4.0  3.5  4.5  6.0  7.0</td>
</tr>
<tr>
<td>7.0</td>
<td>1.0  2.0  3.5  5.0  6.0</td>
</tr>
<tr>
<td>6.5</td>
<td>---  1.0  2.5  4.0  4.5</td>
</tr>
<tr>
<td>6.0</td>
<td>---  ---  1.0  2.5  3.5</td>
</tr>
</tbody>
</table>

*For sandy soils, reduce amount by 1/3; for clayey soils, increase amount by 1/2; if aluminum sulfate is used, multiply by 6.9.

- Sulfur is also an essential plant nutrient.

Do not confuse sulfur as a soil acidifying agent with sulfur as a plant nutrient. All soil test reports recommend 10 pounds of sulfur per acre as a plant nutrient. Most fertilizer sources of sulfur are in the sulfate form (SO₄²⁻) which is readily available to plants, e.g., ammonium sulfate, calcium sulfate (gypsum), potassium sulfate, sul-po-mag, magnesium sulfate (epsom salts), etc. Sulfate sulfur is usually contained in mixed fertilizers. This form will not acidify soils. Elemental sulfur (a yellow powder), the form used for soil acidification, is not plant available until it is oxidized by soil bacteria to the sulfate form. This takes time - usually several weeks.
Elemental sulfur is sometimes sold as "flowers of sulfur".

**Summary**

Before recommending that a gardener add a material to acidify the soil, make sure the pH is too high and find out why. Perhaps using an acid-forming nitrogen source such as ammonium sulfate or sulfur-coated urea will gradually correct the problem. If not, recommend aluminum sulfate as the first choice. He/she is less likely to over-apply this material. Recommend "flowers of sulfur" only for large scale growers, and caution them about over-applying sulfur. Don’t confuse elemental sulfur as a soil acidifying agent with sulfur recommendations as a plant nutrient.

Prepared by: Charles C. Mitchell, Jr., Extension Agronomist-Soil Fertility & James F. Adams, Assistant Professor

---

**Return to Soil Acidity & Liming - Part II**