

## HEAT....The Unseen Killer of Roots in Containers

By Charlie Mosse, May 2023

We've just had our first heat wave of the year---significant but not too hot, and short lived, thankfully. The protection of plants and their roots from heat was discussed in an earlier edition of the Bonsai Wire .....Now we will discuss why we need to do that.

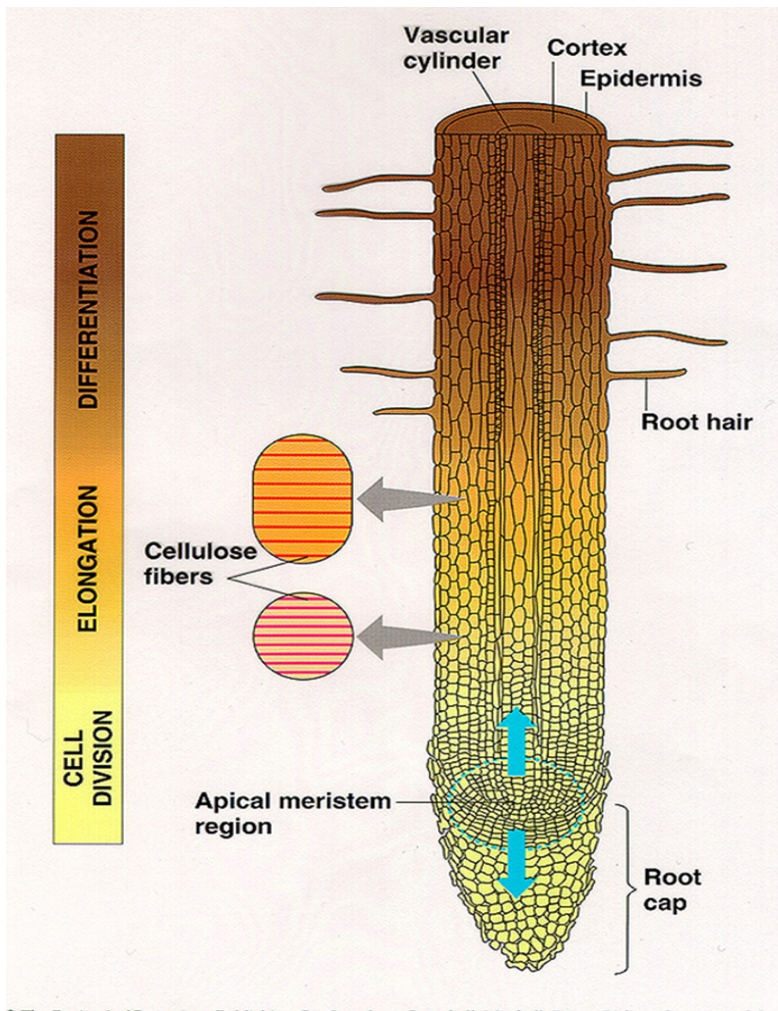
Below is a photo of root hairs. They are very fine, small structures that are very difficult to see with the naked eye. A hand lens or microscope is needed, that is how fine they are. Therefore, they are very easily damaged by heat, freezing of the soil and also during the re-potting process. When the fine hairs are damaged, new ones are very quickly replaced as long as the small rootlets from which the root hairs grow are not damaged. If the rootlets are damaged, then those have to regenerate before new root hairs can be grown. Fragile, yes!



The diagram below shows the basic structure of a rootlet. Starting at the end of the rootlet you'll find the root cap. It burrows through the soil. Just behind the root cap is the area where the rootlet cells divide, which allows the rootlet to grow longer pushing the root cap through the soil. The cells mature and eventually become capable of growing root hairs. Water and nutrients are absorbed by the root hairs. Eventually the root hairs die off a bit further up the rootlet. At this point the root simply becomes the conduit for nutrients, hormones and water to transport up the plant, and allow for some of the food and hormones produced by the plant to travel to the root tips to supply the ever growing root tips.

It is obvious how important the root tips, root hairs and small roots are to the plant and also how fragile they are. A good environment around the roots is everything to plants. A quality environment includes good air/gas circulation, good water percolation, active beneficial soil organisms like fungi, good moisture retention,

good nutrient availability and reasonable soil temperatures. A good environment supports good root growth and function.



Root hairs and, at times, root tips are constantly dying off and being generated. Excess water, too little water, imbalance of beneficial and harmful soil organisms, too much fertilizer, cold and of course heat can kill root hairs/tips. When soil gets too hot or too cold, root hairs are damaged/killed which obviously affects the plant. So, we need to protect the container soil from extremes like heat and cold. In our area we rarely experience freezing temperatures, and if we do, it is for such a short time that the roots are not affected. But as we all know, we get heat for extended periods every year. Note that there are tropical and sub-tropical plants like Ficus, and others, that are affected by cool weather and need winter protection in a greenhouse, indoors, or to be placed on top of a heat pad to keep the roots healthy. We can cover that another day.

Excessive heat is a killer of root tips/hairs, or at least it damages them. We have discussed how to protect the plants or at least the pots from getting too hot by using shade cloth or lattice, placing plants temporarily in the shade of tree/large shrubs, placing them under the benches. Many cover the pots with something like burlap, frost cloth, old t-shirts, old bed sheets, a piece of wood, styrofoam and drainage screen, and a very good

method is to place the container into a larger container by about 2" diameter and fill the gap with pumice. Basically, anything to keep the sun's rays off of the soil and pot during warm periods.

So, what is the big deal? The big deal is the heat extremes that can and certainly do happen. Using a digital temperature thermometer, I took soil temperature readings under many different circumstances to see the temperature differences in the soil in different areas of the soil within a pot. This is a highly recommended exercise to do so that you can determine when you will need to provide protection from heat/sun.

The soil temperature variation can depend on:

1. Coarseness of the soil mix. Is it made of large, medium, small or very small particles.
2. The age of the soil mix. New soil will dry faster and get hotter faster because it is more porous. On the other hand, it will also cool faster as the sun gets lower and the air temperature drops. Whereas older, more compact soil will be slower to heat up, not by much, and be slower to cool down.
3. The type of container is also a significant factor. Black plastic heats up faster and gets hotter than lighter colored plastic. Italian clay does not get as hot as plastic. The brown bonsai pots get very hot, hotter than glazed bonsai pots. Sometimes the temperature differences are not that much and sometimes there is a very significant difference.
4. The sunny side of a pot is much hotter than the opposite side, and the soil close to the side of the pot, where most roots grow, is hotter than the soil at the center of the pot. The sunny side on a hot day can reach 140 degrees and the opposite side can be 20-40 degrees cooler. That can be the difference between life and death for a root.

Wind will help cool a container but at the same time will speed up the drying of the soil. Moist soil will benefit from evaporative cooling. Dry soil will not and will heat up faster. This is another reason to protect the container and the soil from direct sun and wind in the warmer months.

Remember that soil in nature does not get nearly as hot as soil in a container. A most plants are OK in 100 degree air temperature when growing in the ground. The soil is a lot cooler by about 30-40 degrees. At an ambient air temperature of 100 degrees, the soil in a bonsai pot will be 100 degrees, not too harmful, versus 120-150 degrees when the container is in direct sun. The temperature of the soil facing the sun will depend on the type of pot, depth of the pot, moisture content of the soil, soil porosity, color of the pot and if the pot is protected. Just imagine the soil temperature in a sunbaked pot during a heat wave with air temps over 100. Root death, to some degree, is guaranteed.

A plant does begin to stress when the air temperature reaches about 90 degrees. It varies by species, but in general, 90 degrees is a temperature to be wary of, especially if there is wind. The roots cannot absorb water fast enough because the air is too hot, so photosynthesis will most likely slow or stop but transpiration will continue. If the soil gets too hot, the root tips/hairs begin to die. If high soil temperatures remain too high for too long, say most of the day, and continue for several days, the root hairs and small roots will die, especially those against the insides of the pot. Shading the pot solves that problem.

When the soil is too hot, the leaves and stems can burn, drop off, shrivel, basically less functional except to shade the stems and to a degree the soil. The plant then needs to seal off those dead roots, heal and then begin re-growing new root tips and then root hairs. This can take days, weeks and even months depending on the species, seriousness of the damage and the original health of the plant. It is traumatic damage when it happens quickly especially in the spring when the plant is "soft" and growing rapidly. If heat stress increases more slowly, then the plants will have time to properly shutdown, that is to harden off, and go into a more beneficial dormant or rest period rather than being abruptly damaged. **Caution:** If you suspect or through

inspection see damaged roots, be careful not to overwater. Damaged roots do not absorb much, if any, water. A wilted plant with moist soil has enough water. It just needs some relief from the sun and heat. Misting is helpful.

Bottom line....keep sun rays off the container on warm days, say over about 85-90 degrees, to help maintain healthy roots. Roots can tolerate higher temps in direct sun but will be much healthier if given relief from heat. In nature, plant roots do not get the temperature extremes they experience in containers, especially in shallow bonsai containers or training pots.