'If the roots ain't happy, the rest of the tree ain't happy'

[The dynamics of potted tree culture]

by: Les Lonsdale

Question: Forest trees are in fine organic soil, yet do not experience 'root-rot'. Also, no one fertilizes them, yet they grow strong. Why is it so different with our potted trees???

Answer: Trees in nature have completely different soil dynamics than potted trees:

- Free-draining soil (water table almost always below root system)
- Lots of organic matter with high CEC value* that provides nutrients continuously.

For example: trees need Nitrogen to grow. How do they receive it? Mainly through nitrogen-fixation from soil bacteria, converting ammonia and N2 into NO2 and NO3.

But here's an interesting fact for free:

The air is 78% nitrogen, but trees cannot absorb it through the air. However, nearly 10% of the usable nitrogen (nitrites/nitrates) in the soil comes from.....lightening! Lightening converts N2 into NO2 in the air, which is collected in rain and snow and transported into the ground in a usable form!

Bonsai heresy: Putting a large drainage layer in bottom of pot helps drainage. Myth! It makes the problem worse!

Research has shown that due to forces such as cohesion, adhesion, and capillary action, water can form a perched water-layer at the bottom of the soil mass. If the size difference between the soil and the drainage layer is too large, the forces mentioned above cause the water to resist entering the larger layer below. You, in essence, have raised the perched water-layer to the bottom of the smaller soil mix.

A solution would be to keep the soil mix particle size the same, or only gradually increase the size of the drainage layer to keep the water moving downward.

Nutrient supply dilemma:

Our potted trees do not have access to nutrients unless we supply them. We usually limit organic compounds (bark, peat moss, etc), especially in conifers as well as other trees that are not repotted that often, so that they do not break down over the years and harm the roots. However, organic compounds are the main source of nutrients! Here in lies the dilemma!

Our goal is to provide the tree roots with a porous, free-draining mix, but also one that will hold onto nutrients so that the roots will have time to access them. Therefore, we must choose soil components that will not break down quickly, but also some that will hold onto nutrients from fertilizers that we apply.

CEC values:

This is why it is important to understand CEC values. (CEC= cation exchange capacity) It describes how well negatively-charged soil components cling to the positively-charged fertilizer compounds. Soil components with a low CEC (granite grit, lava rock, perlite, etc) allow cationic minerals to rinse through the pot and out onto the ground so the roots will not benefit much. Components with a high CEC (pine bark, turface, charcoal, etc) bind to the chemicals longer, allowing the roots to absorb the nutrients for an extended period of time. This is an important consideration when using liquid fertilizers. *(Using fertilizer cakes or time-release beads alleviates this problem somewhat, as the nutrients are released slowly and continually into the soil.)* [See chart below]

Moisture retention considerations:

Horticulture is a major part of growing bonsai, knowing the requirements of the trees that you are growing. Some trees like a moister root environment while others don't like wet feet at all. Then, it is advisable to understand which soil components hold more moisture and which ones don't. The soil mix should be tailored to the type of tree that will be living in it.

For instance, soil components that have higher water retention include: akadama, turface, pine bark, sphagnum moss, kanuma. Trees that enjoy drier feet would appreciate components such as: granite grit, lava rock, pumice, charcoal. [See chart below]

However, there are other considerations:

- Climate plays an important role in your decisions of soil mixes
- Watering habits/methods should be considered also
- Price and availability of components
- Type of tree: conifer, deciduous, tropical
- Type of container: slab, deep pot, plastic, ceramic

So, choosing the best soil mix becomes a matter of experience as well as trial and error.

- Trees that prefer wetter conditions: azalea, bald cypress, crape myrtle, dawn redwood, elm, ficus, holly, maple, oak, privet, wisteria
- Trees that prefer dryer conditions: boxwood, juniper, pine, rosemary, serrissa

Randy Clark (Bonsai learning center, Charlotte, NC) likened bonsai soil mix recipes to spaghetti sauce, everyone's got their own favorite. This is justifiable because of all the considerations listed above.

Just remember, *'if the roots ain't happy, the rest of the tree ain't happy'*

soil component	CEC	% H_2O retention	pH
Pumice	15-20	16.5	8.6
Turface	25-35	43	4.4
granite grit	0	0	6
lava rock	15-40	22	9.2
akadama	18-31	36	6.0-6.9
pine bark	125	191	4.3
act. Charcoal	40-100	4.5-10	9
sphagnum moss	>125	>300	4.8
kanuma	62	40	4.0-6.0

pH: This aspect is overlooked often, because trees are resilient and will grow even in adverse conditions; however they will not look or grow to their best potential if grown in soil with a pH inconsistent with the nature of the tree.

Many nutrients and minerals are not very soluble or available to the roots at an elevated pH (alkaline).

Conversly, beneficial microbes are hindered if the soil is too acidic, resulting in nitrogen being bound in the organic matter and not available to the tree.

The majority of trees prefer neutral to slightly acid soil, but many can go either way to some extent. It is best to know your trees and what pH they enjoy and choose your soil mix accordingly.

pH can be adjusted in soil by using different components (see chart), or by additives (sulfur for more acidity, lime* for more basic).

* lime = $CaCO_3$, CaO, $CaOH$ ← quick lime; or water w/ 1 TBS/[illegible]; dolomite = $CaCO_3$ + $MgCO_3$

Application = To raise pH 1 pt = 2 TBS/FT² soil