Initiating Fall Leaf Colors

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Spring flower colors are raised in fall to crown the trees. The pigments are the same but the colored Containers have changed from dainty petals to coarse, broad leaves. Fall tree colors are composed of pigments that can be divided into oil paints, watercolors, and earth tones.

The grand show of fall trees represent a living color pallet. It is living leaves that reveal in their decline and fall last summer's results and next spring's promise shown in various colors. The living process in a tree that generates autumn colors is called senescence. Senescence is the pre-planned and orderly dismantling of light gathering structures and machinery inside the leaf. Part of senescence is the development of a structurally weak zone at the base of the leaf stock or petiole.

Failing Connections

The weak zone at the leaf base is initiated when the normal control message and supply of food materials moving past are reduced. Shorter days, longer cool nights, and changing light quality help throw internal genetic switches which change growth regulators and food allocation patterns. The tree begins to build a physical and chemical seal across several layers of living cells at the leaf base. On the leaf side of the seal, cell walls are weakened and become thinner. Across this basal zone of change, the living connections between food transport cells (phloem) become more tenuous.

The water connection (xylem) cells continue to supply water to replace evaporative losses in the leaf. These water supply cells are part of strong but dead connective strands in the leaf stem. As the leaf blows in the wind and is loaded by rain, the leaf stem starts to tear at its weakest point, the leaf-stem-base. As leaf-stem-base cells weaken, internal pressure causes them to swell more than surrounding cells. This mechanical strain causes one living cell to shear away from its neighbors. This zone of separation, or abscission zone, is a design feature of the leaf.

A point is reached when all the living cell connections are broken at the leaf-stem-base and only the dead water connections hold the leaf onto the tree. Only a little bit of force is needed to snap these connections and the leaf will fall to the ground. A single fall wind storm can sweep the colors from the trees. The wound left on the tree (a leaf scar), sometimes highly characteristic of a given species, is the outward face of a constructed barrier wall established to keep the environment outside.

Endings and Beginnings

Senescence is a planned decommissioning process in tree leaves that was established with leaf formation. Inside the leaf, as photosynthesis began to generate food from carbon-dioxide, water and a few soil elements, a growth regulation timer was started that would end in winter dormancy. The fullness of summer production helps establish dormancy patterns, as dormancy processes establish allocations for the next growing season. In senescence, the tree tops recall valuable resources on-loan to the leaves, and then enter a quiet life stage. The roots continue at a slower pace to colonize and control space and resources, waiting for better conditions.

Frosts and freezing temperatures kill the living cells in tree leaves. Dead cells cannot transport materials back into the tree, producing colored pigments as a by-product. Temperature-killed leaves, which have not started to senesce, are a sign that many tree resources were unable to be recalled and now lie outside the tree in falling leaves. Fall coloration is a result of a life process in a tree. Freezing temperatures stop the senescence process with only decay remaining. Only living cells can unmask, manufacture, and maintain the tree pigments we appreciate.

Tree Life Is Green

To appreciate the new and unmasked colors of fall, you must consider the color of tree life -- green. The green color comes from a large, hard-to-maintain, expensive to build molecule with a magnesium atom in its center called chlorophyll. Chlorophyll is the most precious of molecules. The tree conserves, protects, and maintains chlorophyll. With failing light, food, elements or energy, loss of the chlorophyll pigment is the first visible sign of problems. Yellowing or chlorosis in trees is a symptom of many different pests and environmental impacts because chlorophyll manufacture and maintenance are so sensitive to damage.

Trees do not manufacture chlorophyll until light is present. In healthy but unlighted tissues, a good supply of chlorophyll components (requiring iron (Fe) to make) are kept in storage. Until there is light to capture, chlorophyll is not produced. After tissues are exposed to light, the yellow or pale tissue colors are covered by the green of chlorophyll. Chlorophylls are clearly visible and concentrated in the leaves. Chlorophylls are also found in most near-surface tissues that are exposed to light. The inner bark of twigs, light-exposed roots, and inner portions of buds all possess chlorophyll.

A Last Effort

In fall, with changing environmental resource availabilities (like light quantity and quality), chlorophyll production and maintenance begins to decline. The preliminary steps needed to make chlorophyll are slowed and stopped by low temperatures, regulation signals generated from the tree's light sensors, and a build-up of photosynthesis by-products. At the same time, longer dark periods, cool temperatures and bright sunlight, help break chlorophyll apart. Drought conditions can accentuate chlorophyll loss. The green curtain in the leaf begins to withdraw.

Leaf starch or stored food, is rapidly being broken apart and shipped out of the leaf. What chlorophyll remains continues to generate energy gradients used to power the living cells. The products being shipped from the leaves are having a slower and more difficult time escaping through the developing abscision zone in the leaf-stem-base. More sugars and mobile elements are free in the transport and production cells. These conditions lead to chlorophyll loss when leaf energy levels are still relatively high.

Revealed Colors

As chlorophyll declines from sight, other pigments are unmasked. Some color pigments are newly made using the materials that cannot quickly leave the leaf. One of the tough pigments that share chlorophyll's cellular containers, are the red, orange and yellow carotenoids, and the yellow and tan xanthophylls. These pigments were made to shield and protect chlorophylls, but now can be clearly seen. Rich sugar contents, slight drought stress, and developing element deficiencies in living cells also help initiate anthocyanins, blue to red colored pigments used to protect light sensitive processes in the leaves.

Chlorophyll veils slowly drop away and reveal a great pallet of colors, some brand new to this autumn and some having lain hidden all season. The carotenoids are like bright oil paints. The changeable anthocyanins are like watercolors, blending across a tree covered landscape. Behind all the colors remain the deep browns of tannins (the color of tea) and the basic light browns of tree tissues. The number of different color combinations is almost infinite using these various colors. All the colors in leaves eventually fade to brown, the color of the earth.

Further Information:

Coder, Kim D. 1997. Autumn Forest and Landscape Color. University of Georgia Cooperative Extension Service Forest Resources publication FOR97-31. pp.2.

Coder, Kim D. 1997. Best Fall Colors In Trees. University of Georgia Cooperative Extension Service Forest Resources publication FOR97-29. pp. 1.

Coder, Kim D. 1997. Fall Tree Color Outline. University of Georgia Cooperative Extension Service Forest Resources publication FOR97-27. pp. 1.

Coder, Kim D. 1997. Fall Tree Color Pigments. University of Georgia Cooperative Service Extension Forest Resources publication FOR97-30. Pp. 3.