

Why Do Autumn Leaves Change Color?

Penn's Woods in color



We are lucky to live in one of the few parts of the world where nature has one last fling before settling down into winter's sleep.

In these lucky places, as days shorten and temperatures become crisp, the quiet green palette of summer foliage is transformed into the vivid autumn palette of reds, oranges, russets and golden yellows before leaves fall off the trees.

Where to go

For help planning your “leaf peeping” day out visit the “Fall in PA” page at www.visitpa.com. You will find a fall foliage web cam, route suggestions and dates of local events across Pennsylvania.

Locate the nearest State Forest or State Park destination at www.dcnr.state.pa.us.

How does autumn color happen?

For years, scientists have worked to understand the changes that happen to trees and shrubs in autumn. Although we don't know all the details, we know enough to explain the basics and help you to enjoy nature's multicolored autumn display.

Three factors influence autumn color — leaf pigments, length of night, and weather, but not quite in the way we were told as children. The timing of color change and leaf fall are primarily regulated by the increasing length of night. None of the other environmental influences—temperature, rainfall, food supply, and so on—are as unvarying as the steadily increasing length of night during autumn. As days grow shorter, and nights grow longer and cooler, biochemical processes in the leaf begin to paint the landscape with nature's autumn palette.

Where do autumn colors come from?

A color palette needs pigments. These molecules capture energy from sunlight to power the chemical reactions that convert water and carbon dioxide into sugars—photosynthesis. Trees in temperate zones store these sugars for their winter dormant period. Three major pigment types are involved in the production of autumn color.

Chlorophyll is the most abundant pigment. It absorbs red and blue light and reflects green giving leaves their basic color and masking lighter shades.

Carotenoids, (carotene and xanthophylls) reflect orange, yellow and brown colors in corn, carrots, buttercups and bananas. The clear yellow of tuliptree leaves and the russets shades of oaks are due to carotenoids.

Anthocyanins give red, blue and purple colors to cranberries, apples, grapes, berries, cherries, and plums depending on their acidity. They are water soluble and dissolve in the fluids of leaf cells.

Chlorophyll and carotenoids are present in leaf cells throughout the growing season. Most anthocyanins are produced in the autumn, in response to bright light and excess plant sugars within leaf cells.

During the growing season, chlorophyll is continually used, broken down and replaced and leaves appear green. As night length increases in the autumn, chlorophyll production slows and then stops. Eventually all the chlorophyll is destroyed. Carotenoids and anthocyanins present in the leaf are then unmasked and show their colors.

Tree species have characteristic colors. Oaks turn red, brown, or russet; hickories show golden bronze; aspen and yellow-poplar, golden yellow; dogwood, purplish red; beech, light tan; and sourwood and black tupelo, crimson. Maples differ by species — red maple turns brilliant scarlet, sugar maple glows orange-red and black maple a rich yellow. But the little striped maple becomes almost colorless. Leaves of some species such as the elms simply shrivel, turn brown and fall.

When is the best time to see autumn color?

The timing of the color change varies by species. Blackgum begins to show brilliant scarlet branches in late August and the related dogwood is draped in brick-red by mid-September. Maples become red and orange in late September and early October. But oaks only put on their colors long after maples have shed their leaves.

In most years, northern PA counties reach their best autumn color October 1-10. Central counties are at their peak October 10-20 and south central and southeastern PA have the most color October 20-31.

How does weather affect autumn color?

Because carotenoids are always present in leaves, the yellow and gold colors remain fairly constant from year to year. The brilliance of red colors that develop as chlorophyll in the leaves is dwindling can be affected by temperature and soil moisture in late summer and fall.

A succession of warm, sunny days and cool, crisp but not freezing nights seems to bring about the most spectacular color displays. During the day, sugars are produced in the leaf but cool nights and the gradual closing of veins connecting leaves to twigs prevent these sugars from moving out. Lots of sugar and lots of light spur production of brilliant red, purple and crimson anthocyanin pigments.

Dry soils also affect the chemistry of autumn color. Like the weather, soil moisture varies greatly from year to year and place to place. So fall color will never be the same in any two years or locals. A late spring, or a severe summer drought, can affect the onset of fall color. Warm fall weather may lower the intensity of autumn colors. A warm wet spring, favorable summer weather, and warm sunny fall days with cool nights typically produce the most brilliant autumn colors.

What triggers leaf fall?

In response to the shortening days and weakening sunlight, leaves begin processes leading up to their fall. The veins that carry fluids into and out of the leaf gradually close off as a layer of cells forms at the base of each leaf. These clogged veins trap sugars in the leaf and promote production of anthocyanins. Once this separation layer is complete and the connecting tissues are sealed off, the leaf is ready to drop.

What does all this do for the tree?

Winter is a certainty that all vegetation in the temperate zones must face each year. Perennial plants, including trees, must protect themselves from freezing temperatures and desiccation. Stems, twigs, and buds are equipped to survive extreme cold and will reawaken when spring heralds the start of another growing season. Tender leaf tissues, however, would freeze and burst in winter, so plants must either toughen up and protect their leaves or dispose of them.

Evergreens — pines, spruces and other conifers — survive by toughening up. Their needle-shaped foliage is covered with a heavy wax coating and the fluid inside their cells contains substances that resist freezing. Thus the foliage of evergreens can safely withstand all but the severest winter conditions. Evergreen needles survive for several years but eventually fall due to old age.

Leaves of deciduous plants, on the other hand, are typically broad and thin and not protected by any coating. They are tender and vulnerable to damage. The fluid in their cells is usually a thin, watery sap that freezes readily. This means that the cells could not survive winter where temperatures fall below freezing. Tissues unable to overwinter must be sealed off and shed to ensure the plant's continued survival. Thus, leaf fall precedes each winter in the temperate zones



Blackgum is one of the earliest trees to turn, showing scarlet leaves in early September in northern Pennsylvania.



Central counties of the state reach their colorful peak in mid-October.



Southeastern Pennsylvania is most colorful in late October with oaks among the last to turn.

More Information

Download a copy of the *Common Trees of Pennsylvania* booklet from Bureau of Forestry web site:

www.dcnr.state.pa.us/forestry

Email questions about Pennsylvania trees and forests to

PAForester@pa.gov

or phone (717) 787-2703



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