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EXTENSION

Greenhouse Growth Media Sampling, Testing and Interpretations

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Greenhouse growth media, also called soilless growth media, is commonly used in greenhouse, raised bed and container crop production. Media is primarily made up of peat moss, perlite, vermiculite, bark, sand and possibly other ingredients, with properties distinctly different from regular field soil. Therefore, testing soilless growth media requires sampling procedures, test methods and interpretations different from those used for routine field soil testing. A routine soilless growth media test is indispensable to nutrient management for optimal plant performance, problem prevention, or diagnosis.

The OSU Soil, Water and Forage Analytical Laboratory (SWFAL) offers a greenhouse growth media test using the Saturated Media Extract (SME) method. The same method is used by most university and commercial labs to test soilless growth media or growth media with very little soil in it. In this method, the samples submitted by growers are saturated with a solution containing a small amount of chemical, allowed to equilibrate for a few hours, then the extracts are drained for analyses. Typically, pH, soluble salts and major macro- and micro-nutrients are analyzed. The suggested interpretations in this fact sheet are valid for results from SWFAL, but should not be utilized directly for interpreting test results from other soil testing laboratories using different test methods. Following the sampling procedures and interpretation guidelines listed below is essential to make the test useful and reliable for you to make decisions about proper nutrient management.

Sampling Methods

The procedures to take samples for soilless growth media tests affect the accuracy and representativeness of the results. Incorrect sampling can lead to misleading results, interpretations and recommendations. The goal is to collect samples representative of the overall chemical properties of the growth media for the group of plants of interest. Following the steps below can help achieve this goal:

1. Determine the right time for sampling and keep it consistent. Avoid taking samples immediately after irrigation, heavy rainfall or fertilizer application. Instead, wait for a few hours after irrigation or heavy rainfall, and wait for at least a week after fertilizer application before sampling if possible.
2. Sample separately for each different crop. If a problem is to be diagnosed, sample separately from containers with normal and abnormal plants for comparison.
3. Select the right tool for sample collection, such as a clean trowel for containers and a clean soil sampling probe.
4. Collect at least 10 cores of media from spots equally distributed across the growing bed, the bulk of media or from 10 containers. The cores can be taken from the top to the bottom of the media or from the root zone. Avoid sampling only from the upper layer, where the level of nutrients and soluble salts is higher than that in the root zone.
5. Combine the 10 cores in a clean container and mix them well into one sample. Place 3 cups to 1 quart of the combined media into a sample bag and drop it at your local county OSU Extension office to be sent to SWFAL.
6. If slow-release fertilizers are present, remove them from the sample if possible to avoid overestimation of fertility.
7. Check the root condition and record it when sampling, since such information is useful for interpreting the results.
8. Record sample information including the type of growth media (soilless or not, commercial brand), crop, stage of crop development, fertilizer program (specific fertilizer, application rate and frequency), sampling time (relative to irrigation, rainfall if outdoor systems and fertilizer application), root conditions when sampling and symptoms of any problems observed such as stunted growth, yellowing or discoloration of leaves, burning of leaves, etc.
9. Keep sampling procedures consistent and have samples tested by the same lab so growing conditions can be tracked through time.
10. Sampling should be done at least once halfway through production or as soon as symptoms such as yellowing, stunting, or leaf abnormalities occur. Realize that correcting a deficiency or toxicity can take 2-4 weeks, so for short term crops media should be sampled sooner. For longer term crops, soil samples should be taken multiple times throughout production to account for nutrient availability during that crop stage.

Result Interpretations and Recommendations

Soilless growth media test results include values of pH, electrical conductivity (EC) and individual nutrient levels. The

Table 1. Normal ranges of pH, EC, and common nutrients in soilless growth media tests using saturated media extract for general crops.

Analytes	*Units*	*Desirable Ranges*
pH		5.5 to 6.5
EC	μS/cm	750 to 3,500
Nitrate-N (NO_3-N)	ppm (mg/kg)	40 to 199
Ammonium-N (NH_4-N)	ppm (mg/kg)	0 to 20
Phosphorus (P)	ppm (mg/kg)	3 to 15
Potassium (K)	ppm (mg/kg)	60 to 249
Sulfur (SO_4-S)	ppm (mg/kg)	20 to 200
Calcium (Ca)	ppm (mg/kg)	80 to 200
Magnesium (Mg)	ppm (mg/kg)	30 to 100
Sodium (Na)	ppm (mg/kg)	<160
Boron (B)	ppm (mg/kg)	0.05 to 1.0*
Iron (Fe)	ppm (mg/kg)	5 to 30*
Zinc (Zn)	ppm (mg/kg)	5 to 30*
Copper (Cu)	ppm (mg/kg)	0.5 to 1.5*
Manganese (Mn)	ppm (mg/kg)	5 to 30*

*Adopted from University of Kentucky Media Test Results.

ideal ranges for these values vary depending on the crop, developmental stage or age of the crop, production system and management practices. The ranges in Table 1 are generalized for most vegetables and horticultural plants, but realize these values may change based on different plant types and growth stages.

When reading the report:

1) Start with comparing your values to the normal ranges in Table 1. Values of pH out of the normal range indicate unbalanced nutrient availability and may lead to deficiency or toxicity of certain nutrients. Values of EC and individual nutrients below the normal range indicate potential nutrient deficiencies, and above the normal range indicate potential over-fertilization that could lead to root injuries, poor plant performance, additional costs and environmental pollution.
2) Consider your situations (your sample information), refer to Tables 2 through 9 and decide actions to adjust pH or nutrient management if needed.

In addition, a water sample should be submitted to SWAFL if you don't know the water quality in terms of pH, EC, alkalinity, and nutrient level. See OSU Extension leaflet L-323 *Understanding Your Irrigation Water Test Report*. Water samples should be taken before starting production and throughout production, depending on water source.

Micronutrients

Micronutrients are required in small amounts, but still essential for plant growth and development. Not enough micronutrients can inhibit normal growth and development of plants, while too much can cause toxicity and damage plants. Micronutrient management is closely related to pH management. As pH rises, most micronutrients become less available (except for molybdenum). Therefore, high pH (>6.5) may lead to potential micronutrient deficiencies and low pH (<5.5) may lead to potential micronutrient toxicities. Maintaining the media pH within the desirable range (5.5 to 6.5) is the best solution to avoid micronutrient deficiencies or toxicities. If micronutrients are high, consider leaching all nutrients from the media and starting the nutrient fertility again. High levels of specific micronutrients might be from the water supply and if so, water purification using a reverse osmosis system may be required. Lastly, if you are recycling nutrients, flush the tank and start over with the nutrient program.

Consider choosing a complete fertilizer with both macronutrients and micronutrients. Some plants require greater amounts of specific micronutrients and those nutrients can

Table 2. Interpretations and recommendations of pH in soilless growth media tests using saturated media extract for general crops. The pH values reflect the acidity or alkalinity of the media, which affects plants directly as well as the availability of nutrients to plants.

pH	*Interpretations*	*Recommendations*
< 5.5	This is considered low for most plants. Low pH may lead to the deficiency of calcium, magnesium, molybdenum (especially in poinsettia) and toxicity of iron and manganese.	Raise pH by using a suspension of hydrated lime such as calcium hydroxide or pelletized lime. Retest pH after treatments. Generally, 1 pound per cubic yard of hydrated lime will increase the pH test level by about 0.5. Different types of lime products (read the label) and media properties will affect rates. A basic, nitrate-based fertilizer such as a 15-0-15 may also raise pH slightly. Monitor plants closely for possible nutrient deficiency or toxicity.
5.5-6.5	Desirable range for most crops to grow satisfactorily.	Retest pH regularly to make sure pH remains in this range. The pH is affected over time by irrigation water, fertilizer, leaching fraction or amount of water running through the pot compared to total amount of water applied.
>6.5	This is considered high for most plants. High pH may lead to the deficiency of certain micronutrients such as iron.	Lower pH by using an acidic, high-ammonium fertilizer such as 9-45-15 or 21-7-7. If pH is very high, acidify irrigation water using acids such as sulfuric acid and phosphoric acid to drop the pH of irrigation water to 4.5. Take precautions when using acids. Retest pH after treatments. Monitor plants closely.

Table 3. Interpretations and recommendations of EC in soilless growth media tests using saturated media extract for general crops. EC reflects the total soluble salts and thus general fertility.

EC (μS/cm)	*Interpretations*	*Recommendations*
<750	EC lower than 750 indicates very low nutrient status and probably causes nutrient deficiency.	Add fertilizers and retest EC. Generally, one pound of soluble fertilizer mixed into a cubic yard of media will increase the EC reading by 1,000 μS/cm.
750 to 2,000	Suitable for seedlings and salt-sensitive plants (e.g. salvia, sage, zinnia and geophytes). Slightly lower than desirable for established plants.	Monitor plants closely for possible nutrient deficiency symptoms. Raise EC to 2,000 to 3,000 for established plants by adding fertilizers. Retest EC regularly to make sure an acceptable range is being maintained.
2,000 to 3,500	Desirable levels for most established plants for optimal growth and development. Too high for seedlings and salt-sensitive plants.	For seedlings and salt-sensitive plants, lower EC to 1,000 to 2,000 by watering with no fertilizer and leaching or cut back on fertilization.
3,500 to 5,000	Slightly higher than desirable for established plants. Acceptable for high nutrient requiring plants (e.g. poinsettia, chrysanthemum and petunias).	Monitor plants closely. Retest EC regularly to make sure an acceptable range is being maintained. Lower EC by watering with no fertilizer and leaching if plants show stress symptoms.
>5000	Too high for most plants. Excessive soluble salts may result from too much fertilizer, inadequate watering and leaching, poor drainage or root damage from pest issues. Excessive soluble salts may cause root injury, leaf chlorosis, marginal burn, reduced growth and wilting.	Lower EC by watering with no fertilizer and leaching. Improve drainage. Inspect root systems for possible damage. Retest EC and monitor plants closely.

Table 4. Interpretations and recommendations of nitrate-N in soilless growth media tests using saturated media extract for general crops.

Nitrate-N	*Interpretations*	*Recommendations*
< 40 ppm	Low nitrate-N will cause a deficiency in nitrogen, pale green to yellow in lower leaves first and stunted growth.	Adding N fertilizer and retest. 0.7 oz per cubic yard of urea, 0.9 oz per cubic yard of ammonium nitrate or 2 oz per cubic yard of calcium nitrate will increase the test level by about 10 ppm nitrate-N.
40 to 199 ppm	Desirable range for most crops. Young seedlings require lower nitrate-N levels and large, established plants require higher levels.	Test regularly since nitrogen leaches readily to make sure an acceptable range is being maintained.
>199 ppm	High nitrate-N levels may lead to delay in reproductive development, pest issues and environmental pollution.	Stop adding N fertilizers, water to leach excessive nitrogen and retest.

Table 5. Interpretations and recommendations of ammonium-N in soilless growth media tests using saturated media extract for general crops.

Ammonium-N	*Interpretations*	*Recommendations*
0 to 20 ppm	Acceptable amount of ammonium is beneficial.	Monitor regularly to make sure an acceptable range is being maintained.
>20 ppm	High ammonium levels exceeding 50% of the total nitrogen may cause toxicity and damage to most crops.	Stop using ammonium-based fertilizers. Water to leach excessive ammonium and retest.

Table 6. Interpretations and recommendations of phosphorus in soilless growth media tests using saturated media extract for general crops.

Phosphorus (P)	*Interpretations*	*Recommendations*
<3 ppm	Low phosphorus will lead to deficiency, slow growth in roots and tops and sometimes show symptoms of purple foliage.	Add phosphorus and retest. 1 pound per cubic yard of triple superphosphate (46% P_2O_5) will increase the test level by about 5 ppm phosphorus.
3 to 15 ppm	Acceptable range for most crops.	Retest regularly to make sure an acceptable range is being maintained.
>15 ppm	High phosphorus combined with high pH may lead to micronutrient deficiency.	Switch to a low or no phosphorus fertilizer. Retest regularly.

Table 7. Interpretations and recommendations of potassium in soilless growth media tests using saturated media extract for general crops.

Potassium (K)	*Interpretations*	*Recommendations*
<60 ppm	Low potassium will lead to deficiency, marginal yellow or chlorosis in the older leaves first.	Add potassium and retest. 2.75 oz per cubic yard of potassium chloride (60% K_2O) or 3.75 oz per cubic yard of potassium nitrate (44% K_2O) will increase the test level by about 25 ppm potassium.
60 to 249 ppm	Acceptable range for most crops.	Retest regularly to make sure an acceptable range is being maintained.
>249 ppm	High potassium can cause a deficiency of other nutrients and contribute to salinity.	Switch to a low or no potassium fertilizer. Retest regularly.

Table 8. Interpretations and recommendations of calcium in soilless growth media tests using saturated media extract for general crops.

Calcium (Ca)	*Interpretations*	*Recommendations*
<80 ppm	Low calcium is often associated with low pH, and will lead to deficiency and abnormal growth of the growing point (e.g. tipburn in lettuce, blossom-end-rot in tomato and pepper).	Add calcium and retest. 7.0 oz per cubic yard of calcium nitrate (19% Ca) will increase the test level by about 25 ppm calcium.
80 to 200 ppm	Desirable range for most crops.	Retest regularly to make sure an acceptable range is being maintained.

Table 9. Interpretations and recommendations of magnesium in soilless growth media tests using saturated media extract for general crops.

Magnesium (Mg)	*Interpretations*	*Recommendations*
<30 ppm	Low magnesium is often associated with low pH and will lead to deficiency and abnormal growth.	Add magnesium and retest. 13.3 oz per cubic yard of epsom salts (magnesium sulfate with 10% Mg) will increase the test level by about 25 ppm magnesium.
30 to 100 ppm	Desirable range for most crops.	Retest regularly to make sure an acceptable range is being maintained.

Table 10. Recommendations of supplemental sulfur and micronutrients for soilless growth media showing deficiencies in tests using saturated media extract for general crops.

Deficient Nutrient	*Fertilizer Source*	*Rate of Application*
Sulfur (S)	Magnesium sulfate (Epsom salt)	2.400 g/L
Iron (Fe)	Iron chelate or ferrous sulfate	0.300 g/L
Manganese (Mn)	Manganese sulfate	0.150 g/L
Zinc (Zn)	Zinc sulfate	0.150 g/L
Copper (Cu)	Copper sulfate	0.150 g/L
Boron (B)	Borax	0.038 g/L

be supplemented into the fertility program in addition to the base nutrients (Table 10). Specifically, cauliflower, broccoli, turnips and beets prefer greater amounts of boron; turnips, tomatoes, squash and radishes require greater amounts of iron; corn and tomatoes require greater amounts of zinc; peas and beans require greater amounts of sulfur; potatoes require greater amounts of manganese and copper. If using a fertilizer product without micronutrients or multiple micronutrients are needed, consider using Soluble Trace Element Mix (S.T.E.M.).