Lecture # 9
Characteristics of Growth Substrates for Interior Plants
SOIL

Unconsolidated cover of the earth, made up of mineral and organic components, water, and air, and capable of supporting plant growth.
FUNCTIONS

1. Serves to anchor the roots.
2. Supplies water to plants.
3. Yields minerals needed by plants.
4. Provides aeration to plant roots.
The Major Properties of Soils

Soil Texture - Based on the proportions of the different particle size in the soil.

Soil Structure - Based on the size of aggregates formed by small soil particles.
## The Major Properties of Soils

<table>
<thead>
<tr>
<th>Soil Air</th>
<th>- Air contained within macropores.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Solution</td>
<td>- Mixture of water and nutrients extractable from the soil.</td>
</tr>
</tbody>
</table>
The Major Components of Soils

- **Pore space**: 20 - 30%
- **Air**: 20 - 30%
- **Water**: 20 - 30%
- **Soil solids**: 45 - 50%
- **Mineral**: 45 - 50%
- **Organic**: 0 - 5%
Cation Exchange

Cation Exchange Capacity

Soil particle
**Cation exchange:**
the process by which mineral nutrients, absorbed on the surface of the soil particle can be replaced by other cations.

**Cation Exchange Capacity:**
the degree to which a soil can adsorb and exchange cations.
Water - A Unique Molecule

Polarity leads to the two important properties:

Adhesion - attraction of water molecules to other surfaces;

Cohesion - attraction of water molecules to each other.
The Relationship of Soil Texture to Size of Pores, Total Pore Space, and Rate of Percolation

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Sandy</th>
<th>Fine Textured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of pores</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Total Pore Space</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Rate of Percolation</td>
<td>Fast</td>
<td>Slow</td>
</tr>
</tbody>
</table>
Soil moisture

High

Tension with which water is held by soil particles

Low

High

Low
A soil at saturation, field capacity, and wilting coefficient.
Planter Depth and Water Content

Water Content

Soil Height, inches

% Pore Saturation

Drainage Level

A - very coarse - textured sand
C - silty clay
B - mixture of A and C

A

B

C

0 10

Water Content

0 50 100

% Pore Saturation

Drainage Level

Soil Height, inches
Planter Depth and Water Content

- Deep Container
- Medium Container
- Shallow Container

Solids
Dry
Air
Wet
Water
Moist
Planter GS "Dilemma"

- SMALL VOLUME
  - Inadequate water storage
- SHALLOW DEPTH
  - Excess water content (poor aeration)
Ground Bed Growth Substrate (GS)

- Large, "infinite" volume (adequate water storage)
- Deep (good aeration)
Planter GS

Small, infinite volume
( inadequate water storage )

Shallow
( poor aeration )
BONZAI - type

Soil line

restricted air

shallow container
Desirable Qualities of a Growth Sustrate

1. Hold water.
2. Retain nutrients in an available form.
3. Porous to allow adequate soil aeration.
4. Promote beneficial microorganisms.
5. Be free of pathogens and pests.
6. Provide mechanical support for the plant.
7. Availability and reproducibility.
Commonly Used Commercial Amendments

PEAT MOSS:
+ lightweight, high moisture and nutrient holding capacity.
- may contain weed seeds and excessive salts.

PERLITE:
+ lightweight, porous, contains no nutrients, neutral in pH, sterile, ↓ BD.
- low CEC, contains fluorides.
Commonly Used

Commercial Amendments

VERMICULITE:
+ lightweight, holds water, neutral in pH, stores nutrients, well aerated, high CEC,
↑ BD.
- decomposes.

SAND:
+ ↑ BD.
- ↑ BD, low CEC.
Commonly Used Commercial Amendments

MANURES:
+ the organic matter; much better suited for outdoor use.

LEAFMOLD:
+ good if source is uniform in quality.
- tends to vary.
Commonly Used

Commercial Amendments

BARK:
+ ♦ aeration, good water and nutrients holding capacity.
- decomposes.

OSMUNDA FIBER:
+ widely recommended for orchid soil mixes.
- decomposes.
FIR BARK:
+ widely recommended for orchid soil mixes.
- decomposes.

WOOD SHAVINGS:
+ aeration, lightweight.
- break down fast and soil level shrinks.
Commonly Used

Commercial Amendments

RICE HULLS:

- + aeration.
- - decomposes.

SPHAGNUM MOSS:

- + lightweight, very low / pathogens,
  acidic, well aerated, holds 20x water.
- - may contain human pathogen.
Commonly Used

Commercial Amendments

SAWDUST:
+ lightweight, readily available.
- requires additional nitrogen for decomposition.

CALCINED CLAY:
+ \( \uparrow \) BD, aeration, water - holding capacity.
- may contain excessive salts.
MULCH  Modification of the media surface; forms insulating layer between the surface and the air.

FUNCTIONS  Prevents rapid evaporation decoration.
MULCH MATERIALS

Organic: sphagnum, bark, sawdust, wood shavings, peanut shells, ground corn cobs, straw.

Inorganic: decorative rocks, gravel.
PASTEURIZATION OF THE MEDIUM

* Eliminates harmful organisms such as weed seeds, nematodes, insect pests, disease-causing organisms; does not kill all beneficial soil organisms.

1. Heat.
2. Chemical fumigants.
New Soil from NASA: The Artificial Soil

* Provides nutrients to plants during several growing seasons without need to add fertilizer or a nutrient solution.
Major Components of the Artificial Soil

The synthetic APATITE fertilizer is incorporated into the artificial soil in the proportion of 5 or 2 parts by weight.
Major Components of the Artificial Soil

Synthetic APATITE Fertilizer - free of fluorine, cadmium, lead and other toxic elements that occur in natural apatite.
CLINOPTILOLITE - natural mineral that has high CEC.

Major Components of the Artificial Soil

Column with clinoptilolite

KCl and NH₄Cl

Exchange sites saturated with NH₄⁺ ions

Exchange sites saturated with K⁺ ions
**Major Components of the Artificial Soil**

This mixture is incorporated into the artificial soil in the proportion of 5 to 10 parts by weight.
Water

Air: CO₂, N₂, O₂

Soil Solution

Artificial Soil

clinoptilolite

NH₄, K

Soil Solution

Artificial Soil

synthetic apatite

Ca, Mg, Cl, B, Mn, S, Zn, Mo, PO₄

Soil NO$_3$ and microorganism changes when organic matter is added to the soil.
BASIC MIXES FOR INDOOR PLANTS

BASIC MIX A
- 1 part garden loam
- 1 part perlite
- 1 part peat

BASIC MIX B
- 1 part garden loam
- 1 part sand
- 1 part peat
SOIL MIX FOR FLOWERING HOUSE PLANTS

(Soil Mix 1)

1 part garden loam or potting soil
1 part sand or perlite or vermiculite
1 part peat moss
SOIL MIX FOR BROMELIADS

( Soil Mix 2 )

2 parts peat moss or or
1 pt perlite 1 pt peat 1 pt peat
1 pt fir bark 1 pt p.bark 1 pt p.bark
1 pt cypress shavings
SOIL MIXES FOR ORCHIDS
(Soil Mix 3)

3 parts osmunda tree fern fiber
1 part redwood bark or tree fern slabs or
5 parts fir bark
1 part perlite
SOIL MIX FOR SUCCULENTS AND CACTI (Soil Mix 4)

2 parts garden loam or potting soil
2 part sand
2 parts peat
1 part perlite
SOIL MIX FOR FERNS
( Soil Mix 5 )

1 parts garden loam or potting soil
2 part peat moss
2 parts pine bark
1 part coarse sand
SOIL MIX FOR AFRICAN VIOLETS

(Soil Mix 6)

2 parts peat moss
1 part vermiculite
1 part perlite
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Suggested Range</th>
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<tbody>
<tr>
<td>BD, wet wt</td>
<td>25 - 65 lb/ft or 0.4 - 1.0 c/cc</td>
</tr>
<tr>
<td>Water holding capacity</td>
<td>20 - 60% volume or 50 - 300% wt</td>
</tr>
<tr>
<td>Pore space after drainage</td>
<td>5 - 30% volume</td>
</tr>
<tr>
<td>CEC</td>
<td>10 - 40 meq/100 g or 4 - 10 meq/100 cc</td>
</tr>
</tbody>
</table>