

WATER, MEDIA, AND NUTRITION

by:

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Growing plants in controlled environments, such as greenhouses, is a challenging task. It requires not only adequate planning, but also sound choices of appropriate materials needed for the process. Among the materials, you will need to think about the pot sizes and growing media. You will need to have knowledge of the kind of water you are dealing with, and many other factors which may affect your project.

At this station, we are only dealing with **water quality, growing media, and plant nutrition.**

Your water source and quality are very important. You may need to amend it to achieve your goals.

There are several kinds of containerized **growing media** to choose from. Though many claims suggest that these growing media are good for growing anything under the sun, you should pay attention to their functionality, and to their physical and chemical characteristics.

If you are not satisfied, you may think of combining different kinds of soils or soilless media to achieve your objectives. Many combinations have been proposed.

You should also be aware that most of these commercial growing media have no intrinsic fertility. You will be obliged to choose fertilizer(s) to provide appropriate nutrition to your plants.

1. WATER SOURCE AND WATER QUALITY

Factors Affecting Water Quality in Greenhouses [see Table 1, Figures 41 & 42]

1. The pH

Most plants grow best when the media solution pH is 5.6 to 6.2. The main effect of water pH on plant growth is through control of nutrient availability.

A low pH may be responsible for excess iron and manganese availability leading to toxicity, or calcium and magnesium deficiencies. A high pH may cause iron, manganese, and other minor nutrients to become unavailable to plants, leading to deficiencies.

2. Alkalinity – (Carbonates and Bicarbonates) and Hardness

Alkalinity is the concentration of soluble compounds in the water that have the ability to neutralize acids. High alkalinity has a high buffering capacity – it neutralizes added acids. It has much greater effect on plant growth than pH of the water.

Water hardness is an indication of the amount of calcium and magnesium in the water [mg CaCO₃/l, or parts per million CaCO₃]. Water with hardness in the range of 100 to 150 mg CaCO₃/l is considered desirable for plant growth. Plants tolerate high levels of these elements, so toxicity is not normally a problem.

3. Soluble Salts

Soluble salts in water are measured by electrical conductivity (EC_w) expressed as millimhos per centimeter. Electrical conductivity is also referred to as specific conductance or salinity.

Excess soluble salts impair the proper function of roots, which can lead to reduced water uptake and nutrient deficiencies.

Madison City Water has a high concentration of calcium, which results in hard (alkaline) water.

Table 1: Desirable levels of nutrients and other components of irrigation water

Water Quality Measurements	Desirable Range
pH	5.8 to 6.0 (alkalinity matters MUCH more)
Alkalinity	0.75 - 2.6 meq/l CaCO ₃
Soluble salts (EC)	<1.5 mmhos/cm
Hardness	100 to 150 mg CaCO ₃ /l
Calcium (Ca)	40 to 100 ppm
Magnesium (Mg)	30 to 50 ppm
Sodium (Na)	< 50 ppm
Sulfate (SO ₄)	< 50 ppm
Fluoride (F ⁻)	< 0.75 ppm
Boron (B)	< 0.5 ppm

Note: These are ideal levels; acceptable levels may be broader.

2. GROWING MEDIA

For Containerized Production in Greenhouses [Tables 2a, 2b, 2c & 3]

Four functions for growing media:

1. Allow gas exchange (oxygen, carbon dioxide)
2. Hold water that is available to the plants
3. Create a reservoir of mineral nutrients
4. Provide plant support

(Order does not indicate level of importance)

Growing media desirable characteristics:

1. Stability
2. Carbon to nitrogen ratio
 - a. 30:1 or less
 - b. Rate of decomposition
3. Bulk density (the ratio of the mass of dry solids to the volume they occupy)
4. Moisture retention
5. Aeration (10 – 20% air space at field capacity)
6. pH (a measure of the concentration of hydrogen ions (H⁺) found in the media solution)
 - a. Soil based = 6.0 to 6.5
 - b. Soilless based = 5.0 to 6.0

7. Cation exchange capacity – CEC (a measure of nutrient holding ability)

Components of Media

1. Field Soil – High CEC, heavy, high moisture retention, poor air exchange in containers, good source of micronutrients, watch for herbicides.
 2. Peat Moss- High CEC, light, decomposes slowly [no nitrogen tie-up], tremendous water retention, acidic, needs help with air exchange.
 3. Bark – medium CEC, needs to be composted at least 30 days, may need supplemental nitrogen during decomposition, piles of compost must be turned regularly, pine bark is acidic, hardwood bark is alkaline, fair water retention, good air exchange.
 4. Sawdust – Must be decomposed with 24lbs of N/ton of sawdust for 30 days or more, decomposes rapidly, fair CEC after decomposing.
 5. Vermiculite – Rock that has been heat treated, high CEC, good water retention, source of Ca, K, Mg, fair to good aeration.
 6. Calcined Clay – Clay that is compressed and then heated, high bulk density, good aeration and medium-high CEC.
 7. Sand – Use only a coarse grade, high bulk density, good drainage, poor water retention, poor CEC, use only washed sand.
 8. Perlite – Volcanic rock that has been heat treated, used to increase aeration and drainage, light, no CEC, no pH buffering, a good substitute for sand for light weight use.
 9. Rock Wool – High water availability, low CEC, good aeration, light.
 10. Styrofoam – sold as “peanuts”, provides drainage but is otherwise inert, may have environmental concerns.
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Table 2c. Professional products commonly used at Walnut Street Greenhouse and their components:

Commercial Name	Components
Metro-Mix 366P	Specially processed coconut coir pith
	Medium vermiculite
	Composted pine bark
	Perlite
Fafard GM #2	Peat moss,
	Perlite
	Vermiculite
Sunshine Mix #1 / LC1	Canadian Sphagnum peat moss,
	Coarse Perlite,
	Starter nutrient charge (with Gypsum),
	Dolomitic limestone.

Table 3. Percentages of container volume occupied by water and air (at field capacity) for four media in pots, flats, and plugs

	<u>Containers</u>			
	6 in standard	4 in standard	48 cell flat	512 plug tray
	<u>1 Peat Moss: 1 Vermiculite</u>			
Water (%)	67.9	75.2	79.5	84.8
Air (%)	19.0	11.7	7.4	2.1
	<u>1 Peat Moss: 1 Rockwool</u>			
Water (%)	68.4	76.0	80.5	86.9
Air (%)	23.4	15.7	11.2	4.9
	<u>3 Pine bark: 1 Sand: 1 Peat Moss</u>			
Water (%)	51.5	57.6	80.5	86.9
Air (%)	18.9	12.9	9.1	3.6
	<u>1 Natural Soil: 1 Peat Moss: 1 Sand</u>			
Water (%)	47.2	51.2	52.9	54.3
Air (%)	7.4	3.4	1.7	0.3

- Plants roots need airspaces in the media; ~20% air is ideal.
 - In a smaller container, the % air diminishes.

3. PLANT NUTRITION OR FERTILIZATION

Twelve elements need to be supplied:

N-P-K, Ca-Mg-S, Fe-Mn-Zn-Cu-B-Mo

These nutrients must be supplied in adequate amounts, in a form the plant can utilize, and in balance with the other nutrients. The proper pH is critical for your nutrition program to be effective.

- Soil based media should have a pH between 6.2 and 6.8
- Soilless media should have a pH between 5.0 and 6.0.
- Irrigation water can change media pH rapidly.

Fertilizer programs:

1. Pre-plant incorporated
 - a. All 12 nutrients are in the media before planting or transplanting and are expected to last the life of the crop.
 - b. Some of the 12 nutrients are in the media prior to transplanting. More common.
2. Provide fertilization at every watering (fertigation)
 - a. Can be all 12 nutrients, or only a few
 - b. If fertilization is supplied at every watering generally Nitrogen and Potassium are supplied at the rate of 100 PPM to 200 PPM.
 - c. Fertilization on a weekly basis would use 400 PPM N and/or K or more. It is important to look at the crop and adjust your liquid fertilization program accordingly.
3. Slow release fertilizers
 - a. Plastic-encapsulated fertilizers
 Most common- Many types and forms;
 Can be used with liquid or soil incorporated fertilizers
 Good “crop insurance”

Chelated micronutrients – protected from precipitation

b. Slowly soluble fertilizers

Urea formaldehyde (36% N) can last over one year

Mag Amp (7-40-6) plus 12% Magnesium

Limestone (dolomitic is best)

Gypsum

Sulfur coated fertilizers (“Prills” coated with sulfur, wax sealants and diatomaceous earth) can last up to three or four months – microorganism dependent.

Nutritional Monitoring:

1. Visual monitoring – chlorosis, mobility, etc,
2. Soil testing
3. Leaf (foliar) analysis
4. Soluble salts testing
5. pH – can change rapidly ; causes more problems in containerized production than lack of nutrients or an imbalance of nutrients
 - a. sulfur, aluminum sulfate, iron sulfate or acidifying fertilizers are used to push the pH down (use about 0.5 pounds of sulfur per cubic yard to lower the pH about 0.5 units.
 - b. Dolomitic limestone (fine mesh) or certain fertilizers are used to push the pH up.
 - c. Consider an acid injector in areas with high Ca & Mg in the water supply.
 - d. Consider adding dolomitic lime in the areas of neutral or soft water (3 pounds per cubic yard will raise the pH about 0.5 units).

Nutritional Interactions:

1. N in excess competes with or displaces K (and vice versa).
2. Na in excess competes with or displaces K, Ca, Mg.
3. Ca in excess competes with or displaces Mg (and vice versa)
4. Ca in excess competes with or displaces B.
5. Fe in excess competes with or displaces Mn (and vice versa).

Other Nutritional Problems:

Certain clays can tie up potassium.

Bark and peat based media are often associated with micronutrient deficiencies (especially iron).

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