GEORGIA FORESTRY COMMISSION

Autumn Leaves

Shorter days and cooler nights start a precise clockwork of physical and chemical interactions within leaf cells bringing forests ablaze with color as they prepare for winter dormancy. In response to certain environmental stimuli, leaf pigments begin to reveal themselves in the leaves of Georgia's deciduous trees. The amount of pigments in trees depends on the tree species, soil composition, and other environmental components.

Chlorophyll is the green pigment found in tree leaves during the growing season. Chlorophyll uses energy from sunlight, carbon dioxide (CO2) from air, and water from the tree to make simple carbohydrates (food for the tree). This process is known as photosynthesis.

Carotenoids are the yellow, or xanthophyll, and orange, or carotene, cell pigments of leaves. They are present in leaves during the growing season, but are masked by greater amounts of chlorophyll. As cooler temperatures and shorter periods of daylight occur, the manufacture of chlorophyll is slowed and begins to fade. As the green pigment disappears, the carotenoids reveal the brilliant yellow and orange coloration in hardwood tree species such as hickories, birches, cottonwood, and poplars.

Pigments responsible for red and purple colors of persimmons, dogwoods, maples, sumacs, sweetgums, and ashes come from a group of cell pigments known as **anthocyanins**. These color pigments are created in the fall as carbohydrates are made by residual chlorophyll and become trapped in the leaves during the formation of the abscission layer (explained below). Trapped sugars change chemically into anthocyanins. If the tree's sap is acidic, leaves become red; alkaline causes purple coloration.

Carotenoids and anthocyanins combine to give deeper oranges, reds, and bronzes of many hardwood leaves. The brownish leaf color of oaks and beeches is due to the presence of tannin compounds in combination with carotenoids. Tannin, or tannic acid, is a strong astringent found in tree bark, bud scales, and pine cones. Unlike other pigments, tannin stays in fallen leaves all winter.

Tree leaves fall when they turn colorful because a corky layer of cells, known as the abscission layer, develop between the leaf stalk and the woody part of the tree. Stimuli of cooler temperatures and shorter periods of daylight cause the leaves to form a hormone known as abscisic acid inducing the plant to form the abscission layer, slowing the transport of water and carbohydrates. Wind and other physical disturbances eventually cause leaves to drop. A unique trait of oak and beech trees is that abscission often does not occur until the woody part of the tree is older.

Environmental factors can diminish, or enhance, fall leaf color. Warm weather can encourage late-season production of chlorophyll and vegetative growth and decrease fall colors. If an early frost cause leaves to die before the abscission process begins, leaves can shrivel and drop before fall pigments fully develop. Long periods of cloudy, wet weather can produce a drab, fall coloration due to low light intensity. In contrast, the more sunshine that leaves receive, the more vivid the color. That's why shaded trees will be less colorful than those that get lots of sun during autumn changes. Trees that don't get enough water during the growing season may drop their leaves before the color display. Optimum conditions for fall color displays are cool (but not freezing) temperatures, mild late-season drought, and sunny days.

Fall colors are generally considered to be incidental chemical reactions of no importance in the life of trees. Turns out, however, that xanthophylls (carotenoid pigment) are light energy receptors that send light energy to the chlorophyll pigment; this produces chemical energy for the tree.

Whatever the reasons are for cell pigments, enjoy the artwork of fall - compliments of Georgia's forests!