Although most growers are familiar with pH, few realize how complex this property really is. In general, the term pH refers to the acidity/alkalinity of a growing medium. However, these factors also influence the availability of many nutrient elements as well as physiological responses within the plant. The following information reviews the basic concepts of pH and their practical implications.

**Acidity and pH**

Acids, when mixed with water, dissociate or ionize into hydrogen ions (H+) and associated anions. The stronger the acid, the greater the amount of ionization. Those H+ ions which dissociate are measured as active acidity, while those capable of dissociating are measured as potential acidity. The sum of the concentrations of active and potential acidities yields total acidity.

\[ \text{H}_2\text{SO}_4 \xrightarrow{\text{Ionization}} 2\text{H}^+ + \text{SO}_4^{2-} \]

Sulfuric Acid                      H+ Ions  Anions

Dissociation of Sulfuric acid into H+ and associated SO4-anion.

In strong acids, the activity of H+ ions is so nearly equal to the concentration of total acidity that there is little need for separate designations. However, many weak acids dissociate to less than one percent, in which case a measure of total acidity gives no indication of active acidity. With extremely weak acids, H+ ion activity is generally stated in terms of the logarithm of the reciprocal of hydrogen ion activity or pH.

\[ \text{pH} = \frac{1}{\log \text{H}^+ \text{ activity}} \]

**Factors Affecting the Determination of pH in Soilless Growing Media**

Although pH may be determined colorimetrically, the most accurate and widely used method is by means of glass electrode potentiometer. Glass electrodes are unaffected by oxidizing and reducing substances, and do not liberate dissolved gases from the system. However, pH measurements have been found to vary depending upon the method of sample preparation. The principle sources of this variation include: drying, water content of the medium, and soluble salt concentrations.

Measurements made under saturated conditions may be considered the most valid in evaluating the existing environment of the growing media. However, the drying process may hasten certain chemical reactions resulting in samples near equilibrium.

Several dilution ratios have been recommended for the determination of pH. These range from the moisture saturation percentage to 1:10 substrate:solution ratio. Wider dilutions generally require longer equilibration time (30 to 60 minutes) and should be read within 60 seconds of electrode immersion.

Generally speaking, most pH determinations on soilless growing media are made using a 1:2 or 1:5 substrate:solution ratio. Stirring the suspension is necessary to keep the growing media suspended during the pH measurement.

pH measured with a glass electrode potentiometer is conducted by placing a suspension of media in contact with the glass electrode. Since dolloids behave as weak acids, the presence of a solid phase may be expected to give lower pH values when in contact with the electrode. Conversely, as the suspension becomes more dilute, pH values tend to increase.

To obtain an accurate evaluation of acidity, the presence of soluble salts should be accounted for. Salts influence ionic activities, and therefore, reduce pH values. This salt effect may be overcome by leaching with distilled water and then conducting pH determination on the salt-free sample.
Another method of masking the acidifying effects of soluble salts is to suspend the sample in a salt solution rather than water (i.e. CaCl₂). Differences in pH are measured in the added-salt solution suspension. This is a more precise evaluation of acidity than that measured in a substrate water suspension.

**Determining pH in Soilless Growing Media**

Several techniques have been developed for the determination of pH. However, at present, no testing standards exist for soilless growing media. The following steps outline a procedure which is used by many growers and labs throughout Texas and the U.S.

1. **Collect Sample** - Be sure to collect a sample which is representative of the entire mass of growing media in question. Many samples may be pulled and then combined into a representative number of "composite" samples. Remember that variation may exist between locations in individual pots, as well as, different locations within the same pot. Core samples are excellent for accounting for this type of variation. Avoid taking only the top inch or so of media. This is generally where soluble salts accumulate.

2. **Dry the Sample** - Spread samples on a paper towel or clean surface. Allow them to air dry to a uniform consistency (this may take several days). Do not allow samples to dry to a fine powder. This will result in samples that are difficult to re-wet.

3. **Mix Media and Water** - Take 1/4 cup of dried growing media and add either 1/2 cup (1:2 v/v) or 1-1/4 (1:5) of distilled water. Mix thoroughly and allow to equilibrate for approximately 1 hour. If this suspension is left longer before determination, be sure and cover to prevent evaporation. (NOTE - Be sure to keep distilled water bottle closed as water will become acid over a period of time if left open.)

4. **Determine pH** - Using a calibrated pH meter, immerse the electrode in the suspension while stirring. Allow measurement to stabilize for approximately 1-3 minutes.

**Interpreting pH Values**

Nutrient availability is largely determined by the pH of a growing medium. This is primarily influenced by the effect of H⁺ ions on the exchange complex as well as the solubility of various nutrient elements.

Some nutrients such as iron and other micronutrients have been found to be more soluble at low pH values. However, many other essential elements are rendered insoluble at a pH below 4.5. To maximize plant growth, it is essential to achieve a pH which will optimize the availability of all essential elements. Table 1 presents a range of pH values for soilless media with an evaluation of their effect on plant growth.

<table>
<thead>
<tr>
<th>pH Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely low</td>
<td>4.5 or less</td>
</tr>
<tr>
<td>Very low</td>
<td>4.6 - 4.7</td>
</tr>
<tr>
<td>Low</td>
<td>4.8 - 4.9</td>
</tr>
<tr>
<td>Slightly low</td>
<td>5.0 - 5.1</td>
</tr>
<tr>
<td>Optimum</td>
<td>5.2 - 5.5</td>
</tr>
<tr>
<td>Slightly high</td>
<td>5.6 - 5.8</td>
</tr>
<tr>
<td>High</td>
<td>5.9 - 6.3</td>
</tr>
<tr>
<td>Very high</td>
<td>6.4 - 6.8</td>
</tr>
<tr>
<td>Extremely high</td>
<td>6.9 and higher</td>
</tr>
</tbody>
</table>

The interpretation of pH values must be based on the technique used in the determination. The type of growing media and crop must also be considered. Growers must be extremely careful in relating pH values from soil labs or other independent testing facilities to their own operation. In general, it is best for growers to do their own evaluation to insure consistency in the interpretation of pH values in relationship to plant growth.

**Modifying pH**

Since greenhouse crops are generally produced in mostly organic, acid media, growers are most frequently concerned with methods of raising pH. Ground limestone (calcium carbonate) is the most commonly used material for this purpose. The activity of calcium carbonate is determined by its purity, as well as partial size. Together these factors may be used to calculate a calcium carbonate equivalent (CCE).

Hydrated lime (calcium hydroxide) is another material which may be used for the rapid reduction of pH. However, this material contributes more ions to the soluble salt content of the media than ground limestone. Generally speaking, the amount of hydrated lime used is reduced by 1/3-1/2 of the quantity of ground limestone used.

The most preferred material for raising pH is dolomitic lime (a calcium/magnesium carbonate). This material reacts much the same as calcium carbonate but also supplies magnesium for plant growth. This is particularly important where magnesium is not included in the liquid or granular fertilization programs.

The amount of these materials to use per cubic yard of growing media is based on the CCE, cation exchange capacity and existing pH of the media. Since most of these values are not available for soilless growing media, it is virtually impossible to precisely calculate how much material to add to achieve a desired pH. Generally speaking, growers use between 2-8 pounds of dolomitic lime/cubic yard of media to adequately buffer pH. However, the only way to be sure is through a trial and error procedure.
In cases where pH needs to be lowered, agricultural sulfur or flowers of sulfur (60 mesh) may be used. The change in pH that sulfur produces is relatively slow because bacteria are required for the conversion to sulfur dioxide then to sulfuric acid.

**Summary**

Determining the pH of soilless growing media is complex, and interpretation can be confusing. Because of variations between the bulk densities of soilless media it is virtually impossible to compare the pH of one medium to another (i.e. peat:perlite versus peat:vermiculite). Since the pH of a growing medium is influenced by the substrate: solution ratio, volume of medium used as well as soluble salts, growers should strive for consistency in their method of determination.

Generally speaking, a pH of approximately 5.0 is considered optimum for plant growth in soilless media. However, this is dependent on the method of determination used as well as the crop being grown.

Since most soilless media are acid in nature, growers are frequently concerned with raising pH. Several materials may be used for this purpose but dolomitic lime is generally recommended because it also supplies magnesium to the growing medium.