Greenhouse Substrates
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What is a substrate and what does it do for me?

A combination of organic and inorganic materials used to provide the basic requirements for plant growth:
• Hold water
• Hold nutrients
• Permit gas exchange to and from roots
• Support plant
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The idea substrate would:

• Drain well
• Hold water
• Hold nutrients/Reduce nutrient leaching
• Low Carbon to Nitrogen ratio
• Have ideal pH that can be adjusted
• Produce vigorous plants
• Suppress disease
• Not accumulate salts
• Be inexpensive
• Be readily (and preferably locally) available
• Be ultra lightweight for shipping and moving ease of nursery crops (low bulk density?)
• Facilitate plant establishment in the landscape
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What is In a Soil-less Substrate?

**Organic Components:**
- Sphagnum Peat moss
- Pine and hardwood bark
- Composted materials
- Sawdust
- Coir

**Inorganic Components:**
- Mineral soil
- Sand
- Perlite
- Vermiculite
- Polystyrene beads
- Rockwool
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What is Peat Moss?

Different types vary in the degree of their decomposition. U.S. sources are: Canada, some from Florida and Michigan. Slightly decomposed sphagnum moss mined from bogs. Consist of several different species. Must contain over 75% sphagnum moss fiber. Minimum of 90% organic matter. Must have a fiber content greater than 66%. Acidic with a pH of 4.0.
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**Hypnum Peat Moss**
Composted leaves and stems from various species of Hypnum mosses
Fiber content over 50% and an organic matter content of at least 90%.

**Reed-Sedge Peat**
Minimum of 33% fiber with at least 50% coming from reed-sedge and non-moss fibers.
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**Peat Humus**
Fully decomposed. None of the original plant is identifiable
Becomes compacted easily and does not have the water holding capacity of peat moss.

Disadvantages of peat based products:
Non-renewable
Rapidly increasing cost as fuel prices go up
May be source of chronic disease sporotrichosis (Sporothrix schenckii)
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Pine Bark
- Increases air porosity
- Acidic
- Low cellulose and high lignin content
- Resists decomposition
- Use composted bark with pieces less than ¼”

Composted Hardwood Bark
- High pH
- Should be fully composted to prevent nitrogen deficiency
- Use no more than 20% to 50% by volume.
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**Sewage sludge**
High cation holding capacity
pH can be high
Possibility of heavy metals
Use no more than 10% by volume as they are heavy and can negatively impact air holding capacity

**Mushroom Compost**
Use up to 25% - 50% by volume
High salt levels
High pH
Test for soluble salts and do not use if the level is above 2mhos
It will continue to decompose in the container and increase in density
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Sawdust
should be completely composted
high carbon to nitrogen ratio, additional nitrogen may be needed.

Coir
Fibrous outside of shell
May contain high salt content!
Can drawdown nitrogen
Holds water well, re-wets well from dry
Good air holding capacity
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**Par-boiled Rice hulls**
- Used to add porosity
- Industry by-product
- Use at a rate of 20 – 30%
- Neutral pH
- Low CEC

**Wood Fiber Substrate (WholeTree)**
- Finely ground
- Composted & dried
- Low CEC
- No buffering capacity
- pH changes can occur rapidly
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Inorganic Components

Vermiculite
Non-renewable
Mined product of aluminum/magnesium/silicate
South Africa, USA and China
Processed at temperatures close to 1000°C
Expands 15 to 20 times
Larger the particle size the greater water holding and air holding influence
Most use #2 horticultural grade
High pH
Possible asbestos contamination
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Perlite
Non-renewable
Chemically inert
Greece, United States, Turkey, China (?)
Ground
High heat = sterile
Resists compaction, enhances drainage
Increases air-filled porosity
Health risk due to inhalation
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Sand & grit
good drainage
Low water holding capacity
Decreases aeration and drainage depending on particle size and shape
Heavy

Calcined clay
Certain clays, fuel ash, or shale that have been fired at high temperatures
Low bulk density
Internal porosity of 40 – 50%
Reduces phosphorus leaching
High cation exchange capacity
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**Rockwool**
Synthetic wool-like material made from basalt rock, steel mill slag, or other minerals
Liquefied at 1500°C and then spun into fibers
High total porosity, air space, and water holding capacity
Does not biodegrade

**Styrofoam or polystyrene beads**
 Totally inert
Improves drainage and aeration
Float to the top of a mix
Do not biodegrade
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Hydrogel Amendments (hydrophilic polymer)
Can be affected by water quality
Of benefit in **extreme** drought conditions
Broken down by fertilizer salts
Over-wet a moisture retentive mix
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Texture and Structure

Texture
Size of the substrate particles and their relative quantity in a mix
Bark would be the largest, peat the smallest, perlite or vermiculite intermediate in size

Structure
How those particles are bound together in aggregates (soils) or how they are compacted by handling in the case of soilless mixes
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Pore Space
Spaces between the individual particles
Some particles have internal porosity
Total pore volume or **total air filled porosity**

Importance of Pore Shape and Size
In a “just drained” substrate:
Water is held in the smallest pores
As a coating on particle surfaces
Larger pores are filled with air
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If most pores in a substrate are small
Too much water is held and very little air

If most pores are large
Very little water is held

A substrate with a wide range of pore sizes will hold water and air in nearly equal amounts.
Putting it all together

Four factors effect air/water ratio:
• The substrate
• The container
• Substrate handling procedure
• Watering practices

Most greenhouse mixes, 80 – 90% total porosity
Yes, you want to buy SPACE!
Avoid compaction:
- lightly fill and brush away excess
- Do not stack pots and trays
- Moisten substrate the night before handling
  - Plug mix – 2:1 water to substrate ratio
  - Cell packs & larger containers – 1:1 ratio

Air space can be diminished by half or eliminated by compaction