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SP529 Changing Colors of Leaves

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Agricultural Extension Service
The University of Tennessee

SP 529

Changing Colors of Leaves

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Differing shades of red, yellow, orange and purple. Autumn in full color. What triggers the color change? What color or colors do each species of trees turn? What causes the variations in color?

The factors that influence autumn leaf color are shorter day lengths, weather (primarily cooler temperatures and less moisture) and changing levels of leaf pigments. The only constant factor from year to year is the shortening day length. As days become shorter and nights grow longer, biochemical processes in the leaf initiate changing leaf color. All the other factors vary annually, making the prediction of autumn color unreliable.

Sara Clatterbuck

Sweetgum exhibits a wide range of autumn colors.

What causes the color?

Several pigments in leaves are responsible for color: chlorophyll, carotene, xanthophyll and anthocyanins.

Chlorophyll is the pigment in chloroplasts of plants that reflects green light. Plants use the energy absorbed by chlorophyll in photosynthesis to produce food for plant growth and development. Chlorophyll is continually broken down during photosynthesis and being replenished by the plant.

Sara Clatterbuck

Colorful foliage of red maple.

Sara Clatterbuck

Colorful foliage of sugar maple.

Carotene and xanthophyll are pigments that reflect orange and yellow light respectively. Both are present in the chloroplasts, with chlorophyll enabling the plant to absorb a wider range of wavelengths of light and thus capture more energy. These pigments are in such small quantities that they are masked by the more dominant chlorophyll during the growing season.

With the passing of summer, days become shorter. The phytochrome, the light-sensing mechanisms in leaves, recognizes the shorter day lengths. The shorter days and lower temperatures arrest chlorophyll production. Chlorophyll breaks down faster than it is replaced, allowing the yellow and orange pigments to be unmasked.

The molecules reflecting red wavelengths, anthocyanins, are water-soluble pigments that occur in the cell sap creating the red, pink, and purple hues. Not all trees produce anthocyanins. These pigments are not present during the summer, but their formation is encouraged during a succession of cool nights and sunny days. During these days when photosynthesis and chlorophyll production are decreasing, an abundance of sugars accumulates in the leaf. The cool nights promote a separation layer of cells in the petiole, where the leaf attaches to the twig, that prevents sugar from flowing out of the leaf, and also arrests the flow of nutrients into the leaf. The formation of anthocyanin requires bright light, a diminishing water supply and the accumulation of sugars trapped in the leaf.

How does weather affect color?

The amount, duration and brilliance of autumn color depend on weather conditions that occur before and during the time chlorophyll in the leaves is declining. Temperature, light and water supply are the primary factors that influence the synthesis of carbohydrates (sugars) that favors anthocyanin formation and bright fall color. Cool, but not freezing, temperatures favor anthocyanin production. Early frost is more likely to kill leaves, making them turn brown and fall sooner from the trees. Bright light favors red colors, so red color often develops on exposed leaves. Water supply also affects anthocyanin production, with mild drought favoring bright reds. Rainy days occurring near peak coloration will decrease color intensity. Late summer droughts can delay the onset of fall color by a few weeks. Temperature, sunlight and moisture are highly variable each year, assuring that no two autumns are alike.

Individual trees of the same species growing together often show differences in leaf color because of variations in the amount of sugars in the leaves and genetic predisposition. Some reach their peak color earlier than others. Variations among species in the rate of color change reflect differences in chlorophyll breakdown, production of anthocyanin and exposure of carotene and xanthophyll.

When is the best time for autumn color?

In Tennessee, autumn color begins first at the higher elevations in response to cooler temperatures and shorter days. The color progresses to the lower elevations, extending the duration of fall color. The average peak period of fall color in Tennessee ranges from the last week in October through the first week in November.

Two trees recommended for a wide array of leaf color are sugar maple and sweetgum. Sugar maples turn yellow then orange and sweetgum color can vary among individual trees from yellow to red and purple. A few trees with dazzling yellows are ginkgo, hickories, honeylocust and ash. Vibrant reds include red maple, blackgum and red oaks.

The University of Tennessee Agricultural Extension publication SP514, **Small Trees for Fall Splendor**, lists some of the small trees such as dogwoods, sumacs and sourwood that are recommended for fall color. The enclosed table provides information about the fall coloration of larger trees.

Fall Color of Large Trees

Trees with Little or No Color

Botanical Name	Common Name
Acer saccharinum	Silver Maple
Alnus spp.	Alders
Juglans nigra	Black Walnut
Platanus occidentalis	Sycamore
Populus spp.	Cottonwoods
Quercus spp.	Water, Willow Oaks
Robinia pseudoacacia	Black Locust

Trees with Green to Dull Yellow Color

Botanical Name	Common Name
Aesculus spp.	Buckeyes
Catalpa speciosa	Northern Catalpa
Celtis spp.	Hackberry, Sugarberry
Diospyros virginiana	Persimmon
Gymnocladus dioicus	Kentucky Coffeetree
Salix nigra	Black Willow
Tilia americana	American Linden
Ulmus spp.	Elms

Trees with Bright Yellow to Orange Color

Botanical Name	Common Name
Acer nigrum	Black Maple
Acer saccharum	Sugar Maple
Betula spp.	Birches
Carya spp.	Hickories
Fagus grandifolia	American Beech
Fraxinus spp.	Green, White Ash
Ginkgo biloba	Ginkgo
Gleditsia triacanthos	Honeylocust
Liquidambar styraciflua	Sweetgum
Liriodendron tulipifera	Yellow-Poplar
Magnolia acuminata	Cucumbertree
Quercus spp.	Bur, Chestnut, Chinkapin, Overcup, Post, White Oaks
Sassafras albidum	Sassafras

Trees with Red and Purple Colors

Botanical Name	Common Name
Acer rubrum	Red Maple
Liquidambar styraciflua	Sweetgum
Nyssa sylvatica	Blackgum
Quercus spp.	Black, Northern Red, Pin, Scarlet, Shumard, Southern Red Oaks

Sara Clatterbuck

Sara Clatterbuck

Individual trees of sugar maple exhibiting different fall leaf colors.

Sara Clatterbuck

Yellow pigments blend with the red anthocyanin to produce brilliant oranges in sassafras leaves.

Sara Clatterbuck

The red to russet color of black oak leaves.

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