PROCEDURE FOR RAPID TESTING USING FOUR BIO-ION POCKET TESTERS

Useful For Testing Mobile Ion Concentrations In Soil, Compost, & Water - by Pike Agri-Lab Supplies, Inc.

The 4 testers are Conductivity (also referred to as ERGS or E.C.), pH, ORP, & pNa. The pocket testers & reference solutions are used to measure the parameters in the table below. Note: The rH value is obtained by a formula using the pH & ORP values.

Parameter	Meter	Units	Range	Reference Solution
Conductivity (EC) or	dist#3 dist#4	microSiemens (µS) microSiemens (µS)	10 - 1990 µS 100 - 19900 µS	1,000 µS 10,000 µS
pH	pHwp2 or pHwp3	pH	0 - 14 pH	pH 4.01 & pH 7.01
rH (Redox) Value	ORP & pH (above)	mv & pH (above)	0 - 42 rH	250 mv (ORP)
pNa (Sodium Ion)	pNa	pNa units	0 - 5 pNa units	1.0 pNa units (2300 ppm Na)

Before Testing:

Save the box (or cardboard backing) for each tester. Read & follow the instructions provided there. Calibration / reference solutions are available for each tester. Frequent calibration will increase confidence in the accuracy of the instruments. It is most important that the probes of all the testers be thoroughly rinsed after each use. A final rinse in low conductivity (distilled) water is suggested.

NOTE: Some of the testers are now available as waterproof models, however, you must take care with those which are not. Do not fully immerse them and handle only with clean, dry hands. Please check the information provided with each tester to determine whether or not it is waterproof, and also to familiarize yourself with any special care requirements.

IMPORTANT: The manufacturer has made several changes on the dist#3 & dist#4 conductivity testers. Please check the information for your tester to see what its resolution is. The dist#3 resolution will be either 1 or 10 µS. The dist#4 will be 10 or 100 µS. You must multiply the display reading by the resolution in order to obtain conductivity in µS.

Test Apparatus:

- EC Tester & Reference Solution
- pH Tester & Reference Solutions
- ORP Tester & Reference Solution
- pNa Tester & Reference Solution
- Soil Measure, 1/8 cup (29.5 ml)
- Plastic Cups & Lids
- Polyfoam Block to hold Cups
- Soil Stripper Solution (KCL Concentrate)
- Distilled Water

Soil Or Compost Sample:

Gather a fresh soil or compost sample in a plastic bag, taking care not to touch sample with hands. The moisture level of the soil sample should be adjusted to a level at which you would expect plants to grow. If the sample is saturated with water, leave the bag open and allow the soil to air-dry for a few hours. If the sample is very dry, consider adding a small amount of water to obtain a soil which would promote reasonable growth. If soil is hard and dry, grind it using a clean mortar and pestle. Mix the sample in the bag to obtain a homogeneous mixture.

Preparation Of Soil (Or Compost) Extract:

[Note: This 1:1 (by volume) distilled water / soil (or compost) mixture may be used for all four testers.]

Mix equal volumes of soil (or compost) and distilled water, for our example, we use 60 ml of each:

1. Measure 60 ml of sample by filling the 1/8 cup soil measure twice. (Alternately, you can mark a cup at the 60 ml level and use this to measure your samples.) Place the measured soil or compost sample into a plastic cup.
2. Measure an equal volume (60 ml) of low conductivity water (distilled water) and pour into the plastic cup.
3. Place the lid on the cup and gently shake contents back and forth 5 - 7 times to put into solution those ions that are most readily available to plant rootlets or, in other words, the ions weakly bonded to the soil (compost) particles or clusters.
4. Let mixture settle for a couple of minutes. The goal is to measure certain ionic activity levels of the super-natant (clearer) portion of the mixture.

Measuring And Recording Of Data:

1. For each tester: Make sure your hands are clean & dry before using the tester. Pick up the clean, calibrated tester & switch on.
2. Insert the probe end of the tester approximately 1/2" into the extract that you prepared above.
3. Read each meter display and record the data as follows:
   a) <u>E.C.</u> Electrical Conductivity -- Multiply the display reading by the appropriate resolution for your tester in order to obtain conductivity in µS (if the resolution is 10 µS, multiply by 10, etc.; see notes above). If the digit "1" appears on the <u>left</u> side of the display, then the solution is out of range for that meter & must be diluted (see "Conductivity Dilution Procedure").
   b) <u>pH</u> Read and record the number as it appears in the display.
   c) <u>ORP</u> Read and record the number. Use the chart provided or the following formula to determine the rH value:

   $$\text{rH value} = (2 \times \text{pH}) + [(210 + \text{ORP}) / 30]$$

   d) <u>pNa</u> Read and record the number. Use the chart provided or the following formula to determine ppm sodium:

   $$\text{Na (ppm)} = 23000 \times 10^{-\text{pNa}}$$

4. Measure the BIO-ION microbial activity level:
   a) Add 1.5 ml of Soil Stripper Solution to the sample mixture (or 1/4 ml for every 10 ml of original water volume), replace the cap and mix for 30 seconds. Let settle for 1 minute.

b) Use pH meter and read the new pH value. Record this value as "KCL pH". Note the magnitude of decrease (or increase, under some conditions) in pH from initial reading and record this number as "pH difference".

Conductivity Dilution Procedure:

If the Dist#3 (or Dist#4) conductivity tester display shows a "1" on the left side, use the following procedure for dilution:
Mix 1 part of the original extract to 1 or more parts of distilled water & multiply the reading by the appropriate dilution correction factor. Don't forget to multiply by the appropriate number to correct for the resolution of the tester you are using (if the resolution is 10 µS, multiply by 10, etc.; see note on previous page).

For This Ratio of Extract to Distilled Water	1:1	1:2	1:3	1:4	1:9	1:99
Multiply by This Dilution Correction Factor	2	3	4	5	10	100

Additional Information About The Test Parameters:

<u>Conductivity</u>

Measures energy released per gram of soil (ERGS). You should monitor your conductivity for these reasons:

1. Plant growth depends on the amount of mobile ions available to the plant root in a controlled range of 40 - 400µS or microSiemens (micro mhos/cm). Generally, optimum plant growth is attained when soil conductivity is 150 - 190µS.
2. Low conductivity readings, measured as 50 µS or less, indicate that soil nutrients have become insoluble or complexed. This means they are not readily available to the plant and results in poor growth potential.
3. Baseline conductivity levels should be established in the early spring prior to activation of bio-life by rising temperatures. Salt residues and latent plant nutrients in the soil should establish a baseline between 25 and 600 µS.
4. High conductivity in soils is an indication of possible nematode susceptibility.

<u>pH</u>

Measures hydrogen ion activity. The acid / alkalinity test reading determines balance of soil microbes and can be used to make decisions on balancing soil additives. A few reasons for monitoring pH are:

1. Plant nutrient availability is pH dependent. (6.5 is generally ideal.)
2. Certain nitrogen fixing microbes won't live if pH is < 5.8
3. Pesticide usage may be reduced if water mixture pH is < 6.8
4. Early growth plants will respond to alkaline sprays, i.e. pH 7. to 7.4. Later in the season, fruit, root, or seed producing foliars require acid pH (6.4).
5. Rain water in equilibrium with carbon dioxide will have a pH of 5.6. Acid rain has been recorded as low as pH of 3.0
6. Soil acidity is caused by free, active, hydrogen ions. In very acid soils, aluminum displaces reserve hydrogen on the soil particles, thus contributing to greater acidity. The Al+++ impact on acidity disappears when pH > 5.5.
7. Drying a soil at a temperature above field conditions will increase soil acidity. During later part of season, organic acids produced by microbes will be at a higher concentration.

In order to raise soil pH: Use the following alkaline substances <u>diluted in water</u>: KOH, $Ca(OH)_2$, Baking soda, NH_4OH, $CaCO_3$.
In order to lower soil pH: Use the following acidifying substances <u>diluted in water</u>: vinegar (acetic acid), citric acid, ascorbic acid, phosphoric acid, sulfuric acid.

<u>rH</u>

ORP (Oxidation Reduction Potential) and pH readings give you an rH value. Life obtains its energy from the oxidation of reduced materials. In soil, electrons are continually being transferred by the biological oxidation of organic matter. Respiring life captures energy from the transfer of electrons in a series of reactions involved in the movement of electrons to oxygen. Electron flow is reduced as organic matter is converted to humus and increases as fresh organic matter is added. Note: See graph included with ORP tester for conversion of ORP & pH to rH value. You should monitor ORP / rH for these reasons:

1. The ORP reading corrected for pH and temperature provides an rH value between 0 and 42, which gives insight into the suitability of soil or compost for biological life. An rH value of 25 - 28 is desirable.
2. Low rH numbers can be improved through tillage & aeration, while a high rH can be lowered by adding moisture.
3. ORP is also used to determine compost stability.

<u>pNa</u>

Measures sodium ion activity. This test may require 1:1 (by volume) mixture of 1M ammonium acetate extract to filtrate to get total sodium. Note: See graph for converting pNa display reading into ppm sodium ions. A few reasons to monitor pNa are:

1. When soil conductivity readings are high, pNa test is useful in determining what portion is attributable to sodium.
2. Long term irrigation of farm land builds up an abundance of sodium which reduces crop yields.
3. With high sodium levels in soil, care must be taken to avoid over compaction.

For further information, please contact:

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