

News Article

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The Science of Autumn Leaf Color Change

What is the science behind leaf color change in autumn? Folklore tells us the mythical Jack Frost brings reds and purples to autumn trees by pinching leaves with his icy fingers. A common belief is that a hard frost is necessary for good autumn color. An old wives' tale said rain washes color out of leaves. What are the facts?

A timeless Purdue Extension publication, FNR-FAQ-5, "Why Leaves Change Color – The Physiological Basis," authored by William R. Chaney, said the display of color we enjoy each fall is explained by understanding plant pigments, the physiology and anatomy of leaves, and the influence of climate and seasonal weather conditions.

Chaney said hardwood trees generally display the most spectacular autumn color, but larches and baldcypress are two conifers grown in Indiana that drop all their needles each fall, and they offer autumn color in the process.

Other evergreen conifers develop autumn color, but that color is restricted to the older needles. Chaney said, "Two year old or older needles are shed from conifer trees each year after they turn yellow, brown, or rarely reddish." Many homeowners are alarmed in the fall when the inner branches of their conifer trees show yellow needles that later drop. However, this is a normal plant process. Chaney said, "These interior needles appear in sharp contrast to the green needles on the ends of the shoots." So, one could say that evergreens are not truly green forever.

Chaney said four leaf pigments account for leaf color and its changes in the autumn: chlorophyll, carotenoids, tannins, and anthocyanins.

Chlorophyll, essential for photosynthesis, is responsible for the green color of most leaves. In the fall, Chaney said nitrogen and phosphorus are slowly withdrawn from leaves for storage in twigs and branches during the dormant winter period. Gradually, production of chlorophyll stops, leading to other colors being seen.

Carotenoid pigments are responsible for yellow and orange pigments. As chlorophyll degrades, Chaney said that these yellowish colors, always present in the leaves, become apparent and give leaves part of their autumn splendor. Nutrient deficiencies, diseases or other stressors throughout the year can have the same effect on leaves.

Tannins, the waste products of cell processes, cause the brown hues in leaves. Chaney said these pigments are also always present, but only become visible when chlorophyll and carotenoids disappear.

Chaney said anthocyanins are responsible for pinks, reds, and purples in leaves, and their color is influenced by cell pH. Anthocyanins are usually not present in leaves until produced from sugars during autumn coloration. A few trees, such as 'Crimson King' Norway maple and purple European beech have reddish leaves throughout the growing season due to anthocyanins in them. Not all trees have the genes required for the production of anthocyanin pigments, and therefore only turn yellow and brown.

Chaney explained that shorter days and cooler temperatures in fall initiate leaf senescence (dying) through complex biochemical processes that promote the breakdown of cells. Cells in the phloem (tissues that conduct sugars from the leaves to other parts of the plant for maintenance and growth) collapse at the base of leaf petioles (leaf stalks) to form an abscission layer. The abscission layer is the point at which leaves will eventually break and fall off. This traps sugars in leaves, which are available for anthocyanin production and the resulting pink, red or purple colors. Xylem tissues (tissues that conduct water) remain intact longer than phloem tissues, supplying water to the leaves until they die and fall off.

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What about the best weather for fall colors? Chaney said, "Fall weather conditions favoring formation of bright red autumn color are warm sunny days followed by cool, but not freezing, nights." Chaney said rain does not wash color away, but overcast conditions do reduce light intensity and rains and winds can sweep leaves off trees early. Freezing temperatures kill or severely injure the leaves, preventing physiological processes before pigments reach their maximum development.

So, if you are a fall color enthusiast, hope for bright sunny days and cool nights in autumn.

Access the above mentioned publication at <https://www.extension.purdue.edu/extmedia/fnr/fnr-faq-5.pdf>.