Why the Earth Is Not Like a Pot

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By Brent Walston

Introduction

In bonsai we work very hard to create and maintain highly aerated soils, yet when we plant in the earth, the soil is incredibly dense. How can this be? The answer to this and other soil mysteries are below.

A Pot Isn't Like the Earth

The major difference between a pot and the earth is that a pot has impermeable sides and bottom. This reduces air exchange in two ways. First is the obvious, air cannot pass through the plastic, thus we have a contained volume of soil encased 75% with air tight plastic (or high fired ceramic (low fire ceramic will breathe). This is why I design my soil mixes and other environmental factors to 'dry out' the pot once a day during the growing season. Each time the plant is thoroughly watered, it pulls a new charge of air in behind it as the water drains.

Secondly, we have to visit our old pot size argument again. When a downward moving table of water reaches an impermeable layer (in this case the plastic pot bottom) it will not drain until the layer just above the impermeable layer (pot bottom) is saturated. Once this lower layer of soil is saturated, excess water will drain out, but a column of saturated soil will remain since the moving table of water has stopped at the impermeable layer. This means that the soil in the bottom of the pot remains saturated at this lowest level after watering, and stays saturated until something happens to change that condition. That 'something' is primarily absorption from the roots in the bottom of the pot; the secondary factor is (or should be) evaporation. You will probably want to read this paragraph again, and perhaps a third time, it is not obvious.

Overpotting

Most of the water in the pot is removed from the pot by absorption by the roots and not by evaporation. If you overpot, it will take a long time for roots to colonize the bottom of the container and consequently it will take much longer for the saturated layer to become fully aerated (the only factor at work is evaporation). Overpotting will generally lead to too wet conditions and eventually root rot. This phenomenon is also true of planting in the earth, but only when stratification of the soil is present to cause an impermeable layer, such as when you are planting on a layer of clay or hardpan, or you create a boundary between two dissimilar soil types. Otherwise, there is no impermeable layer and the water continues its downward movement into the earth, creating no saturated layers. This is why (along with the absence of impermeable walls) that we can, and do use denser soils when planting in the earth: no saturated layers are formed (until the water table is reached).

Creating Aerated Earth Soils

I have seen saturated layers created in the earth kill plants just as heavy soils in pots do. I was once asked to examine a dying Rhododendron, which was planted in a straight fir bark bed. I knew that the area had heavy clay native soils. I dug up the Rhododendron, and sure enough, about a foot down was a layer of solid clay and the fir bark layer just above it was saturated with water.

Other loose experiments I have been conducting involve using highly aerated soils in growing beds. From the above argument you can see that we can use heavier soils in beds, but will using the same highly aerated potting soils that we use for containers improve growth rates? I think the answer is yes, I have had Chinese elms grow about twice as fast in a highly aerated bed than in a creek side silt bed loaded with natural nutrients from yearly flooding, but comprised of mostly fine silt. The problem with the highly aerated beds is that they will require a lot more water and nutrients than a good garden soil, for example. And again, you must be careful not to create a boundary between a dense soil and the amendments at the bottom of the bed or you will create a saturated layer at the bottom. You can usually avoid boundaries by loosening the native soil at the bottom of the bed and mixing a smaller percentage of the amendment in with the native soil. This will give you a transition zone rather than a sharp boundary.

What About that Saturated Column Thing?

Ok, just how high a column of saturated soil do you get in a container? The height of the column of water retained in the soil by an impermeable layer is related to size of the particles. Sound familiar? The denser the soil, the higher the column will be and the more water will be retained. Large particle, highly aerated soils will not support a large saturated volume. This is what we mean by 'well drained'. You can test this for yourself. Take a regular sponge, soak it with water. Rest it in your hand horizontally until the water stops running out. Then tilt the sponge upright. You are now increasing the saturated column. The sponge density won't support a column that high and water will drain out. This experiment also shows that pot shape is related to water retention. A broad shallow pot will retain more water than a tall narrow pot of equal volume. Although it is counterintuitive, a shallow pot will retain more water and 'dry out' more slowly than a tall narrow one (of equal volume). Another reason we use such coarse soils for bonsai, and also why bonsai can survive in such tiny containers on very hot days.

And finally, soil physics may not be obvious, but knowing what goes on under the surface is bound to lead you to more successful bonsai.