SHORT COMMUNICATION

Preliminary evaluation of H₂SO₄ application methods to soils*

Summary
The effects of sulfuric acid application to soils and water on growth and chemical composition of sorghum (Sorghum bicolor) were compared in a greenhouse experiment using high sodium bicarbonate irrigation water. Significant increases in dry matter yield and plant uptake of P and Fe were produced only by soil treatment of calcareous soils.

Introduction
Soils of the Southwest are predominantly calcareous and frequently exhibit deficiency levels of essential plant nutrients. In general, the solubility of P and Fe decreases with increasing soil pH. Early studies focussed on elemental sulfur as a means of increasing nutrient availability by acidification. Applied sulfur is gradually converted in the soil to sulfuric acid by soil microflora. In view of projected surpluses of smelter acid, principally from the copper industry, as well as a decrease in supply of P fertilizers, attention is now being given to the direct use of sulfuric acid in agriculture.

Soil application of H₂SO₄ has been shown to increase Fe availability, thereby eliminating chlorosis in sorghum and to increase P availability in some calcareous soils. Available information suggests that application of H₂SO₄ in irrigation water is relatively ineffective for evoking a nutritional response in crops. However, no comparison between the two methods of application has been made at similar rates and under similar conditions. This study compared the effects of soil and water application of H₂SO₄ on dry matter yield and P and Fe uptake by sorghum.

Material and methods
Properties of the three soils used in the experiment are shown in Table 1. They are broadly representative of the range of soils found in the southwestern U.S. The soils were low in available P as indicated by values obtained using a CO₂-saturated water extract. The calcareous Anthony and Cave soils were low in DTPA extractable Fe. After sieving through a 2mm

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TABLE 1

Properties of experimental soils

<table>
<thead>
<tr>
<th>Soils</th>
<th>Acid-titratable basicity (ATB) meq/100 g</th>
<th>pH</th>
<th>ESP %</th>
<th>O.M. %</th>
<th>Fe* ppm</th>
<th>PO4** ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sonoita (sl)</td>
<td>5</td>
<td>6.8</td>
<td>1.0</td>
<td>0.8</td>
<td>9.7 (adequate)</td>
<td>4.5 (low)</td>
</tr>
<tr>
<td>Anthony (sl)</td>
<td>72</td>
<td>7.8</td>
<td>1.5</td>
<td>1.5</td>
<td>2.3 (low)</td>
<td>2.5 (low)</td>
</tr>
<tr>
<td>Cave (sl)</td>
<td>192</td>
<td>8.1</td>
<td>0.2</td>
<td>0.6</td>
<td>1.8 (low)</td>
<td>1.9 (low)</td>
</tr>
</tbody>
</table>

* Measured by method of Lindsay and Norvell 4.
** Measured in CO2-saturated water extract.

screen, 1.5 kg lots of soil were placed in plastic pots. The soil treatment consisted of H2SO4 injected into the soil at rates of 1.8 and 3.6 g per pot. Seeds of an iron sensitive variety of sorghum (Sorghum bicolor 'Double Dwarf Yellow Sooner') were then planted. After emergence, the seedlings were thinned to four per pot and grown for nine weeks in the greenhouse.

The irrigation water was designed to simulate poorer quality irrigation water in Arizona with respect to HCO3− content: 5 meq/l NaHCO3. Levels of 1.5 meq/l each of CaSO4 and CaCl2 were chosen to maintain a constant SAR value of 4.1. To this water was added two rates of H2SO4: 5 and 10 meq/l. The lower rate was sufficient to neutralize the HCO3− in the water. Equal amounts of the respective solutions were added to each pot. The total amounts of acid added to the water over the growing period were equal to the amounts applied by soil injection.

All treatments were replicated three times. Nitrogen (200 ppm) was applied in solution as NH4NO3 at sowing time and again after four weeks. After harvest, plant samples were dried, digested with perchloric acid and analyzed for P by colorimetry and for Fe by atomic absorption spectrophotometry. The potted soil was analyzed for exchangeable Na at the end of the experiment. The data were treated statistically, using the standard analysis of variance with LSD values noted at the P ≤ 0.01 and P ≤ 0.05 levels of confidence.

Results and discussion

Dry matter yields from the experiment are presented in Table 2. Injection of 1.8 g H2SO4 significant increased yields on the calcareous Anthony and Cave soils. Both soils exhibited further significant increases with the higher rate of H2SO4 (3.6 g/pot). Addition of acid to the irrigation water had no significant effect at either level when compared with the control. Neither treatment affected yields on the Sonoita soil.

The effect of treatments on plant uptake of P and Fe is presented in Table 3.