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TESTING CONTAINER MEDIA

During this week's lab session your group will develop a container media for growing maize plants. For the rest of the semester you will grow these plants under different watering and fertilizer conditions to test the performance of your media. Today we will use meters to test two chemical properties of your container media: pH and EC.

pH

- a measure of how acidic or basic a solution is due to the presence of H^+ ions
- this is an inherent property of the container media substrates; and is also influenced by water and fertilizer that is added during the experiment
- as we will see below, the pH affects the solubility of fertilizer elements, which influences their ability to be absorbed by roots

Electrical Conductivity (EC) units: dS/m (deciSiemens per meter)

- a measure of the amount of soluble salts in a solution
- soluble salts may come from the substrate itself, fertilizer elements, and as salts that are impurities in water or fertilizers
- the EC meter measures the passage of electrical current through a solution - the more salts that are present in water, the easier it will be for an electric current to pass through the solution

It is often desirable for greenhouse/nursery growers to measure the EC of their container media to estimate if enough fertilizer salts are being provided; similarly they will measure the pH to determine if the nutrients present in the media are in a form easily available to be absorbed by roots

The PourThru Method for Testing Container Media

The pH and EC meters that we use typically measure only a water solution; and therefore cannot be directly inserted into the container media. So to measure these properties we have to find a way to extract a water solution from our container media. The simplest approach is called the “PourThru Method”. In this procedure we will apply a small amount of clear water to the top of a container. This applied water will push out some of the solution in the container media out the bottom of the pot (i.e. leachate). We then collect the leachate to directly measure pH and EC. An advantage of this method is that you are simply collecting a leachate from each container and you do not need to pull out media from a container and disturb plants while they are growing.

Steps for the PourThru method

1. water containers to saturation (so that a few drops of water come out of the bottom of the container) with the normal irrigation water they have been receiving
2. after container has drained for <u>one hour</u>, place a saucer under the container
3. pour enough distilled (DI) water on the surface of the container to get 50 mL (1.5 fluid ounces) of leachate to come out of the bottom of the container (Table 1)
4. collect leachate for pH and EC testing
5. calibrate pH and EC meters
6. measure pH and EC of samples

Table 1. Amount of distilled water to apply to the container surface to obtain 50 mL of solution extract for the PourThru method

Container Size	**Water to Add**	
	mL	**Fluid ounces**
4-6 inch	75	2.5
6.5 inch azalea	100	3.5
1 quart	75	2.5
4 quart	150	5.0
12 quart	350	12.0
Flats (per pack)	50	2.0

Your group will construct your own container media – then measure its pH and EC.

	pH	EC
Sample 1		
Sample 2		
Sample 3		
Average		

At the end of the semester you will again measure pH and EC of your different treatments, and this information will help you analyze the plant growth response in relationship to your container mix, fertilizer, and water regime.

INTERPRETING TEST DATA

EC (Electrical Conductivity)

The values that you measure for EC will depend on the method you use for testing the container media. EC guidelines for several horticulture crops are presented in the table on page 8.

Problems with Low EC

A low EC means that your plants are not getting enough fertilizer salts. Symptoms can include stunted plant growth or leaf discoloration due to lack of nutrients. Nitrogen deficiency (yellowing of lower leaves) often appears first.

Problems with High EC

Excess salts can accumulate when: you are applying more fertilizer than the plant requires; the container media has a high initial salt level; leaching during irrigation is insufficient; or your water source contains naturally high levels of salts (bicarbonates, calcium, chloride, magnesium, sodium, or sulfates). Excess salts can cause tissue death. Symptoms often appear first on the lower leaves and appear as yellowing (chlorosis) or browning (necrosis) that begins at the edges of the leaves and spreads inward. High salts can cause root tips to die back; and plants may show wilting even though the medium is still moist. High salt levels have been shown to increase the incidence of *Pythium* root rot.

pH

pH affects the ability of nutrients to dissolve in water (solubility). Solubility is important because roots can only take up nutrients that are dissolved in solution and cannot take up the solid form of the nutrient. The graphs on page 5 show nutrient solubility in container media (left) and of soil (right) in relationship to pH.

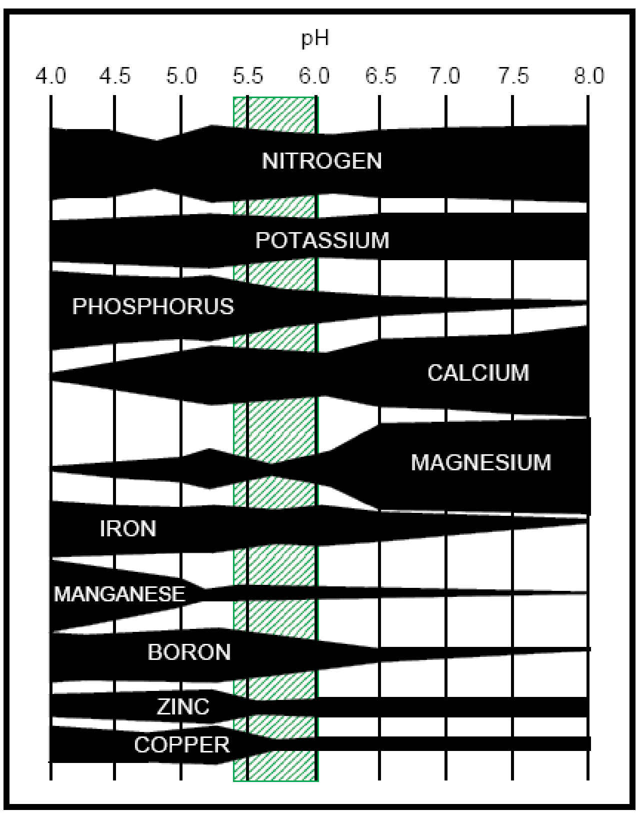
Problems with Low pH

In container media, the micronutrients iron, manganese, zinc, and boron are highly soluble at low pH (pH 5.0-6.0). Therefore, at low pH these nutrients are available and readily taken up by roots. If pH is too low, typically below 5.0 for most plants, the nutrients become so soluble that they may be taken up at harmful or toxic concentrations. A classic symptom of this is iron toxicity which appears as leaf bronzing and chlorosis which appear first on lower leaves. Certain plants that are especially efficient at taking up iron, such as seed and zonal geraniums and marigolds, can exhibit iron toxicity when pH is below 6.0.

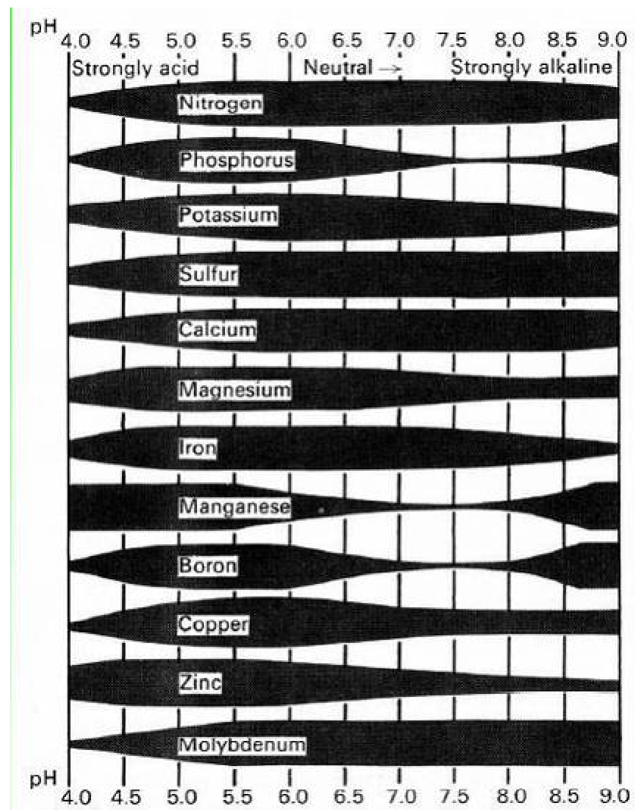
Problems with High pH

At high media pH the low solubility of phosphorus, iron, manganese, zinc, and boron makes these nutrients less available to be taken up by roots and so deficiency symptoms can occur. Certain plants are less efficient at absorbing micronutrients (especially iron and manganese). These plants require a slightly lower pH to be able to absorb enough of these nutrients. A classic example of this is iron deficiency is petunia. Affected plants show yellowing between the veins on the upper leaves. Often there is enough iron provided in the fertilizer/container media, but the pH is too high for roots to absorb it.

Nutrient Solubility in Container Media



Nutrient Solubility in Soil



pH Guidelines

Based on the problems described above, excessively high and excessively low pH should be avoided. For many plants growing in container media a pH of 5.5-6.5 typically allows the various mineral nutrients to be absorbed at adequate levels; and not at levels too high that toxicity can result. As stated above, certain plants are more efficient at absorbing iron and other micronutrients. For this reason we can further break down the recommended pH based on the specific plant that is being studied (see page 9).

EC AND pH OF VARIOUS SUBSTRATES

The organic and inorganic substrates you are using have measurable pH and EC values inherent to the substrate (Table 2). After you have developed your own container media by combining various substrates we will test it to determine baseline pH/EC. This will change during the course of the experiment due to several factors: minerals dissolved in the tap water which can accumulate in the media; leaching - excess water applied that can wash soluble salts out of the media; fertilizer additions; and plant absorption of water and nutrients.

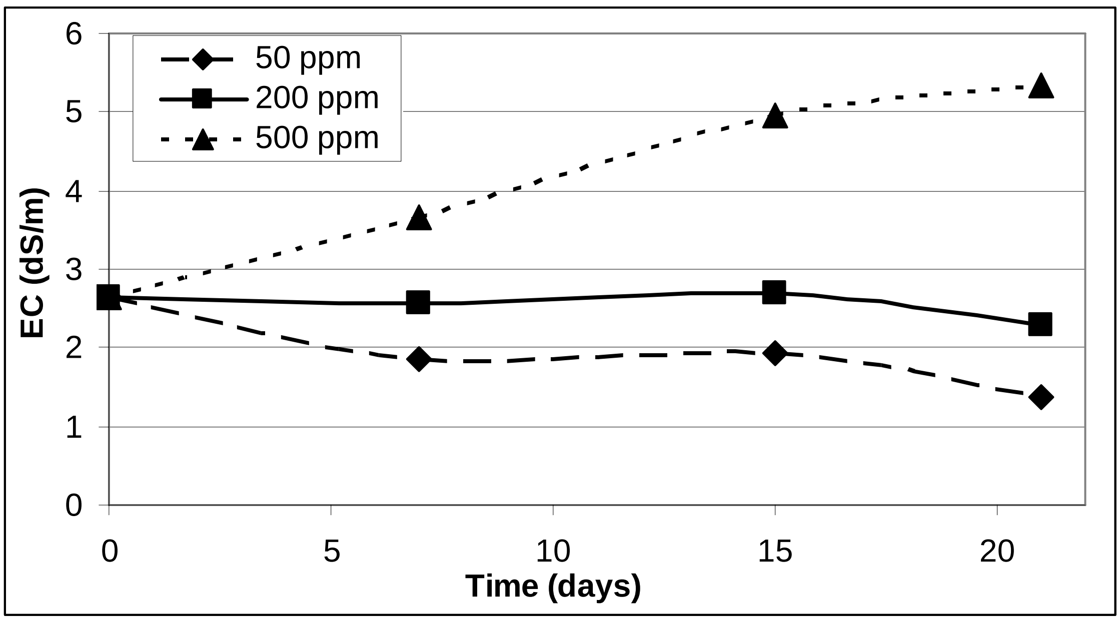
Table 2. Typical pH and EC values of several organic and inorganic substrates

	pH	**EC (dS/m)**
Compost (Dairy)	6.8	18.5
Peat	3.5 - 4.2	1.1
Sand	7.5*	0.2
Soil (Mardin)	7.3	1.3
Vermicompost	6.2	1.3
Vermiculite	7-9*	0.1

*denotes a substrate that is relatively chemically inert so the resulting pH effect in a container media is negligible

LONG-TERM MONITORING

Sampling container media for pH and EC is most effective when samples are taken periodically during crop production as opposed to measuring at only 1 time point. This allows you to look for trends. If pH or EC begin to creep outside of the preferred range, then action can be taken to bring these under control. In the example below, bedding plants were grown with a complete fertilizer mix (21-5-20 N:K_2O:P_2O_5) at 3 different levels of nitrogen.



The general EC guideline for bedding plants is 1.0-2.6 dS/m.

Salts levels are accumulating too high in the 500 ppm treatment. And salt levels are declining and may eventually be below range for the 50 ppm treatment. (Data from: Neil Mattson)

EC Guidelines for PourThru and Saturated Media Extract (SME) Methods

Table 2. The relative nutrient requirements of actively growing greenhouse crops, with EC ranges for both the SME and PourThru methods. Use this classification system and the examples provided in Figure 3 for the PourThru method to determine the suggested target EC ranges for the entire crop production cycle.

No Additional Fertilizer Required
Amaryllis
Crocus
Narcissus

Light (SME EC of 0.76 to 2.0 mS/cm) (PourThru EC of 1.0 to 2.6 mS/cm)	
Aconitum	Coleus
African Violet	Cosmos
Ageratum	Cuttings (during rooting)
Anemone	Cyclamen
Anigozanthos	Freesia
Asclepias	Geranium (seed)
Aster	Gerbera
Astilbe	Gloxinia
Azalea	Impatiens
Balsam	Marigold
Begonia (fibrous)	New Guinea Impatiens
Begonia (Hiemalis)	Orchids
Begonia (Rex)	Pansy
Begonia (Tuberous)	Plugs
Caladium	Primula
Calceolaria	Salvia
Calla Lily	Streptocarpus
Celosia	Snapdragon
Cineraria	Zinnia

Medium (SME EC of 1.5 to 3.0 mS/cm) (PourThru EC of 2.0 to 3.5 mS/cm)	
Alstroemeria	Kalanchoe
Alyssum	Larkspur
Bougainvillea	Lily, Asiatic & Oriental
Calendula	Lily, Easter
Campanula	Lobelia
Cactus, Christmas	Morning Glory
Carnation	Onion
Cauliflower	Ornamental Kale
Centaurea	Ornamental Pepper
Cleome	Oxalis
Clerodendrum	Pepper
Crossandra	Petunia
Dahlia	Phlox
Dianthus	*Platycodon*
Dusty Miller	Portulaca
Exacum	Ranunculus
Geranium (cutting)	Rose
Hibiscus	Sunflower (potted)
Hydrangea	Tomato
Jerusalem Cherry	Verbena

Heavy (SME EC of 2.0 to 3.5 mS/cm) (Pourthru EC of 2.6 to 4.6 mS/cm)
Chrysanthemum
Poinsettia

Adapted from:

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Hofstra, G. and R. Wukasch. 1987. Are you pickling your pansies? Greenhouse Grower. Sept: 14-17.
Nelson, P.V. 1996. Macronutrient fertilizer programs, p. 141-170. In: D.W. Reed. Water, media, and nutrition for greenhouse crops. Ball Publ., Batavia, IL.
Wilkeraon, D.C. Soilless growing media and pH. Texas Greenhouse Management Handbook. p.30-34, 45-47.

Source for chart on this page and the next page: Monitoring and Managing pH and EC Using the Pour Thru Extraction Method. North Carolina State University. Online: http://www.pourthruinfo.com/

Suggested pH ranges for Specific Greenhouse Crops in Container Medium

Figure 2. Suggested substrate pH ranges for specific greenhouse crops grown in soilless substrate.