Bonsai Soil Basics

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1) Primarily, bonsai soil **must** provide <u>adequate airflow and water retention</u> throughout the entire pot volume so as to promote a highly ramified system of fine roots.

   a) There is a way to quantify "adequate airflow and water retention" and for **YOU** to (easily!) measure it for your own soil. See next page & my ABS Journal article: **http://fingerlakesbonsai.weebly.com/uploads/3/9/6/3/39634557/abs_vol_48_no_4_brian_heltsley.pdf**

2) Compaction of spongy soil (including those dominated by organic elements) is inevitable in small pots and can fatally restrict airflow. Bonsai are not houseplants!

3) Bonsai soil **must** be composed of materials that are simultaneously

   a) Rigid (to avoid compaction, which preserves airflow)

   b) Porous (to retain some water and air)

   c) Granular, with granule sizes about the same as each other, but larger than 1 mm (which is **the only way** to obtain adequate airflow). 2-6 mm is a good range. This is achieved by manual screening-out of small and large sizes. No fines allowed!

   d) Stable (will not break down over years of watering, freezing/thaw cycles)

   e) Dense enough to provide ballast so prevent pot blowover in extreme weather

4) Despite what you may read and hear, a good high-performance bonsai soil mix is not dependent on a specific ingredient; rather it can be achieved in many ways

   a) The better versions of hard akadama, lava, and pumice all offer near-ideal combinations of water retention and porosity. They are also $$$$$$.

   b) The water retention and porosity of akadama, lava, and pumice vary greatly from one source to the next. These are naturally-occurring variations.

   c) Growstone GS-2 has nearly the same water retention and porosity as lava at half the price. However, it is whitish-gray in color and not very dense.

   d) Turface, pine bark, and biochar all retain too much water to be used alone as bonsai soil; however, each at up to 20% by volume can be combined with other ingredients to provide a mix with good properties.

   e) Pea gravel and granite grit retain too little water to be used alone as bonsai soil but can be combined with other ingredients, at up to 10-20% by volume.

   f) Biochar is a horticultural charcoal (with very high carbon content) that retains water and nutrients very strongly but is chemically stable, unlike conventional organics. It also provides a favorable habitat for beneficial micro-organisms. It should not be screened. It should be limited to 10-20% by volume. Its benefits for bonsai are not proven, but are highly plausible, given its properties.

Quantifying Airflow and Water Retention

We should be able to say "this soil has better water retention or airflow than that one" in an objective manner. The two measurable quantities are called *Field Capacity* (FC, for short) and *Saturation Porosity* (SP).

FC is the fraction of soil volume that is water just after saturation and drainage.

SP is the fraction of soil volume that is air just after saturation and drainage.

These can be easily measured by anyone with a bonsai pot, duct tape, and a digital kitchen scale. See the article link on the previous page.
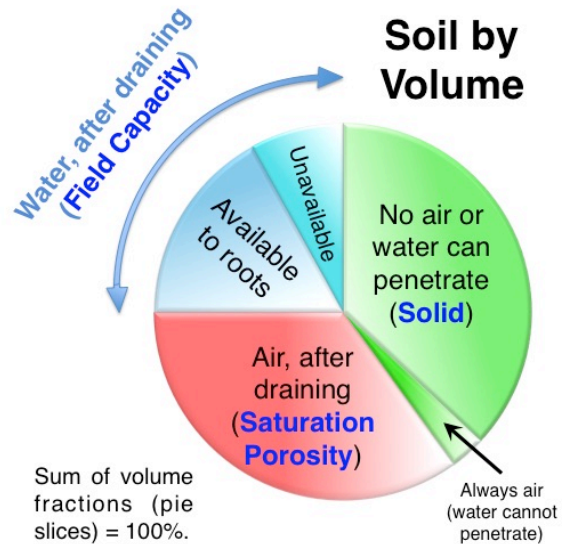
Any soil ingredient, or soil mix, can be described by two numbers, FC and SP, just like food is labeled by nutritional content. One can make what I call *hydroporosity plots* below which demonstrate where a given mix or ingredient is with respect to FC and SP. There is an ideal sweet spot indicated in the green ovals in the region around FC=25% and SP=35%. Venturing away from the ideal region can make a soil too wet, too dry, or too airless. Some ingredients and mixes are shown.
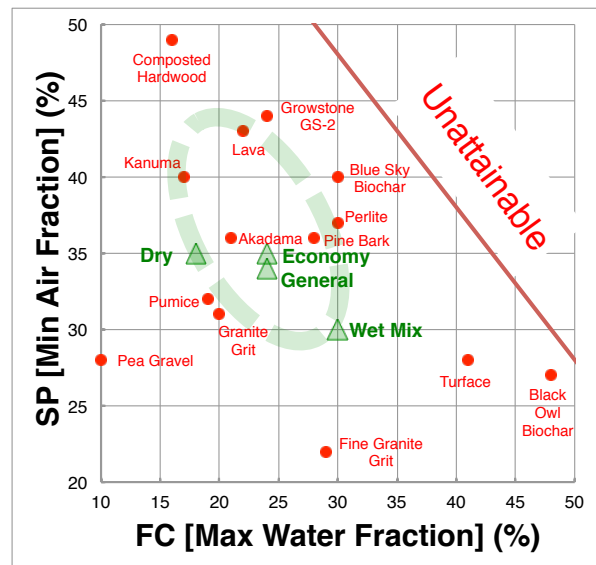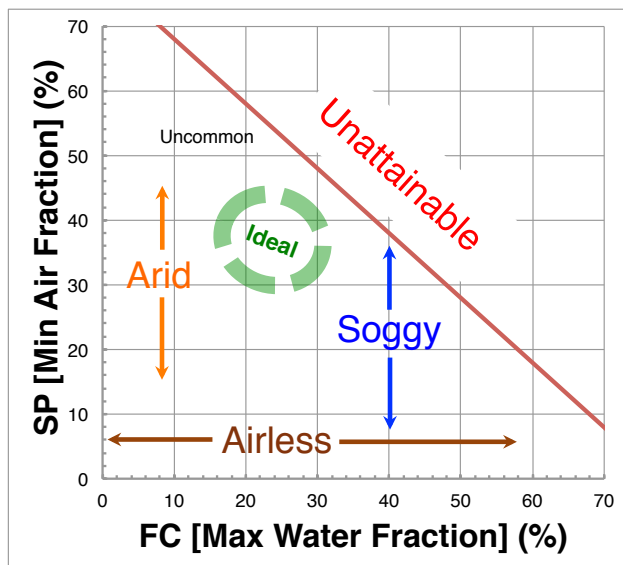
The ***Economy Mix*** (~$6/gallon material cost) is (in parts by volume): Growstone GS-2 (4), Turface (2), Pea Gravel (1), Pine Bark (1), Composted Hardwood (1), & Biochar (1).

The ***General Mix*** (~$12/gallon material cost) is: Akadama (3), Growstone GS-2 (3), Lava (2), Pea Gravel (1), Biochar (1).